Council for Development and Reconstruction

Greater Beirut Water Supply Augmentation Project Environmental and Social Impact Assessment

Draft Environmental and Social Impact Assessment

L12002-0100D - November 2012

dar al-handasah
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Greater Beirut Water Supply Augmentation Project
Environmental and Social Impact Assessment

Report

Greater Beirut Water Supply Augmentation Project
Environmental and Social Impact Assessment

Draft ESIA

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ABBREVIATIONS AND ACRONYMS

AWWA	American Water Works Association
AWW	Arab Water World magazine
BMLWE	Beirut and Mount Lebanon Water Establishment
c.	circa
^{O}C	Degree Celcius
CH_4	Methane
CDR	Council of Development and Reconstruction
CO_2	Carbon Dioxide
CoM	Council of Ministers
CN	Curve Number
DBA	Dam Break Analysis
DBO	Design Build Operate
DBOO	Design Build Own Operate
DGA	Directorate General of Antiquities
DO	Dissolved Oxygen
DoA	Directorate of Antiquities
ESIA	Environmental and Social Impact Assessment
EIA	Environmental Impact Assessment
ESMP	Environmental and Social Management Plan
FS	Feasibility Study
GBA	Greater Beirut Area
GBWSAP	Greater Beirut Water Supply Augmentation Project
GBWSP	Greater Beirut Water Supply Project
GHG	Greenhouse Gas
GIS	Geographic Information System
GoL	Government of Lebanon
ha	hectares
IEE	Initial Environmental Examination
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
IWA	International Water Association
IWRD	Integrated Water Resources Development
km	kilometer
km^2	Square kilometer
LRA	Litani River Authority

m.a.s.l	meter Above Sea Level
m	meter
m^3	cubic meter
MCE	Maximum Credible Earthquake
MEW	Ministry of Energy and Water
MoE	Ministry of Environment
MoF	Ministry of Finance
MSF	Multi-Stage Flash
N_2O	Nitrous Oxide
NGO	Non-Governmental Organisation
NE	North East
NPV	Net Present Value
NWC	National Water Council
NWSS	National Water Sector Strategy
OP	Operating Policy
O&M	Operation and Maintenance
PAP	Project Affected Person
PMF	Probable Maximum Flood
RAP	Resettlement Action Plan
RO	Reverse Osmosis
RPF	Resettlement Policy Framework
RWH	Rainwater Harvesting
s	second
SCS	Soil Conservation Service
SE	South East
SOW	Scope of Work
t	ton
TDS	Total Dissolved Solids
UFW	Unaccounted for Water
USBR	United States Bureau of Reclamation
WB	World Bank

EXECUTIVE SUMMARY

ملخص تنفيذي

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Background

To overcome increasing severe shortages in public water supply, the Government of Lebanon (GoL) through the Council for Development and Reconstruction (CDR), the Ministry of Energy and Water (MEW), and the Beirut and Mount Lebanon Water Establishment (BMLWE), has initiated the Greater Beirut Water Supply Augmentation Project (GBWSAP) to identify the most significant environmentally and socially acceptable, technically viable and economically efficient solutions to the medium and long term provision of potable quality water throughout the Greater Beirut Area. GBWSAP is complementary to the on-going GBWSP (Greater Beirut Water Supply Project) to improve short- term supplies.

In accordance with CDR policy, the Assessment complies with the structure and guidelines of World Bank Operating Policy 4.01 *Environmental Impact Assessment* for a Category A Project, as well as with the requirements of the Lebanese Ministry of Environment, as recently formalized in Decree No. 8633 of August 2012. The expectation World Bank Safeguard Policies will be triggered by the project and the proposed response is shown in the following table:

World Bank Safeguard Policy	Expectation / Response
Environmental Assessment (OP/BP 4.01)	Yes Category A ESIA being undertaken
Natural Habitats (OP/BP 4.04)	Yes Detailed Ecological Survey undertaken
Forests (OP/BP 4.36)	No
Pest Management (OP 4.09)	No
Physical Cultural Resources (OP/BP 4.11)	Yes. Site inspections undertaken Consultations held with DGA
Indigenous Peoples (OP/BP 4.10)	No
Involuntary Resettlement (OP/BP 4.12)	Yes RPF completed. RAP to be prepared.
Safety of Dams (OP/BP 4.37)	Yes Requirements discussed in the report.
Projects on International Waterways (OP/BP 7.50)	No
Projects in Disputed Areas (OP/BP 7.60)	No

GBWSAP is being implemented in two phases. Phase 1 compared dam and non-dam options and recommended Bisri dam as the Priority Scheme, while in Phase 2 a full Category A ESIA for Bisri dam is prepared. The present document is the Phase 2 of the Report.

PROJECT DESCRIPTION

The proposed Bisri Dam site is some 15 km inland from the Mediterranean coastline at Saida and 35 km south of central Beirut, at an elevation of c.395 masl. The reservoir extends for about 4 km upstream of the dam axis on Nahr Bisri, as illustrated in the Figure below. At maximum water level, 462 masl, the total storage volume of the reservoir is estimated at 128 Mm^3 and the area expected to be inundated 450 ha.

Bisri Dam and Reservoir on Nahr Bisri

Land to be expropriated and inundated on the completion of Bisri Dam is primarily agricultural in addition to pine woodland and natural vegetation.

Water quality analyses from Nahr Bisri and its tributaries show that the level of treatment required to bring water into compliance with Lebanese and international standards is only that afforded by a conventional treatment stream.

Repeated site walkovers and discussions with concerned authorities revealed the wealth of historical and cultural heritage to be affected by Bisri dam and reservoir, including a Roman-

Persian era Temple, a single-arched stone bridge, a small vaulted Maronite church, and St. Sophia Monastery.

ANALYSIS OF ALTERNATIVES

A comprehensive comparative analysis of potential solutions to the augmentation of Greater Beirut's long-term water supply has been carried out, the full details of which were presented in the Preliminary Draft ESIA. The GBWSAP ESIA has investigated a range of alternatives; non-dam alternatives, dam alternatives, in addition to the 'Do Nothing' or 'Without Project' alternative. Non-dam alternatives that have been considered are desalination, ground water, rainwater harvesting, wastewater reuse and reduction in 'Unaccounted for Water'. The Preliminary Draft ESIA also considered three dam sites other than Bisri dam; these are dam sites at Damour on Nahr Damour (two sites) and at Janneh on Nahr Ibrahim. Based on the comparative analysis, it has been recommended that Bisri dam is the priority scheme.

ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

The Table below summarises the impacts that might accrue from Bisri dam and the mitigation measures proposed for each impact.

Summary of Potential Impacts Arising from the Bisri Scheme

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
Land Take	Land taken for dam and reservoir, access roads	Unavoidable	Major	Locate reservoir to minimize land take and loss of natural landscape per unit volume impoundment.	Designer
	Loss of natural landscape	Expected	Moderate		
	Land take for `resettlement and/or relocation of PAPs	Unavoidable	Moderate	Locate reservoir to minimize land take per unit volume impoundment. Provide adequate resettlement and compensation in accordance with RPF and RAP compliant with Lebanese Law.	Designer, RAP Developer and Project Proponent
	Loss of existing communities	Not Expected	n/a		
	Loss of individual homes	Unavoidable	Moderate		
	Loss of non-agricultural business premises	Not Expected	n/a		
	Loss of productive land	Unavoidable	Major		
	Loss of temporary employment	Unavoidable	Major		
	Loss of permanent employment	Expected	Moderate		
	Loss of historic and cultural heritage	Unavoidable	Major	Salvage cultural property and reconstruct within existing communities. Avoid inundation of immoveable sites such as burial grounds. Undertake rescue archaeology.	Project Proponent
Impoundment	Additional loss and severance of access	Expected	Moderate	Create alternative access roads around the reservoir;	Project Proponent
	Increased risk of seismicity	Expected	Major	Analyze hydraulic loading to assess seismic potential and avoid areas of high risk. Design to minimise seismic loading.	Designer
	Loss of natural vegetation	Unavoidable	Moderate	Increase planting around reservoir;	Designer
	Impaired water quality from uncleared vegetation	Unavoidable	Major	Vegetation and soil to be cleared prior to inundation. Treatment plant will provide suitable process stream to ensure water delivered to GBA of potable quality.	Contractor
	GHGs from uncleared vegetation	Expected	Major	Vegetation and soil to be cleared prior to inundation.	Contractor

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Soil erosion along new foreshores	Expected	Major	Construct shoreline protection. Increase planting around reservoir.	Designer and Contractor
	Reservoir stratification	Expected	Major	Install provision for mechanical mixing where natural circulation insufficient.	Designer
Sedimentation	Creation of backwaters on tributary streams	Expected	Moderate	Promote development of wetlands. Monitor reservoir depth to assess sedimentation. Operate reservoir to minimize sedimentation build-up. Allow for sedimentation in structural design.	Designer and Operator
	Loss of capacity and sediment build-up at dam	Expected	Major		
Upper Watershed Management	Road construction opens area to non-residents	Expected	Minor	Ban land clearance for new agriculture. Restrict access to previously remote areas.	Project Proponent
	Resettlement increases water use waste generation	Expected	Minor	Adopt an integrated planning framework and a strict ESMP, and provide effective enforcement. Regulate the discharge of wastewater and the use of agrochemicals.	Project Proponent
	Social unrest due to the restriction of human activity	Not Expected	n/a	Ensure new developments prioritize the local employment.	Project Proponent and Contractor
	Loss of water quality due to evaporation	Unavoidable	Major	Promote shoreline planting and reforestation.	Operator
	Impaired water quality due to discharges above dam	Expected	Moderate	Adopt an integrated planning framework and a strict ESMP, and provide effective enforcement. Developing sewerage systems for villages throughout the upper watershed.	Project Proponent
Lower Watershed Management	Reduced non-agricultural surface water resources	Unavoidable	Moderate	Provide agricultural extension and other services to promote low water-use crops and irrigation practices. Ensure resettled communities are adequately resourced without detriment to existing communities.	Project Proponent
	Reduced water resources for existing agriculture	Unavoidable	Moderate		
	Water-use conflict	Expected	Moderate		
	Loss of stock watering points	Not Expected	n/a	None required	
	Salinization of downstream floodplain	Expected	Moderate	Provide adequate compensatory flows to leach salt build-up.	Project Proponent
	Reduced dilution of chemical residues, sewage	Expected	Moderate		
	Reduced Dissolved Oxygen downstream	Expected	Moderate	Provide for multi-level releases to avoid the discharge of anoxic water.	Designer

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
				Design for aeration downstream of dam site;	
	Scour by water released under increased head	Expected	Minor	Provide for energy dissipation from dam outflow; Provide for sediment trap and its orderly release.	Designer
Ground Water	Reverse ground water flow upstream of the dam	Expected	Moderate	Undertake hydrogeological study and modelling to assess impact on ground water levels and flow;	Designer
	Change in water table	Expected	Minor		
	Reduced downstream aquifer recharge	Expected	Moderate	Provide adequate releases to maintain recharge; Provide downstream structures to induce shallow recharge.	Designer and Operator
	Deterioration in ground water quality	Expected	Major	Promote ground water resources management.	Project Proponent
Biodiversity and Habitats	Loss of indigenous flora	Unavoidable	Moderate	Promote the colonization of shoreline trees. Provide for species rescue and relocation. Minimise disturbance of non-inundated vegetation.	Operator
	Loss of terrestrial habitats	Unavoidable	Moderate	Provide mammal-resistant fencing. Provide for species rescue and relocation. Provision safe crossing points to enable dispersal and links between fragmented populations.	Operator and Project Proponent
	Reduced downstream biodiversity	Expected	Moderate	Provide compensatory discharges to maintain downstream biodiversity.	Operator
	Build-up of weed and algal mats around spillways, etc.	Expected	Moderate	Control algal blooms by using appropriate additives (e.g. 22 kg/ha $CuSO_4$. Harvest weed and algal growth for compost, fodder or biogas.	Operator
	Disruption of flyways	Expected	Moderate	Sources of noise to be properly buffered. Planting trees to create habitat corridors; National hunting ban to be enforced as per Law 580/04.	Operator
	Reduced aquatic habitats	Expected	Major	Provide fish leats, ladders and other by-passes. Protect spawning grounds; Incorporate sensitive design, i.e. allow shallow areas for spawning, etc.	Designer
	Barrier to fish migration and loss of spawning areas	Expected	Moderate		Designer
	New habitats for migratory bird species	Expected	Moderate	Promote reforestation and areas of dense shrub.	Operator

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	New farming fish species	Expected	Moderate	Ban the introduction of exotic species such as trout, bass, tilapias, and mosquitofish. Promote the user of native species.	Project Proposal
Agriculture	Inundation of agricultural land	Unavoidable	Major	Consider stripping highly fertile soils from reservoir area and spreading on adjacent less fertile land;	Project Proponent and Contractor
	Loss of fertile soils	Unavoidable	Major		
	Loss of yet-to-be-harvested crops	Unavoidable	Major	Consider relocating the poly-tunnels and their content with no actual loss, or move when fallow.	Project Proponent
	Derogation of downstream irrigation	Unavoidable	Major	Use agricultural extension to promote low water-use crops species and irrigation practices.	Operator
	Fertilizer use upstream increases nutrient load	Expected	Moderate		
	Increased soil salinity downstream	Expected	Major	Provide compensatory discharge to leach soil salts;	Operator
Fisheries	Incompatibility of lake and river environments	Expected	Moderate	Introduce native lake fish species and encourage lake fisheries within sustainable limits. Limit water retention to maintain water quality. Ensure minimum discharges are adequate to sustain downstream fish population.	Operator
	Snagging of nets and lines on uncleared structures	Not Expected	n/a	Clear vegetation and structures prior to filling.	Contractor and Project Proponent
	Mortality of fish entering power plant	Expected	Moderate	Install screens to stop fish entering turbine intakes.	Designer and Contractor
Settlement and Resettlement	All residents in the inundated area will be displaced	Unavoidable	Moderate	Provide adequate compensation in accordance with RPF and RAP compliant with Lebanese law.	Project Proponent
	Disaggregation of communities	Not Expected	n/a	No significant communities to disaggregate. Resettlement unlikely to result in conflict as resident Lebanese PAPs will keep within their previous communities.	
	Impact on indigenous groups/lifestyles	n/a	n/a		
	Social conflict between existing residents and PAPs	Not Expected	n/a		
	Competition for resources between residents & PAPs	Not Expected	n/a	None required.	
	Particular impacts on vulnerable groups	Expected	Moderate	Provide social support to vulnerable groups. Use resettlement to aid poverty alleviation	Project Proponent

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
Public Health	Increase in water-related diseases	Expected	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Maintain water free of algae. Develop and implement an Emergency Response Procedures.	Operator
	Increase in mosquito breeding sites	Expected	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Spray mosquito breeding sites if necessary.	Operator
	Climatic changes such as increased humidity & fogs	Expected	Moderate	None.	
	HV transmission lines in proximity to housing	Not Expected	Minor	Hydropower generated likely to be utilised locally. Insufficient capacity to justify investment in long transmission lines.	
Indirect Issues	Negative impacts from increased urban development	Expected	Moderate	Adherence to coordinated sustainable development via Shoreline Development Master Plan.	Project Proponent
	Upper catchment activities limit dam efficiency	Expected	Moderate	Restrict activities on the upper watershed to those that have minimal environmental and social impact.	Project Proponent
Construction Issues	Construction site unsightliness	Expected	Moderate	Construction contractors to offer priority employment to PAPs and other local residents; Contractor to develop and implement a comprehensive Construction Environmental and Social Management Plan.	Contractor
	Increase traffic generation and exhaust emissions	Expected	Moderate		
	Noise and dust from site clearance and excavation	Expected	Moderate		
	Temporary works such as drainage diversion	Unavoidable	Moderate		
	Camp working area sewage and solid waste disposal	Expected	Moderate		
	Emissions from batching plants & power generators	Expected	Moderate		
	Increased hunting, egg collecting, live capture	Expected	Moderate		
	Social conflict between workers and residents	Expected	Minor		Contractor
	Importation of contagious diseases	Expected	Minor		
	Fuel spillage and waste oil disposal	Expected	Moderate		

ENVIRONMENTAL AND SOCIAL MONITORING

The proposed programme of environmental and social monitoring is summarized in the Table below.

Environmental Quality Monitoring Requirements

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Pre-Construction Environmental Quality Monitoring									
Surface Water Quality	Lebanese Potable Water Standards	4 locations; Nahr Barouk and Wadi Bhannine at extremities of reservoir, two other seasonal inflows	Water sampling and full laboratory analysis	Ongoing until completion of construction	Quarterly, varied to include high and low flows	To confirm background conditions for comparison in operational monitoring	Experienced surface water sampler	BMLWE	US$1,500 per sample
Rate of Sedimentation	Volume and size of sediment captured	Nahr Barouk and Wadi Bhannine at extremities of reservoir	Sediment capture behind a small weir or sediment capture pit	Ongoing	Quarterly, varied to include high and low flows	To confirm design assumption	Hydrologist	BMLWE	US$15,000 per site
Rescue Ecology and Species Relocation	Observation and rate of capture. Adaption to relocation	Reservoir area and site of relocation	Visual observation	Ongoing until completion of construction	Seasonally	To determine extent of rescue and make sure implementation strategy is implemented	Ecological surveyor	CDR	US$50,000
Rescue Archeology and Relocation	Archaeological finds unearthed and documented	Marj Bisri	Excavation, observation and documentation	Ongoing until completion of construction	Seasonally	To make sure implementation strategy is implemented	Archaeologist	DGA	US$ 120,000
	Structures removed and reconstruction	Mar Moussa	Dismantling and reassembling	Prior to construction	Monthly	To address community concern for heritage	Building conservationist	DGA	US$ 250,000
Land Expropriation and Resettlement	Progress of expropriation execution. PAP satisfaction	All lands to be acquired under the project	Expropriation and resettlement reporting	Throughout expropriation	Monthly for 6-months, then bi-annually.	To monitor progress and ensure transparency	Community Liaison Office	CDR	Included in Expropriation costs
Construction Environmental Quality Monitoring									
Site Inspection	General construction activity	All sites associated with the Bisri construction	Visual and descriptive, against check list	Ongoing throughout period of construction	Daily	To ensure compliance with good construction practice and EMP	Environmentalist with construction site experience	Construction Manager	US$ 200,000

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Complaint Investigation	Any parameter relevant to the nature of the complaint	At or in the vicinity of sites for which complaints are received	As appropriate for the parameter being monitored	As necessary	As necessary	To investigate complaints and provide a basis for redress	Environmentalist with experience of field monitoring and analysis	Contractor and Construction Manager	Depends on complaints received
Health and Safety	Absence of unauthorized public. Injuries and work days lost among workers.	All sites of construction and project related activity	Primarily visual and descriptive, against a check list. Time card records	Ongoing throughout period of construction	Monthly	To protect the public and workers in accordance with H&S BMPs	Experienced H&S site supervisor	Contractor and Construction Manager	Included in construction costs
Air Quality	Lebanese atmospheric emissions standards, fixed and mobile	Contractors' work sites and selected sensitive receptors	Visual assessment and portable air quality equipment	Dependent on source	On suspicion of non-compliance	To prevent air pollution	Site inspector	Contractor	Included in construction costs
Noise	Lebanese ambient noise standards	At selected sensitive receptors	Ambient noise monitoring equipment of approved manufacture	Over 1 hour during the working day	On suspicion of non-compliance	To prevent noise nuisance	Site inspector	Contractor	Included in construction costs
Cultural Heritage	Documented Chance Finds	Any unknown remains unearthed during construction	DGA standard procedures	As necessary	Every find DGA deem worthy of recording	To improve understanding of Lebanese and optimise relic recovery	DGA Inspector	Contractor and DGA	Depends on number of finds and delay caused
Post-Construction Environmental Quality Monitoring									
Air Quality	Stack emissions from stand-by generators	At stacks and sensitive receptors	Portable stack insertion monitors and other monitors	Over 12 hours	Every 3 months during the operating season	To prevent air pollution	Plant Engineer	BMLWE	US$ 500 per sample
Workers Health and Safety	No. of accidents and working days lost	On the dam and reservoir sites	H&S records	Ongoing	Ongoing	To monitor compliance with Operator's H&S Manual.	Operator's Health and Safety Inspector	BMLWE	Included in ongoing O&M
Public Health and Safety	No. of accidents and injuries.	Dam, reservoir and environs	Accident reports	Ongoing	Ongoing	Promote security and safety, and adequacy of signage.	Compliance with Operator's H&S Manual and EMP.	Compliance with Operator's H&S Manual and EMP.	Included in ongoing O&M
Dam Safety	Dam Safety Panel inspection reports	Dam site	Visual inspection and review of Dam Safety File	Ongoing	Every 3-5 years	To identify early warning signs of potential failure	Dam Safety Inspection Panel	BMLWE	US$ 25,000 per inspection

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Incoming Surface Water Quality	GBWSP water quality operating standards	Nahr Barouk and Wadi Bhannine inflows	Water sampling and full laboratory analysis	Ongoing	Quarterly, varied to include high and low flows	To monitor quality of incoming water	Experienced surface water sampler	BMLWE	US$1,500 per sample
Reservoir water	To check development of stratification	2 fixed sampling points within reservoir	Multiple depth sampling and on-site analyses	Seasonal	Monthly from May to October	To confirm adequacy of mixing to limit stratification	Experienced water sampler and boatman	BMLWE	US$1,000 per sample
Groundwater	Ground water flow and water quality	Selected springs and wells	- Flow gauging, water level monitoring and sampling	Ongoing	Bi-annual	To identify changes in groundwater regime	Hydrogeologist	BMLWE	US$ 3,000 per sample
Biodiversity	Diversity of species and habitats	Dam, reservoir and environs	Visual observation and survey	Seasonal	Annually for 3 years, then every 5 years	To assess fish migration and reduced biodiversity	Ecological team	BMLWE	US$ 20,000
Downstream abstraction	Adequacy of environmental flows	Downstream abstraction sites	Survey of abstractors	During Autumn	Annually	Optimise abstraction management	Agriculture extension officer	MoA/MEW	US$ 10,000
Reservoir Sedimentation	Sediment build up	Reservoir	Depth or Echo sounding	Ongoing	Annually, in May or June	To check loss of dead storage and protect intakes	Mechanical Engineer and Boatman	BMLWE	US$ 10,000
Induced Development	Adherence to Shoreline Master Plan	Surrounding lands	Enforcement of planning regulation	Ongoing	Ongoing	Safeguard investment in dam and protect water resources	Development inspector	Planning Authorities and Municipalities	No cost to project

CONSULTATION AND COMMUNICATIONS

In accordance with CDR policy on public participation, which generally follows that of the World Bank and other international funding agencies, a *Consultations and Communications Programme* (C&CP) detailing the steps that would be followed throughout the project, from site selection through to commissioning has been drafted.

At the outset of the EIA process, a series of Scoping sessions was held including an Institutional Stakeholders session, meetings in the vicinity of the three potential dam sites, and two separate sessions at Hadath Municipality and Beirut Municipality.

At the present time, the consultation sessions are expected to be as listed in the Table below. Details of the venues, dates and times are subject to confirmation.

Proposed Public Consultation Sessions for ESIA Findings

Proposed Audience	Proposed Venue
Institutional Stakeholders	CDR Central Beirut
Chouf caza PAPs and other stakeholders	Moukhtara or Mazraat El Chouf and/or Mazraat El Dahr
Jezzine caza PAPs and other stakeholders	Midane and/or Bhannine
Southern Beirut water consumers	Hadath

The project proponent will continue consultations throughout the period of land expropriation and beyond from a Project Information Centre (PIC). The RPF and RAP with the ESIA will be made publicly available at the PIC, via the Internet on the World Bank's *Infoshop* website or equivalent portal of other funding agency, and on CDR's website.

SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1 Project Background and Rationale

Lebanon is often perceived to have relatively abundant surface and ground water resources, but while better off than its neighbours, 35th out of 186 countries[1] ranked by severity of water stress[2], annual water availability is less than 1000 m^3 per capita.

The majority of Greater Beirut's water is supplied by the karstic limestone aquifers of Mount Lebanon from the cavern outflows at Jeita and piped to the capital via the Dbaiyeh Treatment Plant. Other significant sources include wellfields at Makhada, Nahr el Kalb, Antélias and Damour, individual wells scattered among the southern Beirut suburbs, and spring sources such as Kachkouch and Ain Ed Delbe. Supplies are inadequate to meet demand; intermittent during the winter months, while during the summer many consumers receive water for just 3 hours each day. The majority of households and businesses have alternative supplies, and many recently constructed buildings have no mains connection, preferring to rely upon private wells within the building plot, and to buy bottled water for drinking and cooking. In designated areas private wells are illegal as there is a long-standing moratorium on drilling, but the procedures for permitting and abstraction licensing are not implemented and there is no compliance monitoring or enforcement. There is also a well-developed and profitable trade in the delivery of tankered water, often taken from non-potable sources subject to saline intrusion and/or wastewater infiltration.

The Central Administration of Statistics (CAS) predicts the population of Greater Beirut will grow from 2 million in 2010 to 2.2 million in 2025 and 3.5 million by 2035[3]. The Ministry of Energy and Water (MEW) estimates the water deficit of 117 Mm^3 for 2009 will increase to 190 Mm^3 by 2025 and 240 Mm^3 a decade later. The reasons for this include:

- Insufficient and often inefficient source development;
- Inefficient, limited and aged transmission and distribution networks;
- Absence of volumetric metering and consumption-related tariff structure;
- Over-abstraction of ground water, resulting in saline intrusion;
- High proportion of non-revenue water and poor cost recovery;
- Poor resources allocation, abstraction licensing and monitoring;

[1] *Maplecroft Global Risk Portfolio*, 2011. Syria 17th, Jordan 11th, Israel 8th, Egypt 9th, KSA 4th

[2] Water stress occurs when availability falls below 1,700 m^3/year/head of population. Falkenmark and Lindh, *Climate Change 2001: Working Group II: Impacts, Adaption & Vulnerability*. UNEP/WMO, 1976.

[3] Central Administration of Statistics, 2010.

- Uncontrolled discharges of industrial and domestic wastewater;
- Uncontrolled irrigation and over-fertilization;
- Lack of investment in modern water infrastructure;
- Lack of institutional capacity; and,
- Lack of public awareness, consultation and participation.

Notwithstanding this, realisation that Greater Beirut and other areas face such problems is not new. Since at least the 1950's, successive governments have invested in a range of alternative sources including improved spring capture, increased ground water abstraction, small hill lakes and impoundment reservoirs.

To secure short and medium term water supplies, the Government of Lebanon (GoL) through the Council for Development and Reconstruction (CDR), MEW and Beirut and Mount Lebanon Water Establishment (BMLWE) has initiated the Greater Beirut Water Supply Project (GBWSP) under which the 50 Mm3 of Nahr Litani water from Qaraoun Lake and Awali-Jezzine ground water currently delivered each year to the Joun hydroelectric power plant and thereafter discharged to Nahr Awali and on to the sea, will in future be diverted to a new treatment facility at Ourdaniyah for onward distribution to consumers[4]. GBWSP comprises three prime components:

1. Bulk water infrastructure including transmission tunnels and pipelines, the treatment plant, and bulk storage reservoirs at Hadath and Hazmieh;
2. Sixteen supply reservoirs, up to 200 km of distribution pipelines, thirty bulk meters, and 200,000 household meters; and,
3. Establishment of a Project Management Unit, technical assistance, capacity building, and studies proposed by MEW's 2010 National Water Sector Strategy (NWSS).

GBWSP sets high aspirations, and while many will be met or exceeded, the lack of public confidence in government institutions and current conditions, such as high traffic loading on distribution systems in Beirut highways, will require targets for reduced leakage and other sources of non-revenue water, and consequently improved cost-recovery, to be lowered.

Notwithstanding the GBWSP benefits, it is prudent for GoL to now look forward and assess the means by which water supply may be augmented as the capital's population expands to 3 million and beyond. The present project, the *Greater Beirut Water Supply*

[4] With the drop in Litani River flow due to increased upstream extraction and global warming, the 50 Mm^3 from Qaraoun may not be sustainable. Some losses from the 50 Mm^3 will be made up from ground water seepages to the unlined Awali Tunnel.

Augmentation Project (GBWSAP) therefore evaluates options by which this might be achieved.

1.2 The GBWSAP ESIA Team

The GBWSAP Project Proponents on behalf of GoL are:

- Council for Development and Reconstruction (CDR);
- Ministry of Energy and Water (MEW); and,
- Beirut and Mount Lebanon Water Establishment (BMLWE).

The GBWSAP Project Coordinator is:

Mr. Assem Fidawi at CDR, whose registered place of business is:
PO Box 3170/11 Tallet El Serail, Riad El Solh, Beirut.

The Project Proponents have entrusted the preparation of the Environmental and Social Impact Assessment (ESIA) to:

Dar Al-Handasah (Shair and Partners), whose registered place of business is:
PO Box 11-7159, Verdun Street, Beirut. Tel: 961 1 790002.

The composition of the Dar Al-Handasah GBWSAP ESIA Team is shown in Table 1.1.

Table 1.1: Key ESIA Team Members

Name	Position
Mr. Fouad El-Khoury	Project Director
Dr. John Davey	Team Leader - Environmental Planning and Management Specialist, Hydrogeologist
Ms. Riwa Elderbas	Environmentalist and Public Consultation Specialist
Dr. Suhail Srour	Consultation Moderator and Technical Advisor
Dr. Nassim Abi Fadel	Dam Engineer
Mr. Philip Nassar	Dam Geologist
Mr. Elie Abourejaili	Water Engineer and Alternatives Benchmarking
Ms. Fay Mushantaf	Environmental Health and Safety Specialist
Dr. Naji Berri	Catchment Management Specialist
Dr. Dunia Tabet	Hydrologist and Water Management Specialist
Dr. Faten Nazzal	Water Quality Specialist
Mr. Khalid Ghannam	Coordination with Municipalities/MoF Cadastre
Dr. Mounir Abi-Said	Ecological Survey Sub-Group Leader
Ms. Alicia Obeid Jammal	Social Survey Sub-Group Leader

1.3 Project Scope

GBWSAP builds upon the objectives and expected achievements of GBWSP, funding for GBWSP is currently being finalized and construction will start imminently. GBWSAP is being implemented in two distinct phases:

Phase One

The technical, environmental, social and economic review of:

1. Potential non-dam water supply schemes; desalination, increased ground water exploitation, rainwater harvesting, wastewater reuse and reductions in UfW; and,
2. A comparative assessment of four previously identified dam and reservoir impoundment schemes; Bisri Dam on Nahr Bisri; Damour East and Damour West Dam on Nahr Damour, and Jannah Dam on Nahr Ibrahim.

Phase Two

A full Category A ESIA of the selected Priority Scheme for Greater Beirut, and a Resettlement Action Plan.

Phase One project deliverables included:

- A Consultation and Communications Programme (February 2012);
- An Annotated ESIA (March 2012);
- Preliminary Draft ESIA and Technical & Economic Review (September 2012); and,
- Resettlement Policy Framework.

The September 2012[5] report included a comparative study of non-dam and dam options, from which CDR determined the Phase Two ESIA, should be undertaken on Bisri Dam. Following CDR policy, this is prepared in accordance with World Bank Operating Policy 4.01 *Environmental Impact Assessment* for a Category A Project, other World Bank safeguard policies, and the requirements of the Ministry of Environment, particularly Decree No. 8633 of August 2012, *Fundamentals of Environmental Impact Assessment*, which entered the statute book during GBWSAP implementation.

The results of GBWSAP Phase One afford GoL the opportunity to illustrate to GBA residents, potential funding agencies and others they have executed a wide-ranging review of all practical alternative solutions for water supply augmentation, and that the

[5] *GBWSAP Preliminary Draft ESIA*. Dar Al-Handasah (Shair and Partners)
Doc. No. L12002-0100D-RPT-PM-01 Rev1, September 2012.

priority scheme will, subject to further investigation and engineering design, be technically feasible, environmentally responsible, socially-acceptable and cost-efficient.

The GBWSAP Phase Two ESIA provides for the identification of potential environmental and social impacts arising from the design, construction and life-time operation of the scheme and presents the mechanism to ensure it is implemented without excessive environmental degradation and human suffering.

1.4 ESIA Report Structure

The structure and content of the Draft ESIA are drawn from the recommendations of World Bank Op.4.01, Lebanese Decree 8633 and the World Commission on Dams, amended as necessary to reflect the way issues of greater or lesser significance need to be discussed.

Section 2 describes the different components of the Bisri project, its location and the proposed construction, while **Section 3** outlines the legal and regulatory framework within which it will be executed.

Sections 4, 5 and 6 respectively discuss the physical, biological and socio-economic conditions throughout the project site and its surroundings, while **Section 7** identifies the potential for environmental and social impacts, be they permanent, primarily the result of scheme location and design, temporary, resulting from construction activities, or longer-term operation, occurring and/or cumulating throughout the life of the project.

Section 8 summarises the analysis of scheme alternatives and the reasons those less favoured than Bisri were considered unsuitable at the present time.

Section 9 is the Environmental and Social Management Plan for the project, presenting for the impacts identified previously, proposals for their avoidance, mitigation or the management of residual impacts and associated risks to environmental sustainability and human wellbeing.

Finally, **Section 11** gives details of the GBWSAP Communications and Consultation Programme and the results of public consultations undertaken during both Phases One and Two of the project.

SECTION 2

PROJECT DESCRIPTION

2. PROJECT DESCRIPTION

2.1 Introduction

This chapter of the ESIA details the project location, what it is proposed to construct, the preparatory investigations that have been completed, and the expected costs.

The potential for dams in Lebanon has long been recognised, **Section 2.2** outlines the previous studies contributing to the present proposals for Bisri Dam, while **Section 2.3** summarises the reasons why the project proponents selected Bisri over other dam sites to be the GBWSAP priority Scheme.

Section 2.4 defines the location of the project and the primary characteristics such as dam and reservoir dimensions, and the storage volumes and inundated areas corresponding to the different design water levels. **Section 2.5** summarises the proposed design for Bisri Dam insofar as the present scheme is subject to amendment as the design process continues.

Finally, **Section 2.6** presents available cost information, again subject to confirmation on completion of detailed design.

2.2 Previous Studies

Prefeasibility studies and field investigations in the Awali catchment were performed during 1954, 1974 and in early 1980's. From June 1994 to April 1995, Lebanese consultants, Dar Al Handasah (Nazih Taleb and Partners) working with ECI, a division of Frederic R. Harris[6], completed feasibility studies and site investigations.

The April 1995 report was updated by Nazih Taleb in January 2011, and included a review of the hydrological basis of the Bisri scheme, reservoir sedimentation, water supply yields and cost estimates.

Bibliographical references for these studies and other sources of relevant information utilized during preparation of the ESIA are given in Appendix A.

2.3 Selection of Bisri Dam as the GBWSAP Priority Scheme

As explained in Section 1.1 above, the GBWSAP ESIA team has previously undertaken a comparative study of three dam sites, from which the project proponents concluded Bisri

[6] Frederic R. Harris has since been absorbed into the AECOM Group.

to be the priority scheme. While the results of this study are discussed in Chapter 8 Analysis of Alternatives, in the present context of project description it is useful to recall the prime reasons for their decision.

From the outset, Bisri had two major advantages:

- The volume of the reservoir and its annual recharge is sufficient to meet the predicted needs of Greater Beirut to 2030 and beyond; and,
- The Bisri-Awali valley is located such that the scheme can utilise GBWSP transmission lines, treatment plant and bulk storage reservoirs, thus maximizing both water supply efficiency and the return on investment.

In addition to having the lowest cost per unit volume of water delivered to Greater Beirut, Bisri is also of a size that will allow cost-effective generation of hydroelectric power. The location of Bisri reservoir relative to GBWSP facilities is shown in Figure 2.1.

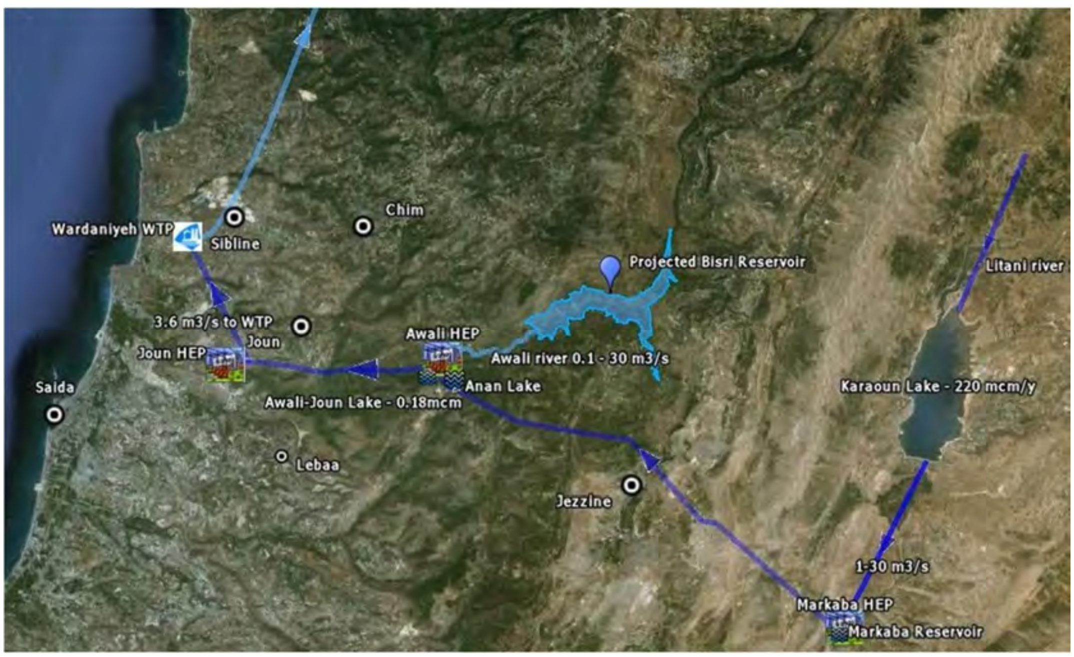

Figure 2.1: Location of the Bisri Scheme Relative to GBWSP Facilities

The Damour West reservoir storage was one-third that of Bisri. While supporters of Damour East claimed a reservoir volume approaching that of Bisri, the assessment concluded that excessive land take, high lateral leakage, and the potential for rock falls were among the prime disadvantageous. Also, any dam on Nahr Damour will have limited interface with GBWSP, increasing both capital and recurrent costs.

Janneh, designed to serve both Greater Beirut and Jbail/Kesrouane, is on a major karstic aquifers to which there will be substantial leakage, the nature of which is subject to intense controversy. Storage capacity is again about one-third that of Bisri, and the transmission of the 50% of supply destined for Greater Beirut was seen to be excessively expensive.

2.4 Project Location and Prime Characteristics

The site currently proposed for Bisri Dam is in the Nahr Bisri Valley some 15 km inland from the Mediterranean coastline at Saida and 35 km[7] south of central Beirut, at an elevation of c.395 masl. The reservoir extends for about 4 km upstream of the dam axis on Nahr Bisri before forking northwards along Nahr Barouk and southwards along Wadi Bhannine, as illustrated in Figure 2.2. At maximum water level, 462 masl, the total storage volume of the reservoir is estimated at 128 Mm^3 and the area expected to be inundated 450 ha.

Figure 2.2: Bisri Dam and Reservoir on Nahr Bisri

In preparing the present study, geographical coordinates were taken from the 2011 Updated Feasibility Study diagrams and via GIS superimposed onto a recent satellite image. These diagrams were the same as those in the 1995 reports, and that they or the base maps were erroneous was evident from stretches of the river falling outside the reservoir area and the shoreline water level crossing steeply-dipping contours. To resolve this, the ESIA has taken the topographic contour corresponding to the maximum water level to equate to the reservoir shoreline. The extent of inundation is therefore

[7] Measured by a straight line from Najmeh Square

somewhat different to that shown in previous reports, although the change in overall volume is unlikely to be significant. The original and revised reservoir shorelines are shown on Figure 2.2.

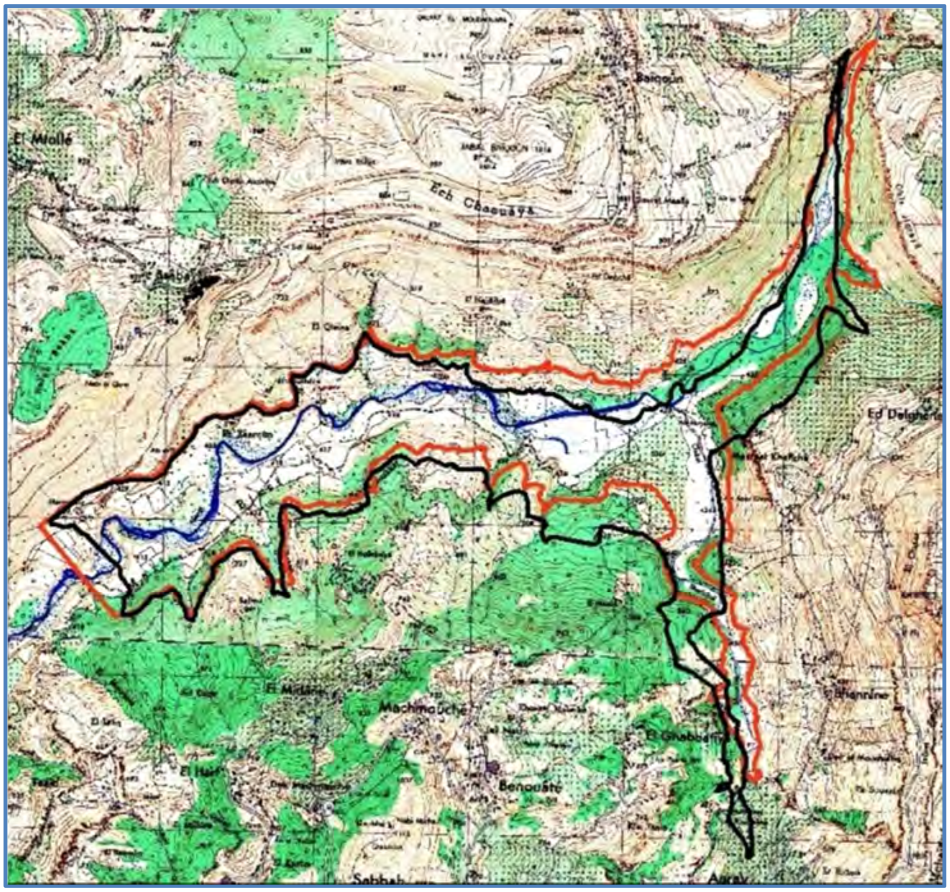

Figure 2.3: Original (black) and Revised (red) Bisri Reservoir Areas

Table 2.1 summarises the primary characteristics of Bisri dam and reservoir as conceived in the 2011 report. Arising from inconsistencies such as that cited above, the ESIA Consultant obtained the most recent rectified topographic maps and established a terrain model from which areas of inundation and storage volumes can be determined for any given water level. The results for Bisri water levels cited in the 2011 report are included in Table 2.1.

Table 2.1: Primary Characteristics of Bisri Dam and Reservoir

Dam Characteristics	
Catchment Area	Approx. 215 km^2
Length of Reservoir	c.6 km +2 km branch
Width of Reservoir	c.550 m
Type of Dam	Earth with RCC section
Maximum Height	74 m
Crest Length	790 m
Crest Width	10 m
Upstream Slope	1H:0.4V
Downstream Slope	1H:0.4V
Continuous Outflow	6.7 m^3/sec
Hydropower Capacity	1.4 MW

Elevations and Areas	
River Bed Elevation	395 masl
Dam Crest Elevation	469 masl
Max Water Level	462 masl
Inundation at Max WL	424 ha
Storage at Max WL	126 Mm^3
Normal Water Level	456 masl
Inundation at NWL	387 ha
Storage at NWL	102 Mm^3
Min Water Level	420 masl
Inundation at Min WL	104 ha
Storage at Min WL	8.6 Mm^3

2.5 Proposed Hydrological Design

The approach taken by the 2011 Feasibility Update to dam design is as discussed below.

2.5.1 Climate and Meteorology

According to the 1995 feasibility study, climatic stations located within and/or in the vicinity of the basin area were used to determine mean monthly and annual rainfall. Because of missing data from these stations, new stations were established in the recent years. Therefore, both the old and new stations[8] are used to update the data for design.

2.5.2 Precipitation

Using the Thiessen-polygon method, mean annual precipitation was calculated for the old and new stations, the result 1,294 mm and 1,107 mm respectively, suggesting a 15% reduction in precipitation has been observed in recent years. Comparing the mean annual precipitation of the old stations to the one planimetered from the national isohyet map (FAO 1973) that takes into account the orographic effects of the surrounding mountains, there is a deviation of about 1%, considered to be insignificant. The adopted design rainfall value is obtained by arithmetically averaging the results over 17 years. These monthly results are obtained by conducting a frequency analysis using the Gumbel distribution method. Neither the use of such a method was justified by the study, nor

[8] The old stations are: Ain Zhalta (512), Kfar-Nabrakh (514), Jdeidet-ech-Chouf (516) and Jezzine (519), whereas the newly established three stations are: Jezzine, El-Barouk-Fraidis and Jbaa-ech-Chouf.

would the arithmetic averages give the best estimates for real averaging over the watershed. Further investigations would therefore be undertaken.

2.5.3 Evaporation

The two weather stations nearest to Bisri dam site are Jezzine, about 6 km southeast, and Kfarnabrakh, some 15 km north east. Kfarnabrakh was selected by the feasibility study over Jezzine and gave a value for evaporation of 718 mm/year. Applying the Class A Pan method to the nearer Jezzine data gave a value of 1486 mm/year, similar to the estimates using the IWMI modeling program, as shown in Table 4.8 below.

Table 2.2: Evaporation Data for Bisri Dam Site

Evaporation (mm/month)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
Kfarnabrakh (1955-1971)	29.5	34.5	45.7	58.0	71.0	85.2	83.5	87.6	67.2	63.3	52.2	39.9	718
IWMI*	41.4	53.7	77.4	113.7	149.4	184.5	195.0	177.9	144.0	100.5	64.2	42.3	1,344
Bisri (Class A Pan)	46	60	98	136	176	199	202	185	152	114	70	80	1,486

Source: http://www.iwmi.cgiar.org/WAtlas/Defaultaspx.

2.5.4 Hydrometric Data

Bisri Bridge gauging station 1.3 km downstream the proposed dam site has a catchment area of 222 km^2, comparable to the dam catchment of 215 km^2. The stream-flow values from this station are therefore used by the feasibility study without adjustment. One set of recorded values is taken for a span of 30 years (1953-1983) and the other for another 20 years (1989-2009). A reduction of 22% is observed in the river flow for the last two decades. This is higher than the reduction in rainfall because upstream abstraction may also contribute to the reduction in flow. Further investigations and the statistical significance of this reduction should be undertaken.

The 1995 and 2011 Feasibility studies reported that drought years with a return period of 10-15 years historically provided as little as 60 Mm^3 annual runoff, although this dry-year figure was not supported by any frequency analysis. Furthermore, the discrepancy between Bisri (134/215) and Damour (172/210) specific yields, lower for Bisri site, despite the fact that both basins are reported to have comparable average annual rainfall and similar infiltration capacities, also required further investigation.

2.5.5 Flood Estimation

The design peak discharge used for the design of Bisri dam spillway is 3,110 m^3/s[9], whereas the proposed diversion peak flood flow during construction period is set to 440 m^3/s, corresponding to the 25-year return period. Neither the flood flow nor the return period criteria were justified in the feasibility studies. Considering how critical flood flow estimation is in dam design, the following concerns are highlighted:

- The reports provide no justification for the use of Gumbel distribution for discharge frequency analysis;
- The rainfall temporal distribution is based on data that do not match any well-known storm distribution method, such as SCS type II;
- The report suggests a Curve Number (CN) using the SCS method, of 75 to 85; which is increased to 88 to 94 for the maximum soil moisture condition. A value of 90 is adopted for the PMP-PMF studies.

2.5.6 Sediment Yield

Only two years' data are available for calculating river sediment load. This is 800 $t/km^2/yr$, to which 200 $t/km^2/yr$ has been added to represent the estimated bed load. Over a 215 km^2 basin area, a total of 8 Mm^3 of sediments are therefore expected to accumulate in 50-year-reservoir operation.

Particle-size analysis of the collected sediment showed it to primarily comprise sand, reflecting the extent of outcrop of the Chouf Formation. However, much of the present river bed is gravel and cobbles, and further attempts should be made to accurately capture bed load prior to detailed design. Allowance should also be made for rock-fall from the valley sides.

2.6 Proposed Dam and Reservoir Construction

Feasibility Study geotechnical investigations show the Bisri dam site to be underlain by up to 30 m of recent alluvial clastics over some 90 m of plastic clays with occasional coarser lenses. The clays are lacustrine in origin, the lake forming behind an ancient landslip that once blocked the valley below Anane. As the lake filled the blockage was eventually overtopped, leaving the present valley profile.

[9] Five methods were used in the studies to estimate the design flow of the spillway: 1] analysis of historical floods in northern Lebanon, 2] extrapolation of 1971 historical floods in Bisri that took away the gaging station, 3] several- day-storm recorded in Jezzine, 4] statistical method of discharge and 5] PMF and PMP method for the spillway design flow.

The flanks of the dam site comprise different materials. To the left, the dam will abut the fine-grained and friable sandstones of the Chouf Formation (C1), while the right abutment will be on the fractured and well jointed limestones and marls of the Abieh Formation (C2a). The active Roum Fault passes beneath or in close proximity to the dam site beneath the alluvium and clays. As a result of differences in geology between the two abutments and the risk of seismic activity, the PD ESIA recommended the dam design consultant review the present dam site relative to others upstream offering potentially more equable conditions.

Bisri dam as presently conceived comprises an earth embankment with a rolled compacted concrete (RCC) section for the spillway, as illustrated in Figure 2.3[10]. The proposed earth embankment will comprise seven zones as follows:

- Shell and transition zones on the upstream side of the dam, followed by the core sloping upstream from the dam centre;
- The filter and chimney drain with transition and shell zones directly downstream of the core;
- The upstream face will be covered entirely with riprap for slope protection;
- The interface with the RCC section will be a continuation of the upstream zones across the upstream face of the RCC.

[10] The dam construction diagrams are scanned from the 2011 *Update Feasibility Report*, which in turn took them from the 1995 Feasibility Report, hence their limited reproducibility. To aid clarity, they are also given in Appendix C herein at a larger scale.

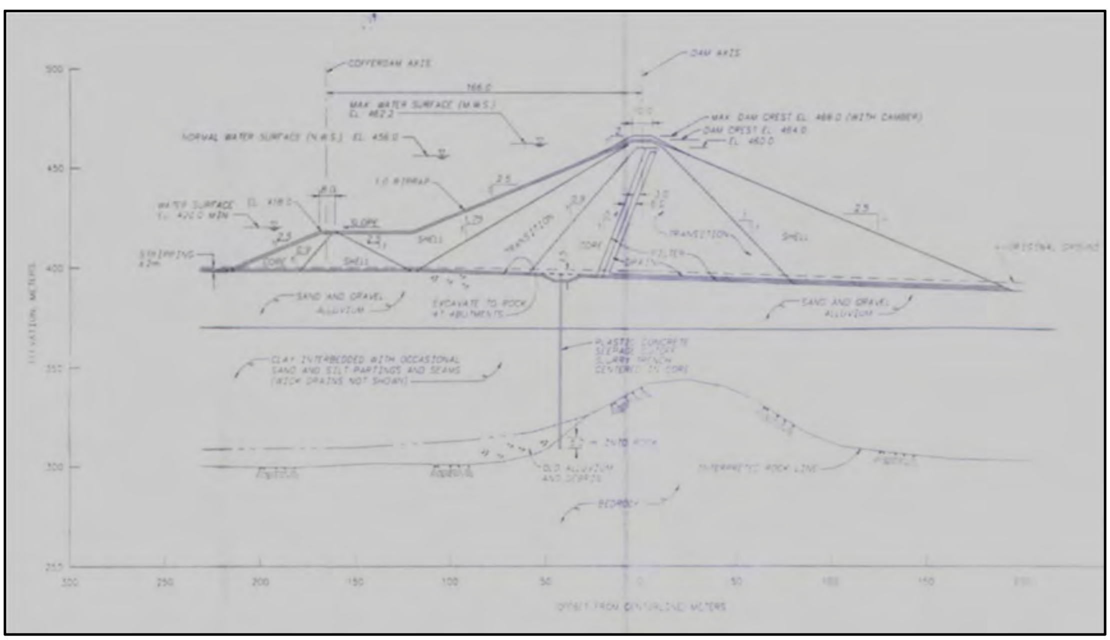

Figure 2.4: Proposed Construction Detail for Bisri Dam

The Feasibility study identified a number of stability issues to be addressed during dam design:

- Potential liquefaction of the granular bed-load;
- The possibility of 3m vertical movement, and allowance for horizontal slippage;
- Maximum Credible Earthquake (MCE) settlement of 5m; and,
- An expected transverse crack in the left abutment.

In the reservoir, where the left bank is mostly made up of sandy rocks and intersected by a series of faults, additional stability measures may be required to prevent rock falls.

In taking account of these issues the proposed dam design adopts measures that include, foundation on fresh or only slightly-weathered rock, the installation of wick drains and stabilizing berms, densification by vibro-compaction, slush grout or shotcrete to scale open cracks, the right abutment to be constructed above an anchored reinforced concrete slab, areas of erodible rock below the shells covered by filters and drains, the embankment drained by a combination of a chimney drain and blanket drain, and the RCC section by a vertical drain.

Measures to limit seepage include:

- A plastic concrete slurry wall fully penetrating the sandstone and embedded into the underlying limestone under the left abutment;
- A 3-line grout curtain along the RCC spillway;
- A deep cut-off wall comprising a slurry trench embedded 5 m into rock to prevent leakage via deeper old alluvium and rock debris;
- Grouting of the right abutment;
- Grouting to a depth of 8 m below the grout cap under the clay core of the embankment and a three-line grout curtain to a depth of 50 m.
- A clay blanket 45 m deep from the embankment core beneath the upstream section;
- In the reservoir above the dam, a synthetic geo-membrane pinned to the exposed rock overlying the Mdairej Formation cliff.

Diversion of river flow during construction will be via cofferdam and conduit along the left bank, the diversion structures a cut-and-cover tunnel on rock beneath the dam embankment and RCC section.

The majority of the construction materials are expected to be obtained from within the reservoir area. For the volumes of materials required, a large quarry to win the bedrock of the valley slopes will be excavated. For the RCC, excavations in the alluvium will include cone-crushers, screen decks, and conveyors to prepare and stockpile sufficient volumes to minimise delays during emplacement.

For monitoring dam safety during and after construction, piezometers, inclinometers, movement monitors, seismographs and seepage monitors are proposed.

In preparing this report, the ESIA team's dam specialist raised significant concerns about the applicability of the proposed design to prevailing site conditions. Some of these concerns are beyond the scope of environmental and social assessment, but on the basis that if left unmitigated they may contribute to the ultimate impact of structural failure, they are summarised below and discussed in greater detail in Appendix C.

- The core should be continuous over the length of the dam and the spillway constructed as a separate structure to prevent separation from the RCC abutment under seismic loading;
- During construction the clay deposits should be treated by vertical drains to permit the dissipation of pore water pressure and the greater part of settlement to occur prior to commissioning;
- Grouting the limestones dipping into the right abutment cannot eliminate leakage as the limestone, a geo-membrane liner will not prevent leakage through the limestone sub-crop, and a clay liner would be at risk of failure by piping erosion;
- The 3-year construction period is considered unrealistic. Given the extensive foundation treatments and likely delays during the rainy season, a 5-year programme will be more realistic.

Of particular concern was that boreholes along the right abutment recorded a total loss of drilling fluid. Since the karst limestones extend some 1.5-2 km upstream, the PD ESIA recommended alternative dam locations upstream, where geological conditions may be more equable, be considered.

2.7 Estimated Costs

The 2011 updated feasibility report included a detailed revision of expected project costs. For a dam at the selected location with a crest elevation of 469 masl, giving a storage volume of 128 Mm^3, the total cost was estimated at US$271 million, of which $197 million are contractors' costs, $39 million for contingencies, and $35 million for engineering, the latter including design, tendering, contract supervision and administration. Of the total sum, $4 million is for a small hydropower plant[11] with a capacity of 1.4 MW.

[11] Small hydropower plants with a capacity of 1-10 MW are considered small.

Specifically excluded from the cost estimate were the conveyance of water to the treatment plant, the cost of water treatment, and onward conveyance for distribution around Greater Beirut. These items are expected to be provided under GBWSP for the water coming from Joun, additional carrying and treatment capacity, under GBWSP or subsequently GBWSAP, will be needed.

Also excluded from the 2011 cost estimate was land expropriation not only for the dam and reservoir, but also that for the hydroelectric plant, access roads, and other minor items. At the current time, the majority of construction materials are expected to be obtained from workings located within the reservoir area and largely submerged on completion. Construction labour camps, site offices and contractors' offices, materials processing, batching and fabrication yards and storage areas are also expected to be contained within the reservoir area and hence necessitate no additional expropriation.

Apparently excluded from the costs are in addition; land clearance prior to filling, additional site investigations and studies prior to the issuing of final design drawings, and reservoir slope protection.

The PD ESIA tentatively estimated land expropriation at approximately US$ 98 million. The GBWSAP Phase two studies investigations include land parcellation and ownership, and a socio-economic survey, the full results of which will be presented in a Resettlement Action Plan, the final deliverable of the project.

Also not included in the current estimates are the costs of mitigating environmental and social impacts other than those associated with resettlement, such as the relocation of Mar Moussa Church, and of the non-indigenous residents of the Gheith menagerie[12]. Further details on environmental and social costs are given in Section 9 herein.

[12] In the interests of animal welfare and conservation, internationally endangered species from the menagerie will be better resettled outside Lebanon.

SECTION 3

POLICY AND LEGISLATIVE FRAMEWORK

3. POLICY AND LEGISLATIVE FRAMEWORK

3.1 Introduction

This section provides an outline of the existing policy and legislative framework under which the Greater Beirut Water Supply Augmentation Project (GBWSAP) will be implemented.

Section 3.2 provides a brief overview of the general framework related to environmental law; while **Section 3.3** reviews with the institutional framework under which the GBWSAP is being pursued. From these, **Section 3.4** outlines the approach adopted in the preparation of the present Environmental and Social Assessment in the context of existing legislative and institutional framework, including the expected application of World Bank Safeguard Policies.

Given the nature of the project, **Section 3.5** separately discusses the provisions of World Bank Operational Policy, *OP.4.37, Safety of Dams* which will span the Bisri project from design to construction and on through the ultimate life of the project to decommissioning.

3.2 Legislative Framework

3.2.1 Existing Lebanese Legislation

When Lebanon initiated its reconstruction and development drive after fifteen years of civil unrest and invasion, the majority of the projects were evaluated on the basis of technical and economic feasibility with little consideration of potential environmental and social impacts. Without adequate economic resources to finance the entire reconstruction and rehabilitation process, Lebanon had no alternative but to rely upon external funds granted by international donors such as the European Commission, World Bank and unilateral donors for whom projects had to be environmentally assessed as a prerequisite for funding.

Subsequently, Draft Decree No. 444 of 2002 defined the binding principles to which all public and private projects are subject in evaluating the impacts projects have on the environment. In accordance with Article 23, all projects are required to undergo an Environmental Assessment, for which the regulatory authority is the Ministry of Environment (MoE). Although the Draft Decree was for many years not passed by the Council of Ministers (CoM), the Ministry influenced project proponents to abide by its requirements. It was eventually passed in August 2012, during the currency of the present project, becoming Decree No 8633, *Fundamentals of Environmental Impact*

Assessment. The EIA Procedure under Decree No 8633 is illustrated in Figure 3.1 and an unofficial English language translation is given in Appendix B. As in most other countries, Lebanese EIA procedures offer projects three paths to approval:

- Those that are small in scale, socially beneficial and impart no significant environmental impact may be approved without further assessment;
- Those expected to impart significant impact, such as traffic congestion, energy and water consumption, solid or liquid waste discharge, and noise or air pollution, are required to undergo EIA against a Scope of Work and Terms of Reference set out in a Scoping Report, itself approved by the Ministry prior to EIA commencement; and,
- Projects for which the nature or scale of impacts is uncertain undergo Initial Environmental Examination (IEE) upon review of which MoE decides whether or not to call for a full EIA.

For GBWSAP, a preliminary draft ESIA has been already prepared as a comparative study between the different alternatives considered to identify the priority option based on an environmental, social, economic and technical assessment. The Project Proponent has selected Bisri Dam to be the Priority Scheme which is the subject of the present draft ESIA.

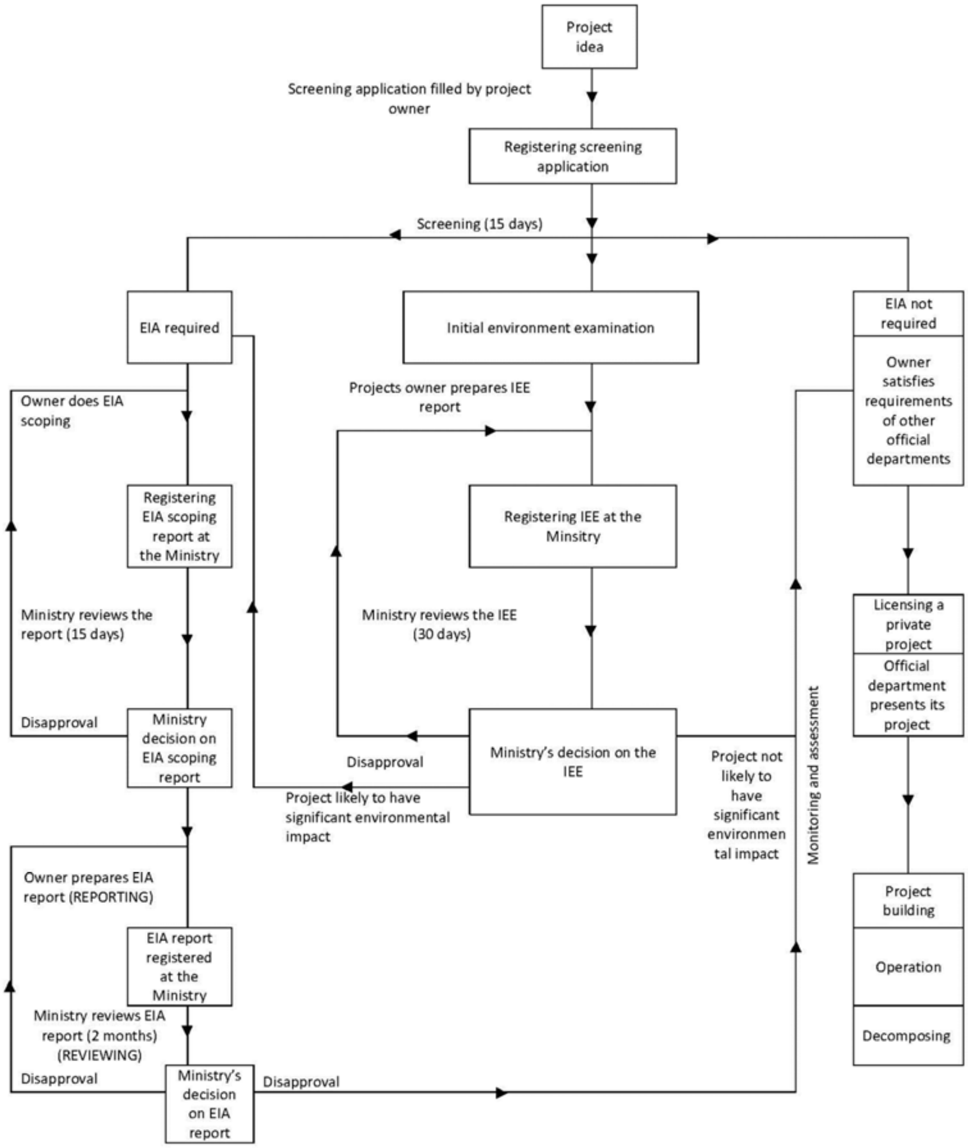

Figure 3.1: Environmental Assessment Procedure in Lebanon

The need for environmental protection has long been recognised by the Lebanese authorities and a large number of parliamentary Laws, Council of Ministers' Decrees and Ministerial Decisions and Orders are available for enforcement. Those most pertinent to GBWSAP are listed in Table 3.1.

Table 3.1: Selected Lebanese Environmental and Water Resources Legislation

Protection through Planning, Land Use and General Exploitation

Document	Date	Subject	Responsible Ministry
Law	07.01.1949	Forest Protection	Agriculture/Environment
Law	09.11.1951	Soil Preservation	Agriculture
Order No. 69	09.09.1983	Urban Development	Public Works
Order No. 2/89	05.01.1989	Urban Development	Public Works
Law No. 85	07.09.1991	Flora and Fauna Protection (Forest Code)	Agriculture/Environment
Decision No. 1/42	01.03.1993	Tree Cutting and Felling	Agriculture/Environment
Decision No. 108/1	12.09.1995	Cedar Seeds and Plants	Agriculture
Decision No. 92/1	27.02.1996	Medicinal and Aromatic Plants	Agriculture
Law No. 558	24.07.1996	Forest Code	Agriculture/Environment
Decision No. 90/1	19.11.2000	Construction in River Basins, etc.	Environment
Law No. 444	29.07.2002	Environmental Code	Environment
Decree No.	August 2012	Fundamentals for EIA	Environment

Protection from Pollution

Document	Date	Subject	Responsible Ministry
Decree No. 8735	23.08.1974	Pollution by Solid & Liquid Wastes	Industry/Environment
Law No. 64	18.08.1988	Pollution from Hazardous Wastes	Industry/Environment
Decision No. 52/1	29.07.1996	Air, Water and Soil Pollution	E&W/Environment
Decision No. 8/1	01.03.2001	National Standards for Environmental Quality	E&W/Environment
Law No. 341	06.08.2001	Transport Exhaust Emissions	Transport

Laws Pertaining to Water Resources

Document	Subject	Content
Order No. 144 of 1925	Protection of Surface & Ground Water Resources	
Decision No. 144/S of 1925	Public Property	Defines publically-owned water resources
Decision No. 320 of 1926	Water Usage	Defines water usage and allocation
Decision No. 3339 of 1930	The Law of Real Estate	Water springs that cannot be used for the public benefit can be owned by individuals.
Decree No. 2761 of 1933	Protection and Use of Public Water Properties	Prohibits of waste and wastewater discharge to watercourses and the sea.

Document	Subject	Content
Decision No. 6/1/T of 1936	General Industrial Health Criteria	States that all water supplies should be taken from piped water networks or springs.
Legislative Decree No. 227 of 1942	Drinking Water Abstraction Projects	Authorises the use of water resources for drinking and identifies protection zones.
Legislative Decrees No. 340 of 1943	The Law of Penalties	Penalties for illegal activities such as unauthorized drilling and water pollution.
Decree No. 10276 of 1962, Decree No. 7007 of 1967	Water Sources Protection Zone Delineation	Identification of protection zones for water resources, based on geological studies.
Decree No. 14438 of 1970	Water Abstraction Management and Use	Defines the permitting requirements for well and spring abstraction.
Decree No. 14438 of 1970	Water Abstraction Management and Use	Indicates the annual abstraction limits and charges for private and public consumption
Decree No. 14438 of 1970	Water Abstraction Management and Use	Indicates the annual abstraction limits and charges for irrigation and industrial use.
Decree No. 14522 of 1970	Allocation of Nahr Litani and other water resources	Sets distribution to South Bekaa, the Western Foothills, and between industrial and potable water
Decision No. 182/1 to 186/1 of 1997	Criteria for the Use of Sand and Rock Quarries	Conducting EIA studies for proposed quarryies to protect the water resources
Decree No. 680 of 1998	The Preservation and Protection of Boreholes	Source protection
Decree No. 1039 of 1999	National Drinking Water Standards	Potable water quality
Law No. 221 of 2000	Water Management	Indicates the responsibility of MEW in water quality assessment.
Law No. 221 of 2000	Water Management	Indicates the responsibility of LRA in all irrigation schemes in South Bekaa and South Lebanon.
Law No. 221 of 2000	Water Management	Need for a new tariff structure for drinking and irrigation based on socio-economics.
Decision No. 75/1 of 2000	Environmental Permitting of Tanneries	Emphasizes rationalizing water use and reuse
Decision No. 90/1 of 2000	Environmental permitting of construction in river basins	Emphasizes on rationalizing water use
MOE, Decision 8/1 of 2001	WWTP Effluent and Atmospheric Emissions	Defines the standards of effluent and air pollutants discharged from a wastewater treatment plant
Decisions Nos. 3/1, 5/1 of 2000 and 16/1, 29/1, 61/1 of 2001	Permitting of Farm, Dairy Plastics and Fruit Processing	Defines methods to limit water consumption in production and cleaning in industrial settings.
Decree No. 8018 of 2002	Environmental Permitting of Industries	Defines distances of industrial zones from surface and groundwater bodies.
Draft Decree No. 444 of 2002	Environmental Protection	Defines an integrated approach for the management of natural resources and sets the criteria for implementing and supervising waste disposal practices, and the penalties for non-compliance.

Notwithstanding the large number of laws that govern the water sector, Lebanon suffers from significant legislative weaknesses leading to the mismanagement of the sector. Most of the laws, decrees, and regulations are at best only poorly implemented due to the lack of institutional capacity and enforcement mechanisms. Many laws have been promulgated without accounting for significant environmental and social factors. Political instability, conflict between institutions and the lack of financial resources have aggravated the situation.

The recently drafted Water Code attempts to address long-standing institutional shortcomings and improve water sector governance and its technical approach to an Integrated Water Resources Management Plan. Included in the Code are:

- Establishment of a National Water Council (NWC), to oversee sustainable development policy throughout the water sector;
- Preparation of a six-year Water Sector Development Plan;
- Consistent application of the “user pays” and “polluter pays” principles; and,
- Restriction of government subsidies to financing of capital investments with high social or environmental benefit.

But according to the World Bank[13], the Water Code is un-likely to deliver the expected gains unless there is a strong political will to address the challenges facing the sector. With weak accountability between policy-makers and service providers, the NWC risks become an additional institutional layer with limited ability to improve coordination and align incentives.

3.2.2 International Legislation

Internationally, Lebanon is a signatory to a variety of environment-related international and regional conventions and protocols, of which the most significant to the present project are listed in Table 3.2.

[13] Republic of Lebanon Water Sector: Public Expenditure Review. World Bank, Report 52024-LB, May 17 2010

Table 3.2: International and Regional Conventions and Protocols

Date	Title
1954	International Convention for the prevention of Pollution of the Sea by Oil Covered by Law no. 68/66 dated 16th November 1966
1972	Convention on the prevention of marine pollution by Dumping of Wastes and other Matter Signed 15th May 1973
1976	Convention for the Protection of the Mediterranean Sea against Pollution. Barcelona. Signed 16th February 1976. Covered by Law No. 126 dated 30th June 1977.
1980	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources. Athens. Signed 17th May 1980. Accession: 27th December 1994.
1982	Protocol Concerning Mediterranean Specially Protected Areas. Accession: 27/12/1994.
1985	Convention for the Protection of the Ozone Layer. Vienna. Covered by Law No. 253 dated 30th March 1993.
1987	Protocol on Substances that deplete the Ozone Layer. Montreal. Covered by Law No. 253 dated 30th March 1993.
1989	Convention on the Control of Transboundary Movement of hazardous Wastes and their Disposal. Basel. Ratified 21st December 1994. Covered by Law No. 387
1990	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer. London. Covered by Law No. 253 dated 30th March 1993.
1992	United Nations Framework Convention on Climate Change. Rio de Janeiro. Ratified 11th August 1994. Covered by Law No. 359.
1992	Convention on Biological Diversity. Rio de Janeiro. Ratified 11th August 1994. Covered by Law No. 360.
1992	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer. Copenhagen. Covered by Law No. 120 dated 3rd November 1999.
1994	United Nations Convention to Combat Desertification. Paris. Ratifications: 21/12/1994 by the law number 469.
1999	Convention on Wetlands of International Importance especially as Waterfowl Habitat-Ramsar. Accession: 1/3/1999 by the law number 23.
2001	Convention on Persistent Organic Pollutants. Stockholm Signed 22nd May 2001.

The design, construction and operation of the GBWSAP will comply with all applicable Lebanese Standards and guidelines, including but not necessary limited to:

- Water Supply for Public and Commercial Facilities;
- Drinking Water Quality Standards 1999;
- Wastewater Discharged into the Sea 2001;
- Stack Emission Standards 2001;
- Recommended Noise Emission Limits for Outdoor Areas;
- Draft Ordinance on the Use and Disposal of Sewage Sludge;
- National Environmental Action Plan; and,
- National Biodiversity Strategy and Action Plan.

3.3 Institutional Framework

Institutional capacity for environmental management and monitoring in Lebanon is weak, thus the potential range and effectiveness of policy options for environmental management is severely constrained. Law enforcement in Lebanon is also weak, particularly so in respect of environment and social legislation. While much has improved in recent years, particularly with the creation of the MoE and the consequential strengthening of institutional framework for the design and implementation of environmental policy, much remains to be achieved. For GBWSAP, the prime institutional stakeholders and their particular roles are listed in Table 3.3.

Table 3.3: Roles and Responsibilities of the Prime GBWSAP Stakeholders

Institution	Role and Responsibilities
Council for Development and Reconstruction (CDR)	Accountable to CoM for sectorial investment planning and international donor funding. GBWSAP Project Proponent.
Ministry of Energy and Water (MEW)	Water policy, national budgeting, oversight of RWEs, water legislation and enforcement. GBWSAP Project Proponent.
Beirut and Mount Lebanon Water Establishment (BMLWE)	Water supply and treatment operations, distribution to consumers, billing and cost recovery for the Beirut and Mount Lebanon service area. GBWSAP Project Proponent.
Litani River Authority (LRA)	All water sector issues throughout the Litani Basin and gauging river flows at national level.
Ministry of Environment (MoE)	The national regulatory authority for environmental protection, permitting, monitoring and enforcement
Concerned municipalities	Organized into Federations where projects are too large for a single municipality. Responsibilities include local roads and buildings, community facilities, wastewater and drainage.
Directorate General for Antiquities (DGA)	Part of the Ministry of Culture, responsible for execution, monitoring and enforcement of the Antiquities law and for archaeological remains, antiques, traditional and historical monuments
Other institutions agencies, academia and NGOs	As appropriate to the relevant organisation

3.4 Project Environmental and Social Assessment Framework

In accordance with CDR policy, and while simultaneously complying with MoE procedures illustrated in Figure 3.1 above and the Decree No 8633, *Fundamentals of Environmental Impact Assessment*, the present Assessment also follows the requirements of World Bank Operating Policy OP 4.01 for a Category A Project, thus rendering it acceptable for any future funding by the Bank or other international funding agencies, most of which follow World Bank requirements for environmental and social assessment. In consequence, GBWSAP therefore followed World Bank safeguard policies, and the likelihood of these being triggered by future GBWSAP construction is listed in Table 3.4.

Table 3.4: Likelihood of World Bank Safeguard Policies Being Triggered

Environmental Assessment (OP/BP 4.01)	Yes Category A ESIA being undertaken
Natural Habitats (OP/BP 4.04)	Yes Detailed Ecological Survey undertaken
Forests (OP/BP 4.36)	No
Pest Management (OP 4.09)	No
Physical Cultural Resources (OP/BP 4.11)	Yes. Site inspections undertaken Consultations held with DGA
Indigenous Peoples (OP/BP 4.10)	No
Involuntary Resettlement (OP/BP 4.12)	Yes RPF completed. RAP to be prepared.
Safety of Dams (OP/BP 4.37)	Yes Requirements discussed in Section 3.5.
Projects on International Waterways (OP/BP 7.50)	No
Projects in Disputed Areas (OP/BP 7.60)	No

The response to triggering OP 4.01 is the preparation of an ESIA for the GBWSAP.

A preliminary ecological survey has already been undertaken on Bisri dam site for the purpose of the PDESIA. Being the priority option, Bisri underwent a detailed ecological survey, the results of which are presented in Section 5.

Reconnaissance sites visits to Bisri dam site have identified some physical cultural resources within the reservoir limits and discussions have been held with the Directorate General for Antiquities, as to the necessary measures to be undertaken to preserve those cultural remains. A 'Chance Find' procedure should be included in the construction documents should any physical remains be unearthed.

Critical of the safeguard policies in respect of Bisri is OP 4.12, because reservoir inundation will require substantial expropriation of land and property. A Resettlement Policy Framework (RPF) for the project has been prepared and a Resettlement Action Plan (RAP) will be prepared on completion of the ESIA.

3.5 Dam Safety

Dams funded by the World Bank or another of the international financing agencies, are expected to adhere to the provisions of World Bank Operational Policy, *OP.4.37, Safety of Dams*. Most developed countries such as the US, UK and most EU countries already have equivalent provisions for dam safety incorporated within national water supply and/or Health and Safety legislation.

Both the Bank and the World Commission on Dams considers *Large Dams* to be those over 15 m in height, and treats smaller dams as large dams if located in areas of high seismic risk, have large flood-handling requirements, or require complex foundations. On both counts, Bisri is a large dam.

Under OP.4.37, the prime design and operation controls that will be imposed will include:

- Appointment of an *Independent Panel of Experts* to review site investigations, design, construction and commissioning;
- Preparation and implementation of detailed plans to include:
    - Construction Supervision and Quality Assurance Plan;
    - Instrumentation Plan;
    - Operational and maintenance Plan; and,
    - Emergency preparedness Plan.
- Prequalification of construction and procurement contractors prior to tendering;
- Periodic safety inspections throughout the operational life of the dam.

The Panel usually consists of three eminent persons with a wealth of practical experience of dam design, construction and operation. As such, these persons are unlikely to be appointed from within Lebanon. Their role will be to advise on all critical aspects of the dam; its appurtenant structures, its catchment areas, the surrounding and downstream areas. They are also usually in charge with oversight of project formulation, technical design, construction procedures, and associated works such as power facilities, river diversion during construction, fish ladders, etc.

Initial agreement to fund a dam project and any staged loan or grant payments are usually dependent upon the approval of progress by the Panel.

SECTION 4

PHYSICAL BASELINE CONDITIONS

4. PHYSICAL BASELINE CONDITIONS

4.1 Introduction

This section of the ESIA is the first of three to describe and discuss the environmental and social baseline conditions pertaining within the project area and its region. In this, Section 4, the physical conditions are presented, in Section 5 the biological conditions, and in Section 6 the social conditions.

Herein under **Section 4.2** the prevailing climatic regime is discussed, while **Section 4.3** describes the landscape and topography. The geology and soils on which Bisri Dam and Reservoir will be founded are detailed in **Section 4.4**, while the risk of seismicity is presented in **Section 4.5**.

The surface water hydrology is described in **Section 4.6**, and the ground water hydrology summarised in **Section 4.7**. The likely tightness of the reservoir is discussed in **Section 4.8**, and the prevailing water quality in **Section 4.9**.

Finally, a note on the present air quality and noise regime are given in **Section 4.10**.

