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Council for Development and Reconstruction

Greater Beirut Water Supply Augmentation Project Environmental and Social Impact Assessment

Final Environmental and Social Impact Assessment

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dar al-handasah shair and partners

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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
CAS	Central Administration of Statistics
CBO	Community Based Owner
CH_4	Methane
CDR	Council of Development and Reconstruction
CLO	Community Liaison Officer
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
ERP	Emergency Response Procedures
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
ILO	International Labour Organisation
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
LCWMC	Lebanon Centre for Water Management and Conservation
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
MoSA	Ministry of Social Affairs
MPWT	Ministry of Public Works and Transport
MSF	Multi-Stage Flash
N_2O	Nitrous Oxide
NE	North East
NERP	National Emergency Recovery Programme
NGO	Non-Governmental Organisation
NPV	Net Present Value
NWC	National Water Council
NWFP	Non-Wood Forest Product
NWSS	National Water Sector Strategy
OP	Operating Policy
O&M	Operation and Maintenance
PAP	Project Affected Person
PDESIA	Preliminary Draft ESIA
PIC	Project Information Center
PMF	Probable Maximum Flood
PMT	Project Management Team
POE	Panel of Experts
RAP	Resettlement Action Plan
RCC	Roller Compacter Concrete
RO	Reverse Osmosis
RPF	Resettlement Policy Framework
RWE	Regional Water Establishment
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
WFP	Wood Forest Product

EXECUTIVE SUMMARY

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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..

The GBWSAP ESIA has been implemented in two phases. Phase 1 compared dam and non-dam options for water supply augmentation to the Greater Beirut and Mount Lebaon area in the long term and recommended Bisri dam as the Priority Scheme, while in Phase 2 a full Category A ESIA for Bisri dam has been prepared. This report reflects the changes to dam design and area to be expropriated of January 2014. The report has been discussed with stakeholders and has been endorsed by CDR and other agencies involved in implementation of various portions of the ESMP.

ESIA Process

An environmental and social assessment process is in place to avoid, mitigate and/or compensate those identified potential negative environmental and social impacts.

The environmental and social analytical work and recommendations, all designed in a transparent and collaborative manner has been packaged into two sets of documents:

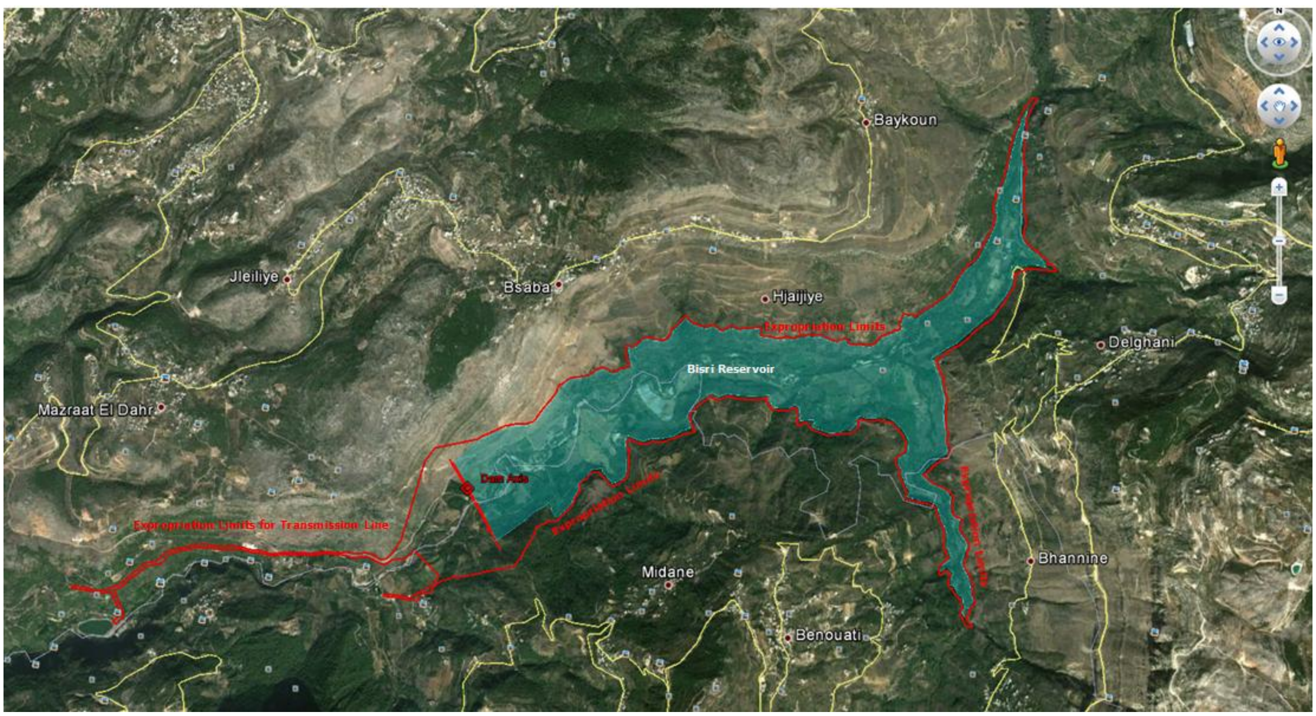
- The ESA documentation consisting of:

1. Environmental and social impact assessment (ESIA) report – i.e. the present report
2. Its accompanying appendices
    - Appendix A: Bibliography and List of References
    - Appendix B: Dam Design
    - Appendix C: Unofficial translation of Law No 8633 of August 2012, Fundamentals of Environmental Impact Assessment
    - Appendix D: ‘Chance Finds’ procedure
    - Appendix E: Geological and Geoechnical review report
    - Appendix F: Water quality
    - Appendix G: Ecological Assessment Report
    - Appendix H: Preliminary report of Polish-Lebanese Expedition to the Eshmoun Valley (Wadi Bisri)
    - Appendix I: Benefit Sharing
    - Appendix J: Dam Breach report construction, supervision and quality assurance plan
    - Appendix K: ToR for consultancy services to monitor water quality entering Bisri Reservoir
    - Appendix L: Records of Public Consultations

- The Resettlement Action Plan (RAP) for the dam, reservoir, transmission line, and access roads – a separate report

Project Description

The proposed Bisri Dam site on Nahr Bisri is about 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 following Figure. The two easterly lobes of Bisri Reservoir formed by Nahr Barouk from the north and Wadi Bhannine where Aari'ye River runs from the south 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. At maximum water level 467 masl, the total storage volume of the reservoir is estimated at 116 Mm^3 and the area expected to be inundated at 434 ha.



Bisri Dam, Reservoir and Expropriation Limits

GBWSAP involves the construction and operation of a series of infrastructure, notably:

- The dam and its 256 ha reservoir (excluding the dam footprint),
- A 4 km transmission line connecting the dam to the Awali HEP, and,
- The construction and improvement of several access roads.

While land take will be extensive within the proposed area to be expropriated, some 570 ha, residential properties are few and there are no commercial or industrial premises and no significant public infrastructure or community facilities within the impoundment area. The occupied residential accommodations house seasonal farm workers, mostly non-Lebanese, that will need to be relocated.

Land to be expropriated and inundated on the completion of Bisri Dam is primarily agricultural estimated at 150 ha in addition to pine woodland (82 ha) and natural vegetation (131 ha).

Estimated Costs

The updated design report 2014 estimated the total cost of the dam and associated facilities to be some US$300 million, comprising $220 million contractors' costs, $66 million contingencies, and $10 million for engineering. The construction of the transmission line is estimated at $20 million. The construction cost of the hydropower plant is estimated at $15 million.

Specifically excluded from these costs are the cost of the expansion of the Ouardaniyeg water treatment plant (currently under construction), and onward conveyance for distribution to Greater Beirut, which will be provided under the independent Greater Beirut Water Supply project (GBWSP), currently under implementation The estimated cost of land acquisition, to be covered by GoL, was estimated at $150,228,686 for around 570 ha of land (including inundation area, dam footprint and a 15 m buffer).

Legal, regulatory and institutional framework

Existing Lebanese Legislation

Following Lebanon's reconstruction and development drive after fifteen years of civil unrest and invasion, 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). The Draft Decree was eventually passed in August 2012, during the currency of the present project, becoming Decree No 8633, Fundamentals of Environmental Impact Assessment.

Triggered World Bank Safeguard Policies

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. Five of the WB Safeguard Policies are triggered by GBWSAP, these are: Environmental Assessment, Natural Habitats, Physical Cultural Resources, Involuntary Resettlement and Safety of Dams:

Environmental Assessment (OP/BP 4.01): The project will have significant and irreversible environmental impacts. Phase I of the ESIA has thus been prepared as a comparative study between the different alternatives considered to identify the priority option based on an environmental, social, economic and technical assessment. Based on the findings of the alternatives analysis, Bisri Dam was selected as the Priority Scheme for long term water supply augmentation to the Greater Beirut area. An ESIA and an ESMP have subsequently been prepared, following OP/BP 4.01 guidance for category A projects.

Natural Habitats (OP/BP 4.04): The project will have significant impacts on natural habitats, both during construction and operation of the dam. 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. In line with OP/BP 4.04, a Biodiversity Management Action Plan has subsequently been proposed, building on the results of the detailed ecological survey.

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

Physical Cultural Resources (OP/BP 4.11): The significance and extent of archaeological, historic and recent cultural heritage throughout the Bisri project area is a crucial issue. While there is much overlap between the archaeological and cultural, measures to be undertaken to rescue and preserve the various cultural heritage components, each of these have been addressed separately, with the Directorate General of Antiquities (DGA) and the Maronite Diocese of Saida respectively.