4.2 Climate

4.2.1 Prevailing Regime

Lebanon enjoys a Mediterranean climate characterized by a hot dry season extending from May to October, and a cool, wet season between November and April. Although only a little over 10,500 km^2 in area, its wide topographical variation gives rise to a wide variety of microclimates.

Being topographically part of the region that lies between the coastal strip and the western mountains, the Bisri project area site affords all the climatic features of a transitional microclimate that unfolds for hot and humid summers at the proposed location for the dam axis to less humid and mild summers at the extremities of the proposed impoundment. The five winter-months are generally characterized by abundant rains with cool temperatures at the dam-site, and severe winters with more precipitation in form of snow, which contributes over time to the replenishment of the mountains springs, with their water heads, extending between the Barouk and Jezzine mountains.

The climatic parameters of most concern to dam studies are those having direct or indirect impact on the state of water being impounded. Among others, rainfall and evaporation will affect directly the water balance in terms of inflow and outflow to and from the reservoir. The indirect effect of temperature, relative humidity and prevailing wind is expressed in term of how much water will evaporate from the surface of the impoundment. These parameters also impact on the occurrence of ecosystems and natural habitats, and levels of biodiversity.

The following discussion of the prevailing climate at Bisri draws heavily on the National Climatic Atlas for Lebanon[14].

4.2.2 Rainfall

The southwesterly winds bring humid air masses to the Eastern Mediterranean coast, which on reaching the high Lebanese mountains intensifies and triggers precipitation on the Lebanese western mountain chain. The Bisri dam site extends in a moderately steep-sided valley, nested between the Iklim-el-Kharoub, Barouk-Niha and Jezzine mountains, with a part of the Valley axis in a north-east direction, exposing the site to southwesterly winds. This physiological features of the site explain why the Nahr Bisri catchment receives rainfall totaling 1250 mm/yr compared to the 70-year national average of 877 mm/yr. **Table 4.1** shows how this total annual rainfall is distributed throughout the year.

Table 4.1: Distribution of Rainfall at Bisri

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
297	260	175	84	27	3	0	0	2	38	127	237	**1,250**

Figures in mm. Source: Atlas Climatique du Liban.

The considerable rainfall falling at Bisri is not distributed equally throughout the year. Almost 95% of rain falls between November and April, leaving the other six months almost dry. Such unequal rainfall distribution will have a decisive impact not only on the annual yield of the river, and as such on the water storage and delivery patterns of the dam, but also on natural habitats and biodiversity.

4.2.3 Temperature

As general rule, the increase in altitude and latitude across the Lebanon western mountains produces milder weather. As such, the more eastward we move from the coast, the lower will be the air temperatures throughout the various seasons of the year. The Bisri dam site is no exception to this rule, where the annual and monthly temperatures are lower than those on the coast at Saida, as shown in Table 4.2.

[14] *Atlas Climatique du Liban*, 1977 Publié par le Service Météorologique du Liban avec l'aide de l'Observatoire de Ksara Deuxième Edition.

Table 4.2: Mean Monthly and Annual Temperatures for Bisri and Saida

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Mean**
Bisri	7.5	7.8	11.1	14.3	18.3	20.3	21.5	22.5	20.3	18.8	14.4	9.1	**15.5**
Saida	12.5	13.6	15.1	17.8	20.1	22.9	24.7	26.0	24.8	21.6	18.7	19.6	**19.8**

Figures in °C Source: Atlas Climatique du Liban.

4.2.4 Relative Humidity

The key factor ruling the variation in relative humidity in Lebanon is the proximity and remoteness of the site from the sea, where the humid south-westerly winds off the sea saturate the air during the summer months and the more the air masses move inland the less humidity they will bear. The annual mean relative humidity may drop from 72% on the Beirut coast during summer, to 40% at Baalbek in the Bekaa Valley, for the same period. As mentioned above, since the Bisri site is in a transitional zone between the wet and humid coast and the dry hinterland, one could predict that Bisri dam site may record values for relative humidity in between these two extremes, as shown in Table 4.3.

Table 4.3: Relative Humidity for Bisri

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Mean**
72	69	66	60	56	59	57	57	63	65	57	60	**62**

Figures as % Source: Atlas Climatique du Liban.

The lowest humidity levels are generally recorded during the summer months, the highest in January and February.

4.2.5 Prevailing Wind

Across Lebanon, southwesterly (SW) and westerly (W) winds predominate on the coast and in the mountains while northeasterlies (NE) prevail in the north of the country and in some inland areas during the winter. Being within the coast-mountain transitional zone and considering the Bisri valley's orientation, the prevailing wind at the dam site is southwesterly. While these winds are active all year, the months of October and November witness relative calm. During the period from December to April, the SW winds bring maritime air masses that trigger rainfall all along the coast and over the mountains.

During the period from May to September these winds carry humid air that accumulates as fog on the flanks of the Lebanese western mountains where, during nighttime they are swept away by the local breezes blowing down from the surrounding mountain tops.

Variations in the degree of windiness relative to average wind throughout the year are shown in Table 4.4. Not surprisingly, January to March are the most windy months, while October and November are the calmest.

Table 4.4: Relative Monthly Windiness at Bisri

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
113	110	109	102	102	102	103	93	91	86	87	97	**100**

Figures in % Source: The National Wind Atlas of Lebanon, 2011.

4.2.6 Evaporation

As mentioned above, air temperature combined with relative humidity and wind are the major determinants of how much water will evaporate from the surface of the reservoir. The nearest and within basin climate station to the Bisri site is Jezzine, station, from which data have been used to estimate evaporation[15], given in Table 4.5, for the project site.

Table 4.5: Evaporation at Bisri

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
46	60	98	136	176	199	202	185	152	114	70	48	**1486**

Figures in mm Source: Atlas Climatique du Liban.

As shown above, the highest evaporative demands occur during the six dry months from April to August, with a peak in July, by when the reservoir is expected to reach its full storage capacity and start delivering water to GBA[16]. While the estimated evaporative demands are not expected to exceed 5% of the full storage capacity, these losses have to be accounted for in any reservoir yield-capacity analysis because 60% of these losses will occur during the months June to November when the reservoir will be delivering to Greater Beirut.

Moreover, the occurrence of the highest reservoir evaporative losses are expected to coincide with the lowest recorded air relative humidity levels for the months May to September. This will have a decisive impact on altering the humidity of the air surrounding the reservoir. High relative humidity coupled with warm temperatures favour fauna and flora species proliferation, while the same conditions are ill-suited to the thermal comfort of humans.

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[15]Evaporation rates were determined using Class A Pan method applying the empirically determined pan coefficient ETo = Kp x Ep (FAO Irrigation and Drainage Paper 56).

[16]*Design of Bisri Dam*: *Updated Feasibility Report.* Dar Al-Handasah (Nazih Taleb and Partners), 2011.

4.3 Landscape and Topography

The two easterly lobes of Bisri Reservoir formed by Nahr Barouk from the north and Wadi Bhannine from the south together drain a substantial portion of the southern Chouf Mountains. These two watercourses merge at Marj Bisri to form Nahr Bisri, which after a further 5 km merges with Wadi Khallet west of Bisri Village to become Nahr Awali, thereafter continuing to the sea. Above the dam site on Nahr Bisri the surface water catchment area extends to some 215 km^2. The dam site is at an elevation of 395 m and its catchment rises to a height in excess of 1,900 m. Typical scenery throughout the Bisri reservoir site and adjacent areas is shown in Figure 4.1.

The upper catchment area is characterized by the steep slopes and cliffs, with small traditional villages comprising red-tiled houses perched on hilltops and at cliff edges. The landscape consists mainly of wild plantations, cedar trees in Barouk Mountain, oak and pine forests in Jezzine, Bkassine, and the Upper Chouf, in addition to woodland varieties, farmland and natural scrubby bush vegetation. The plant cover is important for controlling erosion and landslip, promotes aquifer recharge and boosts carbon sequestration. The natural beauty of the mountains is an important resource but the lack of landscape management and the absence of planning control have resulted in severe degradation over the last two decades. Typical upper catchment scenery is shown in Figure 4.2.

The Awali Valley south of the dam site is moderately steep sided and largely under natural vegetation. Downstream of Bisri Village, beyond the area of ancient landslip that gave rise to form the lake that subsequently silted-up to give the dam site its float and fertile character, the valley again occupies a steep generally-V-shaped valley in which the bottom lands are narrow and agriculture is largely limited to tree-crops grown on terraced slopes. The nature of the lower catchment is also shown in Figure 4.2.

Looking NE from the dam site

Pine woodland on the left bank

Looking W from above Wadi Bhannine

Rocky hillside and scrub on the right bank

Looking E towards of Wadi Bhannine

Looking N towards the far end of the reservoir

Figure 4.1: Typical Landscape and Scenery of the Bisri Area

Upper Catchment Landscape at Bater

Upper Catchment Landscape at Niha

Nahr Awali 3km below the Bisri Dam Site

Joun Hydropower Plant

Figure 4.2: Landscape and Scenery Above and Below the Project Area

4.4 Geology and Soils

4.4.1 Geology of Catchment Area

The Bisri Dam catchment area encompasses a geological sequence extending from the Jurassic Kesrouane Limestone (J4) in the higher mountainous areas through the intervening formations to the Cretaceous Sannine Limestone (C4) and the recent Quaternary alluvial and fluvial deposits exposed along the course of the Bisri river and continuing downstream of the dam site. This sequence presence in the catchment and its primary lithologies are shown in Table 4.6, the blue shaded formations being those falling within the area of the dam and reservoir.

Table 4.6: Stratigraphical Succession in the Bisri Catchment Area

Age	Formation		Lithology
Middle Cretaceous	C4	Sannine Limestone	Finely bedded limestones and marly limestones, c.600+ m in thickness, highly fractured and karsified.
	C3	Hammana Formation	Varied limestones overlain by clays marls and sands, c.140 m.
Lower Cretaceous	C2b2	(Now part of C3)	Marls with limestone and sandstone intercalations.
	C2b1	Mdairej Limestone	Massive cliff limestone unit, generally confined at depth, 40-50 m.
	C2a	Abeih Formation	Variable limestones, marls and sandstones, fractured, karstic at depth. Clays near the top give landslips. c.170 m thick.
	C1	Chouf Sandstone	Friable quartzitic sandstones with subordinate clays, shales, lignites and marine basalts. Fractured. Up to 300 m.
Upper Jurassic	J7	Salima Formation	Mostly thin-medium bedded ferruginous oolitic limestones with marly and sandy beds, 80-180 m in thickness.
	J6	Bikfaya Formation	Massive fine-grained micritic limestones, highly fractured and karstic, 60-80 m thick.
	J5	Bhannes Formation	Limestones, basalts, pyroclastics and shales, 50-150 m thick.
Middle Jurassic	J4	Kesrouane Limestone	Massive grey cliff limestones with chert, 1000+ m in thickness, heavily fractured and karsified

4.4.2 Geology of Bisri Dam and Reservoir

The proposed dam will stretch to nearly 800 m across the valley and stand about 74 m high. The present floodplain and active river deposits have a maximum thickness of some 30 m in the main channel but overlie up to 90 m of mainly fine grained lacustrine material deposited in an ancient lake that formed behind a landslip downstream of the dam site. The left abutment primarily comprises the fine grained and friable Chouf Sandstone (C1), where two adits were excavated in 1982 and during the previous investigations, for distances of 210 and 215 m respectively. Both encountered friable rock and evidence of past land sliding. Close to the dam axis the depth of slide was less than 10 m, while elsewhere larger slides were reported. The right abutment presents a sequence of strata covering the period between the Basal Cretaceous up to the Middle Cretaceous going through C1 to C4.

The stratigraphy in the reservoir consists mainly of Chouf Sandstone. Close to the dam site, a sequence of interbedded limestones and marls representing the sequence from C2a to C3 extends from the dam axis upstream about 1.7 km along the right abutment. The right wall of the reservoir also contains areas of landslip. The Quaternary and Recent alluvial and lacustrine deposits comprise sands, silts, gravels, and cobbles, overlying highly plastic clayey silts and silty clays interstratified with sandy lenses.

The limestone rocks exposed along the right side of the dam reservoir are highly fractured and show evidence of developing karstification, as shown in Figure 4.3. This secondary permeability will ultimately affect water tightness and make the exposed rocks prone to leakage from the reservoir. In this respect, it was noticed during the previous investigations, that all the boreholes drilled along the right bank of the dam showed evidence of water loss down to a depth of 18m, where the complete loss of drilling fluid was reported.

Figure 4.3: Highly Fractured and Jointed Mdairej Limestones on the Right Bank of the Reservoir

Further upstream, the transition from the limestone rocks to the sandstones of the clastic Chouf Formation (C1) can be traced along the right bank. However, further detailed mapping is needed to establish the precise boundary/contact between the carbonate rocks of the Abeih Formation (C2a) and the basal sandstone of the C1 formation because landslide material and eboulis are masking the exact location of the contact. At close proximity to the eboulis, the sandstone strata show variable dip direction and higher degrees of systematic jointing. In addition, greyish clayey/shale intercalations are not uncommon within the sandy strata, as shown in Figure 4.4.

Figure 4.4: Altered and Jointed Chouf Sandstone and Eboulis.

Further upstream on the same right bank, another massive mass movement feature is encountered; large blocks originating from the Mdairej cliff at the topmost right wall of the valley have become detached and moved downslope under gravity, intermixed with smaller and finer debris, as shown in Figure 4.5. Any dam axis relocation should be upstream of the eboulis, bypassing fractured Middle Cretaceous strata and unstable slopes

Figure 4.5: Old Landslide on the Right Bank of the Valley.

Given the highly jointed nature of the C2b Formation, as shown in Figure 4.6, and the presence of already detached blocks resting at the toe of the cliff, it is probable that sizeable limestone blocks will completely detach themselves and move downslope during the lifetime of the project.

Figure 4.6: Well Jointed Mdairej Limestone with Fallen Blocks on Underlying Abeih Formation

Agricultural terracing along the slopes of Nahr Bisri act to stabilise slopes, especially in the softer and friable sandstone layers.

4.4.3 Structural Geology

The geological structure at Bisri comprises a complex interaction of faults, folds and mass movements. The faults appear to be high angle to vertical normal faults that essentially trend generally north-south and east-west. Two major faults pass close to the dam axis; the Roum Fault and the Qalaat El Hambra Fault. The major landslide that caused the lake to be formed that resulted in the lacustrine deposit is believed to have occurred along the latter fault.

Boreholes along the dam axis encountered a succession of older beds of J5-J7 abruptly displaced against the C2a, for which the Jurassic succession must have been uplifted along a major fault. The report interprets this fault to be the subsurface extension of the Roum Fault, although this remains somewhat speculative and must be investigated during detailed dam design.

In addition, other faults can be seen intersecting the upstream area of the reservoir. One fault cuts the upper part of the reservoir area, near Marj Bisri and along the Bhannine valley. Where this intersects the dam reservoir along the northern bifurcation, its trace is masked by the floodplain and fluviatile sediments. The faulted cliff can above Wadi Bhannine is shown in Figure 4.7, with the fault trace marked by shattered rock.

Figure 4.7: The Faulted and Fractured Mdairej Limestone above Mar Bisri

Most of the faults are local and of limited extent, although their effect can be clearly seen in jointing and fracturing in addition to displacement, as shown in Figure 4.8, in which the line of trees highlights the availability of water within the zone of fracturing.

Previous reports have helped define the geological structure within the vicinity of the dam, but not to the extent detailed design can proceed without further investigation. Little work has been undertaken on the reservoir, where the impact of the old landslips or the potential for new movements, and fracture and joint surveys are still required. The detailed design phase should map/study in detail the slides and their effect on the reservoir, banks stability and dam safety. The presence of faults below the lacustrine deposits remains speculative and should be confirmed by exploratory drilling, perhaps backed up by geophysical exploration.

Figure 4.8: The Limestone Cliff Displaced above Wadi Bhannine

Further details of the geology and geotechnical aspects of Bisri Dam are presented in Appendix C.

4.5 Seismicity

4.5.1 Regional Seismicity

Given its location on a major tectonic plate boundary it is of little surprise that Lebanon and adjacent regions suffer frequent structural movements. Fortunately, only a small number of the several hundred tremors recorded each year by seismograph are felt by residents. Figure 4.9 illustrates the epicentres of those recorded over just a three year period, 2006 to 2009. Features to consider in the context of the present ESIA are primarily:

- The large number of events (all dots) and their widespread occurrence;
- The widespread occurrence of deeper (black dots) and potentially more catastrophic events;
- The distribution of events around the Bisri site.

4.5.2 Seismic Risk

Given the structural and tectonic setting of Lebanon, the main structures likely to affect the dam site are the Roum Fault and the Yammouneh Fault. The closest surface expression of the Roum Fault is about 2 km SW of the dam site, but its subsurface trace or an offshoot of it appears to continue into the Awali valley and beneath the proposed dam site. The Yammouneh Fault is approximately 10 km east of the dam site, and two other faults of regional significance, the Rachaya and the Serghaya Faults, 28 and 40 km east, respectively. While the Yammouneh Fault, the extension of the Dead Sea Fault System, appears not to have moved for several thousand years, more recent movements, including the 1956 Chhim Earthquake, have taken place on the Roum Fault. It is thought by some seismologists that this lineation, running from Marjayoun towards Beirut, is now the effective plate margin.

Two notable earthquakes with a magnitude of 8.3 were recorded in 1201 and 1759. Both epicenters were within a radius of 75 km from Bisri and resulted in a high level of destruction and loss of life. On March 16 1956, a magnitude 6.0 earthquake occurred 4 km east of the proposed dam site causing 136 deaths and destroying 6,000 houses. This event is thought to have occurred along the Roum Fault.

The widespread faulting and fracturing has caused secondary discontinuities that further dislocate and decrease structural integrity. The permeability of the rock mass is thus increased and the potential for leakage from the reservoir enhanced. That the Roum Fault, known to be significantly active, may pass under the dam and reservoir site presents a major risk to the viability of the Bisi project. A dedicated seismo-tectonic study is required to ascertain the presence and extent of the Roum Fault or one of its branches beneath the dam site and reservoir area, and to confirm the requirements for ground treatment and dam design.

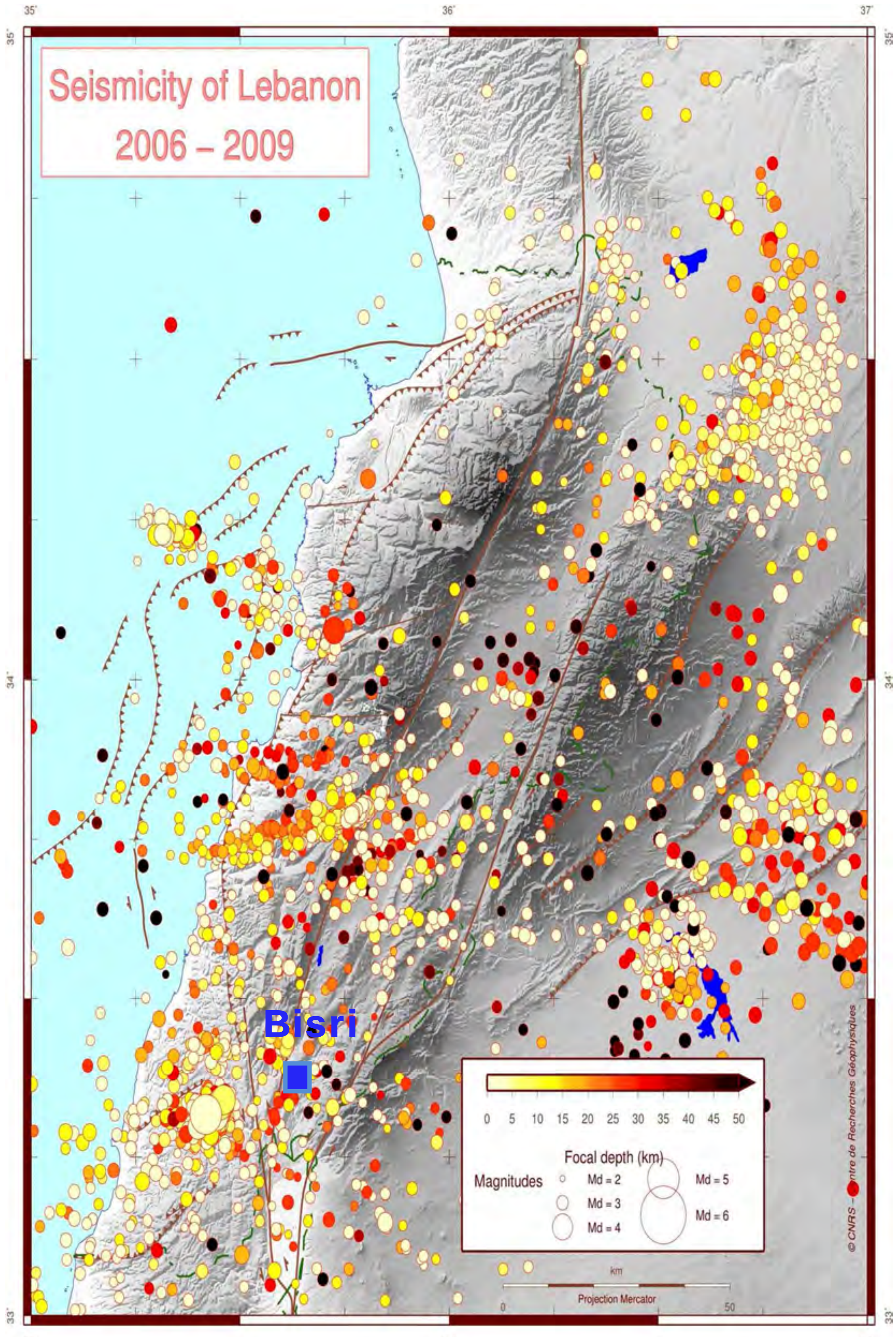

Figure 4.9: Main Centres of Seismic Activity in Lebanon (2006-2009)

4.6 Surface Water Hydrology

Nahr Bisri above the dam site has a 215 km^2 catchment area that gathers water from various perennial and seasonal spring issues as shown in Figure 4.10. The headwaters of most perennial springs are at elevations varying between 1000 and 1900 masl along the western rims of the Al-Barouk, Toumat-Niha and Jezzine mountains, while those of seasonal tributaries generally have headwaters at elevations below 1000 masl.

The two main influents of Nahr Bisri are Nahr Barouk, running in southerly direction, and Aa'rye-Jezzine watercourse running in northern direction into Wadi Bhannine, converging at Marj Bisri, some 3 km east of Bater village. Nahr Bisri then meanders down through the project area until south of Bisri Village, after taking in minor tributaries, it becomes Nahr Awali. The watercourse provides both the physical and administrative boundary between the Chouf and Jezzine Cazas. The lower reaches of Nahr Awali has an abundant flow even during the summer months because of the Litani-Awali scheme that transfers water from Qaraoun Lake and intermediate springs to the Joun hydropower plant that discharges ultimately into that final stretch of the river.

The rainy season across the catchment is from October to April, with the peak monthly precipitation of around 300 mm in January. Almost no rain falls during the other months. The average annual precipitation, recorded for the period of 8 years from 2001 to 2009 is 1107 mm, representing a decrease of 15% over a period of 27 years from 1944 to 1971.

The nearest river gauging station to the proposed dam axis is located 1.3 km downstream of the dam site at Bisri road bridge, where the recorded average annual yield is about 134 Mm^3 (4.2 m^3/s) for a recording period of 30 years, extended up to 65 years for the purpose of the feasibility study. The minimum average monthly stream flow for the same period, 1.31 Mm^3 (0.5 m^3/s), occurs during the month of September, whereas the maximum average monthly stream flow recorded in February was 30.44 Mm^3 (12.0 m^3/s). Comparing the most recent 20-years' worth of records with those from the period 1944 to 1974, a 22% reduction in recent average annual river yield is apparent.

The monthly flow-duration analysis for Nahr Bisri shows that the base monthly flow is about 0.6 m^3/s, with 90% chance of exceedance. The slope of the flow-duration curve (Figure 4.11)[17] is considerably flattened in its low flow portion, indicative of significant

[17] From, *Bisri Dam Feasibility Report, Dar Al-Handassah (Nazih Taleb & Partners), 1995*).

ground water inflow. Moreover; the curve shows that Nahr Bisri flows are reliable about 40% of the time, corresponding very well to the wet rainy season of 5-6 months.

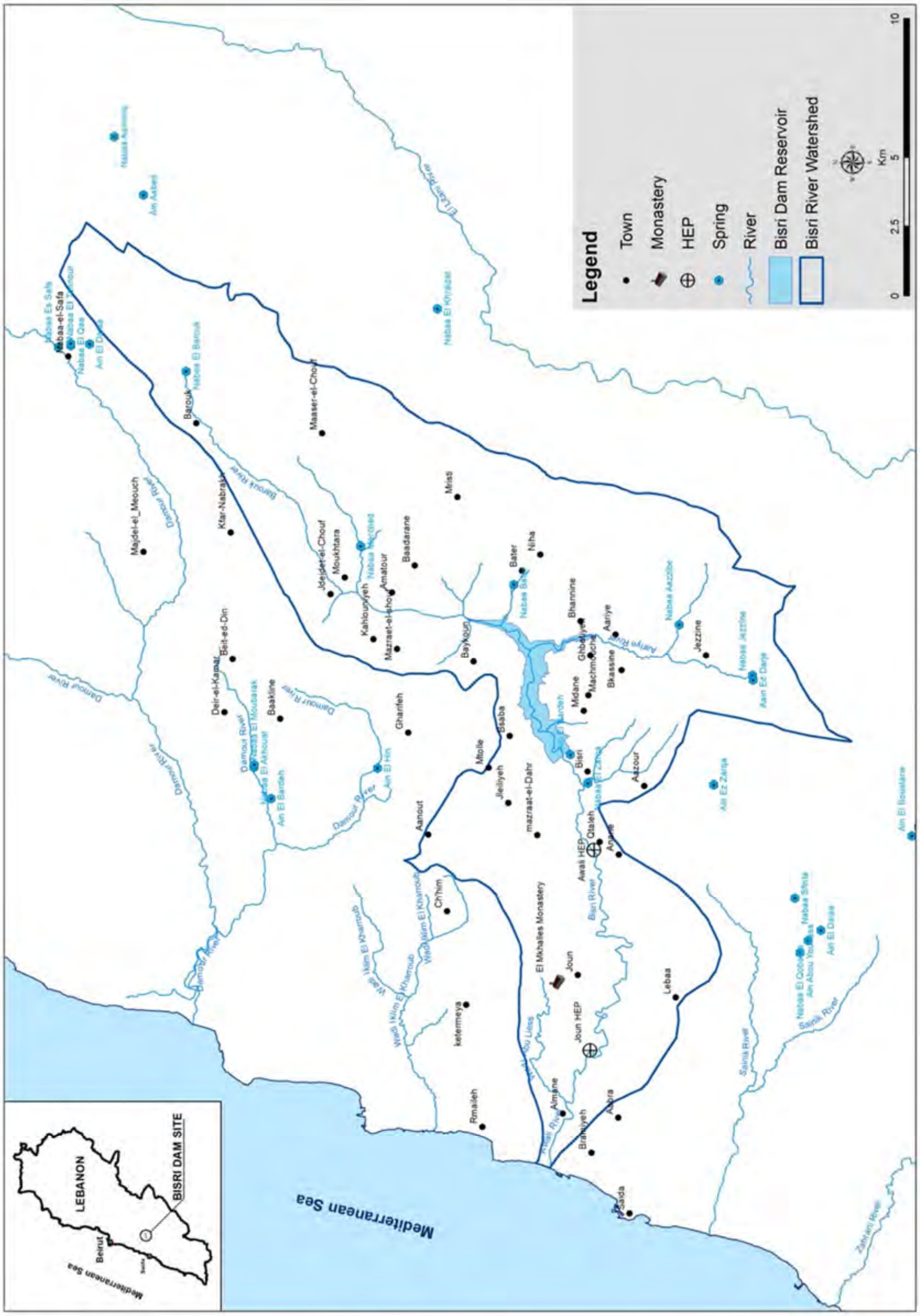

Figure 4.10: Bisri-Awali Catchment Area

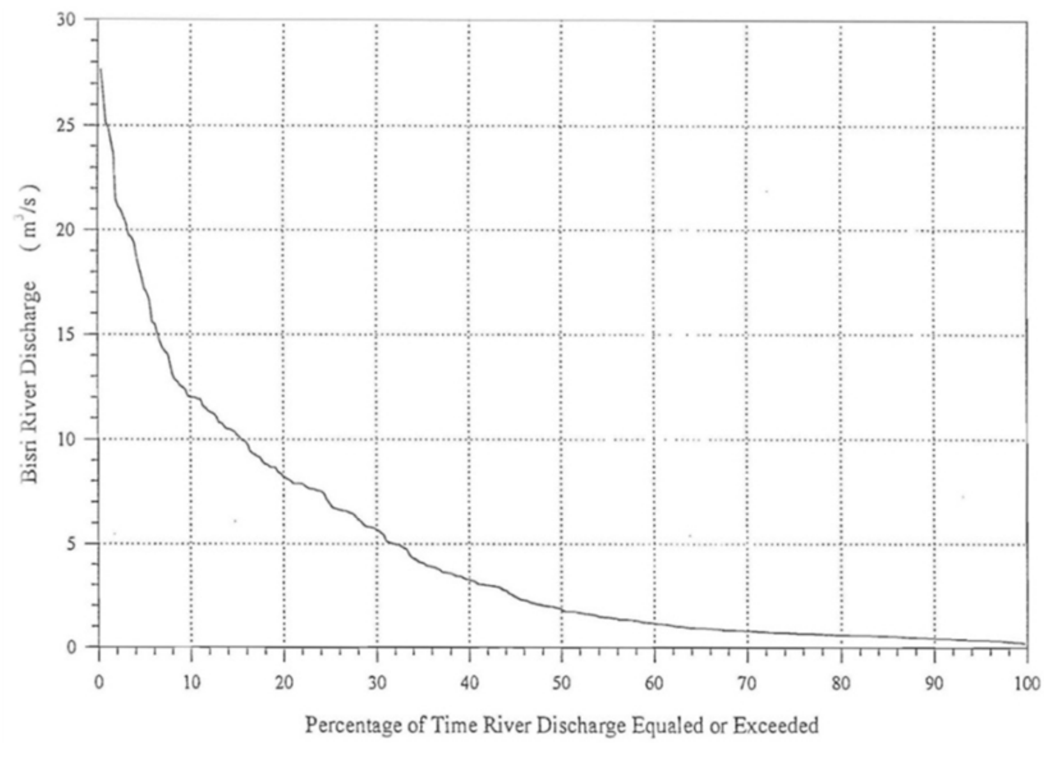

Figure 4.11: Nahr Bisri Flow-Duration Curve

A summary of the key hydrological parameters pertaining to the Bisri dam site taken from the 1995 and 2011 feasibility studies are listed in Table 4.7.

Table 4.7: Bisri Dam Site Hydrology

Parameter	Quantity
Catchment area	215 km^2
Site elevation	395 masl
Average Precipitation	1,107 mm/year
Average annual yield	134 Mm^3
Annual dry year yield	60 Mm^3
Annual evaporation	718 mm
Spillway design discharge	3,110 m^3/s (for PMF)
PMF estimate and safety check discharge for spillway	3,110 m^3/s
Diversion during construction (25-year return flow)	440 m^3/s
Annual sediment yield	1,000 $t/km^2/yr$
Water release	6.7 m^3/s (June-Nov)
Dam storage	128 Mm^3

4.7 Ground Water Hydrology

As discussed previously, Lebanon had access to plentiful ground water resources but while those of the aquifers underlying the coastal plain and adjacent foothills are generally over-exploited and increasingly subject to saline intrusion, those in the upper hills and mountains, despite affording a potentially valuable resource, remain not only largely unexploited but also unexplored.

The geological sequence discussed in Section 4.4 comprises a series of permeable aquifers separated by poorly permeable aquicludes[18], as illustrated in Table 4.8. The Kesrouane Formation (J4) and the Sannine Formation (C4) comprise hard, fractured and karstic limestones and are Lebanon's major ground water aquifers.

Table 4.8: Aquifer Units within the Geological Sequence

Age	Formation		Hydrogeological Significance
Middle Cretaceous	C4	Sannine Limestone	Major Aquifer
	C3	Hammana Formation	Aquiclude
Lower Cretaceous	C2b2		
	C2b1	Mdairej Limestone	Minor Aquifer
	C2a	Abeih Formation	Aquiclude
	C1	Chouf Sandstone	Minor Aquifer
Upper Jurassic	J7	Salima Formation	Aquiclude
	J6	Bikfaya Formation	Minor Aquifer
	J5	Bhannes Formation	Aquiclude
Middle Jurassic	J4	Kesrouane Limestone	Major Aquifer

The occurrence of these formations across the Bisri project areas has been discussed previously. In the absence of a national geological survey to which well drillers' and site investigation contractors' records are routinely submitted, neither modern field mapping, nor specialisations such as hydrogeology and engineering geology have been developed for the public good. Even basic concepts such as the definition of fractured and karstic aquifer catchment areas, which unlike granular aquifers do not mirror surface water catchments, are very poorly understood. This is equally true of the Bisri dam and reservoir site as for elsewhere.

[18] The terms *aquifer* and *aquiclude* relate to a formation's relative ability to accept recharge, store and move water and yield usable quantities economically. Formations classified as aquicludes may have ground water passing through them, often via discrete fissures, but cannot productively yield it in usable quantities.

The 1995 feasibility studies for Bisri makes almost no mention of hydrogeology, although it seems that the main ground water level beneath the dam and reservoir are within the coarser alluvium beneath the lacustrine clays, with near-surface ground water limited to existing and old river channel deposits with hydraulic continuity to Nahr Bisri and Wadi Bhannine.

The most significant formation for ground water within the project area will be the Chouf Sandstone, which while only a minor aquifer, crops out over much of the reservoir slopes. While the geological investigations at the dam site show up to 90 m of low permeability clays and other generally fine clastic material, these lacustrine deposits may be expected to coarsen and perhaps also thin northwards, and with increased hydraulic head due to the depth of inundation, reservoir water may penetrate the courser horizons to seep into the underlying faulted bedrock.

4.8 Reservoir Water Tightness

For a dam to be successful, the water impounded behind it should not infiltrate through the valley floor or walls into the underlying bedrock, flow beneath the dam, or issue as spring discharge downstream. There are numerous examples in many parts of the world where such leakages occur and reservoir areas remain almost dry years after dam construction. Leakage is already a major problem at the 63 m high Chabrouh Dam in North Lebanon. Completed in 2007 with a design storage of 8 Mm^3, leakage has always been a problem and the reservoir design water level has never met. Current losses reported by different sources, vary from 22,000 to 33,000 m^3 each day.

While hydraulic continuity between river flow and shallow ground water in superficial alluvial aquifers is common, the raising of water levels during reservoir filling increases hydraulic pressure, allowing the water to exploit open fissures and fractures in the underlying bedrock. In large dams, the increase in hydraulic head may be sufficient to prise open previously closed fractures or to clear those previously clogged with sediment.

The ideal dam site will therefore be one located on solid, poorly fractured bedrock. While ground improvement, such as injection grouting or the use of geosynthetic membranes, may be practical for a broken and permeable dam site, both quickly become prohibitively expensive if the whole area inundated by the impoundment has to be treated to render it watertight.

At Bisri, almost all the bedrock outcrop exposed around the lower slopes of the valley comprise the friable and easily eroded Chouf Sandstone (C4), with small proportions of overlying C2a, C2b and C3 strata. Investigation boreholes into the Lower Cretaceous C2 formations repeatedly record lost fluid circulation, suggesting these strata will readily accept water from the surface. Conversely, a recently drilled borehole downstream of the dam site recorded confined conditions. The ground water regime therefore appears to be complex and hydrogeological investigations will be required for detailed design.

Notwithstanding this, the main valley bottom is infilled with a sequence of lacustrine deposits, in places more than 90 m thick, largely comprising low impermeable clays and silts but with occasional coarser units and an underlying layer of older and coarser alluvium. While the lacustrine deposits can be expected to provide an effective seal over much of the reservoir floor, the coarser horizons and underlying alluvium will, if adequately interconnected, provide a leakage pathway.

Of most concern therefore are the exposed sandstones, which are both fractured and friable. Not only will the water leak into the fractures but it will also disaggregate the sand grains, enlarging the fissures and increasing reservoir sedimentation. The presence of clay horizons, which will soften and collapse on contact with water, will only increase this process.

Clay horizons near the top of the Abeih Formation are known to give rise to landslips, which will not only contribute to reservoir sedimentation, but more significantly, raise dam safety concerns. Old landslips recorded on the geological maps of the 1950s already occupy some 1.5 km of the proposed Bisri reservoir shoreline.

Regional structures in the vicinity of and cutting the reservoir afford an additional cause for concern. A major fault zone passes under or very close to the dam site and any movement on this will threaten the integrity of the impoundment. Whether or not this is the Roum Fault, the significance of which has been referred to above, remains the subject of some speculation, but even if it is not, any significant seismic event would be likely to cause movement here. While measures can be taken to 'earthquake-proof' dams, the potential to safeguard against historical seismic events on this structure is limited. In addition, a NW-SE trending fault with a mapped surface trace of some 8 km crosses the reservoir in the vicinity of the confluence of Nahr Barouk with Wadi Bhannine. That the rivers meet at this location suggests adjacent rocks in the valley were comparatively easy to erode. A parallel fault approximately 2 km upstream crosses the reservoir just before the northern end of the impoundment.

4.9 Surface Water Quality

4.9.1 General

This section discusses the water quality aspects of the water source considered for augmenting Greater Beirut water supply, including the expected requirements for water treatment prior to distribution.

Two process streams are commonly used for treating natural surface waters:

- Conventional treatment including clarification (coagulation, flocculation and sedimentation), filtration and disinfection; and,
- Advanced treatment to remove pollutants that cannot be removed by conventional treatment.

The objective is therefore to assess Nahr Bisri water and its suitability for potable use after conventional treatment. In order to achieve this, two short rounds of sampling and analysis have been undertaken within Nahr Bisri and its tributary springs and watercourses.

One of the prime advantages of the Bisri scheme option over other GBWSAP dam alternatives, discussed further in Section 8 below, is that it can technically and economically benefit from and give benefit to, the regional water infrastructure already agreed upon for the Awali basin, with water coming from various sources including Qaraoun Lake, springs at Ain Zarqa and near Jezzine, ground water seepage into the unlined transmission tunnel, and Nahr Awali.

A detailed account of the make-up of this water was given in Section 6 of the PD ESIA of September 2012. With Qaraoun water coming from the Nahr Litani, concern was expressed during public consultation that the water to be delivered to Beirut consumers under GBWSP would not be of potable quality. The PD ESIA showed this to categorically not to be the case, and that the water delivered to the Ouardaniye treatment plant from Joun Reservoir contained only some 9% of Qaraoun water, but could be rendered potable in accordance with both Lebanese and international standards using only a conventional water treatment stream.

The purpose of the present ESIA is therefore to show that water impounded behind Bisri Dam is of at least equivalent quality, is free from potentially harmful contaminants, and can also be rendered suitable for consumption by Greater Beirut through the same conventional treatment stream. Figure 4.12 illustrates schematically how the Bisri Dam interfaces with the GBWSP scheme and feeds into the Ouardaniye treatment plant.

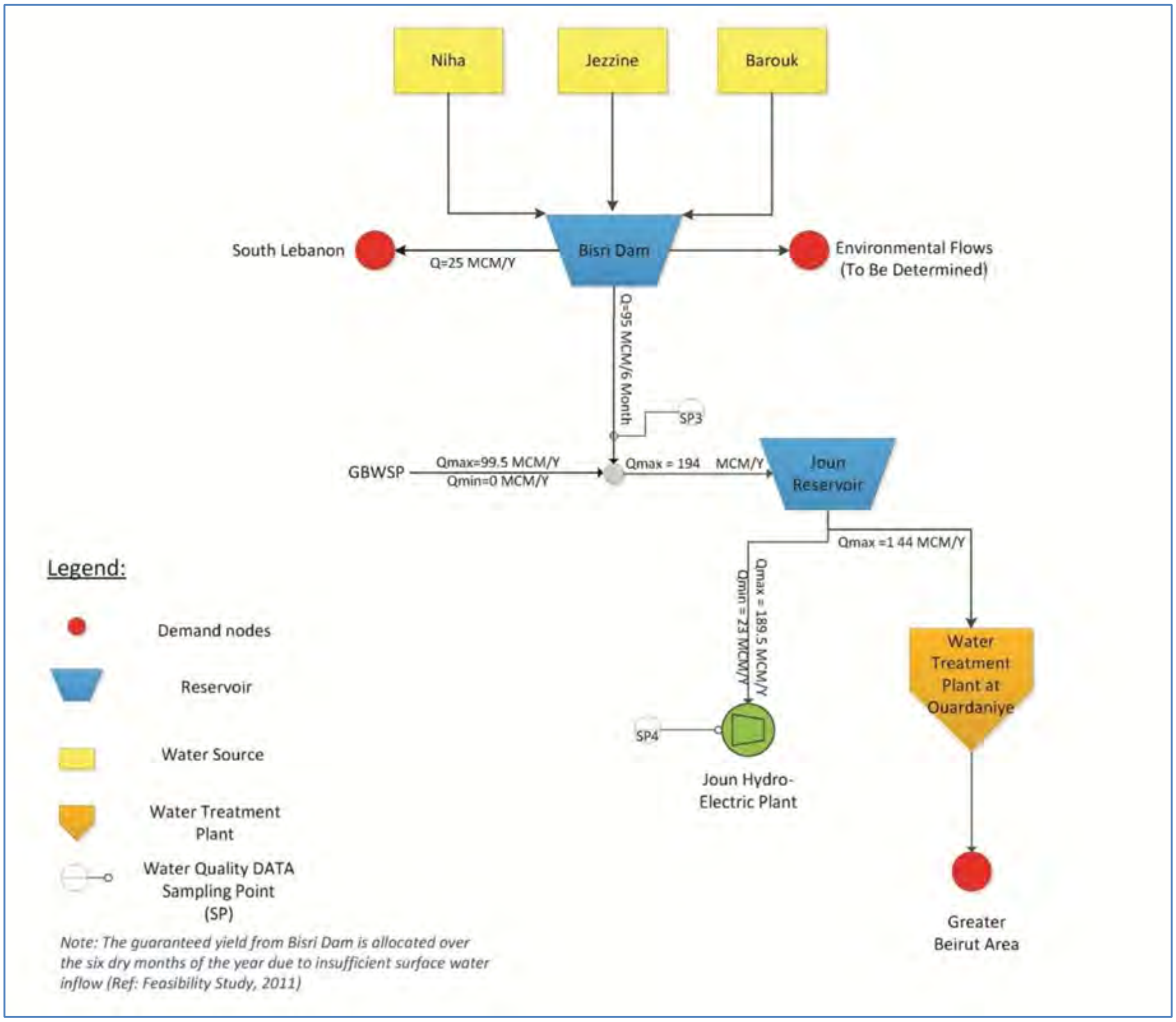

Figure 4.12: The Bisri Scheme within the Awali/GBWP Scheme

The criteria against which to assessing Bisri water quality are the Lebanese Standards and WHO Guidelines for drinking water. Table 4.9 lists the primary and secondary standards, while Table 4.10 lists additional parameters generally used in water quality assessment.

Table 4.9: Primary and Secondary Potable Water Standards and Guidelines

	Parameter	Lebanese MOE Standards[19]	LIBNOR Standards[20]	WHO Guidelines	EU Standards	US EPA Standards
Primary Standards	Turbidity	<4 NTU	<10 NTU	<5 NTU	Not Mentioned	-
	Nitrate/Nitrate-nitrogen	50 mg/l	45 mg/l	-	50 mg/l	10 mg/l
	Nitrite/Nitrite-nitrogen	0	0.05 mg/l	-	0.5 mg/l	1 mg/l
	Cyanide	0.05 mg/l	0.05 mg/l	0.07 mg/l	0.05 mg/l	0.2 mg/l
	Fluorides	0.7 mg/l at 25-30°C	0.7 mg/l at 25-30°C	1.5 mg/l	1.5 mg/l	4 mg/l
	Arsenic	0.05 mg/l	0.05 mg/l	0.01 mg/l	0.01 mg/l	0.05 mg/l
	Cadmium	0.005 mg/l	0.005 mg/l	0.003 mg/l	0.005 mg/l	0.005 mg/l
	Chromium	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.1 mg/l
	Copper	-	1 mg/l	2 mg/l	2 mg/l	1.3 mg/l
	Lead	0.05 mg/l in flowing water	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.015 mg/l
	Selenium	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.01 mg/l	0.05 mg/l
	Faecal Coliforms	0	0 in 250 ml	-	0	0
	Total Coliforms	0	0 in 100 ml	-	0	0
	Antimony	0.01 mg/l	-	0.005 mg/l	0.005 mg/l	0.006 mg/l
	Beryllium	-	-	-	-	0.004 mg/l
	Barium	-	0.5 mg/l	0.3 mg/l	-	2 mg/l
	Mercury	0.001 mg/l	0.001 mg/l	0.001 mg/l	0.001 mg/l	0.002 mg/l
	Thallium	-	-	-	-	0.0005 mg/l
Secondary Standards	pH	9	6.5 – 8.5	6.5-8.5	-	6.5-8.5
	Color	15 mg/l Pt-Co	20 mg/l Pt-Co	15 mg/l Pt-Co	-	15 mg/l Pt-Co
	Total Dissolved Solids	1500 mg/l	500 mg/l	-	-	500 mg/l
	Sulfates	250 mg/l	250 mg/l	500 mg/l	250 mg/l	250 mg/l
	Chlorides	200 mg/l	200 mg/l	250 mg/l	250 mg/l	-
	Iron	0.2 mg/l	0.3 mg/l	0.3 mg/l	0.2 mg/l	0.3 mg/l
	Manganese	0.5 mg/l	0.05 mg/l	0.5 mg/l	0.05 mg/l	0.05 mg/l

[19] Ministry of Environment Decree No. 52/1- Standards for Minimization of Pollution of Air, Water and Soil 1996"
[20] LIBNOR Standard 161; 1999.

Table 4.10: Additional Conventional Water Quality Parameters

Parameter	Limiting value	Remarks
Electrical Conductivity	250 µS/cm [1-2]	-
Total suspended solids	-	Guideline value linked to Turbidity
Hydroxide Alkalinity	-	Guideline value linked to pH
Bicarbonate Alkalinity	-	Guideline value linked to pH
Carbonate Alkalinity	-	Guideline value linked to pH
Total Hardness	150-500 mg/l [1]	-
Calcium Hardness	150-500 mg/l [1]	-
Magnesium Hardness	50 mg/l [3]	-
Ammonia Ammonia-nitrogen	0.5 $(NH)_4$ mg/l [3] 50 mg/l [2]	-
Total Phosphorus	0.015 mg/l [5]	-
Orthophosphates	0.05 mg/l [5]	-
Chemical Oxygen Demand	10 mg/l [5]	-
Biochemical Oxygen Demand	5 mg/l [2]	-
Total Organic Carbon	2 mg/l [4]	-
Volatile Organic Compounds	-	VOC compounds identified if VOCs detected
Organochlorinated Pesticides	N/A	-
Organophosphorus pesticides	N/A	-

Limiting values are reported by different sources [1]WHO Guidelines [2]EU Standards [3]Lebanese Standards [4]US EPA [5]General practice

Water analysis reviewed by the present Bisri ESIA have come from the following studies:

- GBWSP studies for the Awali Scheme;
- AUB study for BMLWE, *Long Term Water Quality Assessment: Litani, Qaraoun Lake and Bisri/Awali River*, Quarterly Reports 1 and 2;
- Analyses for GBWSAP PD ESIA; and,
- Analyses for the present GBWSAP ESIA for Bisri Dam.

During the present ESIA samples were taken in June 2012 from Nahr Bisri at the proposed dam site, and in September 2012 from the sites shown in Figure 4.13 and listed in Table 4.11, this later round approximating the lowest 2012 flow in the river.

The results of all Bisri water analyses made available to the ESIA together with copies of the original PD ESIA and Draft ESIA analyses are given in Appendix E.

Figure 4.13: September 2012 Water Quality Sampling Locations

Table 4.11: September 2012 Water Sampling Locations

Site	X-Y-Z	Stream	Description
BW1	35°32'45"N 33°35'12"E 402 masl	Main	On Nahr Bisri at the proposed dam axis
BW2	35°35'17"N 33°35'29"E 441 masl	Tributary	On a tributary a few meters downstream of an abundant spring. The tributary branches out upstream from Wadi Bhannine and follows a sub-parallel course before discharging into Nahr Bisri. The water had a turbid and soapy appearance
BW3	35°35'23"N 33°35'27"E 446 masl	Tributary	On Wadi Bhannine, to which water drains Aazibe and Ain-el-Darjeh springs from Jezzine. The water had a dark appearance and a sewage odour.
BW4	35°35'56"N 33°36'23"E 473 masl	Tributary	On the tributary from Bater spring, draining Bater Village. fall ends up into this tributary. The water had a dark appearance.
BW5	35°35'52"N 33°36'50"E 463 masl	Tributary	On a tributary that rises at Nabaa el-Barouk and receives many spring issues befor reaching the Bisri Valley, most importantly Nabaa Mershed in Moukhtara. The water was generally clearer than other sampling points but still turbid.

The results of recent analyses show Nahr Bisri water quality conforms to the Lebanese and International Standards and Guidelines for potable use with respect to pollutants that would otherwise require advanced treatment. In respect of specific pollutants, no volatile organic compounds (VOCs), nor any organochlorine presticides were present in quantities that could be detected. Of the organophosphorous pesticides, minute quantities of Lindane and Dieldrin in concentrations marginally above the limit of detection were present in two samples. Since both these substances are banned by the 2001 Stockholm Convention on Persistent Organic Pollutants (POPs), to which Lebanon is a signatory, the source is not immediately obvious. They are, however, known to be carried on the wind and deposited by rain. With prevailing winds generally from the west and Israel being one of the few states not a signatory to the POP convention, transboundary air pollution is the likely source.

The majority of heavy metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Se, Tl, Hg, Be, Sb) were not detected in any of the recent samples. While Barium, present in most common sedimentary rocks, was identified in all samples, its presence was well below the limits given for any of the standards listed in Table 4.10 above.

With the October 2012 sampling round undertaken when surface water flow was near its lowest level for the year, and hence the dilution of sewage discharges from surrounding villages at its minimum, it is surprising BOD, COD and TOC are also below the level of detection, confirming minimum organic pollution. One reason for this may be that by the time of the samples were taken many summer residents had already departed, and that despite low flows, the contributions of high-volume high-nutrient discharges are limited. Another reason might be that the influence of sewage discharges is less than anticipated, which is supported by the absence of ammonia and ammoniacal nitrogen except in the sample from the dam site. Opposing this thesis however are the high concentrations of total and faecal coliforms.

Nahr Bisri does not appear to suffer the high concentrations of nitrate common in intensely agricultural catchments, with all samples recording concentrations well below potable water standards, and nitrate only marginally exceeding the standard in one sample. While NPK (nitrogen-phosphorous-potassium) fertilisers are commonly applied throughout Lebanon to citrus and other tree crops, the nitrogen content is often low while the potassium content is higher, hence the greater concentrations of phosphate.

From the results of recent water sampling, the need for conventional and advanced water treatment to provide Greater Beirut consumers with high quality potable water is shown in Table 4.12[21].

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[21] Assuming no extraordinary adverse change in water quality during reservoir storage.

Table 4.12: Treatment Requirements for Bisri Reservoir Water

Parameter	Conventional Treatment	Advanced Treatment
Temperature (°C)	No	No
Color (mg/l Pt-Co)	Yes	No
Turbidity (NTU)	No	No
Conductivity (microS/cm)	Yes	No
Acidity $CaCO_3$ (mg/l)	Yes	No
Total Alkalinity $CaCO_3$(mg/l)	Yes	No
pH (units)	No	No
Calcium hardness $CaCO_3$ (mg/l)	No	No
Magnesium hardness $CaCO_3$ (mg/l)	No	No
Total hardness $CaCO_3$ (mg/l)	No	No
Chlorides Cl^- (mg/l)	No	No
Sulphates SO_4^{2-} (mg/l)	No	No
Phosphates P (mg/l)	Yes	No
Phosphorus P_2O_5 (mg/l)	Yes	No
Dissolved Iron Fe^{2+} (mg/l)	No	No
Ammonia Nitrogen NH_4^+(mg/l)	No	No
Nitrites NO_2^- (mg/l)	Yes	No
Nitrate Nitrogen (mg/l NO_3^-N)	No	No
Nitrite Nitrogen (mg/l NO_2^-N)	No	No
Nitrates NO_3^- (mg/l)	No	No
Dissolved Oxygen (mg/l)	No	No
TDS as NaCl (mg/l)	No	No
Total Organic Carbon (mg/l)	No	No
Mineralization Virtual (mg/l)	Yes	No
CO_2	No	No
Fluorides	No	No
Manganese Total (mg/l)	No	No
Sulphide (mg/l)	No	No
COD/%S. Humic (mg/l)	No	No
BOD_5 (mg/l)	Yes	No
Coliform Bacteria at 37°C	Yes	No
Thermotolerant Coliform at 44°C	Yes	No
Escherichia Coli at 44°C	Yes	No
Citrobacter Freundi at 44°	Yes	No
Entrebacter Cloacae at 44°C	Yes	No
Kleb. Pneum. Ozaenae at 37°C	Yes	No

Table 4.12: Treatment Requirements for Bisri Reservoir Water (Cont'd)

Parameter	Conventional Treatment	Advanced Treatment
Chryseomonas Luteola at 37°C	Yes	No
Non fermenter spp at 37°C	Yes	No
Pseudomonas Aeruginosa at 44°C	Yes	No
Flavi. Oryzihabitans at 37°C	Yes	No
Salmonella typhimurium or *Proteus mirabilis* at 37°C	Yes	No
Alpha-BHC	No	No
Arsenic (µg/l)	No	No
Cyanide (mg/l)	No	No
Gumma-BHC (Lindane) (µg/l)	No	No
Beta-BHC (µg/l)	No	No
Heptachlor(µg/l)	No	No
Delta-BHC (µg/l)	No	No
Aldrin (µg/l)	No	No
Heptachlor Epoxide (µg/l)	No	No
Endosulfan I (µg/l)	No	No
4,4 DDE (µg/l)	No	No
Dieldrin (µg/l)	No	No
Endrin (µg/l)	No	No
4,4 DDD (µg/l)	No	No
Endosulfan II (µg/l)	No	No
4,4 DDT (µg/l)	No	No
Endrin Aldehyde (µg/l)	No	No
Endosulfan Sulfate (µg/l)	No	No
Chromium (mg/l)	No	No
Manganese (mg/l)	No	No
Iron (mg/l)	No	No
Copper (mg/l)	No	No
Zinc (mg/l)	No	No
Cadmium (mg/l)	No	No
Lead (mg/l)	No	No
Mercury (mg/l)	No	No
Selenium (µg/l)	No	No

During public consultation, the issue of *cyanobacteria* was raised, suggesting its presence in Qaraoun Lake and elsewhere in the GBA supply system would render the water unfit for human consumption. Cyanobacteria, more commonly known as blue-green algae, are often a problem in reservoirs with high nutrient loadings, causing algal blooms. Sources of high nutrient loadings may be vegetation uncleared prior to inundation, the discharge of sewage effluent, and soil organic matter washed in during high river flow. Some strains of the bacteria may contain toxins, *cyanotoxins*, of concern to human health. The general occurrence of these is low and exposure through drinking water or during water-based activities such as swimming or canoeing is largely unknown[22]. While there are some recorded poisonings of livestock and wildlife, it is considered unlikely that humans would ingest sufficient amounts to impart a lethal dose.

Measures to reduce the build-up of nutrients, such as the clearance of vegetation prior to inundation and the implementation of sewerage systems for villages draining to the reservoir have already been proposed. In any case, any algae that get through to the treatment plant can be readily taken out by coagulation and filtration within the type of conventional treatment stream proposed for Greater Beirut.

In conclusion, water quality analyses from Nahr Bisri and its tributaries show that while the water is not immediately of potable quality, the level of treatment required to bring it into compliance with Lebanese and international standards is only that afforded by a conventional treatment stream. No special or advanced water treatment will be required. Treatment for physical parameters including colour, alkalinity and conductivity are primarily for aesthetic reasons, such as appearance and taste, to improve consumer acceptance, while that for chemical and bacteriological parameters, such as coliforms, is required to safeguard public health and prevent gastro-digestive ailments. The treatment stream expected to be provided at Ouardaniye is expected to include coagulation/flocculation, sedimentation, filtration, and disinfection.

4.10 Air Quality and Noise

The Bisri project area is entirely rural with anthropogenic activity predominantly agricultural. Site walkovers, meetings with municipalities and on-site investigations have revealed no industrial, non-agricultural commercial or significant construction activities within the project area and its vicinity. There is therefore an absence of potentially significant sources of atmospheric pollutant or noise emissions.

Given the sparse population and the absence of community facilities, there is also an absence of sensitive receivers. Mar Moussa Church, used only on Mar Moussa day in August each year, is some 1.400 m from the nearest metalled public road, more than

[22] All human deaths accorded to cyanobacteria have been due to intravenous exposure during renal dialysis.

400 m from the nearest occupied house, 200 m from the nearest seasonal farm workers shelters, and over 100 m from the nearest site where farm machinery is used.

Notwithstanding this, short periods of particulate matter emissions due to the movement of agricultural vehicles moving on unsurfaced tracks are evident. Although such periods are rare, they are concentrated in the summer months, when there is greatest tendency to generate dust.

With no public water or power supplies, a number of generators and water pumps are scattered across the project area, but given the openness of the area and the spacing of buildings the emission of SO_x, NO_x and CO are much less of an issue than the impacts posed to those working and living in their immediate vicinity, which is itself primarily seasonal.

Similarly, noise emissions are also deemed to be of little concern given the sparse population and extremely low per capita exposure.

The chances that the level of atmospheric emissions and noise generated in the valley carry up the hillsides to surrounding villages such as Bsaba (850 m distant and 400 m higher), Midane (900 m distant and 350 m higher), or down the valley to Bisri (over 1 km distant and hidden from line-of-sight behind a hill) is almost inconceivable.

SECTION 5

BIOLOGICAL BASELINE CONDITIONS

5. BIOLOGICAL BASELINE CONDITIONS

5.1 Introduction

This section of the ESIA discusses the biological conditions pertaining within the project area and its region. A detailed assessment has been carried out to draw the ecological profile of the area, assess flora and fauna diversity, and to identify those species endangered or IUCN-listed that are at added risk from the project proposed for Bisri.

Herein under **Section 5.2** the flora of the area is discussed, while **Section 5.3** describes its fauna including fish and macro-invertebrates, amphibians and reptiles, avifauna, and mammals. Endangered species and sensitive areas are discussed in **Sections 5.4 and 5.5** respectively.

5.2 Flora

A rapid flora inventory was conducted to identify existing species and their status (rare, endangered, iconic, etc). Walking transects were identified to obtain an understanding of the vegetation communities in the area, identify community boundaries, record existing species, and determine the potential distribution of threatened species. Vegetation communities were randomly assessed in both the thermo-Mediterranean (0-500 m) and part of the Eu-Mediterranean in Bisri.

The area reflects mosaics of ecological niches for various vegetation formations and agricultural fields with various hedges type such as Cyprus and Casuarinas trees. The composition of the vegetation is typical to South/South East and North/North East plants associations. The former represents bushy type vegetation reflecting past uses of the forests with agricultural terraces. The latter mingles trees association of Calabrian pine, stone pine, oak, hawthorn, laurel, pistachio, juniper, carob, etc. with bush formations and herbaceous vegetations. The valley is home to agricultural fields, riverside plant formations and islands of patches of natural vegetation and alien tree species such as willow, alder, tamarisk, oriental plane, Cyprus, stone pine and casuarina. Three types of vegetation are identified:

Type 1 River course vegetation as shown in Figure 5.1, including *Platanus orientalis* L., *Salix libani* Bornm, and *Alnus orientalis* Decne with associated shrubs and herbaceous plants.

Figure 5.1: Riverside Vegetation along Nahr Bisri

Type 2. Hillside North/North East dominated by associations of *Pinus brutia* Ten., *Pinus pinea*, *Quercus calliprinos* Oliv., Quercus infectoria, *Laurus nobilis L. and Pistacia paleastina* Boissm as shown in Figure 5.2.

Figure 5.2: Associations of Plant Populations

Type 3. South/South East similar to the previous type but formed by denser bush-like formations.

Approximately 50 plants were identified, the most important species including *Ricotia lunaria* (L.) DC. (endemic), *Orchis anatolica* Boiss., *Orchis morio* L., *Orchis papilionaceae* L., *Orchis pyramidalis* M. Bieb., *Orchis romana* subsp. *libanotica* Mt., *Orchis tridentata* Scop., *Ornithogalum umbellatum* L. and *Fritillaria libanotica* (Boiss.) Baker, some of which ate illustrated Figure 5.3.

Orchis papilionaceae L.

Orchis morio L.

Orchis romana subsp. *libanotica* Mt.

Orchis tridentata Scop.

Fritillaria libanotica (Boiss.) Baker

Figure 5.3: Examples of Plant Species in the Bisri Area

In addition to its wild plant species, Marj Bisri is rich in fruit trees mainly citrus, roses and strawberry grown in polytunnels, and commercial grass plots for turf.

5.3 Fauna

5.3.1 Fish and Macro Invertebrates

Electro-fishing was used to survey fish and macro invertebrates. It is a non-selective method that provides a broad overview of the fish fauna living in the surveyed water body. Figure 5.4 shows electro-fishing for ichthyofauna at Bisri site.

Figure 5.4: Survey of Ichthyofauna using Electro-Fishing on Nahr Bisri.

Five fish species and one crab were identified in Nahr Bisri, as listed in Table 5.1.

Table 5.1: Fish Species Recorded from the Awali Basin

Species	Family
Salaria fluviatilis (Asso, 1801)	Blenniidae
Anguilla anguilla (Linnaeus, 1758)	Anguillidae
Capoeta damascina (Valenciennes, 1842)	Cyprinidae
Pseudophoxinus kervillei (Pellegrin, 1911)	Cyprinidae
Oxynoemacheilus leontinae (Lortet, 1883)	Balitoridae
Potamon potamios (Olivier, 1804)	Potamidae

Three of the above fish species deserve special mention. These are the Freshwater blenny, the European eel, and the Middle Eastern Green carp. No exotic fish or macro invertebrates were captured.

Freshwater blenny or Salaria fluviatilis

The fish resides in lakes and streams with moderate current and has a clear preference to stony bottoms. It is a territorial species that can live up to 5 years. It feeds on insects, crustaceans, and fry. In Lebanon, it reproduces during spring.

Figure 5.5: The Freshwater Blenny Salaria Fluviatilis

According to IUCN, the Freshwater blenny is not currently considered threatened around the Mediterranean. However, populations have declined considerably in recent years and the fish has completely disappeared from most rivers in Lebanon. This is mainly because of habitat alteration, rivers drying up, drought, and pollution. Two small populations seem to be confined in the lower parts of Nahr Awali and Nahr Damour, living only in the last few hundred meters of freshwater close to the estuary. Thus This these two populations, each thought to be less than 100 individuals, critically endangered. While they are downstream of the Bisri project, the curtailment and control the project will impose of seasonal flow way put their survival in peril.

European eel or Anguilla Anguilla

This is a *catadromous* fish that resides in freshwater most of its life and migrates to the sea for spawning. The species lives in all types of habitats from small streams to large lakes. It reproduces between March and July in the Atlantic Ocean (Sargasso Sea) and feeds on a wide variety of benthic organisms. The species has a high commercial value in Europe and around the Mediterranean. European eel has been recently considered as critically endangered by IUCN. In Lebanon, Eel is found in all rivers connected to the sea with running waters.

Figure 5.6: The European eel Anguilla Anguilla; adult (left) and Larvae (right)

The decline in its population is mainly due to water diversion for agricultural, industrial, and domestic use and heavy chemical pollution.

Middle Eastern Green carp or Capoeta damascina

This is a very common carp that lives in all rivers of Lebanon, as well as the Quaraoun and the Chouan lakes. It is a bottom fish, feeding mainly on algae, invertebrates and detritus. It reproduces in small streams where it deposits its eggs on gravel.

Figure 5.7: The Middle Eastern Green Carp Capoeta Damascina

The fish can withstand poor water conditions and high levels of pollution. It is commonly targeted by Lebanese anglers for consumption and has a local commercial importance.

5.3.2 Amphibians and Reptiles

Survey of amphibians and reptiles in the Bisri area was conducted during the day and the night. In addition to field visits and surveys, identifying active animals was based on inventories and bibliographic reviews. Emphasis was made on species richness, areas of activity and breeding habitats.

Various species of reptiles were identified in the proposed dam and reservoir site. None of them are known to be endangered or endemic. Table 5.2 shows the species that might be impacted directly or indirectly by dam construction and inundation. The impact on the species could be in terms of changes in habitat, breeding sites or food sources.

Table 5.2: List of Reptiles and Amphibians in the Bisri Area.

Species	Common Name	Picture	Status				Type of Impact		
			T	E	R	C	HT	BR	FD
Natrix tessellata	Water snake					+	+		?
Pelophylax bedriagae	Marsh frog					+	+	+	?
Pelobates syriacus	Eastern or Syrian spadefoot				+		+	+	?
Bufo viridis	Green toad					+		+	?
Bufo cf. *bufo*	European common toad			+	+		+	+	?
Hyla savignyi	Tree frog					+	+	+	?
Salamandra infraimmaculata	salamander					+	+	+	?
Triturus vittatus	Newt				+				

T = Threatened, E = Endemic, R = Rare, and C = Common.
HT= general habitat, BR=breeding habitat, FD=food requirements.

5.3.3 Avifauna

The 20-minute point-count method was used to identify the existing avian species in the Bisri reservoir area. Species were recorded at different places and times in the most characteristic habitats. This method is semi-quantitative and changes in abundance of a species are estimated by changes in the frequency of this species over a series of point counts. Other information about species status and trends was retrieved from past experience literature when available.

Thirty two species were identified as shown in Table 5.3, four of which are forest dependent and may reappear in the riparian areas above and below the Bisri dam site. These are the Wren, Jay, Chaffinch and Blackbird. Species that tolerate high disturbance were found across the site. These include the Graceful Prinia, Sparrow, Hooded Crow and Bulbul. Several birds common to the region were spotted in the site including Graceful Prinia (*Prinia gracilis*), Jay (*Garrulus glandarius*), Hooded Crow (*Corvus cornix*), Wren (*Troglodytes troglodytes*), and Sparrow (*Passer domesticus*),

Swift (*Apus apus*) and Lesser White Throat (*Sylvia curruca*) were frequently spotted. A few other bird species were reported by villagers, such as Lesser Kestrel (*Falco naumannii*), Black Redstart (*Phoenicurus ochruros*), Masked Shrike (*Lanius collurio*), and Barn Owl (*Tyto alba*). Field visits during October increased the total number of birds from 28 to 32 species, 24 of which are common, and none are endemic. Four bird species are threatened as shown in Figure 5.8. These are White storks, Lesser Spotted Eagle, White Pelicans that are of passage only, and Short-toed Eagle that is of wide range of action.

Table 5.3: Birds Identified in the Vicinity of Bisri Dam Site.

	Species	*Scientific name*	Status	T	E	R	C
1	Bulbul	*Pycnonotus xanthopygos*	R				+
2	Graceful Warbler	*Prinia gracilis*	R				+
3	Common Chiffchaff	*Phylloscopus collybita*	SB, PM, WV				+
4	Chaffinch	*Fringilla coelebs*	R, PM, WV				+
5	Winter Wren	*Troglodytes troglodytes*	R				+
6	Blackbird	*Turdus merula*	R				+
7	Eurasian Jay	*Garrulus glandarius*	R				+
8	Great Tit	*Parus major*	R				+
9	European Greenfinch	*Carduelis chloris*	R				+
10	Blackcap	*Sylvia atricapilla*	SB, PM, WV				+
11	Sardinian Warbler	*Sylvia melanocephala*	R, PM, WV				+
12	Lesser Whitethroat	*Sylvia curruca*	SB, PM, ?wv				+
13	White Storks	*Ciconia ciconia*	PM	+			+
14	Pelican	*Pelecanus onocrotalus*	PM	+			+
15	Short-toed Snake Eagle	*Circaetus gallicus*	SB, PM	+		+	
16	Long-legged Buzzard	*Buteo rufinus*	R, PM, WV				+
17	Hooded Crow	*Corvus cornix*	R				+
18	Palestine Sunbird	*Cinnyris osea*	R, wv			+	
19	European Goldfinch	*Carduelis carduelis*	R, WV, pm				+
20	House Sparrow	*Passer domesticus*	R				+
21	Swift	*Apus apus*	SB, PM				+
22	Lesser Spotted Eagle	*Aquila pomarina*	PM				+
23	Black headed Bunting	*Emberiza melanocephala*	SB				+
24	Corncrake	*Crex crex*	pm	+		+	
25	Black Kite	*Milvus milvus*	PM				+
26	Steppe Buzzard	*Buteo vulpinus*	PM				+
27	Hoopoe	*Upupa epops*	R, SB			+	
28	White Wagtail	*Motacilla alba*	PM, WV				+
29	Steppe Buzzard	*Aquila nipalensis*	pm			+	
30	Levant Sparrowhawk	*Accipiter brevipes*	PM				+
31	European Sparrowhawk	*Accipiter niseus*	PM			+	
32	Marsh Harrier	*Circus aeroginosus*	PM			+	

R= resident, PM= passage migrant, WV= winter visitor, SB= summer breeder, ?= uncertain status. T= threatened, E= endemic, R= rare, and C= Common

White Storks *Lesser Spotted Eagle* *White Pelican* *Short-toed Eagle*

Figure 5.8: Threatened Bird Species in the Bisri Area

5.3.4 Mammals

Two approaches, direct and indirect were used to monitor mammals. The indirect approach was conducted during day time through diurnal walking surveys where opportunistic observations of secondary signs such as tracks, footprints, fur and scats were recorded. Caves and dens were inspected for bats, animal signs and animal remains. The direct approach was conducted in two ways night surveys and photo trapping to obtain data on the more secretive and nocturnal species.

Photo-trapping equipment to survey mammals consisted of seven pre-baited active and passive remote camera traps, as shown in Figure 5.9.

Figure 5.9: Camera Traps and Bait being Laid for the Mammal Survey at Bisri.

The rapid field survey on mammals at the proposed dam site revealed the presence of 17 mammal species belonging to 14 families, as shown in Table 5.4.

Table 5.4: List of Mammalian Species at Bisri

Family	Species	Scientific Name	Nahr Bisri
Erinaceidae	Hedgehog	*Erinaceus concolor*	R, r
Miniopteridae	European Free-tailed bat	*Tadarida teniotis*	R, r
Vespertilionidae	Common pipistrelli	*Pipistrellus Pipistrellus*	R, c
	Khul's pipistrelle	*Pipistrellus kuhli ikhawanius*	R, c
Rhinolophidae	Lesser horseshoe	*Rhinolophus hipposideros*	R, c
	Greater horseshoe bat	*Rihnolophus ferrumequinum*	R, c
Canidae	Jackal	*Canis aureus syriacus*	R, c
	Fox	*Vulpus vulpus palaestina*	R, c
Mustelidae	Pine Martin	*Martes foina syriaca*	R, c
	Badger	*Meles meles canescens*	E, r
	Otter	*Lutra lutra*	E, r
Hyaenidae	Striped hyaena	*Hyaena hyaena syriaca*	R, c
Felidae	Wild cat	*Felis silvestris tristrami*	R, r
Suidae	Wild boar	*Sus scrofa lybicus*	R, c
Sciuridae	Squirrel	*Sciurus anomalus syriacus*	E, c
Hystricidae	Porcupine	*Hystrix indica indica*	R, c
Spalacidae	Moles	*Spalax leucodon ehrenbergi*	R, c
Muridae	House mouse	*Mus musculus praetextus*	R, c
	Rats	*Rattus rattus*	R, c
	Field mouse	*Apodemous mystacinus*	R, c
Microtinae (Subfam.)	Voles	*Microtus sp.*	E, c

R= recorded, E= Expected, c= common, r= rare, endemic or endangered at National level

In addition to wild mammals domestic mammals like goats, cows, dogs and cats were also encountered. Moreover, within the dam site there is a private menagerie that houses lions, tigers, lamas, deer, hyaenas, a fox, some farm animals, and a chimp.

Out of the 17 species of mammals, one species, the hedgehog is dependent on forests, farmlands, gardens and orchards. In addition, 3 bat species: the European free tailed bat, lesser horseshoe, and greater horseshoe, hunt along open woodland, woodland edges and paths as well as hedgerows.

Most other species can tolerate high disturbance and are referred to as urban wildlife; these included the common pipistrelle, Khul's pipistrelle, jackals, foxes, pine martins, wild boar, house mice, rats, and field mice.

Several mammals which are common to the region were spotted in the site, such as wild cats, striped hyaenas, porcupine, and moles.

Finally, two other mammal species which are dependent on the riparian ecosystem are expected to be present: the otter *Lutra lutra* an amphibian mammal that was reportedly recorded in Moukhtaram, and voles, which are other riparian ecosystem inhabitants that usually live in river banks.

Only five species are considered to be rare species, as shown in Table 5.5.

Table 5.5: Five 'Rare' Mammal Species at Bisri

English name	**Hedgehog**	
Scientific name	*Erinaceus europaeus concolor*	
Status	This species was common in Lebanon, especially in the coastal plain. However, at present the species is endangered due to excessive use of pesticide, unintentional killing during hibernation and road kills.	
English name	**European Free-Tailed bat**	
Scientific name	*Tadarida teniotis*	
Status	This species is threatened in Lebanon due to habitat destruction excessive use of pesticide.	
English name	**Eurasian Badger**	
Scientific name	*Meles meles canescens*	
Status	Badgers are endangered in Lebanon due to persecution by human.	
English name	**Wild cat**	
Scientific name	*Felis silvestris tristrami*	
Status	Endangered species due to cross breeding with domestic cats	
English name	**Common Otter**	
Scientific name	*Lutra lutra seistanica*	
Status	This species is endangered in Lebanon due to hunting and drying of wetlands.	

SECTION 6

SOCIO-ECONOMIC BASELINE CONDITIONS

6. SOCIO-ECONOMIC BASELINE CONDITIONS

6.1 Introduction

The cadastral regions within which land will be expropriated are listed in Table 6.1.

Table 6.1: Cadastral Regions in the Vicinity of Bisri Reservoir

Caza	Cadastral Regions
Chouf	Mazraat El Dahr; Bsaba, Mazraat El Chouf, Aamatour and Bater
Jezzine	Bisri; Harf; Midane; Ghbatiye; Benouati; Aariye; and Bhannine

Lebanon has long suffered the lack of accurate comprehensive socio-economic analysis because no national census has been undertaken since 1932, and while sample surveys in selected areas and communities have been carried out, no such survey is available for the very sparsely populated Nahr Barouk/Nahr Bisri valley. In addition, there is a lack of accurate cadastral and land ownership data. The area is not included in the priority areas of the Department of Real Estate at the Ministry of Finance, for which UNDP has financed surveys and the developed land ownership records. Data available for the ESIA has therefore primarily been derived from the following:

- Desk study and publicly available information from previous studies;
- maps and plans from municipalities, the Mof Real Estate Department (*Cadastre*) and the Directorate General of Urban Planning;
- Repeated site walkovers in the dam site, the area expected to be inundated and the anticipated shoreline;
- Visits and walkovers within the upper and lower dam catchment areas;
- Photography for visual documentation; and,
- Informal meetings with elected members of affected municipalities, muktars, local residents, seasonal farm workers, and others.

As part of the ESIA but later in the project cycle than the present report, the ESIA Consultant will be undertaking a full socio-economic survey on which to base proposals for land expropriation and the development of a Resettlement Action Plan.

Section 6.2 outlines the key social indicators, while **Section 6.3** discusses population and employment. **Section 6.4** discusses household structure and tenure; **Section 6.5** education and health, and **Section 6.6** access to public utilities and community services. **Section 6.7** identifies and discusses vulnerable groups within the community that may require special attention during the execution of the Bisri project.

Section 6.8 discusses land utilization, with **Section 6.9** summarises the cadastral information collected to date.

Finally, **Section 6.10** discusses in some detail the interesting archaeological, historical and recent cultural heritage to be found in the Bisri reservoir and its environs.

6.2 Key Social Indicators

The key social indicators for the most projects in Lebanon include demographic profile (the representation within the population of different age groups and genders), access to public utility services (roads, power, telecoms, water, wastewater and drainage), to community services (schools, health centers, recreational facilities, NGOs and public open space), land ownership and utilisation, standards of public health, educational attainment, and employment and income-generating activities. Of particular relevance to the present project, is the seasonality of residence and employment place of work.

By international standards, Lebanon scores relatively high in terms of social indicators such as educational attainment, life expectancy, and income. It is ranked 71 out of 187 countries in UN Human Development Index (HDI)[23] with a score of 0.739, greater than the World average of 0.682 and also higher than the average for all Arab States, 0.641.

6.3 Population

The population of Lebanon in 2011 was estimated[24] to be 4.2 million, of which 87% are urban and 13% rural[1]. The population of the Greater Beirut conurbation, the prime recipient beneficiaries of the Bisri project, is currently estimated at 2 million and is expected to reach 2.2 million by 2025 and 3.5 million by 2035[25]. Growth rates vary between the organisation undertaking the survey, but generally the urban population is increasing at twice the rate of the rural population. As always, real growth in Lebanon is difficult to determine due to the high level of emigration and the absence of a national census.

In 2005, the total population of Lebanon was estimated to comprise 49% males and 51% females, of which 28% were minors under 16 years of age, 65% adults between 16 and 64, and 7% 65 years or older. Such a composition mirrors those of adjacent Arab countries. The age-sex distribution represented in the population pyramids in Figure 6.1 illustrates the youth bulge in 2005 and its predicted transition by 2050[26]

[23] UNDP (2011). Lebanon: HDI values and rank change in 2011, Human development Report

[24] The government of Lebanon has not held a national Census since 1932

25 Central Administration of Statistics, 2010.

[26] ESCWA, UN. Population Information Network. Lebanon Demographic Profile.

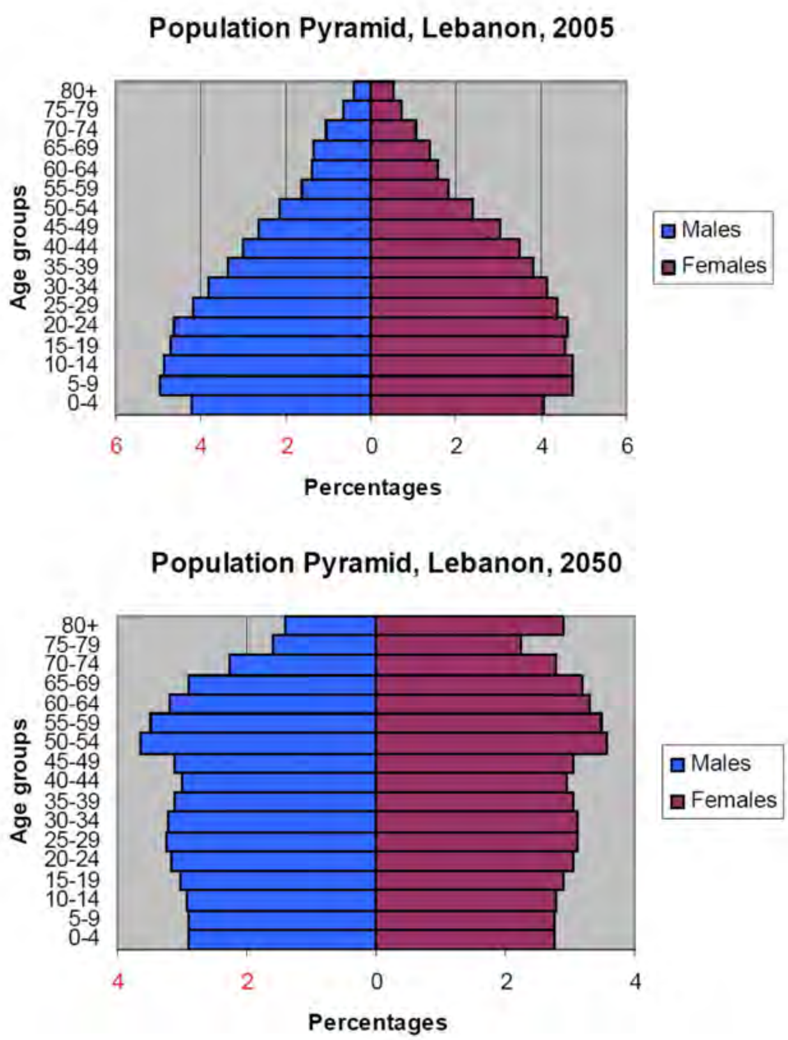

Figure 6.1: Population Pyramids in Lebanon over Years 2005 and 2050

Over the last two decades the Saida-Jezzine area witnessed substantial increase in population, its share of the total households nationally increasing from 4.8% to 6.5%, primarily resulting from the return of displaced families, both during the post-war decade (1990-2000) and following the liberation from Israeli occupation post in 200027.

Within the broad vicinity of the dam, the estimated summer and winter populations of the areas surrounding Bisri Reservoir, as reported by discussions with municipalities, total over 18,000 in the summer and more than 11,000 in the winter, divided as shown in Table 6.2.

[27] UNDP (2005) Development of Mapping of Living Conditions in Lebanon, 1995-2004

Table 6.2: Approximate Population Surrounding Bisri Reservoir

Area	Estimated Population	
	Winter	Summer
Chouf Caza		
Mazraat El Dahr	250	500
Bsaba	2,000	3,000
Mazraat El Chouf	4,000	6,500
Aamatour	1,500	3,000
Bater	2,000	2,000
Sub-total	9,750	15,000
Jezzine Caza		
Bhannine	50	50
Benouati	450	1,000
Ghibatiye	400	400
Aariye	500	1,000
Midane	120	500
Harf	100	200
Bisri	100	200
Sub-total	1,720	3,350
TOTAL	**11,470**	**18,350**

Both sides of the river have about a 40% greater population in summer than winter. The reasons for this are primarily:

- Natives working in the coastal cities take their families to benefit from access to education, health and other social and community services;
- Natives living away from their villages will migrate back to avoid Beirut's summer heat and humidity during the long summer school vacation;
- Many natives of Beirut have summer houses, owned or rented, that they occupy during the summer months.

Notwithstanding this, only a small percentage of this population will in any way be impacted by the dam. Even those with only a distant view of the reservoir will be few. Most landowners within the proposed area of inundation are 'absentee landlords'.

6.4 Employment

The pursuing of UN's Millennium Development Goals[28] in Lebanon reported an increase in the employment-to-population ratio from 31.1% 1997 to 35.7% in 2004, still weak when

[28] UNDP. The Millennium Development Goals. Lebanon.

compared to an average of 47.8% for the Middle East and 45%-60.9% for developed countries, implying a particularly high rate of economic dependency, not only within families in Lebanon but also on relatives in the Lebanese Diaspora.

According to the International Labor Organization (ILO) strict definition of unemployment[29], the unemployment rate in Lebanon is 6.4%, although the real rate is, in common with other countries of similar social development, believed to be substantially higher than official figures suggest. A 2011 World Bank analysis suggests 20% of the population live below the poverty line and, not surprisingly, unemployment is highest among unskilled workers.

The current minimum monthly wage in Lebanon is LBP 675,000 (about US$450).

Of the total workforce some 46% work in the service sector, 22% in trade, 15% in process industries, 9% in construction and 8% in agriculture, as illustrated in Figure 6.2. 86% of workers are employed by private sector companies and institutions, 13% by the public sector and 1% by international organizations, civil or partisan organizations.

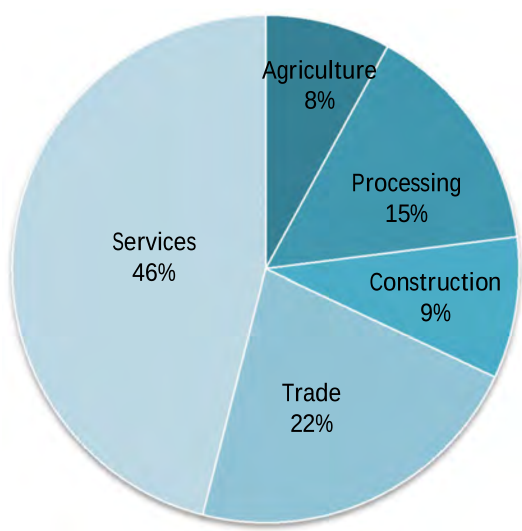

Figure 6.2: Distribution of Labour Force by Economic Sector

Agricultural activities are prevalent throughout the area of Bisri Reservoir, the valley upstream and downstream, the adjacent hillsides, and include fruit and vegetables grown in poly-tunnels and open fields, fodder crops, citrus and olives. Very few if any residents within the area directly impacted by the project work anywhere else other than

http://www.undp.org.lb/WhatWeDo/MDGs.cfm.

[29] The unemployment rate is the per cent unemployed (aged 15-64) of the economically active population.

where they reside, while few if any residents of adjacent villages work within the directly impacted area.

6.5 Household Structure and Tenure

As expected, most of the buildings in the villages surrounding the reservoir are residential, often with retail and service outlets on the ground floor and limited in height to generally no more than four stories. Within the valley in general and the reservoir area in particular, there are a number of spaced residential buildings, some of substantial structure and originally well appointed, but those that are not now derelict have fallen into disrepair and are used only to house seasonal farm labourers. There are also a small number, three or less, significant farmsteads fronting a modern farming operation supporting two or more related kinship groups.

The 2005 National Survey of Household Living Conditions showed that the population aged 15 and above in the Mohafazats of Mount Lebanon and South Lebanon were less economically active than those in Beirut, as shown in Table 6.3.

Table 6.3: Economic Activity by Mohafazat

Mohafazat	Females	Males	All
Beirut	36.2%	69.9%	51.1%
Mount Lebanon	23.7%	70.8%	47.2%
South Lebanon	16.6%	65.3%	39.7%
North Lebanon	11.2%	70.7%	40.0%
Bekaa	10.9%	64.2%	37.7%
Nabatieh	19.4%	63.6%	40.8%
Lebanon	**20.4%**	**68.9%**	**44.05**

According to the UNDP[30], South Lebanon has a high percentage of deprived households (37%), followed by Mount Lebanon (16%) in comparison to Beirut (9%). There was no significant reduction in the level of deprivation between 1995 and 2004 in the Chouf and Saida-Jezzine regions adjacent to the Awali Valley

Initial indications, prior to the full socio-economic survey that will comprise structured interviews with pro-forma questionnaires is that the majority of land holdings are large but within a family-holding may be sub-divided among individuals. Land owners are

[30] UNDP (2005) Development of Mapping of Living Conditions in Lebanon, 1995-2004

commonly absentee landlords, and the majority of those that work the land have formal or informal tenancy agreements. Those that work the land without title are expected to be few. While much labour is seasonal, with many workers migrating from Syria and Egypt, a high proportion may stay on the land after harvest, waiting for the next planting season simply because they have nowhere else to go.

6.6 Education and Health

The World Bank reports[31] a relatively high education enrolment rate in Lebanon especially during the early years, as shown in Table 6.4.

Table 6.4: Education Enrolment in Lebanon

Level	Enrolment
Elementary	95.4%
Intermediate[32]	86.9%
Secondary	74.9%
Tertiary[33]	51.6%

These rates are similar for females and males, with a slight increase for females after secondary level, an indication of women empowerment and development. Those who have attained only an elementary education make up the highest proportion of workers, 28.1%. As would be expected, the proportion of students continuing in education after the age of 15 is significantly higher in Beirut and Mount Lebanon than elsewhere, as shown in Table 6.5. According to a 2011 UNDP study, the expected years of schooling in Lebanon are 13.8, but the average achieved is only 7.9 years.

Table 6.5: Enrolment in Education by Mohafazat

Age	Beirut	Mount Lebanon	North Lebanon	Bekaa	South Lebanon	Nabatieh	Lebanon
5-9	98.9%	98.1%	99.1%	99.0%	98.3%	99.6%	98.6%
10-14	96.1%	96.5%	92.5%	96.6%	94.0%	95.7%	95.2%
15-19	79.4%	76.9%	61.4%	70.6%	67.2%	66.8%	71.1%
20-24	39.8%	39.0%	27.6%	29.3%	29.3%	32.3%	34.2%
25-29	9.8%	6.7%	4.8%	6.5%	8.1%	6.2%	6.8%

[31] The World Bank EdStats Database". http://go.worldbank.org/ITABCOGIV1.

[32] National Survey of Household Living 2004-2005. Chapter III. Labor Force and Economic Activity Rates (Employment and Unemployment) Ministry of Social Affairs, UNDP and CAS, 2006

[33] The Status and Progress of Women in the Middle East and North Africa, The World Bank, 2009

The percentage of illiteracy, measured by non-enrollment rates in schools, in Beirut and Mount Lebanon is only 5.6% and 6.6% respectively, whereas in the Bekaa it reaches 13.4%. Lebanon is well known for its numerous private educational institutions, which are attended by 53% of all students, while only 45% attend government education facilities.

According to UN statistics[34], the average life expectancy in Lebanon is 73 years. The country has witnessed significant improvement in pre/post-natal care and the under-five mortality rate is only 20/1000 births. The infant mortality rate dropped from 28/1000 live births to 24/1000 between 1996 and 2011, and maternal mortality fell from 140/100,000 to 107/100,000 live births over the same period.

The reporting of HIV/AIDS cases is limited, with 52% of total cases being among those aged 31-50 years. Tuberculosis declined from 983 cases in 1995 to 375 in 2006 as a direct result of Directly Observed Treatment Short Course Chemotherapy (DOTS Strategy)[17].

More than half, 51%, of workers do not receive any health insurance, while 49% are covered by at least one type of insurance as shown in Table 6.6. Since there is no unemployment welfare, the labour force is dependent on employment for health benefit. If those benefiting only from the NSSF[35] become unemployed, their coverage lapses after 3 months.

Table 6.6: Distribution of Health Insurance Coverage and Type

Type of Health Insurance	Proportion of Workers
National Social Security Fund (NSSF)	27%
Private (at own or employer's expense)	10%
Army and the Internal Security Forces	6%
Public Servants Cooperation	4%
Other type of cover	2%
Total Covered	**49%**
No Covered	**51%**

Other cover includes policies held outside Lebanon, municipality and mutual fund schemes, and UNRWA

[34] UNDP, The Millennium development Goals. Lebanon
http://www.undp.org.lb/WhatWeDo/MDGs.cfm

[35] NSSF (National Social Security Fund) is a health insurance and end-of service pension

6.7 Public Utilities and Community Services

There is a poor public utility provision throughout the project area. In most villages potable water is primarily obtained from wells after basic chlorination, from natural springs or obtained as bottled water.

While many residential buildings in the surrounding village centres are connected to a local sewerage network, this usually delivers to a plant only providing primary treatment, the effluent then inevitably discharged to surface watercourses. Premises lying on the outskirts of villages and remote from population centres, including all the buildings within the Bisri Reservoir area, discharge sewage to holding tanks, which in turn infiltrate to the ground. Although often termed 'septic tanks' they do not impart the level of treatment that their name implies elsewhere.

Power to existing buildings within the reservoir area is generally obtained from private generating units. Power cables are generally absent from the reservoir area. The farm at the top end of Bisri Reservoir has at least one small photovoltaic panel but primarily relies upon a diesel generator. Some surrounding villages receive power from the Karkosh HEP.
Within the reservoir and the adjacent valley slopes there are no community facilities, although other than the historic Mar Moussa Church adjacent to the dam site within Mazraat El Dahr. Those in the surrounding villages are summarised in table 6.7. The project proponent must invite the NGOs identified to future public consultation exercises. There are also few communal services within the vicinity of the reservoir, such as schools, playgrounds, non-governmental organizations, and health centres.

Table 6.7: Community Services in the Vicinity of Bisri Reservoir

Area	Playgrounds	Schools	Churches and Mosques	Cemeteries	Health Centres	NGOs and CBOs
Mazraat El Dahr	-	-	2 Church	1	-	-
Bsaba	1	-	2 Mosques	1	1	• Youth Association of Bsaba
Mazraat El Chouf	1	1	1 Church 5 Majlis	5	1	• Progressive Women's Assoc. • Assoc. of Social Solidarity
Aamatour	1	1	1 Church 1 Majlis	1	1	• Aamatour Women's Assoc • Ammatour Club • Cultural Gathering Assoc
Bater	1 playground 1 public garden	1	1 Church 4 Majlis	1	1	• Tasleef • Cultural and Social Club
Bhannine	-	-	1 Church	1	-	-
Benwati	1	-	1 Church	1	-	-
Ghibatiye	-	-	1 Church	1	-	• Ghibatiye Charitable Society
Aariye	-	1	1 Church	1	-	-
Midane	1	-	1 Church	1	-	-
Harf	1	-	-	1	-	-
Bisri	-	-	1 Church	1	-	-

6.8 Vulnerable Groups

The project area has no indigenous tribes or ethnic minorities. The distinction between areas, municipalities and villages is essentially along confessional lines, with Muslim, Christian and Druse communities all present within the vicinity of Bisri Reservoir. Primarily comprising Lebanese citizens, each person is treated equally under the law without institutionalised discrimination of injustice. In respect of vulnerable groups, those identified in the project area are as follows:

- Women;
- The elderly and infirm
- Young people;
- Lebanese farm labourers;
- Foreign farm labourers.

6.8.1 Women

Lebanon has made significant progress towards achieving gender equality, with female illiteracy falling from 27% in 1990 to 7% in 2011. Educational attainment is greater for females than males and females occupy high positions in many fields of specialization. For instance, 42% of Lebanon's judiciary are now women.

There remain, however, differences in gender achievement across the spectrum of professions, with a greater proportion of females in office, service and unskilled work, and a higher proportion of males in management and skilled occupations. As elsewhere in the region, women, including those predominantly employed as homemakers, are primarily responsible for awareness and education, and frequently control 70% or more of household expenditure.

In many ways, educated Lebanese women who remain single have opportunities for advancement not universally available throughout the region. For political rather than spiritual reasons, marriage, divorce, child custody, inheritance and associated issues are controlled by the various religious sects. Despite a long–running campaign, the Government of Lebanon refuses to introduce civil law alternatives. One result of this is that many couples travel to Cyprus and other destinations offering civil marriage. Lebanese law requires offspring to take the nationality of the father; a Lebanese mother is unable to pass on her nationality to children sired by a non-Lebanese father. Perhaps most significantly, divorce initiated by women, even in the face of severe domestic violence, is difficult to obtain and often only granted after several years of suffering.

Within the villages surrounding the Bisri project, the most women take on the traditional roles of homemaking and child-rearing, or work in local services. Within the agricultural families working in the reservoir area, many women play equal part in farming activities in addition to their other gender-related duties.

6.8.2 The Elderly and Infirm

In accordance with Lebanese tradition, the elderly and infirm are usually cared for within the family. In the Bisri valley, where most land owners are absentee landlords, elderly and infirm family members will live elsewhere. Seasonal workers and other residing temporarily on the land they are working will generally not bring elderly and infirm relations with them.

given the relative remoteness of the Bisri valley, with no metalled roads, lack of public transport, and access to medical services, it is infeasible for elderly or infirm person to live there alone or with their family.

6.8.3 Young People

Young people under 25 years of age comprise 47% of the population. While few would now remember the years of civil unrest and invasion, their formative years have coincided with ones of political instability and stagnation. Many are therefore poorly motivated, unemployed or underemployed, and those who are employed either made use of the first opportunity available to them or are dependent upon opportunities provided through kin and family contacts. Around 20% of those aged 15-24 are unemployed and child labor is common, especially among the urban and rural poor.

Those children resident within the reservoir area are primarily those of migrant farm labourers who work alongside their parents and probably are not enrolled in school.

6.8.4 Lebanese Farm Labourers

Within the reservoir area there are a proportion of the farm workers who are Lebanese nationals and commute daily from Saida and surrounding villages to work for either the land owners or more commonly for those with formal tenancy agreements with the owners. These workers have no entitlement to land and under Lebanese expropriation law will receive only limited compensation for their loss of livelihood when the land they work is flooded.

During the period of construction and subsequent operation, these workers should be offered priority employment in dam and reservoir maintenance.

6.8.5 Foreign Farm Labourers

During the frequent site visits for the ESIA the consultant's staff have met a variety of non-Lebanese farm labourers, including Syrians, Syrian Kurds, Palestinians and Egyptians. Those with a permanent residence elsewhere come and go seasonally, for planting and/or harvest. Others come with their families and either take over one of the vacant houses or set up camp within the area in which they are working. These often have no permanent residence elsewhere and may remain on the site between periods of employment for the simple expediency that they have nowhere else to go. Some of those met at Bisri have been on site for more than five years. Typically, a male worker will come and find work and after a few weeks or months send for his immediate family. In time, as the work appears more secure, more distant members of his extended family will join him, thus extending the family unit present on the site.

Invariably, these workers and their family have no security of tenure or right of occupancy. On completion of Bisri Dam, these workers will lose both their livelihood and home, yet have no entitlement to compensation or other redress other than what may be offered through the generosity of their employer and/or land owner.

6.9 Land Utilisation

The Consultant has carried out several walkovers throughout the reservoir area and adjacent buffer zones to identify the types of land uses and properties that may need to be expropriated or the communities that might be impacted by the project. Within the inundated area, there are no significant communities beyond migrant labour family groups.

There are no non-agricultural commercial activities and no industrial activities throughout the reservoir area.

Land to be expropriated and inundated on the completion of Bisri Dam is presently utilised as shown in Table 6.8 and Figure 6.3. Photographs of typical examples of current usage are shown in Figure 6.4.

Table 6.8: Current Land Use within Bisri Reservoir

Land Use	Approx. Area (ha)	% Reservoir
Built-up areas	1	<1
Open fields and fallow	110	25
Poly-tunnels	4	1
Open land	68	15
River bed and bankside vegetation	103	23
Pine woodland	46	10
Natural vegetation	117	26
Total	**450**	**100**

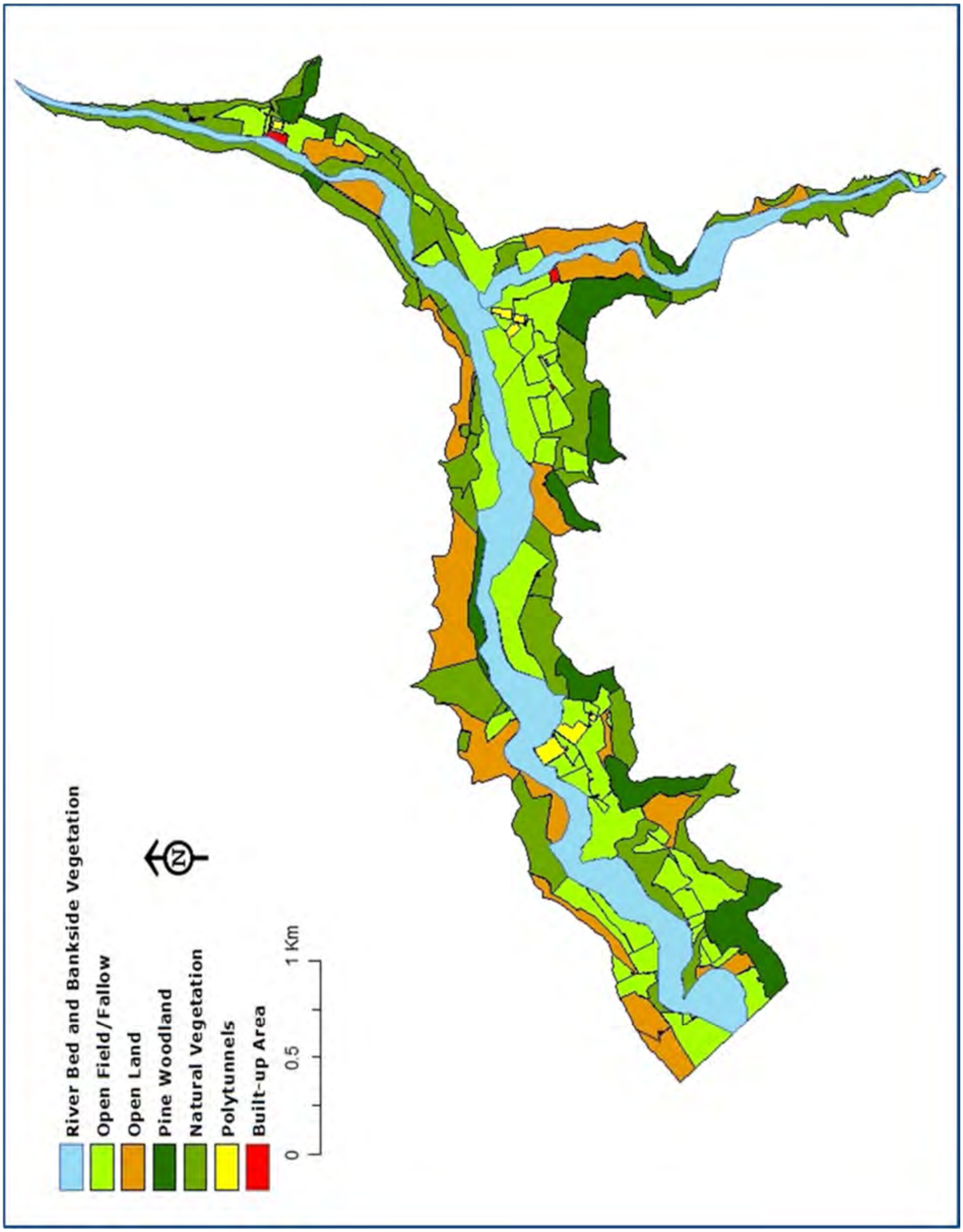

Figure 6.3: Current Land Use within Bisri Reservoir from GE Imagery

Built up areas in the reservoir area include:

- Two or three significant farmsteads, one housing a private menagerie that includes several endangered species, another predominantly a cattle farm;
- Otherwise abandoned 2-3 storey houses now used by agricultural workers;
- Temporary poor quality shelters used by agricultural workers;
- Two designated archaeological sites, one the remains of a Roman temple, the other of unknown significance; and,
- The historic and culturally valued Mar Moussa Church and adjacent structures.

Agricultural lands include open fields variously tilled, cropped, laid fallow or under poly-tunnels. Open land is generally unused land with only sparse natural vegetation or scrub. River bed area includes the current braided flow channels, gravel and sand banks, and the natural vegetation resulting from seasonal inundation; such land generally unsuitable for agriculture.

Pine woodland comprises stands of mature pine trees with relatively little undergrowth, which if properly addressed on clearance prior to inundation will yield significant tradable timber resources. Finally, Natural vegetation includes areas that are well vegetated but for a variety of reasons have not been developed for agriculture.

Large farmstead

A substantial residence now used by seasonal workers

Housing for seasonal farm workers

Housing for seasonal farm workers

Historic arches from St.Sophia Monastery

Roman columns at Marj Bisri Archaeological Site

Mar Moussa Church

Newly irrigated land with tree crops

Poly-tunnels growing strawberries

Private menagerie with endangered species

Quarry in the Chouf Sandstone

Pine woods reminiscent of much greater forest cover

River bed and bankside vegetation

Open land, sparce vegetation and scrub

Mainly ropped fields, with some fallow land and pine forest

Figure 6.4: Current Land Utilisation within Bisri Reservoir

In addition to the dam site, area of inundation and adjacent areas within the confines of the valley, the ESIA has also looked at two broad buffer zones, the first up to 500 m from the expected reservoir shoreline, the second 500-1000 m away, as shown on Figure 6.5.

Figure 6.5: Buffer Zones around Bisri Reservoir

The 500 m zone is dominated by the even more sparsely inhabited and valley slopes that are often devoid of significant vegetation. Where terraces have been formed, tree crops such as citrus and olives predominate. Within this zone are a few outlying houses of Bater, Bhannine and Aariye, together with a few isolated houses and agricultural holdings away from village centres. Elevations at the edge of the zone reach an elevation of some 800 m.

The 1,000 m zone spans the tops of the surrounding hills and takes in the main areas of development at Bsaba, Aariye, Ghbatiye, Midane and together with outlying properties. At the far eastern edge of this zone is the nearest metalled road linking Aariye with Bhannine and onto Delghani, traversing the hilltops but not going down to the valley. between the scattered settlements terraced slopes, hilltop fields, and areas of natural vegetation and woodland prevail.

6.10 Cadastral Divisions and Information

The cadastral regions upon which Bisri Dam and reservoir will impose are shown in Figure 6.6 and the expected land take from each listed in Table 6.9. Evidently, more than two thirds of land take for the reservoir area are from Chouf Caza, with Aamatour and Mazraat Ech Chouf having equally the biggest shares of 33% and 31% respectively. Cadastral maps for every village showing plot areas, boundaries and numbers are endeavored from all possible sources, including but not limited to municipalities, the Cadastre departments of the MoF at both the Saida and Baabda offices, Directorate of Urban Planning at the Ministry of Public Works. The ESIA team was successful in obtaining some maps from these sources, rectified and digitized these maps using GIS whenever and wherever possible depending on clarity and accuracy of the maps in terms of availability of coordinates. Particularly important for land expropriation, plots that are potentially to be inundated within each cadastral area/village are identified, counted, delineated and classified on a basis of full inundation, partial inundation and buffer zone plots that lie within a distance of 50 m from the reservoir shoreline. The latter approach allows for utilities such as access roads, safety measures to be implemented with reasonable management. Individual plot numbers and their land use classification are given in Appendix F.

Figure 6.6: Cadastral Regions of the Bisri Project

Table 6.9: Cadastral Regions Imposed upon by Bisri Reservoir

Caza	Cadastral Region	Approx. Area (ha)	Approx. % Reservoir
Chouf	Mazraat Ed Dahr	21	5%
	Bsaba	3	<1%
	Mazraat El Chouf	140	31%
	Aamatour	147	33%
	Bater	20	4%
	Sub-total	**331**	**c.73%**
Jezzine	Bisri	4	<1%
	Harf	40	9%
	Midane	55	12%
	Ghbatiye	2	<1%
	Benouati	4	<1%
	Aariye	1	<1%
	Bhannine	14	3%
	Sub-total	**120**	**c.27%**
	TOTAL	**451**	**100%**

6.11 Archaeological, Historic and Cultural Heritage

By comparison to today's impression of quiet rural life, history relates the broad, flat and fertile valley of Nahr Barouk and Nahr Bisri to be a hive of human and community activity. Repeated site walkovers, discussions with municipalities, mukhtars and residents as well as investigations of available maps from DGUP and DGA revealed the wealth of historical and cultural heritage to be affected by Bisri dam and reservoir, including the structures listed in Table 6.9 that have been visited by the ESIA team.

In addition to the features seen, there are also believed to be a number of caves in which monks and priests hid during periods of religious persecution, and a floor and foundations of another unidentified structure that were subsequently reburied.

The locations of the primary sites, Marj Bisri, the second designated site, Mar Moussa and St. Sophia, are shown on Figure 6.7, and discussed below.

Table 6.10: Heritage Sites in Bisri Reservoir

Site	Description
Marj Bisri	A Roman-Persian era Temple of which four columns and some temenos boundary stones remain visible.
Marj Bisri Bridge	A single-arched stone bridge believed to date from the Mamluke-Ottoman period.
(Second Site)	Like Marj Bisri, designated by DGUP as an archaeological site but nothing appears visible on the ground.
Mar Moussa el Habchi	A small vaulted Maronite church dating from the 13th Century, rebuilt authentically in modern times.
St. Sophia Monastery	Adjacent to Mar Moussa Church but said to predate it, the stables and stable yard, together with one end of a Byzantine wall are all that now remain.
Other sites near Mar Moussa and St. Sophia	• Two stone arches of unknown provenance; • A well believed to belong to Mar Moussa; • One or more rock-hewn burial chambers, now empty.

Figure 6.7: Location of Heritage Sites within Bisri Reservoir

6.11.1 Marj Bisri

Close to the confluence between Nahr Barouk and 'Aariye', now more commonly known as Wadi Bhannine, lies the Temple of Marj Bisri, believed to be dated back to Roman and Persian times. Marj Bisri is believed to be connected with the Temple of Ashmoun, also known as Bustan El Sheikh, in the Lower Awali Valley, dating back to the 7th Century BC. Originally Phoenician, Ashmoun was constructed over several centuries and shows Roman and Persian influences, with colonnades, mosaics, and the foundations of a Byzantine church. Both Ashmoun and Marj Bisri are believed to lie on the ancient road from Saida to Damascus, used by, among others, Alexander the Great, with Marj Bisri at the crossing point of Nahr Barouk doubtless affording refuse and respite prior to ascending Jebel Niha. The site of Marj Bisri and its immediate vicinity are shown in Figures 6.8 While the bridge across the river is thought to have existed since medieval times, the present single-arch structure, Figure 6.9, is thought to date from the Mamluke-Ottoman period.

Today, the visible remains of Marj Bisri are limited to four black granite columns shown in Figures 6.9, perhaps the entrance to the main temple, and several large dressed stone blocks exposed in the nearby river bank, believed to be the wall of the Temenos, the sacred area surrounding the temple (Figure 6.9). Pottery sherds of both Roman and Persian origin have been found in the vicinity and it is assumed the buried remains of other buildings and at least a small village will also be present. No comprehensive archaeological surveys of Marj Bisri, neither of another suspected temple site downstream, have been completed, although very preliminary investigations without excavation have been undertaken by the Polish Centre for Mediterranean Archaeology at the University of Warsaw working in conjunction with the University of Balamand.

The physiology of the Bisri Valley above the proposed dam location is very different from other westward-draining valleys from the Lebanese Mountains. Rather than being narrow, V-shaped and generally inhospitable to development, it is a broad and flat bottomed with thick, fertile and productive soils. Historically, a short distance downstream of Bisri and Al Jouba villages, seismicity along the Roum Fault caused a landslide that naturally dammed the valley to form a lake. As shown by site investigation boreholes, this was subsequently infilled by a thick sequence predominantly comprising black lacustrine clays. As the lake became filled, the river overtopped the landslip material and surface water once again flowed to the sea, meandering across the old lake bed and re-entering the previous and more typical steep-V-shaped valley downstream. The age of the landslip is unknown but archaeological evidence suggests the lake became filled and dried out during the late Hellenistic–Early Roman period. Furthermore, climate change in the form of increased rainfall during Late Roman times is thought to have increased river flow, rejuvenated erosion, and resulted in some damage to the remaining buildings.

At the site proposed for Bisri Dam, the lacustrine deposits are up to 90 m in thickness. While there has been no site investigation in the vicinity of Marj Bisri, some 4 km upstream from the dam site, these deposits will be expected to both thin and coarsen upstream.

While the current condition of Marj Bisri remains are unknown, it is reasonable to postulate the factors that may have played a role in their current state of preservation. From the ages cited above, it is likely the lake had dried up and the present fluvial regime reinstated prior to temple construction and that burial is the result of river flood deposition. The river course is complicated by both converging streams being braided. The present river channel immediately adjacent to Marj Bisri may have therefore migrated across the floodplain several times, accompanied by both erosional and depositional activity. Like many Lebanese archaeological remains, they may have collapsed prior to burial due to seismicity, although the presence of the four columns suggests any collapse may be only partial. The small, single-arch stone bridge over the river c.30 m from the columns contains blocks of likely Roman origin, so some of the temple may have been salvaged for other uses, a particularly common practice during the Crusader and early Arab period. With the reservoir full, current design proposals suggest the Marj Bisri Temple site will be covered by some 30 m of water.

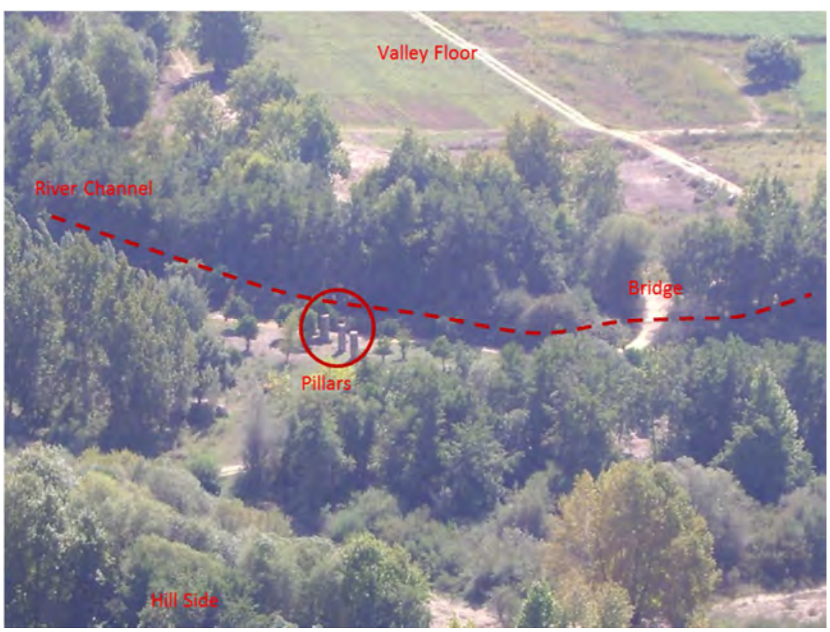

Figure 6.8: View across the Marj Bisri Site, Looking Southwards

Mar Bisri columns

Large stones in river bed

Mar Bisri bridge

Dressed shones in river bank

Figure 6.9: Photographs of Marj Bisri

6.11.2 Second Designated Site

In addition to the Marj Bisri temple site, which is a DGUP designated archaeological site, the land use plan for Aamatour shows a second such site, much smaller in area and some 1.3 km downstream from Marj Bisri. However, inquiries at DGA have revealed no information on this site and walkover surveys for the present ESIA found nothing of interest above ground, although any search is hampered by poor access and often dense vegetation.

The basis of designation therefore remains unknown. If feasible it would be useful to carry out initial investigations – site clearance, trial pits, auguring and geophysics, at the same time as these are undertaken at Marj Bisri.

6.11.3 Mar Moussa El Habchi Church

On the lower slopes of the valley almost directly above the dam axis, Mar Moussa Church is located just 200 m from the currently proposed dam axis, just 75 m from the base of the back slope. While the church is small and unimposing, its importance in local culture and tradition was evident from the concern shown at public consultation. The future of the church is an emotive issue for many Mazraat El Dahr residents.

The site is believed to have been used for worship since the 13th century, but the church may have been rebuilt a few decades or more ago as evidenced by the anomaly of a particular cross-engraved stone, broken prior to rebuilding. While the major part of the block has been reused, the missing part was probably lost. Because access is limited to an unmetalled track that is rough and untended, services are no longer held other than on Mar Moussa Day, 28th August, each year. Photographs of the church are shown in Figure 6.10.

Mar Moussa Church

Engraved lintel over one of the windows

Part of the interior

Broken engraved stone indicating the church has been rebuilt

Figure 6.10: Images of Mar Moussa el Habchi Church

With the Mar Moussa site close to construction activity it will be irreparably impacted both directly and indirectly, the latter in the form of vandalism and/or theft of artifacts and old building materials. Unlike at Marj Bisri, the period available for rescue archaeology is likely to be insufficient for extensive and carefully documented excavations. The local community has already indicated they wish to see the church moved to a new location. Given the nature and relative simplicity of the structure, it will be entirely feasible to dismantle the church and the monastery arches block-by-block, number them and reassemble them in the same order. Saving old buildings this way is well practiced outside Lebanon. Since there does not appear to be any spiritual significance to the Mar Moussa site, or its original significance is now lost to memory, relocating the church may be an acceptable solution.

If an alternative site is not immediately available the blocks could be stored under cover pending future reconstruction but this is not a recommended option. Once the impetus of demolition has passed, there is a risk reconstruction would be delayed for an extended period, during which the stones will deteriorate and those with carvings stolen.

6.11.4 Saint Sophia Monastery

Saint Sophia Monastery is just some 30 m from Mar Moussa but is thought to predate it. Investigations for the ESIA have yielded little information, but the type of construction seen in walls and arches of the stables, the only remaining part of the monastery, suggests it is considerably older than the church, even allowing that latter has been rebuilt. Adjacent to the stables are the remains of a thick stone wall, reported to be Byzantine in age that was once the boundary wall of the monastery. This suggests the monastery was also Byzantine. Photographs of the stable and the wall are shown in Figure 6.11.

Remains of the monastery stables

The Byzantine wall to the monastery

Figure 6.11: Remains of St. Sophia Monastery

In conclusion, it is worth noting that if the location of Bisri Dam is moved upstream, as recommended by the PD ESIA to a site of more equable geology, both Mar Moussa El Habchi church and the remains of St. Sophia monastery will be saved.

6.11.5 Other Cultural Sites

The other sites within the area to be inundated by Bisri reservoir appear to be of much less significance but nevertheless contribute to the overall heritage value of the site and aid our understanding of life in the valley in times past. These sites, illustrated in Figure 6.12, are all in the vicinity of Mar Moussa/St. Sophia, and hence in close proximity to the presently proposed dam site.

Old well c.20 m above Mar Moussa church

Rock-hewn burial chamber

Arches, c.350 m upstream from the church

Lack of planning empathy with heritage

Figure 6.12: Other Sites of Historic and Cultural Interest

SECTION 7

ENVIRONMENTAL AND SOCIAL IMPACTS

7. ENVIRONMENTAL AND SOCIAL IMPACTS

7.1 Introduction

This section of the ESIA report addresses the potential environmental and social impacts that might accrue from the GBWSAP.

The potentially permanent impacts, most commonly accruing from project location and design, are discussed in **Section 7.2**, the primarily temporary impacts suffered during the period of construction in **Section 7.3**, and those likely to perpetuate throughout post-construction operation including the vitally important topic of dam safety in **Section 7.4**.

Section 7.5 discusses a potentially major impact, induced development, that may be mitigated through careful planning.

Finally, **Sections 7.6** presents a tabulated summary of the potential impacts identified previously, their likelihood of occurrence, likely severity, and suggested means of mitigation.

7.2 Potentially Permanent Impacts

7.2.1 Land Acquisition and Property Take

The development of dams always involves the permanent occupation of land, not only for dam construction and reservoir impoundment, but also for new access roads to previously remote sites, and for the resettlement of displaced PAPs (Project Affected Persons), relocation of their businesses and rehabilitation of their livelihoods. As well as opening up areas for construction, new roads may also improve access to previously remote settlements, affording them better access to regional centres, government facilities and public services. They may also open areas to less desirable influences such as trespass, fly-tipping, and a range of illegal social and commercial activities. Land acquisition for the resettlement of PAPs may be in less advantageous areas, away from family and friends, with longer home-to-work and home-to-school journeys, and inconvenient for previous social gatherings, places-of-worship, etc. The act of resettling can also cause conflict with existing residents, especially in Lebanon where small adjacent areas are often socially removed by being under the control of different social, political and religious factions.

Therefore, the loss of agricultural land, tilled and improved over generations, is not simply the loss of fertile soils and yet-to-be harvested crops. Similarly, cultural heritage is not limited to archaeological and historic sites but includes recent sites such as traditional bathing places, wedding venues and burial sites. Both the Lebanese Diaspora and those that have remained have a great sense of place and many retain relations with *their village*.

Many site visits to Bisri dam site have been undertaken since January 2012 to identify land property, cultural and other sites that may need to be expropriated or otherwise be impacted by dam construction. A detailed socio-economic survey of households and businesses within and adjacent to the impoundment area will be undertaken once all cadastral and land ownership information is gathered. The survey will comprise structured interviews at all available households, businesses and agricultural holdings, the results and systematic analysis of which will provide the basis for the GBWSAP Resettlement Action Plan.

The existing utilization of land within the Bisri reservoir area, examples of the different types of land use and properties, and the substantial historic and cultural interests, have previously been discussed in Section 6.9 to 6.11 above. Bisri reservoir extends over some 450 ha located across 12 cadastral regions. Construction will result in the loss of productive land estimated to extend over 160 ha, some 35% of the area to be taken. The braided river bed and natural bankside vegetation occupies 23%, with built-up areas; farm buildings, housing and heritage, less than 1%. The remaining 185 ha is primarily uncultivated natural vegetation on the bottomlands away from the river, and generally open land and scrub on the lower valley slopes. The number of individual houses to be inundated is provisionally estimated at 31, the majority already abandoned (some derelict) or only providing seasonal accommodation for agricultural labourers.

The total number of individual plots of land, identified from available cadastral mapping, is currently identified to be 823, split between the various cadastral regions as shown on Table 7.1. A full list of the plot numbers by cadastral region is given in Appendix F. Cadastral plans are still awaited for Bsaba and Bater, so the final number of plots may be expected to be around 850.

Table 7.1: Land Plots to be Acquired

Caza	Cadastral Region	No. Plots to be Acquired	Approx. Total Area (ha)
Chouf	Mazraat El Chouf Dahr	27	21
	Bsaba	TBC	3
	Mazraat El Chouf	293	140
	Aamatour	316	146
	Bater	TBC	20
	Sub-total	**636**	**330**
Jezzine	Bisri	1	4
	Harf	61	40
	Midane	73	55
	Ghbatiye	3	2
	Benouati	20	4
	Aariye	1	1
	Bhannine	28	14
	Sub-total	**187**	**120**
	TOTAL	**823**	**450**

TBD: To be determined (Cadastral information awaited)

7.2.2 Involuntary Resettlement

One of the most significant impacts of development projects such as dams is the involuntary displacement of the resident population. It is estimated that worldwide, large dams have displaced nearly 60 million people.

Involuntary resettlement is a critical process that can result in negative impacts with wide ranging cultural, economic and health consequences, especially on ethnic minorities and vulnerable groups such as women and children, the elderly and infirm, and others whose lives may focus on the home and may have done so all their lives. Enforced relocation can cause alienation in a socio-cultural milieu, leaving them severely disadvantaged. A fundamental tenet of resettlement policy is that it should provide PAPs with standards of living at least equivalent to, and preferably better, than their pre-relocation conditions, compensated not only for physical loss but also for discomfort and social loss. Bisri dam when constructed should allow PAPs priority advantage to new economic opportunities such as tourism, fisheries, or increased irrigation, to restore and improve their standard of living.

As previously discussed with social baseline conditions, there are few residential buildings in the reservoir area most of which house seasonal farm workers including Lebanese and non-Lebanese, the latter mainly Syrian, Syrian Kurd, Palestinian and Egyptian, the majority of which may stay on the land till the next planting season. Since the land on which they work will also be inundated, they will search for work elsewhere.

They will lose both their livelihood and home. There will be however no need to rehouse them on adjacent land and under Lebanese law they will not be eligible for compensation.

Land take and resettlement involving families, their property and livelihood are few in number within the proposed area of inundation. Most landowners are absentee landlords. Under the Lebanese law, compensation for land and asset expropriation and resettlement is made via a single cash payment, with no provision for land-swaps or other assistance in re-establishing a home or livelihood. Funding agencies such as the World Bank are usually more considerate and will usually expect PAPs to be compensated for loss of livelihood, even where that livelihood is obtained by working land to which they have no title.

Also within the reservoir area, there are about three significant farmsteads, one of which is a modern farm that includes a private menagerie that included protected and endangered species. Other than agricultural activity, there are no commercial or industrial premises within the impoundment area. The precise number of individuals that will lose their sole residence, their place of work, and/or their livelihood is not yet ascertained but is expected to be relatively few compared with the extent of land to be expropriated.

A Resettlement Policy Framework (RPF) has already been prepared for the project and a Resettlement Action Plan (RAP) for the Bisri scheme is being prepared. The RAP will be based on the results of a full socio-economic survey comprising structured questionnaires for households, agricultural establishments and commercial enterprises.

7.2.3 Impoundment and Inundation

Dam projects are often the cornerstone of water resources development policy. By storing runoff when it is abundant and preventing its loss to the sea they provide populations with a reliable source of water, help control flooding, and provide not only for domestic consumption, but also for irrigation, industry and for hydropower, the latter a non-fossil fuel source of energy that also reduces GHG emissions. Dam impoundment reservoirs frequently become the focus for tourist developments, commercial fisheries and water-based recreational activities. Land values along reservoir shorelines and on hillsides overlooking the water often escalate in value and adjacent villages benefit from the influx of new residents and visitors. The potential for induced development is discussed further in Section 7.5 below.

The presence of a new body of standing water will result is a variety of potentially adverse changes, the most serious of which will be the loss of land, be it natural landscape or productive farmland, developed or uninhabited. While the Bisri reservoir area is sparsely inhabited, the loss of productive land and natural vegetation is, as discussed above, extensive. The Bisri site contains no metalled roads and no easily useable river crossing points. There will therefore be no severance of communications. Indeed, the physical divide imposed by the valley also reflects political and confessional divides between surrounding settlements.

As discussed in Section 6.4.5 above, large impoundments may emit substantial GHG emissions due to the release of the carbon sequestrated in the soil, plants and trees as these decompose. Soil and plant debris washed into the rivers and mixed with wastewater from catchment villages and fertiliser residues from farmland contributes to the accumulation of biomass.

As reservoir filling increases the load on underlying bedrock faults and fractures so will the risk of seismicity. This is a concern at Bisri where the reservoir is large and a major fault zone crosses under the valley beneath or very close to the dam site. As this risk increases so will the risk of rock falls and landslides.

Inundation will also cause the loss, alteration and creation of ecological niches and habitats. The permanent presence of the reservoir will transform riparian riverine habitats into lacustrine habitats with both adverse and beneficial effects. The likely impact on ecology and biodiversity are discussed further in Section 7.2.8.

A further permanent impact due to the presence of inundation will be erosion along the newly created reservoir shoreline, primarily generated by the inflow of tributary water courses and wind. This will erode the surrounding Chouf Sandstone (C1) and also transport shoreline and shallow water material further out into the reservoir and towards the dam.

7.2.4 Erosion and Sedimentation

A major significance of erosion and sedimentation is that it imparts a progressive decrease in reservoir storage, albeit this reduction is primarily in dead storage rather than operational storage. The accumulation of sediment behind the dam can increase pressure on the structure and hence the risk of failure, and also lead to turbine malfunction. Where erosion results in the catastrophic collapse of a rock face or landslip into the reservoir, the pressure wave created rather than the physical movement of water may be sufficient to cause the dam to collapse.

The potential for shoreline erosion has been highlighted above. The crest line of much of the upper valley slopes is marked by the outcrop of fractures cliff-forming Mdairej

Limestones (C2b) from where blocks frequently collapse, mass movement influenced of gravity and rain eventually depositing this material on the valley floor. The potential for such block erosion is illustrated in Figure 7.1.

Fractured limestones lining the crest of the Nahr Awali River

Large blocks on the upper valley slopes

Blocks on a lower slope above the valley floor

Figure 7.1: Block Erosion of the Cliff Limestone at Bisri

At the extremities of the inundation where the existing streams enter the impoundment, flow will suddenly slow and the sediment load will be deposited in the same way as a river flowing into the sea forms a delta. The first annual flood flows will remobilize some of this material and carry it further into the reservoir. Over the years, deposition either side of the main channel will predominate, and advantageously, new wetland environments and habitats will be created. At Bisri, the northern extremities of the reservoir on Nahr Barouk and the shallow, narrow lobe of reservoir in Wadi Bhannine, will be particularly susceptible to sedimentation.

The positioning of a dam to catch upstream sediment will also prevent sediment passing downstream. Silt and clay will therefore no longer be deposited over the downstream flood plain to annually enrich soil fertility. A common consequence of this is greater reliance on the use of chemical fertilisers. However, the extent to which flood deposition was important in the Nahr Awali valley might make this relatively insignificant.

While the floor of Bisri reservoir may be largely impermeable due to the presence of lacustrine clays, the walls will primarily comprise friable Chouf Sandstone that will easily be eroded by both shoreline wind-generated wave action and water circulation at depth. The Feasibility study predicted sedimentation rates of 0.18 Mm^3/yr, a relatively high rate for Lebanon, reflecting the occurrence of sandstone outcrop across the upper catchment. To overcome the main effects of this, the Feasibility study proposed a dead storage volume of 8 Mm^3 at Bisri, suggesting that depending on design and the uniformity of settlement across the reservoir, dredging may be needed after 40-45 years.

Clay horizons in the sandstone formation tend to soften on contact with water and cause more competent overlying strata to collapse, thus generating landslip. Significant landslip deposits (eboulis) are evident in certain parts of the reservoir, such as at the location shown in Figure 7.2.

Figure 7.2: Eboulis Material above Bisri Reservoir

7.2.5 Upper Watershed Management

The *Atlas du Liban* prepared by CDR in 2004 identifies the Bisri Catchment to be among the *exceptional natural valleys of national interest*. Dam projects typically benefit communities other than those within their immediate vicinity and the public consultation session held to date quickly revealed an undercurrent of opposition to sending water and power to Beirut when there was unfulfilled demand locally. While conflict does arise, it need not be inevitable if the issues are addressed from the outset of the project.

Upper watershed and surrounding communities are often the main beneficiaries of opportunities presented by the physical presence of the reservoir; be it investment opportunities in tourism and recreational businesses, nature reserves, and enterprises such as commercial fisheries. Each of these opportunities will also create considerable employment, as will dam operational management and maintenance. It should be

MEW/BMLWE policy to prioritise the employment of local residents, particularly those resettled by inundation of their land or otherwise severely impacted by the project.

The major negative impacts upstream of the dam are of course those associated with the formation of the reservoir, such as the loss of land. Road construction for dam and power plant access, and if required, around the periphery of the lake, will open up areas previously only poorly accessible to the general public and encourage exploration further upstream. Tourism also has its downside, such as the abuse of existing communities, ecology and landscape with littering, fly-tipping, fire-lighting, trespass, tree-felling, rare flower-picking, egg-collecting, capture of live species, illegal fishing and general eco-vandalism.

A common consequential impact of reservoir development is the clearance of land for agriculture to replace the productive land inundated. Given the general steepness of surrounding and adjacent slopes, there is little opportunity to turn areas of natural vegetation into productive land. Even if this were feasible, the resulting land would not be of such high quality as that lost in the valley bottom. It must therefore be generally accepted that the Bisri scheme will result in the loss of some 160 ha of prime productive land to Lebanon’s fertility bank.

A significant impact will be the discharge of wastewater from upper catchment villages, directly or via leaking holding tanks, to the rivers feeding the reservoir[36], substantially increasing the nutrient load and resulting in eutrophic conditions. The discharge of wastewater into surface watercourses with only primary screening remains in places throughout Lebanon, although the areas served by rural sewerage schemes are slowly increasing[37]. With population growth in the mountains, and the dramatic increases experienced during the summer months when Beirutis and others escape the heat and humidity of the coastal plain, wastewater generation will continue to grow. Upper catchment villages must therefore be prioritised for the installation of a sewage collector system and treatment plants with at least primary and secondary process streams. Wherever cost-effective, particularly when neighbouring settlements deliver to a single treatment plant, the inclusion of tertiary treatment to provide water of a quality suitable for irrigation of public landscaping and tree crops should also be considered.

[36] During an ESIA site visit in October 2012 the water at the head of Narh Bisri, the confluence between Nahr Barouk and Wadi Bhannine emitted a distinct odour, suggesting that at least at times of low flow, the loading of nutrients is greater than the river can accommodate.

[37] In 2002, less than 25% of households in the Cazas of Jezzine and Chouf were connected to public sewage networks, and this proportion is believed to have increased little in subsequent years.

Similarly, storm drainage systems, primarily open channels along roads, also discharge into surface water courses, and hence ultimately to the impoundment area, without the benefit of sand traps, settling basins or hydrocarbon interceptors. With development and the imposition of hard surfaces, the rate of runoff will steadily rise.

While all municipalities have now initiated solid waste collection, in some remote villages this is less efficient than elsewhere and some may also find its way to watercourses. Fly-tipping by outsiders to the area remains a significant problem throughout the Lebanese mountains, with much of the material dumped ultimately finding its way into natural watercourses.

While rainwater harvesting is impractical for a city the size of Beirut, where several families share the single roof area of a high-rise multi-occupancy building, it does play an important role in many more upper catchment villages where low-rise single family occupancy buildings are more common. For example, the municipality of Mazraat Ech Chouf is planning to store 50,000 m^3 in a hill lake. Some residents construct concrete reservoirs besides or underneath their buildings to store rainfall for reuse during the dry season. Such individual schemes are generally small and for the foreseeable future are unlikely to seriously impede runoff to Bisri Reservoir.

A negative impact of all impoundment schemes is the loss of water to evaporation. This will vary seasonally, being high in the summer and low in the winter, and be dependent upon a number of climatic and physiographic criteria. As defined previously in Section 4.2.5 using the Class A pan method, evaporation at Bisri is expected to vary between 46 mm in January to 202 mm in July, with an average annual total of 1486 mm, which from a 450 ha impoundment equates to a loss of some 6.5 Mm^3, some 5% of the reservoir volume, and equivalent to that expected to leak into the surrounding rocks. Although a minor amount when considered against seasonal changes in reservoir storage, this may rapidly increase throughout at extended drought to become significant. Evaporative losses also work to decrease the dilution of incoming pollutants, including fertilizer and agricultural chemical residues, to the detriment of both water quality and aquatic habitats, and increased aquatic animal deterioration in the water reservoir.

7.2.6 Lower Watershed Management

Water below the proposed Bisri dam site currently originates from the following sources:

- Natural flows from the upper catchment;
- Inflow from lower tributary catchments;
- Spring discharge direct to the river;

- Discharge from Qaraoun and intermediate spring inflow from Awali and Joun power plants;
- Wastewater discharges including sewage from downstream communities;
- Drainage from ground water sourced irrigation schemes.

The most significant positive impact of almost any dam to downstream land owners will be the ability to control flow and reduce or curtail seasonal flooding. In Lebanon, the physiology of the generally steep sided valleys and major variations in seasonal flows have served to limit settlement to the higher valley flanks and hilltops, although the coastal plain through which Nahr Awali passes to the sea is prone to flooding as torrential river flows spread as they leave the confines of their valley. This situation may become more serious as global warming and consequential climate change increase. Sea level has been progressively rising since the 1950s, with the warming oceans being subject to thermal expansion. In the Eastern Mediterranean this has manifested itself in a sea-level rise of 1-2 mm/year. While the science of climate change remains imprecise, the consensus is that the total rise will reach 0.25 m by 2030 and 0.50 m by 2050. Coupled with the increasing intensity of rain storms and future urban expansion into presently unsettled flood-prone areas, capturing peak flows and releasing them in a controlled manner that does not cause flooding is therefore a major positive impact for downstream communities.

However, the benefits of control can be carried too far and most people consider the most significant risk to be that as demand for water across Greater Beirut increases, the dam operators will reduce environmental releases, thereby endangering riverine ecology and downstream irrigation supplies, increasing soil salinization, potentially leading to conflict between downstream users. Given the poor perception of the Right to water of riparian land holders[38], MEW should undertake a detailed study of existing water use and establish a public register of Water Rights. This will greatly help establish procedures and programme for determining the volumes of environmental flows to mitigate the derogation of downstream resources.

The reduction in downstream flow will also result in reduced dilution of chemical residues and dissolved oxygen (DO), increasing organic pollution. Reduced DO will also result from water passing through the hydropower turbines. Insufficient surface water will encourage farmers to abstract greater quantities of ground water, and increase saline intrusion to the aquifer. In the longer term, coastal plain ground water may cease to be

[38] *Annual Index of Economic Freedom: Property Rights Index*. Heritage Foundation and the Wall Street Journal.

suitable for irrigation unless treated, thereby increasing costs and decreasing farmers' competitiveness.

Reduced flow will consequently reduce the dilution of wastewater discharges, bringing those discharging immediately below the dam, such as Bisri village residents, into conflict with those abstracting further downstream.

Depending on the development and control of stratification within the reservoir, provision may be needed to ensure any releases of anoxic water are adequately aerated and diluted to render it fit for downstream use.

Immediately downstream of the dam and for a short stretch of the river thereafter, the high head and turbulence of spillway overflow and hydropower plant discharges may adversely scour the river bed and banks.

7.2.7 Ground Water Resources

In unconfined aquifers it is generally the case that water table elevation is a subdued reflection of topography. Thus, ground water flow is often towards valleys and the occurrence of springs is most common on hillside slopes. In confined aquifers, ground water under pressure will find the route of least resistance to the surface, usually where the fractures penetrate the confining horizon and the overlying unsaturated material is thinnest, such as in the bottom of valleys.

Impoundment can therefore have a variety of impacts on both the local and regional ground water regime, and on the sustainability of existing water sources. The impact is two-fold; the additional quantities of water physically infiltrating the underlying strata and the pressure exerted by the column of impounded water above. As a result, water will flow laterally into any permeable or fractured zones within the reservoir walls. Water tables will be raised and hydraulic gradients changed, even reversed. Springs may cease to issue from their traditional sites and subsequently appear elsewhere, disrupting established water supply systems, and having potentially devastating effects where the new issues rise beneath or even within structures.

The pressure imposed by the reservoir on the valley floor will not only serve to exacerbate the situation by forcing water into the underlying strata, but will extend the impact where the reservoir is deeper than the confining pressure under which ground water is retained in the aquifer. Such impact is often of greater significance in karst systems, where underground flow may be enhanced and/or diverted to the extent reservoir storage and the predicted water supply is never realised.

The impact on ground water seepage from Bisri is expected to be relatively minor, estimated by the 2011 Update Feasibility Report to be just 5% of storage at any given time, some 6 Mm^3. Most significantly, the floor of the reservoir is primarily composed of low permeability lacustrine clays which, while known to reach a depth of some 90 m in the vicinity of the proposed dam axis, is only assumed to continue upstream over much of the area to be inundated. The lower valley walls that will contain the water are predominantly composed of Chouf Sandstone, a minor aquifer unit but containing clay horizons and intercalations that will do much to reduce infiltration. Although fractured, many of these are not open.

Overlying Lower and Middle Cretaceous strata crop out on the right bank of the river at the dam site, near the confluence of Nahr Barouk and Wadi Bhannine, and again at the northern extremity of the reservoir, where the dominant formation is the variable and hence relatively low permeability Abeih Formation (C2a). Leakage from the reservoir is therefore not expected to be excessive and may not exceed acceptable limits.

Only to the right of the proposed dam site does the fractured cliff limestone of the Mdairej Formation transcend to the valley floor. The PD ESIA recommended the project proponent consider moving the dam site upstream to a location where the difficulties this outcrop affords dam design and construction can be avoided. Such a move would also reduce the potential for leakage through this unit. It will also save the Mar Moussa Church from inundation.

A major shortcoming of the feasibility studies, original and updated, is the lack of detailed hydrogeological analysis and modelling to more precisely determine the nature and extent of impacts of surface water impoundment upon the ground water regime.

7.2.8 Biodiversity and Habitats

The construction of Bisri dam and its associated structures, in addition to the creation of the reservoir, will cause both loss and alteration of natural habitats, with resulting impacts on ecology and biodiversity. Direct loss of habitat will occur as a result of dam construction, inundation, installation of pipelines, and the upgrading of access roads. The presence of the reservoir will transform riparian riverine habitats into lacustrine habitats with both adverse and beneficial effects. The reservoir will reduce habitats for wildlife species that require flowing water but attract those adapted to still or slower-moving waters such as waterfowl.

Beneficial effects will arise from the habitats presented by the reservoir and new biological communities will establish themselves over time.

Flora

Dam construction will always result in the direct loss of riparian habitats and natural vegetation within areas that are recognised by UNEP to be fragile and vulnerable ecological zones. This however, must be balanced against the new shoreline habitats that favour the colonization of tree species on the banks of the reservoir. Table 7.2 summarises the assessment of the expected impacts on the flora in Bisri dam and reservoir areas.

Table 7.2: Potential Environmental Impact on Flora at Bisri Dam Site

Indicators	Degree of Impact
Surface area of water reservoir	5
Biodiversity indices	2
Conservation status & values of species	2
Forest age structures/Vegetation formation type	2
Ecosystem resilience in the defined location	5
Change in micro-climate conditions	5
Availability of same ecological niches in the area	3
Landscape value	4
Post Dam vegetation adaptation	3

1 is the minimum impact, 5 the greatest impact

Detailed botanical surveys including targeted searches for protected species and/or those identified as species of significant nature conservation value in either a Species Action Plan or Local Biodiversity Action Plan are required if impacts on valuable habitats or species are significant. Where a habitat of potential nature conservation value is identified, more detailed quadrate-based surveys may be required.

Fish and Macro Invertebrates

Impacts on fish are considered to be moderate to minor at Bisri dam site, but some mitigation measures should be taken to maintain fish populations downstream of the dam and to allow the passage for migratory fish so to protect spawning grounds.

The construction of the dam will significantly reduce water flow downstream, which will definitely affect the freshwater blenny population surviving in the lower course of the river. It will not, however, pose however a direct threat to the European eels. The Middle Eastern green carp may be expected to benefit from the new habitat created by the reservoir. A large population is expected to quickly become established and being commercially valuable, will also provide economic opportunity.

Both the minnow (*P. kervillei)* and the loach (*O. leontinae)* may thrive in large numbers and may have a significant role in the newly formed ecosystem, with the former offering some potential for commercial importance.

Herpetofauna (Amphibians and Reptiles)

The Bisri project will have direct impacts on reptile and amphibian habitats, both upstream and downstream of the dam, which will include disruption to habitats and/or breeding sites, reducing sources of food, and increasing vulnerability to predators.

Species with poor swimming ability may become stranded and prevented from interacting with mainland populations, particularly for breeding, and make them more vulnerable to illegal hunting. Other species may be positively affected by new created habitats.

In the upper watershed, upstream habitats will be flooded and destroyed and species including *Bufo bufo* will be forced to move to new habitats that might not be suitable.

Amphibians usually require shallow aquatic habitats with slow-moving water for breeding, such as will only be found along the peripheral shoreline of the reservoir. These areas will suffer from seasonal and yearly fluctuating levels. Considering the breeding period involves several stages; mate attraction (advertising), mating, egg stage and larval stages (e.g. tadpoles), the breeding process might last for several weeks. If fluctuations occur during the breeding season (March-June), it would affect one or more of these stages. Since this period may correspond to that of increased snow melt in the mountains, it is highly likely such fluctuations will occur.

All amphibians are insectivorous (feeding on invertebrates) and food sources are primarily found in riparian and shallow water (littoral) habitats. The existing riverine habitats will be inundated on completion of dam construction, and new reservoir shoreline habitats offering the same abundance of food only established over time. The time to complete the filling of the dam is likely to take two years.

In the lower watershed the regulated river flow will positively impact those natural habitats subject to flooding while harming others where water flow is normally limited. New breeding habitats downstream of the dam will be created while other suitable aquatic habitats will disappear as a result of the dam construction. Thus, all amphibians in the dam area will be affected. Whether invertebrates, the source of food for amphibians near the river itself or in the riparian zone, will be affected, remains subject to speculation.

The upper level of the reservoir approaches the lower reaches of the Moukhtara River where there are populations of rare *Bufo cf bufo, whose* habitat appears to consist mostly of rocky terrain and riparian trees, some of which will be inundated.

Birds

The construction of the dam will certainly cause the disappearance of the majority of the bird species, although may be expected to return after completion of construction work. Other species, waterfowl such as ducks and geese, will be attracted by the new water-body. Shallower water downstream of the dam may be beneficial to wader species and individuals of the heron family.

The presence of a large body of standing water may disrupt the flyways of migratory soaring raptor species, as they will be deprived of thermal air currents necessary for soaring and saving energy during migration.

Noise generated by dam operation, the HEP and associated activities may also result in the disappearance of some bird species, while others may adapt to the new conditions and stay. The level of impact will be more apparent if a survey is conducted on a regular basis to understand population variations for the different species.

Some birds will be driven away permanently from nesting areas like the Short-Toed Eagle and the Long-Legged Buzzard, whereas others, like the Graceful Warbler, will adapt.

Mammals

Construction activity around the dam and elsewhere will result in habitat fragmentation, to which mammals are particularly vulnerable. However, once the dam is completed, mammals will adapt and adjust their behavior, despite any permanent obstructions to their previous dispersal routes. The reservoir may attract species such as bats and otters. Smaller mammals such as shrews and squirrels will tend to have smaller home ranges, and will therefore be susceptible to both habitat loss and fragmentation. Larger or more mobile species are less likely to experience significant habitat loss, albeit habitat fragmentation.

Creation of Wetlands

As discussed previously, the likelihood that the upper reaches of Bisri Reservoir, much of the areas upstream of the Nahr Bisri-Wadi Bhannine confluence, are likely to only contain narrow and shallow bodies of water that over time will silt up. initially these areas may attract waders and other shallow water species, but with time, be transformed through marsh, peat bogs to eventually become dry land. such areas are exceedingly rich in biodiversity may become an major ecological attraction. Even as dry land, these areas will continue to discharge surface watercourses to the reservoir and should hence remain undeveloped or uncleared for agriculture.

7.2.9 Public Health and Wellbeing

Despite the obvious adverse impacts such as inundation, dam projects are generally perceived to assist socio-economic development by providing improved access to water supplies, hence improved public health, increased educational and career attainment, power for industry, and new commercial opportunities such as tourism and fish farming.

A consequence of upgraded roads for construction and operational traffic will be better access to and from adjacent settlements, which in turn leads to improved accessibility to health care and social services, education and employment, thus enhancing the overall quality of life. At Bisri, the most immediate beneficiaries of improved access will be the residents of Bisri village and its environs, but as development induced by the scheme expands so will improved access to surrounding villages.

Optimising reservoir management will require the imposition of improved wastewater management in villages currently discharging to the dam catchment area. In addition to benefitting the water utility company, who may be more motivated by the desire to improve water supply to distant consumers rather than the local population, it will also help local residents acquire improved sanitary conditions in their homes and throughout the community. If wastewater inflows to Bisri reservoir are to be minimised, sewerage schemes for up to 60 existing villages will eventually be required.

7.3 Potentially Temporary Impacts during Construction

7.3.1 Introduction

Potential temporary impacts are primarily limited in duration to the period of construction and are the result of the activities of the contractor and his workforce. The majority are therefore most readily mitigated through the adoption of good construction practices and strict adherence to a Construction Environmental Management Plan (CEMP).

7.3.2 Landscape and Productive Land

Construction sites are inherently unsightly and may impart substantial visual impact upon the landscape. Particularly bothersome may be spoil heaps and stock piles, labour camps, workshops, batching plants and parking areas. Large expanses of cleared ground prior to reservoir filling may also be unsightly, but it is better that crops are cleared as they come to harvest and trees cut to allow optimum recovery of timber rather than to inundate planted land and suffer excessive greenhouse gas emissions during the early years of dam operation. Contractors should plan land clearance to minimise the destruction of un-harvested crops.

As on most construction projects, land beyond the limited area of construction will be required for site offices, camp sites, materials storage, fabrication yards, and borrow sites for the winning of granular construction materials. At Bisri, it is currently expected that all these facilities, including sand pits and rock quarries will be within the reservoir area and hence inundated on completion. Where the excavation of materials extends above maximum water level, the contractor will be expected to provide benching and/or to grade slopes in a manner that meets the requirements of the Master Plan for Shoreline Development.

7.3.3 Biodiversity and Habitats

Construction activity, increased lorry movements, equipment noise and dust will result in the destruction and disturbance of wildlife and habitats. The erosion of unprotected excavations and from land cleared for both construction facilities and in preparation for inundation will increase sedimentation and turbidity downstream of the dam site, damaging and destroying riverine and bankside habitats, injure the gills of fish, and smother river flora and river bottom invertebrates.

Always a major concern with construction in an area such as the Bisri Valley is the propensity of construction labourers will partake of hunting, egg-collecting, plant-removal and trade-in-live-species, the cutting of trees outside the reservoir area, and the starting of fires.

The need to temporarily divert surface water flows around the construction site may introduce flow velocities, turbulence and submerged structures that some aquatic species are unable to tolerate.

7.3.4 Disruption to Existing Traffic Routes

There are no metalled public rights-of-way in the immediate vicinity of the Bisri dam site nor within the area to be inundated. Traffic on existing unsurfaced tracks and footpaths in the vicinity of the dam site and throughout the reservoir area will be subject to disruption during construction but access to all properties will be maintained.

Access to the dam site from the coastal highway via Joun is narrow and only poorly capable of handling a significant increase in heavy transport. While it is expected this road will eventually be upgraded to serve induced developments, consideration should be given to the need for additional passing places or other improvements to reduce congestion, particularly during the transportation to site of heavy equipment and plant.

7.3.5 Disruption to Existing Public Utilities

With little settlement throughout the dam site and reservoir area, power is supplied from skid-mounted diesel generating units, and telecommunications by one of Lebanon's two mobile operators with relay stations on the surrounding hills. Water supply and sewerage facilities are provided locally and the only pipework is private, within individual premises.

There will therefore be no temporary disruption of public utility services.

7.3.6 Soil and Water Pollution

The main risk to soil and water pollution at Bisri will be during land clearance, when sewage holding tanks, underground fuel storage tanks will need to be emptied and removed prior to reservoir filling. Vacated property should be searched for containers, part-full or empty, originally containing oils, lubricating fluids and agricultural chemicals.

At the construction site itself, greatest concern is the potential for spillages of chemicals, fuel and hydrocarbon products, and for sewage discharges from the labour camp and on-site domestic facilities.

7.3.7 Drainage, Erosion, Turbidity and Sediment Load

The Updated 2011 Feasibility Study anticipates the diversion of river flow through the dam site using a combination of cofferdam and conduit sized to cater for a 25-year return flood. With this in place, all existing drainage should be maintained.

Dam site excavation, land clearance over the reservoir area, the stock-piling of granular materials, and heavy vehicle movements on cleared soil surfaces will all promote sediment discharge to the river, heighten turbidity and increase sediment loading, particularly during the rainy season. As discussed above, high turbidity and sediment load will seriously impact riverine and bankside ecology, as well as interfere with downstream abstractors and irrigation systems.

7.3.8 Air Quality and Dust

All construction sites are inherently dusty, especially during the hot summer months, primarily arising from soil and rock excavation, concrete batching, and heavy trucks and equipment operating on land cleared of vegetation. Bisri will be no exception and different mitigation measures will be required to safeguard the public and construction workers. The large numbers of heavy vehicles and machinery working at the dam site will concentrate the discharge of exhaust emissions, while the site offices, and camp and other facilities will operate diesel turbines for power generation.

Construction traffic egressing the site will take mud and dust onto public roads, and the increase in traffic will enhance also exhaust emissions along the main access roads.

7.3.9 Noise and Vibration

Noise and vibration are also unavoidable at construction sites and their impact may, depending on prevailing wind directions, be noticeable at Bisri where there are few other significant noise and vibration generators within the valley but potential sensitive receptors on the hillsides. Excessive noise, particularly when experienced continuously, outside normal working hours and on rest days, can be a nuisance, and in extreme cases, a health hazard. Those most at risk from excessive noise and vibration will be construction workers due to their proximity to construction plant and equipment, typical noise emissions from which are shown in Table 7.3.

Table 7.3: Typical Noise Emission Levels for Types of Construction Plant

Type of Plant	Distance between Plant and Observer		
	5m	20m	50m
Loader	90	78	70
Grader	90	78	70
Vibration Roller	86	74	66
Bulldozer	86	74	66
Sprayer	87	75	67
Generator	98	86	78
Impact Drill	87	75	67
Impact Piling	112	100	92
Concrete Mixer	91	79	71
Concrete Pump	85	70	62
Pneumatic Hammer	84	86	78

Figures in dB(A)

Perhaps the most significant impacts from construction noise and vibration are those arising during piling and blasting. Piling at Bisri is expected to be required in at least the approaches either side of the main dam and in the construction of the cut-off-trench and the monotonous series of pile-driver blows will echo through and around the valley. Given the nature of the reservoir floor, any need to blast out foundation excavations is expected to be minor. More significant will be the need to secure limestone rip-rap from a quarry expected to be within the upper catchment area. Blasting at the dam site may be required if the present site with one abutment in limestone strata is confirmed.

7.3.10 Accidental Damage to Property

The risk of damage to adjacent properties during construction at Bisri is minimal, primarily limited to over-zealous land clearance downstream of the agreed working area beyond the toe of the dam, and upslope from the agreed shoreline clearance level.

7.3.11 Intentional Damage to Property

The risk to natural habitats and wildlife through construction workers partaking of hunting, egg-collecting, plant-removal and other deleterious activities was highlighted in Section 7.3.3 above. Construction workers are also known to partake in theft, vandalism and otherwise intentional damage to property. Theft of materials and equipment within the site is an issue for the contractor alone and may be expected to be contained by his own disciplinary procedures. Beyond the camp in adjacent villages it will be a matter for the local police and judicial authorities. Within the reservoir there are a number of locations where wanton damage may occur. These will include theft from crops yet to be harvested from land not yet taken over for the project, vandalism of abandoned buildings, and perhaps most significantly, desecration of Mar Moussa Church and of the Marj Bisri archaeological site, and damage or destruction of other heritage sites.

7.3.12 Public Health and Safety

Construction sites are inherently unsafe and given the scale of construction and land clearance to be undertaken, the risk to public safety in terms of both physical extent and the types of risk posed will be substantial. While the Bisri construction site is generally remote from immediately adjacent settlements, it is to be expected that people wishing to see the dam throughout the period of construction will increase traffic and visitor numbers.

Notwithstanding this, if public access is adequately managed, the prime risks during the period of construction are expected to be from unauthorized access and trespass.

7.3.13 Worker's Health and Safety

The construction industry has an inevitable record of annul deaths and injuries. While risk to public safety will be limited by only casual acquaintance with site activities, the risks to those employed on the project are more varied and omnipresent. They are however generally well understood, documented and relatively easily managed through adherence to good construction practices, standard H&S provision, and common sense.

Worldwide, several thousand of construction workers are killed each year, about one-third of them as a result of injuries received from construction site falls. Other common types of construction site accidents the Bisri project may susceptible to include:

- Crane and scaffolding accidents;
- Run-over by operating equipment;
- Unsafe and dangerous equipment accidents;
- Trench collapses;
- Welding, brazing, cutting accidents;
- Structure failure and collapse; and,
- Supervisor negligence.

The risk to workers on the Bisri site is enhanced due to its relative remoteness and the distance, in both kilometres and travel time, to the nearest hospital. While doctors and health centres are available in surrounding villages, the closest medical facilities are the public hospitals in Saida (125 beds) and Jezzine (40 beds), together with a selection of public and private facilities of all types in Beirut.

7.3.14 Excess Spoil

Current expectations are that relatively minor quantities of surplus soil and rock will be generated during the construction of Bisri dam. While accurate quantities of 'cut' and 'fill' will be calculated during final design, the relative quantities quoted costed in the 2011 Update report, summarised in Table 7.4, provide the most accurate estimation to date. The main requirements for concrete and concrete products are included as they mostly comprise rock materials and are expected to be sourced from within the immediate vicinity of the dam. The largest requirements for 'fill' are of course for the main dam shell (3.5 Mm^3) and core (0.7 Mm^3).

Table 7.4: Preliminary Estimates of Cut and Fill for Bisri Dam.

Structure	'Cut' to be Excavated	'Fill' to be Emplaced
Cofferdam	86,860 (Earth)	230,400 (Shell) 147,200 (Core) 27,460 (Riprap) 2,870 (Backfill)
Subtotals	***86,860***	***407,930***
Main Dam	746,900 (Earth) 8,921 (Rock)	3,536,420 (Shell) 686,250 (Core) 247,390 (Transition) 208,540 (Drain) 256,140 (Filter) 110,900 (Riprap) 408,332 (RCC)
Subtotals	***755,821***	***5,453,972***
Diversion Conduit	265,800 (Earth) 29,000 (Rock)	17,200 (Lean concrete) 10,800 (Structural concrete) 280,000 (Backfill)
Subtotals	***294,800***	***308,000***
Spillway		49700 (Structural concrete) 13590 (Paving)
Subtotals	***0***	***63,290***
TOTAL	***1,137,481***	***6,233,192***

All figures in m^3.

The exception where 'fill' is most unlikely to be sourced from 'cut,' and may even have to be sourced from outside the immediate area of the works, is for the provision of riprap.

The 1.1 Mm^3 'cut' materials, primarily earth rather than rock, is taken to include the lacustrine clays and overlying alluvial sands and gravels, which are assumed to be reusable, and surface soils and sub-soils that are not. Material that is not reusable is expected to be graded and compacted into the reservoir landscape prior to filling.

The quantities given above do not include the clearance of vegetation and fertile soils from throughout the reservoir area prior to filling. On the basis 0.5 m of soil and topsoil are to be stripped over an area of at least 450 ha, some 2.25 Mm^3 of material will be removed, almost all of which is unlikely to be reusable for construction purposes. Given its organic content, this material cannot be left within the area to be inundated. Since much of the topsoil will have been conditioned with a high fertility, it is recommended this be used to improve poorer soils elsewhere in the vicinity, or used within the Master Plan for Shoreline Development to promote landscape planting around the periphery of the reservoir.

Similarly, if the rock materials required cannot be obtained from the inundated area, any quarry excavation that will remain above water levels should be designed and graded to minimise landscape scaring and promote rehabilitation and/or future development.

7.3.15 Off-site Impacts

Access and Construction Traffic

The contractor will need to build a new access road to the Bisri Dam site from the public metalled road serving Bisri village, a distance of some 1.5 km. The potential need to increase the number of available passing places on existing local roads has been highlighted in Section 7.3.4 above. All points of contact between construction and public traffic will potentially give rise to accident black spots due the relatively low speed of contractors' trucks, damage to the road surface from increased flow of heavy traffic, and from the deposition of mud, chippings, oil and other foreign matter.

Road conditions and congestion may be expected to significantly increase if construction materials such as riprap cannot be taken from the reservoir area or adjacent areas.

Pollution

The most significant risk of off-site pollution will be those sources of soil and water contamination discussed in section 7.3.6 above carried downstream. With all construction facilities, including the camp site, being powered from diesel generating sets, regular, almost daily fuel deliveries are likely to be required. The risk of pollution from accidents resulting in spillage on the narrow public roads from the coastal highway will therefore be increased.

Similarly, if concrete batching is undertaken on site, there will be regular deliveries of bulk cement. Any spillage during offloading will increase particulate matter circulating in the air.

Other Sites

The need to include third party supply sites such as quarries, fabrications yards and concrete batching plants is not expected other than perhaps for riprap. Solid waste disposal sites, preferably outside the dam catchment area unless a registered and controlled landfill, will be required for wastes other than inert construction materials.

7.3.16 Consumption of Materials

The consumption of materials for construction will be excessive but all granular materials and rock products such aggregate are expected to be sourced from within the reservoir site, either from the alluvial detritus lining the river bed, the underlying lacustrine clays, or from borrow areas on the valley sides. The exception may be riprap, which because of block size and rock quality specifications may need to be sources from outside.

All water consumed on site is likely to be taken from the river and given appropriate treatment prior to use. Only drinking water used for camp messing facilities may be brought in from outside.

Working from Table 7.4 above, the preliminary consumption of materials, with no allowance for wastage, is expected to be as given in Table 7.5.

Table 7.5: Preliminary Estimates of Consumption of Materials at Bisri

Material	Total Volume	Composition and Volume of Materials					
		Cement	Aggregate	Sand	Clay	Water	Block Rock
Shell	3,766,820	-	60% 2,260,092	40% 1,506,728	-	-	-
Core	833,450	-	-	-	100% 833,450	-	-
RCC	408,332	20% 81,666	30% 122,500	40% 163,333	-	10% 40,833	-
Transition	247,390	-	45% 111,325	55% 136,065	-	-	-
Filter	256,140	-	60% 153,684	40% 102,456	-	-	-
Drain	208,540	-	65% 135,551	35% 72,989	-	-	-
Paving	13,590	10% 1,360	45% 6,115	45% 6,115	-	-	-
Structural Concrete	60,500	20% 12,100	45% 27,225	25% 15,125	-	10% 6,050	-
Lean Concrete	17,200	15% 2,580	40% 6,880	30% 5,160	-	15% 2,580	-
Riprap	138,360	-	-	-	-	-	100% 138,360
Backfill	282,870	Assume taken from excess 'cut'.					
TOTALS	-	97,706	2,823,372	2,007,971	833,450	49,463	138,360

All figures in m^3.
Since excavated 'cut' exceeds the required 'fill', it is assumed no additional consumption is required for backfill

In summary the total volumes of materials are nearly 100,000 m^3 of cement, over 4.8 million m^3 of crushed and/or graded earth materials such as sand and aggregate, more than 800,000 m^3 of clay, 50,000 m^3 of water, and 140,000 m^3 of block rock. The aggregate, sand and clay is expected to come from working resources within the reservoir area, and the water will be taken from the river. The block rock is likely to worked from a borrow area on the overlooking hillside, but remain exposed after the reservoir is full.

The 100,000 m^3 of dry cement, which will come from elsewhere in Lebanon, probably Sibline, will weigh some 150,000 tonnes, and its manufacture may be expected to emit some 135,000 tons of CO_2-equivalent greenhouse gases.

7.4 Potential Post-Construction Operational Impacts

7.4.1 Water and Power Supplies

The 1995 Feasibility report, updated in 2011, established the prime objective sets of the Bisri project to be the supply of domestic and industrial water to Greater Beirut, the production of hydroelectric power, being a "by-product" of dam releases and hence of secondary priority. Once all these demands are met, the availability of irrigation water will then be determined from the water supply and release patterns finally adopted, providing there is excess of water for irrigation. Neither of the feasibility reports makes reference to the provision of environmental flows for aesthetic purposes and the maintenance of bankside vegetation and riverine fish stock.

Domestic and Industrial Water Balance

The various simulations of reservoir water supply for a period of thirty years, as presented in the feasibility studies, concluded that a 6-month-delivery period, at a constant rate of 6 m^3/s from a reservoir volume of approximately 128 Mm^3, will generate the least shortages in supply under the following assumptions:

- Reservoir evaporation losses will be 0.8 of monthly pan evaporation;
- A 2% shortage criteria[39] will be imposed over the 30-year period; and,
- Diverted flows to the Barouk-Beiteddine regional water supply scheme were added to Bisri river historical flows, i.e. assumed to be available for GBWSAP.

The elevation of the water surface for a reservoir volume of 128 Mm^3, is 462m. The proposed water supply pattern will result in additional water supplies of about 95 Mm^3 during the six dry months from May to October, of which 10 Mm^3 is to be allocated to the City of Saida[40], leaving a balance of 85 Mm^3 for Greater Beirut. This allocation is intended to alleviate any potential for conflict between the nearest urban center to Bisri and the major project beneficiaries in the capital.

In determining the water supply available from Bisri, the present proposal makes no allowance for continuing the present off-take from Nahr Barouk upstream of the proposed Bisri Reservoir to serve Iklim-el-Kharoub and the higher Chouf communities from the Barouk regional reservoir. In outstanding design studies for Bisri, provision for

[39] A 2% shortage criterion means the reservoir will be able to deliver 98% of the total volume requested over the 30-year period. In most years there will be no shortages, while in some there will be shortages for 1-4 months.

[40] Dar Al-Handasah (Shair and Partners). *Feasibility Study for Water Supply of the Area Between Damour River and the Southern International Boundary Master Plan*. Doc. No. MP-L9514-5. 1996.

the existing and future water supply to these communities must be included, or alternative resources provided.

In assessing the environmental and social impacts of Bisri dam, the inevitable conclusion is that the viability of the scheme on a highly seasonal watercourse – and increasingly so with global warming - is based on capturing all the available flow without any reasonable maintenance of existing upstream abstraction, downstream irrigation, or compensatory environmental flows.

The Preliminary Draft ESIA Report of August 2012 recommended Bisri Dam to be the GBWSAP priority scheme on the basis that its conjunctive use with GBWSP facilities made it most cost-effective in comparison with other dam and non-dam alternatives. Bisri afforded the greatest volume of water to alleviate the water shortage crisis looming in GBA. Therefore; the water supplies figures discussed here below should include both schemes with the assumptions that the GBWSP and Bisri Dam projects will not come on the supply line before 2015 and 2020 respectively as shown in Table 7 6 below.

Table 7.6: Water Use Balance for the Greater Beirut Area to 2035

Water Use Balance for GBA[41]		2011	2015	2020	2025	2030	2035
Demand	Gross Domestic & Industrial	225	240	255	290	320	341
	Domestic & Industrial after leakage reduction	225	225	220	248	250	273
	Domestic & Industrial after metering & awareness campaigns	225	210	180	190	210	229
Supply	Available current water resources	101	101	101	101	101	101
	Allocated water from GBWSP to GBA	-	50	50	50	50	50
	Allocated water from Bisri dam to GBA	-	-	85	85	85	85
	TOTAL	**101**	**151**	**236**	**236**	**236**	**236**

All figures in million m^3.

As shown above, the 2011 domestic and industrial demands of 225 Mm^3 is, without savings, expected to grow to 341 Mm^3 by 2035. With the GBWSP leakage reduction achieved in its entirety, this is expected to reduce to 273 Mm^3, and to 229 Mm^3 with further savings from GBWSP public awareness and metering.

There is no doubt that with GBWSP fully implemented and Bisri Dam fully operational, improved access to water supply will be felt by residents throughout the Greater Beirut area. But until Bisri becomes fully operational, most likely by 2019 or 2020, GBA gross and reduced water demands will not be fully met. With Bisri on-stream, GBA demands,

[41] MEW Potable Water Balance for the Greater Beirut Area for 2011-2035.

with all the anticipated GBWSP savings achieved, may be expected to be met until about 2035. If the savings do not materialize, Bisri will satisfy demand until about 2025. As such, the water savings predicted by MEW for GBWSP is critical to optimizing the benefits of the Bisri project. The ESIA therefore concludes that the viability of the proposed savings needs to be reassessed. For example, as discussed in detail in the PD ESIA, leakage reduction below 25% is unlikely to be achieved in the short term, although in the longer term, when all GBA networks may be deemed to have been replaced, a 20% reduction may be achievable. This is due to many factors, including the presence of residual war damage, the excessive traffic loading on pipelines within roads, and the limitations of civil society.

Therefore, it is imperative the potential for resource exploitation within the Lower Awali valley are realised. With GBWSP and GBWSAP as currently conceived, there will still be excess flow beyond Joun HEP, which if they greatly exceed downstream abstraction and environmental needs, might be pumped back into Bisri Reservoir from where they can be more efficiently managed. If these flows do not greatly exceed downstream requirements, they may be left as they are but with compensatory dam releases geared to make up any shortfall.

Water supply is an emotive issue throughout Lebanon and given the social discourse between communities village by village, area by area, it is important that future water supplies for greater Beirut and elsewhere make optimal use of the available resources, and any predicted future changes therein, without derogation of not only existing supplies but also for the natural development of the communities and activities that utilise these supplies.

Hydro-Power Generation

Given the present condition of the power sector in Lebanon and the chronic shortages of electricity in Greater Beirut and elsewhere, together with the worldwide focus on non-fossil fuel energy, it is a natural extension of the Bisri project proposal to include for the generation of hydroelectric power. Given reservoir impoundment is required for water supply, which will itself generate substantial GHG emissions as discussed in Section 7.4.5 below, the additional emissions from hydropower will be minimal, thereby improving the overall GBWSAP carbon footprint.

The installed capacity of Bisri dam plant depends in part on the normal water surface elevation in the reservoir, the number of months when water will be released, and the rate of release. Assuming a 12-month release pattern, the installed capacity will be approximately 1.4 MW, with 1,100 MWh generated from a constant release of water of

3.0 m^3/s. This could be increased to 2.8 MW from a release rate of 6 m^3/s over a 6-month-release period, with energy generation approximately the same as for 3 m^3/s rate.

Current installed capacity in Lebanon is 2,259 MW, of which 2,038 MW comes from seven thermal power plants and 221MW from hydropower plants. The three existing hydropower plants of the Litani-Awali scheme have a combined capacity of 190 MW Power. the addition of 1.4 WM from Bisri is therefore a minor increase, but if used locally, for dam operations, to power the treatment plant, and the remainder applied to local villages, would reduce the demand on other meager resources and reduce the need for long HV transmission cables.

Irrigation Water Requirements

No criteria were established by the 2011 Feasibility study, for determining downstream irrigation needs. Although the study omitted these needs, it is a demand that is currently being satisfied and one that must continue to be provided for in the future if consequential derogation of agriculture, breakdown of social cohesion and the break-up of established communities are to be avoided. From repeated field visits and previous studies for the area, the ESIA team has identified two areas where significant agricultural activities, diverting substantial flows from the river will need to be provided for:

- The Barouk-Beiteddine irrigation scheme in the upper catchment area diverts an estimated 10 Mm^3 each year from Nahr Barouk; and,
- The agricultural lands of Iklim el-Kharoub in the lower catchment area, where the 1996 Feasibility Study/Master Plan projections for 2020 were for 10 Mm^3, which includes 4 Mm^3 for use downstream of the Joun HEP on both banks of Nahr Awali at Almane, Rmaileh and northern Saida.

A third zone, in the vicinity of Marj Bisri, also currently takes water from the river to irrigate about 130 ha of land, but since this is within the reservoir area, agricultural activities will cease and no future irrigation will be needed.

The compensatory flows required to allow current irrigation practices to continue are therefore expected to be of the order of 20 Mm^3, although the emplacement of an effective agricultural extension service to optimise crops species selection and irrigation efficiency may be expected to reduce this considerably. Some of the upper catchment requirement may also be met from the extension of ground water abstraction and/or the development of small hill ponds filled during times of peak watercourse discharge.

The loss of these areas of irrigated agriculture, coupled with the loss due to inundation will, in addition to severe ecological and social-economic impacts, also reduce the supply of fresh-foodstuffs to Greater Beirut and eventually increase the cost-of living.

Environmental Water Flow

All surface watercourses require a base level of flow to provide for downstream abstractions, the dilution of wastewater discharges, the maintenance of river bed and bankside biodiversity and habitats, and for aesthetic purposes. Environmental flows are critical for the area below any dam, where the natural hydrological regime is substantially changed, downstream flood spreading and the deposition of silt is curtailed, and reduced water quality. Commonly, as will be the case at Bisri, environmental flows will not be expected to reproduce natural stream flow, but should be sufficient to satisfy the requirements outlined above.

In respect of water quality, of most concern are temperature and dissolved oxygen. The lower the temperature and oxygen content of the water released from the dam, the more severe the disruption to the spawning, migration and reproduction of many native fish species[42]. Ideally, environmental releases should be the same temperature as the water entering the reservoir. When flow is maintained at a low level, Periphyton[43] may accumulate in thick layers, trapping sediment and organic matter, lowering dissolved oxygen levels, and changing pH (Stevenson 1996)[44]. To minimize the impact, base flow releases should be varied by as much as 50% of the recommended volume.

During the dry season, environmental flow tends to be dominated by the base flow, primarily originating from the seepage of groundwater into the watercourse. This base flow is the minimal needed to support the fish, plants and insects, and to protect water quality. Low flows need to be maintained as close as possible to the natural stream flow, although given the dam’s fundamental objective is to arrest runoff and the consequential loss of water to the sea, this is often not practical. Base flow should also provide for any natural infiltration to ground water in order to avoid the depletion of downstream aquifers.

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[42] Environmental Flow Guidelines ACT Government 2006.

[43] A benthic mixture of algae, cyanobacteria, heterotrophic microbes, and small crustaceans.

[44] Stevenson, R.J., (1996). Patterns of benthic algae in aquatic ecosystems. *Algal ecology: freshwater benthic ecosystems.* R Jan Stevenson, R. Bothwell, M.I. and Lowe, R. L., California, Academic Press.

Using the 90 percentile of water flow[45] from the flow-duration curve shown in Section 4.6 above, the 2011 updated Feasibility study for Bisri estimated the base flow to be 0.6 m^3/s. This is the minimal requirement downstream of the dam if a healthy aquatic ecosystem is to be maintained.

Under natural conditions, winter flood flows purge the river of silt and other detritus that smother invertebrate and plant habitats. While silt deposition downstream will be greatly reduced by construction of the dam, the need to purge clastic detritus brought in by tributaries entering below the dam will need to be reviewed when designing operational procedures.

7.4.2 Downstream Flood Control

The most significant positive impact to downstream land owners will be the ability to control flow and reduce or even curtail seasonal flooding. However, the physiology of the generally steep-sided valleys and the major variations experienced in seasonal flow in Bisri River have served to limit settlement to the higher valley flanks and hilltops. Other than the floods of April 1971 that affected the Awali hydropower Plant, no major flooding of populated areas has been recorded in the valley. The coastal plain areas adjacent to the river are prone to flooding as torrential river flows spread on leaving the confines of the valley, which occasionally has a serious impact on agriculture.

The Feasibility study for Bisri Dam Project included flood analysis to estimate the Probable Maximum Flood expected from the most severe combination of critical meteorological and hydrological conditions that might risk the structural integrity of the dam. Accordingly, a peak flow of 3,110 m^3/s was considered in the design of the spillway to guarantee dam safety. This flow is equivalent to more than ten-times the peak annual flow of around 265 m^3/s recorded in the river. Despite being a rare occurrence, such a flow will erode and scour the existing river bed, and cause considerable flooding. This will result in physical damage to the river banks, the hydropower plants and their appurtenant structures, coastal plain agriculture, buildings and public infrastructure.

Flooding is the third largest cause of death due to natural hazards worldwide[46] and a Flood Management Plan with appropriate Emergency Response Procedures (ERPs) must be developed within the Bisri Dam management procedures. It should include a demarcation of the PMF inundation limits as well as a register of structures including buildings, agriculture areas, and public infrastructure, together with a prioritization of the damages caused by flood flows and frequency to develop appropriate mitigation. This

[45]The 90th percentile is the flow discharge that will be exceeded 90% of the time.
[46] Tobin, Graham A. and Burrell E. Montz. 1997. *Natural Hazards Explanation and Integration.* Guilford Press.

Plan would be in addition to that developed following Dam Break Analysis, which will cover the ultimate disaster.

7.4.3 Dam Safety

Dam safety is a vital consideration and one that must be taken extremely seriously. As mentioned in Section 3.5, international funding agencies generally require the provisions of World Bank Operational Policy *OP.4.37 Safety of Dams* to be implemented in full where equivalent provisions is not incorporated within national legislation.

The appointment of the expert Panel is usually undertaken at an early stage in the project cycle, and that Bisri has progressed as far as it has without one suggests it is an issue that requires to be expedited if potential funding agencies are to seriously consider specific design proposals. The project proponent must therefore expect some delay while the Panel is appointed and its members review the location, the site investigations and the proposed designs undertaken to date. While funding agencies may fund *dams-under-construction* without prior Panel review, they usually require evidence:

- That an effective dam safety programme is already underway; and,
- Full inspections and safety assessments have been satisfactorily conducted and implemented.

The Panel will certainly expect to see the results of a Dam Break Inundation Analysis, an assessment of the downstream hazard should the dam undergo catastrophic failure. Often referred to a Dam Break Analysis or DBA, this primarily hydrological modelling exercise is standard procedure in dam design and provides for (i) the evaluation of design performance, including the sizing of emergency spillways, and (ii) the development of regional and community Emergency Response Procedures,

At Bisri, the proposal for a RCC section within an earth embankment, coupled with the potential for differential settlement because of differing geology on either side of the dam axis, and the high risk of seismicity, hence the possibility of significant failure during the expected life of the structure cannot be ignored. Notwithstanding this, the wide flat valley immediately below the dam is almost as equally wide as it is upstream, and after just 1 km, beyond Bisri village as far as El Kherbe, the valley expands further around the confluence of Wadi en Naassa. Below El Kherbe, beyond the location of the landslide that gave rise to the lacustrine clays, the Nahr Awali enters a far more restricted channel bordered by high and steep slopes. Significant attenuation of dam brake flows may be expected within a short distance of the proposed dam site, but as the rising waters feed into the more restricted valley, further attenuation before reaching the coastal plain may be minimal. A consequence of any relocation of dam axis upstream will be the potential to improve dam break flow attenuation within the sparsely populated area immediately downstream. Wherever the final dam axis is located, with the potential for flood waters to annihilate Bisri and El Kherbe, the Downstream Hazard Classification is expected to be 'High'.

7.4.4 Public Health and Safety

The permanent impacts on public health, such as enhanced water and power supplies, improved access to villages and community services, to better wastewater disposal, have previously been identified in Section 7.2.9 above. Operational impacts will primarily focus on health and safety issues of the impounded water and its use.

The flow control afforded by Bisri Dam will, under most return storms, will prevent overbank events downstream and hence the risk to life from flooding. It will also prevent the worst effects of drought, when addition flow can be released from storage to sustain downstream licenced abstractions and irrigators. Conversely, the World Health Organisation has long been concerned about the impact of dams and other types of water projects on human health, especially the transmission of communicable diseases. More water use generally translates to more wastewater generation, and local communities given improved access to water supply should also be provided with improved sanitation to decrease the risk of waterborne disease.

Reservoirs promote the breeding of vectors and vermin as well as the spread of disease, particularly where there is poor circulation that gives rise to stagnant backwaters, favoured breeding site for mosquitoes. At Bisri, the northern extremity of the reservoir, and to a greater extent the southerly arm along Wadi Bhannine may only be inundated to a relatively shallow depth. Such areas will be highly susceptible to silting, which after only a few years operation may create a marshy and humid wetland habitat in which vectors and vermin will readily breed. However, the most serious diseases that may arise under these circumstances, such as schistosomiasis, dysentery and typhoid, are not endemic to Lebanon.

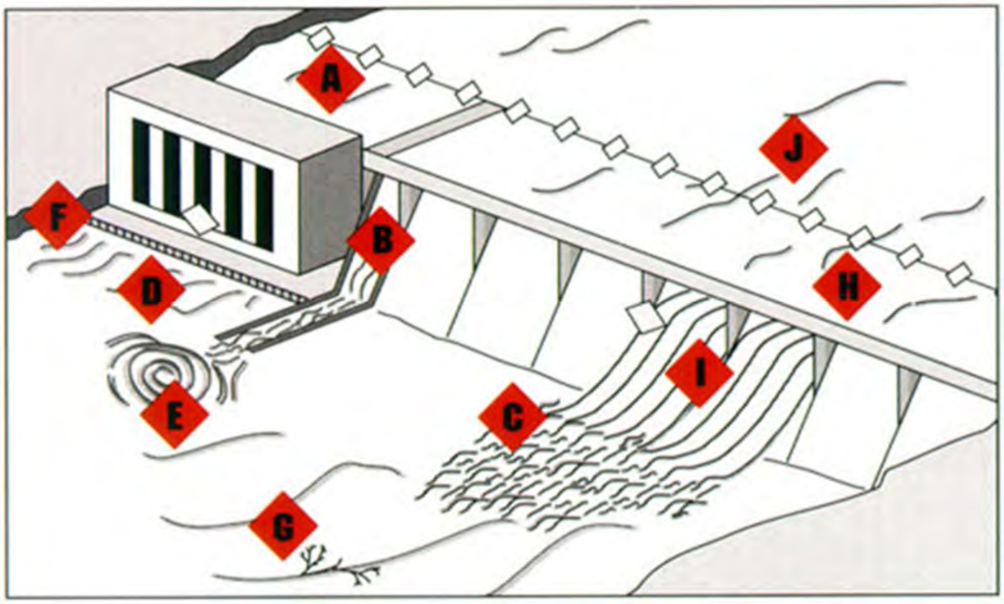
Reduced water availability and quality at the lower end of the catchment towards the sea may result in reduced dilution of fertiliser residues and other agricultural chemicals. If releases from the dam substantially reduce mean monthly flows, dam construction and social development should be accompanied by agricultural extension services to help farmers minimise chemical applications, reduce residue runoff, and hence the risk to public health. In semi-arid regions like Lebanon, new dams can quickly be subject to eutrophication due to over-enriching by organic nutrients from wastewater discharge and fertilizer runoff. The most common result is excessive aquatic weed growth or 'blooms' of cyanobacteria that may, in excessive doses, become toxic and hence lethal to humans and animals. Low level exposure to some of these toxins can promote live cancer and various gastrointestinal and allergenic illnesses in humans, but the majority of cyanobacteria species are relatively easily treated by the normal elements of water treatment such as that proposed for Ouardaniye.

For present purposes, the ESIA assumes Bisri Dam and reservoir will be opened to public access, with recreational use of the water and shoreline permitted, albeit perhaps to only limited vehicular access and/or at a cost to the user. Given the site's proximity to urban centres such as Beirut and Saida, and to summer resorts in the Chouf Mountains, the prevention of public access may be almost impossible. Opening the site will enable appropriate measures for public safety and environmental protection to be put in place and regulated, as well as stimulate commercial activity.

Permitted activities might include walking, running, fishing, swimming, canoeing, yachting, picnicking, and camping, each perhaps limited to specifically designated areas. Banned activities should include motocross and rallying, use of ATVs, cutting of timber, motor boats, water skiing, and others that will disturb the general peace and tranquillity the presence of a large body of water inherently imparts.

There are, of course, multiple risks to public health and safety simply from the presence of a large body of water and its associated facilities. Dams and reservoirs constitute a major risk of drowning and other accidents, especially for the elderly and small children, trespassers and those involved in horse-play. The risk of drowning also extends to livestock drinking at the shoreline. While particularly dangerous areas may be fenced off, it will be both impractical and undesirable to fencing the entire 6-7 km periphery of Bisri Reservoir. Significant reduction of the inherent risks can be achieved with a *Master Plan for Shoreline Development*, restricting activities such as bathing and children's activities to shallow areas, and separating bathing areas from those used for yachting and canoeing. While much of the Bisri shoreline must be expected to be developed privately, public access must be maintained if people are not going to run unnecessary risks in areas of deep, turbulent and otherwise unsafe waters. Typical risks to public safety at dams[47] are shown in Figure 7.3.

[47] From: Federal Energy Regulatory Commission, *Safety Signage at Hydropower Projects* October 2001



A	Hazardous approach marked by boom
B	Sudden change in spillway discharge
C	Strong unpredictable currents above & below dam
D	Sudden turbulent discharges from power plant
E	Deceiving reverse currents below spillways
F	Slippery surfaces on dam crest and shoreline
G	Submerged hazards above and below the dam
H	Open spillways not be visible from the dam
I	Debris passing over or through the dam
J	Turbulent water in dam approach

Figure 7.3: Typical Risks to Public Safety in the Vicinity of a Dam

The primary means of protecting the public is to erect walls and fences where access needs to be prevented, information and warning signs where there is danger and/or activities need to be restricted. A Code of Conduct will need to be developed. Examples of the type of signage used on reservoirs are given in Figure 7.4.

On completion of Bisri dam, the following are likely be needed:

- Booms across the reservoir upstream of the dam, a safe distance (50 m or more) above first occurrence of turbulent water, to prevent the entry of boats and to warn swimmers;
- Security fencing around all elements of the dam and hydropower plant;
- Fencing either side of the reservoir upstream as far as the boom, and downstream to a point below the reach of spillway eddies, whirlpools and other turbulence;
- Fencing both sides of the crest if public crossing is to be permitted;
- Warning notices to publicise the dangers around the dam;

- Information notices to show areas safe for the range of water based activities (boating, swimming, fishing, etc.), parking areas, boat launching ramps, public access tracks, picnic areas, etc.;
- Siren to warn when discharge structures are to open or close;
- A Public Awareness Campaign via national media, local schools and community organisations, as well as on site.
- Utilisation of the dam and reservoir as an educational resource, teaching about the surrounding countryside, its history, its geology, the river and its catchment area, reservoir ecology, dam and reservoir operation, hydropower generation, water safety, water sports, training, etc.;
- Regulation backed up with meaningful enforcement for non-compliance.

Figure 7.4: Examples of Dam Public Safety Information and Warning Notices

As the surrounding areas are developed, particularly if facilities such as restaurants, resort hotels, boatyards and fisheries are developed along the shoreline, public safety will need to become a responsibility shared between the dam and reservoir operator (assumed to be BMLWE), property developers, owners and facilities managers. Safety issues should also be addressed in the proposed Shoreline Master Plan, Development Guidelines, Building Controls, etc.

7.4.5 Greenhouse Gas Emissions

With increasing concern about the global impact of Greenhouse Gas (GHG) emissions[48] from all aspects of human activity, climate scientists have recently been looking at the potential for emissions from reservoir-based hydropower schemes, in which GHGs are emitted from both the reservoir and the power plant. Bisri will emit GHGs with or without a power plant.

Bisri reservoir may be expected to reach a maximum depth of 65-70 m, with the average throughout the inundated area around 35-40 m. Thermal and water quality stratification may therefore be expected due to changes in seasonal mixing within the water column and the introduction of nutrients through soil erosion and wastewater discharge[49]. The various sources of the main GHGs, carbon dioxide (CO_2) and methane (CH_4), associated with reservoirs, are illustrated in Figure 7.5.

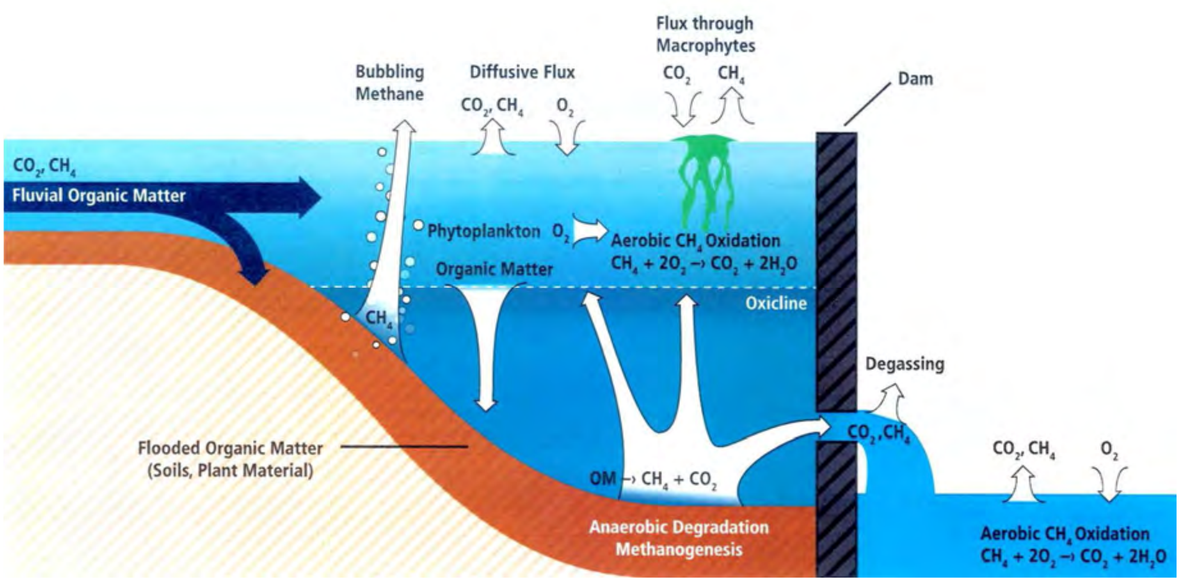


Figure 7.5: CO2 and CH4 Pathways in a Freshwater Reservoir (After Guerin, 2006)

When a reservoir is initially filled, the carbon sequestrated in the soil, plants and trees is released as this material anaerobically decomposes. After this initial period of enhanced emissions, inflowing rivers wash in soil and plant debris that contribute to the accumulation of biomass on the reservoir bottom. In Bisri, given the lack of sewerage systems throughout many of the mountain villages draining into the valley, this will also include raw or only partially treated wastewater discharges, and soil eroded from the

[48] Primarily, according to the IPCC, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)

[49] The impact of stratification on water quality is discussed elsewhere.

steep valley slopes during heavy rain and turbulent snow melt. The main gas given off by this decomposing biomass is methane, a major constituent of GHG, twenty-one times more ozone-depleting than carbon dioxide.

Seasonal variations in climate and river flow maintain a constant annual supply of biomass. The reservoir shoreline becomes vegetated as the high spring water levels fall throughout the dry season, and are inundated again with the onset of winter rains and early spring snow melt. While this vegetation will have sequestered only limited amounts of CO_2 during its short life, this will also be converted to CH_4 as it aerobically decomposes. Also within the aerobic zone, phytoplankton will photosynthesise oxygen, promoting methane oxidation to CO_2 and water, while macrophytes will take in CO_2 and give off CH_4.

These and other gases dissolved in the water, in addition to being released from bottom sediment and at the water surface, the water is further degassed during its passage over the spillway or through power turbines.

Scientific research is not sufficiently advanced to enable the various GHG contributions to be quantified, but the likely relevance each to Bisri reservoir is outlined in Table 7.7

While hydropower is generally considered to be a 'green' source of power that contributes little to global warming, recent studies have shown GHG emissions from hydropower schemes may, under particular circumstances, meet or even exceed those of fossil-fuel alternatives for the same generation capacity. However, literature research for the present ESIA suggests emissions from the plant alone are likely to be minor, 5-15 g CO_2eq/kWh [50, 51], with substantially higher values quoted for hydropower including contributions from the impoundment, such as the biodegradation of vegetation, and changes in land use arising from the scheme. In respect of the Bisri scheme, the potential for GHG emission due to hydropower will be limited by the limited generating capacity and that it is operate for only six months of the year. As indicated above, greater emissions will arise from the reservoir, for which hydropower is not the prime objective.

[50] Consensus suggests hydro-plants emit 35-70 times less GHGs than conventional fossil-fuel plants.

[51] Kumar, A., et al. 2011. *Hydropower*, In IPCC Special Report on Renewable Energy Sources and Climate Change.

Table 7.7: Susceptibility for GHG Emissions from Bisri Reservoir

GHG Source	Susceptibility of Bisri
Rainfall and Wind	Heavy intense rainfall and strong wind increases shallow water turbulence and hence the release of dissolved gasses.
Drawdown zone vegetation	In areas of less-steep slopes and fertile soil cover, seasonal vegetation growth and hence carbon inputs may be extensive.
Upper catchment inputs	Treated and untreated sewerage outflows, storm runoff and soil erosion will each contribute significant carbon inputs.
Decay of inundated soils and biomass	Given the fertility of much of the inundated land, total clearance of soil and vegetation prior to filling may be difficult, and hence methane emissions from anaerobic degradation high.
Growth and decay of aquatic plants	Reservoir margins will frequently abut fertile soils. Shallow water growth will be extensive, particularly in the shallower areas such as the northern end of Bisri reservoir and in Wadi Bhannine, where with sedimentation, wetland environments may develop.
CH_4 bubbles	Being largely surrounded by friable sandstones, the sediment load at Bisri will be high, and the potential for bubbling methane significant. Bisri sediments are Bedrock most susceptible to erosion, so high sediment load. Lower hydrostatic pressure will release more bubbles
Plankton growth and decay	High nutrient inputs such as wastewater and storm drainage discharges will increase plankton growth.
Degassing at turbine outlet	Flow through turbines will rapidly change water pressure and temperature. Gas solubility will decrease with decreasing pressure, and CO_2 and CH_4 released.
Lower catchment emissions	Increased turbulence downstream of the dam will induce oxidation, the growth of methanotrophic bacteria, leading to methane oxygenation.

7.4.6 Reservoir Stratification

Lakes and reservoirs greater than 3-5 m in depth will tend to develop seasonal thermal stratification due to the differences in density between warm and cold waters. Although most common in areas of climatic extremes, such as where surface icing forms, the anticipated conditions at Bisri; cold high-volume inflows from spring snow melt and warm low-volume inflows throughout the summer and autumn, are likely to result in the stratification of the reservoir. Failure to identify and control it frequently poses major problems for water service companies and may compromises the effectiveness of water treatment streams, the meeting of regulatory water quality standards and consumer expectation, and the adequacy of environmental flow releases. The different strata that typically develop and the characteristics of each are illustrated in Table 7.8.

Table 7.8: Potential Stratification of Water Supply Reservoirs

Zone	Characteristics
Epilimnium	Aerobic conditions, with relative warmth A high dissolved oxygen maintained by penetrating sunlight, and kept mixed by surface winds
Thermocline	Thin layer with rapid change of T°C and DO
Hypolimnium	Anaerobic conditions, relatively cold and low dissolved oxygen

Typically, and to be expected at Bisri, stratification becomes more severe during the summer months when the intensity and duration of sunlight increases and mixing due to reservoir inflow decreases; thus coinciding with the main period of Bisri operations. The differences in temperature and DO become more marked and the thermocline rises within the water column. Hence a greater proportion of the reservoir turns anaerobic and in consequence minerals such as manganese, iron, sulphides and arsenic are released from bottom sediments, phosphorous and ammonia may be released, causing algal blooms proliferate, and dissolved mercury is converted to methylated mercury, a form that bio-accumulates in fish and fish eaters, including humans.

The rate at which the hypolimnium becomes anaerobic significantly increases where inflows are nutrient-rich, i.e. contain a high proportion of sewage discharge; the added bacteria more quickly consuming what little oxygen may be available.

7.4.7 Operational Management

Dam and reservoir management is more than operating sluice valves to send water to the treatment plant for Greater Beirut and keeping the hydropower plant generating electricity. While these may meet the prime objective of the Bisri scheme, the dam is expected to be operational for only six months of the year, natural low flows insufficient to keep reservoir water level at a height from which water and power supplies can be continuous. Notwithstanding seasonal operation, operational management of the dam and reservoir will need to be continuous if resources are to be directly available when the next operating season commences.

MEW working with BMLWE and EDL will prepare procedures for the operation of the dam, the release and control of water, both supplies to GBA and environmental flows, and the generation and distribution of hydropower. GBWSP initiatives include water saving measures such as the introduction of household metering and a volumetric tariff structure, and programmed works to reduce leakage and other sources of UfW. GBWSAP ongoing initiatives on completion of Bisri Dam might include improved agricultural extension services to optimise downstream irrigation water-use efficiency, and compensation scheme giving monetary or other rewards, e.g. priority planning permits, for landowners who voluntarily relinquish their Rights to Water.

Day-to-day managerial tasks required throughout the year will include but not necessarily be limited to, the following:

- Adhere to dam safety procedures including the maintenance of warning signage;
- Monitor downstream abstractions;
- Monitor the quantity and quality of releases to the GBA treatment plant;
- Ensure adequate releases to maintain environmental flows, given the requirement will change seasonally and with time;
- Monitor the quality of reservoir inflow and hydropower plant outflow;
- Monitor the development of lake stratification, and operate mixing facilities to limit the spread of eutrophic conditions to pre-determined levels;
- Limit the growth of algae and maintain fish stocks;
- Maintain the shoreline to limit wind and wave erosion;
- Monitor potential bloc-collapse from the high valley cliffs and take remedial action;
- Maintain the dam, the reservoir and their surroundings in a clean and litter-free condition; watch for fly-tippers;
- Facilitate Dam Safety Panel inspections and implement their recommendations.

7.4.8 Operational Employment

The operation of Bisri dam and reservoir will necessitate a wide range of different skill sets. The institutional structure within which these may be deployed and managed is discussed in Section 9 below. The types of staff required are expected to include those listed in Table 7.9 below. The numbers of individuals required for each position is only tentative and will depend on management efficiency, maintenance requirements, and involvement with associated activities such as recreational use of the reservoir. It is strongly recommended that senior BMLWE senior engineers responsible for overall operational issues be seconded to the design team and construction management prior to the commencement of operational duties.

Table 7.9: Likely Requirement for Bisri Dam Operational Staff

Position	No.	Prime Responsibilities
Bisri Site Manager	1	Overall management and organisation. Oversight of development proposals
Deputy Manager Water Supply	2	Oversight of all water supply activities and the release of environmental flows
Deputy Manager Hydropower	2	Oversight of all power generation activities
Deputy Manager Dam Safety	1	All aspects of dam safety including coordinating Panel inspections
Deputy Manager Reservoir Operations	1	Level control, water quality monitoring, aeration and mixing
Deputy Manager Shoreline Operations	1	Inspection of shoreline, public safety and signage, landscape management, vegetation control
Senior Engineer Dam operations	2	Assignment and supervision of day-to-day operational and maintenance tasks
Hydraulic Engineer	3	Performance monitoring and maintenance of hydraulic equipment
Mechanical Engineer	3	Performance monitoring and maintenance of mechanical equipment
Electrical Engineer	3	Performance monitoring and maintenance of electrical equipment
Maintenance Technician Mechanical Plant	2	Maintenance inspections, cleaning and repair
Maintenance Technician Electrical plant	2	Maintenance inspections, cleaning and repair
Maintenance Technician non-plant structures	2	Maintenance inspections, cleaning and repair
Craftsman/Labourer	4	Assist technicians with maintenance and repair
Janitor	2	Cleaning of offices and facilities
Groundsman	2	Maintain grounds and dam structures
Landscape Gardener	4	Maintenance of planted areas and vegetation control
Bankside Labourer	6	Maintain reservoir shoreline
Reservoir Labourer	6	Clear floating refuse from reservoir
Boatman	3	Manage and maintain workboats
Security/Gatekeeper	5	Prevention of unauthorized access.

Some of these positions will be full-time, some part-time during the operating season only or filled by staff seconded from other BMLWE activities. Sufficient numbers of staff will be required to work a shift system giving 24/7 cover with call-out support during the operational season.

This employment makes no allowance for associated activities such as the management and operations of the Visitor’s Centre, which may include guides, antiquities wardens and conservators, not for involvement with any recreational use of the reservoir.

BMLWE must be a *statutory consultee* for all planning or permit applications for any development or activity within the dam catchment area, and will therefore need appropriate staff to review these.

7.5 Induced Development

Induced development is the expansion of economic activities within and into an area that has suddenly become attractive through a new but prior development. Prime examples are the opening up of previously inaccessible land induced by the construction of a new highway, or, as in the present case, the access road to a dam, the reservoir providing the focus for visitor interest. Most commonly, and likely to be the case at Bisri, the attracting development is public sector; the induced development private sector.

Given the relative uniqueness of the Bisri scheme and its proximity to urban centres such as Beirut and Saida, visitor attraction may be expected will commence soon after the start of construction. The precursor to induced development may therefore be coffee vans and refreshment trucks, with existing cafés, petrol stations and other services in Bisri and villages en-route from the highway catering for the influx. To avoid conflict with construction operations and risk to public safety, the project proponent might invest in a Visitor's Centre on the hillside a short distance downstream from where views over the works can be enjoyed in safety. Once the dam is commissioned, the Visitor's Centre might be expanded to provide information and educational facilities with restaurants and the usual public facilities, together with a view over the completed dam and power plant.

The greater attraction will be the simple presence of the body of water that will become Bisri Reservoir. On the overlooking hillsides the demand for land on which to construct villas, apartment blocks, hotels, hill resorts and restaurants, all with access roads and public infrastructure will be extensive. While these may also occupy shoreline plots, waterside land is more likely to induce smaller water sport focused accommodation, camping and picnic sites, bathing areas, shoreline walkways and cycle tracks, boat rental and repair yards, yacht and canoe clubs. In addition to visitor and recreational activities, the reservoir will also afford the opportunity to expand local irrigated agriculture and develop water-based commercial enterprises such as fish farming.

Although created artificially, reservoirs soon become inextricable features of the natural landscape and it is imperative to develop their ecological function to maintain their biological health. One way in which this can be achieved is to stock them with fish that control algae and limit weed growth. Not surprisingly, fish are a fundamental component of the Lebanese diet and while the vast majority are still taken from the Mediterranean, as natural stocks become depleted attention is increasingly turning to aquaculture. Lebanon has had fledgling fish-farming industry since the mid-1960s, with some 150 family-run small businesses in Hermel, Akkar, Chouaifat and Anjar producing around 1,100 tonnes annually, the most common species farmed being Rainbow Trout (*Onchorhyncus mykiss*) and Tilapia (*Oreochromis* spp).With annual fish imports, live, fresh and frozen put at 14,000 tonnes with a value of US$ 35.6 million, there is clearly room for expansion.

The main problems for the industry include:

- Lack of technical expertise, especially fish health;
- Poor management practices and planning;
- High cost of establishing fish farms, lack of government support;
- Shortage of locally-produced feed;
- Shortage of skilled manpower; and,
- Lack of legislative control.

If fisheries are seen to be an economic activity that is to be promoted, the alternatives to be explored might include open reservoir fish for commercial (netting) and recreational (rod and line) fishing, bankside ponds and shallow water basket tanks, and perhaps ponds downstream of the dam fed by the warmer waters heated by passage through the power-generating turbines. For stocking, fish roe can be imported or gathered from a captive stock and raised as fingerlings for release. At the present time there are no Ministry of Agriculture regulations or guidelines for the establishment of aquaculture, although fish farming facilities are classified enterprises subject to the Mayoral licensing. The Ministry of Environment will require an EIA.

Consideration should also be given to aquaponics, which combines fish farming with the growing of vegetables, flowers and herbs suited to closed circulation systems.

Whether or not induced development is a positive or negative impact will wholly depend upon the degree to which it is controlled by the planning authorities. If development complies with a well formulated and agreed Master Plan the results may be entirely positive. If development is not planned and piecemeal, or certain political and/or commercial interests are allowed to violate the Plan, the results may be entirely negative. The spread of new development of any type will increase the flow of surface runoff and wastewater, including raw sewage, to the reservoir unless the installation of public utility infrastructure of appropriate capacity keeps place with development. The lack of public infrastructure will not only cause water pollution, rendering the tourist facilities and water-based activities a risk to public health, but will also propagate algal blooms that will impact power generation equipment and water treatment plant operation, and derogate the quality of water available for downstream irrigation.

Given current conditions throughout the reservoir area, atmospheric emissions and noise and dust from power generators, vehicles and boats, etc. will also be a significant impact of induced development.

7.6 Summary of GBWSAP Potential Impacts

Table 7.10 summarises the impacts that might accrue from Bisri dam design, construction and operation, along with the likelihood of occurrence and likely severity of each.

Table 7.10: Summary of Potential Impacts Arising from the Bisri Scheme

Issue	Potential Impact	Likelihood	Likely Severity
Land Take	Land taken for dam and reservoir, access roads	Unavoidable	Major
	Land take for resettlement and/or relocation of PAPs	Expected	Moderate
	Loss of natural landscape	Unavoidable	Moderate
	Loss of existing communities	Not Expected	n/a
	Loss of individual homes	Unavoidable	Moderate
	Loss of non-agricultural business premises	Not Expected	n/a
	Loss of temporary employment	Unavoidable	Major
	Loss of permanent employment	Expected	Moderate
	Loss of productive land	Unavoidable	Major
	Loss of historic and cultural heritage	Unavoidable	Major
Impoundment	Additional loss and severance of access	Expected	Moderate
	Increased risk of seismicity	Expected	Major
	Loss of natural vegetation	Unavoidable	Moderate
	Impaired water quality from uncleared vegetation	Unavoidable	Major
	GHGs from uncleared vegetation	Expected	Major
	Soil erosion along new foreshores	Expected	Major
Sedimentation	Creation of backwaters on tributary streams	Expected	Moderate
	Loss of capacity and sediment build-up at dam	Expected	Major
Upper Watershed Management	Road construction opens area to non-residents	Expected	Minor
	Resettlement increases water use waste generation	Expected	Minor
	Social unrest due to the restriction of human activity	Not Expected	n/a
	Loss of water quality due to evaporation	Unavoidable	Major
	Impaired water quality due to discharges above dam	Expected	Moderate

Table 7.10: Summary of Potential Impacts Arising from the Bisri Scheme (Cont'd)

Issue	Potential Impact	Likelihood	Likely Severity
Lower Watershed Management	Reduced non-agricultural surface water resources	Unavoidable	Moderate
	Reduced water resources for existing agriculture	Unavoidable	Moderate
	Water-use conflict	Expected	Moderate
	Loss of stock watering points	Not Expected	n/a
	Salinisation of downstream floodplain	Expected	Moderate
	Reduced dilution of chemical residues, sewage	Expected	Moderate
	Reduced Dissolved Oxygen downstream	Expected	Moderate
	Scour by water released under increased head	Expected	Minor
Ground Water	Reverse ground water flow upstream of the dam	Expected	Moderate
	Reduced downstream aquifer recharge	Expected	Moderate
	Change in water table	Expected	Minor
	Deterioration in ground water quality	Expected	Major
Biodiversity and Habitats	Loss of indigenous flora	Unavoidable	Moderate
	Loss of terrestrial habitats	Unavoidable	Moderate
	Reduced aquatic habitats	Expected	Major
	Reduced downstream biodiversity	Expected	Moderate
	Build-up of weed and algal mats around spillways	Expected	Moderate
	Disruption of flyways	Expected	Moderate
	Barrier to fish migration and loss of spawning areas	Expected	Moderate
	New habitats for migratory bird species	Expected	Moderate
	New farming fish species	Expected	Moderate

Table 7.10: Summary of Potential Impacts Arising from the Bisri Scheme (Cont'd)

Issue	Potential Impact	Likelihood	Likely Severity
Agriculture	Inundation of agricultural land	Unavoidable	Major
	Loss of fertile soils	Unavoidable	Major
	Loss of yet-to-be-harvested crops	Unavoidable	Major
	Derogation of downstream irrigation	Unavoidable	Major
	Fertiliser use upstream increases nutrient load	Expected	Moderate
	Increased soil salinity downstream	Expected	Major
Fisheries	Incompatibility of lake and river environments	Expected	Moderate
	Snagging of nets and lines on uncleared structures	Not Expected	n/a
	Mortality of fish entering power plant	Expected	Moderate
Settlement and Resettlement	All residents in the inundated area will be displaced	Unavoidable	Moderate
	Disaggregation of communities	Not Expected	n/a
	Impact on indigenous groups/lifestyles	n/a	n/a
	Social conflict between existing residents and PAPs	Not Expected	n/a
	Competition for resources between residents & PAPs	Not Expected	n/a
	Particular impacts on vulnerable groups	Expected	Moderate
Public Health	Increase in water-related diseases	Expected	Moderate
	Increase in mosquito breeding sites	Expected	Moderate
	Climatic changes such as increased humidity & fogs	Expected	Moderate
	HV transmission lines in proximity to housing	Expected	Minor
	Public services overburdened	Not Expected	n/a
	Risk of landslides/rock collapse into reservoir	Expected	Moderate
Indirect Issues	Negative impacts from increased urban development	Expected	Moderate
	Upper catchment activities limit dam efficiency	Expected	Moderate

Table 7.10: Summary of Potential Impacts Arising from the Bisri Scheme (Cont'd)

Issue	Potential Impact	Likelihood	Likely Severity
Construction Issues	Construction site unsightliness	Expected	Moderate
	Increase traffic generation and exhaust emissions	Expected	Moderate
	Noise and dust from site clearance and excavation	Expected	Moderate
	Temporary works such as drainage diversion	Unavoidable	Moderate
	Camp working area sewage and solid waste disposal	Expected	Moderate
	Emissions from batching plants & power generators	Expected	Moderate
	Increased hunting, egg collecting, live capture	Expected	Moderate
	Social conflict between workers and residents	Expected	Minor
	Importation of contagious diseases	Expected	Minor
	Fuel spillage and waste oil disposal	Expected	Moderate

SECTION 8

ANALYSIS OF ALTERNATIVES

8. ANALYSIS OF ALTERNATIVES

8.1 Introduction

This section of the ESIA summarises the discussion, results and conclusions of the comprehensive comparative analysis of potential solutions to the augmentation of Greater Beirut's long-term water supply, the full details of which were presented in the Preliminary Draft ESIA of September 2012[52].

In accordance with standard environmental assessment procedure, the section nevertheless commences with a summary of the consequences of the 'Do Nothing; or 'Without Project' Alternative in **Section 8.2**.

To secure a holistic view of the potential solutions for the long-term supply to water to Greater Beirut residents, the GBWSAP ESIA has investigated a range of alternatives, some of which do not necessitate surface water impoundment by the construction of a dam. Given its location on the Dead Sea Transform Fault System, the boundary between the Arabian Plate and the African Plate, Lebanon is renowned for the dense coverage of structural discontinuities that impart spectacular topographic variation. That much of the geological succession comprises highly karstic carbonate strata clearly renders much of the country less than ideal for the construction of large dams and reservoirs. It is therefore prudent to consider non-dam alternative sources of water supply, and in **Section 8.3** the advantages and disadvantages afforded by the following are discussed:

- Desalination;
- Ground Water;
- Rainwater Harvesting;
- Wastewater Reuse; and,
- Reduction in 'Unaccounted for Water'.

The PD ESIA also compared of four dam sites of which Bisri dam on Nahr Bisri was selected by the project proponent to be the priority scheme to go forward to the full ESIA. In considering potential alternatives, the advantages and disadvantages of the considered dam sites at Damour on Nahr Damour (two sites), and at Janneh on Nahr Ibrahim, are summarised in **Section 8.4**.

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[52] Greater Beirut Water Supply Augmentation Project, Environmental and Social Impact Assessment. *Preliminary Draft Environmental and Social Impact Assessment*. Dar Al-Handasah (Shair & Partners) September 2012.

8.2 The 'Without Project' Alternative

With the Greater Beirut conurbation predicted to be home to some 3.5 million people by 2035, the present shortages of water, particularly severe during the hot and dry summer months will only be exacerbated by continued population growth, increased living standards, and changing climatic conditions due to global warming. With existing installed facilities and those proposed under GBWSP for the short-term relief of water stress, Greater Beirut may be expected to suffer severe stress and chronic shortages by 2020.

Longer term demographic changes are more difficult to predict, dictated more by changes into and out of the Lebanese Diaspora, the consequences of political stagnation, economic decline, and regional events more than internal organic growth. Following a period of relative stability on the cessation of civil war hostilities in 1990, population growth steadily declined from 1.4% in 2000 to 1.1% in 2009, after which the rate of decline accelerated, down to 0.24% in 2011[53]. The World Bank estimate for the same year was significantly higher, 0.73%. Whichever is correct, Lebanese population growth is lower than near neighbours Egypt (1.9%), Jordan and Syria (1%). Even taking the World Bank figure and assuming it will be sustained beyond 2035, the population of Greater Beirut may be expected to reach 5.5 million before the end of the century.

The consequences of not commissioning new sources for public supply may therefore be expected to include:

- Further reduction in water availability to less than 3 hours/day;
- Increased pumping from illegal, unlicensed wells;
- Further depletion of resources already developed beyond their level of sustainability;
- Increase in both salinity concentrations and the area suffering saline intrusion;
- Increased use of tankered supplies, often from non-potable sources;
- Increased household expenditure on water[54];
- Increased wastewater seepage, hence in the prevalence of water-borne disease;
- Social discord within families[55]; and,
- Conflict between those with access to potable quality water and those without.

[53] From Index Mundy.

[54] Estimated to be US$28/month over the summer (World Bank 2010 GBWSP Project Appraisal Document)

[55] It is well documented that in communities with adequate potable water where food can be prepared healthily and premises and persons cleaned hygienically, children have improved educational attainment, adults are motivated to optimise their employment potential, and there is less social unrest and family breakdown.

8.3 Non-Dam Alternatives

8.3.1 Desalination

Desalination is the removal of salts from seawater or saline/brackish groundwater. Two primary processes are in common use; Membrane Filtration, also called Reverse Osmosis (RO), and Thermal Distillation, often referred to as Multi-Stage Flash Desalination (MSF).

Lebanese source of waters that could be considered for desalination are likely to be limited to (i) seawater drawn from the Mediterranean and (ii) highly brackish near-coastal ground waters already impacted by saline intrusion. Desalination would theoretically afford a technically-feasible solution to water supply for Greater Beirut, best achieved through a long-term DBO or DBOO contract with an energy supplier with a proven track record.

Environmental impacts of Desalination process include the need to locate an industrial complex on or near the coast, land expropriation, carbon and other atmospheric emissions and particularly the production of large quantities of wastewater in form of super-saline brine that will adversely impact coastal and near shore communities and habitats.

The major drawback of the MSF and RO processes is that they are energy intensive accounting for up to 60% and 45% of total production costs[56] respectively. Thus the overall costs of MSF, the dominant water source in Arabian Gulf countries, remain very expensive despite their access to cheap energy. Given the insufficiency and inadequacy of the energy sector in Lebanon, desalination must, at least for the immediate future, remain the *source of last resort*, when no other potential sources of water are available.

Seawater desalination can cost as much as 3-4 times brackish water desalination (Dore 2005). For instance, RO desalination costs reported by Arroyo and Shirazi (2009) vary between 0.33 and 0.69 $\$/m^3$ for brackish water compared to 0.95-1.52 $\$/m^3$ (2009 equivalent) for seawater. Hence, a significant economic burden can be expected with aggravated saltwater intrusion and increased groundwater salinity.

8.3.2 Ground Water

In the absence of adequate water supply for all citizens, ground water is already a proven and valuable source of water supply throughout Greater Beirut. With shallow

[56] FWR 2011: *Desalination for Water Supply*. The Foundation of Water Research.

near-coastal aquifers over-exploited, the potential for additional resource development from deep bedrock aquifers inland is believed to be extensive.

This potential should be approached within an Integrated Water Resources Development (IWRD) program to exploit those ground water resources that may be both sustainable and cost-effective. Prudent use of ground water sources may delay the need to invest in future dams and/or permit smaller and less costly dams to be constructed as part of an integrated conjunctive-use scheme.

At Bisri, long-term demands might be supported by the conjunctive use of ground water pumped from adjacent Jurassic limestones. Alternatively, the GBWSP, for which funding is already agreed and design well advanced, might take additional water from a Bisri Wellfield rather than from a Bisri Dam, replacing and enhancing the flow no longer taken from Qaraoun Lake.

Notwithstanding this, the priority for good water resources management should be to phase out illegal and unlicensed wells to limit further saline intrusion, and to preserve all large scale development of ground water resources for the public good. Alternatively, for ground water to become a cost-effective contributor to Greater Beirut's future water supply, existing abstractions will need to be retrospectively licensed against a restructured tariff structure that combines a fixed annual license renewal fee with an incrementally increasing volumetric fee. The licensing authority, MEW, will need to use aquifer modeling to determine the safe yield of individual aquifer units and the total abstractions from wells in that unit, do not exceed what can be sustained through annual recharge.

Expansion of ground water abstraction will also require GoL to prioritize the installation of efficient sewage collection, treatment and disposal systems for developments that currently discharge raw sewage and storm drainage from urban areas in a manner that causes ground water pollution.

The economics of ground water are primarily a function of pump efficiency, the depth from which the water is taken, and the cost of energy, the latter increasing with depth and decreasing with improved pump efficiency. Typically, these costs vary widely, from US\$0.05/m^3 to US\$0.30/m^3.

8.3.3 Rainwater Harvesting

Rainwater harvesting works best in areas of low population density where a single family has access to a roof. In urban areas such Beirut, where multiple families live under a single roof, the ability to capture sufficient rain for meaningful distribution is limited.

For rainwater harvesting to sustain domestic consumption, precipitation should be frequent and of low intensity, thus permitting runoff to be easily controlled and the water in retention regularly renewed. In Lebanon, the dry season may extend to 6 or 7 months, and during the wet season storms are frequently intense. Even if all the rainfall could be captured and treated, water quality would deteriorate if storage was extended throughout the dry season. It is therefore impractical to consider rainwater harvesting as making any significant contribution to the public water supply at a city scale such as of Greater Beirut Area.

8.3.4 Wastewater Reuse

At the present time, Greater Beirut disposes of its sewage to the Mediterranean Sea after, at best screening to remove the most significant solids, although the installation of secondary treatment is planned to allow GoL to meet its responsibilities under the Barcelona Convention.

MEW predicts[57] water consumption growing from 225 Mm^3 in 2011 to 341 Mm^3 in 2035 without network improvements, and to 273 Mm^3 with leakage reduction. With the addition of public awareness and metering, the 2035 figure reduces to 229 Mm^3, little more than at present. Using the intermediate figure of 273 Mm^3, and assuming 80% of this (218 Mm^3) is returned to public sewers as wastewater and 10% of this (22 Mm^3) is lost through infiltration from sewers. During the treatment process, leakage from the redistribution pipework may account for 20% of outflow, making the total TSE resource delivered to the end user some 150 Mm^3. In practice, it will be somewhat less than this, as treatment will need to be provided at several different sites.

While high-quality TSE that has undergone primary, secondary and tertiary treatment may be suitable for non-potable uses such as the irrigation of roadside planting for fodder and tree crops, there is significant social resistance against its use. Without experience of major urban sewage treatment schemes, not only will the treatment plants need to be designed and constructed, operators will need to be trained, separate non-potable color-coded distribution networks constructed and the TSE use and application areas approved in accordance with MOE requirements[58].

The cost of wastewater reuse will include capital, O&M and life-cycle costs. Construction costs include land expropriation, construction, and equipment cost and pipes fee and sewage facilities. O&M costs include electricity, chemical treatment, personnel costs,

[57] Ministry of Energy and Water. *Potable Water Balance in the Greater Beirut Area 2011-2035*.(MS PowerPoint presentation)
[58] *MoE Policy for the Above Ground Use of Reclaimed Domestic Wastewater*. Draft 2, July 2004

reparation, and network maintenance. Depending on water reuse alternative necessitating different treatment levels, the annual costs[59] of wastewater reuse may vary between 0.20–2.64 $/m^3 (Asano, 1998), cheapest for agricultural irrigation, most expensive for artificial aquifer recharge.

8.3.5 Reduction of Unaccounted-for-Water

Unaccounted-for-Water (UfW)[60] is all the water that for one reason or another is lost to the system, cannot be charged for, and hence does not contribute to the commercial viability of the supplying authority, the BMLWE. The IWA[61] identifies the different categories of UfW, those relevant to the present project listed in Table 8.1. MEW/BMLWE estimates are that the current level of UfW is 40% of water supplied from the treatment plant, although many put the real figure significantly higher.

Table 8.1: Categories of 'Unaccounted for Water'

Type of Loss	Category
Non-Technical	Unbilled metered consumption; Unbilled unmetered consumption; and, Unauthorized consumption.
Technical	Consumer metering inaccuracies; Data handing inaccuracies; Leakage from network; Leakage and overflow from storage tanks; and, Leakage on service pipe before consumer meter.

Non-Technical Losses

At the present time there is no volumetric metering of domestic consumers within the BMLWE service area. Each householder connected to the system pays a flat fee and water is received as frequently or as rarely as operational availability allows. Metering of commercial and industrial consumption is practiced but many small business premises, particularly those occupying the basement and ground floors of otherwise residential buildings, are often not metered. In total, only 16% of GBA consumer connections are metered and only 62% of water bills settled.

[59] Costs are estimated for 4,000 to 40,000 m^3/d. Lower cost figure represents a 40,000 m^3/d plant while the upper cost represents a 4,000 m^3/d facility. Annual costs include amortized capital costs based on a facility life of 20 years and a return rate of 7 %..

[60] Also sometimes referred to as 'Non-Revenue Water'

[61] International Water Association.

GBSWP proposes to install 200,000 consumer meters to monitor consumption and reduce illegal connections. This in itself will not reduce UfW unless concurrently there is the introduction of a consumption-based tariff structure and the administrative mechanism, political will, and judicial support to ensure the fair and equitable application of this tariff, efficient billing and revenue collection.

Economically, a volumetric or rising bloc tariff has advantages and disadvantages. First it will provide an incentive to conserve water as excessive levels of consumption impose increasing financial penalty. Secondly, it will ensure financial sustainability for BMLWE. However, there is a risk that poor households might be subject to higher unit rate tariffs. For metering to be entirely effective therefore, research is needed into how variable tariffs will impact poorer residents. The basic volume of water necessary to maintain personal and household hygiene and health should be supplied at minimum charge.

The economic and social gains of household-level metering will be captured only if meter installation follows after the improvement and extension of the water supply network and is closely aligned with the Government's contemplated switch to volumetric tariffs. Meters are expensive to install and read and they tend to have short service lives under intermittent supply. Households utilize meter information most when they face volumetric tariffs and are unlikely to change their behavior when under a flat rate system.[62]

Technical Losses

Losses due to the inaccuracies in consumer metering will be minimized by the efficient training of meter-readers or the use of smart-meters. Those due to data handing will be minimized by audit control.

The majority of leakage and overflow from storage tanks, most frequently from valves, meters and other pipeline fittings, are usually observed by operators and can be substantially controlled providing the equipment, materials and expertise to affect repair are available.

The service pipe from the network to the consumer's meter is often shallow or exposed, and leakage is often observed within a short period of time. Losses from deeply buried transmission and distribution pipework may be less easily observed if the leaking water infiltrates to ground water.

[62] Study of Project Cost Estimates, Financial and Economic Analysis, World Bank, p. 20

Across the Greater Beirut area, it is to be expected that leakage will primarily be from the networks. The reasons for this are various and will include but not be limited to the aging, inefficient and sporadically extended networks, poor construction practices, the lack of investment in modern infrastructure such as telemetry and smart meters, insufficient operational experience, and the lack of resources. While 15% leakage is attainable in small rural service areas where water is charged at a rate that particularly penalizes heavy users, most urban water supply authorities are pleased to achieve leakage losses of 20-25%. Given the erratic development of GBA networks, with pipes often laid at shallow depths and poor bedding material, residual war damage, and the lack of lorry weight-limit enforcement leading to excessive traffic loading, BMLWE will do well to realize a reduction to 25%.

The Public Expenditure Review (2010) assessed documented international experience in developing countries, and estimated average costs in the range of US$215-500 to reduce losses by 1 m^3/day. Assuming this is achieved for the entire year, it can be calculated that leakage/loss reduction through the measures implemented under GBWSP cost within the range US$0.58-1.37/$m^3$ saved. This compares favourably with the other non-dam options for potable water supply.

The reduction in UfW is good management practice and all its sources, technical and non-technical, need to be the subject on on-going investigation and remediation, be it a leaking pipeline or errors in billing.

8.3.6 Summary of Non-Dam-Alternatives

In summary, the technical and administrative aspects of the potential alternatives for the long-term supply of potable water to Greater Beirut are given in **Table 8.2**.

Table 8.2: Summary of Potential Non-Dam Alternative Sources

Source	Advantages	Disadvantages	Conclusion
Desalination	• Plentiful and sustainable resources; • Could supply whole GBA demand; • Technically reliable; • Independent of Climate.	• Utilises an Industrial process; • Only 40% of intake to supply; • High construction cost; • Substantial coastal land take; • High energy and O&M costs; • Marine env. damaged by brine; • Politically unflavoured.	Highly feasible, but expensive. For current consideration, the 'Source of Last Resort'
Ground Water	• Significant sustainable resources • Most discharge to supply; • Suitable for conjunctive-use; • Better quality than surface water; • Diverse source locations; • Modest carbon footprint.	• Resources currently ill-defined; • Probably insufficient to supply GBA alone; • Recharge climate-dependent; • Substantial energy costs.	Resources remain to be quantified but at minimum will significantly contribute to conjunctive use with a dam alternative
Rainwater Harvesting	• Basic technology; • Local sources; • Low carbon footprint.	• Short wet season; • Ill-suited to high-rise urban areas; • Climate dependent; • Poor public perception.	At best, it will contribute to household or compound non-potable water use.
Wastewater Reuse	• Source origin within GBA; • Source generally sustainable; • Majority of technology already required for best management practice.	• High treatment costs; • Lack of technical expertise; • Insufficient resources to meet GBA demand; • Very poor public perception and confessional objection.	Strong cultural objections. At best can supply substantial quantities of non-potable water for landscape irrigation, etc.
Reduction in UfW	• Optimises existing system efficiency and cost-recovery; • Promotes Best Management Practice.	• Requires political will, legal reform and judicial support; • Requires public cooperation; • Leakage unlikely to be <25%.	Should be pursued as is economically viable. Will not reduce the need for new source development.

In conclusion, desalination, albeit it technically, economically and politically the 'Source of Last Resort', is the only non-dam alternative capable of sustaining long term water supplies to Greater Beirut. While additional ground water abstraction from bedrock aquifers away from the coastal plain may contribute significantly, the current understanding of the hydrogeological regime requires many years of study, testing and modelling before large-scale sustainable supplies can be assured.

Other sources may reduce demand for potable quality water for non-potable uses. Reductions on UfW are simply good water industry housekeeping and should in any case be pursued as far as is economically feasible. While some non-dam source alternatives may delay the need to invest in future dam project, after Bisri, they are unable to cater for the bulk of Greater Beirut demands.

8.4 Dam Alternatives

8.4.1 Introduction

To meet the long term requirement to augment Greater Beirut's water supply it will be necessary to impound some of the estimated 400,000 million m^3 of rainfall and snow melt that annually runs to the Mediterranean Sea.

The potential for impounding surface water has long been recognized, and broader investigations to identify feasible river basins were completed as long ago as the 1950s. Subsequent work identified potential dam sites and over the last three decades GoL has commissioned feasibility studies at two sites in addition to Bisri:

- On the Damour River, above its confluence with Nahr Hammam; and,
- On Nahr Ibrahim upstream of the Janneh Plain.

The results of the detailed comparative analysis of all three sites together with a second site on Nahr Damour, have previously been presented in the Preliminary Draft ESIA of August 2012. The results for the Damour sites and for the Janneh site, located, with Bisri on Figure 8.1, are therefore summarised herein as the alternatives to the proposed project analysed within the present ESIA.

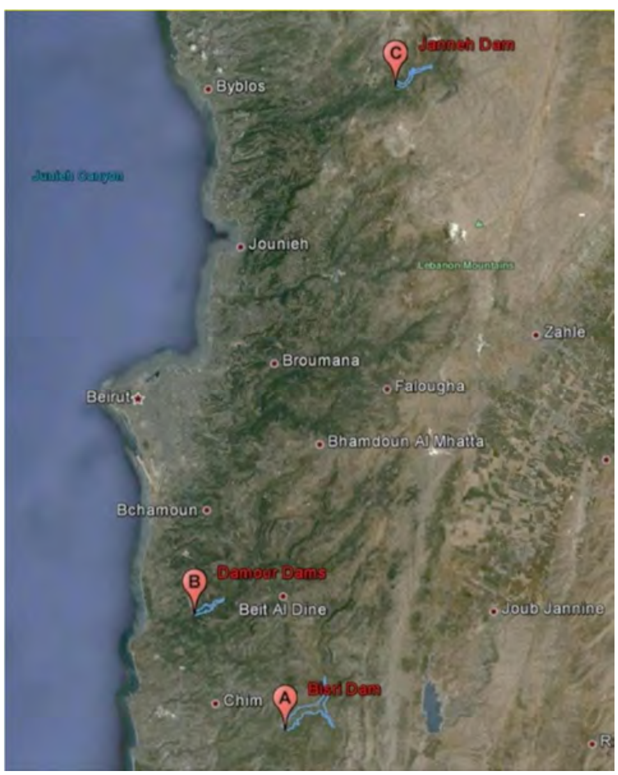

Figure 8.1: Dam Locations

Of the two Nahr Damour sites, the second is a short distance upstream from the first, are respectively referred to as Damour East and Damour West. Damour East was never subjected to feasibility study but has long been argued by a group of concerned Beirut residents to be superior to either Damour West or Bisri.

8.4.2 Damour Dams

The layouts of both the Damour reservoirs are shown in Figure 8.2 and the outline of both for comparison in Figure 8.3.

Figure 8.2: Damour East and Damour West Reservoirs

Figure 8.3: Comparison of Damour West and Damour East Reservoirs

The proposed Damour West dam, 98 m in height, is some 2 km upstream of the confluence of Nahr Hammam with Nahr Damour and about 4.5 km inland from the Mediterranean coast, at an elevation of c.50 masl. The reservoir has a catchment area of some 210 km^2, a capacity of 42 Mm^3, and extends for about 3 km upstream, largely contained within a narrow gorge. The proposal was subject to a Feasibility study by LibanConsult in 1995. Photographs of the reservoir area are shown in Figure 8.4.

In 2010, some fifty Beirut residents campaigned against GBWSP, which they incorrectly perceived to include Bisri dam, to propose the Damour East dam, 150 m in height, located 300-400 m upstream of Damour West. In the absence of any maps or plans, the area of inundation has been determined by tracing the maximum water level contour on the most recent topographic map. Total storage is estimated (Chatila, 1998) to be 113 Mm^3. Due to the higher reservoir water level together with the relatively low valley bottom gradient, the area of inundation stretches 2.5 km further upstream than that of Damour West.

The prime difference between these two dam sites is that Damour West is on the lower marly limestones of the Sannine Formation (C4), while Damour East lies on the Abeih Formation (C2a), a sequence of thin limestones, marls and sandstones. While these formations may have markedly difference intrinsic permeability, the whole area is near the crest of the regional Mount Lebanon Western Flexure and hence secondary permeability resulting from expansional fracturing and fissuring predominates. No feasibility study is available for Damour East.

The symmetric V-shape cross-section of the valley, similar at both sites, is considered suitable for dam construction as it will minimise foundation excavation. However, several longitudinal and transverse faults are reported to cross-cut the sites. A major concern for both dam sites is the potential increase in leakage through the fissured and karstic limestones of the westward dipping Bikfaya Formation (J6) in which many joints and fissures are infilled with clayey and sandy detritus. As the reservoir fills the water movement and pressure will flush out this material, increasing infiltration and consequentially enhancing fissure widening and rejuvenating karsification. With more extensive inundation at Damour East, both upstream and laterally, the potential for the water to flush out fissure infill and aggravate the already obvious instability of the valley sides is substantial. While neither of the Damour dams was recommend for the priority scheme, the area was recognised to have the potential of sustaining a small dam constructed on the Damour East site with a reduced maximum water level to limit lateral leakage.

8.4.3 Janneh Dam

Janneh dam on Nahr Ibrahim, 37 km from Beirut, is located in a steep gorge 17 km from the Mediterranean coast between the villages of Qartaba and Hdaine to the northeast, Lassa and Saraaita to the south east, as shown on Figure 8.5. The reservoir, with a catchment area of some 242 km^2, extends for 3.2 km upstream from the dam and is expected to contain 37 Mm^3 of water. A Feasibility study was carried out by Khatib and Alami in 2006.

Figure 8.4: Janneh Dam and Reservoir on Ibrahim River

The principle formation underlying both the dam and reservoir site is the highly fractured and karstic Kesrouane Formation (J4). Several longitudinal and transverse faults cut the dam site, some infilled with basaltic material, thus reducing their permeability. None are believed to be active. The stated height of the dam is 165 m, of which 105 m will be above current river bed level, the lowermost 60 m within alluvial deposits that will be excavated to rock head.

Excessive leakage such as would render the dam infeasible has recently been promulgated by BGR (2012). While the thesis has merit and is perhaps worthy of further study, the discussions of geological, hydrogeological and structural settings are based upon assumptions for which no justification is offered. In particular, there is nothing to support the suggestion the Jurassic aquifer of Upper Nahr Ibrahim is connected to Jeita Spring, north of Beirut. Such justification would need to involve exploratory drilling, dye-tracing, geophysics, test pumping and ground water modelling. If such a connection was proven and Janneh water did flow naturally to Jeita, the cost saving in transmission and the opportunity to upgrade existing Jeita abstraction would be attractive.

8.4.4 Summary of Dam Alternatives

In assessing each of the options for augmenting Greater Beirut water supply, the PD ESIA looked at both the fundamental considerations and the detailed impacts. In summarising the conclusions to recommend a preferred scheme option on which to progress more comprehensive assessment and environmental management proposals, two approached were adopted. The first was a simple subjective comparison of the primary advantages and disadvantages, while the second more detailed comparison developed a Trade-Off Matrix, which despite often disparate and often inconsistent data, affected a multi-criteria analysis of the GBWSAP results at the time.

In developing the trade-off matrix, 13 technical, economic, environmental and social issues subdivided among 35 separate scored parameters were utilised. Since all the issues were not of equal significance, they were weighted as shown in Table 8.3.

Table 8.3: Trade-Off Matrix Major Issues Weightings

<table>
<tr><th>Issue</th><th>Parameter</th><th>Weighting</th></tr>
<tr><td>Natural and Human Heritage</td><td>Area of natural beauty;
Ecological value;
Archaeology/history inundated.</td><td rowspan="2">1</td></tr>
<tr><td>Lower Catchment Impacts</td><td>Flood protection;
Loss of irrigation.</td></tr>
<tr><td>Ground Water</td><td>Aquifer at outcrop;
Downstream recharge zone;
Hydraulic gradient reversal.</td><td rowspan="5">2</td></tr>
<tr><td>Upper Catchment Impacts</td><td>Erodibility of strata;
Population contributing wastewater.</td></tr>
<tr><td>Land Take</td><td>Loss of natural landscape;
Loss of productive land;
Loss of public infrastructure;
Loss of Agricultural infrastructure;
Household and business relocation.</td></tr>
<tr><td>Hydroelectric Power</td><td>Supplied from dam.</td></tr>
<tr><td>Dam Construction</td><td>Dam design;
Construction materials.</td></tr>
</table>

Table 8.3: Trade-Off Matrix Major Issues Weightings (Cont'd)

Issue	Parameter	Weighting
Seismicity	Proximity to regional structures; Historic seismic activity; Reservoir loading; Liquefaction	**3**
Surface Water	Mean annual flow; Water quality.	
Dam Site Geology	Formation Karsticity; Formation fracturing; Foundation issues.	**4**
Reservoir Geology	Floor water tightness; Sidewall water tightness; Shoreline erodibility; Past landslips.	**5**
Water Supply	Meets GBA 2020 shortfall.	
Cost Effectiveness	Overall cost of supply scheme; Use of common facilities; Cost per unit volume of water	

Experimenting with a number of scoring regimes[63], including separately weighting positive and negative impacts, the results from the trade-off matrix divided the four dam options into two distinct groups, with Damour East and Janneh being consistently less favoured that Bisri and Damour West. The advantages and disadvantages of each are summarised in Table 8.4.

[63] Full details of trade-off matrix development, and the scoring regimes are given in the PB ESIA (September 1012)

Table 8.4: Summary of Potential Dam Alternatives

Scheme	Advantages	Disadvantages	Conclusion
Bisri	• High storage volume that meets GBA demands to 2030 or longer; • Utilises GBWSP transmission, treatment and storage facilities at limited additional cost; • Reservoir floor underlain by low permeability deposits; • Little or no pumping costs; • Lowest cost per unit volume delivered to GBA; • Maximize return on GBWSP investment;	• Most land take is productive land; • Historic and cultural remains at risk; • High sedimentation risks; • High seismic risk.	Bisri dam is the only site that will supply GBA demand over an appreciable period of time with cost effective investment. Nevertheless; additional studies into reservoir geology, water tightness, seismic and sedimentation risks are needed prior to detailed design. Preference for the present dam axis location should be confirmed.
Damour West	• Land take mostly non-productive; • Favorable dam-site morphology in V shape; • Might utilise some GBWSP facilities.	• Small storage capacity; • Unlikely to sustain significant hydropower; • New treatment plant required otherwise additional conveyances costs; • Significant pumping costs.	Water storage is substantially less than at Bisri or Damour East, and dam site geology is less favoured. Any dam here should have a reduced water level to limit lateral leakage and/or be part of a conjunctive use scheme with ground water.
Damour East	• Dam site geology better than at Damour West; • Favorable dam-site morphology in V shape; • High storage volume that meets GBA demands to 2030 or longer.	• High lateral leakage; • New treatment plant required, otherwise additional conveyance costs; • Significant costs to treat the J6 permeable strata; • Significant pumping costs; • Subject to block collapse from reservoir cliffs.	Notwithstanding; the high storage volume and the relatively better site-dam geology than Damour West, this scheme raises serious concerns about the potential excessive lateral leakage.
Janneh	• High flow rates, reservoir readily replenished each spring. • Favorable dam-site morphology in V shape;	• Most land take is natural landscape; • Located on highly permeable strata, hence leakage likely to be substantial; • New treatment plant and transmission line required; • Highest cost per unit volume delivered to GBA.	As a stand-alone dam Janneh will only meet GBA short term needs at the highest expected costs. Concerns about dam and reservoir geology and water tightness are expected to result in massive water leakage and transfer to adjacent aquifers.

In assessing Damour East, the Consultant attempted to score all parameters despite the unavailability of technical data. Although conceived to be substantially larger than Damour West, and acknowledging its site lithology may be better suited to dam construction, Damour East is likely to suffer the same problems such as lateral leakage that limit the size of Damour West. While the attributes accredited by the supporters of this site are generally accepted, they are less advantageous than is argued. The deeper geology beneath the reservoir floor may be well suited to impoundment but the high water level will provide substantial lateral leakage, perhaps resulting in an inter-basin transfer of water.

Damour West has few significant disadvantages but also few advantages. In addition to providing only limited water supply, it may also not sustain significant hydropower plant. By comparison, Bisri is the only site capable of adequately supplying GBA demands to an acceptable and cost efficient design horizon.

In recommending Bisri Dam to be the preferred source for the long term augmentation of Greater Beirut water supply, the PD ESIA also recommended the following:

- For subsequent dams, Damour West be constructed on the Damour East site, with reduced water level to limit lateral leakage; and,
- If Janneh is to be built it should be limited in size to reduce leakage and used to supply only Jbail and Kesrouane until such time as the hydrogeological regime and hence the destination of leakage could be verified by investigations and aquifer modelling.

While some technical disciplines had been studied in great detail during the Feasibility studies, no one site is considered to have the full range of detailed and technically justified information to allow detailed dam and reservoir design to progress without substantial time and expenditure on additional site and modeling investigations. While all dams are reported to require a 3-year construction program, ESIA team specialists regard 5 years to be a more realistic time frame for construction once the additional investigations are complete.

SECTION 9

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1 Introduction

This section of the ESIA report discusses the three elements of the Environmental and Social Management Plan (ESMP). Proposals for impact mitigation are discussed in **Section 9.2**., while Environmental Monitoring and Institutional Strengthening/Capacity Building are presented in **Sections 9.3 and 9.4** respectively.

9.2 Environmental and Social Impact Mitigation

This section proposes mitigation measures to address the impacts identified in Section 7 under three separate groupings:

- Pre-Construction impacts
- Construction impacts
- Operational impacts

Section 9.2.5 summarizes the mitigation measures proposed in respect of land acquisition and resettlement, details of which will be discussed in the Resettlement Action Plan. Section 9.2.6 presents a summary table listing the mitigation measures expected to be required.

9.2.1 Pre-Construction Impact Mitigation

The most effective pre-construction impact mitigation strategies are implemented throughout all phases of engineering design. In particular, the precise location of the dam should be chosen to provide the best possible geological conditions with minimum risk of settlement and seismicity, minimum and least disruptive land take, and minimum loss of biodiversity, habitats and cultural heritage. The need to confirm the proposed location of Bisri Dam to meet these objectives has previously been highlighted.

With Roum Fault passing at least in close proximity to the Bisri Dam and to the project in general, its significance, the potential for movement, and the impact of reservoir loading, should be studied in greater detail than hitherto.

Loss of property, assets and means of livelihood will be mitigated by providing adequate resettlement and compensation in accordance with RPF and RAP for the project that is compliant with World Bank Operational Procedure OP 4.12 and relevant provisions of the Lebanese Law. While the loss of productive land of the quality of that in the Bisri Valley is almost irreplaceable, it would be possible to use some of the deep fertile soils for improving other less soil-rich agricultural areas in the vicinity. in clearing vegetation prior to inundation, the value of the pine woods in respect of commercial timber should be realised.

Loss of species diversity cannot be directly mitigated, but significant individuals will be subject to a capture and resettlement programme. Many of the species at Bisri will adapt to the new conditions, which new species and habitats will develop over time. In particular, wetland environments are expected to develop in the upper reaches of Nahr Barouk and in Wadi Bhannine, which in addition to creating a most ecologically-valued habitat, may if properly managed, greatly improve the quality of surface water inflow to the reservoir by reducing the amount of nutrients and hence the proliferation of algae blooms and deleterious stratification.

The significance and extent of archaeological and historic interest in the area of Bisri reservoir has been one of the primary surprises of the ESIA study. The Roman temple at Marj Bisri should be subject to investigation and rescue excavation, which Mar Moussa Church and the remains of St. Sophia Monastery, almost on the presently proposed dam site, can be carefully dismantled and reassembled in a more assessable location where it can continue to be available to worshipers old and new for decades to come.

9.2.2 Temporary Construction Impacts Mitigation

Most construction impacts are temporary and can be mitigated through good construction practices and effective site supervision. The World Bank has published[64] principles on waste management that are applicable to many construction activities.

The Contractor will be expected to manage his staff and adopt the ESMP contained herein and develop it in relation to his own particular activities, methodologies and equipment, in a Bisri Dam Construction Environmental and Social Management Plan, to be approved by the client and the construction manager prior to commencement of work on site. The CESMP will contain a number of specialist sub-plans including but not limited to the following:

- Traffic Management;
- Demolition and Land Clearance;
- Drainage, Erosion and Sedimentation;
- Public Utilities Disruption;

[64] Pollution Prevention and Abatement Handbook, World Bank, 1998.

- Solid Waste Management;
- Liquid Waste Management;
- Public Safety and Security; and,
- Worker's Health and Safety.

Thereafter, implementation of the CESMP shall be subject to ongoing monitoring and inspection by the construction manager. Each sub-plan shall include a considered assessment of risk, and for those events with a high risk of occurrence Emergency Response Procedures (ERPs) shall be formulated. A public complaints procedure will also be put in place. The minimum scope for each of the proposed sub-plans is given in Table 9.1.

Table 9.1: Minimum Scope for CESMP Sub-Plans

CESMP Sub-Plan	Minimum Scope
Traffic Management	For vehicular and non-vehicular traffic, the location and schedule of road closures, diversions and temporary passages, traffic control and signage, lighting and watching at night, notification procedures. Breakdown recovery, accident reporting, and emergency access.
Demolition and Land Clearance	Proposals for demolition, checks for asbestos and other hazardous materials, hazmat disposal, architectural salvage and recycling, debris treatment and recycling, and ultimate disposal of non-reusable/recyclable items. Schedule of land clearance to minimize loss of un-harvested crops and the generation of dust.
Drainage, Erosion and Sedimentation	Maintenance of flow in the existing watercourse, prevention of erosion from excavations and cleared land, use of settling ponds, trenches and silt curtains.
Public Utilities Disruption	Schedule of any expected disruptions and details of alternative arrangements to be put in place.
Solid Waste Management	The minimization of waste, off-cuts, materials no-fit-for-purpose, spent materials and defunct equipment. Proposals for sorting and recycling, and for ultimate recycling of residual debris. Identification and disposal of hazmat. All residual waste (after reuse/recycling) shall be disposed of at a licensed disposal site. Only inert construction waste may be buried on site. Non-reusable cleared vegetation shall be shredded and composted. There shall be no open burning of waste.
Liquid Waste Management	Identification of waste liquids, and the arrangements for their reuse/recycling and ultimate disposal. Proposals for bunded fuel tanks, waste oil disposal, and site sewerage for workers.
Public Safety and Security	Site security to prevent public access, badge control, fencing and signage for working, storage and other areas.
Worker's H&S	General adherence to 'best practice' health and safety practices. Provision of protective clothing, site safety regulations, confined area working, awareness training, signage and posters, first aid facilities, accident reporting and emergency procedures

9.2.3 Operational Impacts Mitigation

Operational impacts will primarily be the responsibility of BMLWE, the Bisri scheme operator. Mitigation measures for the major impacts will include those discussed below.

Soil erosion along new foreshores

Plant cover shall be increased around reservoir to help control erosion and landslip. loose blocks from the upper cliffs to be safely removed as they appear.

Reservoir stratification

Water stratification may cause a great proportion of the reservoir to turn anaerobic, leading to the release of minerals that promote the development of algal blooms and form methylated mercury, thus posing major problems for water service companies and potentially compromising the effectiveness of water treatment streams. Blowers, compressors, pumps and other equipment will be needed to maintain a level of mixing within the reservoir that prevents the development of water quality stratification.

Sedimentation

To minimize sedimentation and the loss of capacity and sediment build-up at the dam, it is important to promote reforestation and soil conservation, and to monitor reservoir depth to assess sedimentation. The development of wetland on the main contributing watercourses will reduce sediment load.

Deterioration in groundwater quality

Groundwater quality may deteriorate from the seepage of reservoir water into the adjacent aquifers. The best way to sustain ground water quality is to promote groundwater resource management and maintain surface water quality.

Reduced aquatic habitats

Many of the aquatic species currently present in Nahr Bisri will adapt to the new lacustrine environment. Others will come to occupy vacated niches. To permit migration for spawning and feeding the means for fish to by-pass the barrier of the dam should be provided. This may necessitate the construction of fish leats, ladders and tubes. Any commercial fish farming enterprises can be based on native species rather than introduced species such as trout, bass, tilapias, and mosquitofish, which will come to overwhelm native species.

Derogation of downstream irrigation

The quantity of irrigation water is expected to decrease downstream while fertilizer use will increase upstream. As such, agricultural extension services will be required to optimise the use of low water-use crops and promote water-saving irrigation practices. A reasonable allowance shall be made for the release of environmental and other compensation flows that matches changes in future requirements.

Increased soil salinity downstream

Due to the reduced water quantities downstream, compensatory discharge will have to be provided to leach soil salts.

Maintenance

The potential significance of these impacts will be a direct function of the quality of the planning and preparation carried out beforehand, the effectiveness of advance warning signs, and the quality of site supervision.

9.2.4 Land Acquisition and Resettlement

The Project Proponent is committed to providing entitlement to persons who lose their land or other assets. The principal form of compensation will be a cash payment based on the assessment of full replacement cost, as described in the previously issued GBWSAP Resettlement Policy Framework.

A detailed socio-economic survey of impacted households and business enterprises is being undertaken to enable the preparation of a comprehensive but separate Resettlement Action Plan.

9.2.5 Summary of GBWSAP Impact Mitigation

In summarizing the mitigation measures proposed for the Bisri scheme, Table 9.2 builds on the risk of individual impacts previously given in Table 7.10 above, and provides an assessment of the risk associated with post-mitigation residual impacts using the same definitions as previously given in Section 7.5. In ensuring the full range of potential impacts and mitigation measures are covered, the ESIA draws upon the documentation of the World Commission on Dams.

Generally, the GBWSAP ESMP shall be applied to all phases of the project, from preliminary and detailed design through construction and on to operational and maintenance.

Table 9.2: Summary of Proposed Environmental and Social Impact Mitigation Measures

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
Land Take	Land taken for dam and reservoir, access roads	Unavoidable	Major	Locate reservoir to minimize land take and loss of natural landscape per unit volume impoundment.	Designer
	Loss of natural landscape	Expected	Moderate		
	Land take for `resettlement and/or relocation of PAPs	Unavoidable	Moderate	Locate reservoir to minimize land take per unit volume impoundment. Provide adequate resettlement and compensation in accordance with RPF and RAP compliant with Lebanese Law.	Designer, RAP Developer and Project Proponent
	Loss of existing communities	Not Expected	n/a		
	Loss of individual homes	Unavoidable	Moderate		
	Loss of non-agricultural business premises	Not Expected	n/a		
	Loss of productive land	Unavoidable	Major		
	Loss of temporary employment	Unavoidable	Major		
	Loss of permanent employment	Expected	Moderate		
	Loss of historic and cultural heritage	Unavoidable	Major	Salvage cultural property and reconstruct within existing communities. Avoid inundation of immoveable sites such as burial grounds. Undertake rescue archaeology.	Project Proponent
Impoundment	Additional loss and severance of access	Expected	Moderate	Create alternative access roads around the reservoir;	Project Proponent
	Increased risk of seismicity	Expected	Major	Analyze hydraulic loading to assess seismic potential and avoid areas of high risk. Design to minimise seismic loading.	Designer
	Loss of natural vegetation	Unavoidable	Moderate	Increase planting around reservoir;	Designer
	Impaired water quality from uncleared vegetation	Unavoidable	Major	Vegetation and soil to be cleared prior to inundation. Treatment plant will provide suitable process stream to	Contractor

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
				ensure water delivered to GBA of potable quality.	
	GHGs from uncleared vegetation	Expected	Major	Vegetation and soil to be cleared prior to inundation.	Contractor
	Soil erosion along new foreshores	Expected	Major	Construct shoreline protection. Increase planting around reservoir.	Designer and Contractor
	Reservoir stratification	Expected	Major	Install provision for mechanical mixing where natural circulation insufficient.	Designer
Sedimentation	Creation of backwaters on tributary streams	Expected	Moderate	Promote development of wetlands. Monitor reservoir depth to assess sedimentation. Operate reservoir to minimize sedimentation build-up. Allow for sedimentation in structural design.	Designer and Operator
	Loss of capacity and sediment build-up at dam	Expected	Major		
Upper Watershed Management	Road construction opens area to non-residents	Expected	Minor	Ban land clearance for new agriculture. Restrict access to previously remote areas.	Project Proponent
	Resettlement increases water use waste generation	Expected	Minor	Adopt an integrated planning framework and a strict ESMP, and provide effective enforcement. Regulate the discharge of wastewater and the use of agrochemicals.	Project Proponent
	Social unrest due to the restriction of human activity	Not Expected	n/a	Ensure new developments prioritize the local employment.	Project Proponent and Contractor
	Loss of water quality due to evaporation	Unavoidable	Major	Promote shoreline planting and reforestation.	Operator
	Impaired water quality due to discharges above dam	Expected	Moderate	Adopt an integrated planning framework and a strict ESMP, and provide effective enforcement. Developing sewerage systems for villages throughout the upper watershed.	Project Proponent
Lower Watershed Management	Reduced non-agricultural surface water resources	Unavoidable	Moderate	Provide agricultural extension and other services to promote low water-use crops and irrigation practices. Ensure resettled communities are adequately resourced without detriment to existing communities.	Project Proponent
	Reduced water resources for existing agriculture	Unavoidable	Moderate		
	Water-use conflict	Expected	Moderate		

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Loss of stock watering points	Not Expected	n/a	None required	
	Salinization of downstream floodplain	Expected	Moderate	Provide adequate compensatory flows to leach salt build-up.	Project Proponent
	Reduced dilution of chemical residues, sewage	Expected	Moderate		
	Reduced Dissolved Oxygen downstream	Expected	Moderate	Provide for multi-level releases to avoid the discharge of anoxic water. Design for aeration downstream of dam site;	Designer
	Scour by water released under increased head	Expected	Minor	Provide for energy dissipation from dam outflow; Provide for sediment trap and its orderly release.	Designer
Ground Water	Reverse ground water flow upstream of the dam	Expected	Moderate	Undertake hydrogeological study and modelling to assess impact on ground water levels and flow;	Designer
	Change in water table	Expected	Minor		
	Reduced downstream aquifer recharge	Expected	Moderate	Provide adequate releases to maintain recharge; Provide downstream structures to induce shallow recharge.	Designer and Operator
	Deterioration in ground water quality	Expected	Major	Promote ground water resources management.	Project Proponent
Biodiversity and Habitats	Loss of indigenous flora	Unavoidable	Moderate	Promote the colonization of shoreline trees. Provide for species rescue and relocation. Minimise disturbance of non-inundated vegetation.	Operator
	Loss of terrestrial habitats	Unavoidable	Moderate	Provide mammal-resistant fencing. Provide for species rescue and relocation. Provision safe crossing points to enable dispersal and links between fragmented populations.	Operator and Project Proponent
	Reduced downstream biodiversity	Expected	Moderate	Provide compensatory discharges to maintain downstream biodiversity.	Operator
	Build-up of weed and algal mats around spillways, etc.	Expected	Moderate	Control algal blooms by using appropriate additives (e.g. 22 kg/ha $CuSO_4$. Harvest weed and algal growth for compost, fodder or biogas.	Operator

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Disruption of flyways	Expected	Moderate	Sources of noise to be properly buffered. Planting trees to create habitat corridors; National hunting ban to be enforced as per Law 580/04.	Operator
	Reduced aquatic habitats	Expected	Major	Provide fish leats, ladders and other by-passes. Protect spawning grounds; Incorporate sensitive design, i.e. allow shallow areas for spawning, etc.	Designer
	Barrier to fish migration and loss of spawning areas	Expected	Moderate		Designer
	New habitats for migratory bird species	Expected	Moderate	Promote reforestation and areas of dense shrub.	Operator
	New farming fish species	Expected	Moderate	Ban the introduction of exotic species such as trout, bass, tilapias, and mosquitofish. Promote the user of native species.	Project Proposal
Agriculture	Inundation of agricultural land	Unavoidable	Major	Consider stripping highly fertile soils from reservoir area and spreading on adjacent less fertile land;	Project Proponent and Contractor
	Loss of fertile soils	Unavoidable	Major		
	Loss of yet-to-be-harvested crops	Unavoidable	Major	Consider relocating the poly-tunnels and their content with no actual loss, or move when fallow.	Project Proponent
	Derogation of downstream irrigation	Unavoidable	Major	Use agricultural extension to promote low water-use crops species and irrigation practices.	Operator
	Fertilizer use upstream increases nutrient load	Expected	Moderate		
	Increased soil salinity downstream	Expected	Major	Provide compensatory discharge to leach soil salts;	Operator
Fisheries	Incompatibility of lake and river environments	Expected	Moderate	Introduce native lake fish species and encourage lake fisheries within sustainable limits. Limit water retention to maintain water quality. Ensure minimum discharges are adequate to sustain downstream fish population.	Operator
	Snagging of nets and lines on uncleared structures	Not Expected	n/a	Clear vegetation and structures prior to filling.	Contractor and Project Proponent

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Mortality of fish entering power plant	Expected	Moderate	Install screens to stop fish entering turbine intakes.	Designer and Contractor
Settlement and Resettlement	All residents in the inundated area will be displaced	Unavoidable	Moderate	Provide adequate compensation in accordance with RPF and RAP compliant with Lebanese law.	Project Proponent
	Disaggregation of communities	Not Expected	n/a	No significant communities to disaggregate. Resettlement unlikely to result in conflict as resident Lebanese PAPs will keep within their previous communities.	
	Impact on indigenous groups/lifestyles	n/a	n/a		
	Social conflict between existing residents and PAPs	Not Expected	n/a		
	Competition for resources between residents & PAPs	Not Expected	n/a	None required.	
	Particular impacts on vulnerable groups	Expected	Moderate	Provide social support to vulnerable groups. Use resettlement to aid poverty alleviation	Project Proponent
Public Health	Increase in water-related diseases	Expected	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Maintain water free of algae. Develop and implement an Emergency Response Procedures.	Operator
	Increase in mosquito breeding sites	Expected	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Spray mosquito breeding sites if necessary.	Operator
	Climatic changes such as increased humidity & fogs	Expected	Moderate	None.	
	HV transmission lines in proximity to housing	Not Expected	Minor	Hydropower generated likely to be utilised locally. Insufficient capacity to justify investment in long transmission lines.	
Indirect Issues	Negative impacts from increased urban development	Expected	Moderate	Adherence to coordinated sustainable development via Shoreline Development Master Plan.	Project Proponent
	Upper catchment activities limit dam efficiency	Expected	Moderate	Restrict activities on the upper watershed to those that have minimal environmental and social impact.	Project Proponent

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
Construction Issues	Construction site unsightliness	Expected	Moderate	Construction contractors to offer priority employment to PAPs and other local residents; Contractor to develop and implement a comprehensive Construction Environmental and Social Management Plan.	Contractor
	Increase traffic generation and exhaust emissions	Expected	Moderate		
	Noise and dust from site clearance and excavation	Expected	Moderate		
	Temporary works such as drainage diversion	Unavoidable	Moderate		
	Camp working area sewage and solid waste disposal	Expected	Moderate		
	Emissions from batching plants & power generators	Expected	Moderate		
	Increased hunting, egg collecting, live capture	Expected	Moderate		
	Social conflict between workers and residents	Expected	Minor		Contractor
	Importation of contagious diseases	Expected	Minor		
	Fuel spillage and waste oil disposal	Expected	Moderate		

9.3 Environmental and Social Monitoring

9.3.1 Introduction

This section of the ESIA outlines the proposed Environmental Monitoring Plan for Bisri dam and reservoir. **Section 9.3.2** presents the Key Performance Indicators for the Project, while **Section 9.3.3** presents Environmental Monitoring and Reporting which includes:

- Baseline Condition Monitoring;
- Site Inspections;
- Environmental Quality Monitoring;
- Complaints Monitoring;
- Bi-Annual EMP Implementation Reports;
- Land Acquisition and Resettlement Reporting;
- Environmental Auditing;
- Post-Construction Operational Reporting; and,
- Monitoring Programme.

9.3.2 Key Performance Indicators and Standards

The Key Performance Indicators and Standards for the project are listed in Table 9.3.

Table 9.3: Key Performance Indicators and Standards

Parameter	Standard / Indicator
During Design	
Dam Site Confirmation	Optimum/minimal land take and E&S impacts
Dam Design	World Bank Operational Policy, *OP.4.37, Safety of Dams*.
During Construction	
Potable Water	Lebanese Drinking Water Standards
Air Quality Emissions	Lebanese Stack Emission Standards for Fixed Plant Lebanese Exhaust Emissions Standards for Mobile Plant and Vehicles
Noise	Lebanese Noise Emission Limits for Outdoor Areas
Worker's Health and Safety	No. of accidents and working days lost Compliance with Lebanese Labour Law Compliance with Lebanese Standards for the Discharge of Wastewater to Watercourses
Public Safety	No. of incidents involving the public
Vibration	No. complaints from the public
Cultural Heritage	The documentation of Chance Finds
During Operation	
Dam Safety	World Bank Operational Policy, *OP.4.37, Safety of Dams*, and, Reports of the Dam Safety Panel
Water Quality	Lebanese Standards and WHO Guidelines for Drinking Water

Design standards to be confirmed by design consultant

9.3.3 Environmental Monitoring and Reporting

The prime objectives of the proposed environmental monitoring are as follows:

- Monitor any significant changes to the project environment;
- Determine if such changes result from project or non-project causes;
- Determine the impact of non-compliance with national and international standards;
- Assess the effectiveness of impact avoidance and mitigation; and,
- Highlight unforeseen areas of concern and any need for additional measures.

For environmental monitoring to be both effective and meaningful to the implementation of the ESMP, the results need to be available to all concerned parties, with milestone reports also made available for public consultation, perhaps most easily via CDR's GBWSAP web page.

Pre-construction environmental performance in respect of the design standard adopted will be reported by the design consultant in the Final Design Report.

The primary reporting of environmental issues during the period of construction will be as follows:

- The results of individual monitoring campaigns will be reported by the contractor to the Construction Manager as and when they become available;
- Individual Site Inspection Reports by the Construction Manager's inspectors, reported at Monthly Contract Progress Meetings;
- The results of environmental quality monitoring received during the month will be appended to Monthly Progress Reports; and,
- Bi-annual ESMP Implementation Reports prepared by the Construction Manager, to include the results of individual site inspections and environmental quality monitoring, together with a discussion of the implications and issues arising.

Post-construction environmental monitoring will primarily focus on the safety of dams and all its operations, the quantity of reservoir inflows and outflows, and water quality within the reservoir and delivered to supply.

Baseline Condition Monitoring

Baseline measurements of existing surface water flows, their quality, and sediment loading should be taken to provide baseline values against which operational monitoring can be assessed.

Site Inspections

For site inspections and monitoring to be effective, it will be necessary for authorised personnel from MEW, MoE and the construction manager to have guaranteed access to all project sites, for which a suitable clause must be incorporated into contract documents.

The day-to-day visual monitoring of construction activities will be the primary mechanism by which the contractor's performance will be shown to comply with good construction practice, applicable legislation, standards and guidelines, and the requirements of the ESMP. Whilst these inspections will be the responsibility of the construction manager, MEW and MoE may wish to undertake occasional independent inspections in respect of issues over which they have particular concern.

To facilitate inspections, a standard pro-forma checklist will be deployed. This will detail the locations and activities inspected, identify areas in which the Contractor is non-compliant with the ESMP, and propose remedial action. Copies of these reports shall be circulated to the CDR Project Manager, the Construction Manager and the Contractor. Where remedial action is proposed, discussions with the Contractor shall be held within a period not exceeding 24 hours to ensure the requirements have been understood and the works put in hand.

Daily site reports will be tabled at monthly Progress Meetings, at which *Environmental Issues* will be a specific agenda item. The Minutes of Meeting will summarize areas of non-compliance and/or areas where additional mitigation is required. Monthly Progress Reports will also include a specific section on *Environmental Issues* and will summarize issues arising, compliance and non-compliance during the reporting period, and issues outstanding. These reports will primarily be circulated internally within CDR, the Construction Manager and the Contractor.

The cost of environmental site inspections is deemed to be included in the cost of broader construction activity inspections born by the Construction Manager.

Environmental Quality Monitoring

Environmental Quality monitoring undertaken by the Contractor will be reported as and when the results become available. Where this involves direct measurement of a given parameter, the results should be reported to the Construction Manager within a period not exceeding 24 hours. Where numerical or laboratory analyses are required, the outcome should be reported within 24 hours of receipt of the analytical results. All laboratories and other third party reporting enterprises shall be subject to pre-approval by the project proponent and MoE.

Complaints Monitoring

Additional monitoring needed to investigate specific complaints made by riparian landowners or the public arising from construction activity will be given highest priority and reported in good time for remedial action to be identified and executed with the minimum of delay.

Reporting of all complaints monitoring results will include the following:

- Details of the complaint, including its nature, name and contact details of the complainant, and the reported severity of the incident;
- Sampling, methodologies, equipment calibration reports, and other background material, and the empirical results;
- Details of any extreme or abnormal events that may have influenced the empirical findings;
- Analysis of the findings highlighting any changes of significance and discussing the causes of change;
- Recommendations on actions to be taken; and
- Follow up on the recommendations of previous reports.

Bi-Annual EMP Implementation Reports

Incorporation of individual site reports, relevant sections of Monthly Progress Reports, and all monitoring results from the period being reported, into Bi-Annual ESMP Implementation Reports will highlight persistent non-compliance or continued negligence by Contractors and present all supporting documentary evidence. The circulation of bi-annual reports will include concerned municipalities and the Ministry of Environment. Bi-Annual reports should also be uploaded to the CDR GBWSAP web page.

Land Acquisition and Resettlement Reporting

Progress on land acquisition and resettlement will be reported as laid down in the GBWSAP Resettlement Action Plan at the following intervals.

- From the approval of the Expropriation Decree by the Council of Ministers for a period of six months – monthly;
- Thereafter, bi-annually until all outstanding land acquisition and resettlement issues, including Appeals to Court, have been settled.

In addition to the standard pro-forma format, these progress reports will include descriptive narrative on the following:

- Progress on land acquisition and resettlement;
- Progress on the disbursement of compensation;
- Community Liaison Activities;
- Grievances registered, actions taken, and the outcomes;
- Issues related to female heads of Households and Vulnerable Groups;
- Other issues on which the CLO wishes to report.

A separate social survey of resettled and relocated PAPs will be undertaken as part of the project evaluation six months after resettlement.

Environmental Auditing

No specific provision is made for Environmental Audits. The Ministry of Environment will *de facto* audit the bi-annual reports of the Supervision Consultants as approved the Project Proponent.

Although international funding agencies are unlikely to undertake formal auditing, future missions during the period of construction can be expected to include members tasked with particular responsible for environmental and social issues.

Post-Construction Operational Reporting

Post-construction monitoring will take the form of routine site inspections to confirm Bisri Dam and all its appurtenances are operating properly. These should be undertaken at least monthly, even when the off-takes and hydropower plant are not operational, but with operational experience this time period may be extended during the dry season and/or reduced during the rainy season.

No provision is also made for operational reporting. it is currently assumed MEW will be the effective owner of the dam and decide policy, while BMLWE will be operator, incorporating existing and new GBWSP O&M practices, including reporting procedures.

Monitoring Programme

The proposed programme of environmental and social monitoring is summarized in Table 9.4 and includes the means by which the required information will be obtained, the frequency of collection and the responsible organization. The cost of construction environmental monitoring for ESMP implementation is assumed to be incorporated within construction costs, i.e. those of the contractor and the construction manager, while those of operational monitoring will be incorporated in BMLWE operating costs.

Table 9.4: Environmental Quality Monitoring Requirements

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Pre-Construction Environmental Quality Monitoring									
Surface Water Quality	Lebanese Potable Water Standards	4 locations; Nahr Barouk and Wadi Bhannine at extremities of reservoir, two other seasonal inflows	Water sampling and full laboratory analysis	Ongoing until completion of construction	Quarterly, varied to include high and low flows	To confirm background conditions for comparison operational monitoring	Experienced surface water sampler	BMLWE	US$1,500 per sample
Rate of Sedimentation	Volume and size of sediment captured	Nahr Barouk and Wadi Bhannine at extremities of reservoir	Sediment capture behind a small weir or sediment capture pit	Ongoing	Quarterly, varied to include high and low flows	To confirm design assumption	Hydrologist	BMLWE	US$15,000 per site
Rescue Ecology and Species Relocation	Observation and rate of capture. Adaption to relocation	Reservoir area and site of relocation	Visual observation	Ongoing until completion of construction	Seasonally	To determine extent of rescue and make sure implementation strategy is implemented	Ecological surveyor	CDR	US$50,000
Rescue Archeology and Relocation	Archaeological finds unearthed and documented	Marj Bisri	Excavation, observation and documentation	Ongoing until completion of construction	Seasonally	To make sure implementation strategy is implemented	Archaeologist	DGA	US$ 120,000
	Structures removed and reconstruction	Mar Moussa	Dismantling and reassembling	Prior to construction	Monthly	To address community concern for heritage	Building conservationist	DGA	US$ 250,000

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Land Expropriation and Resettlement	Progress of expropriation execution. PAP satisfaction	All lands to be acquired under the project	Expropriation and resettlement reporting	Throughout expropriation	Monthly for 6-months, then bi-annually.	To monitor progress and ensure transparency	Community Liaison Office	CDR	Included in Expropriation costs
Construction Environmental Quality Monitoring									
Site Inspection	General construction activity	All sites associated with the Bisri construction	Visual and descriptive, against check list	Ongoing throughout period of construction	Daily	To ensure compliance with good construction practice and EMP	Environmentalist with construction site experience	Construction Manager	US$ 200,000
Complaint Investigation	Any parameter relevant to the nature of the complaint	At or in the vicinity of sites for which complaints are received	As appropriate for the parameter being monitored	As necessary	As necessary	To investigate complaints and provide a basis for redress	Environmentalist with experience of field monitoring and analysis	Contractor and Construction Manager	Depends on complaints received
Health and Safety	Absence of unauthorized public. Injuries and work days lost among workers.	All sites of construction and project related activity	Primarily visual and descriptive, against a check list. Time card records	Ongoing throughout period of construction	Monthly	To protect the public and workers in accordance with H&S BMPs	Experienced H&S site supervisor	Contractor and Construction Manager	Included in construction costs
Air Quality	Lebanese atmospheric emissions standards, fixed and mobile	Contractors' work sites and selected sensitive receptors	Visual assessment and portable air quality equipment	Dependent on source	On suspicion of non-compliance	To prevent air pollution	Site inspector	Contractor	Included in construction costs

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Noise	Lebanese ambient noise standards	At selected sensitive receptors	Ambient noise monitoring equipment of approved manufacture	Over 1 hour during the working day	On suspicion of non-compliance	To prevent noise nuisance	Site inspector	Contractor	Included in construction costs
Cultural Heritage	Documented Chance Finds	Any unknown remains unearthed during construction	DGA standard procedures	As necessary	Every find DGA deem worthy of recording	To improve understanding of Lebanese and optimise relic recovery	DGA Inspector	Contractor and DGA	Depends on number of finds and delay caused
Post-Construction Environmental Quality Monitoring									
Air Quality	Stack emissions from stand-by generators	At stacks and sensitive receptors	Portable stack insertion monitors and other monitors	Over 12 hours	Every 3 months during the operating season	To prevent air pollution	Plant Engineer	BMLWE	US$ 500 per sample
Workers Health and Safety	No. of accidents and working days lost	On the dam and reservoir sites	H&S records	Ongoing	Ongoing	To monitor compliance with Operator's H&S Manual.	Operator's Health and Safety Inspector	BMLWE	Included in ongoing O&M
Public Health and Safety	No. of accidents and injuries.	Dam, reservoir and environs	Accident reports	Ongoing	Ongoing	Promote security and safety, and adequacy of signage.	Compliance with Operator's H&S Manual and EMP.	Compliance with Operator's H&S Manual and EMP.	Included in ongoing O&M
Dam Safety	Dam Safety Panel inspection reports	Dam site	Visual inspection and review of Dam Safety File	Ongoing	Every 3-5 years	To identify early warning signs of potential failure	Dam Safety Inspection Panel	BMLWE	US$ 25,000 per inspection
Incoming Surface Water Quality	GBWSP water quality operating standards	Nahr Barouk and Wadi Bhannine inflows	Water sampling and full laboratory analysis	Ongoing	Quarterly, varied to include high and low flows	To monitor quality of incoming water	Experienced surface water sampler	BMLWE	US$1,500 per sample
Reservoir water	To check development of stratification	2 fixed sampling points within reservoir	Multiple depth sampling and on-site analyses	Seasonal	Monthly from May to October	To confirm adequacy of mixing to limit stratification	Experienced water sampler and boatman	BMLWE	US$1,000 per sample

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost
Groundwater	Groundwater flow and water quality	Selected springs and wells	- Flow gauging, water level monitoring and sampling	Ongoing	Bi-annual	To identify changes in groundwater regime	Hydrogeologist	BMLWE	US$ 3,000 per sample
Biodiversity	Diversity of species and habitats	Dam, reservoir and environs	Visual observation and survey	Seasonal	Annually for 3 years, then every 5 years	To asses fish migration and reduced biodiversity	Ecological team	BMLWE	US$ 20,000
Downstream abstraction	Adequacy of environmental flows	Downstream abstraction sites	Survey of abstractors	During Autumn	Annually	Optimise abstraction management	Agriculture extension officer	MoA/MEW	US$ 10,000
Reservoir Sedimentation	Sediment build up	Reservoir	Depth or Echo sounding	Ongoing	Annually, in May or June	To check loss of dead storage and protect intakes	Mechanical Engineer and Boatman	BMLWE	US$ 10,000
Induced Development	Adherence to Shoreline Master Plan	Surrounding lands	Enforcement of planning regulation	Ongoing	Ongoing	Safeguard investment in dam and protect water resources	Development inspector	Planning Authorities and Municipalities	No cost to project

9.4 Institutional Strengthening and Capacity Building

The requirements for the post-construction management, operation and maintenance of a large dam such as Bisri are not to be taken lightly. With the exception of Qaraoun Lake managed by the Litani River Authority and from which water is taken for hydropower generation and irrigation, neither MEW nor BMLWE have significant experience of managing and operating a dam to supply such a large urban service area.

9.4.1 Institutional Structure and Responsibilities

The prime institutional stakeholders in respect of management responsibilities are expected be as shown in Table 9.5.

Table 9.5: Prime Institutional Stakeholders for Bisri Dam Management

Institution	Prime Responsibilities
CDR	In its planning role, commissions specialist studies and dam design, secures funding, pre-qualifies contractors and manages the tender process through to award, executes land acquisition, and on behalf of GoL acts as the contract administrator.
MEW	The effective dam owner; establishes operational policy including determining available yields and environmental releases. Ensures formal Dam Safety Panel inspections are undertaken according to pre-agreed schedules.
BMLWE	Day-to-day operational management, implements MEW policy, ensures permitted yields are delivered, treated and distributed to customers. Maintains the dam, water supply off-takes and hydropower plant, the reservoir shoreline and all operational monitoring. Facilitates dam safety inspection visits. Responsible for public safety including the maintenance of warning signage.
MoE	Setting and monitoring the adequacy of environmental flow releases to cater for non-abstraction requirements. A *statutory consultee* for the Dam Safety Panel. As existing laws, shoreline development environmental permitting.
EDL	Purchase from BMLWE the hydropower output and sell it on customers at a rate that at least ensures cost recovery.
MPWH	Implements the Bisri Reservoir Shoreline Development Master Plan.
MoA	Puts in place agricultural extension services to maximise the efficiency of downstream irrigation practices for minimum water use. Advises MEW on the adequacy of releases to maintain legal abstractions. Advises the dam operators on the permitting of commercial fish farming within the reservoir.

It is important that Bisri Dam is managed as an integral part of Greater Beirut Water Supply and in close coordination with the structure and responsibilities promulgated in the recent law setting out the details of the project.

It is assumed that once construction is completed and the dam commissioned, CDR will relinquish responsibility to MEW and BMLWE.

MoE, as a statutory consultee on the Dam Safety Panel, will need to identify an individual who will take this on insofar as the ministry's responsibilities warrant.

While CDR should commission the Bisri Reservoir Shoreline Development Master Plan, MPWH working with the concerned municipalities will be responsible for implementing it.

9.4.2 Institutional Strengthening

MEW and BMLWE will need to establish specialist departments to operate Bisri dam and reservoir, which should (i) interface with the operation of the Awali Conveyor, the Ouardaniye Treatment Plant, and onward transmission, and (ii) also provide for the operation and management of future dams elsewhere in Lebanon.

The required institutional strengthening and reform is expected to be incorporated with broader reorganisation required for the successful management and operation of GBWSP facilities and proposals for increasing operational efficiencies.

9.4.3 Capacity Building and Training

The lack of dam management and operational experience extends to individuals, and Bisri dam will require a substantial programme of capacity building, provided through (i) the new employment of suitably qualified managers and maintenance staff, (ii) training schemes for selected existing staff, and (iii) the subcontracting of selected services, or indeed the overall management of the dam and reservoir pending the building of in-house capacity.

As part of the construction contract, it will be important for MEW and BMLWE staff to be seconded to the teams of both the contractor and construction manager to receive hands-on knowledge and experience of the equipment and apparatus installed. This secondment must in addition and separate from any contract oversight on behalf of GoL these organisations may impart.

Selected operation staff proposed for supervisory positions should also be given the opportunity to visit and receive detailed briefing, including hands-on training, at dams of similar size and purpose outside Lebanon.

Internal capacity building is also likely to be required within the Ministry's legal team, to allow them fully understand the issues surrounding the 'Right-to-Water' in Lebanon.

With few large master planning exercises outside the Beirut Central District, which is managed by Solidere, and various urban expansion plans for the main cities and towns, capacity building in overseeing such an exercise in a hitherto largely undeveloped area will require training, most pertinently through the secondment of Ministry staff to the appointed consultant's master planning team.

While MoA already provides extension services, the consensus among agriculturalists is that it does not provide the level of expertise required to optimise farming efficiencies. Capacity building of staff in respect of modern low water-use crop species and irrigation equipment and practices is therefore likely to be required. Ministry fisheries staff will also need to be trained on the potential for commercial fisheries in water supply reservoirs, the issues to be addressed and the safeguards to be put in place. Currently, the Ministry does not have a permitting process for fisheries, although it does require proposed projects to undergo EIA approved by MoE. Since Bisri may afford far larger fisheries operations than have previously been attempted in Lebanon, and other impoundment reservoirs are planned in the future, the feasibility of fish farming should be subject to investigation by a panel set up to include MEW, MoA, MoE and industry representatives, to draw on overseas experience and to develop Lebanese fish farm permitting and inspection procedures.

SECTION 10

CONSULTATIONS AND COMMUNICATIONS

10. CONSULTATIONS AND COMMUNICATIONS

10.1 Introduction

In accordance with CDR policy on public participation, which generally follows that of the World Bank and other international funding agencies, GBWSAP commenced with the drafting of a *Consultations and Communications Programme*[65] (C&CP) detailing the steps that would be followed throughout the project, from site selection through to commissioning. Prepared prior to the PD ESIA, C&CP was necessarily somewhat generic since the form of water supply augmentation, dam or non-dam, had yet been determined.

In this section of the ESIA, **Section 10.2** summarises the scoping consultation sessions undertaken for the ESIA, while **Section 10.3** details the consultations undertaken during preparation of the present report.

Section 10.4 details the consultation sessions planned shortly after submission of the present report, to relate the details of the study and to disseminate the results to stakeholders, and summarises the remaining C&CP programme though design, construction and commissioning.

10.2 Scoping Consultations

At the outset of the EIA process, the preparation of the PD ESIA, a series of Scoping sessions was held during April and May 2012, commencing with an Institutional Stakeholders session at CDR offices in Central Beirut to which ministries, other governmental agencies and NGOs were invited. This was followed by separate meetings in the vicinity of the three potential dam sites, that for Bisri being held at Mazraat El Dahr Municipality on Tuesday 10 April. Finally, two separate sessions were held for Beirut residents, the prime GBWSAP beneficiaries, at Hadath Municipality on Tuesday 24 April for southern suburb residents and in Downtown Beirut at Beirut Municipality on Saturday 5 May for Beirut municipality residents. All presentations and the subsequent proceedings were conducted in Arabic, but the Consultant's team was also prepared to present and respond in English and French had the need arose.

With the exception of the institutional stakeholders meeting, which was by written invitation, all these meetings were advertised in the national press and via flyers to concerned municipalities. The ESIA Consultant established a dedicated mobile phone line

[65] *GBWSAP Consultations and Communications Programme*. Dar Al-Handasah (Shair and Partners) Doc. No. L12002-0100D-RPT-ENV-01 Rev1, February 2012.

manned 24/7 and a dedicated email address via which details of venues, dates and times, together with other information on the meetings and the project, could be obtained.

Full details of these meetings, lists of attendees, the issues raised and the Consultant's written responses were given in the PD ESIA and are repeated in Appendix G herein.

In respect of the Bisri scoping session, attendees represented just over 50% of the potential area to be inundated, including several from municipalities within the Chouf Al-Aala municipal federation, in whose jurisdiction nearly 70% of the inundated area is located. As at all meetings, arriving attendees were given a handout relating the nature of the project and the intent of the meeting. Following the Consultant's presentation, the session was opened to the floor and attendees could raise comments or questions verbally or in writing. Those doing so verbally were also asked to record what they said in writing so that in addition to the immediate verbal response, a formal written response could be provided.

Attendees generally conducted themselves in an orderly fashion, many recognising the importance of water supply, the urgent need for additional power generation, and the potential economic opportunities from waterside developments, recreational activities and commercial enterprises such as fish farming.

10.3 ESIA Consultations

One of the difficulties in undertaken public meetings for Bisri is that GoL have been discussing the project for so long that residents have come to believe it will never be built. Even with the identification of Bisri as the priority scheme from the PD ESIA, many recently contacted landowners continue to express this opinion.

To overcome this and the limited availability of formal land ownership details, GBWSAP Phase Two commenced with a wide range of informal discussions with heads of municipalities, local residents and farmers, and literally, give the low population of the area, anyone seen within the area to be inundated.

These informal contacts allowed the Consultant to establish a land ownership data base, which provided the basis for the more formal socio-economic survey comprising structured interviews with affected households, businesses and agricultural holdings.

Following submission of the present report, the Consultant will, on behalf of the project proponents, hold a series of meetings to disseminate the finding of the study, to outline the proposed construction programme in so far as it is known, and to outline for PAPs the procedures for land and asset expropriation.

At the present time, the consultation sessions are expected to be as listed in Table 10.1. Details of the venues, dates and times are subject to confirmation.

Table 10.1: Proposed Public Consultation Sessions for ESIA Findings

Proposed Audience	Proposed Venue
Institutional Stakeholders	CDR Central Beirut
Chouf caza PAPs and other stakeholders	Moukhtara or Mazraat El Chouf and/or Mazraat El Dahr
Jezzine caza PAPs and other stakeholders	Midane and/or Bhannine
Southern Beirut water consumers	Hadath

Although Moukhtara is some 4.5 km north of the northern extremity of the reservoir, 7 km from the main body of water, it is included as an option being the seat of the municipal federation of Chouf al Aala, which includes Mazraat El Chouf, Aamatour and Bater, in whose jurisdictions nearly 70% of the proposed land take falls. In addition to the proposed venues, the Consultant is ready to hold additional sessions wherever requested.

Jezzine, 4 km from the southern extremity of inundation, 6 km from the main body of water, is not considered an option as it is a cultural enclave, primarily a summer resort, with little in common with the communities bordering Bisri reservoir and with a very small population during the winter months, when the ESIA PC sessions are expected to be held.

10.4 On-Going Consultation and Communications Programme

Subsequent to completion of the Final ESIA, which will include the details and results from the post-Draft ESIA consultation sessions, and completion of the RAP for the project, more focused sessions for directly affected PAPs will be held to explain expropriation procedures, the information they need to prepare, and respond to their queries.

These consultations are currently outside the ESIA Consultants Scope of Works and are expected to be primarily conducted by either the design consultant or CDR's Expropriation Department.

Thereafter the project proponent will continue consultations throughout the period of land expropriation and beyond from a Project Information Centre (PIC) where PAPs and other concerned persons will be able to consult project documents, find contact details of real estate agents, lawyers and other service providers, and lodge comments, queries and complaints. The PIC will continue to operate throughout the period of construction and until the reservoir is at least 80% filled. The location of the PIC should be in a village adjacent to the project and in close proximity to the optimum number of PAPs.

The RPF and RAP, in which the policy and detail of land and asset expropriation will be described and the procedure for resettlement detailed, will with the ESIA, be made publicly available at the PIC, via the Internet on the World Bank's *Infoshop* website or equivalent portal of other funding agency, and on CDR's website.

APPENDIX A

BIBLIOGRAPHY AND LIST OF REFERENCES

APPENDIX A BIBLIOGRAPHY AND LIST OF REFERENCES

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APPENDIX B

Unofficial Translation of Law NO. 8633 of august 2012

FUNDAMENTALS OF ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX B UNOFFICIAL TRANSLATION OF THE ENVIRONMENTAL DECREE 2012

Fundamentals of Environmental Impact Assessment (EIA)

Based on Law No. 216 dated 2 April 1993 (establishment of the Ministry of Environment), specially the first article thereof;

Based on Law No. 690 dated 26 August 2005 (defining the role and organization of the Ministry of Environment), particularly paragraph 27 of article 2 and paragraph 5 of article 6 thereof;

Based on Law No. 444 dated 8 August 2002 (Environment Protection), specially Article 23 thereof;

Based on Decree No. 2275 dated 15/6/2009 (organizing the units of the Ministry of Environment, defining their roles, structure, and conditions of recruitment for some positions), in particular paragraph 2 of Article 25 thereof;

Based on the proposal of the Minister of Environment;

After consultation with State Advisory Board;

After the approval of the Council of Ministers on ….

The following has been decreed:

Chapter 1

Preliminary Provisions

Article 1: Objective

This decree aims at setting forth rules that should be observed in the environmental impact assessment (EIA) of public and private projects to avoid potential environmental impacts at building, operating and decommissioning these projects.

Article 2: Definitions

Terms and phrases set forth below, as used in this Decree, shall have the following meanings:

Environment: The sum of natural surroundings (physical, chemical and biological) and the social surroundings where all organisms live, interact with each other and with their surroundings.

Environmental Impact Assessment: Assessment of the likely environmental consequences of a proposed project, and determination of necessary measures for mitigating negative environmental consequences and increasing positive impact on the environment and natural resources before approving or disapproving the project.

Environmental Results: Implications of the project on the environment at its building, operation, and decommissioning.

Initial Environmental Examination: A preliminary study to capture potential environmental impact of a project in order to determine whether conducting an EIA study is necessary for the project.

Environmental Management Plan: A group of impact mitigation measures, monitoring and control tools, and institutional procedures taken during building, operating, or decommissioning a project, with a view to eliminating or mitigating negative environmental effects to locally acceptable levels, if any, or to UN standards. The "environmental management plan" shall be deemed to be an integral part of the EIA report and the report of the Initial Environmental Examination.

EIA Scoping: An interaction process among the project owner, official departments and the affected public to identify (1) limits of the EIA study; (2) significant issues; (3) necessary information for report preparation; (4) significant implications that should be examined.

The Project: The building and other construction works that may have significant impact on the environment.

- Any interferences with the natural surroundings, including those containing extractive activities or addition to natural resources, which may have major effects on the environment as a result of their building, operation or decommissioning.

Significant Impact: To determine the significance of the impact, the following factors should be taken into consideration: type of the impact; its magnitude, nature, scope, timing and duration; likelihood of occurrence; and its implications.

Project owner: The natural or moral person from the private sector requesting a license to establish his project.

Licensing: The basic decision made by official departments and/or a license receipt allowing the project owner to embark on establishing or operating the proposed project.

Official Department: Public departments and/or public institutions, municipalities and/or municipal unions.

Annex 1: List of projects that duly require an EIA study.

Annex 2: List of projects that require an "initial environmental examination"; except projects located within an area listed in Annex 3 or projects which may have a significant impact on such areas, as these projects shall be subjected to "EIA" studies.

Annex 3: List of Lebanese environmentally sensitive areas where no project is allowable.

Annex 4: EIA classification form to be filled in by project owner, and according to which the Ministry of Environment classifies the project.

Annex 5: List of potential parties involved.

Annex 6; Statement of information required for the "initial environmental examination" report.

Annex 7: Statement of information required for the EIA scoping report.

Annex 8: Statement of information required for the EIA report.

Annex 9: Diagram of the EIA system.

Article 3: Project Scope

(1) It is prohibited to submit a project proposal to competent official departments in a piecemeal fashion that precludes the accurate classification of the project. In this case, the “initial environmental examination” or the “EIA” study of a piecemeal project shall be deemed to be null and void.

(2) The provisions of this decree shall apply to any modification, addition, expansion, rehabilitation or decommissioning - of any existing licensed private project or any approved public project - which may result in significant environmental consequences.

Chapter 2

Phases of Environmental Impact Assessment (EIA)

Article 4: Fundamentals of Requesting the EIA Approval

(1) Project owner will submit an application to the official department concerned inquiring about the classification of his project according to the form shown in Annex 4 together with supporting documents required by the Ministry of Environment. The official department will register the application and refer it to the Ministry of Environment, except what falls in the domain of the industrial licensing committees at the Ministry of Industry and health councils in the governorates where applicable rules are observed.

(2) The official department concerned will request a statement for the Ministry of Environment on the classification of its project or a project implemented on its behalf in accordance with the form shown in Annex 4 together with supports documents required by the Ministry of Environment.

Article 5: Project Classification

(1) Subject to paragraph 1 of Article 4, upon receiving the proposed project classification request as per the standard format and supporting documents, the Ministry of Environment shall verify whether the project falls in the domain of Annex 1 or Annex 2 or is located in an area listed in Annex 3, in addition to the likelihood of a significant impact on that area.

(2) The Ministry of Environment shall advise the competent official department and project owner of the classification decision <u>within 15 days</u> from the date of the registration of the classification request:

A. If the proposed project falls in the domain of Annex 1, it will be subjected to an "EIA" study according to information contained in Annex 8.

B. If the proposed project falls in the domain of Annex 2, it will be subjected to an "initial environmental examination" as per information contained in Annex 6.

C. If the proposed project is classified in the domain of item "B" of this paragraph and located in an area listed in Annex 3, or it may have a significant environmental impact on that area, the project will be subjected to an EIA study.

D. If the project does not fall in the domain of Annex 1 or Annex 2 but located in an area listed in Annex where it may have a significant environmental impact, it will be subjected to an 'initial environmental examination".

E. If the Ministry of Environment does not respond with the prescribed time limit, the project owner and the official department concerned may proceed with the completion of the project file in a way that does not contradict items (A), (B), (C), and (D) of this paragraph.

(3) Based on an informed review during the period mentioned above, the Minister of Environment may request an initial environmental report or an EIA report on the project regardless of its classification in accordance with paragraphs 1 and 2 of this article.

Article 6: Initial Environmental Examination

(1) If the proposed project requires an initial environmental examination, the project owner shall prepare and submit to the Ministry of Environment an initial environmental examination report on the project as per information contained in Annex 6. The Ministry will review and evaluate the report within 30 days from the date of receiving the report, and declare its position as follows:

A. Advising the project owner to prepare an EIA report if its evaluation of the initial environmental examination report demonstrates that the proposed project may significantly have a negative impact on the environment due to building, operating or decommissioning the project. If the project pertains to the private sector, the decision of the Ministry of Environment will be communicated to the official department concerned.

B. Advising the project owner that his project does not require an EIA study as its evaluation of the initial environmental examination report has shown that the project is not likely to have a significant negative impact on the environment, on the condition that he adheres to the mechanism of the environmental management plan in accordance with Article 11 of this decree. If the project pertains to the private sector, the decision of the Ministry of Environment will be communicated to the official department concerned.

C. Advising the project owner to correct some information or provide the missing data. The Ministry should declare its position regarding the submitted additional information within 30 days from the date of receiving such information.

D. If the Ministry of Environment does not respond within the time limit mentioned above, the project owner and the official department concerned may consider that the project does not require an EIA study, and they may proceed with the completion of the project file.

(2) The mechanism of the review mentioned in paragraph 2 of this article shall be determined by virtue of a decision of the Minister of environment.

(3) The official department concerned will issue a license of a private project base on the Ministry of Environment's decision regarding the initial environmental examination of the project according to paragraph1 of this article, except in cases referred to in item (D) of the same paragraph.

(4) Any official department will not embark on building or operating its proposed project before the Ministry of Environment declares its position regarding the initial environmental examination of the project in accordance with paragraph 1 of this article, except in cases defined in item (D) of the same paragraph.

Article 7: EIA Scoping

(1) If the proposed project requires an EIA study, the project owner shall, in coordination with the Ministry of Environment, identify the EIA scope of the project as per information contained in Annex 7.

(2) On advising the project owner that his project requires an EIA study, the Ministry of Environment will require that he informs the parties involved, identified by the Ministry based on the list contained in Annex 5 in coordination with the project owner. The stamp seal of the official departments concerned and the date of registration on a special document shall deemed to be a proof of informing these parties by the project owner.

(3) Once advised, the municipality (or the governor or commissioner in case there is no municipalities) where the project will be located, should immediately advertise the project to inform the public. The advertisement should be placed on a public bulletin board and at the location of the project for a period of 15 days. The advertisement should include information that the project requires an EIA study and seeking feedback from the public. The municipality will inform the Ministry of Environment of the commencement date of the advertisement. If the municipality is late in publishing the advertisement, the Ministry of Environment order placing adhesive advertisements by the mayor or other public officials.

(4) The Ministry of Environment will give the public a chance to provide feedback to the Ministry or the official department concerned within one month from the date of the advertisement publication. All remarks and feedback will be communicated to the project owner after being sorted out and evaluated during the review of the EIA report, and after the Ministry of Environment declares its position in accordance with Article 10 of the decree.

(5) The project owner shall submit to the Ministry of Environment a report pertaining to the EIA scoping of the project including attachments of the remarks communicated to him, all incoming comments, the original minutes of public dialogue meetings or the minutes of bilateral meetings with the parties involved.

(6) Within a period of 15 days from receiving the report of EIA scoping, the Ministry of Environment shall declare its position thereon and communicate it to the project owner. Its position will either be an approval of the report or approval pending specific modifications or requesting additional information. The Ministry shall declare its position regarding any submitted additional information within 15 days from the date of receiving such information.

(7) If the Ministry of Environment does not respond during the period mentioned above, project owner may consider that the EIA scoping report has been approved, and he undertakes to use it while preparing the EIA report.

(8) Upon the request of the project owner, the Ministry of Environment shall arrange for a meeting to discuss its remarks and decisions. The Ministry will invite any person or institution to attend the meeting, as appropriate.

(9) The EIA scoping report will be made available to the public and the parties concerned.

Article 8: Preparation of the EIA Report

(1) The project owner will be responsible for the application of the EIA scoping report. This shall include the preparation of the EIA report and submitting it to the Ministry of Environment according to information contained in Annex 8.

(2) The project owner is also responsible, according to the provisions of this decree, for handling any environmental impact not contained in the EIA scoping report but has been revealed during the phases of studying the project.

Article 9: Review of the EIA Report

(1) The Ministry of Environment shall review the EIA report and its conformity to the EIA scoping report approved within two months from the date of receiving the EIA report. If the EIA report does not conform to the approved EIA scoping report, and if the project owner does not conduct the additional studies referred to in paragraph 2 of Article 8, he will be requested to correct the information or provide the missing data and resubmit the report. The Ministry shall review the additional or corrected information within a period not exceeding two months from the date of receiving such information.

(2) If the Ministry of Environment does not respond with the time limit prescribed above, the project owner and the official department concerned may consider that the EIA report is approved, and they may proceed with the completion of the project file.

(3) The mechanism of the review, mentioned in paragraph 1 of this article, will be identified by virtue of a decision of the Minister of Environment.

Article 10: Position of the Ministry of Environment Regarding the EIA Report

(1) After reviewing the final copy of the EIA report, the Ministry of Environment will declare its position regarding the report, either with approval or conditional approval or rejection with explanation.

(2) The Ministry's position shall be communicated to project owner and the official department concerned if the project is pertaining to the private sector. Such position will be made available to the public and the parties involved, but this right does not include access to information relating to intellectual or industrial property or to any details of the finances of the project. The Ministry's position will also be communicated to the municipality concerned to be published on the public bulletin board for a period of 15 days.

(3) The official department concerned shall issue a license of the private project in light of the position of the Ministry of Environment regarding the EIA report, except cases identified in paragraph 2 of Article 9 of this decree.

(4) Any official department will not embark on building or operating its proposed project before the Ministry of Environment declares its position regarding the initial environmental examination of the project, except cases identified in paragraph 2 of Article 9 of this decree.

Article 11: Environmental Management of the Project, and Subsequent Monitoring for Project Commencement

(1) The project owner undertakes to observe the mechanism of "environmental management plan" during the building, operations, and decommissioning works.

(2) The Ministry of Environment will monitor the application of the mechanism of the environmental management plan of the project during the building, operations, and decommissioning works.

(3) The project owner shall be responsible, according to the provisions of this decree, for handling any environmental impact not contained in the EIA report, or mistakenly estimated, but has been revealed during the works of building, operating, and decommissioning.

Article 12: Information Publication

The public and the parties involved have the right to see the final EIA report or the initial environmental examination report and the relevant report of the Ministry of Environment, but this right does not include access to information relating to intellectual or industrial property or to any details of the finances of the project.

Article 13: Validity of the Report

The report issued by the Ministry of Environment on the EIA study and/or the initial environmental examination shall be valid for two years in case of the non commencement of the implementation of the project.

Upon the lapse of this period, the project owner has to advise the Ministry of Environment of his wish to follow through with the project. The Ministry will, then, verify if there are any new elements requiring a new EIA study or an initial environmental examination.

Article 14: Objections and Reviews

(1) The project owner, parties involved, stakeholders and the public have the right to submit written objections to positions of the Ministry of Environment specified in Article 10. These objections should be submitted within 15 days from the date of declaring the Ministry's position. The Ministry shall consider these objections within 15 days from the date they have been received. Objections submitted after

the period prescribed in the paragraph shall not be accepted. If the objectioner, within the period mentioned above, does not receive a response from the Ministry regarding the objections, this shall mean that these objections are not accepted by the Ministry.

(2) If any official department objects to the positions of the Ministry of Environment, stipulated in Articles 6, 7, 10, and 15 of this decree, such objections shall be presented to the Council of Ministers for decision.

Article 15: Contraventions and Penalties

(1) In case the project owner contravenes the provisions of this decree, he will be subjected to the provisions of Chapter 6 – especially article 58 – of Law No. 444 dated 8/8/ 2002 (Environment Protection).

(2) The application of the provisions of Chapter 6 of Law No. 444 dated 8/d/2002 (Environment Protection) shall not preclude requiring the project owner, in case of the non commencement of the implementation of the project, to prepare an EIA study or an initial environmental examination of the project, or oblige him, in case he has embarked on the implementation of the project, to prepare, at least, the **environmental management plan** of the project in accordance with the provisions of this decree.

Article 16: Cost of Reviewing the EIA Study and the Initial Environmental Examination

(1) In accordance with the provisions of Article 23 of Law No. 444 dated 8/8/2002 (Environment Protection), the project owner shall, on being advised of the classification of his project, pay fees amounting to LL 250000 for a project requiring an initial environmental examination and the sum of LL 500000 for a project requiring an environmental impact assessment.

(2) According to the provision of Article 23 of Law No. 444 dated 8/8/2002 (Environment Protection), the project owner whose private project requires an EIA study, shall deposit at the Ministry of Environment a guarantee representing an initial percentage of 0.05% of the value of the project according to the value he submitted in Annex 4, and this will take place on the commencement of identifying the EIA scoping of the project. This guaranteed will cover the cost of reviewing the EIA study if the Ministry of Environment needs the assistance of a specialized expert. The guarantee is refundable according to reimbursement conditions and by virtue of an explained decision of the Ministry of Environment.

(3) As regards projects submitted by official departments and requiring an EIA study, these departments undertake to observe, within the project budget, the coverage of the study review cost and the payments.

(4) Compensations of employees of the Ministry of Environment assigned to review the initial environmental examination reports and the EIA reports in accordance with Articles 6 and 9 of this decree shall commensurate with the overtime as per applicable regulations.

Chapter 3

Miscellaneous General Provisions

Article 17: Transitional Provisions

If public departments or institutions have prepared EIA studies which are approved by recognized international organizations or studies prepared by these recognized international organization, these studies shall be referred to the Ministry of Environment to declare its position thereon in accordance with Article 10 of this decree.

Article 18: Effective Date of the Decree

This Decree shall come into force on the date of its publication in the Official Gazette.

Issued by President of the Republic Baabda on ------

Prime Minister

Minister of Finance

Minister of Environment

Annex 1: Projects that duly require an EIA study

1. Irrigation and drainage:
    - Building dams, man-made lakes and pools/ponds
    - Irrigation projects for area exceeding 500 hectares
2. Drinking water:
    - Building dams, reservoirs, pools and man-made lakes
    - Water desalination plants
    - Integrated projects for drinking water supply
3. Wastewater:
    - Establishment of wastewater treatment plants
    - Drainage channels into the sea
    - Integrated projects for wastewater
4. Solid waste:
    - Establishing centers for the management, treatment, and discharge of the various sold waste
5. Agriculture and forestry:
    - Preparing land for farming, include leveling, clearing, reclaiming, and using chemicals in agricultural activity
    - Deforestation projects
6. Building roads, bridges, railway lines, and tunnels
7. Airports and harbors
8. Power generation and supply:
    - Power generating stations
    - Power transformation stations
9. Oil and gas:
    - Installation of pipelines on/off the beaches
    - Excavation and extraction of oil and gas
    - Oil refineries
    - Oil platforms
    - Oil tanks
10. Mines, sanders, stone mills, sand sucking
11. Building hospitals
12. Tourism and recreation projects
    - Establishing skiing centers
13. Land reclamation

14. River and sea public properties
15. Inland and marine fisheries
16. Zoo building
17. Factories:
    - Construction of industrial areas
    - Industries included in the table below:

ISIC	Description
D	Industry
15	Food industry (heading)
1511	Fresh and preserved meat. Including slaughterhouse
1512	Poultry meat – fresh and preserved, slaughterhouses
1571	Poultry fodder manufacture
1583	Sugar hot/cold
19	Leather industry:
1910	clean, dye, process, iron (and other works)
21	Paper industry (heading)
2111	Wood pulp
23	Petroleum and coal (heading)
2320	Petroleum refined products, refineries
24	Chemical industries (heading)
2411	Industrial gases capacity= more than 10 tons units/day Various gas factories
2414	Various organic chemicals
2415	Fertilizer and nitrogen compounds
2416	Raw plastic material

2420	Insecticides and other agricultural chemical products. See decrees on Agriculture
2430	Paints, varnishes, printing ink production
2461	Explosives (see Law of Ministry of the Interior for explosives)
26	Building material (heading)
2651	Soil blocks – industry
2652	Limestone – industry
2653	Gypsum
2680	Other mining products (non-metal) – not previously specified
27	Raw mineral industry (heading)
2710	Manufacture of iron, steel and metal mixture
2721	Cast iron pipes and accessories (working space = + 1000 M2)
2722	Steel pipes and accessories (working space= + 1000 M2)
2733	Non-alloy iron and steel products (working space = + 1000 M2)
2735	Iron and steel alloys (working space =+ 1000 M2)
2741	Precious metals (Capacity = - 1000 ton/year; and + 1000 ton/year)
2742	Aluminum casting
2743	Lead and zinc products
2744	Copper products (capacity = + 1000 ton/year)

2745	Other non ferrous metals (capacity= +1000 ton/year)
29	Manufacture of machinery (heading)
2960	Weapons and ammunition
31	Various machines and electrical equipment (heading)
3140	Compounds, batters of preliminary cells
34	Transport-related industry (heading)
3410	Car manufacturing
35	Transport (heading)
3511	Ships
37	Remanufacturing (heading)
3710	Remanufacture of paints
3720	Reuse of non-metal waste

Annex 2: Projects that duly require an initial environmental examination report

1. Irrigation and drainage:

- Irrigation projects if space exceed 100 hectares

2. Drinking water:

- Water treatment plants

3. Wastewater:

- Sanitary sewage networks

4. Agriculture and forestry:

- Reforestation projects

5. Road and transport:

- Building agricultural roads
- Multi-storey parking
- Terminals

6. Power generation and distribution:

- Distribution lines of electrical power(high voltages)

7. Oil and gas:

- Stations for distributing petroleum derivatives

8. Cars:

- Garages with car painting facility
- Car decommissioning
- Neglected car warehouses

9. Tourism and recreation projects:

- Any tourism and recreation project, including hotels, marine complexes, parks and protected areas

10. Housing projects:

- High towers (+15 storeys)
- Housing complexes

11. Farms (classified in the first and second categories)
12. Warehouses of hazardous material
13. Factories:

- Industries included in the table below:

ISIC	Description
D	Industry
15	Food industry (heading)
1511	Fresh and preserved meat (excluding poultry and slaughterhouses)
1512	Poultry meat – fresh and preserved excluding slaughterhouses
1513	Processing all kinds of meat products
1520	Fish products
1531	Processed potato
1532	Fruit and vegetable juice (decree No. 108/83)
1533	Processed and preserved vegetable and fruit – not previously specified, capacity = + 25000 ton/year)
1541	Raw oils and fats (vegetable, animal)
1542	Purified oils and fats (vegetable and animal)
1551	Milk derivatives (between one and 2.5 tons/day, capacity = + 2.5 ton/day)
1552	Ice cream and frozen products ready for consumption (between one and 2.5 tons/day, capacity = + 2.5 ton/day)
1561	Grain mill products (capacity = - 5 ton/hour/ + 5 ton/hour)
1562	Starch and starch products (capacity = - 5 ton/hour/ + 5 ton/hour)
1571	Processed fodder for poultry (vegetable, animal; mix)
1572	Processed food for domestic animals
1589	Other food products
1591	Distilled alcoholic drinks (capacity = + 10000 litres/year, bottled)
1592	Ethyl alcohol
1593	Alcoholic drinks (capacity = + 10000 litres/year, bottled)
1596	Beer
1598	Mineral water, non alcoholic beverages (see decree No. 108/83)
16	Tobacco products (heading)
1600	Tobacco products (cigarettes, not cigars)
17	Textile products (heading)
1710	Textile and threads, weaving and wool manufacture (power= engines of + 25 kilowatts) Use of chemicals and flammable material (whitening, dyeing, steam broiler)
1720	Textile cloth (sewing), (power= engines of + 25 kilowatts) Use of chemicals and flammable material (whitening or dyeing)
1730	Complementary textile services (whitening or dyeing), other services
1771	Socks and pantyhose (sewed or tight)- (power= engines of 25 kilowatts) Use of chemicals and flammable material (whitening, dyeing, steam broiler)
19	Leather industry (heading)
1930	Various shoes (not including leather manufacturing, (power= engines of +35 kilowatts) Manufacture of shoe accessories from plastics and chemical compounds
20	Furniture and wood industry (heading)
2010	Sawed or scrap wood (power =+ 100 kilowatts) Use of dissolvent material
2020	Compression wood or opposite wood logs or fiber etc (power= + 100 kilowatts) Use of dissolvent material
2030	Carpentry (installation and joining), (power= + 100 kilowatts)

2040	Wooden containers (power= + 100 kilowatts)
2051	Other wood products (power = + 100 kilowatts)
21	Paper industry (heading)
2112	Paper and cartoon paper (w/without use of chlorine material)
22	Publishing, printing and advertisement (heading)
2211	Books, printing, printing and dried in air and fire
24	Chemical industry (heading)
2412	Dyeing
2430	Paints, varnishes, other paints, printing ink A mix of paint and inc
2441	Basic medical products (see Decree 83/105)
2442	Pharmaceuticals (see Decree 83/105)
2451	Soap, detergents, polishing, sanitizers
2452	Perfume and ornaments
2462	Glue and gelatin (from raw animal materials and without them)
2464	Photography chemicals
2466	Other chemicals – not previously specified
25	Rubber and plastic (heading)
2511	Rubber tyres and pipes
2512	Remanufactures rubber tyres and pipes
2513	Other rubber products
2521	Plastic plates, pipes and plastic casting
2522	plastic products for packing
2523	Plastic clothing
2524	Other plastic material
26	Building material (heading)
2611	Surface glass (power= +100 kilowatts)
2612	Surface glass fabrication (power= + 100 kilowatts)
2613	Void glass (power= + 100 kilowatts)

2615	Fabricated glass of different kinds including technical glass equipment (power = + 100 kilowatts)
2621	Domestic appliances and ceramic tiles (power = + 100 kilowatts)
2622	Ceramic sanitary ware
2624	Artistic ceramic products
2626	Thermal ceramics
2630	Ceramic tiles and bottles
2640	Tile, stone, brick products made of dried mud
2661	Cement blocks (w/without compressors and cement vibrating equipment)
2662	Gypsum products
2663	Bricks for mixture (capacity = 50 ton/day)
2666	Other gypsum and cement brick products
2680	Other mining non-metal products (not previously specified – without asbestos)
2681	Sand scratchers
2682	Other mining non-metal products – not previously specified
27	Raw metal industry (heading)
2721	Pipes and accessories of cast iron (working space = + 500 m2; and a range between 500 and 1000 m2)
2722	Steel pipes and accessories (working space = + 500 m2; and a range between 500 and 1000 m2)
2731	Cold iron products (working space = + 1000 m2)
2732	Cold galvanized thin plates (working space = + 1000 m2)
2733	Non alloy iron and steel products (working space = +500 m2), (working space between 500 and 1000 m2)
2734	Metal rail (working space = 1000 m2)
2735	Iron alloys and iron/steel alloys (working space + 500 m2; and between 500 and 1000 m2)
2744	Brass products (capacity = + 1000 ton/year)

2745	Other non ferrous metal products (capacity = + 1000 ton/year)
2751	Iron casting services
2753	Light metal casting services
2754	Other no ferrous metal casting services
28	Metal and electrical technical products (heading)
2851	Metal painting treatment services (electrical – non electrical)
2873	Wire products w chemical insulators
2875	Other fabricated metal products – not previously specified
29	Machinery industry (machines) (heading)
2911	Engines and turbines (except aviation, cars, revolving engines)
2912	Pumps and compressors
2913	Valves and taps
2914	Carrier, machine tooth, pushing tools
2921	Burners and incinerators
2922	Lifting and handling equipment
2923	Non domestic cooling and ventilation equipment
2924	Tools and equipment for different uses – not previously specified
2931	Agricultural tractors
2932	Other machinery for agriculture and forestry
2940	Mechanical tools
2951	Tools for metal works
2952	Equipment for mining and building
2954	Machines for textile, clothing, and leather works
2956	Machines for various purposes – not previously specified
2971	Domestic electrical appliances (capacity = + 50 ton/year)
30	Computer and office equipment (heading)
3001	Production of office equipment
3002	Production of computers

31	Production of various electrical machines and equipment (heading)
3110	Electric engines, generators, transformers
3130	Wires and cables insulated
3150	Lighting bulbs and equipment
3161	Electrical equipment for engines and cars- not previously specified
3162	Various electrical equipment – not previously specified
32	Audio-visual equipment (video) and communication industry (heading)
3210	Valves, electronic pipes, other electronic elements
3230	Recording telecasters and related products
33	Medical and optical equipment (heading)
3310	Medical and surgical equipment
3340	Optical and photographic equipment
34	Transport- related industry (heading)
3420	Manufacture of wagons; seats for cars, trucks, and trailers
3430	Parts and accessories for cars and their engines (capacity= + 50 ton/year; capacity = + 50 ton/year)
35	Transport (heading)
3550	Other transportation means – not previously specified
36	Various tools and fitting industry (heading)
3615	Furniture (with sponge manufacture), (capacity = + 50 ton/year)
3622	Jewelry and related arts – not previously specified (capacity = + 50 ton/year)
3640	Sporting equipment and supplies Use of chemicals or flammable material
3650	Toys Use of chemicals or flammable material
3663	Other manufactured products – not previously specified

Annex 3: Environmentally Sensitive Areas

1. Areas classified, b virtue of laws or decrees, as specifically protected areas, or natural environment protected areas, or natural forests or wetlands or important areas of birds or public gardens or natural scenery sites or touristic and historic sites and/or archaeological locations or river banks or springs or holy places.
2. Areas that are home of endangered species (animal and plants).
3. Watersheds
4. Sea beaches, river waterways, and springs
5. Public land

Annex 4: EIA Classification Model

1. Name of he project
2. Project owner:
   - Name:
   - Address:

❑ Tel number: ❑ Fax:
❑ Email:

3. Type of the project:

❑Public
❑Private
❑

❑Agricultural :
❑Industrial (specify the ISIC number):
❑ Tourism (specify):
❑Services (specify):

❑Others:

4. Nature of the project:

❑New Project

❑Existing project or holder of a license or approved
- ❑ Modification
- ❑ Addition
- ❑ Expansion
- ❑ Rehabilitation
- ❑ Closure

5. Project Objectives:

6. Estimated cost of the project:

    - Construction
    - Preparations

7. Project time schedule

	commencement	End
Planning and designs	…………………………….……	……………………………………………
Construction		
operation		

8. Map showing project location – scale 1/20,000 (attached)

9. Other documents attached

Note: the Ministry of Environment may request other documents as per the nature of the project.

The EIA classification decision

(to be filled by the Ministry of Environment)

Annex 5: List of Potential Parties Involved

1. All ministries concerned.
2. Public institutions concerned, for example, Higher Council for Planning and Development; Investment development Authority of Lebanon; and the National Council for Scientific Research.
3. Municipal authorities, and the local department responsible for organization.
4. Local non-government environmental societies (duly established).
5. Affected individuals and groups.
6. Universities and research centers concerned.
7. Any society, trade-union or association interested in the project, e.g. the Association of Lebanese Industrialists

Annex 6: Statement of information required for the "initial environmental examination" report

The initial environmental examination report should include the following information (not necessarily in this order):

1. Executive summary.
2. Table of contents
3. Introduction: defining the project, the project owner, the person of office conducting the initial environmental examination, as well as a brief explanation of the type, size and location of the project.
4. Policy, legal and administrative frameworks: an investigation of the enforceable regulations, principles, and standards observed by the environment sector at the local and national levels, laws governing the sector under which the project is included. The information should address specifying the official department concerned, and its potential at the local and national levels.
5. Description of the proposed project: description of project components, the relevant maps according to the appropriate scale and photos, information of project location, comprehensive design, size, capacity, work program, services, the duration of operation, etc.
6. Description of the surrounding environment of the project: gathering and evaluation basic information of environmental characteristics of the study location (physical, chemical, biological, social and economic environment) taking into consideration any expected modifications before the commencement of the project or any likely changes in future.

7. Potential environmental impact of the project: identification, estimation, and assessment of all potential effects of the project on the environment (physical, chemical, biological, social and economic consequences) whether positive or negative, direct or indirect, over the short or long term.

8. Environmental management plan: this paragraph summarizes a group of impact mitigation measures, monitoring and control tools, and institutional procedures taken during building, operating, or decommissioning a project, with a view to eliminating or mitigating negative environmental effects to locally acceptable levels, if any, or to global standards. This paragraph should include the estimated cost of the environmental management plan.

9. Conclusion

10. Annexes:

- Summary of project documents.
- Tables and information statements
- List of scientific and non scientific references used
- List of the names of who prepared the initial environmental examination report (individuals and institutions).

Note: The Ministry of Environment has the right to modify items required in this annex in accordance with environmental essentials that are applicable to standards and role of the project. Special consideration is given to the application of article 12 “Information Publication”.

Annex 7: Statement of information required for the EIA scoping report

1. Introduction: This paragraph defines the objective of the EIA scoping report, the project under stud, in addition to explanation of the EIA executive measures.

2. Background information: This paragraph includes relevant information about potential parties conducting the EIA study, a synopsis of the basic content of the proposed project, a statement of the importance of the project, its objectives, the implementing office, and a summary of the history of the project, the alternatives and related projects. Reference will be made to any projects planned or currently implemented in the same area since they could be competing with the project under consideration in terms of resources.

3. Objectives: This paragraph identifies the EIA scope, and discusses its timing in view of the phases of preparing, designing and implementing the project.

4. EIA requirements: This paragraph sets forth any regulations and guidelines organizing the EIA implementation. It defines the content of the EIA scoping report.

5. Study area: This paragraph shows the boundaries of the area covered by the study for the purposes of environmental impact assessment. And if there is a neighboring or far away area that should be studied in terms of the potential consequences of implementing or managing this project, such area should be included in the EIA scoping report.

6. Scope of work: In some cases, knowing clearly the tasks of the project owner facilitates defining them full in the EIA scoping report. However, in other cases, there is a need to carry out specialized field studies or forming models in order to asses the consequences of the proposed project, and at that point, the project owner is required to define these certain tasks in detail. The scope of work include the following points:

6.1 Policy, legal and administrative frameworks: an investigation of the enforceable regulations, principles, and standards observed by the environment sector at the local and national levels (the study sets forth the known considerations, and the project owner is requested to verify the existence of any other considerations), laws governing the sector under which the project is included. The information should address specifying the official department concerned, and its potential at the local and national levels.

6.2 Assistance in coordinating among official departments and public participation: Assistance in cording the study with official departments, seeking feedback of local NGOs and groups affected by the project, and keeping the minutes of meetings, other activities, communications, comments and how to act regarding them (The EIA scoping report identifies the types of activities such as the meeting on work scoping attended by stakeholders, briefing sessions at the environment sector for project employees, supporting consultants of the environment sector, public seminars etc)>

6.3 Description of the proposed project: Description of project components, the relevant maps according to the appropriate scale and photos, information of project location, comprehensive design, size, capacity, work program, services, the duration of operation, etc.

6.4 Description of the surrounding environment of the project: gathering and evaluation basic information of environmental characteristics of the study location (physical, chemical, biological, social and economic environment) taking into consideration any expected modifications before the commencement of the project or any likely changes in future.

6.5 Potential environmental impact of the project: It should be distinguished between positive and negative effect, direct and indirect impact, short term and long term impact. Permanent unavoidable consequences should be identified, as well as defining universal and cross border effects. Project owner should describe estimation means and techniques used in assessing the impact of the project on the environment. The scope and quality of available information will be determined, together with an explanation of significant information gaps and uncertainties regarding the assessment of the potential impact of the proposed project. It is advisable to review the conditions of some planned studies in order to obtain the missing information. This paragraph should list the possible mitigation measures per each impact and recommend the most effective and low cost measures.

6.6 Analysis of project alternatives: preliminary description of alternatives studied during the preparation of the proposed project and listing other alternatives that can achieve the same objectives. The concept of these alternatives generally include the selection of project site, its designs and technology, construction methods and the stages, and the operation and maintenance procedures. A preliminary comparison will be made among these alternatives in terms of potential environmental effects, their costs relative to the capital and operation, adequacy of local conditions, institutional requirements, training needs, and monitoring and control requirements. It should, as much as possible, identify the preliminary cost and profits of all alternatives, as well as the estimated cost of mitigation measure. The alternation regarding the no implementation of the project should also be included to clarify environmental conditions “AS IS” without the project.

6.7 Environmental management plan:

- Mitigation measures for negative impact
- Monitoring and control plan
- Institutional capacity development plan to implement recommendations contained in the EIA report.

The project owner should prepare a detailed environmental management plan including mitigation measures for all negative consequences, monitoring and control program, the needs of workers and institutions to apply these measures. The cost of this plan should also be identified, including compensations for those affected by impact that will not be mitigated.

7. The Report: The EIA report should be brief addressing only major environmental issues. The body text should focus on investigation results, the conclusion, practical recommendations supported by summaries of the gathered information, and any approved references to explain and interpret such information. The detailed or unclear information is not appropriate in the body text, and should be presented in the annexes or in a separate document. The same thing applies to unpublished documents used in the EIA study and they should be grouped in an annex.

The EIA report must include the following:

- Executive summary
- Table of contents
- Introduction
- Policy, legal and administrative frameworks
- Public participation
- Description of the proposed project
- Description of the surrounding environment of the project
- Potential environmental impact of the project
- Analysis of project alternatives
- Environmental management plan
- Conclusion
- Annexes – minutes of public participation sessions
- Summary of project documents
- Tables and information statements
- List of relevant reports
- List of scientific and non scientific references used
- List of the names of who prepared the EIA report (individuals and institutions)

Note: The Ministry of Environment has the right to modify items required in this annex in accordance with environmental essentials that are applicable to standards and role of the project. Special consideration is given to the application of article 12 "Information Publication".

Annex 8: Statement of information required in the EIA report

The EIA report should include the following information (not necessarily in this order):

1. Executive summary.
2. Table of contents
3. Introduction
    - Objective and rationale of the project:

- Definition of the project and the project owner
- Brief description of the type, size and location of the project
- Importance of the project to the country

    - The EIA scoping, which include the person or the agency that prepared the study

4. Policy, legal and administrative frameworks:
    - Official department concerned, its capabilities at local and national levels
    - Environmental legislation, other regulations related to the environment, the policy observed in the country
    - Environmental requirements for any of the parties participating in financing the project
    - Applicable Environmental agreements or treaties the country have joined
5. Public participation:

- Official agencies
- NGOs
- Groups affected by the project

6. Description of the proposed project:

- Type of the project
- Location of the project: maps showing the project site and its impace
- Size of the project, including the related activities
- Proposed program for construction and operation

7. Description of the surrounding environment of the project:

7.1 Physical and chemical environment:

- Topographical and geological aspects, and the impact of earthquakes and other hazards
- Study of surface and underground water
- Measuring sea and coasts
- Available means of discharging polluted water, and the quality of water
- Surround air quality, sources of air pollution
- Climate and weather service
- Noise

7.2 Biological environment:

  - Vegetation and animal life
  - Fish and water living creatures
  - Rare or endangered species
  - Sensitive areas (forests, protected areas, natural parks,etc)

7.3 Socio-economic environment:

  - Demographics (population, social fabric, employment, income distribution, customs and traditions, people expectations etc)
  - Development activities (infrastructure, industry, agriculture, institutions, tourism, recreation etc)
  - Land use
  - Traffic
  - Public health
  - Historic and archaeological heritage
  - Aesthetic values
  - Culture and civilization values (customs and tradition,aspirations)

8. Potential environmental impact of the project:

8.1 Physical and chemical environments

8.2 Biological environment

8.3 Social and economic environment

9. Preliminary analysis of project alternatives:

- Non establishment of the project
- Alternative projects with same objectives
- Same project with different technologies
- Comparing various environmental and economic potentials

10. Environmental management plan:

a. Negative impact mitigation program:

  - Summary of significant environmental consequences
  - Technical detail of each mitigation measure (applicable to which impact, the conditions of their application, designs, detailed fittings and operational procedures)
  - Potential environmental effects of these measures
  - Linkage between these measures and other mitigation programs
  - Cost of negative impact mitigation program

b. Monitoring and control program:

- Specific technical detail of control means (control standards, control techniques, periodicity of the required control, control location, measurement procedures, keeping and analyzing information, and emergency measures)
- Reporting and report submission
- Detailed budget, acquisition program and the required supplies
- Cost of monitoring and control program

c. Institutional capacity development program:

- Detailed description of institutional procedures required for the above environmental measures (responsibility for implementing mitigation measures and control/follow up procedures etc).
- Technical assistance programs
- Acquisitions and supplies
- Organizational changes
- Cost of institutional capacity development program

11. Conclusion:

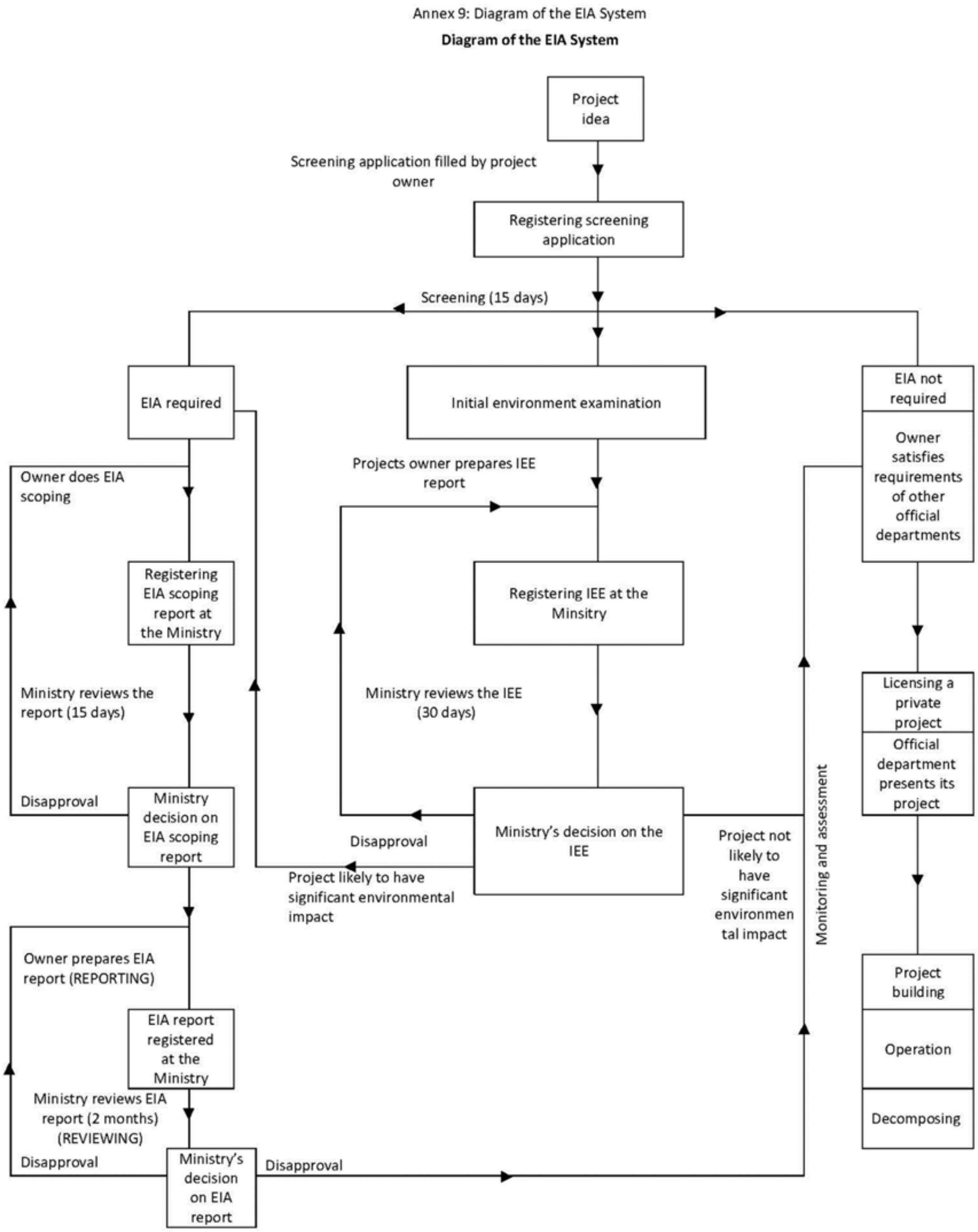
- Net profit justifying the establishment of the project
- Explanation of how to mitigate negative impact
- Prior preparations for following up control and supervision

12. Annexes:

- Minutes of public participation
- Summary of project-related documents
- Tables and information statements
- List of related reports
- List of scientific and non scientific references used
- List of the names of who prepared the EIA report (individuals and agencies)

Note: The Ministry of Environment has the right to modify items required in this annex in accordance with environmental essentials that are applicable to standards and role of the project. Special consideration is given to the application of article 12 “Information Publication”.

Annex 9: Diagram of the EIA System



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Annex 8: Statement of information required for the EIA report.

Annex 9: Diagram of the EIA system.

APPENDIX C

GEOLOGICAL AND GEOTECHNICAL REVIEW REPORT

APPENDIX C GEOLOGICAL AND GEOTECHNICAL REVIEW REPORT

Geotechnical Review Report for Bisri Dam

Table of Content

Table of Figures

Technical Overview of Bisri Dam

The referenced documents relating to this technical review include the following:

1- Design of Bisri Dam: Updated Feasibility Report. Dar Al-Handasah (Nazih Taleb and Partners) for CDR. January 2011 (R1).
2- Bisri Dam Project Feasibility Study. ECI and Dar Al-Handsah (Nazih Taleb and Partners) for CDR, April 1995. 3 volumes - Main Report, Appendices A-D, and Appendix E (R2).

In the following, a description of the findings of these reports is stated, followed by relevant comments.

A. Previous ground investigations and shortcomings

1. Prefeasibility studies and field investigation were performed by the USBR in the 1954, 1974.
2. Another study with accompanying subsurface investigations was performed by ONL during the period between 1974 and 1978.
3. In early 1980's and middle 1990's, Dar Al Handasah Nazih Taleb-ECI (ECIDAH), performed feasibility studies and investigations for the Bisri Dam Project. The 2011 feasibility study is an updated version of the 1995 study.
4. The engineering properties of the valley floor deposits, as summarized from the reported previous studies and investigations are summarized as follows (R2):
    a. The surficial alluvial soils are 2-3m thick normally, but may reach about 30m depth under the active river channel. They have the following characteristics:
        - The relative densities of the upper alluvial sediments -sand, gravels and cobble deposits ranged between 25 to 75%.
        - The fine grained soils fine sands and silty sand) have relative densities ranging between 25 to 70%, with the majority less than 40%.
    b. The investigation results showed that the clayey soils at depth lack the required strength to support the embankment loads, and need to be treated. Consolidation could be enhanced by wick drain installation, and stabilizing berms would account for better safety factors.
    c. The lacustrine clay deposits underlying the surficial sediments were tested and their properties summarized in the following extract:

Property	USBR 1952-1954 Study Low(s)	Range or Average	High(s)	ONL 1975-1978 Study Low(s)	Range or Average	High(s)	ECIDAH 1982-1984 Study Low(s)	Range or Average	High(s)
LL	-	66 57 - 68	74	36, 45	47 - 60.5 53.5	-		40.5 - 58.3 52.2	61.4
PI	26, 29	36 32 - 39	43	14	23 - 35 29.5	38	13.1	18.2 - 30.5 25.7	32.5
wn (%)	27.7	36.6 31.6 - 40.6	42, 42.1	24, 26, 27.5	34.2 - 46.2 41.0	47.5, 48.2, 49.3	-	30.7 - 43.0 37.3	-
LI	-	0.12 - 0.42	-	0.08, 0.17	0.30 - 0.84	0.9, 0.99	0.15, 0.19, 0.21, 0.25	0.28 - 0.55	0.76, 0.79, 1.1
Sand (%)	-	0 - 10	-	-	0 - 5	-	-	0 - 6	-
Silt (%)	-	56 - 70	-	-	42 - 65	-	-	43 - 65	-
Clay (%)	-	30 - 44	-	20, 20, 23	28 - 50	54, 59	12, 22, 25	35 - 55	-
γ d	-	1.237 - 1.440	-	-	1.150 - 1.500	-	-	1.200 - 1.392	-
γ m	-	1.730 - 1.920	-	-	1.675 - 1.890	-	-	1.760 - 1.900	-
Su	-	0.6 - 1.70	-	-	-	-	-	-	-
c(UU)	-	-		0.04	0.1 - 1.0 (15 Tests)	2.4		0.7 (1 Test)	-
ϕ (CD)	-	-			25° - 31.5° (4 Tests)				
Consolidation					(21 Tests)			(5 Tests)	
Cc					0.17 - 0.40			0.325 - 0.44	
Cr								0.025 - 0.09	
Pp (t/m^2)								100 - 145	
O.C.R.								2 - 4.5	

ECI
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DAR AL HANDASAH NAZIH TALEB & PARTNERS

BISRI DAM
FEASIBILITY STUDY
LABORATORY TEST RESULTS
SUMMARY

FIGURE 5-5

ACCURVE SPW / KAS
3/06/95

C1-Comments:

1- *The joint line surveys were missing from the reported geological study done. Given the nature of the formations, and the structural setting of the area under investigation, a detailed reporting of the joints and fractures is required for a better understanding of the local geology.*
2- *Geophysical surveys by seismic refraction are required to identify the variation in bedrock surface under the river bed at the dam location.*
3- *One noticeable comment is the undifferentiated reporting of the Jurassic succession in (R2), knowing the variable nature of the different (rock) formations making up this Upper Jurassic sequence.*

B. Catchment geology

The project watershed area covers around 215 km^2, mostly draining the western slope of the Jabal el Barouk and Jabal Niha Mountains which rise to elevations higher than 1900 m asl.

The stratigraphy of the catchment basin covers the geologic succession from the Middle Jurassic rocks to the recent Quaternary Deposits.

Upstream from the reservoir, on the western flank of Mount Lebanon, the Bisri River is incised into sedimentary rocks of the Cretaceous and Jurassic sequences. The Cenomanian Sannine Limestone Formation (C4) has a widespread extent and consists of well stratified, fractured, karstic, interbedded limestones, dolomites, and marls. In the canyons and escarpments, the calcareous rocks and argillaceous and marly sandstones of the Lower Cretaceous (Aptien Formation-C2b &C2a) are exposed. The cliff-forming rocks of the Mdairej Formation (C2b) are karstic, while the underlying Abeih Formation (C2a) is mostly clastic and made up of sandstone and alternating marls and grades upwards into limestones. The highest part of the catchment area is underlain by Jurassic dolomite and limestone rocks with volcanic horizons, chert nodules, and interbedded basalts.

From the higher elevations of the drainage basin, the river slopes steeply to the alluvial valley which will constitute the reservoir of the proposed dam. The valley floor occurs at an elevation of about400m asl.

C. Dam site and reservoir geology

The proposed dam will stretch more than 700 meters across the valley and stand about 70 meters above river level. The Nahr Bisri follows a sinuous course meandering with a sandy bed, cutting through old floodplain and terrace deposits. The present floodplain and active river deposits have a maximum thickness of 30 meters in the main channel section. These deposits overlie up to 90 meters of lake deposits which formed as a result of the large landslide at Anane (about three kilometers downstream from the axis).

The outcrops at the site area include geologic formations extending from Jurassic to Quaternary (see attachments 1&2). The left abutment is essentially comprised of the Chouf Sandstone Formation (C1; see Figure 1). This formation is varicolored sandstone, generally fine grained, and friable. Sometimes it contains ferruginous zones, lignite, and pyrite in addition to thin argillaceous and clay-marl lenses.

Figure 1: The sandstone strata of the Chouf Sandstone Formation (C1) exposed along the cut face of a quarry on the left bank of the Bisri River and proposed dam reservoir.

During a previous investigation (1982), two adits were excavated for distances 210 and 215 meters into the C1 formation. Both adits encountered rather friable rock with some more sound zones with much evidence of past sliding events. The adits also indicated that close to the dam axis, the depth of slide is less than 10m. At other locations in the reservoir, large scale slides were also reported.

The J6-J7 formation (undifferentiated on geologic map) is represented by beige limestone which is hard, locally karstic, sometimes fractured, sandy, and rarely dolomitic. The J5 is a sandy, dolomitic hard limestone with some chalcopyrite. It is moderately karstic, contains some chert and ranges in color from chocolate brown to olive. Overlying the reported Roum Fault contact are the 90 m-thick succession of old alluvium, lake, and river deposits.

On the right abutment side of the main river fault, the succession follows younger formations (see attachment 3). The Lower Aptien Abeih Formation (C2a) comprises limestone and marl containing pisolites. This formation is sandy, multicolored but generally grayish white. It is fine grained, friable at places, contains some lignite, some oolites and a few orbitulinas. It also contains some argillaceous layers.

Overlying the C2a is the Upper Aptien Mdairej (C2b) which is beige to slightly reddish limestone. This formation is karstic. Above the C2b lies the Albien Hammana Formation (C3) which forms the upper part of the right abutment. This formation is a combination of beige limestone, brown marly limestone, and sandy limestone. It is moderately soft rock and is highly fractured. In addition, the lower part of the Sannine Formation (C4) covers a part of the hillside on the right abutment. This formation consists of beige, karstic, sometimes dolomitic, fractured, and well bedded strata (see Figure 2).

Figure 2: Photo of the right bank of the Bisri River where the Lower Cretaceous sequences are exposed. The limestone strata occupy the top of the hillside. The agricultural terrains in the foreground are underlain by the Quaternary river and lake deposits. Photo taken facing eastwards.

The stratigraphy in the reservoir consists mainly of Lower Cretaceous Chouf Sandstone Formation (C1) which is friable sandstone with marl and argillaceous interbeds and some lignite layers. Close to the dam site, a sequence of interbedded limestones and marls of the Albien (C3), Upper Aptien (C2b) and Lower Aptien (C2a) extends from dam axis upstream for about 1.7 km on the right abutment side. The right wall of the reservoir also contains certain slide areas in the Chouf Sandstone Formation.

The left side of the reservoir is essentially composed of the Chouf Sandstone Formation except for a limited exposure of the Mdairej Formation (C2b) along the Ouadi Bhannine. Localized landslides can be seen in the Chouf Sandstone Formation along the left reservoir side.

The river and lake deposits of the Quaternary unconformably overlie the Jurassic and Cretaceous outcrops. The upper river deposits consist of a mixture of sand, silt, gravel, and cobbles. Very little clay was found. In contrast, the underlying lake deposits are nearly all highly plastic clayey silts or silty clays. The lake deposits are often interstratified with sandy lenses or zones of different thicknesses.

The geologic structure at the dam site includes a combination of faulting, folding and slides. The faults appear to be high angle to vertical normal faults that essentially trend nearly north-south and nearly east-west. The boreholes drilled indicated the occurrence of a number of minor faults.

Two major faults intersect the area of the dam, and pass at close proximity of the dam axis. The first one is the Roum Fault, trending northwards, enters into the Nahr Bisri valley about 1.5 km southwest of Dam Axis. The second major fault (the Qalaat el Hambra Fault) strikes east-west on the right abutment side and trends across the river towards the left abutment upstream of the dam axis. The major landslide (downstream along the right bank) is believed to have occurred along this fault. Jointing, fracturing and fissuring are also encountered in the different formations exposed.

Borings along the dam axis, going from the left towards the right abutment, encountered a succession of older beds of the Jurassic formations (J7- J6) abruptly superposed against the Lower Cretaceous Abeih Formation (C2a). The Jurassic succession must have been uplifted by a major fault which has caused this considerable displacement of both Jurassic and Cretaceous formations. The report interprets this fault to be the Roum Fault (see attachment 3).

C2-Comments:

1- *The reports (R1 &R2) acknowledge the complex geologic setting of the proposed dam. In addition, the karstic nature of the exposed limestone formations is also indicated. In this respect, the right abutment of the dam, in addition to the right bank of the river represent substantial leakage potential, especially that fracturing and jointing characterize the outcropping limestone strata.*
2- *Given that the rockmass is fractured and fissured, and the exposed rocks at the left abutment are detrital and granular, the continuous erosive action of water, coupled with the structural setting will definitely make the rocks exposed at the dam site, and the reservoir susceptible to erosion. The presence of several landslides at the right and left banks of the river inside the reservoir area, in*

addition to the eboulis and sedimentary deposits along the course of the Bisri River course, require a detailed evaluation of these features and their effect on the water body of the reservoir.

3- *Karstic formations and karsts in general offer unique conditions resulting in uncertainties. The karstic nature of the terrain should be carefully studied and evaluated in relation to the tectonic setting of the reservoir and its water-tightness.*

D. Fault activity and seismic risk

The major structural and tectonic considerations reported in the reviewed documents are as follows:

1. The major structures affecting the dam site in this tectonic unit are the Roum Fault (flexure) and the Yammouneh Fault.

2. The closest surface trace of the Roum Fault to the Bisri dam site is located about 2 km southwest of the dam site. However, it appears that the fault continues within the Bisri River Valley (covered by alluvial deposits) to the vicinity of proposed dam axis.

3. The closest trace of Yammouneh Fault is approximately 10 km east of the site.

4. The Anti-Lebanon Range located about 25 km east of the Bisri dam site. The major faults of this tectonic unit are the Rachaya and the Serghaya Faults.

5. The Rachaya Fault is located 28 km east of the Bisri dam site.

6. The Serghaya Fault is located 40 km east of the Bisri dam site.

7. There are two notable earthquakes with magnitude 8.3 recorded in 1201 and 1759. Both earthquakes centers lies within a circle of 75 km from the site and both resulted in considerable casualties and a tsunami event.

8. On March 16 1956, a magnitude 6.0 earthquake occurred 4 km east of the proposed dam Axis causing 136 deaths and destroying 6000 houses. This event possibly occurred along the Roum Fault.

9. Most of the faults within the project area are considered to be active. Accordingly, the reported seismic design criteria is summarized in the following table:

Criteria	**Source**	
	Roum	**Yammouneh**
Length, km	50	600-1000
Distance from dam site (km)	2	10
MCE Magnitude	7.3	8.5
Bracketed Duration (sec)	20	45
Peak Ground Accelerations at Dam site		
Horizontal	0.70g	0.55g
Vertical	0.47g	0.37g

<u>C3-Comments</u>:

1- *The widespread extent of faulting and fracturing causes the development of secondary discontinuities in rocks that further dislocate and decrease their structural integrity. The permeability of the rockmass is thus increased and the potential of leakage from the water reservoir is enhanced.*
2- *The reports (R1&R2) acknowledge the seismic nature and activity of the area under study and neighboring areas (regional scale). However, no dedicated Seismotectonic study was done for the Bisri Dam.*
3- *A major risk is stated in the report (R2) whereby the Roum Fault and/or other associated faults pass under the dam axes. Roum Fault is a highly active fault and the source of earthquakes. For that purpose, a detailed field campaign in addition to a Seismotectonic study is mandatory. The occurrence of such a fault under the dam axis, if proven, places a severe constraint on the dam feasibility and a high risk on downstream developments in case of dam rupture.*
4- *The reservoir area as observed during our site visit is characterized by block tectonics rendering the prediction of the hydrogeological regime under water load very complex and with high degree of uncertainty (see Figure 3).*

Figure 3: View form the dam axis looking downstream (facing WSW). The area is characterized by the movement of tectonic blocks to accommodate prevailing structural elements such as faults.

E. Dam type, location and stability

1. The Bisri Dam Project is located on the Bisri River, approximately 17 km inland from the sea and 30 km southeast of Beirut.
2. The Bisri dam site is situated in a wide valley with moderately sloping abutment walls.
3. The reservoir for the proposed Bisri Dam extends about 4 km upstream of the adopted dam axis on the Bisri River and then branches out along both the Nahr Barouk towards the north and the Ouadi Bhannine towards the south.
4. The Dam Characteristics are reported as follows:
    a. Type of Dam is a zoned earth embankment dam with an RCC section as the spillway.
    b. Maximum Dam Height: 74 meters.
    c. Streambed Elevation: 395m.
    d. Dam Crest Elevation: 469m.

   e. Spillway Elevation: 461m.
   f. Dam Crest Length: 790 meters (RCC section 70meters long)
   g. Crest width: 10 meters.
   h. Upstream and downstream dam slopes are 2.5H: 1V.
   i. Freeboard: 8 meters.
   j. Storage Volume: 128 Mm3.
   k. Dead Volume: 8 Mm3.

5. At the proposed dam location, the Bisri River is actively cutting through floodplain and terrace deposits. The following was reported regarding the riverine deposits:
   a. The present floodplain and active river deposits have a maximum thickness of 30 meters in the main channel section.
   b. These deposits are composed of silt, sand, gravel and cobbles. They overlie up to 90 meters of lake deposits which are generally highly plastic clayey soils with occasional sandy lenses of variable thicknesses.
6. The earth embankment comprises seven zones and has the following reported characteristics:
   a. The shell and transition zones are provided on the upstream side of the dam and are followed by a core sloping upstream from the center of the dam.
   b. The filter and chimney drain with transition and shell zones are located directly downstream of the core.
   c. The upstream face of the embankment will be covered entirely with riprap as a slope protection measure. The average thickness of the riprap is around 1m.
   d. The interface with the RCC section will be constructed by continuing the upstream shell and transition zones of the embankment across the upstream face of the RCC. A slope of 0.25H:1V was adopted for the interface wall.
   e. The loading conditions, minimum factors of safety, and the results are summarized in the following table:

Stability Analyses Cases and Results

Loading Condition	Foundation Clay		Factors of Safety		Remarks
	f	r_u	Minimum Required	Actual	
End of Construction	20°	0.5	1.3	1.3	Upstream and downstream
Steady State Seepage	20°	0.5	1.5	2.2	Upstream only
Rapid Drawdown	20°	-	1.2	1.6	Upstream only

f= angle of friction; $\mathbf{r_u}$= pore pressure ratio

f. The materials properties for the reported stability analyses undertaken at the feasibility level are summarized in the following:

Zone	Angle of Friction ø	Cohesion kg/cm2	Moist Density (t/m3)
Shell	42°	0	2.14
Transition	38°	0	2.1
Filter/Drain	37°	0	2.18
Core	0 and 20°*	0 and 0.7*	1.67
Foundation Alluvium	35°	0	1.9
Foundation Clay	20°	0.7 and 1.4*	1.75

* Post consolidation strength resulting from embankment construction

7. Stability considerations for the design of the proposed dam include the following:
   a. Potential liquefaction of dam foundation soils. For that purpose, 60 samples were tested, and the results indicate that the clays do not appear to be liquefiable. (To be verified during upcoming investigations)
   Moreover, the granular bed-load deposits have been evaluated as prone to potential liquefaction. Proposed possible remedial measures include removal or in-situ densification to provide stability/safety during a seismic event.
   b. Fault rupture/movement under foundations: The report predicted a possibility of 3m vertical movement. A horizontal slippage of equal amount should be considered also for safety purposes.
   c. The deformation of the embankments: The estimated maximum amount of settlement for the Bisri Dam crest (by using an empirical relationship between settlement, earthquake magnitude, and peak ground acceleration, during a MCE event occurring at the Roum or Yammouneh Faults) will be in the order of 5m. The feasibility report adopts a settlement of 6m.
   d. Potential cracking: The report refers for the left abutment area in this respect. More specifically, a transverse crack is expected to develop where the surface of the rock foundation changes from gentler to steeper slopes.
8. The reported foundation design considerations are summarized as follows:

a. Wick drains and stabilizing berms (at upstream and downstream embankment toe areas) to achieve adequate clay drainage and strength beneath and beyond the embankment section for end of construction stability. Surcharge and stability berms will be constructed for that purpose.
b. Densification of the surface alluvial deposits through vibro-compaction.
c. In the abutment areas, and where the embankment is placed on rock, the foundation rockmass should be fresh to slightly weathered rock.
d. The foundation for the core will be excavated to controlled slopes in both the longitudinal and transverse directions. Slopes in the downstream direction will be limited to 1.5H: 1 V.
e. Beneath the core in the rock abutment zones, all open cracks or joints will be scaled using slush grout or shotcrete.
f. The core material of the right abutment will be constructed above a reinforced concrete slab anchored to the (limestone) bedrock. This slab will serve as the concrete grout cap for consolidation grouting.
g. Beneath the shells, areas of erodible rock will be covered by suitable filters and drains.
h. Monitoring of the dam site will be ensured by the following instrumentations/ measurements (during and after construction):
   i. Piezometers
   ii. Settlements
   iii. Inclinometers
   iv. Movement monitors (survey monuments)
   v. Seismographs
   vi. Seepage (when feasible)
i. The embankment drainage will be done through a combination of chimney drain and a blanket drain. The RCC section will include a vertical drain drilled down into the rockmass foundation.

9. Dam site Water-tightness and seepage considerations. The foundation conditions along the proposed dam axis are reported to have significant variations in permeability and leakage conditions, mainly resulting from the prevailing geologic conditions (lithology and structures). The following considerations were reported:
   a. The left abutment sandstone layers exhibit high permeability intervals within the rockmass. Of importance also is the eventual saturation and weakening of the sandstone rocks along fractures resulting in erosion and potential material losses.
   b. The lacustrine clays occur with intercalations of sandy and silty layers that might reach a thickness of 3m. These clays have been scoured and incised by

the coarser granular alluvial deposits of the river channel (which are considered to be permeable). Permeability reported for the intercalations ranged between 10^{-4} cm/s for the slightly clay sand horizons, to 10^{-5}cm/s for the layered silt and silty clay intercalations. The consolidation tests carried on the lacustrine clay samples resulted in an average value of 10^{-8}cm/s.

c. The deep lacustrine clays are underlain by a stratum of old alluvium and rock debris (possible colluvium). These deposits range between 2 to 15m (as evidenced from borehole logs). This stratum yielded variable permeability results ranging from as low as 2-4 LU to as high as 425 LU.

d. The boreholes drilled along the right abutment resulted in the total loss of drilling water. It is to be noted that karstic limestones strata extend to 1.7km upstream into the reservoir along the right abutment.

e. The proposed seepage control measures include:

   i. A plastic concrete slurry wall is recommended for the left abutment. The slurry wall would fully penetrate the sandstone formation and embed into the underlying limestone formation.

   ii. The seepage control along the RCC spillway section would encompass a 3-line curtain with one line grouted from outside the RCC section (at the RCC upstream face) while the other two lines will be grouted from within a gallery running parallel to the upstream face and accessible via a vertical shaft or an access parallel to the diversion conduit.

   iii. The valley fill deposits might cause severe leakage losses, especially along the deeper old alluvium and rock debris. For that purpose a deep cut off wall is adopted. This cutoff will consist of a slurry trench with plastic concrete backfill embedded 5 m into rock.

   iv. The right abutment will be treated by grouting. The clay core of the embankment will be established over a concrete grout cap anchored into the limestone bedrock. Consolidation grouting will be performed down to a depth of 8 meters under the full extent of the grout cap and a three-line curtain will be installed to a depth of 50 m. A clay blanket will be established from the embankment core beneath and to 5 m beyond the upstream embankment section. The blanket will extend from elevation 460m on the right abutment down to about elevation 415m (about 45m deep) and will be anchored into the relatively impermeable upper terrace lacustrine deposits.

f. Additional seepage control measures will be required along the exposed face of the limestone formation overlying the Mdairej Formation cliffs. These measures include a synthetic geo-membrane pinned to the exposed rock surface. The full extent of the synthetic liner will be confirmed during the final design studies.

g. Since the left bank of the reservoir is mostly made up of sandy rocks and intersected by a series of faults, the rockmass is weakened and potential rockmass sliding may be expected. Moreover, steeply sloping surfaces may require additional stability measures.

C4-Comments:

1- For the purpose of preventing the separation of the clay core from the RCC abutment under seismic loading, the detail of the joint between RCC and clay core should be carefully studied. Should there be a risk of breaching, then the clay core must be continuous along the complete length of the dam, and the spillway should be constructed as a separate structure.

2- The alluvial clay deposits must be treated by vertical drains or stone columns during construction in order to allow for dissipation of pore water pressure caused by the dam load and for the major part of settlement to occur during the period of construction.

3- The clay core should be constructed of plastic clay such that it can sustain deformation without the risk of cracking under the effect of vertical differential settlement.

4- The clay core should be wide enough such that it maintains its integrity under the effect of seismic loading or fault movement, if the latter is of tolerable magnitude.

5- The cost of treatment of the foundation of the dam should be carefully evaluated in subsequent phases of study considering the various geotechnical issues commented above.

6- The grouting of the bedded limestone on the right abutment cannot eliminate the water leakage through it especially that the limestone is dipping steeply into the abutment. On the other hand the construction of a liner such as a geo-membrane over the limestone has a main disadvantage: leakage will occur through the limestone strata under the level of the river bed. Also, from our experience, a clay liner would be at the risk of failure by piping erosion.

7- The study of the dam requires a detailed risk identification and assessment in order to decide how the dam design can further proceed.

8- Consideration should be given to relocating the dam axis further upstream, beyond the karstic limestone encountered on the right abutment.

F. Spillway type and location

1. The spillway, including the crest structure, will be constructed as an RCC section integrated along the left side of the zoned-earth embankment (see attachment 4). The crest will be an ungated 65m long concrete dam with crest invert at Elevation 456m.
2. The RCC will be located on sound rock and constructed at the same time as the embankment. Given the large concrete mass and shape, the RCC section is essentially considered stable.
3. The spillway consists of an ungated crest structure with a sloping, stepped, discharge channel with energy dissipation by means of a stilling basin.
4. A conventional stilling basin will be located at the downstream end of the chute with riprap downstream of the stilling basin in the discharge channel for a length of 50 m.

<u>C5-Comment</u>: as explained above, the interface between the proposed RCC section and fill material is critical and necessitates for safety reasons a detailed study; should the interface cause a failure risk, then the spillway should be constructed as a separate structure from the dam body; the latter would cause an increase in the cost of the spillway. In any case, the reviewer recommends a separate spillway structure.

G. Diversion structures-tunnels

1. During construction, diversion of the river through the dam site will be accomplished with a combination of cofferdam and conduit along the left bank of the dam.
2. The diversion structures are designed to protect the embankment construction against a flood of 440m^3/s with a return interval of 25 years. The diversion structures will consist of a cut and cover concrete conduit located on rock under the dam embankment and RCC section.
3. The cofferdam will have a crest at Elevation 418m.
4. The outlet works shall be combined with the diversion canal. In addition, it will be used for access for maintenance from the downstream end.

<u>C6-Comment</u>: In the proposed design, the system of diversion is placed within the RCC spillway. However the feasibility of the latter should be re-evaluated in terms of the behavior of the joint between clay core and RCC considering two critical factors: high vertical settlements of the foundation and high seismic loads.

H. Dam constructability and duration

The different aspects and considerations for the constructability of the dam are summarized as follows:

1. A period of 3 months has been allocated to accomplish the initial mobilization of personnel and equipment to the dam site.
2. The main access route to the project will be from Saida, through Lebaa to the Bisri village. A 12 m wide, unpaved road will be constructed from Bisri to the left abutment dam crest, continuing to the campsite location approximately 1 km upstream.
3. Before the construction of dam facilities, the existing river channel will be straightened and shaped so as to contain the stream flow in the minimum possible space, and maximize the area available for the improvements of the dam foundations.
4. Care of water during construction of other facilities will involve conventional sumping, sloping, and pumping of seepage and runoff water to maintain the work areas in acceptably dry conditions.
5. Construction of the upstream cofferdam is the first critical activity to be undertaken. Materials for the cofferdam fills will come from required excavations and from borrow areas developed in the valley upstream from the dam.
6. Commencement of the open cut excavation for the diversion conduit can begin at an early stage of construction.
7. Upon diversion of the stream through the conduit, the foundation treatment in the old riverbed will proceed to completion. A certain amount of fill placement will be permitted during the foundation treatment phase because of the need to have all areas of the dam footprint loaded at approximately the same rate.
8. A separate rock quarry will be required to produce the volumes of transition and shell materials called for by the design.
9. The intake tower facilities may be started as soon as the diversion conduit construction passes the intake location. Second stage concreting for the tunnel plug and for the gate chamber will be coordinated following installation of the stop logs.
10. Construction of the structures and installation of the gates and valves at the outlet of the conduit will take place after flow has been stopped and the reservoir impoundment has commenced.
11. For the Roller Compacted Concrete (RCC), a separate materials production operation in the alluvium borrow area upstream from the dam has been anticipated to prepare the fill materials. This will involve cone-crushers, screen decks, and conveyors to

prepare and stockpile a sufficient volume to avoid unnecessary interruptions during placement.

12. Shell and riprap material will be quarried from the exposed limestone cliffs nearby.
13. The core zone will be constructed by the “Wet Core” method, as the natural moisture content of the clayey deposits are 8-12% greater than the optimum moisture content.
14. The reported schedule of works indicates a construction period of 3 years.

C7-Comments: the proposed completion date is unrealistic; it is expected that the dam construction requires at least a five years duration. The construction schedule should take into consideration:

- *The delays caused by the wet season.*
- *The extensive foundation treatment works as well as their cost*

I. Concluding Statements

1. The findings of the submitted feasibility study and annex reports are summarized as follows:
   a. The complex geologic and structural setting of the proposed dam was highlighted. In addition, the different geologic formations exposed at the dam axis and reservoir were described.
   b. The feasibility reports indicate that karstic formations are exposed along the right bank/abutment that will require treatment. In fact a complex treatment for the purpose of water tightness of the different elements of the dams, in addition to the stability of the dam is proposed.
   c. The reports offer a regional tectonic overview of the dam area, stating the different structural/tectonic elements of influence, in addition to the seismic criteria required for the design.
   d. The design considerations, such as the potential for transverse cracking of the embankment during severe earthquakes have been addressed.
   e. The reported foundations treatment methods proposed include complex and delicate measures including concrete slurry walls, three line grout curtains, consolidation grouting, stabilizing berms, and vibro compacting to treat and mitigate potential leakage, liquefaction of foundation soils, fault rupture under the foundations, and the potential deformation of the embankment.

f. The dam body material, in addition to the spillway, temporary water diversion and outlet structures were also presented in the submitted reports.

g. The different aspects of the constructability of the dam were also addressed.

2. Our comments on the submitted feasibility study and annexed reports are summarized as follows:

   a. The reported subsurface investigations have yielded data on the geotechnical parameters. However, geophysical surveys to identify the variation in the bedrock surface under the river bed are required. This will shed more light also on the nature and extent of the reported Roum Fault under the dam site.

   b. A joint line survey is required to better understand the jointing and discontinuities orientation in combination with the main faults in the dam area, especially that the structural context of the proposed dam is one of active deformation and block tectonics, as evidenced from the site visit and topography of the area under investigation.

   c. It is noted that the karstic limestone formations exposed along the right bank of the dam site present a potential of leakage as they are fractured. In addition, karstic terrains offer unique conditions resulting in uncertainties. As such, the permeability andwater tightness assessments should be carefully revised and reassessed.

   d. Since the report acknowledges the seismic nature and activity of the dam site area, a dedicated Seismotectonic study is mandatory. This study will further shed light on the different structural components of influence to the dam design/stability and will ascertain the extent of the Roum Fault or a branch of it underneath the dam site.

   e. The effects of landslides on the waters of the reservoir should be carefully evaluated and reassessed.

   f. For the purpose of preventing separation of the clay core from the proposed RCC abutment under seismic loading, the feasibility of the joint between the RCC clay core should be carefully evaluated.

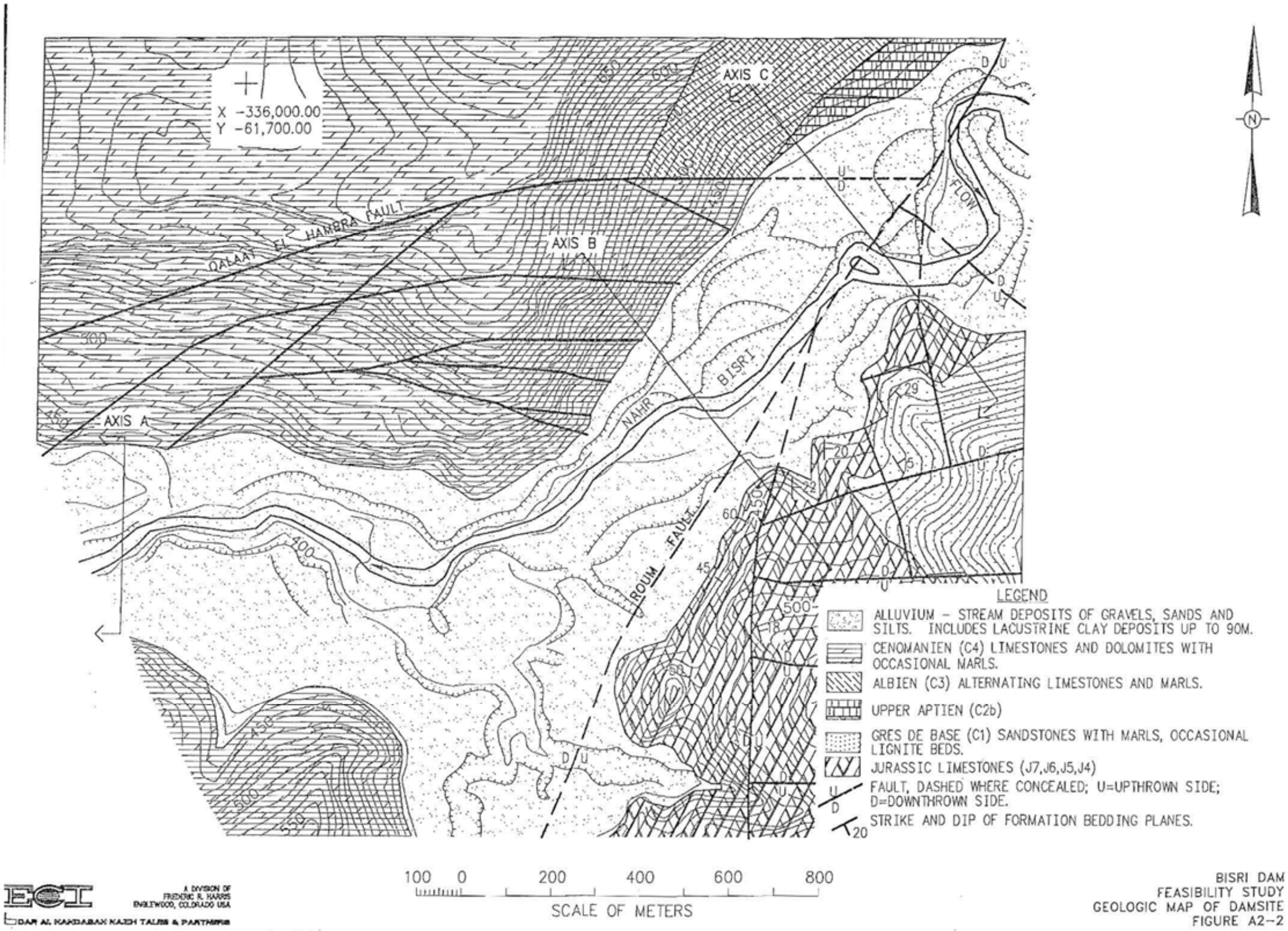
   g. The grouting of the bedded limestone on the right abutment cannot eliminate the water leakage through it. On the other hand the construction of a liner such as a geo-membrane over the limestone has a main disadvantage: leakage would continue to occur in the limestone beds under the level of the river bed.

h. Consideration should be given to relocating the dam axis further upstream beyond the karstic limestone encountered on the right bank.

i. The proposed completion date proposed is unrealistic; it is expected that the dam construction requires at least five years taking into consideration the delay caused by the wet seasons and the extensive foundation treatment works.

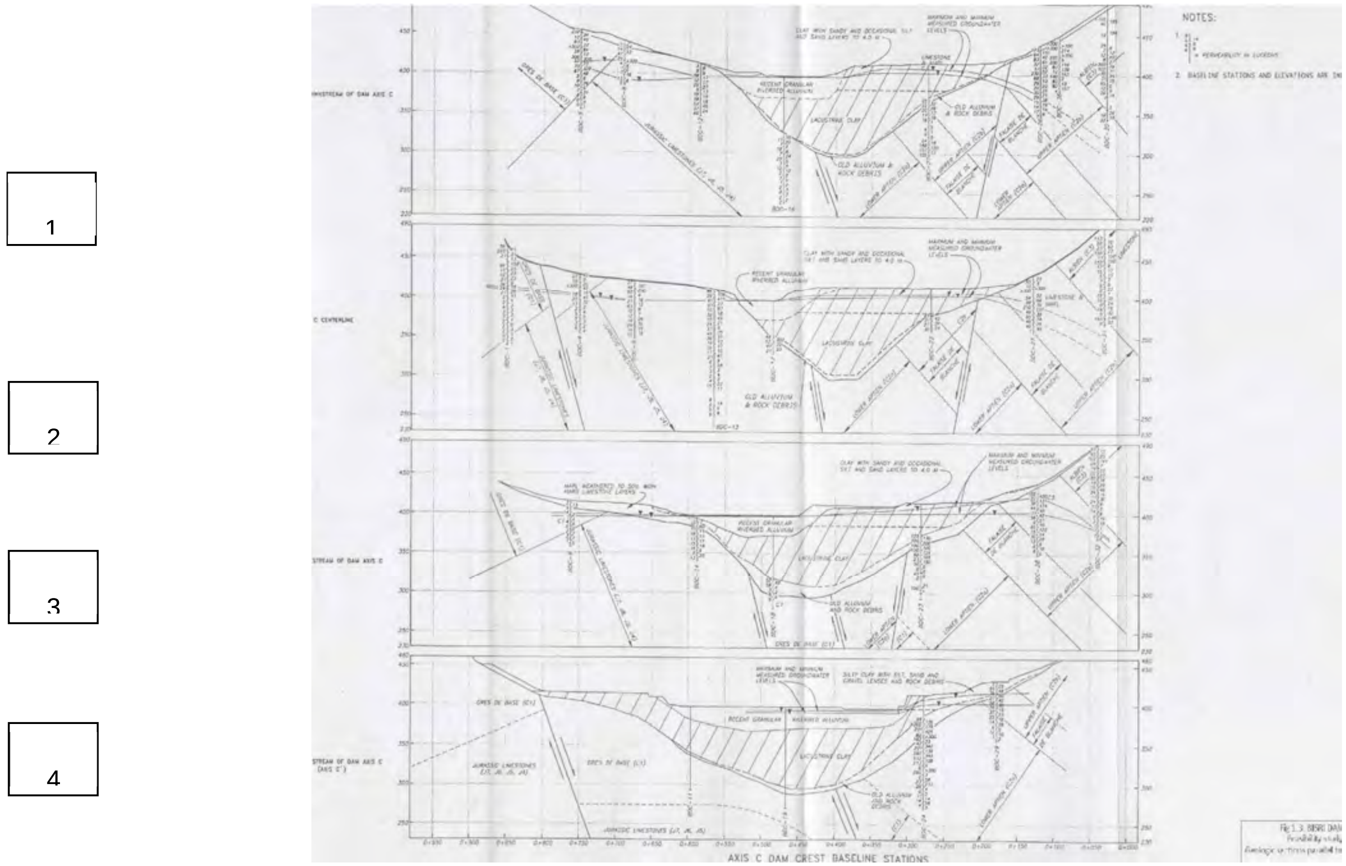
j. The study of the dam requires a detailed risk identification and assessment in order to decide how the dam design can further proceed.

ATTACHMENTS

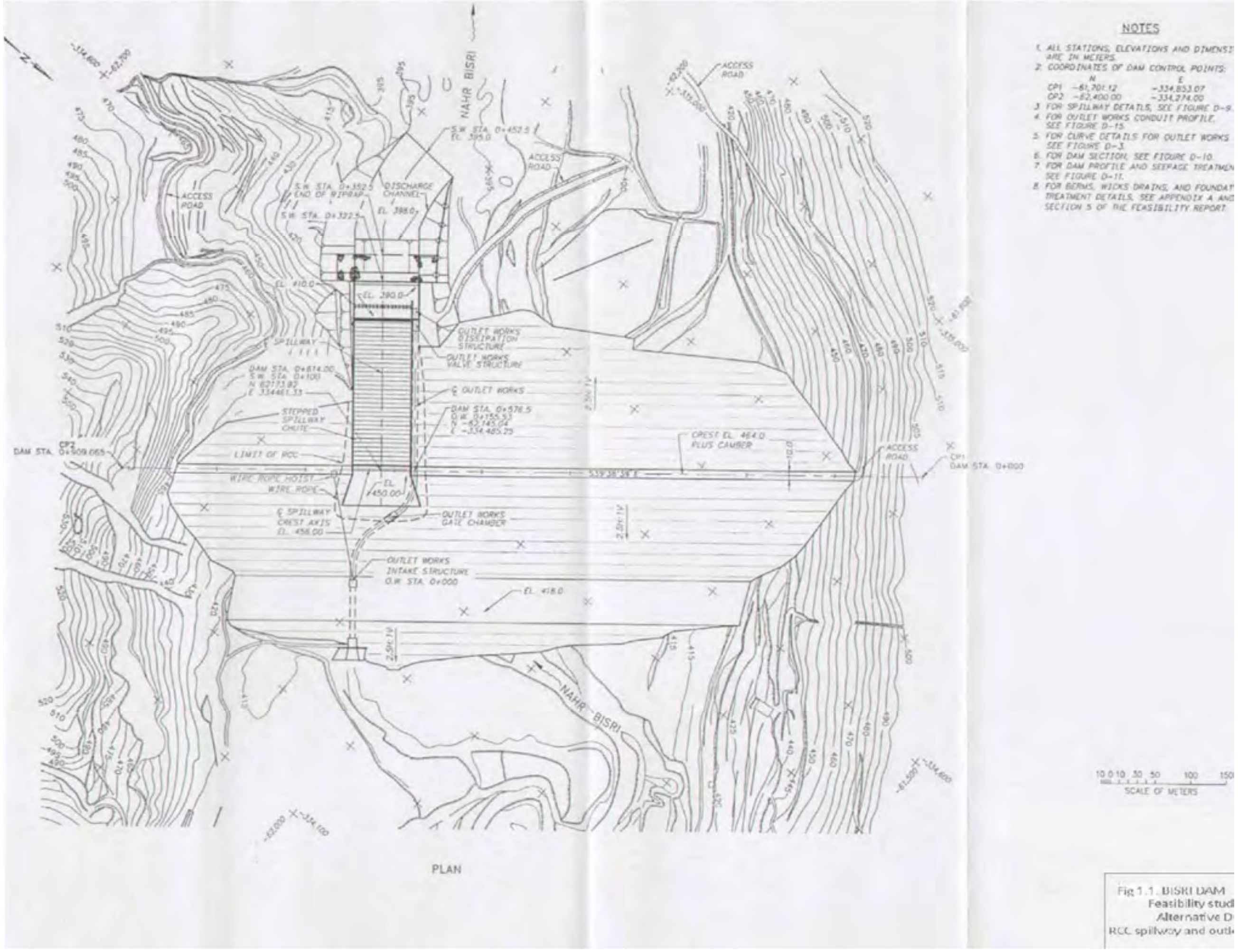


Attachment 1 : geologic map of the proposed dam site as reported in the feasibility study (R2).

Attachment 2 : geologic map of the dam reservoir area as reported in the feasibility study (R2).



Attachment 3: the different geologic profiles as reported in (R1&R2) along the dam axis centerline (2), downstream of dam axis (1), and upstream of the dam axis (3 &4).



Attachment 4: a layout plan showing the proposed dam structure along with the RCC spillway as reported in the feasibility study reported in (R1&R2).

APPENDIX D

ECOLOGICAL ASSESSMENT REPORT

LEBANON WATER SUPPLY AUGMENTATION PROJECT

PRE-DAM CONSTRUCTION

ECOLOGICAL ASSESSMENT SERVICES

for

AWALI RIVER

Submitted to
Dar Al Handasa
Shair and Partners

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November 2012

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1. INTRODUCTION

Due to the increased attention given to the concept of nature conservation in Lebanon, several national action plans and strategies were developed, among which biodiversity conservation principles are being prioritized through the Environmental Impact Assessment (EIA) (Article 4- Code of the Environment Law 444/2002). However, EIA in Lebanon is in its first stages. According to the Ministry of Environment, the decree concerning EIAs was recently approved by the Council of Ministers under the number 8633/2012 and FEA under the number 8213/2012. EIA Decree aims to identify keys to assess the environmental impact of public and private projects in order to avoid significant environmental damage that may result from such projects.

On the international level, Lebanon is now member in several international conventions and agreements on the conservation of nature. Most notably, are the Ramsar Convention, the Convention on Biological Diversity (CBD), and lately Convention on International Illegal Trade with Endangered Species (CITES) and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES).

Lebanon is a water-rich country compared to Jordan, Palestine or Syria. However, because of limited and contradictory data, it is difficult to accurately assess the availability of water resources as well as water consumption in Lebanon. In 2005, the FAO estimated water withdrawal at 1.31 billion m^3 or about 63% of economically exploitable water resources. Sixty percent (60%) of this water went to agricultural usage, 29% for domestic usage and 11% for industrial use. Moreover, only part of the flooded water from rivers can be captured in dams, while most of the groundwater flows unused to the sea.

Throughout the history of the world, dams and reservoirs have been successfully constructed across rivers to collect and store vast amounts of water and then manage releases to make daily river flows to support civilization in water supply, irrigation and flood control. However, large-scale reservoir construction will have varied impacts, including both positive and negative aspects.

Currently, in Lebanon, a pilot dam project is being considered on Awali River, South of Lebanon, aiming at the utilization of the large quantities of water that are being wasted to the sea. The dam project involves the construction of a freshwater reservoir to provide potable water to a wide range of inhabitants. Legal procedures require the preparation of an environmental impact assessment for the proposed dam project which might have adverse effects on the environment. EIA plays an important role in predicting the environmental, social, economical, and cultural consequences, along with evaluating the mitigation plans for any adverse impacts resulting from the proposed activity.

The current study focuses on evaluating biodiversity of the Awali River site, highlight environmental concern that might arise upon implementation of the dam project on existing biodiversity and recommend mitigation measures to decrease the impact of the dam on biodiversity. A rapid flora and fauna assessment was conducted and the findings were analyzed taking into account the basics of the Code of Environment of Lebanon (Law 444/2002), to assess potential impact of the proposed project on the natural environment and consider mitigation measures to minimize the expected environmental damage resulting from the proposed project implementation.

2. OBJECTIVES

The second phase of the pre-dam construction ecological assessment services for the Lebanon Water Supply Augmentation Project aims at drawing the ecological profile of Awali River in South Lebanon, assessing the conservation values of flora and fauna diversity; as well as the vegetation formation. This will lead to identifying the risks of dam construction on the environment and local communities, to defining ways to mitigate the effects of dam construction, and to ensuring the implementation of integrated ecosystem approach combined with sustainable development. However, due to the short time period, the report focuses on building up a groundwork database on biodiversity in the project site, defining threats and proposes mitigation measures. The second phase aims at:

1- Conducting a rapid field survey of flora and fauna in the proposed project site

2- Identifying and listing major flora and fauna species and their status
3- Identifying potential threats from the proposed project
4- Recommending mitigation measures to enhance the project acceptability by maximizing the benefits while minimizing adverse impacts on biodiversity

3. METHODS

3.1. Plant Survey:

The flora cover was assessed to draw the ecological profile of the plant cover, its status and the impact of the dam on it. A rapid inventory was conducted to identify existing species and their status (rare, endangered, iconic …). Walking transects were identified to obtain an understanding of the vegetation communities in the area, to identify community boundaries, to record species present, and to determine the potential distribution of threatened species (Plate 1). Transects were assigned to cover the different habitats, topographic diversity, and variety of vegetation communities mapped from aerial photos.

Plate 1. Walking transects for flora identification

Information and location of plant species and their habitats were recorded during transect walks. This information was used to assist in identifying the presence of vegetation communities, determining vegetation boundaries, assessing the homogeneity of the study area, and determining the required number of plots.

3.1.1. Field survey

Vegetation communities were randomly assessed in both the thermo-Mediterranean (0-500m) and part of the Eu-Mediterranean in Bisri. Field visit were performed during a very short period in spring 2012 and the first week of November. The number of visits during spring was limited as they aimed to develop preliminary study to estimate the conservation value of the three sites namely Bisri, Dammour and Ibrahim River. While during autumn very few species are expected to be in bloom.

3.1.2. Site diagnosis and analysis

The impact of the dam construction on the vegetation communities in the riparian ecosystem was rapidly identified. Species of special concerns surveyed during very short visit in the spring was defined based on the national assessment.

3.2. Fish and Macro Invertebrates

Electrofishing is a common method used for catching fish for surveying and monitoring purposes. The fishing device emits an electric current through the water, stunning fish and making them easy to capture (Cowx, 1990; Cowx and Lamarque, 1990). Carefully regulated amperages of currents used will allow the fish to be stunned effectively without damaging their muscles, vertebrae and spinal nerves. This is a non-selective method of capture that provides a broad overview of the fish fauna living in the surveyed water body. It is very efficient and suitable for running and still waters. It can be used to make total population estimates for a given stretch of river using multiple catch techniques (Hill et al., 2005).

Plate 2. Survey of the ichthyofauna using electro-fishing method conducted at Bisri (Awali River) Site.

Field expeditions to Awali River were carried out in 2012 (Plate 2). The river had also been extensively surveyed between year 2007 and 2008 (Bariche, unpublished data). A backpack electric fishing device was used. Electrofishing was carried out by chest wading and the small streams were fished on foot. Electrofishing was performed with minimum voltage and avoiding contacts between the fish and the anode, in a manner that minimizes harm to the fish. Stream segments were sampled systematically, moving the anode continuously through the water. All captured fish were handled properly for identification. They were released afterwards into the water at the location of capture and some specimens were kept as voucher specimens. They were preserved and stored in the collections of the Natural History Museum of the American University of Beirut (AUBNHM).

3.3. Herpetofauna (Amphibians and Reptiles) Survey

Amphibians and reptiles were conducted on two intervals days and nights focusing on the water bodies, the riparian habitats and their peripheries (Plate 3). Compiling previous knowledge, observing and studying the potential habitats and observations of active animals was the only method for the animals that are active in warmer seasons. Emphasis was made on the species richness and on rough estimations of the areas of activity and breeding habitats. Specimens collected for species encountered and was preserved and deposited at AUBNHM.

Plate 3. Survey of reptiles and amphibians conducted at Bisri (Awali River) Site

3.4. Ornithology Survey

From an ornithological point of view, the implementation of the Bisri Environment Impact Assessment project requires a methodology that is necessary to be undertaken in order to reach the objectives.

To assess the impact on the avian species, the 20-minute point-count method is used, whereby all species noted during this time period are recorded at different places and different times in the most characteristic habitats of a given area (Ramadan-Jaradi, 1975; Blondel *et al*. 1981; Ramadan-Jaradi, 1984). This method is semi-quantitative and changes in abundance of a species are estimated by changes in the frequency of this species over a series of point counts. Frequencies could be mathematically transformed into densities through the use of some statistical rules. This task is easier when the study is undertaken in line-transects within quadrates (Ramadan-Jaradi & Ramadan-Jaradi, 2002) (Figure 1).

Plate 4. Capturing birds by camera for later identification.

Limitations of the method and alternatives: on days of heavy raptor or stork movement, it was necessary on occasion to estimate the number of birds passing. At other times, birds are individually counted. In addition, some birds were identified through capture with camera from a distance (Plate 4). Single-shelf mist-nets for species identification were not used due to the familiarity of the expert with the birds of Lebanon.

The remaining required knowledge about species status and trends are retrieved from the past experience of the expert, from the records and from literature when available.

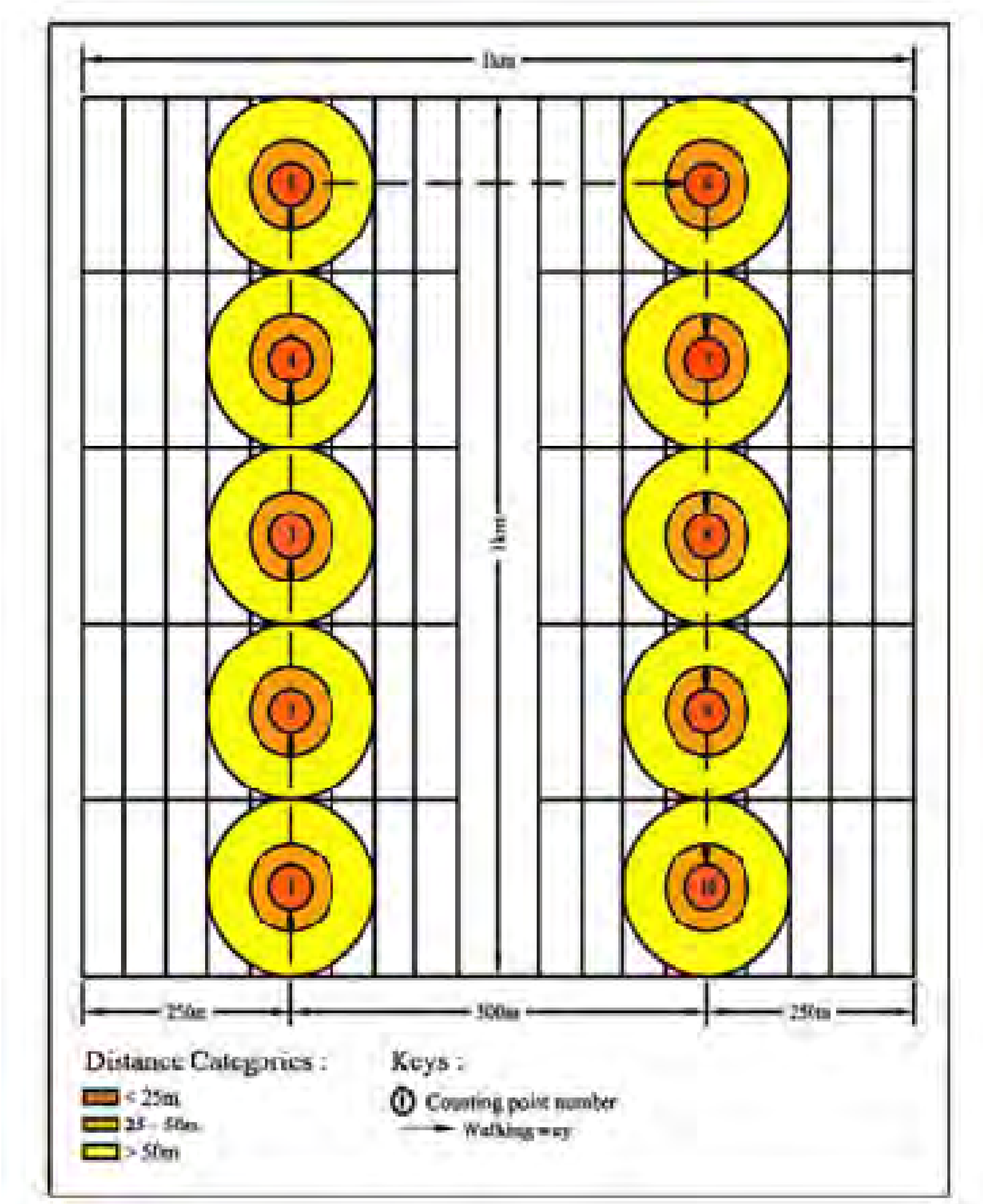


Figure 1. Point counts combined with transects.

3.5. Mammal Survey:

Most mammals are highly persecuted by humans. To avoid such a threat, they became nocturnal, which renders surveying and monitoring mammals a hard task, requiring many techniques and hi-tech equipment Two approaches, direct and indirect, were used to monitor mammals. Indirect approach was conducted during day time through diurnal walking surveys, where opportunistic observations of secondary signs such as tracks, footprints, fur and scats detected were recorded. Moreover, caves and dens were inspected for bats, animal signs and animal remains. Diurnal surveys were conducted between 09:00 and 17:00. Walking was at a slow pace and noise kept to a minimum. Periodical stops for periods of at least five minutes to assess the surroundings and to allow the disturbance caused by the movement of people through the forest to pass.

The direct approach was conducted in two ways night surveys and photo-trapping to obtain data on the more secretive and nocturnal species. Night surveys commenced using a 4x4 vehicle at two different times before or after midnight and lasted between two to three hours. A powerful spot light (1-1.5 million candle power) was used to illuminate animals once their eye-shine had been detected to help with the identification. The pace was slow to increase the chances of sighting the animals.

Photo-trapping equipment to survey mammals consisted of seven pre-baited active and passive remote camera traps, triggered by both heat and motion, were tied to a tree 40-60cm above ground (Plate 5). The cameras were programmed to take photographs 24hours/day with a 2-minute interval between photos, and to record date and time on each photograph. Sites for camera trapping were chosen randomly to cover different habitats, topographies and landscapes. Baits were placed on the ground 3m away from the camera trap. The bait consisted of animal leftovers from butcheries, fruits, domestic refuse and corn.

Data describing each direct and indirect animal sign was recorded. Data recorded included the place where the sign was encountered and in which habitat type was found. Moreover, photos from the camera traps were downloaded to a computer for future analysis.

Plate 5. Camera traps used in surveying mammals and the bait used at Bisri site.

4. RESULTS

4.1. Flora Survey

4.1.1. Description of the site

The area reflects mosaics of ecological niches for various vegetation formation and agricultural fields with various hedges type such as cyprus and casuarina trees. The composition of the vegetation is typical to South/South East and North/North East plants associations. The former represents bushy type vegetation reflecting past uses of the forests with agricultural terraces. The latter mingles trees association of Calabrian pine, stone pine, oak, hawthorn, laurel, pistachio, juniper, carob, etc. with bushes formations and herbaceous vegetations. The valley is home to agricultural fields, riverside plant formations and islands of patches of natural vegetation and alien tree species such as willow, alder, tamarisk, Oriental plane, Cyprus, stone pine and casuarina. Three types of vegetation are identified:

<u>Type 1.</u> River course vegetation formations: Trees observed are *Platanus orientalis* L., *Salix libani* Bornm., *Alnus orientalis* Decne with associated shrubs and herbaceous plants (Plate 6).

Plate 6. River course vegetation along Awali River

<u>Type 2.</u> Hillside North/North East dominated by associations of plant populations of *Pinus brutia* Ten., *Pinus pinea*, *Quercus calliprinos* Oliv., Quercus infectoria, *Laurus nobilis L. and Pistacia paleastina* Boiss (Plate 7) .

Plate 7. Associations of plant populations.

Type 3. South/South East similar to the previous type. It was formed by denser bush-like formations.

4.1.2. Vegetation survey

An approximate number of 50 plants were identified in Bisri (Table 1). Important plant species were identified among which *Ricotia lunaria* (L.) DC. being endemic , *Orchis anatolica* Boiss., *Orchis morio* L., *Orchis papilionaceae* L., *Orchis pyramidalis* M. Bieb., *Orchis romana* subsp. *libanotica* Mt., *Orchis tridentata* Scop., *Ornithogalum umbellatum* L. and *Fritillaria libanotica* (Boiss.) Baker. (Fig. 1-5).

Table 1. List of plant surveyed in Bisri region during spring and autumn 2012.

Species Scientific Name	Species Scientific Name
1. *Acer syriacum Boiss*. & Gaill.	2. *Nerium oleander* L.
3. *Adiantum capillus-veneris* L.	4. *Onosma frutescens* Lam.
5. *Ajuga orientalis* L.	6. *Orchis anatolica* Boiss.
7. *Alnus orientalis* Decne.	8. *Orchis morio* L.
9. *Anemona coronaria* L.	10. *Orchis papilionaceae* L.
11. *Arceuthos drupacea*(Labill.) Ant. & Ky.	12. *Orchis pyramidalis* M. Bieb.
13. *Arum hygrophylum* Boiss.	14. *Orchis romana* subsp. *libanotica* Mt.
15. *Asparagus acutifolius* L.	16. *Orchis tridentata* Scop.
17. *Asperula sp.*	18. *Ornithogalum umbellatum* L.
19. *Asphodellus microcarpus* Salzm. & Viv.	20. *Oxalis per-caprae* L.
21. *Bellevalia latifolia* Ten.	22. *Pinus brutia* Ten.
23. *Bellis sylvestris* Cirillo.	24. *Pinus pinea* L.
25. *Calycotome villosa* (Vahl) Link.	26. *Pistacia palaestina* Boiss.
27. *Ceratonia siliqua* L.	28. *Phillyrea media* L.
29. *Cercis siliquastrum* L.	30. *Platanus orientalis* L.
31. *Cistus creticus* Sibth. & Sm.	32. *Pteridium aquilinum* (L.) Kuhn.
33. *Cyclamen persicum* Sibth. & Sm.	34. *Quercus calliprinos* Webb.
35. *Cupressus sempervirens* L.	36. *Quercus infectoria* Oliv.
37. *Fritillaria libanotica* (Boiss.) Baker	38. *Ricotia lunaria* (L.) DC.
39. *Gallium sp.*	40. *Ruscus aculeatus* L.
41. *Hyacinthus orientalis* L.	42. *Salix libani* Bornm
43. *Iris histrio* Reichb.	44. *Salix* sp.
45. *Lathyrus hierosolymitanus* Boiss. & Bl.	46. *Smilax aspera* L.
47. *Laurus nobilis* L.	48. *Allium neapolitanum* Cyr.
49. *Lavendula stoechas* L.	50. *Tamarix* sp.
51. *Lupinus digitatus* Forsk.	52. *Tamus communis* L.

53. Muscari comosum (L.) Mill.	54. *Valeriana dioscoridis* Sibth. & Sm.

Besides wild plants Marj Bisri is rich with its fruit trees mainly citrus trees, greenhouses of roses and strawberry, and commercial lawn grass plots.

 *Fig. 1.Orchis papilionaceae* L.	 *Fig.2. Orchis morio* L..
 *Fig. 3. Orchis romana* subsp. *libanotica* Mt.	 *Fig. 4. Orchis tridentata* Scop.,

Fig. 5. Fritillaria libanotica (Boiss.) Baker

4.2. Fish and Macro Invertebrates Survey

Five fish species and one crab were present in Awali River, out of which three deserve special attention (Table 2). These are the Freshwater blenny, the European eel, and the Middle Eastern Green carp. No exotic fish or macroinvertebrates were captured.

Table 2. Fish species recorded from Awali River

Species	**Family**
Salaria fluviatilis (Asso, 1801)	Blenniidae
Anguilla anguilla (Linnaeus, 1758)	Anguillidae
Capoeta damascina (Valenciennes, 1842)	Cyprinidae
Pseudophoxinus kervillei (Pellegrin, 1911)	Cyprinidae
Oxynoemacheilus leontinae (Lortet, 1883)	Balitoridae
Potamon potamios (Olivier, 1804)	Potamidae

4.2.1. Freshwater blenny:

Biology: Salaria fluviatilis (Asso, 1801) is a small freshwater blenny that lives in river estuaries (Plate 8). The fish resides in lakes and streams with moderate current and has a clear preference to stone bottoms. It is a territorial species that can live up to 5 years. It feeds on insects, crustaceans, and fry. It reproduces during spring in Lebanon.

Plate 8. The Freshwater blenny *Salaria fluviatilis*

Conservation status: According to the IUCN, the Freshwater blenny is not currently considered threatened around the Mediterranean Sea. However, populations have declined considerably in recent years in its area of distribution.

The Freshwater blenny has completely disappeared from most rivers in Lebanon. This is mainly because of habitat alteration, river drying up due to of water diversion, drought, and pollution. The presence of habitat suitable for its larvae is very important for the survival of the species. Two small populations seem to be confined to the lower parts of Awali River and Damur River, living only in the last few hundred meters of freshwater close to the estuary. This makes the population (< 100 individuals) currently existing in Awali River critically endangered.

4.2.2. European eel:

Biology: The European eel *Anguilla anguilla* (Linnaeus, 1758) is a catadromous fish; that resides in freshwater most of its life and migrates to spawn at sea. Upon sexual maturity, adults migrate from the river to the Mediterranean Sea, and then to the Atlantic Ocean where they reproduce. Larvae drift back in the Atlantic using the Gulf Stream current, metamorphose into young eels (elvers), and go upstream to the rivers in the North eastern Atlantic Ocean and the Mediterranean Sea (Plate 9). The species lives in all types of habitats from small streams to large lakes. It reproduces between March and July in the Atlantic Ocean (Sargasso Sea) and feeds on a wide variety of benthic organisms.

Plate 9. The European eel *Anguilla anguilla.* Adult (left) and larvae (right) (source internet)

Conservation status: The species has a high commercial importance in Europe and around the Mediterranean. European eels are sharply declining worldwide, mainly because of overfishing. It has been recently considered as critically endangered by the IUCN.

In Lebanon, this eel is found in all rivers connected to the sea with running waters. Water diversion for agricultural, industrial, or domestic use and heavy chemical pollution are the main cause of its decline.

4.2.3. Middle Eastern Green carp:

Biology: Capoeta damascina (Valenciennes, 1842) is a very common carp occurring in most rivers, streams, and lakes of the Levant, Mesopotamia, and parts of southern Turkey. The fish is present in all rivers (inland and coastal) of Lebanon, as well as the Quaraoun and the Chouan dam (Plate 10). It can be found in various types of water currents and substrates. It is a bottom fish feeding mainly on algae, invertebrates and detritus. It reproduces in small streams where it deposits its eggs on gravel.

Plate 10. The Middle Eastern Green carp *Capoeta damascina*

Conservation status: The Middle Eastern Green carp is a least concern species. It is common wherever it occurs and can withstand poor water conditions and high levels of pollution. It is commonly targeted by Lebanese anglers for consumption and has a local commercial importance.

4.2.4. Minnow and Loach:

The two remaining fish species present in Awali River are a minnow *Pseudophoxinus kervillei* and a loach *Oxynoemacheilus leontinae* (Plate 11). The two species are common wherever they occur and their biology is completely unknown.


Plate 11**.** *Oxynoemacheilus leontinae* (left) and *Pseudophoxinus kervillei* (right) from Awali River

4.2.5. Freshwater crab:

Biology: Potamon potamios (Olivier, 1804) is a freshwater crab living in the eastern Mediterranean, from the Sinai to South Anatolia and Greece. It is found in almost all rivers and water bodies of Lebanon (Plate 12). It is a scavenger that complements its diet on invertebrates as well as tadpole and fish. Its biology has not been studied.


Plate 12. The freshwater crab *Potamon potamios*

*Conservation status:*The species is widespread and can tolerate a wide range of habitats. It does not seem to be endangered.

4.3. Herpetological (Amphibians and Reptiles)

Various species of reptiles are found in the Bisri basin. None of the species of snakes and lizards in that basin are known to be endangered or endemic. Most of these species are quite common in the surrounding areas and many parts of the country. There are no apparent impacts on these species due to the dam construction. In this survey, emphasis was placed on species that might be affected or impacted directly or indirectly by changes in the aquatic habitat to the dam construction. The species most like to be impacted are listed in Table 3. The impact on the species could be in terms of changes in habitat, breeding sites and food sources

Table 3. A list of the reptiles and amphibians that might be impacted by the Bisri dam. The status of the species might be: T = Threatened, E = Endemic, R = Rare, and C = Common. The type of impact might be: HT= general habitat, BR=breeding habitat, FD=food requirements.

Species	Common name	Picture	**Status**				Type of Impact		
			T	E	R	C	HT	BR	FD
Natrix tessellata	Water snake					+	+		?
Pelophylax bedriagae	Marsh frog					+	+	+	?

Pelobates syriacus	Eastern or Syrian spadefoot				+		+	+	?
Bufo viridis	Green toad					+		+	?
Bufo cf. *bufo*	European common toad			+	+		+	+	?
Hyla savignyi	tree frog					+	+	+	?
Salamandra infraimmaculata	salamander					+	+	+	?
Triturus vittatus	Newt				+				

4.4. Bird survey

The Point counts, which involved recording all birds seen and heard at selected locations, were used to generate a species list. The list is inclusive of resident and migrant birds. A total of 23 points (each point 50 m ≤distance) were located randomly across the site. Point Counts were done in the mornings (sunrise to 10 am), in April-May 2012 and in the peak of the silent breeding season for most birds (June 2012), as at this time many of the birds are not vocal (G. Ramadan-Jaradi, *pers. comm*); and in September-October 2012 during the autumnal passage of the migrants. Bird distribution and habitat usage varies throughout the property, with an average of 11 individuals per point count (min = 4: max = 19).

Thirty two (32) species were observed during the surveys (Table 1). Of the observed birds, 4 are forest dependent and may reappear in the riparian areas above and below Bisri site: Wren [figure 1], Jay [Figure 2], Chaffinch [Figure 3] and Blackbird [Figure 4].

Figure 1: Winter Wren

Figure 2: Eurasian Jay

Figure 3: Chaffinch

Figure 4: Eurasian Blackbird

Species that tolerate high disturbance were found across the site, particularly in the overgrown pastures or where human agglomeration is found. These included the Graceful Prinia (Figure 5), Sparrow (Figure 6), Hooded Crow (Figure 7) and Bulbul (Figure 8).

Several birds common to the region were spotted in the site (Table 4). Birds like Graceful Prinia (*Prinia gracilis*), Jay (*Garrulus glandarius*), Hooded Crow (*Corvus cornix*), Wren (*Troglodytes troglodytes*), Sparrow (*Passer domesticus*),

Figure 5: Graceful Warbler

Figure 6: House Sparrow

	
Figure 7: Hooded Crow	Figure 8: White Spectacled Bulbul

Swift (*Apus apus*) and Lesser White Throat (*Sylvia curruca*) were frequently spotted during the visits to the area. A few other bird species were reported by the inhabitants of the area but not observed by us, such as Lesser Kestrel (*Falco naumannii*), Black Redstart (*Phoenicurus ochruros*), Masked Shrike (*Lanius collurio*), and Barn Owl (*Tyto alba*). The villagers also reported a few other species but due to various inconsistent local names, these could not be properly identified. However, our field visits during October cumulated the total number of birds from 28 to 32 species where 24 of them are common and none of them is endemic. Four are threatened (White storks, Lesser Spotted Eagle, White Pelicans that are of passage only, and Short-toed Eagle that is of wide range of action (within and beyond the limits of the site). Hence their conservation depends on areas other than Bisri Site.

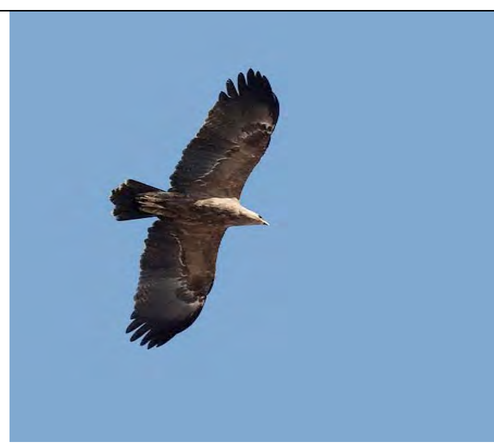
	
Figure 9: White Storks	Figure 10: Lesser Spotted Eagle

	
Figure 11: White Pelican	Figure 12: Short-toed Eagle

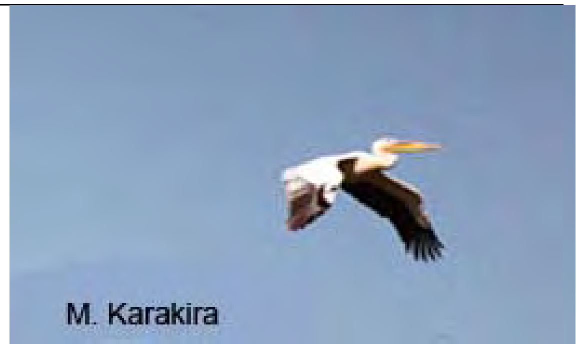
Table 4. Birds of Bisri Village site. R= resident, PM= passage migrant, WV= winter visitor, SB= summer breeder, and ?= uncertain status. T= threatened, E= endemic, R= rare, and C= Common.

	Species	***Scientific name***	**Status**	**T**	**E**	**R**	**C**
1	Bulbul	*Pycnonotus xanthopygos*	R				+
2	Graceful Warbler	*Prinia gracilis*	R				+
3	Common Chiffchaff	*Phylloscopus collybita*	SB, PM, WV				+
4	Chaffinch	*Fringilla coelebs*	R, PM, WV				+
5	Winter Wren	*Troglodytes troglodytes*	R				+
6	Blackbird	*Turdus merula*	R				+
7	Eurasian Jay	*Garrulus glandarius*	R				+
8	Great Tit	*Parus major*	R				+
9	European Greenfinch	*Carduelis chloris*	R				+
10	Blackcap	*Sylvia atricapilla*	SB, PM, WV				+
11	Sardinian Warbler	*Sylvia melanocephala*	R, PM, WV				+
12	Lesser Whitethroat	*Sylvia curruca*	SB, PM, ?wv				+

13	White Storks	*Ciconia ciconia*	PM	+			+
14	Pelican	*Pelecanus onocrotalus*	PM	+			+
15	Short-toed Snake Eagle	*Circaetus gallicus*	SB, PM	+		+	
16	Long-legged Buzzard	*Buteo rufinus*	R, PM, WV				+
17	Hooded Crow	*Corvus cornix*	R				+
18	Palestine Sunbird	*Cinnyris osea*	R, wv			+	
19	European Goldfinch	*Carduelis carduelis*	R, WV, pm				+
20	House Sparrow	*Passer domesticus*	R				+
21	Swift	*Apus apus*	SB, PM				+
22	Lesser Spotted Eagle	*Aquila pomarina*	PM				+
23	Black headed Bunting	*Emberiza melanocephala*	SB				+
24	Corncrake	*Crex crex*	pm	+		+	
25	Black Kite	*Milvus milvus*	PM				+
26	Steppe Buzzard	*Buteo vulpinus*	PM				+
27	Hoopoe	*Upupa epops*	R, SB			+	
28	White Wagtail	*Motacilla alba*	PM, WV				+
29	Steppe Buzzard	*Aquila nipalensis*	pm			+	
30	Levant Sparrowhawk	*Accipiter brevipes*	PM				+
31	European Sparrowhawk	*Accipiter niseus*	PM			+	
32	Marsh Harrier	*Circus aeroginosus*	PM			+	

From the list above, the four threatened species are:

English name	Short-toed Eagle	
Scientific name	*Circaetus gallicus*	
Distribution	All over Lebanon where thermals are well formed	
Status	Breeding in small numbers in montane areas, especially at Charquieh (Ramadan-Jaradi & Ramadan-Jaradi 1999), hills above Aammiq, Dalhoun and Arz el Shouf (Ramadan-Jaradi *et al* 2004). It is also a widespread and common passage migrant over much of the country, early March–late April (most first half of April) and early September–late October. First recorded by Tristram (1864) and first confirmed breeding recorded at Charquieh in 1996 by Ramadan-Jaradi & Ramadan-Jaradi (1999).	
English name	White Stork	
Scientific name	*Ciconia ciconia*	
Distribution	All over Lebanon where thermals are formed and in wetlands	
Status	Abundant and regular on both passages, but generally commoner in spring over the whole country, but occurs principally over coastal plains (*e.g* in early March–late June, a maximum of 10000 recorded on 9 April 2000 over Dalhoun) and over Beqaa Valley, where in autumn occurs early August–late October (MR-J). Largest flocks usually appear following periods of hot easterly winds. Very few oversummer June-July. First recorded in 1948 (West 1954).	

English name	White Pelican	
Scientific name	*Pelecanus onocrotalus*	
Distribution	All over Lebanon where thermals are well formed and in wetlands	
Status	Common regular passage migrant at both seasons with flocks of up to 1000 birds near coasts, at Aammiq and Qaraoun, and over mountains up to 1800m asl. Occurs mid-February–early June and early September–late November, principally on Palm Islands. First recorded by Tristram (1882).	
English name	Corncrake	
Scientific name	*Crex crex*	
Distribution	In wetlands: Coastal and inlands	
Status	An uncommon passage migrant over Lebanon in mid-August–late October and early March–late May (Ramadan-Jaradi *et al* 2004). Regular in May and beginning of June on Palm Islands (Ramadan-Jaradi & Ramadan-Jaradi 2001), with peaks of up to six birds. An isolated record at Tyre Coast on 6 December 2003 was exceptional (Ramadan-Jaradi *et al* 2005). First recorded in 1824 (Hemprich & Ehrenberg 1833)	

4.5. Mammal Survey

The rapid field survey on mammals for Bisri site revealed the presence of 17 mammal species belonging to 14 families (Table 5). Four species including badgers, otters, squirrels, and voles are expected to exist (Table 5). In addition to wild mammals domestic mammals like goats, cows, dogs and cats were also encountered. Moreover, within the dam site there is a small private zoo that houses lions, tigers, lamas, deer, hyaenas, a fox, some farm animals, and a chimp

Out of the 21 species of mammals, one species, which is the hedgehog [Figure 1] is dependent on forests, farmlands, gardens and orchards. In addition, 3 bat species: the European free tailed bat [Figure 2], lesser horseshoe [Figure 3], and greater horseshoe [Figure 4], hunt along open woodland, woodland edges and paths as well as hedgerows.

Figure 1: Hedgehog

Figure 2: Lesser horseshoe bat

Figure 3: Greater horseshoe bat

Figure 4: Eurasian free tailed bat

Most other species can tolerate high disturbance and are referred to as urban wildlife; these included the common pipistrelle [Figure 5], Khul's pipistrelle [Figure 6], jackals [Figure 7], foxes [Figure 8], pine martins [Figure 9], wild boar [Figure 10], house mice, rats, and field mice.

Figure 5: Common pipistrelle bat

Figure 6: Khul's pipistrelle bat

Figure 7: Jackal

Figure 8: Red fox

Figure 9: Pine martin

Figure 10: Wild boar

Several mammals which are common to the region were spotted in the site, such as wild cats [Figure 11], striped hyaenas [Figure 12], porcupine [Figure 13], and moles [Figure 14].

Figure 11: Wild cat

Figure 12: Striped hyaena

Figure 13: Porcupine

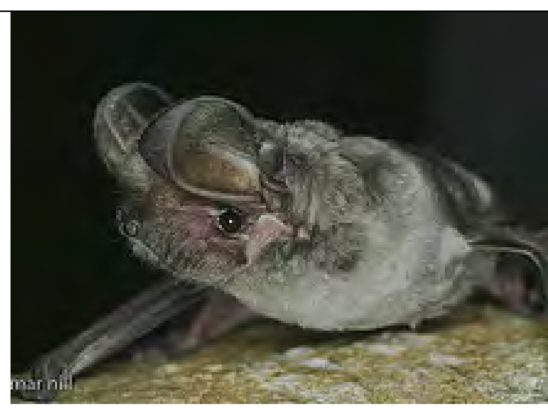
Figure 14: Mole rat

Finally, two other mammal species which are dependent on the riparian ecosystem are expected to be present: the otter *Lutra lutra* an amphibian mammal that was recorded in Moukhtara (Tohme and Tohme 1985) and documented in Ammique Wetland and Anjar (personal observation) and voles, which are another riparian ecosystem inhabitants, that usually inhabit river banks.

Table 5. List of mammal species present on the three sites (R= recorded, E = Expected, c= common, r = rare, endemic or endangered on the National level)

Family	Species	Scientific Name	Awali River
Erinaceidae	Hedgehog	*Erinaceus concolor*	R, r
Miniopteridae	European Free-tailed bat	*Tadarida teniotis*	R, r
Vespertilionidae	Common pipistrelli	*Pipistrellus Pipistrellus*	R, c
	Khul's pipistrelle	*Pipistrellus kuhli ikhawanius*	R, c
Rhinolophidae	Lesser horseshoe	*Rhinolophus hipposideros*	R, c
	Greater horseshoe bat	*Rihnolophus ferrumequinum*	R, c
Canidae	Jackal	*Canis aureus syriacus*	R, c
	Fox	*Vulpus vulpus palaestina*	R, c
Mustelidae	Pine Martin	*Martes foina syriaca*	R, c
	Badger	*Meles meles canescens*	E, r
	Otter	*Lutra lutra*	E, r
Hyaenidae	Striped hyaena	*Hyaena hyaena syriaca*	R, c
Felidae	Wild cat	*Felis silvestris tristrami*	R, r
Suidae	Wild boar	*Sus scrofa lybicus*	R, c
Sciuridae	Squirrel	*Sciurus anomalus syriacus*	E, c
Hystricidae	Porcupine	*Hystrix indica indica*	R, c
Spalacidae	Moles	*Spalax leucodon ehrenbergi*	R, c
Muridae	House mouse	*Mus musculus praetextus*	R, c
	Rats	*Rattus rattus*	R, c
	Field mouse	*Apodemous mystacinus*	R, c
Microtinae (Subfam.)	Voles	*Microtus sp.*	E, c

From the list above, the five rare species are:

English name	**Hedgehog**	
Scientific name	*Erinaceus europaeus concolor*	
Distribution	The hedgehog was first reported by Lewis et al. (1967). Tohme and Tohme (1985) gave a detailed description and distribution of the species in Lebanon. The hedgehogs are reported from Hadath, Kfarchima, Bsaba, Ibrahim River, Saida, Jaj, Laqlouq, Baalbek, Zahleh, Chmistar, Sarafand, Tamnine Tahta, Barouk, Mokhtara, Rihane, Jezzine, Tyre, Koura, Farayya.	
Status	This species was common in Lebanon, especially in the coastal plain. However, at present the species is endangered due to excessive use of pesticide, unintentional killing during hibernation and road kills. Its habitat does not apparently exceed 2.5 hectares.	
Habitat	The Hedgehog suitable habitats where insects and invertebrates are abundant. This reveals its economic importance besides their presence is a bio-indicator for unpolluted habitat. Dumps are excellent source of food for hedgehogs besides cultivated or semi-desert areas. They are also found in Pine and olive groves as well as in forest edges, gardens and parks.	
English name	**European Free-Tailed bat**	
Scientific name	*Tadarida teniotis*	

Distribution	The European free tailed bat was first reported by Harrison (1962), Tohme and Tohme (1985), and Horacek et al 2008. This species was reported from Faraya, the coastal zone, and from northern part of the Beka'a valley.	
Status	This species is threatened in Lebanon due to habitat destruction excessive use of pesticide.	
Habitat	The European free tailed bat inhabits narrow and inaccessible rock cervices. It roosts in large colonies in narrow cervices in the chalk cliffs Their feeding habit (feeding on insects) as well gives them an economic importance as well a major role in the ecosystem.	
English name	**Eurasian Badger**	
Scientific name	*Meles meles canescens*	
Distribution	It was reported by Lewis et al. 1968 and By Tohme and Tohme (1985) in several areas of Mount Lebanon and East Beqa'a. It was also reported in Ehden and Tannourine Reserve (Abi-Said 2008) and lately in Jabal Moussa Biosphere Reserve (Abi-Said 2010a,b).	
Status	Badgers are endangered in Lebanon due to persecution by human.	
Habitat	Badgers occur in woods, open areas, orchards and vine yards.	
English name	**Wild cat**	
Scientific name	*Felis silvestris tristrami*	
Distribution	This species was reported by Tohme and Tohme (1985). Several	

	personal observations between 1995-2005 in Ehden, Tannourine and AlShouf Reserves besides East Beqa'a as well in Jabal Moussa Biosphere Reserve in 2009. They were reported in most reserves as well as non protected areas, at the coastal areas and East Beqa'a.
Status	Endangered species due to cross breeding with domestic cats
Habitat	Wild cats are nocturnal animals that inhabit steppes, hills, valleys, forests, and rocky areas.
English name	**Common Otter** 
Scientific name	*Lutra lutra seistanica*
Distribution	The otters were reported by Lewis et al, 1968 and Tohme and Tohme 1985. Their distribution is limited to wetlands and some rivers in Lebanon. However, they face several threats due to conflict with fisheries, dryness of wetlands, and killing by humans. They were reported from Ammique, Kfarzabad, AlAssi river, Jisr AlQadi, AlDamour river and AlMoukhtara river which is an extension of Bisri.
Status	This species is endangered in Lebanon due to hunting and drying of wetlands.
Habitat	The otters are very tolerant of where they live, in environments ranging from lakes and bogs to rivers and little from sea level up into the highest mountains. Otters could be found anywhere as long as there is water, sufficient food and away from human disturbance and persecution.

5. IMPACT ON THE BIODIVERSITY

5.1. Impact on Flora

5.1.1. Loss of habitat

As vegetation is concerned, it is expected that the loss of part of the riparian vegetation will occur because of the inundation of the site resulting from dam construction. Though patches of the riparian vegetation will remain outside the dam construction site, the colonization of tree species on the banks of the dam is expected. If significant impacts on valuable habitats or species are unavoidable, detailed botanical surveys would be required. These may involve targeted searches for protected species and/or those identified as species of significant nature conservation value in either a Species Action Plan or Local Biodiversity Action Plan. Where a habitat of potential nature conservation value is identified, more detailed quadrate-based surveys may be required.

5.1.2. Loss of species

It was not possible to undertake a full survey of the plant species thriving in the site because of the time when the final decision given on the selection of the site. Though through observations during the autumn and the rapid assessment performed during the spring, it expected that the site is shelter to more than 250/300 species including riparian plant and low altitude plant species. Though the species identified are found in other places and they are expected to be found at higher altitude in the region.

5.2. Impact on Fish and Macro invertebrates

The construction of the dam at the level of Bisri will significantly reduce the water flow downstream, to the Awali River estuary. This will certainly affect the Freshwater blenny population surviving in the lower course of the river. The construction of the dam will not pose a direct threat to the European eels present in the river. It is expected that the Middle Eastern Green carp will find the dam a suitable habitat and a large population is expected to quickly establish. The species will certainly have a local commercial importance. Furthermore, the presence of this herbivore will be valuable to the new ecosystem that will be created with the construction of the dam.

Both the minnow *P. kervillei* and the loach *O. leontinae* will probably not be negatively affected by the presence of the dam. On the contrary, they may thrive in large numbers and have a significant role in the newly formed ecosystem. *Pseudophoxinus kervillei* may have commercial importance locally.

5.3. Impact on Herpatofauna (Amphibians and Reptiles)

The impacts of the dam on each species could be upstream or downstream and could affect the general habitat requirements, breeding habitats, food requirements and vulnerability to predators. Some species could be negatively impacted and some could be positively affected.

5.3.1. Upstream Impact:

a. General Habitat: the habitats will be flooded and destroyed and all the species will be pushed into new habitats that might not be suitable. The established riparian habitats that includes *Platanus* (and similar) trees, reed beds and other habitats of the river's wetted zone. The fluctuating levels of the artificial lake will inhibit the formation of a littoral zone which is part of the general habitat. All species will be affected especially *Bufo bufo*.

b. Breeding Habitat: All the amphibian species require shallow aquatic habitats for breeding with slow water flow rates. This will only be found on the peripheral (coastal) zones of the resulting lake. These zones will suffer from fluctuating levels from season to season or from year to year. Considering that the breeding period involves several stages, namely, mate attraction (advertising), mating, egg stage and larval stages (e.g. tadpoles), the breeding process might practically involve several weeks. If the fluctuation occurs during the breeding season (March-June), it would affect one or more of these stages. All amphibian species will be affected

c. Food Source: All the amphibian species are insectivorous feeding on invertebrates. These are affected by riparian and shallow water (littoral) habitats. It is not certain how long it will take these invertebrates to reach the levels of abundance as those before the dam. All species will be affected.

5.3.2. Down Stream Impact:

a. General Habitat: The regulated river flow might benefit the riparian vegetation in some locations normally subjected to flooding and might harm it in other locations where the water flow is normally limited in pre-dam days. All species will be affected.
b. Breeding Habitat: The regulated river flow below the dam might provide suitable habitats for breeding that were not available in pre-dam days. The danger lies when the flow reaches levels that will lead to the disappearance of suitable aquatic habitats. All amphibian species will be affected.
c. Food Source: There is uncertainty about the effect of the dam on the invertebrate fauna of the river itself or that of the riparian zone. All species will be affected.

The upper level of the resulting lake might reach the lower regions of the Moukhtara River where there are populations of the rare species *Bufo* cf *bufo* whose habitat, based on current knowledge is very specialized consisting mostly of rocky terrain and riparian trees. This habitat will be flooded and destroyed.

5.4. Impact on Birds

5.4.1. Impact of noise on wildlife

The project area is inhabited by several species of wild animals and birds. Harm to animals is difficult to quantify since laboratory studies are often quite dissimilar to the real situation. Nevertheless, certain effects are obvious. In the case of short-term noises, e.g. construction, the animals may simply vacate the area. Their return depends on the nature of the project. The response of animals varies from species to species; from almost no reaction, to no tolerance of the sound. The long term noises originating due to blasting, hydraulic drills, vehicular noise and loading of vehicles may result in disappearance of some of the species of birds and animals from the area. However, some fauna may get used to the noise and stay. The level of impact will be more apparent if a survey is conducted on regular intervals such as either quarterly or bi-annually to understand the variations in the population of different species.

Some birds will be driven away permanently from nesting areas as a result of a project that brings a human population into the area (e.g. Long-legged Buzzard), whereas others do not seem to be affected at all (e.g. Graceful Warbler).

5.4.2. Loss of habitat

The project and various other activities will also affect the habitat of established species. Although, the project area itself is a very small portion of the general landscape, but the transport roads within the site and from the main road to the site, all become part of the project area and will result in disturbance and fragmentation of the habitat.

The project activity will also affect birds. Some species will desert the site like the Short-toed Eagle and Long-legged Buzzard for a more safe area. The other birds are considered banal species and may remain in the site with smaller numbers and in fragmented areas.

5.5. Impact on Mammals

The dam will certainly have an effect on mammal species during the construction phase; however, after the completion of the dam mammals' species will adapt to the dam presence and adjust their behavior accordingly, despite obstructing their dispersal route at some point. Moreover, the dam might attract other kinds of species like bats, shrews and otters who favor such habitat. The principal impacts of the project on individual mammal species depend on the ecology and behavior of the species in question. All animals, regardless of their behavior, will be subject to a degree of habitat fragmentation. Smaller mammals such as the shrew and squirrel will tend to have smaller home ranges, and will therefore be susceptible to both habitat loss and fragmentation. Larger or more mobile species may find their territories and key habitats fragmented by this dam, but are less likely to experience significant habitat loss. Mortality of species, both during the construction and operational phases of the project, should also be considered particularly, for those species with large home ranges that will tend to seek to cross roads more often.

6. MITIGATION MEASURES

Mitigation starts with minimizing disturbance through limited access to the area, minimize habitat alteration and land leveling as possible along with their natural vegetation, avoid direct persecution of animal species, and provide necessary training and awareness for project employee

6.1. Flora

Dams' downstream effects on riparian forests are strongly affected by the character and magnitude of adjustment of the fluvial-geomorphic system. The geology, hydrology, climate, and management have a direct influence on the ability of the fluvial system to adjust to dam-induced changes, as well as on the character and magnitude of that adjustment. The major concern for the vegetation and flora diversity is the control of water flooding, niches destruction of important plant species and the disturbance to the riparian forest age structure and sex ration of some tree species. The timing of the implementation of the mitigation strategies for managing impacts to flora can be divided into activities that will be undertaken during the pre-construction, construction and post construction phases of the project.

Consequently, the suggested mitigation measures are the following:

1- Fluvial adjustment must be anticipated along alluvial channels where dams alter downstream hydrology and/or sediment load. This is important to give room for the colonization of tree species expected to occur along the banks of the lake.
2- The management strategies of river ecosystem among which riparian forest must focus on simulation of natural hydrographs especially the restoration of flooding frequency
3- The sex ratio of dioecious species such as populous and salix must be monitored to ensure the re-establishment of the tree populations.
4- Translocation of Orchis sp., Fritillaria sp., Ornithogalum sp., Hyacinthus sp., ferns and other species must be done before the construction of the dam and the inundation of downstream areas.
5- Management practices of the dam must foresee steps to reduce the disturbance intensity in order to increase biodiversity in the newly established river banks and lake formation.
6- Measures should also be undertaken to ensure that existing micro-climatic conditions in habitats supporting communities or species of nature conservation importance are maintained.

7- Individual trees and patches of vegetation to be retained close to busy construction zones will be fenced. The location of fencing will be approved by a plant ecologist. Signs indicating the area is a "sensitive environmental area" will be clearly and securely affixed to the fencing.

8- A qualified ecologist will audit the clearing of vegetation during construction of the project and will quantify the area of the dam vegetation community cleared for the biodiversity offset strategy.

9- Mature citrus and stone fruit trees are hard to be transplanted. Consequently, the orchards in Marj Bisri will be lost. This loss has to be accounted for during planning and implementation of the project.

10- The green houses in Marj Bisri could be relocated with their plants with no actual loss.

6.2. Fish and Macro invertebrates

Since the dam is an artificial newly formed ecosystem, it will be highly advisable from an aquatic scientist's point of view to have:

1- Clearly defined boundaries
2- A year-round regular river inflow and outflow
3- Shallow vegetated areas
4- Minimum human disturbance

Continuously running unpolluted water would help preventing the complete disappearance of the species. It is of high importance that

1- Freshwater keeps running between the dam and the sea in order not to hamper the eels from migrating back and forth and,
2- one or more fish-passes that connect the river to the dam are built, allowing the fish to enter and leave the dam (Figure 2). The presence of this species in the dam will result in adding a significant commercial value.

Figure 2. Different types of passes suitable for the freshwater eel (source Internet)

6.2.1. Fish introduction:

The introduction of exotic species such as carps, trouts, bass, tilapias, and mosquitofish is not recommended. Various studies have shown that the presence of these introduced species negatively affects the native fauna and the ecology of the dam. If introduction is deemed profitable, a full ecological impact assessment by an aquatic ecologist should precede it.

6.3. Herpetofauna (Amphibians and Reptiles)

Amphibians are water dependent animals hence the following mitigation measures have to be taken into consideration to insure their persistence.

1. Water flow downstream should always be maintained at levels that do not harm the riparian vegetation or destroy general and breeding habitats.
2. Breeding habitats on the lake peripheries should be evaluated regularly and alternative habitats should be created. One measure that would benefit not only the amphibian species but many other plants and animals, is to create artificial wetlands in the areas at the edge and/or surrounding the artificial lake whereby water levels are kept there at constant permanent or semi-permanent levels especially during the breeding season. This

will allow the establishment of permanent shallow littoral zones that will become home to various plant and animal species.

3. Measures should be taken to avoid drying-out amphibian breeding sites through local disruptions to hydrology.
4. Pollution of amphibian breeding sites should also be prevented, by the sensitive design of construction site drainage and the implementation of pollution control measures.
5. The installation of reptile-proof fencing to prevent reptiles from returning or accessing to the most hazardous parts of the construction site should also be considered.
6. The seasonal programming of site clearance works should also be reviewed, to avoid the hibernation period during which aggregations of torpid reptiles could be encountered that would not have the ability to escape the works.

6.4. Birds

Birds are very sensitive group of animals and can be easily disturbed. Hence, disturbance by dam construction might have a negative impact on their status. The following mitigation measures should be considered

1. Noise creating sources should be properly lined and secured. The compressor and generator have been installed in a properly constructed room, which should be enough to filter out most of the noise. However, if that is not enough, other lining options should be explored, such as a clay liner inside and outside the room.
2. Blasting should be kept to a minimal and scheduled during the daytime.
3. Transport related noise should be kept to minimal through the optimum use of vehicles and proper vehicle maintenance.
4. No exotic bird species should be introduced to the wilderness of the site without guidance from a natural resourced approved specialist.
5. No hunting will be allowed in the site for any reason, especially that the hunting is not allowed by the Law 580/04 within 500 meters from any human agglomeration.
6. Proper guidance to be taken from a wildlife expert on occasions when wildlife is noticed within or near the site.
7. There is a need to maintain the Oak (*Quercus calliprinus*) in some stands to maintain the population of Jay that is known for its benefits to ecosystems.

8. The Bruti Pine (*Pinus brutia*) is a flammable tree and easily infested by the Processionary caterpillar. Subsequently, it should be managed to avoid natural fire near houses and to reduce the allergic impact of the caterpillar. Its management should be accompanied with the introduction of Cuckoo that eats the poisonous caterpillar.
9. Wherever possible, undertake vegetation clearance outside the bird nesting season March to August inclusive.

6.5. Mammals:

The diverse life-cycles, behavior, and habitat requirements of the different mammal species found in Lebanon, require effective mitigation, compensation and enhancement measures to be designed on a species-specific and also site- and project-specific basis. It is important to take measures to avoid impacts on habitats likely to be of particular value to mammal species of nature conservation importance wherever possible. Where valuable habitats or other important sites for mammals (e.g. places of shelter, or key foraging resources) cannot be avoided, appropriate mitigation measures should be designed and implemented.

1- Where impacts associated with fragmentation are expected, mitigation may include the provision of safe crossing points to enable dispersal and maintain links between otherwise fragmented populations. Such crossing points may take the form of pipes, culverts, tunnels and bridges with associated mammal-resistant fencing to 'funnel' animals towards these structures.

2- Mammal-resistant fencing along with appropriate hedgerow treatments should be used as a barrier to guide animals towards safe crossing points and to prevent animals from straying onto the carriageway, reducing the risk of mammal mortality.

3- The visual deterrents such as roadside reflectors may also be installed to discourage animals, in particular, from approaching the carriageway, although the effectiveness of such measures is questionable and should only be used in areas where only occasional interaction between mammals and roads are expected.

4- Habitat and/or species translocation should be considered as a last resort where it is not possible to avoid impacts on a sensitive habitat or species.

5- Concerning the two dairy farms present within the site could be relocated easily. As for the the private zoo, it has to be managed in different ways depending on the animal species in question. For example the chimp and the wild carnivores like tigers and lions have to be returned to their country of origin or sent to other sanctuaries since Lebanon is not a suitable habitat for them. However, Lebanese wild carnivores like the hyaenas and foxes could be reintroduced to the Lebanese wilderness with no problems because of their opportunistic feeding behavior. Deer and other herbivore could be maintained in a suitable place as these are semi-domestic animals.

6.6. General mitigation

1. There should be maximum recruitment of labor from the site and its neighboring areas to make them feel part of the project. Recruitment of labor from down country should be avoided.
2. Since women have a very significant role to play in the protection of biodiversity, they should be kept informed of the project through regular meetings or through the labors within the community.
3. Contact between the outsiders and the community should be kept to a minimal to avoid any conflict.
4. The community should abide by its agreement with the local authority to provide full protection to the wildlife and other natural resources.
5. Regular monitoring of the biodiversity should be undertaken.
6. Minimize greenhouse gas releases from reservoirs by minimizing the flooding of land in general and forests in particular.

7. CONCLUSION

In the planning, implementation and operation of projects, the conservation of the quality of environment and the ecological balance should be of primary consideration. The adverse impact, on the environment should be minimized and should be off-set by adequate compensatory measures. Moreover, building a dam, sacrificing nature does not solve the challenges of overconsumption, over-pollution, and under-distribution. World Commission on Dams (WCD) 2000 reported “dams have made an important and significant contribution to human development, and benefits derived from them have been considerable. But in too many cases an unacceptable, and often unnecessary and high price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers, and by the natural environment."

Lebanon which is rich in its natural resources, face on the other hand lack of efficient environmental management causing an alarming degradation in those resources, and therefore, resulting in deforestation, soil erosion, water-resources' pollution, marine habitat destruction, and air pollution. . Hence, the adoption of appropriate EIA procedures will undoubtedly bring about necessary and innovative measures towards environmental protection, particularly after much environmental degradation during nearly two decades of civil unrest. Water pollution control measures may be needed to improve reservoir water quality. Fishing regulation is often essential to maintain viable populations of commercially valuable species, if effectively implemented; watershed management can minimize sedimentation and extend a reservoir's useful physical life. Finally, demands are increasing every year for water while resources are becoming more and more limited, combined with the pollution of water which has had many adverse effects on the environment, growth and economy of many countries. Hence, improving irrigation methods, wise use of water, and efficient water transport are of utmost importance to be implemented.

In conclusion, protecting biodiversity of a project area is in the interest of all the stakeholders of a project. The biodiversity protection cannot be achieved without the support of the community, as is evident from this project. Proper cooperation between community and the project proponent can help in protecting the biodiversity of an area. Efforts should be made to incorporate BIA in all EIAs since this is one tool, which has proven successful in minimizing the impacts on biodiversity.

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APPENDIX E

WATER QUALITY

Appendix E1: AUB sampling at Bisri Bridge

Date	20/04/10	27/04/10	04/05/10	11/05/10	18/05/10	05/04/11	12/04/11	19/04/11	26/04/11	22/06/12
Temperature	19.6	14.1	17.5	18.6	20.5	16.1	19.2	13.1	16.2	
Color	17	3	5	4	4	19	15	14	6	22
Turbidity	5.05	1.37	1.15	2	1.11	5	3	4	2	2.4
Conductivity	428	446	465	518	534	451	482	448	468	383
Acidity as $CaCO_3$	10	5	5		5	10	5	10	5	
Total Alcalinity as $CaCO_3$	155	175	175		180	140	145	140	150	
pH at 20°C	7.51	7.57	7.88		7.81	7.84	7.86	7.99	7.95	7.89
Calcium hardness as $CaCO_3$	180	190	200		200	200	200	190	190	181
Magnesium hardness as $CaCO_3$	35	50	35		40	40	40	45	50	61
Total hardness as $CaCO_3$	215	240	235	5	240	240	240	235	240	242
Chlorides Cl^-	10	10	15	180	20	12.5	12.5	12.5	12.5	14.6
Sulfates SO_4^{2-}	40	39	37	7.81	45	35	36	34	35	29
Phosphates as P	0.04	0.06	0.05	210	0.07	0.03	0.03	0.03	0.11	0.10
Phosphorus as P_2O_5	0.06	0.08	0.07	40	0.09	0.05	0.04	0.04	0.13	
Dissolved Iron Fe^{2+}	0.06	0.09	0.09	250	0.13	0.18	0.13	0.13	0.12	
Ammonia Nitrogen as	0.36	0.32	0.33	25	0.35	0.19	0.24	0.37	0.33	0.09

Date	20/04/10	27/04/10	04/05/10	11/05/10	18/05/10	05/04/11	12/04/11	19/04/11	26/04/11	22/06/12
NH_4^+										
Nitrites as NO_2^-	0.049	0.045	0.043	42	0.079	0.042	0.039	0.045	0.072	0.036
Nitrates as NO_3^-	8.85	8.35	8.41	0.05	7.97	8.41	7.02	7.52	8.41	7.2
Dissolved oxygen as O_2 (23°C)	4	5	5	0.07	6	5	6	5	5	
TDS as NaCl	216	225	235	262	270	228	243	226	236	192
Mineralization Virtual	306	319	333	371	382	323	345	320	335	
CO_2	9	10	4	5	5	4	3	3	3	
Fluorides	0.15	0.21	0.43	0.05	0.35	0.09	0.11	0.12	0.09	0.30
Manganese Total	0.04	0.05	0.08	0.08	0.02	na	na	na	na	3.4
Sulphide	0.002	0.004	0.001	0.001	0.001	0.005	0.006	0.006	0.003	
BOD_5	21	21	0.2							<2
COD						3	4	17	12	<2
Coliform Bacteria (at 37°C) U.F.C./100ml	14407	8419	8710	11278	34420	39230	20300	25100	22000	>500
Thermo Tolerant Coliform (at 44°C) U.F.C./100ml	12650	7560	7835	6645	14370	24150	5540	4980	13240	
Escherichia coli	545	1160	870	760	1400	1720	1320	660	4760	284

Appendix E2: AUB Sampling at Bisri bridge for BMLWE

Parameter	**07/12/11**	**21/12/11**	**04/01/12**	**25/01/12**	**01/02/12**	**15/02/12**	**29/02/12**	**14/03/12**	**28/03/12**	**11/04/12**	**25/04/12**	**09/05/12**
Water Temp. (°C)	12.8	13.5	14.1	12.5	11.2	14.3	9.3	12.8	14.2	16.0	18.6	20.7
DO (mg/L)	9.38	9.84	9.11	8.18	9.41	8.11	9.19	8.58	8.24	8.9	8.99	9.6
TOC (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BOD_5 (mg/L)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
COD (mg/L)	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Cyanide (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron (mg/L)				<0.25							<0.25	
Manganese (mg/L)				<0.25							<2.0	
Arsenic (µg/L)				<1							<2.0	
Cadmium (µg/L)				<0.25							<0.25	

Parameter	**07/12/11**	**21/12/11**	**04/01/12**	**25/01/12**	**01/02/12**	**15/02/12**	**29/02/12**	**14/03/12**	**28/03/12**	**11/04/12**	**25/04/12**	**09/05/12**
Chromium (µg/L)				<1							<1.0	
Copper (µg/L)				3.2							<1.0	
Lead (µg/L)				<1							<1.0	
Selenium (µg/L)				<2							<2.0	
Antimony (µg/L)				<2							<2.0	
Barium (µg/L)				25							24	
Berylium (µg/L)				3							na	
Mercury (µg/L)				<1							<0.5	
Thallium (µg/L)				<2							<2	

Appendix E3: Dar Sampling for ESIA (Oct 2012)

Sampling Point	BW 1	BW 1	BW 2	BW 3	BW 4	BW 5
Date	**22/06/12**	**03/10/12**	**03/10/12**	**03/10/12**	**03/10/12**	**03/10/12**
Turbidity	2.4	1.1	1.1	0.64	1.0	0.75
Conductivity	383	537	590	576	461	324
Colour	22	6	19	9	40	15
pH at 20°C	7.89	7.66	7.77	7.73	8.11	8.08
Carbonate Alkalinity as $CaCO_3$		0	0	0	0	0
Bicarbonate Alkalinity as $CaCO_3$		246	235.4	231.2	234	240
Calcium Hardness as $CaCO_3$	181	na				
Magnesium Hardness as $CaCO_3$	61	na				
Total hardness as $CaCO_3$	242	254	346	342	276	254
Calcium		7504	104.7	105.4	81	78.6
Magnesium		1601	20.6	19.2	18	14.0
Sulphate SO_4^{2-}	29	45	144	146	45	28
Nitrate as NO_3^-	7.2	6.5	10.6	10.7	9.6	8.9
Nitrate-Nitrogen		1.5	2.4	2.4	2.2	2.0
Nitrite as NO_2^-	0.036	0.057	0.020	0.020	0.035	0.022
Nitrite-Nitrogen		0.017	0.006	0.006	0.011	0.007
Ammonia		0.16	<0.09	<0.09	<0.09	<0.09
Ammonia Nitrogen as NH_4^+	0.09	0.13	<0.09	<0.09	<0.09	<0.09
Ortho-Phosphate		0.09	0.39	0.28	0.29	0.41
Total Phosphorus	0.10	0.11	0.19	0.17	0.17	0.22
Chlorides Cl^-	14.6	24.2	37.4	37.6	36.6	32.8
Fluorides	0.30	0.32	0.45	0.56	0.52	0.52

Sampling Point	**BW 1**	**BW 1**	**BW 2**	**BW 3**	**BW 4**	**BW 5**
Date	**22/06/12**	**03/10/12**	**03/10/12**	**03/10/12**	**03/10/12**	**03/10/12**
BOD_5	<2	<2	<2	<2	<2	<2
COD	<2	<2	<2	<2	<2	<2
TOC		<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide		<0.005	<0.005	<0.005	<0.005	<0.005
TDS	192	267	295	288	231	212
TSS		13.2	10	4.7	12.8	5.2
Arsenic		<2	<2	<2	<2	<2
Cadmium		<0.25	<0.25	<0.25	<0.25	<0.25
Chromium		<1	<1	<1	<1	<1
Copper		<1	<1	<1	<1	<1
Iron		<0.25	<0.25	<0.25	<0.25	<0.25
Lead		<1	<1	<1	<1	<1
Manganese	3.4	<2	<2	<2	<2	<2
Selenium	3.4	<2	<2	<2	<2	<2
Barium	0.008	0.012	0.014	0.016	0.006	0.005
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Beryllium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Faecal coliforms	284	203	312	343	>500	>500
Total Coliforms	>500	>500	>500	>500	>500	>500
Gamma-BHC (Lindane) ug/l		0.01	0.02			
Dieldrin ug/l		0.02				0.05

Conductivity in μS/cm; pH in PH units; OGP pesticides in μg/l. All other determinations in mg/l.

Appendix E4: Certificate of test for 5 Samples taken by DAR for ESIA (Oct 2012)

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CERTIFICATE OF TEST

Requested by: **Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)**

Date **11/10/2012**

Your Ref. **R -22626-W**

Our Ref.

Nature of Test: **Sample ID:** **BW 1**
Date Received: **03/10/2012**

Turbidity (NTU)	**1.1**
Conductivity (µSiemens/cm at 25°C)	**537**
Apparent Color (Pt-Co units)	**6**
pH (pH Units 25°C)	**7.66**
Hydroxide Alkalinity (mg/L as $CaCO_3$)	**0**
Carbonate Alkalinity (mg/L as $CaCO_3$)	**0**
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	**246**
Total Hardness (mg/L as $CaCO_3$)	**254**
Calcium (mg/L Ca^{2+})	**75.4**
Magnesium (mg/L Mg^{2+})	**16.1**
Sulfate (mg/L SO_4^{2-})	**45**
Nitrate (mg/L NO_3^-)	**6.5**
Nitrate-Nitrogen (mg/L NO_3^-N)	**1.5**
Nitrite (mg/L NO_2^-)	**0.057**
Nitrite- Nitrogen (mg/L NO_2^-N)	**0.017**
Ammonia (mg/L NH_3)	**0.16**
Ammonia-Nitrogen (mg/L NH_3^-N)	**0.13**
Ortho-Phosphates (mg/L o-PO_4^{3-})	**0.09**
Total Phosphorus (mg/L P)	**0.11**
Chlorides (mg/L Cl^-)	**24.2**
Fluoride (mg/L F^-)	**0.32**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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CERTIFICATE OF TEST

Requested by: Date

Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)

Your Ref. **11/10/2012**

Our Ref. **R -22626-W**

Nature of Test:

Sample ID: **BW 1**
Date Received: **03/10/2012**

Biochemical Oxygen Demand (mg/L BOD_5)	**< 2**
Chemical Oxygen Demand (mg/L O_2)	**< 2**
Total Organic Carbon (mg/L C)	**< 0.5**
Cyanide (mg/L CN^-)	**< 0.005**
Total Dissolved Solids (mg/L 25 °C)	**267**
Total Suspended Solids (mg/L)	**13.2**
Arsenic (µg/L)	**< 2.0**
Cadmium (µg/L)	**< 0.25**
Chromium (µg/L)	**< 1.0**
Copper (µg/L)	**< 1.0**
Iron (mg/L)	**< 0.25**
Lead (µg/L)	**< 1.0**
Manganese (µg/L)	**< 2.0**
Selenium (µg/L)	**< 2.0**
Fecal Coliforms (CFU/100ml)	**203**
Total Coliforms (CFU/100ml)	**~>500**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 1
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Organochlorine Pesticides Profile:

Analysis	MDL	Sample BW 1 Result (R)	Method	UR	EPA / WHO MCL	MOH MCL
Alpha-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Gamma-BHC (Lindane)	0.01 ug/L	0.01 ug/L	EPA 608/508.1M	NE	0.2 ug/L	0.2 ug/L
Beta-BHC	0.01ug/L	<0.01ug/L	EPA 608/508.1M	NE	NA	NA
Heptachlor	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±40% of R	0.4 ug/L	NA
Delta-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Aldrin	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±41% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Heptachlor Epoxide	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±42% of R	0.2 ug/L	NA
Endosulfan I	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4' DDE	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	NE	NA	NA
Dieldrin	0.02 ug/L	0.02 ug/L	EPA 608/508.1M	R±26% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Endrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±29% of R	0.2 ug/L	NA
4,4'DDD	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan II	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4'DDT	0.06ug/L	<0.06ug/L	EPA 608/508.1M	R±43% of R	NA	NA
Endrin Aldehyde	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan Sulfate	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 1
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Volatiles Organic Compounds:

Analysis	MDL (ug/L)	Sample BW 1 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
Benzene	1	<1	EPA 524.2/602M	R ± 51% of R	5 ug/L	NA
Bromobenzene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
Bromochloromethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
Bromodichloromethane	1	<1	EPA 524.2/602M	R ± 10% of R	NA	NA
Bromoform	1	<1	EPA 524.2/602M	R ± 20% of R	NA	NA
n-Butyl Benzene	1	<1	EPA 524.2/602M	R ± 19% of R	NA	NA
tert Butyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
sec Butyl Benzene	1	<1	EPA 524.2/602M	R ± 15% of R	NA	NA
Carbon tetrachloride	1	<1	EPA 524.2/602M	R ± 12% of R	5 ug/L	NA
Chlorobenzene	1	<1	EPA 524.2/602M	R ± 57% of R	100 ug/L	NA
Chloroform	1	<1	EPA 524.2/602M	R ± 27% of R	100#	100
4-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
2-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 18% of R	NA	NA
1,2-Dibromo-3-chloropropane	1	<1	EPA 524.2/602M	R ± 57% of R	DBCP: 0.2 ug/L	NA
Dibromochloromethane	1	<1	EPA 524.2/602M	R ± 23% of R	NA	NA
1,2-Dibromoethane	1	<1	EPA 524.2/602M	R ± 31% of R	NA	NA
Dibromomethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,3-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	NA	NA
1,2-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 25% of R	600 ug/L	NA
1,4-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	75	NA
1,1-Dichloroethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,2-Dichloroethane	1	<1	EPA 524.2/602M	R ± 30% of R	NA	NA
cis-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 39% of R	NA	NA
trans-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
1,1-Dichloroethene	1	<1	EPA 524.2/602M	R ± 11% of R	5 ug/L	NA
1,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 19% of R	5 ug/L	NA
1,3-Dichloropropane	1	<1	EPA 524.2/602M	R ± 39% of R	5 ug/L	NA
2,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 26% of R	5 ug/L	NA
1,1-Dichloropropene	1	<1	EPA 524.2/602M	R ±27% of R	NA	NA
cis-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA

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Analysis	MDL (ug/L)	Sample BW 1 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
trans-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA
Ethylbenzene	1	<1	EPA 524.2/602M	NE	700 ug/L	NA
Hexachlorobutadiene	1	<1	EPA 524.2/602M	NE	NA	NA
Isopropylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
p-Isopropyltoluene	1	<1	EPA 524.2/602M	NE	NA	NA
Methylene Chloride	1	<1	EPA 524.2/602M	NE	NA	NA
Naphtalene	1	<1	EPA 524.2/602M	NE	NA	NA
n-Propyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
Styrene	1	<1	EPA 524.2/602M	NE	100	NA
1,1,1,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,2,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
Tetrachloroethene	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Toluene	1	<1	EPA 524.2/602M	NE	1000 ug/L	NA
1,2,3-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,4-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,1-Trichloroethane	1	<1	EPA 524.2/602M	NE	200 ug/L	NA
1,1,2-Trichloroethane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Trichloroethene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,3-Trichloropropane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
1,2,4-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,3,5-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
o-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
m-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
p -Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA

= MCL shown is for the total of these four compounds
@ = MCL shown is for total Xylene's
All detected analytes referred to as "Detected" were between instrument detection limit (0.1 µg/L) and the limit of quantification (1 µg/L).The qualified results represent values determined at levels where the true value of the measured chemical cannot be quantified with a high degree of confidence. The data user may consider these qualified results as estimates when making project decisions.

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Metal Analysis:

Analysis as Total per metal	MDL (mg/L)	Sample BW 1 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
Barium	0.002	0.012	EPA200-7/8 M	R ±11% of R	2.0 mg/L	0.5 mg/L
Thallium	0.002	<0.002	EPA200-7/8 M	R ±19% of R	0.002 mg/L	NA
Antimony	0.002	<0.002	EPA200-7/8 M	R ±26% of R	NA	NA
Beryllium	0.002	<0.002	EPA200-7/8 M	R ±13% of R	0.004 mg/L	NA
Mercury	0.0005	<0.0005	EPA200-7/8 M	R ±27% of R	0.002 mg/L	0.05 mg/L

Retention of Samples: Samples are discarded one week after delivery of report.
Contact Information: For administrative information, complaints or any other queries, Mrs. Asma Bazzi, EVL Administrator, can be reached at 01-350000, extension 5204, or by email at ab19@aub.edu.lb or by fax: 01-370845.

For further technical information, Ms. Carol Sukhn, EVL supervisor, can be reached at extensions 4845, 4849 or 4860, or by email at cs02@aub.edu.lb. Dr. Zuheir Habbal, EVL Technical Director, can be reached at extensions 5163 or 5220 or by email at mh03@aub.edu.lb. Thank you for using the Analytical Chemistry Laboratory at AUB.

Z. HAB
Dr. Zuheir Habbal
Director of Clinical Chemistry Laboratory
Director of Environment Core Laboratory

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CERTIFICATE OF TEST

Requested by:	**Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)**	Date	**11/10/2012**
		Your Ref.	**R -22626-W**
		Our Ref.	
	Sample ID: **BW 2**		
Nature of Test:	**Date Received:** **03/10/2012**		

Turbidity (NTU)	**1.1**
Conductivity (µSiemens/cm at 25°C)	**590**
Apparent Color (Pt-Co units)	**19**
pH (pH Units 25°C)	**7.77**
Hydroxide Alkalinity (mg/L as $CaCO_3$)	**0**
Carbonate Alkalinity (mg/L as $CaCO_3$)	**0**
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	**235.4**
Total Hardness (mg/L as $CaCO_3$)	**346**
Calcium (mg/L Ca^{2+})	**104.7**
Magnesium (mg/L Mg^{2+})	**20.6**
Sulfate (mg/L SO_4^{2-})	**144**
Nitrate (mg/L NO_3^-)	**10.6**
Nitrate-Nitrogen (mg/L NO_3^-N)	**2.4**
Nitrite (mg/L NO_2^-)	**0.020**
Nitrite- Nitrogen (mg/L NO_2^-N)	**0.006**
Ammonia (mg/L NH_3)	**< 0.09**
Ammonia-Nitrogen (mg/L NH_3^-N)	**< 0.09**
Ortho-Phosphates (mg/L o-PO_4^{3-})	**0.39**
Total Phosphorus (mg/L P)	**0.19**
Chlorides (mg/L Cl^-)	**37.4**
Fluoride (mg/L F^-)	**0.45**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

George M. Ayoub, Ph.D.
Professor of Civil & Environmental Engineering

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CERTIFICATE OF TEST

Requested by: Date

Dar Al-Handasah (c/o Elie Abou Rejaili)
(Shair and Partners)

Your Ref. **11/10/2012**

Our Ref. **R -22626-W**

Nature of Test:

Sample ID: **BW 2**
Date Received: **03/10/2012**

Biochemical Oxygen Demand (mg/L BOD_5)	**< 2**
Chemical Oxygen Demand (mg/L O_2)	**< 2**
Total Organic Carbon (mg/L C)	**< 0.5**
Cyanide (mg/L CN^-)	**< 0.005**
Total Dissolved Solids (mg/L 25 °C)	**295**
Total Suspended Solids (mg/L)	**10**
Arsenic (µg/L)	**< 2.0**
Cadmium (µg/L)	**< 0.25**
Chromium (µg/L)	**< 1.0**
Copper (µg/L)	**< 1.0**
Iron (mg/L)	**< 0.25**
Lead (µg/L)	**< 1.0**
Manganese (µg/L)	**< 2.0**
Selenium (µg/L)	**< 2.0**
Fecal Coliforms (CFU/100ml)	**312**
Total Coliforms (CFU/100ml)	**~>500**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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Organochlorine Pesticides Profile:

Analysis	MDL	Sample BW 2 Result (R)	Method	UR	EPA / WHO MCL	MOH MCL
Alpha-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Gamma-BHC (Lindane)	0.01 ug/L	0.02 ug/L	EPA 608/508.1M	NE	0.2 ug/L	0.2 ug/L
Beta-BHC	0.01ug/L	<0.01ug/L	EPA 608/508.1M	NE	NA	NA
Heptachlor	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±40% of R	0.4 ug/L	NA
Delta-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Aldrin	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±41% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Heptachlor Epoxide	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±42% of R	0.2 ug/L	NA
Endosulfan I	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4' DDE	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	NE	NA	NA
Dieldrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±26% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Endrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±29% of R	0.2 ug/L	NA
4,4'DDD	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan II	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4'DDT	0.06ug/L	<0.06ug/L	EPA 608/508.1M	R±43% of R	NA	NA
Endrin Aldehyde	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan Sulfate	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA

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Volatiles Organic Compounds:

Analysis	MDL (ug/L)	Sample BW 2 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
Benzene	1	<1	EPA 524.2/602M	R ± 51% of R	5 ug/L	NA
Bromobenzene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
Bromochloromethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
Bromodichloromethane	1	<1	EPA 524.2/602M	R ± 10% of R	NA	NA
Bromoform	1	<1	EPA 524.2/602M	R ± 20% of R	NA	NA
n-Butyl Benzene	1	<1	EPA 524.2/602M	R ± 19% of R	NA	NA
tert Butyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
sec Butyl Benzene	1	<1	EPA 524.2/602M	R ± 15% of R	NA	NA
Carbon tetrachloride	1	<1	EPA 524.2/602M	R ± 12% of R	5 ug/L	NA
Chlorobenzene	1	<1	EPA 524.2/602M	R ± 57% of R	100 ug/L	NA
Chloroform	1	<1	EPA 524.2/602M	R ± 27% of R	100#	100
4-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
2-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 18% of R	NA	NA
1,2-Dibromo-3-chloropropane	1	<1	EPA 524.2/602M	R ± 57% of R	DBCP: 0.2 ug/L	NA
Dibromochloromethane	1	<1	EPA 524.2/602M	R ± 23% of R	NA	NA
1,2-Dibromoethane	1	<1	EPA 524.2/602M	R ± 31% of R	NA	NA
Dibromomethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,3-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	NA	NA
1,2-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 25% of R	600 ug/L	NA
1,4-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	75	NA
1,1-Dichloroethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,2-Dichloroethane	1	<1	EPA 524.2/602M	R ± 30% of R	NA	NA
cis-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 39% of R	NA	NA
trans-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
1,1-Dichloroethene	1	<1	EPA 524.2/602M	R ± 11% of R	5 ug/L	NA
1,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 19% of R	5 ug/L	NA
1,3-Dichloropropane	1	<1	EPA 524.2/602M	R ± 39% of R	5 ug/L	NA
2,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 26% of R	5 ug/L	NA
1,1-Dichloropropene	1	<1	EPA 524.2/602M	R ±27% of R	NA	NA
cis-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA

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Analysis	MDL (ug/L)	Sample BW 2 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
trans-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA
Ethylbenzene	1	<1	EPA 524.2/602M	NE	700 ug/L	NA
Hexachlorobutadiene	1	<1	EPA 524.2/602M	NE	NA	NA
Isopropylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
p-Isopropyltoluene	1	<1	EPA 524.2/602M	NE	NA	NA
Methylene Chloride	1	<1	EPA 524.2/602M	NE	NA	NA
Naphtalene	1	<1	EPA 524.2/602M	NE	NA	NA
n-Propyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
Styrene	1	<1	EPA 524.2/602M	NE	100	NA
1,1,1,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,2,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
Tetrachloroethene	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Toluene	1	<1	EPA 524.2/602M	NE	1000 ug/L	NA
1,2,3-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,4-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,1-Trichloroethane	1	<1	EPA 524.2/602M	NE	200 ug/L	NA
1,1,2-Trichloroethane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Trichloroethene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,3-Trichloropropane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
1,2,4-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,3,5-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
o-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
m-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
p -Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA

= MCL shown is for the total of these four compounds
@ = MCL shown is for total Xylene's
All detected analytes referred to as "Detected" were between instrument detection limit (0.1 µg/L) and the limit of quantification (1 µg/L).The qualified results represent values determined at levels where the true value of the measured chemical cannot be quantified with a high degree of confidence. The data user may consider these qualified results as estimates when making project decisions.

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Metal Analysis:

Analysis as Total per metal	MDL (mg/L)	Sample BW 2 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
Barium	0.002	0.014	EPA200-7/8 M	R ±11% of R	2.0 mg/L	0.5 mg/L
Thallium	0.002	<0.002	EPA200-7/8 M	R ±19% of R	0.002 mg/L	NA
Antimony	0.002	<0.002	EPA200-7/8 M	R ±26% of R	NA	NA
Beryllium	0.002	<0.002	EPA200-7/8 M	R ±13% of R	0.004 mg/L	NA
Mercury	0.0005	<0.0005	EPA200-7/8 M	R ±27% of R	0.002 mg/L	0.05 mg/L

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For further technical information, Ms. Carol Sukhn, EVL supervisor, can be reached at extensions 4845, 4849 or 4860, or by email at cs02@aub.edu.lb. Dr. Zuheir Habbal, EVL Technical Director, can be reached at extensions 5163 or 5220 or by email at mh03@aub.edu.lb. Thank you for using the Analytical Chemistry Laboratory at AUB.

Z.HAB
Dr. Zuheir Habbal
Director of Clinical Chemistry Laboratory
Director of Environment Core Laboratory

النتائج في هذا التقرير تتعلق فقط بالفحوصات التي تم اجرائها على العينات التي سُلمت إلى المختبر
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Department of Civil and Environmental Engineering | قسم الهندسة المدنية والبيئية

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CERTIFICATE OF TEST

Requested by:	**Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)**	Date	**11/10/2012**
		Your Ref.	**R -22626-W**
	Sample ID: **BW 3**	Our Ref.	
Nature of Test:	**Date Received:** **03/10/2012**		

Turbidity (NTU)	**0.64**
Conductivity (µSiemens/cm at 25°C)	**576**
Apparent Color (Pt-Co units)	**9**
pH (pH Units 25°C)	**7.73**
Hydroxide Alkalinity (mg/L as $CaCO_3$)	**0**
Carbonate Alkalinity (mg/L as $CaCO_3$)	**0**
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	**231.2**
Total Hardness (mg/L as $CaCO_3$)	**342**
Calcium (mg/L Ca^{2+})	**105.4**
Magnesium (mg/L Mg^{2+})	**19.2**
Sulfate (mg/L SO_4^{2-})	**146**
Nitrate (mg/L NO_3^-)	**10.7**
Nitrate-Nitrogen (mg/L NO_3^-N)	**2.4**
Nitrite (mg/L NO_2^-)	**0.020**
Nitrite- Nitrogen (mg/L NO_2^-N)	**0.006**
Ammonia (mg/L NH_3)	**< 0.09**
Ammonia-Nitrogen (mg/L NH_3^-N)	**< 0.09**
Ortho-Phosphates (mg/L o-PO_4^{3-})	**0.28**
Total Phosphorus (mg/L P)	**0.17**
Chlorides (mg/L Cl^-)	**37.6**
Fluoride (mg/L F^-)	**0.56**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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CERTIFICATE OF TEST

Requested by: Date

Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)

Your Ref. **11/10/2012**

Our Ref. **R -22626-W**

Nature of Test:

Sample ID: **BW 3**
Date Received: **03/10/2012**

Biochemical Oxygen Demand (mg/L BOD_5)	**< 2**
Chemical Oxygen Demand (mg/L O_2)	**< 2**
Total Organic Carbon (mg/L C)	**< 0.5**
Cyanide (mg/L CN^-)	**< 0.005**
Total Dissolved Solids (mg/L 25 °C)	**288**
Total Suspended Solids (mg/L)	**4.7**
Arsenic (µg/L)	**< 2.0**
Cadmium (µg/L)	**< 0.25**
Chromium (µg/L)	**< 1.0**
Copper (µg/L)	**< 1.0**
Iron (mg/L)	**< 0.25**
Lead (µg/L)	**< 1.0**
Manganese (µg/L)	**< 2.0**
Selenium (µg/L)	**< 2.0**
Fecal Coliforms (CFU/100ml)	**343**
Total Coliforms (CFU/100ml)	**~>500**

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 3

Organochlorine Pesticides Profile:

Analysis	MDL	Sample BW 3 Result (R)	Method	UR	EPA / WHO MCL	MOH MCL
Alpha-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Gamma-BHC (Lindane)	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	0.2 ug/L	0.2 ug/L
Beta-BHC	0.01ug/L	<0.01ug/L	EPA 608/508.1M	NE	NA	NA
Heptachlor	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±40% of R	0.4 ug/L	NA
Delta-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Aldrin	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±41% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Heptachlor Epoxide	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±42% of R	0.2 ug/L	NA
Endosulfan I	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4' DDE	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	NE	NA	NA
Dieldrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±26% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Endrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±29% of R	0.2 ug/L	NA
4,4'DDD	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan II	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4'DDT	0.06ug/L	<0.06ug/L	EPA 608/508.1M	R±43% of R	NA	NA
Endrin Aldehyde	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan Sulfate	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 3
Page 4 of 5

Analysis	MDL (ug/L)	Sample BW 3 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
trans-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA
Ethylbenzene	1	<1	EPA 524.2/602M	NE	700 ug/L	NA
Hexachlorobutadiene	1	<1	EPA 524.2/602M	NE	NA	NA
Isopropylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
p-Isopropyltoluene	1	<1	EPA 524.2/602M	NE	NA	NA
Methylene Chloride	1	<1	EPA 524.2/602M	NE	NA	NA
Naphtalene	1	<1	EPA 524.2/602M	NE	NA	NA
n-Propyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
Styrene	1	<1	EPA 524.2/602M	NE	100	NA
1,1,1,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,2,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
Tetrachloroethene	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Toluene	1	<1	EPA 524.2/602M	NE	1000 ug/L	NA
1,2,3-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,4-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,1-Trichloroethane	1	<1	EPA 524.2/602M	NE	200 ug/L	NA
1,1,2-Trichloroethane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Trichloroethene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,3-Trichloropropane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
1,2,4-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,3,5-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
o-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
m-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
p -Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA

= MCL shown is for the total of these four compounds

@ = MCL shown is for total Xylene's

All detected analytes referred to as "Detected" were between instrument detection limit (0.1 µg/L) and the limit of quantification (1 µg/L).The qualified results represent values determined at levels where the true value of the measured chemical cannot be quantified with a high degree of confidence. The data user may consider these qualified results as estimates when making project decisions.

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 3
Page 5 of 5

Metal Analysis:

Analysis as Total per metal	MDL (mg/L)	Sample BW 3 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
Barium	0.002	0.016	EPA200-7/8 M	R ±11% of R	2.0 mg/L	0.5 mg/L
Thallium	0.002	<0.002	EPA200-7/8 M	R ±19% of R	0.002 mg/L	NA
Antimony	0.002	<0.002	EPA200-7/8 M	R ±26% of R	NA	NA
Beryllium	0.002	<0.002	EPA200-7/8 M	R ±13% of R	0.004 mg/L	NA
Mercury	0.0005	<0.0005	EPA200-7/8 M	R ±27% of R	0.002 mg/L	0.05 mg/L

Retention of Samples: Samples are discarded one week after delivery of report.
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Director of Clinical Chemistry Laboratory
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CERTIFICATE OF TEST

Requested by: **Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)**

Date **11/10/2012**

Your Ref.

Our Ref. **R -22626-W**

Sample ID: **BW 4**
Date Received: **03/10/2012**

Nature of Test:

Turbidity (NTU)	**1.0**
Conductivity (µSiemens/cm at 25°C)	**461**
Apparent Color (Pt-Co units)	**40**
pH (pH Units 25°C)	**8.11**
Hydroxide Alkalinity (mg/L as $CaCO_3$)	**0**
Carbonate Alkalinity (mg/L as $CaCO_3$)	**0**
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	**234**
Total Hardness (mg/L as $CaCO_3$)	**276**
Calcium (mg/L Ca^{2+})	**81**
Magnesium (mg/L Mg^{2+})	**18**
Sulfate (mg/L SO_4^{2-})	**45**
Nitrate (mg/L NO_3^-)	**9.6**
Nitrate-Nitrogen (mg/L NO_3^-N)	**2.2**
Nitrite (mg/L NO_2^-)	**0.035**
Nitrite- Nitrogen (mg/L NO_2^-N)	**0.011**
Ammonia (mg/L NH_3)	**< 0.09**
Ammonia-Nitrogen (mg/L NH_3^-N)	**< 0.09**
Ortho-Phosphates (mg/L o-PO_4^{3-})	**0.29**
Total Phosphorus (mg/L P)	**0.17**
Chlorides (mg/L Cl^-)	**36.6**
Fluoride (mg/L F^-)	**0.52**

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		Your Ref.	**R -22626-W**
		Our Ref.	
Nature of Test:	**Sample ID:** **BW 4** **Date Received:** **03/10/2012**		

Biochemical Oxygen Demand (mg/L BOD_5)	**< 2**
Chemical Oxygen Demand (mg/L O_2)	**< 2**
Total Organic Carbon (mg/L C)	**< 0.5**
Cyanide (mg/L CN^-)	**< 0.005**
Total Dissolved Solids (mg/L 25 °C)	**231**
Total Suspended Solids (mg/L)	**12.8**
Arsenic (µg/L)	**< 2.0**
Cadmium (µg/L)	**< 0.25**
Chromium (µg/L)	**< 1.0**
Copper (µg/L)	**< 1.0**
Iron (mg/L)	**< 0.25**
Lead (µg/L)	**< 1.0**
Manganese (µg/L)	**< 2.0**
Selenium (µg/L)	**< 2.0**
Fecal Coliforms (CFU/100ml)	**~>500**
Total Coliforms (CFU/100ml)	**~>500**

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 4
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Organochlorine Pesticides Profile:

Analysis	MDL	Sample BW 4 Result (R)	Method	UR	EPA / WHO MCL	MOH MCL
Alpha-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Gamma-BHC (Lindane)	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	0.2 ug/L	0.2 ug/L
Beta-BHC	0.01ug/L	<0.01ug/L	EPA 608/508.1M	NE	NA	NA
Heptachlor	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±40% of R	0.4 ug/L	NA
Delta-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Aldrin	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±41% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Heptachlor Epoxide	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±42% of R	0.2 ug/L	NA
Endosulfan I	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4' DDE	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	NE	NA	NA
Dieldrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±26% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Endrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±29% of R	0.2 ug/L	NA
4,4'DDD	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan II	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4'DDT	0.06ug/L	<0.06ug/L	EPA 608/508.1M	R±43% of R	NA	NA
Endrin Aldehyde	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan Sulfate	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA

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Volatiles Organic Compounds:

Analysis	MDL (ug/L)	Sample BW 4 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
Benzene	1	<1	EPA 524.2/602M	R ± 51% of R	5 ug/L	NA
Bromobenzene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
Bromochloromethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
Bromodichloromethane	1	<1	EPA 524.2/602M	R ± 10% of R	NA	NA
Bromoform	1	<1	EPA 524.2/602M	R ± 20% of R	NA	NA
n-Butyl Benzene	1	<1	EPA 524.2/602M	R ± 19% of R	NA	NA
tert Butyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
sec Butyl Benzene	1	<1	EPA 524.2/602M	R ± 15% of R	NA	NA
Carbon tetrachloride	1	<1	EPA 524.2/602M	R ± 12% of R	5 ug/L	NA
Chlorobenzene	1	<1	EPA 524.2/602M	R ± 57% of R	100 ug/L	NA
Chloroform	1	<1	EPA 524.2/602M	R ± 27% of R	100#	100
4-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
2-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 18% of R	NA	NA
1,2-Dibromo-3-chloropropane	1	<1	EPA 524.2/602M	R ± 57% of R	DBCP: 0.2 ug/L	NA
Dibromochloromethane	1	<1	EPA 524.2/602M	R ± 23% of R	NA	NA
1,2-Dibromoethane	1	<1	EPA 524.2/602M	R ± 31% of R	NA	NA
Dibromomethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,3-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	NA	NA
1,2-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 25% of R	600 ug/L	NA
1,4-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	75	NA
1,1-Dichloroethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,2-Dichloroethane	1	<1	EPA 524.2/602M	R ± 30% of R	NA	NA
cis-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 39% of R	NA	NA
trans-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
1,1-Dichloroethene	1	<1	EPA 524.2/602M	R ± 11% of R	5 ug/L	NA
1,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 19% of R	5 ug/L	NA
1,3-Dichloropropane	1	<1	EPA 524.2/602M	R ± 39% of R	5 ug/L	NA
2,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 26% of R	5 ug/L	NA
1,1-Dichloropropene	1	<1	EPA 524.2/602M	R ±27% of R	NA	NA
cis-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 4
Page 4 of 5

Analysis	MDL (ug/L)	Sample BW 4 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
trans-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA
Ethylbenzene	1	<1	EPA 524.2/602M	NE	700 ug/L	NA
Hexachlorobutadiene	1	<1	EPA 524.2/602M	NE	NA	NA
Isopropylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
p-Isopropyltoluene	1	<1	EPA 524.2/602M	NE	NA	NA
Methylene Chloride	1	<1	EPA 524.2/602M	NE	NA	NA
Naphtalene	1	<1	EPA 524.2/602M	NE	NA	NA
n-Propyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
Styrene	1	<1	EPA 524.2/602M	NE	100	NA
1,1,1,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,2,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
Tetrachloroethene	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Toluene	1	<1	EPA 524.2/602M	NE	1000 ug/L	NA
1,2,3-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,4-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,1-Trichloroethane	1	<1	EPA 524.2/602M	NE	200 ug/L	NA
1,1,2-Trichloroethane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Trichloroethene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,3-Trichloropropane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
1,2,4-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,3,5-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
o-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
m-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
p -Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA

= MCL shown is for the total of these four compounds
@ = MCL shown is for total Xylene's
All detected analytes referred to as "Detected" were between instrument detection limit (0.1 µg/L) and the limit of quantification (1 µg/L).The qualified results represent values determined at levels where the true value of the measured chemical cannot be quantified with a high degree of confidence. The data user may consider these qualified results as estimates when making project decisions.

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 4
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Metal Analysis:

Analysis as Total per metal	MDL (mg/L)	Sample BW 4 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
Barium	0.002	0.006	EPA200-7/8 M	R ±11% of R	2.0 mg/L	0.5 mg/L
Thallium	0.002	<0.002	EPA200-7/8 M	R ±19% of R	0.002 mg/L	NA
Antimony	0.002	<0.002	EPA200-7/8 M	R ±26% of R	NA	NA
Beryllium	0.002	<0.002	EPA200-7/8 M	R ±13% of R	0.004 mg/L	NA
Mercury	0.0005	<0.0005	EPA200-7/8 M	R ±27% of R	0.002 mg/L	0.05 mg/L

Retention of Samples: Samples are discarded one week after delivery of report.
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Z. HABB
Dr. Zuheir Habbal
Director of Clinical Chemistry Laboratory
Director of Environment Core Laboratory

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CERTIFICATE OF TEST

Requested by:	**Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)**	Date	**11/10/2012**
		Your Ref.	**R -22626-W**
		Our Ref.	

Nature of Test:

Sample ID: **BW 5**
Date Received: **03/10/2012**

Turbidity (NTU)	**0.75**
Conductivity (µSiemens/cm at 25°C)	**423**
Apparent Color (Pt-Co units)	**15**
pH (pH Units 25°C)	**8.08**
Hydroxide Alkalinity (mg/L as $CaCO_3$)	**0**
Carbonate Alkalinity (mg/L as $CaCO_3$)	**0**
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	**240**
Total Hardness (mg/L as $CaCO_3$)	**254**
Calcium (mg/L Ca^{2+})	**78.6**
Magnesium (mg/L Mg^{2+})	**14.1**
Sulfate (mg/L SO_4^{2-})	**28**
Nitrate (mg/L NO_3^-)	**8.9**
Nitrate-Nitrogen (mg/L NO_3^-N)	**2.0**
Nitrite (mg/L NO_2^-)	**0.022**
Nitrite- Nitrogen (mg/L NO_2^-N)	**0.007**
Ammonia (mg/L NH_3)	**< 0.09**
Ammonia-Nitrogen (mg/L NH_3^-N)	**< 0.09**
Ortho-Phosphates (mg/L o-PO_4^{3-})	**0.41**
Total Phosphorus (mg/L P)	**0.22**
Chlorides (mg/L Cl^-)	**32.8**
Fluoride (mg/L F^-)	**0.52**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

George M. Ayoub, Ph.D.
Professor of Civil & Environmental Engineering

Beirut PO Box 11-0236, Riad El Solh 1107 2020, Beirut, Lebanon | Tel: 961-1-350000 Ext. 3462/8/9 | Email: soilab@aub.edu.lb
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CERTIFICATE OF TEST

Requested by:		Date	
	Dar Al-Handasah (c/o Elie Abou Rejaili) (Shair and Partners)	Your Ref.	**11/10/2012**
		Our Ref.	**R -22626-W**

Nature of Test:

Sample ID: **BW 5**
Date Received: **03/10/2012**

Biochemical Oxygen Demand (mg/L BOD_5)	**< 2**
Chemical Oxygen Demand (mg/L O_2)	**< 2**
Total Organic Carbon (mg/L C)	**< 0.5**
Cyanide (mg/L CN^-)	**< 0.005**
Total Dissolved Solids (mg/L 25 °C)	**212**
Total Suspended Solids (mg/L)	**5.2**
Arsenic (µg/L)	**< 2.0**
Cadmium (µg/L)	**< 0.25**
Chromium (µg/L)	**< 1.0**
Copper (µg/L)	**< 1.0**
Iron (mg/L)	**< 0.25**
Lead (µg/L)	**< 1.0**
Manganese (µg/L)	**< 2.0**
Selenium (µg/L)	**< 2.0**
Fecal Coliforms (CFU/100ml)	**~>500**
Total Coliforms (CFU/100ml)	**~>500**

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW5
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Organochlorine Pesticides Profile:

Analysis	MDL	Sample BW 5 Result (R)	Method	UR	EPA / WHO MCL	MOH MCL
Alpha-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Gamma-BHC (Lindane)	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	0.2 ug/L	0.2 ug/L
Beta-BHC	0.01ug/L	<0.01ug/L	EPA 608/508.1M	NE	NA	NA
Heptachlor	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±40% of R	0.4 ug/L	NA
Delta-BHC	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	NE	NA	NA
Aldrin	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±41% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Heptachlor Epoxide	0.01 ug/L	<0.01 ug/L	EPA 608/508.1M	R±42% of R	0.2 ug/L	NA
Endosulfan I	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4' DDE	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	NE	NA	NA
Dieldrin	0.02 ug/L	0.05 ug/L	EPA 608/508.1M	R±26% of R	0.03ug/L(Aldrin/Dieldrin)	0.02ug/L (Aldrin+ Dieldrin)
Endrin	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±29% of R	0.2 ug/L	NA
4,4'DDD	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan II	0.02 ug/L	<0.02 ug/L	EPA 608/508.1M	R±35% of R	NA	NA
4,4'DDT	0.06ug/L	<0.06ug/L	EPA 608/508.1M	R±43% of R	NA	NA
Endrin Aldehyde	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA
Endosulfan Sulfate	0.06 ug/L	<0.06 ug/L	EPA 608/508.1M	NE	NA	NA

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Page 3 of 5

Volatiles Organic Compounds:

Analysis	MDL (ug/L)	Sample BW 5 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
Benzene	1	<1	EPA 524.2/602M	R ± 51% of R	5 ug/L	NA
Bromobenzene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
Bromochloromethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
Bromodichloromethane	1	<1	EPA 524.2/602M	R ± 10% of R	NA	NA
Bromoform	1	<1	EPA 524.2/602M	R ± 20% of R	NA	NA
n-Butyl Benzene	1	<1	EPA 524.2/602M	R ± 19% of R	NA	NA
tert Butyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
sec Butyl Benzene	1	<1	EPA 524.2/602M	R ± 15% of R	NA	NA
Carbon tetrachloride	1	<1	EPA 524.2/602M	R ± 12% of R	5 ug/L	NA
Chlorobenzene	1	<1	EPA 524.2/602M	R ± 57% of R	100 ug/L	NA
Chloroform	1	<1	EPA 524.2/602M	R ± 27% of R	100#	100
4-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
2-Chlorotoluene	1	<1	EPA 524.2/602M	R ± 18% of R	NA	NA
1,2-Dibromo-3-chloropropane	1	<1	EPA 524.2/602M	R ± 57% of R	DBCP: 0.2 ug/L	NA
Dibromochloromethane	1	<1	EPA 524.2/602M	R ± 23% of R	NA	NA
1,2-Dibromoethane	1	<1	EPA 524.2/602M	R ± 31% of R	NA	NA
Dibromomethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,3-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	NA	NA
1,2-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 25% of R	600 ug/L	NA
1,4-Dichlorobenzene	1	<1	EPA 524.2/602M	R ± 16% of R	75	NA
1,1-Dichloroethane	1	<1	EPA 524.2/602M	R ± 24% of R	NA	NA
1,2-Dichloroethane	1	<1	EPA 524.2/602M	R ± 30% of R	NA	NA
cis-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 39% of R	NA	NA
trans-1,2-Dichloroethene	1	<1	EPA 524.2/602M	R ± 13% of R	NA	NA
1,1-Dichloroethene	1	<1	EPA 524.2/602M	R ± 11% of R	5 ug/L	NA
1,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 19% of R	5 ug/L	NA
1,3-Dichloropropane	1	<1	EPA 524.2/602M	R ± 39% of R	5 ug/L	NA
2,2-Dichloropropane	1	<1	EPA 524.2/602M	R ± 26% of R	5 ug/L	NA
1,1-Dichloropropene	1	<1	EPA 524.2/602M	R ±27% of R	NA	NA
cis-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA

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Analysis	MDL (ug/L)	Sample BW 5 Result (R) (ug/L)	Method	UR	EPA / WHO MCL	MOH MCL
trans-1,3-Dichloro-1-propene	1	<1	EPA 524.2/602M	NE	NA	NA
Ethylbenzene	1	<1	EPA 524.2/602M	NE	700 ug/L	NA
Hexachlorobutadiene	1	<1	EPA 524.2/602M	NE	NA	NA
Isopropylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
p-Isopropyltoluene	1	<1	EPA 524.2/602M	NE	NA	NA
Methylene Chloride	1	<1	EPA 524.2/602M	NE	NA	NA
Naphtalene	1	<1	EPA 524.2/602M	NE	NA	NA
n-Propyl Benzene	1	<1	EPA 524.2/602M	NE	NA	NA
Styrene	1	<1	EPA 524.2/602M	NE	100	NA
1,1,1,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,2,2-Tetrachloroethane	1	<1	EPA 524.2/602M	NE	NA	NA
Tetrachloroethene	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Toluene	1	<1	EPA 524.2/602M	NE	1000 ug/L	NA
1,2,3-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,4-Trichlorobenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,1,1-Trichloroethane	1	<1	EPA 524.2/602M	NE	200 ug/L	NA
1,1,2-Trichloroethane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
Trichloroethene	1	<1	EPA 524.2/602M	NE	NA	NA
1,2,3-Trichloropropane	1	<1	EPA 524.2/602M	NE	5 ug/L	NA
1,2,4-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
1,3,5-Trimethylbenzene	1	<1	EPA 524.2/602M	NE	NA	NA
o-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
m-Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA
p -Xylene	1	<1	EPA 524.2/602M	NE	1000@	NA

= MCL shown is for the total of these four compounds
@ = MCL shown is for total Xylene's
All detected analytes referred to as "Detected" were between instrument detection limit (0.1 µg/L) and the limit of quantification (1 µg/L).The qualified results represent values determined at levels where the true value of the measured chemical cannot be quantified with a high degree of confidence. The data user may consider these qualified results as estimates when making project decisions.

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Page 5 of 5

Metal Analysis:

Analysis as Total per metal	MDL (mg/L)	Sample BW 5 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
Barium	0.002	0.005	EPA200-7/8 M	R ±11% of R	2.0 mg/L	0.5 mg/L
Thallium	0.002	<0.002	EPA200-7/8 M	R ±19% of R	0.002 mg/L	NA
Antimony	0.002	<0.002	EPA200-7/8 M	R ±26% of R	NA	NA
Beryllium	0.002	<0.002	EPA200-7/8 M	R ±13% of R	0.004 mg/L	NA
Mercury	0.0005	<0.0005	EPA200-7/8 M	R ±27% of R	0.002 mg/L	0.05 mg/L

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ENVIRONMENT CORE LABORATORY AMERICAN UNIVERSITY OF BEIRUT MEDICAL CENTER P.L.M.

Dr. Zuheir Habbal
Director of Clinical Chemistry Laboratory
Director of Environment Core Laboratory

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APPENDIX F

Records of Public Consultations

Introduction

As part of the GBWSAP ESIA, public consultations sessions, part of the project's Consutlation and Communications programme, will be undertaken. To date, a series of ESIA Scoping Sessions have been held in different venues for instutional stakeholders, those in the vicinity of the propsed dam sites, and for Greater Beirut residents, the main GBWSAP beneficiaries. Details of these meetings are given in the following Table.

Public Consultation Session	Venue, Date and Time	Total No. Attendees
Institutional Stakeholders	CDR, Central Beirut Tuesday 3 April 2012, 10am.	16
Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali	Mazraat El Dahr Municipality Tuesday 10 April 2012, 10am	23
Local authorities and residents in the vicinity of Damour Dam and Nahr Damour	Dmit Municipality Thursday 12 April 2012, 10am	46
Local authorities and residents in the vicinity of Jannah Dam and Nahr Ibrahim	Qartaba Municipality Saturday 21 April 2012, 11am	28
Water consumers of Beirut southern suburbs	Hadath Municipality Tuesday 24 April 2012, 10am	25
Water Consumers of Central Beirut	Beirut Municipality Saturday 5 May 2012, 10am	43

The date and timing of all meetings was agreed with individual municipalities. For instance, the session at Qartaba was delayed because the village is largely unpopulated during winter months and was scheduled for a Saturday when those working in Beirut during the week could attend. Similarly, the Beirut session was scheduled for a Saturday to enable those at work during the week to attend.

Each session commenced with the introduction by the Project Proponent in which the scope and objectives of GBWSAP were outlined and the Consultant (Dar Al-Handasah) introduced. The Consultant then gave a presentation about the project before the floor was opened to attendees to air their comments and concerns. In order to focus on the expected concerns of the different audiences, the presentations varied slightly between sessions. The proceedings of all sessions were in Arabic.

As attendees arrived they were given a handout that related the nature of the project and the intent of the meeting. Shortly after the meeting commenced, to allow for latecomers, Attendance Sheets were circulated on which names, contact details and signatures were collected. Attendees were given the option to make comments or ask questions verbally or in writing. Those doing so verbally were also asked to record what they said in writing so that in addition to the immediate verbal response, a formal written response, could be provided. In the event, few attendees chose to record their comment in writing and as a back-up, one of the Consultant's team transcribed much of what was said.

The consultant's presentation in Central Beirut, which encompassed all the changes for the individual site meetings, copies of the Beirut handout, and copies of the original attendance sheets, are given in Appendix X to the present report. A photograph taken at each session is presented in Figure x 1.

Attendees generally conducted themselves in an orderly fashion. Many of those in the vicinity of the dams recognised the potential for water supply, hydropower, and waterside developments, and were generally in favour. The session in Beirut was briefly disrupted after Mr. Fathi Chatila had expounded his well- documented views and a number of his supporters tried to shout down opposing views.

In the following pages the comments and concerns raised at each of the public Scoping sessions are documented and a considered written response given. While audience response was good, they were less enthusiastic about committing their comments to paper on the forms provided. There are therefore unattributed comments recorded by the consultant in addition to those for whom a speaker was identified.

The primary issues on which comments were made were:

- The extent to which local populations will be served with water and/or hydropower;
- The need to preserve archaeological, historic and cultural heritage;
- The impact on downstream agricultural activities;
- The opportunities for tourism and other job creating developments the reservoirs will afford;
- The impact on water quality of the general lack of effective wastewater treatment across the villages surrounding each of the reservoirs;

Session 1: Institutional Stakeholders

CDR on April 3, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مجلس الإنماء والإعمار الزمان: الثلثاء ٣/٤/٢٠١٢ الساعة ١٠ صباحاً

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	emoussalli@cdr.gov.lb	03/774451	مجلس الإنماء والإعمار	م. إيلي موصللي	8
	raffi.gergian@dga.culture.gov.lb	03/747105	المديرية العامة للآثار	م. رافي جرجيان	9
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	ismailm@cdr.gov.lb	03/665650	[illegible]	اسماعيل مكي	11
	rolandg@cdr.gov.lb	03/308174	مجلس الإنماء والإعمار	رولان غاوي	12
	assemf@cdr.gov.lb	03/600337	مجلس الإنماء والإعمار	عاصم فداوي	13
	b.sabbagh@moe.gov.lb	03/646171	وزارة البيئة	بسام الصباغ	14
	John.Davey@dargroup.com	01-790002	Dar Al-Handasah	John Davey	15
	Riwa.ElDerbas@dargroup.com	01-790002	دار الهندسة	روى دربس	16
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Name	Affiliation
Institutional Stakeholders, CDR – 3 April 2012	
Mona Seridinne	Ministry of Finance, Dir. of Real Estate
Ziad Zakhour	Ministry of Energy and Water
Randa Nemr	Ministry of Energy and Water
Jean Jebran	Ministry of Energy and Water
Raffi Gergian	General Directorate of Antiquities
Antoinette Sleiman	Litani River Authority
Elie Mousalli	Council for Dev. & Reconstruction
Ismail Makke	Council for Dev. & Reconstruction
Roland Ghawi	Council for Dev. & Reconstruction
Assem Fidawi	Council for Dev. & Reconstruction
Bassam el Sabbagh	Ministry of Environment
John Davey	Dar Al Handasah
Riwa El Derbas	Dar Al Handasah
Suhail Srour	Dar Al Handasah
Fay Mushantaf	Dar Al Handasah
Mohammed Chamseddine	Information International

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: مجلس الإنماء والإعمار **الزمان:** في ٢-٤-٢٠١٢

أسئلة وملاحظات

الإسم
المهندسة انطوانيت سليمان asleiman@litani.gov.lb

المؤسسة
المصلحة الوطنية لنهر الليطاني

الملاحظات والأسئلة
أرفق ربطاً نسخة التقرير السنوي للمصلحة الوطنية لنهر الليطاني لعام ٢٠١٠ ومنه تقريرين أرجو الاطلاع عليهما إذ أنهما يتضمنان رأي المصلحة الوطنية لنهر الليطاني حول مشروع تزويد مدينة بيروت بالمياه ومن رؤية المصلحة إلى مجلس الإنماء والإعمار بطريقة غير رسمية والى وزارة الطاقة بطريقة رسمية بحسب أرقام وتواريخ الكتب الواردة في كل تقرير

- التقرير الأول من ص ٦٨ حتى ٧٩
- التقرير الثاني من ص ٧٩ حتى ٨١

نؤكد أن هذا المشروع يؤثر على المصلحة الوطنية لنهر الليطاني اجتماعياً إذ أن الكمية التي سيقوم المشروع باستهلاكها لن تدخل في توليد الطاقة الكهربائية في معمل جون وهذا ما هو الشرح الوارد في التقرير

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:......C.D.R.........**الزمان:**....23/04/2012....

أسئلة وملاحظات

الإسم
م. زياد زخور

المؤسسة
مستشار معالي وزير الطاقة والمياه لقطاع المياه والسدود

الملاحظات والأسئلة
① - ليس هناك من بدائل، مفضلة وفقاً للخطة الوطنية من قبل وزارة الطاقة والمياه.
② - ليس بالإمكان إجراء مقارنة تقنية بين المشاريع الثلاثة لتفاوت المعطيات ومراحل الدراسات ومستواها بين مشروع وآخر، فهناك دراسة نهائية تنفيذية لسد الجنة، بينما أن هناك فقط دراسة أولية لسد الأسور....؟
③ - إن المقارنة الممكنة فقط ممكن أن تشمل النواحي البيئية والإجتماعية دون سواها.
④ - نقترح تعديل أن الإستعاضة عن تعابير بدائل بتعبير يتلاءم مع خطة التخزين السطحي الوطنية من قبل وزارة الطاقة والمياه التي تشمل تنفيذ المشاريع الثلاثة وفقاً لجدول زمني.
⑤ لم يتسنى من إبداء الرأي بالمعطيات المقدمة إلينا خلال العرض لعدم توفر هذه المعطيات لدينا أو أي نسخة عنها.
⑥ هل بالإمكان تخطي القانون اللبناني للإستملاك لإعتماد مبادئ أخرى؟؟؟

Summary of issues raised during Session 1

with corresponding responses by the consultant

Name	Affiliation	Comment(s)	Consultant's Response
Ziad Zakhour	Advisor to the MEW on Water and Dams	Based on the strategy of MEW, there is no preferred alternative.	Noted
		A technical comparison cannot be done for the three sites due to the discrepancies in data and the different stages of study of each site. There is a final executive study for Jannah whereas the study is just preliminary for Damour. The study can only be compared environmentally and socially.	No Consultant's response required
		We suggest amending the expression "alternatives" to one that better fits the National Water Strategy for the eventual implementation of all three dams.	The ESIA will attempt to 'prioritise' the three dam projects
		Is it possible not to abide by the Lebanese legislation in terms of land expropriation and adopt other policies?	Generally no. Lebanese law generally applies but may be amended by any special funding agency requirements, although these are almost always more onerous. If MEW wish to adopt other measures they would need to take it up with the Government lawyers.
Antoinette Sleiman	Litani River Authority	I have included a copy of the annual report of the Litani River Authority (2010), which contains 2 reports that summarize the opinion of the LRA concerning the GBWSP. Report 1 (p68 to 79) and report 2 (p.79 to 81). We hereby insist that the GBWSP affects the LRA socially since the quantities of water taken will not be used to produce HEP in Joun.	We thank the LRA for the information provided and will take it into consideration in our report.
		Dragging water from Bisri and Jannah to Beirut will be very expensive. The	Again thank you for the information, which we

Name	Affiliation	Comment(s)	Consultant's Response
		LRA suggests from expertise the 3rd option (1st option: No Option, 2nd option: Dam), to dig horizontal tunnels from the west mountains like the tunnel of Awali with length 17 km and provides 55 M m3/year. Ras Baalbeck tunnel 4 km and provides drinking water for villages of Ras Baalbeck. The quality of water from the tunnel is naturally filtered and won't need treatment against pollutants (heavy metals, pesticides, coliforms, and organic pollutants…); unlike the water from the Qaraoun Lake.	will follow up in preparing the ESIA.
Unattributed Comment		GBWSP doesn't only come from Qaraoun lake	Noted
Unattributed Comment		Is an ESIA being done for the 3 dams?	The GBWSAP is divided into two phases. Phase 1 is a comparative technical economic, environmental and social assessment of the three dams and the identification of the priority in which they should be constructed. Thereafter, a full ESIA together with a RAP will be undertaken for the priority site
Unattributed Comment		It is advisable to contact the Antiquities Authority if need be	This is standard practice in any ESIA study
Unattributed Comment		People living in the vicinity of the dam need to benefit as well from the water	Noted

Scoping Session held for Institutional Stakeholders held at CDR on Tuesday 3 April 2012

Session 2: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Mazraat El Dahr Municipality on April 10, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة. المكان: ...... الزمان: ......
جدول الحضور

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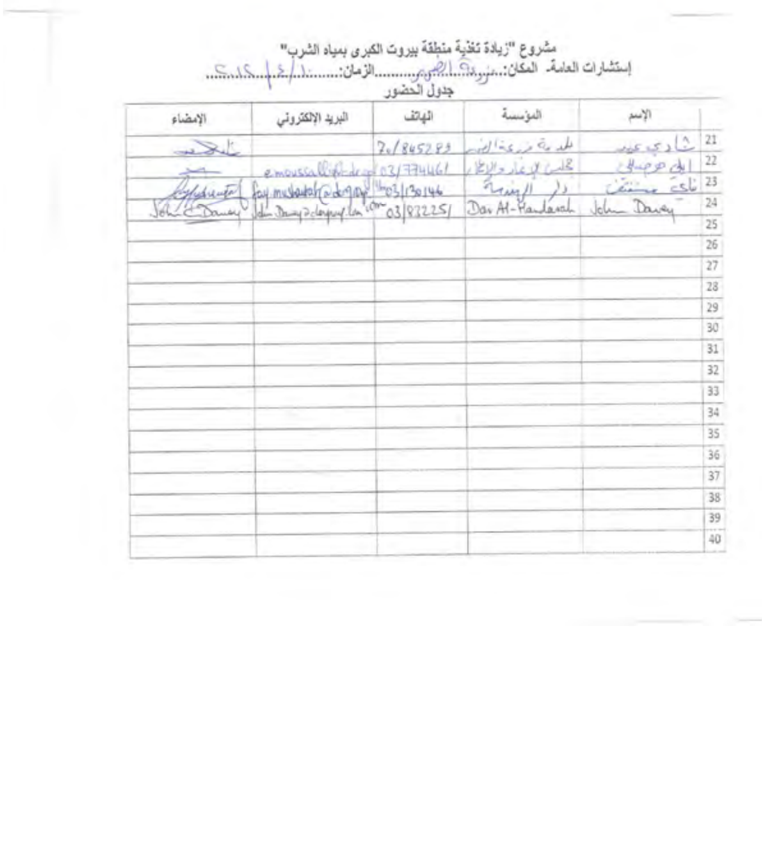

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة. المكان: ...... الزمان: ......
جدول الحضور

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Mazraat El Dahr Municipality - 10 April 2012	
Riwa Al Derbas	Dar Al-Handasah
Elie Abou Rjeili	Dar Al-Handasah
Alicia Jammal	Information International
Issam Fidawi	Council for Dev. & Reconstruction
Roland Ghawi	Council for Dev. & Reconstruction
Maroun Houbaika	Midan Village
Maroun El Khoury	Midan Village
Hasib Jamil Eid	Mazraat El-Daher Municipality
Fouad Abdel Samad	Amatour Municipality
Thoukan Abdel Samad	Amatour Municipality
Monsif Al-Akkoum	Baba Municipality
Antoine Hasib Eid	Mazraat El-Daher Municipality
Johnny Yousef Eid	Mazraat El-Daher Municipality
Jack Elias Eid	Mazraat El-Daher Municipality
Nawal Elias Eid	Mazraat El-Daher Municipality
Hikmat Kaysar Eid	Mazraat El-Daher Municipality

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:...بلدية مزرعة الضهر.....الزمان:..١٠/٤/٢٠١٢............

أسئلة وملاحظات

الإسم الاستاذ حبيب جميل عيد

المؤسسة رئيس بلدية مزرعة الضهر

الملاحظات والأسئلة

الأولوية القصوى لبلدة مزرعة الضهر والقرى المجاورة عدم غمر كنيسة مار موسى الأثرية وما يحيط بها من آثار لدير قديم.

أما في حال استحالة الحفاظ على هذا المقام، فنطالب الحكومة اللبنانية ومن ضمن كلفة المشروع العمل على:

- نقل الكنيسة وما يحيط بها من آثار دون أي تعديل أثري الى مكان لا تغمره مياه السد،
- استملاك الأرض المناسبة لإقامة الكنيسة والآثار المنقولة،
- التنسيق مع بلدية مزرعة الضهر باعتبار أن كنيسة مار موسى وما يحيط بها تابعة لمنطقة مزرعة الضهر العقارية، كما وأن بلدية مزرعة الضهر لا تملك الامكانيات المادية الكافية للقيام بهذا المشروع.

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: بلدية مزرعة الضهر الزمان: ١٠/٤/٢٠١٢

أسنلة وملاحظات

الإسم: جوني يوسف عيد

المؤسسة: بلدية مزرعة الضهر

الملاحظات والأسئلة

١. مصير معمل وسد بسري الحالي؟

٢. هل سيقام معمل كهربائي على السد الجديد؟

٣. ما هي الغازات المسببة للاحتباس الحراري الناتج عن المياه؟

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:...ترعيش الطلعة.....**الزمان:**......12/4/2012......

أسئلة وملاحظات

هل هناك دراسة جديدة بعد هذه الدراسة

الإسم

الريادي فؤاد عبد الصمد 03/311158

المؤسسة

جمعية ... عاجور اتحاد بلديات ... اللبنانية

الملاحظات والأسئلة

هل تم اطلاع على التقييم للأثر البيئي بالدراسات
السابقة - الدراسات والتقييمات للعقارات
المجاورة للسد - الطبيعة الجغرافية للمنطقة - الآثارات
المخفية ~~...~~ جرد عاجور - أنفاق الأعمدة الرومانية

- هل القيمة التاريخية للآثارات يمكن تسجيلها
من قبل الجمعيات الأهلية
- المخطط التوجيهي العام
مع كل التقدير

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:.............................الزمان:...........................

أسئلة وملاحظات

الإسم مارون حبيقه مختار بلدة الميدان - قضاء جزين

المؤسسة

الملاحظات والأسئلة ان مشروع سد بسري هو امنية منطقتي جزين واقليم الخروب ويثمنون الاسراع في تنفيذ هذا المشروع الحيوي الحصول لمياه الشفة للعاصمة بيروت وغيرها ومن شأنه هذا المشروع ايجاد مناطق سياحية وسكانية على ضواحيه بالاضافة الى تأمين فرص العمل لأبناء الجبل والعمال. ويطلب الاسراع بتنفيذ ~~تخطيط~~ طريق الميدان بسري التي هي بحاجة الى سرعة التنفيذ وهو ~~مخطط~~ لها اكثر من عشرة اعوام.

يرجى الانتباه الى موقع الارث الطبيعي منطقة جزين المشرف على ملاك الله.

وشكرا

**Summary of issues raised during Session 2
with corresponding responses by the consultant**

Name	Affiliation	Comment(s)	Consultant's Response
Hassib Jamil Eid	Head of Mazraat El Dahr Municipality	The priority and main concern of Municipality of Mazraat El Dahr is not to inundate the church of Mar Moussa and other historical ruins. In case it is impossible to preserve this church, we ask the Lebanese government to fund the protection or relocation of the church in coordination with the Municipality	Noted. The ESIA will address this issue
Johnny Youssef Eid	Mazraat El Dahr Municipality	What will happen to the present Awali-Joun HEP?	This will depend on the proposed compensatory flows discharged from the dam
		Will there be a new HEP on the new dam?	A new HEP will be proposed
		What are the GHG resulting from the reservoir?	GHG from reservoirs has been the subject of studies in several parts of the world. Much depends on efficient project management, and this will be fully discussed in the ESIA
Fouad Abd El Samad	Ammatour Municipality	Has there been an ESIA done in the previous studies and has an inspection been made to check the roman columns? The historical value is of great importance to the local people	An ESIA was undertaken previously. The Consultant is aware of the Roman columns and other historic and cultural remains, and will discuss them in the ESIA.
Maroun Hobeika	Midane Village	The Bisri Project is vital project for the region and we ask to speed up implementation because it will provide new job opportunities and improve tourism. This also requires the construction of the Midane/Bisri road which is ready for implementation and is of length 60 km and width 10 m.	Noted. New road construction is outside the scope of the present ESIA.
		Please note the disposal of wastewater from Jezzine-Meshrif into the location of the dam will affect the quality of the reservoir	Noted. Sewerage for the villages discharging above the dam site will be a clear recommendation of the ESIA.
Unattributed Comment		The overall attitude was positive towards the Project and they were expecting since long time	No Consultant's response required.
Unattributed Comment		What will be 2 planned roads upstream of the projected dam and that connect the villages of Jezzine caza (southern bank of river) to Iklim villages (northern bank)?	Road construction other than to access the dam is outside the present scope of the ESIA.
Unattributed Comment		This project is solely for Beirut Water supply, how can we be beneficiaries	In most dam projects, some allowance is made for local water use.
Unattributed Comment		Should Permits for construction inside the reservoir continue to be given to people?	Since MEW has stated clearly that it intends to construct all three dams, planning policy should perhaps be reconsidered.

Public Scoping Session for residents of
the Bisri Area held at Mazraat El Dahr

Session 3: Local authorities and residents in the vicinity of Damour Dam and Nahr Damour

Dmit Municipality on April 12, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة- المكان:..............................الزمان:...............................
جدول الحضور

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	[illegible]@hotmail.com	03/696963	المصلحة الوطنية لنهر الليطاني	م. [illegible] سليمان	2
	Fadi_Tarabey@bbac[illegible]	03/672429	BBAC	فادي طربيه	3
	aminch2ko@hotmail	03/956522	بلدية كفرحيم	امين شمس (غنام)	4
	SAK1554@hotmail.co	03.333885	رئيس بلدية كفرحيم	سمير ابي عزام	5
		٣/٧٠٠٥٠٤	بلدية كفرحيم	عيسى ابو عزام	6
		٣/٤٠٦٦٤٨	بلدية دميت	كمال قائدبيه	7
		71/528088	بلدية دميت	صلاح جمّاح	8
	aounaccs@hotmail	70 900650	بلدية المشرف	م. فادي عون	9
	imaco_ec@hotmail.com	03 346586	بلدية المشرف	م. [illegible]	10
		05/720414	بلدية دير بابا	حسان فؤاد طربيه	11
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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة- المكان:..............................الزمان:...............................
جدول الحضور

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		03/413414	عضو بلدية دميت	[illegible] ابو [illegible]	22
	Amin.Tarabay@Hotmail.com	03.725923		امين طربيه	23
		7/185628	مختار دميت السابق	سعيد [illegible]	24
	assaad_ghannam@hotmail	3/445715	محامي	د. اسعد غانم	25
		03/191632	عضو مجلس بلدية كفرمتى	[illegible]	26
		03/821856	عضو مجلس [illegible]	[illegible]	27
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adelkhaddaje hotmail.com

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:..............................الزمان:..............................

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
21	عثمان نالوت / مختار	ركرتا شور	٠٢/٩٢٠٨٦٢		
22	فوزي الصغير / مختار	كرتا شور	٠٢/٤٦٤٦٧٤	@HOTMAIL.COM	
23	مروان مراد بلدية	كفر فاقود	٠٢/٦٤٩٨٧٧	MARWANMRAD6	
24	سمير عزام		٧١/٤٨٨٥٨٤	ADELKHADDJ@H...	
25	عادل خداج	بلدية كفرحي	٠٢/٦٢٢٦٤٣		
26	د. اسماعيل مكي	مجلس الانماء والاعمار	٠٣/٦٦٥٦٥٠	ismailm@cdr.gov.lb	
27	زياد كعكي	وزارة الطاقة والمياه	03/240553	cnemer@cyberia.net.lb	
28	رندة ضاهر	وحدة ادارة مشروع الاولي	01/389997	randa.daher@awali-pmu.com	
29	رونالد غاريب	مجلس الانماء والاعمار	01/980371	ronaldg@cdr.gov.lb	
30	اكرم الحربية مختار	دير بابا	٠٥/٧٥٠١٦٢		اكرم الحربية
31	ايمن ابو كرم مختار كفرحيم	كفرحيم	٧٠١٠٤٤٩٤		
32	سعيد غنام مختار كفرحيم	كفرحيم	٧٠/٩٦٧٦٢٤		
33	ناجي ابو زيوان	بلدية دميت	٠٢/٢٥١٨٨		
34	زهير القاضي	دميت	٠٢/٦٦٩١٢	zelkadi@Hotmail	
35	سمير الكفرشي	MOA	03/905648	SamerKhawand@Hot...	
36	غازي ابو خزام	الحزب التقدمي الاشتراكي مسؤول	٠٣/٥٣٢٨٩٨	GhaziAbouKhuzam@...	
37	مسلم غانم ابو عزم	الحزب التقدمي الاشتراكي	٠٣/٤٤٧٥٨٥		مسلم غانم
38	رسلان السعدي	تجمع للدولة دوقين	٧٥/٩١٨٧٥٧		
39	نبيل ابو شقرا	مدير مدرسة بيت الدين	03/492326		نبيل
40	كريم الرحال	اكرملي	03 381733	ecovillagelebanon@gmail.com	
41	عامر مزاري	مجلس الانماء والاعمار	01-981431	aBany@cdr.gov.lb	

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:..............................الزمان:..............................

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
21	ألسيا جمال	الدولية للمعلومات	03-451728	analysis@information-international.com	
22	عفيف ابو الحسن	دميت	03/413414		
23	سعيد منح ابو زرع	مختار دير السياحة	71/185628		
24	روى الدرك	دار الهندسة	[illegible]	Riwa.Eldurk@dargroup	
25	John Davey	Dar Al-Handasah	01/790002	John.Davey@dargroup.com	
26	فايز مصطفى	Dar Al-Handasah	03/130146	fayezmustafa@dargroup	
27	[illegible]	Dar Al-Handasah	03 885353	[illegible]@dargroup.com	
28					
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Dmit Municipality - 12 April 2012	
Alicia Jammal	Information International
Afif Abou Kheir	Dmit Municipality
Said Shahine Abou Dargham	Dmit Municipality
Riwa Al-Derbas	Dar Al-Handasah
John Davey	Dar Al-Handasah
Fay Mushantaf	Dar Al-Handasah
Suheil Srour	Dar Al-Handasah
Afif Zein El-Dine	Kfar Fakoud Municipality
Faouzy Naser	Kfar Fakoud Municipality
Marwan Mrad	Kfar Fakoud Municipality
Samih Azzam	*(not given)*
Adel Khadah	Kfar Matta Municipality
Ismail Makki	Council for Dev. & Reconstruction
Randa Nimr	Ministry of Energy and Water
Randa Daher	PMU Awali Project
Roland Ghawi	Council for Dev. & Reconstruction
Akram Torbey	Deir Baba Municipality
Anis Bou Dargham	Kfarhim Village
Said Ghannam	Kfarhim Village
Naji Wadia Zeidan	Dmit Municipality
Zouheir Al-Kadi	Dmit Municipality
Samer Al-Khawand	MoA
Ghazi Abou Khouzam	Progressive Socialist Party
Salim Ghanem Abou Dargham	Progressive Socialist Party
Basir Al Saadi	Dmit Municipality
Nabil Abou Chakra	Dmit Municipality
Karim Al-Khatib	Eco Village
Assem Fiddawi	Council for Dev. & Reconstruction
Nader Azzam	*(not given)*
Afif Abou Kheir	Dmit Municipality
Amin Torbey	*(not given)*
Said Shahine About Dargham	Dmit Municipality
Asaad Ghannam	Lawyer
Majed Said Zahreddine	Kfar Fakoud Municipality
Hamid Hilmy Torbey	Deir Baba Municipality
Bassam Nasrallah	PMU Awali Project
Antoinette Sleiman	Litani River Authority
Fandy Torbey	Bank of Beirut and the Arab Countries
Amin Ghneim	Kfarhim Municipality
Samir Khouzam	Kfarhim Municipality
Kamal Kaed Bey	Dmit Municipality
Hani Khaddaj	Dmit Municipality
Khaled Aoun	Mushref Municipality
Michel Mhanna	Mushref Municipality
Hassan Fouad Torbey	Deir Baba Municipality

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:..............................الزمان:...........................

أسئلة وملاحظات

الإسم
حسان فؤاد طربيه (ت ١٥/٧٢٠٤١٤)

المؤسسة

الملاحظات والأسئلة
١- يوجد طاحونة مياه أثريه
٢- يوجد مغارة طبيعية ا
٣- يوجد ارض زراعيه نعتاش منها

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: ....دميت.................. **الزمان:** ....٢٤/٤/٢٠١٢....

أسنلة وملاحظات

الإسم غازي ابو عزام

المؤسسة الحزب التقدمي الاشتراكي

الملاحظات والأسئلة

استخلصنا ان المشروع جاء لتلبية حاجة بيروت الكبرى
للمياه اما المناطق المحيطة بالمشروع فلم يلحظ المشروع لتأمين مياه الشفة
ومياه الري وتطوير القطاع الزراعي.
هل هنالك دراسات لتقديم الحلول (الحاجة الى المياه الري والشفة)
للمناطق المجاورة للمشروع.
مع الشكر.

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:..............................الزمان:...........................

أسئلة وملاحظات

الإسم دكتورا سعد خناع

المؤسسة محام

الملاحظات والأسئلة

هل سيطبق قانون الاستملاك
بدفع التعويضات الايجابية أم
ترك كل المواضيع مع المالك
الدولة استناداً الى حلول
البلديات.

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:..دميت الشوف..**الزمان:**...........................

أسئلة وملاحظات

الإسم نبيل ابو شقرا 03/492326

المؤسسة بلدية دميت

الملاحظات والأسئلة
لماذا تريدون حضرتكم موافقتنا على مشروع السد
ونقلوا نحن كبلدة دميت والجوار لا نستفيد منه بالمياه
والطاقة الكهربائية، وهل هذا السد هو لمدينة بيروت
فقط. نريد توضيحاً لهذا السؤال وشكراً

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان:.............................الزمان:..........................

أسئلة وملاحظات

الإسم عادل فرح

المؤسسة بلدية كفرقي ٠٣/٦٢٦٦٤٢٧

الملاحظات والأسئلة

لشمال غير جدية في الدراسة الحالية
توزيع الدراسة في DVD
الطريقة للوصول إلى كافة المعلومات

عادل فرح

Summary of issues raised during Session 3

with corresponding responses by the consultant

Name	Affiliation	Comment(s)	Consultant's Response
Hassan Fouad Torbey	Deir Baba Municipality	There is an antique water mill and a natural cave in the reservoir area which were not mentioned in the presentation.	Thank you for informing us. The ESIA Consultant will investigate.
		There is a productive land we depend on.	Loss of productive land will be minimized as much as is possible.
Ghazi Abou Khouzam	Progressive Socialist Party	We understand the project is going to serve the water need of Greater Beirut, whereas the villages around the project will benefit from the drinking water and water for irrigation to develop the agricultural sector	Allowances for local water supplies will be provided.
Assaad Ghneim	Lawyer	Will they implement the Expropriation law and pay the mandatory compensation or leave it to the World Bank based on the Municipalities' solutions?	Compensation for land and asset take will be in accordance with the laws of Lebanon, primarily the Expropriation Law of 1991 and its later amendments, and, if financed externally, with any particular requirements of the Funding Agency
Nabil Abou Chakra	Dmit Municipality	Are we benefiting from the water and energy supply from this project or is this dam solely going to serve Beirut?	Allowances for local services will be provided.
Unattributed Comment		How would productive land above the reservoir benefit from the water? Will the project account for any pumps?	Local water supplies are likely to be provided. The issue of pumps is one for detailed design.
Unattributed Comment		Will there be HEP for the 3 sites?	It is expected that each of the dam sites will also supply hydropower.

Public Scoping Session for residents of
the Damour Area held at Dmit
Municipality on Thursday 12 April 2012

Session 4: Local authorities and residents in the vicinity of Jannah Dam and Nahr Ibrahim

Qartaba Municipality on April 21, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:....قرطبا.........الزمان:....21/4/2012....

جدول الحضور

الإمضاء	البريد الإلكتروني	الهاتف	المؤسسة	الإسم	
[illegible]	Rima.Eldaher@dargroup.com	01-790003	Dar Al Handasah	ريما الظاهر	1
[illegible]	—	03/355147	[illegible]	[illegible]	2
[illegible]		03/618121	قرطبا	[illegible]	3
[illegible]	sakrabdo@gmail.com	03/713615	قرطبا / [illegible]	[illegible]	4
[illegible]	info@jescompetitors.com	03/836838	قرطبا / [illegible]	[illegible]	5
[illegible]	Fax 04/451092	03/638744	[illegible]	[illegible]	6
[illegible]		09/405028	[illegible]	[illegible]	7
[illegible]		12/885[illegible]	[illegible]	[illegible]	8
[illegible]		[illegible]	[illegible]	[illegible]	9
[illegible]		03/346261	[illegible]	[illegible]	10
[illegible]	akramkaram@yahoo.com	03/260201	[illegible]	[illegible]	11
[illegible]	[illegible]@cdr.gov.lb	03/665650	[illegible]	[illegible]	12
[illegible]	[illegible]@cdr.gov.lb	03/[illegible]737	[illegible]	[illegible]	13
[illegible]	[illegible]@litani.gov.lb	03 696963	المصلحة الوطنية لنهر الليطاني	[illegible]	14
[illegible]		03 383653	[illegible]	[illegible]	15
[illegible]	[illegible]@cdr.gov.lb	03/[illegible]	مجلس الإنماء والإعمار	[illegible]	16
[illegible]	[illegible]@dargroup.com		دار الهندسة	[illegible]	17
[illegible]	John.Davey@dargroup.com	01-790202	Dar Al-Handarah	John Davey	18
[illegible]	[illegible]	01 9[illegible]	[illegible]	[illegible]	19
[illegible]		01-790003	دار الهندسة	[illegible]	20

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:....قرطبا.........الزمان:....[illegible]....

جدول الحضور

الإمضاء	البريد الإلكتروني	الهاتف	المؤسسة	الإسم	
[illegible]		٠٢٧١٠٥٤١٧	[illegible]	[illegible]	21
[illegible]	—	03/822851	قرطبا / [illegible]	[illegible]	22
[illegible]	—	01/393983	[illegible] / قرطبا	[illegible]	23
[illegible]	—	03/644169	[illegible] / [illegible]	[illegible]	24
[illegible]	—	03240553	[illegible]	[illegible]	25
[illegible]	—	—	[illegible] قرطبا	[illegible]	26
[illegible]		٠٣/٦١٥٥١٥	[illegible]	[illegible]	27
[illegible]	faymushantaf@dargroup.com	٠٣/١٣١٤٦	دار الهندسة	[illegible]	28
					29
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Qartaba Municipality - 21 April 2012	
Mohammad Chamseddine	Information International
Abdo Francis	Electricite du Liban
Kamal Youssef el Khoury	Kartaba Municipality
Riwa Al-Derbas	Dar Al-Handasah
John Davey	Dar Al-Handasah
Fay Mushantaf	Dar Al-Handasah
Suheil Srour	Dar Al-Handasah
Abdo Elias Saker	Kartaba Municipality
Joseph Tanious El Sokhn	Kartaba Municipality
Abdo Daniel Challita	Kartaba - Mkattaf Company
Walid Salem	Butcher
Melkan El Beainy	Yanouh & Hdaine Municipality
Chehade Karam	Electricite du Liban
Monsenieur Youssef el Sokhn	Maronite Parish of Jbeil
Akram Karam	Engineer
Ismail Makka	Council for Dev. & Reconstruction
Assem Fidawi	Council for Dev. & Reconstruction
Antoinette Sleiman	Litani River Authority
Joseph Dakkash	Lebanese Maronite Monastery
Roland Ghawi	Council for Dev. & Reconstruction
Elie Abou Rjeili	Dar Al Handasah
Nemr Beiruti	*(not given)*
Youssef Tanious Chahine	Kartaba- Truck Owner
George Antoine Najem	Kartaba- Engineer
Hanna Youssef Frem	Saraaita- Contractor
Randa Nemr	Ministry of Energy and Water
Karam Karam	Kartaba
Kalim Karam Karam	Karam Trade

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: مجلس الجنوب...........**الزمان:** مجلس الإنماء والاعمار...........

أسئلة وملاحظات

الإسم
مهندسة انطوانيت سليمان

المؤسسة
المصلحة الوطنية لنهر الليطاني

الملاحظات والأسئلة
ان جر مياه الشفة من سد بسري وسد جنة الى بيروت
مهمة مكلفة جدا
ان فرق المصلحة الوطنية لنهر الليطاني تقترح خيار ثالث
(الخيار الاول: لا مشروع ، الخيار الثاني مشروع السد)
لم يجر البحث منذ ١٩٦٠ او ١٩٧٠ حفر أنفاق أفقية في جبال السلسلة
الغربية كنفق الدولي طوله ١٧ كلم ويؤمن ٥٥ مليون م٣/سنويا
في السنوات الماطرة و ١٧ مليون م٣/سنة في السنوات الجافة
نفق المضيق طوله ٤ كلم ويؤمن ٢٥ مليون م٣/سنويا. نفق
رأس بعلبك ٤ كلم طول ويؤمن مياه الشفة لقرى رأس بعلبك.
ان ~~[illegible]~~ نوعية المياه المستخرجة من النفق هي "ممتازة" طبعا
ولن تتطلب محطات تكرير ~~[illegible]~~ للملوثات التي
كالمعادن الثقيلة والادوية الزراعية والمبيدات Coliforms والمواد العضوية وغيرها
والتي تتطلب في بعض الاحيان ان تكرير المياه في ~~[illegible]~~ البحار المغلقة بطريقة
الـ Reverse Osmosis والتي تقترحونها اذا ~~[illegible]~~ لزم جر مياه خزان
القرعون الى محطة الوردانية.

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: قرطبا **الزمان:** ٢١/٤/٢٠١٢

أسئلة وملاحظات

الإسم
فوزي الحسن 03-836838

المؤسسة
قرطبا - استاذ جامعي

الملاحظات والأسئلة
ان مسار نهر ابراهيم هو مسار لحقبة تاريخية
غنية تبدأ من قلعة جبيل امتدادا الى مغارة افقا
حيث كانت تقام الطقوس الدينية على طول هذا الوادي
ومن المؤكد ان هناك الكثير من الآثار لهذا يرجى
الكشف عن هذه الآثار ليتم اتخاذ القرارات المناسبة
بخصوصها قبل فقدانها بشكل ابدي.

"وشكرا"

الرجاء شرح المخاوف والنقاط لمرحلتين
- قبل بناء السد
- بعد بناء السد
والاجابة على كامل المخاوف لكي تأتي الدعوة
بمفهوم ايجابي لبناء السد.

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة
المكان: طاولة عمية ما بالا **الزمان:** جرطا ....

أسئلة وملاحظات

الإسم
عمرو سعيد شمس

المؤسسة
كهرباء لبنان

الملاحظات والأسئلة
بالإيرادات الذي تستفيد منه منطقة جرطا وجوارها - مع التحفظ على البيئة - وآثارها السلبي

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: مرجبا **الزمان:** السبت ٢١/٤/٢٠١١

أسئلة وملاحظات

الإسم عبدو دانيال شلهوب من مرجبا (03/638744)

المؤسسة

الملاحظات والأسئلة

السد إيجابي جداً لمصلحة المنطقة
ولمصلحة اهالي بلدتنا سياحياً وزراعياً
وتشجيعاً وبالتوفيق ببناء السد
في أقرب وقت مع الشكر سلفاً

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: قرطبا **الزمان:** ١٢/٤/٢٠١٢

أسئلة وملاحظات

الإسم المهندس [illegible] 03/139393

المؤسسة

الملاحظات والأسئلة

١- التأثير البيئي على بلدة قرطبا من
حيث الأضرار التي تنتج عن إقامة السد
وخاصة السد [illegible] قرطبا غير معروفة للأهالي
[illegible] وكونه [illegible] شبه جاف
وكونها تقع على منحدر جنوبي [illegible]
[illegible]

٢- قرطبا تقع على [illegible]
[illegible]
[illegible]
هل هناك تأثير على [illegible] قرطبا [illegible]
لمياه [illegible]

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة

المكان: قرطبا **الزمان:** السبت ٢١/٤/٢٠١٢

أسنلة وملاحظات

الإسم الأب جوزيف الدكاش رئيس دير مار سركيس وباخوس - قرطبا

المؤسسة

الملاحظات والأسئلة المخاطر والمخاوف:

دراسة التربة علمياً لصلاحية المشروع
الأضرار الناجمة في محيط القرى الجبلية
الأضرار البيئية من ناحية المزروعات والنباتات:
والأسماك Ecosysteme
حقوق المالكين من ناحية ري الأراضي المحاذية للسد أعلى وأسفل
ضمانة اقامة المشاريع السياحية - منشآت -
المحافظة على تصنيف مجرى نهر ابراهيم في التراث العالمي
كيفية التعويضات والمبالغ الفارقة من ناحية تخمين الأراضي
المحافظة على الآثار الموجودة في المكان
المحافظة على الكنائس والأديار
استثمار الأراضي سياحياً وزراعياً وسكنياً كيف تصالح؟

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة
المكان: شرطيا **الزمان:** ١-٤-٢٠١٢

أسئلة وملاحظات

الإسم ملحم البعيني 13285805

المؤسسة رئيس بلدية بإبرح وصوفيتا

الملاحظات والأسئلة
- أولا، معالجة الصرف الصحي ونظافة القرى الموجودة على ضفاف النهر قبلة بإبرح وصوفيتا
- استملاك الطرقات من نهر أبراج الى ضهر السد تسميع المساحة في القرى الموجودة على ضفاف السد

Summary of issues raised during Session 4

with corresponding responses by the consultant

Name	Affiliation	Comment(s)	Consultant's Response
George Najem	Engineer	The environmental impact on Qartaba is the humidity that will arise from the dam, knowing that its climate now is dry	*The reservoir will have a relatively small surface area for the volume of water stored. Direct evaporation will therefore be limited and while there will be an increase in humidity in the immediate vicinity of the shoreline; this is not expected to significantly extend to the surrounding villages on the higher slopes where regional air movements will generally reduce any local impact.*
		Qartaba stands on top of underground reservoir of water. Is there any problem with its slope being linked permanently to water?	Slope stability will be considered within the ESIA.
Joseph Dakkash	Head of Mar Sarkis and Bacchus Monastery	The project needs the scientific study of the geology	*MEW has already undertaken extensive geological investigations for Janneh and no doubt more will be undertaken as construction proceeds.*
		The negative impacts affecting the villages surrounding the dam site and the damage to agriculture, plants, fisheries and the ecosystem	These will also be addressed by the ESIA.
		Rights of land owners to irrigate the lands in the upstream and downstream of dam	The rights of Riparian owners under Lebanese law will be protected.
		Conserving the categorization of Nahr Ibrahim as a World Heritage site, preserving the heritage and archaeological remains, and preserving the churched and monasteries.	Nahr Ibrahim is not formally classified as a World Heritage site. It is also not a Protected Area under Lebanese law, although it has long been recommended it should be. Its heritage is nonetheless significant and the ESIA will take account of this. Within the area of the proposed reservoir there are no churches or monasteries.
		Means of compensation for land take	*Compensation for land and asset take will be in accordance with the laws of Lebanon, primarily the Expropriation Law of 1991 and its later amendments, and, if financed externally, with any particular requirements of the Funding Agency.*

		Invest the tourism, agriculture and residential development. Guarantee establishing tourist projects	While it is likely investment will be attracted to the reservoir this is likely to be largely in the hands of the private sector. The steep slopes and cliffs within which the reservoir will be located may constrain shoreline development.
Abdo Daniel Challita	-	The dam is for the benefit of our region in its tourism, agriculture, and development. Good luck in building the dam as soon as possible.	No Consultant's response required.
Abdo Samir Francis	Electricite Du Liban	I support building the dam because it benefits Qartaba and its surroundings but keeping in mind the negative impacts on the environment.	Noted
Melkan El Beainy	Head of Municipality of Yanouh and Hdaine	Treat the wastewater from the villages surrounding the reservoir by suggesting upgrading the system.	A major recommendation of the ESIA is likely to be that sewerage schemes for the villages currently discharging into the valley upstream of the dam be prioritized.
		Improve the roads from Nahr Ibrahim to dam site to help tourism in the villages around the dam	Some improvements can be expected in order to improve the flow of construction traffic. The ESIA will address this and any need for subsequent improvements

Name	**Affiliation**	**Comment(s)**	**Consultant's Response**
Joseph El Sokhn	Instructor	The course of Nahr Ibrahim is a path of historical value starting from the fortress of Jbeil to the Afqa cave, where religious rituals used to take place. It is certain that there are cultural monuments there, thus we ask to disclose of any archeological remains in order to take the proper decisions before losing them for good	A full archaeological, historical and cultural heritage survey will be undertaken on the priority site in accordance with the requirements of the General Directorate of Antiquities
		Please categorize the Concerns in 2 phases: (before construction and after construction) and answer all the questions to have a positive outcome of this project	The ESIA will, as is usual, address the pre-construction, construction and post-construction impacts and their management separately
Unattributed Comment		People are concerned with land slide in Saraaita	The potential for slope instability will be addressed by the ESIA.
Unattributed Comment		What is the water level in the reservoir?	The currently proposed operating water level in the Jannah Reservoir is 834 m above national datum level
Unattributed Comment		Is the dam site location final?	MEW have already completed substantial site investigations and subject to detailed design, is considered final.
Unattributed Comment		Geology is not favorable for storing water in the reservoir	The water-tightness of the reservoir is an important consideration that will be addressed in the ESIA and subsequently
Unattributed Comment		Will we get drinking water from the dam? Will the villagers benefit from the dam?	The design reports make an allowance for water supply to adjacent villages.
Unattributed Comment		We want pumps to get water to Qartaba and Lassa	Noted.
Unattributed Comment		Apple orchards will be inundated, compensation will not be enough.	Compensation for land and asset take will be in accordance with the laws of Lebanon, primarily the Expropriation Law of 1991 and its later amendments, and, if financed externally, with any particular requirements of the Funding Agency
Unattributed Comment		There are archeological remains in: Wadi Betrayish, Wadi Adonis, Roman inscriptions on the rocks	A full archaeological, historical and cultural heritage survey will be undertaken on the priority site in accordance with the requirements of the General Directorate of Antiquities

Public Scoping Session for residents of the Jannah Area
held at Qartaba Municipality on Saturday 21 April 2012

Session 5: Water consumers of Beirut southern suburbs

Hadath Municipality on April 24, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة- المكان:..............................الزمان:..............................
جدول الحضور

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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"
إستشارات العامة- المكان:...بلدية الحدث......الزمان:....2012/4/24......
جدول الحضور

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13		[illegible]			
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Hadath Municipality - 24 April 2012	
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Phillipe Nassar	Dar Al Handasah
Riwa Al-Derbas	Dar Al-Handasah
John Davey	Dar Al-Handasah
Elie Abou Rjeili	Dar Al Handasah
Suheil Srour	Dar Al-Handasah
Randa Daher	Awali Project
Elie Moussali	Council for Dev. & Reconstruction
Roland Ghawi	Council for Dev. & Reconstruction
Assem Fidawi	Council for Dev. & Reconstruction
Edward Aoun	Municipality of Hadath
Mohsen Sabra	Slomia Co.
Fathi Chatila	Arab World Water Magazine
Khalil Sasi	Furn El Chebbak Municipality
Marie-Noelle Cherfan Maalouk	Chiah Municipality
Elie Farhat	Kfarshima Municipality
Antoinette Sleiman	Litani River Authority
Elie Harb	Hadath Municipality
Mounir el Rishani	Choueifat Municipality
Farouk Arbid	Choueifat Municipality
Salim Sakr	Hazmieh Municipality
Elias Habib Hatem	Hazmieh Municipality

Summary of issues raised during Session 5

with corresponding responses by the consultant

Name	Affiliation	Comment(s)	Consultant's Response
Fathi Chatila	Arab World Water	There will not be enough water in Qaraoun Lake to supply Greater Beirut	This is not disputed
		There is a need to consult people from the South and Saida before taking water	The Ministry and CDR are committed to public consultation of internationally-funded projects
		I am concerned about the poor water quality coming from Qaraoun	While Qaraoun water will not be used to supply Greater Beirut, recent and ongoing studies have shown it can be satisfactorily treated by conventional techniques
		I believe Nahr Damour can store 90 Mm^3 in and not just 32 Mm^3 as suggested by Libanconsult	The Consultant will be checking the capacity for reservoir storage and supply during the study
		90% of the water in Joun comes from Qaraoun	The proportion of Qaraoun water in Joun is subject to seasonal variation, which is unlikely to exceed 30% and may at times be significantly less
		A dam in Damour will be more cost-effective than conveying water from Qaraoun	If taking Beirut water from Qaraoun Lake were possible, the two schemes would not be comparable
		We are depriving the people of the south from getting their water, whereas if we get the water from Damour dam this will not be a problem.	The people of South Lebanon will not be asked to forfeit their rights to water for Beirut residents
Mohsen Sabra	Litani Water Authority	Qaraoun is highly polluted and although treatment is very costly, though it's not impossible	Recent studies have shown Qaraoun water may be treated by conventional means.
		What's the time frame for the preparation of the ESIA and when are you going to start implementation?	The current ESIA project will be completed by the end of September 2012. Implementation will commence with detailed design as soon as funding is made available
		Damour dam is closer to Beirut and water quality is much better and more cost effective than the other options.	If so, the present study will confirm it
Municipality of Hazmieh		Why don't we study constructing a dam at Beirut River?	The Beirut River is outside the present scope of study. The Consultant assumes Nahr Beirut has previously been studied and disregarded on technical and economic considerations

Session 6: Water Consumers of Central Beirut

Beirut Municipality on May 5, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:..............................الزمان:..............................

جدول الحضور

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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.................................الزمان:.................................

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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.................................الزمان:.................................

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Beirut Municipality - 5 May 2012	
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Mohammad Chatila	Universal Equipmentt
Riwa Al-Derbas	Dar Al-Handasah
John Davey	Dar Al-Handasah
Elie Abou Rjeili	Dar Al Handasah
Suheil Srour	Dar Al-Handasah
Basma Traboulsi	National Women's Union
Ismail makke	Council for Dev. & Reconstruction
Tania Zakhan	Directorate General of Antiquities
Assem Fidawi	Council for Dev. & Reconstruction
Ahmad Mgharbel	Association of the Charity Center
Aref Dia	Lebanese University
Mohammad Ali Sinno	Beirut Union
Mohammas el	Beirut Union
Idriss Saleh	Union of Lebanese & Arab Associations
Fathi Chatila	Arab World Water magazine
Khaled el Daouk	Group of Reform and Progress
Imad Akkawi	Organization of Isa'af Sha'abi
Phillipe Nassar	Dar Al Handasah
Antoine Habib	Future Pipe
Ziad el Salini	Future Pipe
Abboud Zahr	DEP
Nawal Chatila	*(not given)*
Zeinab Chehab	*(not given)*
Antoinette Sleiman	Litani River Authority
Mohammad el Z'anni	*(not given)*
Walid Deghman	Social Committee
Samir Knio	*(not given)*
Walid Itani	*(not given)*
Mahmoud Oz'or	Organization of Isa'af Sha'abi
Randa Nemr	Ministry of Energy and Water
Khaled Zahran	Beirut Inhabitants Association
Salim Kreidie	Dar El Nahda Engineering
Dahej el Mokdad	Ministry of Agriculture
Mona Itani	Beirut Inhabitants Association
Elham Bekdash	National Labor Campaign
Souhaila Edriss	Operation Big Blue
Samir Zaatiti	Lebanese University
Hassan Jaafar	Hydrogeologist
Bassam Jaber	Ministry of Energy and Water
Motassem Fadel	American University of Beirut
Mohammad Khaled Soubra	Office of MP Bahaa El Dine Itani

Name	Affiliation	Comment(s)	Consultant's Response
Fathi Chatila	Arab World Water	The fact that the Damour reservoir can supply 32 Mm^3 is wrong. There is the capacity for 90 Mm^3	The Consultant will be checking the capacity for reservoir storage and supply during the study.
		The Awali Project is 90% from Litani, it should not be called Awali	The current proposal is for no further water for Beirut to be taken from Nahr Litani
		In the 1970's the people of South Lebanon were against water being conveyed from Nahr Litani to Beirut.	Noted
		Nahr Litani is the most polluted river in Lebanon but MEW claims it can be treated conventionally. They disregard the fact that sixty villages around Qaraoun are susceptible to diseases such as cancer due to the bad water quality.	Whilst the Litani continues to suffer pollution, ongoing projects such as Litani Wastewater will substantially improve water quality. The enforcement of existing environmental laws could be used to address specific problematic discharges.
Salim Kriedieh	Dar El Nahda Engineering	Provide drinking water from Bisri dam	As shown in the presentation, this is one of the options being studied.
Idriss Saleh	President of Union of the Lebanese and Arab Associations	I recommend to group all the specialists to come up with a solution	To the same end, the Consultant has been appointed to consider everyone's point-of-view and make a considered judgement
Randa Nemer	Advisor to MEW	With the construction of Canal 800 and Canal 900 there is insufficient water to supply Greater Beirut from Qaraoun to supply Greater Beirut area. If the money is provided, all three dams will be implemented, because over the years the costs will only rise.	No Consultant's response required

Name	Affiliation	Comment(s)	Consultant's Response
Basma Traboulsi	National Women's Union	We don't want water if it will be polluted	It will be the intention of both the Ministry and the Water Establishment to ensure water delivered to consumers' taps meets current environmental health standards and is fit-for-purpose
Hassan Jaafar	Hydrogeologist	Qaraoun water does not go to Beirut consumers	The Consultant confirms that at the present time no Qaraoun water is supplied to Greater Beirut, and as MEW has commented above, it is not proposed to do so in the future
Abboud Zahr	DEP	I am a citizen who buys water due to water shortage in Beirut. We need a solution, I don't care what decision you take, and I just need to have water in my tap	I am sure your concerns are shared by the vast majority of Beirut's population and this is what the National Water Strategy aims to provide
		My greatest concern is that after the water is conveyed, the water quantities will actually decrease rather than increase because of the excess of leakage that will occur when the water pressure suddenly increases in the pipes. Poor conditions of the household connections lead to leakage. Thus they need to be rehabilitated at the same time of the project.	You are correct to highlight the present significance of leakage. For this reason the GBWSP includes major elements of leakage identification and repair, and the installation of both bulk meters on the distribution network and household meters to monitor water use and assist with the identification of future leaks
Aref Dia	Lebanese University	Qaraoun Lake contains cyanobacteria, which is a dangerous toxin. Does the Ministry know by what means and where it will be treated?	For those not familiar with the term, cyanobacteria are more commonly known as blue-green algae, a variety of planktonic cells found in most terrestrial and aquatic habitats; in the sea and fresh water, in the soil and on bare rock. Some cyanobacteria produce cytotoxins that may be harmful to animal and marine life, including humans but 30-50% of cyanobacteria are harmless. A number of standard elements of conventional water treatment process streams, such as flocculation, chlorination, microfiltration and ozonation have been shown to be effective in destroying cyanobacteria and in removing microcystins, a major cytotoxin common in fresh water for which the WHO has established a guideline value. Any future MEW/BMLWE treatment plant will be expected to meet or exceed WHO standards for water quality delivered to consumers.

Name	Affiliation	Comment(s)	Consultant's Response
			The reduction in discharges into the environment of nutrient-high wastewaters will also reduce the potential for cyanobacteria and algal bloom formation
Imad Akkawi	Organization of Isa'af Sha'abi	For 42 years, studies have discussed Litani's pollution. People from the south need this water for their development	Litani water is indeed vital for South Lebanon. For this reason the GBWSP will not take water from Qaraoun Lake
Ahmad Mgharbel	Association of the Charity Center	Leakage is external (visual) and hidden. I will focus on the visual leakage and leave the other leakage to be discussed by specialists. Leakage occurs as a result of float valve malfunction, water tank and pipe deterioration. I therefore suggest giving notice to fix all leakages within a specific time frame and thereafter penalize offenders, and increase public awareness of the negative impact of leakages.	Leakage is indeed an important issue and current estimates are that 50% or more of water put into distribution may be lost. The GBWSP includes elements for leakage identification and repair, for bulk metering to help identify future leaks, and for household metering to assist families better manage their own losses. Whether regulation of public activities within the water sector will work in Lebanon any better than it does in other sectors will doubtless be subject to debate. Almost certainly, one recommendation of the GBWSAP ESIA will be the establishment of a 'hot line' via which citizens can report leakages and water use abuse.
Unattributed Comment		The stakeholders are not concerned with people's opinion; they do projects without asking people	While accepting this may be the view of many, the Consultant views everyone, those that supply and consume water, as stakeholders. Hence the Consultant has embarked on the present series of public consultation meetings and will hold another round of meetings to report the results of his study
Unattributed Comment		The people of Beirut want Damour Dam because of its easy access and better water quality than other rivers	If this is the case the present study will confirm it.
Unattributed Comment		The numbers in the presentation are not correct.	The numbers in the presentation are drawn from recognised sources such as MEW's National Water Strategy, the World Bank's GBWSP Project Appraisal Document, and the various Feasibility Reports for the dam options. For Scoping purposes they will suffice and the Consultant will endeavor to elicit the correct figures for presentation in the ESIA
Unattributed Comment		Despite considering mainly surface water, 75%	Ground water is already an important source of

Name	Affiliation	Comment(s)	Consultant's Response
		of Lebanon's geology comprises karst formations. Thus we need to take into consideration ground water	water supply and will continue to be so. Over-abstraction of the coastal aquifers has increasingly led to saline intrusion. While valuable ground water resources remain these have to be fully investigated and shown to be sustainable before they can be relied upon for vital supplies such as for the capital. There is currently a moratorium on the drilling of new water wells

GREATER BEIRUT WATER SUPPLY AUGMENTATION PROJECT

ESIA Public Consultation Scoping Sessions

Power Point Presentation

مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب

دراسة تقييم الأثر البيئي والإجتماعي

المرحلة الأولى

Greater Beirut Water Supply Augmentation Project

Environmental and Social Impact Assessment

Phase I

Presenters المقدمون

سيقوم السيدة روى الدرياس بدور المقدم الرئيسي لهذه الندوة

كما حضر للاجابة عن اسئلتكم:

د. سهيل سرور- الذي سيقوم بدور رئيس الجلسة

د. جون دايفي- قائد فريق تقييم الاثر البيئي والاجتماعي لمشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب

الآنسة فاي مشنتف- مختصة في مجال البيئة

كما يضم فريق تحضير تقييم الأثر البيئي والإجتماعي اخصائيين في مجال الجيوتقنية والهيدرولوجيا وبناء السدود واخصائيين اجتماعيين

كما حضر للاجابة على الاسئلة التي تتجاوز النطاق المباشر للمشروع **السيد عاصم فيداوي** - مدير مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب لدى مجلس الانماء والاعمار

Objectives of this session أهداف الندوة

إن أهداف الندوة اليوم هي:

1. شرح أولي عن نطاق **مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب**.

2 . عرض ملخص للتقييم الأولي للاستشاري فيما يخص الآثار البيئية والاجتماعية المحتملة، منها الإيجابي والسلبي.

3. الحصول على تعليقاتكم بشأن المشروع، الإيجابية منها والسلبية، وتسجيل ملاحظاتكم وإقتراحاتكم لأخذها بعين الإعتبار خلال عملية تقييم الأثر البيئي والإجتماعي.

Outline العناوين

- الوضع الحالي لامدادات المياه
- شح المياه في لبنان
- الوضع المستقبلي المتوقع
- معلجة مشكلة شح المياه
- مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP
- الخيارات التي سيتم البحث فيها
- بناء السدود كحل محتمل
- مقارنة بين المواقع المقترحة
- الآثار المحتملة للسدود
- خطة للإدارة البيئية والإجتماعية
- الحد من إستملاك الاراضي
- استشارات العامة

Present Water Supply Situation الوضع الحالي لامدادات المياه

- يقدر عدد سكان لبنان بـ4.4 مليون (2010)، 46% منهم يعيشون في بيروت الكبرى وجبل لبنان
- يتلقى 1.9 مليون شخصاً المياه من جعيتا عبر محطات المعالجة في الضبية وأبار الدامور وعدة مصادر ثانوية، إلا ان امدادات المياه غير كافية وغير متوازنة موسمياً
- تتلقى بعض الاسر المياه من الشبكة العامة لأقل من 3 ساعات يومياً في منطقة بيروت الكبرى
- تعتمد الكثير من الاسر على:

  (أ) المياه الجوفية من الآبار ذات البنية الضعيفة وغالباً غير قانونية

  (ب) شراء المياه من الخزانات العائدة للقطاع الخاص، منها ما هو غير صالح للشرب

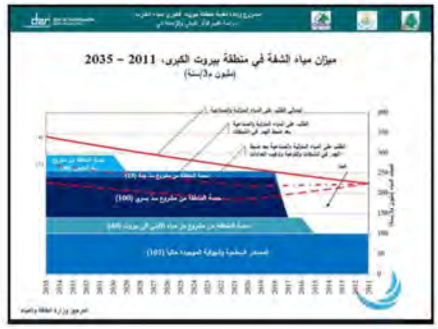
  (ج) مياه الشرب المعبئة ذات الكلفة العالية ومنها ما هو غير صالح للشرب

Lebanon's Water Stress شح المياه في لبنان

- يقدر مجموع تدفق المياه السطحية بـ 735 مليون متر مكعب/سنوياً، تذهب كمية كبيرة مفقودة الى البحر
- تعود أسباب مشاكل قطاع المياه في لبنان إلى العوامل التالية:

  ✓ شبكات نقل وتوزيع غير فعّالة ومحدودة وقديمة
  ✓ غياب العدادات وهيكلية التعرفة المتعلقة بالاستهلاك
  ✓ الافراط في استخراج المياه الجوفية، مما يؤدي الى تسرّب المياه المالحة
  ✓ نسبة عالية من المياه غير المحتسبة والضعف في استرداد التكاليف
  ✓ نقص في الاستثمار في البنية التحتية الحديثة للمياه
  ✓ ضعف في القدرة المؤسساتية
  ✓ غياب الوعي والمشورة والمشاركة العامة


Predicted Future Situation
الوضع المستقبلي المتوقع
• يقدر عدد سكان بيروت الكبرى بـ1.9 مليون (2010)
• من المتوقع ان يصل عدد سكان بيروت الكبرى الى 2.3 مليون بحلول العام 2035
• من المتوقع أن يصل الطلب على المياه المنزلية والصناعية إلى 341 مليون م3\السنة بحلول العام 2035
• تقدر مصادر المياه الحالية بـ 101مليون م3\السنة
• تقدر حصة منطقة بيروت الكبرى من جر مياه الأولي إلى بيروت بـ 40 مليون م3\السنة
• يقدر حجم المياه التي ستتوفر من سد بسري، جنّة، والدامور بـ155 مليون م3\السنة
• الحد من الطلب من خلال ضبط الهدر في الشبكات، وتركيب العدادات وتوعية العامة


ميزان مياه الشفة في منطقة بيروت الكبرى، 2011 – 2035
(مليون م3/سنة)


Addressing Water Stress (short-term)
معالجة مشكلة شح المياه على المدى القصير (1)
• أطلقت الحكومة اللبنانية من خلال وزارة الطاقة والمياه، مجلس الانماء والاعمار ومؤسسة مياه بيروت وجبل لبنان مشروع جر مياه الأولي الى بيروت لسد العجز الحالي وضمان الامدادات المستدامة لتلبية الطلب على المدى القصير والمتوسط
سيتم من خلال المشروع نقل 50 مليون متر مكعب (40 مليون لمياه الشفة و10 مليون للإستعمالات الصناعية) من سد القرعون، وعين الزرقا، ونبع نفق جزين والنهر الأولي الى جون عبر قناة قائمة، ثم نقلها في قناة جديدة الى خلدة ومعالجتها في محطة جديدة في الوردانية بغية توزيعها على المستهلكين في بيروت الكبرى .


Addressing Water Stress (short-term)
معالجة مشكلة شح المياه على المدى القصير (2)
• يتضمن مشروع جر مياه الأولي الى بيروت :
✓ نفق بطول 27 كم
✓ محطة المعالجة في الوردانية
✓ خزانات في الحدث والحازمية
✓ شبكات توزيع
✓ عدادات


Addressing Water Stress (long-term)
معالجة مشكلة شح المياه على المدى الطويل
• بدأ مجلس الانماء والاعمار، بالتعاون مع وزارة الطاقة والمياه ومؤسسة مياه بيروت وجبل لبنان، مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP بغية تحديد وسائل تعزيز المياه في بيروت الكبرى الاكثر استدامة بيئياً والمقبولة اجتماعياً كي تلبي الطلب على المدى الطويل.


مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP (1)
ينقسم مهام المشروع الى مرحلتين :
المرحلة الاولى
•اجراء مراجعة تقنية، إقتصادية، بيئية، واجتماعية واسعة، من ضمنها تقييم اولي للاثر البيئي والاجتماعي لكافة المصادر البديلة واقتراح الخيار مفضل
المرحلة الثانية
•اجراء تقييم للاثر البيئي والاجتماعي من الفئة أ، من ضمنها خطة ادارة بيئية، واذا لزم الامر، مستندات اعادة الإسكان، للخيار المفضل الموافق عليه


مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP (2)
• سوف يتبع تقييم الأثر البيئي والإجتماعي للمشروع المعايير الدولية مثل ضمانات البنك الدولي، وذلك وفقاً لسياسة الحكومة اللبنانية.
• تم تكليف دار الهندسة (شاعر ومشاركوه) لتحضير الدراسة، نظراً لخبرتها الطويلة في مشاريع البنى التحتية، ولكونها لم تقم بإعداد أي من الدراسات التي ستتم مراجعتها.


مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP (3)
يتضمن تقييم الأثر البيئي والإجتماعي خطة للإدارة البيئية والإجتماعية

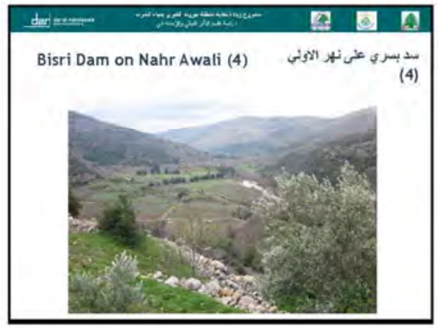

Alternative Source of Water
الخيارات التي سيتم البحث فيها
1. خيار الـ <<لا مشروع>>
2. التحسين بالتوزيع
3. الحد من التسرب
4. تخفيض المياه غير المحتسبة
5. بناء السدود
6. المياه الجوفية
7. تحلية مياه البحر
8. حصاد مياه الأمطار
9. معالجة مياه الصرف الصحي

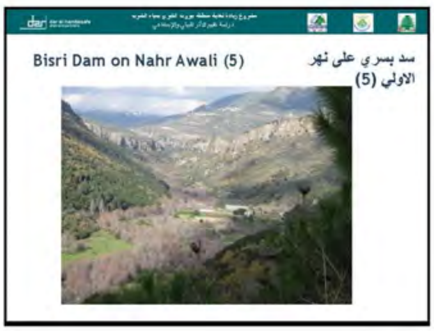

Potential Dam Solutions
بناء السدود كحل محتمل
• سد بسري على نهر الاولي
• سد الدامور على نهر الدامور (موقعين)
• سد جنة على نهر ابراهيم
سد الدامور
سد بسري
سد جنة

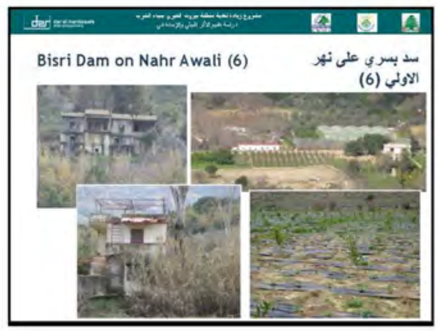

Bisri Dam on Nahr Awali (1)
سد بسري على نهر الاولي(1)

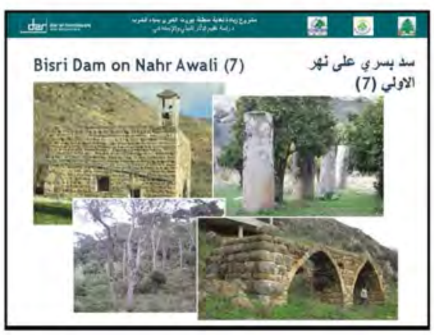

Bisri Dam on Nahr Awali (2)
سد بسري على نهر الاولي (2)


Bisri Dam on Nahr Awali (3)
سد بسري على نهر الاولي (3)


Bisri Dam on Nahr Awali (4)
سد بسري على نهر الاولي (4)


Bisri Dam on Nahr Awali (5)
سد بسري على نهر الاولي (5)


Bisri Dam on Nahr Awali (6)
سد بسري على نهر الاولي (6)


Bisri Dam on Nahr Awali (7)
سد بسري على نهر الاولي (7)


Damour Dam on
Nahr Damour (2 sites)
سد الدامور على نهر الدامور
(موقعين)


Jannah Dam on
Nahr Ibrahim (1)
سد جنة على نهر ابراهيم (1)


Jannah Dam on
Nahr Ibrahim (2)
سد جنة على نهر ابراهيم (2)


Jannah Dam on
Nahr Ibrahim (3)
سد جنة على نهر ابراهيم (3)


Jannah Dam on
Nahr Ibrahim (4)
سد جنة على نهر ابراهيم (4)


Jannah Dam on
Nahr Ibrahim (5)
سد جنة على نهر ابراهيم (5)


Jannah Dam on
Nahr Ibrahim (6)
سد جنة على نهر ابراهيم (6)


Jannah Dam on Nahr Ibrahim (7)
سد جنة على نهر ابراهيم (7)


Comparison of the Three Sites
مقارنة بين المواقع الثلاثة
السد
النهر
الارتفاع المقترح
مساحة البحيرة
حجم التجميع
بسري
نهر الاولي
74 م
5.9 كلم²
128 مليون م³
الدامور (موقعين)
نهر الدامور
90 م
1.2 كلم²
32 مليون م³
جنة
نهر ابراهيم
105 م
1.0 كلم²
37 مليون م³


Potential Impacts of Dams (1)
الآثار المحتملة للسدود (1)
1. الآثار الدائمة
المسألة
إيجابي
سلبي
• استملاك الاراضي
• تحسين الوصول من والى الأراضي المجاورة للسد والبحيرة
• خسارة المناظر الطبيعية والاراضي الزراعية
• خسارة المجتمعات، المنازل، ومباني الاعمال
• تجميع المياه
• توفير مصدر إضافي للمياه والطاقة
• القيام بأنشطة ترفيهية في محيط السد والبحيرة
• صعوبة الوصول إلى بعض الأمكنة
• الترسبات
• تآكل التربة
• سلامة السد
• ادارة الحوض الأعلى
• تنمية السياحة والانشطة الترفيهية
• فرص عمل جديدة
• جرف المنشآت المبنية


Potential Impacts of Dams (2)
الآثار المحتملة للسدود (2)
1. الآثار الدائمة
المسألة
إيجابي
سلبي
• ادارة الحوض الأسفل
• السيطرة على الفيضان
• نقص في موارد المياه السطحية
• تخفيض موارد الري وزيادة في التلوث
• التنوع البيولوجي والموائل الطبيعية
• إيجاد بحيرات وموائل طبيعية جديدة
• تكاثر انواع جديدة: النباتات، الطيور المائية، الزواحف
• فقدان النباتات الطبيعية
• فقدان التنوع البيولوجي البري والنهري
• تأثير على موارد الأسماك
• اعادة الإسكان القسرية
• توفير فرص اقتصادية جديدة
• تهجير المقيمين والاعمال التجارية
• آثار خاصة على الفئات الضعيفة
• الصحة العامة
• تحسين الوصول الى الخدمات الصحية والاجتماعية
• تزايد الامراض المتعلقة بالمياه
• تزايد مخاطر الزلازل
• سلامة السدود


Potential Impacts of Dams (3)
الآثار المحتملة للسدود (3)
2. الآثار المؤقتة
المسألة
إيجابي
سلبي
• الآثار خلال فترة البناء
• التوظيف المؤقت
• الطلب المتزايد على الخدمات المحلية
• الآثار الاعتيادية الناجمة خلال البناء: ضجيج، غبار، إعاقة في حركة السير
3. آثار ما بعد البناء
• الآثار التشغيلية
• توظيف مشغلي السد والمحطة
• انخفاض في الإنبعاثات الإقليمية
• انخفاض في تآكل التربة في الحوض الأسفل
• زيادة في انبعاثات غازات الإحتباس الحراري من محطة توليد الكهرباء والبحيرة
• إحتمال زيادة التلوث في الحوض الأسفل
• خسائر بسبب التبخر
• سلامة السدود


Environmental Management
الإدارة البيئية
• سيتم إقتراح سبل لتفادي، الحد ، وإدارة كل من الآثار السلبية الناتجة عن المشروع، خلال فترة التصميم، والبناء، والتشغيل.
• سيتم إعداد خطة للإدارة البيئية والإجتماعية.
• سيقوم المقاول بتحضير خطة للإدارة البيئية خلال فترة البناء.


Land Take Mitigation
الحد من إستملاك الاراضي
• تطبيق عادل لاستملاك الأراضي وإعادة الإسكان.
• القيام بمسح اجتماعي واقتصادي من شأنه توفير المعلومات اللازمة عن الأسر والشركات بغية ضمان تحقيق عملية الإستملاكات بأقل حدّ ممكن من الاضطراب والمشقة.
• تحضير الوثائق المتعلقة بإعادة الإسكان.


Your Opinion Matters
رأيكم يهمنا
نود الآن معرفة وجهات نظركم بعد ان اطلعتم على المشروع.
لا تترددوا بطرح أي سؤال والاشارة الى أية هواجس، أو إبداء أي ملاحظات
ما هي بنظركم الآثار الأولية البيئية أو الاجتماعية؟
كيف يُحتمل ان يتأثر الاشخاص الذين تمثلونهم؟
كيف سيتأثر مجتمعكم؟
كيف ستتأثرون انتم وعائلتكم؟


Addressing Public Consultation
استشارات العامة
جلسة تحديد النطاق | المكان | التاريخ
ندوة مع المعنيين في القطاع | مجلس الانماء والاعمار | 3 نيسان
سد بسري | بلدية مزرعة الضهر | 10 نيسان
سد الدامور | بلدية دميت | 12 نيسان
سد جنة | بلدية قرطبا | 21 نيسان
مستهلكو المياه في ضواحي بيروت الجنوبية | بلدية الحدث | 24 نيسان
مستهلكو المياه في مدينة بيروت | بلدية بيروت | 5 أيار
• سيتم عقد جلسات اخرى عند الطلب
• سيتم عقد مجموعة اضافية من المشاورات لنشر نتائج تقييم الآثار البيئية والاجتماعية


dar
شكراً لمشاركتكم
نرحب بتعليقاتكم
تبقى فرصتكم للتعليق مفتوحة لمدة ستة أيام عمل
BWSA 12002
01/869026
BWSA.12002@dargroup.com
71-137532
نتطلع للسماع منكم


dar
شكراً
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي
(المرحلة الأولى)
Greater Beirut Water Supply Augmentation Project
Environmental and Social Impact Assessment
(Phase 1)

GREATER BEIRUT WATER SUPPLY AUGMENTATION PROJECT

ESIA Public Consultation Scoping Sessions

Handouts

مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب

دراسة تقييم الأثر البيئي والإجتماعي

1 مقدمة

قدر عدد سكان لبنان بـ4.4 مليون في العام 2010، 46% منهم يعيشون في بيروت الكبرى وجبل لبنان. يتلقى حوالي 1.8 مليونشخصاً المياه من جعيتا عبر محطات المعالجة في ضبية، إلا ان إمدادت المياه غير كافية وغير متوازنةموسمياً. والجدير بالذكر أن بعض الأسر المعيشية تتلقى المياه من الإمدادات العامة لأقل من 3 ساعاتيومياً.

من المتوقع ان يصل عدد سكان لبنان الى 6.8 مليون بحلول العام 2035. تبلغ الموارد المائية المتجددة في لبنان حوالي 600 متر مكعب/للشخص/سنوياً، بينما يبلغ خط الفقر المائي الذي وضعته الامم المتحدة 1000 متر مكعب/للشخص/سنوياً. بالتالي، هناك مخاطر عالية للنقص المزمن في المياه بحلول العام 2020.

أطلق مجلس الانماء والاعمار بالتعاون مع وزارة الطاقة والمياه ومؤسسة مياه بيروت وجبل لبنان مشروع تغذية منطقة بيروت الكبرى بمياه الشرب للتغلب على العجز الحالي وضمان الإمدادات المستدامة لتلبية الطلب على المدى القصير والمتوسط. سيتّم من خلال المشروع تحسين توزيع الإمدادات، بما في ذلك الحدّ من التسّرب ونقل 50 مليون متر مكعب من المياهسنوياً من بحيرة القرعون بغية توزيعها على مستهلكي بيروت الكبرى.

تبحث وزارة الطاقة والمياه منذ عدّة سنوات عن إمكانية تخزين المياه الناتجة عن جريان المياه السطحية المفقودة سنوياً الى البحر عبر إنشاء بحيرات وبناء السدود والخزانات الكبيرة لتعزيز الإمدادات الزراعية وتلبية متطلبات بيروت الكبرى والمراكز السكانية الاخرى على المدى الطويل.

مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP

أطلق مجلس الانماء والاعمار، بالتعاون مع وزارة الطاقة والمياه ومؤسسة مياه بيروت وجبل لبنان، هذا المشروع الجديد لزيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP بغية تحديد الوسائل الاكثر مستدامةبيئياً والمقبولةاجتماعياً كي تلبي الطلب على المدى الطويل. تنقسم مهام المشروع الى مرحلتين:

المرحلة الاولى

إجراء مراجعة بيئية وإجتماعية واسعة، من ضمنها تقييم أولي للاثر البيئي والاجتماعي لكافة المصادر البديلة واقتراح البديل المفضّل.

المرحلة الثانية

اجراء تقييم للاثر البيئي والاجتماعي من الفئة أ، من ضمنها خطة ادارة بيئية، واذا لزم الامر، مستندات اعادة الإسكان، للبديل المفضل الموافق عليه.

سوف يتبع مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP سياسات ضمانات البنك الدولي ومتطلبات الإستشارات العامة، وذلكوفقاً لسياسة مجلس الانماء والاعمار والاجراءات الدولية الثابتة للمستشارين.

تتضمن المصادر البديلة للمياه التالي:

1. تحسين توزيع المياه
2. الحد من التسرّب
3. تخفيض غيرها من المياه غير المحتسبة
4. بناء السدود

يمكن تحسين الامدادات الحالية للمياه بشكل كبير والتقليل من الخسائر نتيجة التسرّب والوصلات غير القانونية. سوف يساهم تحصيل الفواتير في تحسين استرداد التكاليف والمساعدة في تمويل عمليات خدمات المياه. في حين ان هذه التدابير ستمكّن الامدادات الحالية الإستجابة لمطالب المدى القصير والمتوسط، لا بدّ من توفير موارد اضافية للمياه لتلبية الطلبات على المدى الطويل.

ان الوسائل الأقل تكلفة لضمان امدادات جديدة ومستدامة للمياه هي الحفاظ على ما يزيد عن 160 مليون متر مكعبسنوياً من المياه السطحية العذبة التي تفيض الى البحر، من خلال بناء سدود مثل:

1. سد بسري على نهر الاولي
2. سد الدامور على نهر الدامور (موقعين)
3. سد جنة على نهر ابراهيم

يبيّن الجدول التالي مقارنة بين المواقع الثلاثة.

السد	النهر	الارتفاع المقترح	مساحة الخزان	حجم التجميع	امدادات المياه المتوقعة
بسري	نهر الاولي	74 م	5.9 كلم^2	128 مليون م^3	0.56 مليون م^3/يوم
الدامور	نهر الدامور	90 م	1.2 كلم^2	32 مليون م^3	0.2 مليون م^3/يوم
جنة	نهر ابراهيم	105 م	1.0 كلم^2	37 مليون م^3	0.2 مليون م^3/يوم

الآثار البيئية والاجتماعية

أيا كان البديل المفضّل ، سوف تنتج آثار بيئية واجتماعية عن المشروع. وقد تكون الآثار سلبية او ايجابية، مؤقتة او دائمة، مباشرة او غير مباشرة.

تتمركز الآثار الايجابية حول تزويد امدادات المياه المستدامة للعامة والتحسينات التي ستنعكس على الحياة الاجتماعية، هذا بالإضافة إلى فرص النمو والتطور الاقتصادي.

وتركز الآثار السلبية الدائمة على استملاك الاراضي، والحاجة الى اعادة إسكان الاسر ونقل الاعمال التجارية. هذا الى جانب المسائل الصحية العامة التي ترافق بناء السدود إجمالاً مثل تكاثر الحشرات والمخاطر المتزايدة للغرق. وتتم مناقشة الآثار الدائمة خلال تصميم المشروع.

تنتج الآثار السلبية المؤقتة بشكل اكثر شيوعا خلال فترة البناء نتيجة نشاطات المقاول ومستخدميه. وعلى الاغلب سوف تزيد من الضجة والغبار ومشاكل ادارة السير والاضطراب الاجتماعي بين المقيمين ونزوح العمال. تتم مناقشة هذه المسائل في خطة سلامة الصحة البيئية العائدة للمقاول، اضافة الى خطة الادارة البيئية والاجتماعية للمشروع.

اخيراً، ان الآثار التشغيلية هي تلك التي سوف تنتج عن تشغيل المرافق. وقد تتضمن الضجة واهتزاز المضخات والتخلص من النفايات. وتتم مناقشة الآثار التشغيلية خلال تصميم المشروع.

سيتم إقتراح تدابير لتخفيف، تجنّب، وادارة جميع الآثارالمنتجة وسيتم التحقق من آلية الإمتثال لخطط الادارة البيئية.

الحد من إستملاك الاراضي

إن الأثر الأكبر للمشروع هو إستملاك الأراضي. سيتم تطبيق عملية استملاك الأراضي وإعادة الإسكانوفقاً للقانون اللبناني حول نزع الملكية والاجراءات العملية للبنك الدولي OP 4.12 ، وسيعتمد التطبيق الاكثر صرامة في حال وجود ثغرات بين الإجراءين.

سوف يقوم الاستشاري ، قبل تحديد البديل المفضل بشكل نهائي، بإعداد وثيقة *الإطار السياسي لاعادة الإسكاRPF* التي سوف تتضمن مقارنة مفصلة بين التشريع اللبناني ومتطلبات سياسة البنك الدولي، وتحديد إجراءات إعادة الإسكان التي سوف تتبعها عملية إستملاك الاراضي المتعلقة بالمشروع.

ما ان يتم الاتفاق على البديل المفضل وتحديد مدى إستملاك الاراضي وإعادة الإسكان، سيقوم الاستشاري بمسح اجتماعي واقتصادي من شأنه توفير المعلومات اللازمة عن الأسر والشركات بغية ضمان تحقيق عملية الإستملاكات باقل حد ممكن من الاضطراب والمشقة.

Consultation sessions are planned shortly after submission of the present report, to relate the details of the study and to disseminate the results to stakeholders, and summarises the remaining C&CP programme though design, construction and commissioning.

APPENDIX G

AVAILABLE CADASTRAL MAP FOR BISRI RESERVOIR

Note on Cadastral Mapping

The preparation of the final ESIA and the RAP require a detailed socio-economic survey of households and businesses within and adjacent to the impoundment area based on cadastral and land ownership information. To this end, GBWSAP ESIA team has prepared provisional cadastral mapping for the reservoir area, gathering information from different sources including the Cadastre department of the Ministry of Finance at both Saida and Baabda offices, Directorate General of Urban Planning at the Ministry of Public Works and concerned municipalities.

The ESIA team was successful in rectifying the available plans and digitizing plot boundaries using GIS whenever and wherever possible depending on clarity and accuracy of maps. As most available plans are not geo-referenced, plots boundaries are not accurate due to scaling and stretching during assembling to match common boundaries between cadastral regions and features from GE imagery. Therefore plot areas calculated using GIS should not be treated as accurate.

Cadastral plots are still awaited for Bsaba and Bater, with one conflict area between Aamatour and Bater.

On this basis the socio-economic survey and the RAP will be prepared.


132000
133000
134000
135000
136000
137000
138000
Legend
Bisri Dam Reservoir
Town Boundary
Plot Boundary
1:6,000
Km
0
0.25
0.5
1