The DGA will carry out archaeological investigations and rescue excavation in accordance with their policies and procedures and in collaboration with the University of Warsaw. These mitigation measures shall be funded by the project as required by OP/BP 4.01 and are included in the cost estimates of dam construction. A detailed Cultural Heritage Plan (including a Chance find Procedure to be adopted during construction and maintenance of the main infrastructure works as a sub-component of the ESMP) is further detailed in the ESIA and provided in Annex I.

Heritage preservation, as distinct from archaeological rescue, is primarily concerned with the relocation of Mar Moussa Church, St. Sophia's Monastery and architectural salvage from some of the old ruined houses throughout the valley. Meetings have been held with the Bishop of the Maronite Archdiocese of Saida, the Church's architectural advisors, the head of Mazraat El Dahr municipality and the priest responsible for Mar Moussa. Repeated walkovers have identified four potential Mar Moussa relocation sites four potential sites. The most appropriate site has been agreed with stakeholders (including the Maronite Church) and arrangements made for the full expropriation of the land as detailed in the RAP. Present responsibilities must, however, extend to provision of a storage area within which to retain excavated material from Marj Bisri and elsewhere pending its re-erection as and when DGA determine.

Similarly, the DGA has agreed the need for rescue archaeology and the time frame proposed in the ESIA. In accordance with its normal internal procedures, it will review the situation and make arrangements to implement its responsibilities under Lebanese law once the Loan Agreement and Project Appraisal Document have been ratified by a Decree of the Council of Ministers. CDR and DGA have agreed that DGA will appoint a team of qualified archaeology specialists to undertake the rescue archaeology, with costs of hiring these appointed experts to be borne by the project. The cost of rescue works are included in the dam works contract. A Physical Cultural Resources Plan is provided in the appendix.

Involuntary Resettlement (OP/BP 4.12): GBWSAP is expected to have direct and indirect social impacts in its area of influence and beyond. Consistent with WB safeguards policies, OP/BP 4.12 was triggered and social mitigation plans identified. A Resettlement Action Plan by broad categories of works (dam and reservoir, power plant and transmission line, access roads) was prepared to mitigate, offset, reduce negative impacts and strengthen positive impacts on the communities in the Project area. The resettlement recommendations are discussed in the RAP, which is a separate document.

Safety of Dams (OP/BP 4.37): A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation. Dam Safety Plans either issued to date or under preparation include:

- Construction Supervision and Quality Assurance Plan;
- Instrumentation Plan;
- Operation and Maintenance Plan; and,
- Emergency Preparedness Plan.

ANALYSIS OF ALTERNATIVES

A comprehensive comparative analysis of the economic, social, technical and environmental aspects 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 Table below summarizes the major advantages and/or setbacks that may facilitate or deter these solutions from being realistically achieved for the long-term supply of potable water to Greater Beirut.

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 environment damaged by brine;	Highly feasible, but very expensive. For current consideration, the 'Source of Last Resort'
Ground Water	• Most discharge to supply; • Suitable for conjunctive-use; • Better quality than surface water; • Diverse source locations; • Modest carbon footprint.	• Limited future use due to over-exploitation • 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 alternative but with limited volumes to be used in the future
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.

Based on the above, 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, but at the highest cost. The significant limitations in the Lebanese energy sector currently also impede the development of desalination as an economically feasible alternative.

The ESIA also considered three dam sites other than Bisri dam, all of which are included in the Ministry of Energy and Water's National Surface Storage Strategy; these are dam sites at Damour on Nahr Damour (two sites) and at Janneh on Nahr Ibrahim. Based on the comparative analysis, CDR has opted for Bisri dam being the priority scheme. The advantages and disadvantages of each are summarised in the following Table.

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;	• Most land take is productive land; • Historic and cultural remains at risk; • High sedimentation risks to be mitigated; • High seismic risk to be mitigated.	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. These studies have been completed as part of the finalization of the detailed design of Bisri dam.
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.

Scheme	Advantages	Disadvantages	Conclusion
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; • High Potential of hydropower generation.	• 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. Janneh dam is thus best suited to serve the northern areas of the Greater Beirut and Mount Lebanon region. Futher investigations need to be carried out to address the concerns about dam and reservoir geology and water tightness.

Based on the above, the following conclusions can be drawn:

- Given its size, cost effectiveness, and all combined favourable geological settings, Bisri Dam is considered the priority option.
- Janneh Dam could be constructed in phases, catering on short term for Jbeil and Kesrwane needs.
- The first years of construction of Bisri and Janneh Dams will allow for a more in depth study about the feasibility of Damour West Dam, the outcome of which should indicate the way forward either to proceed with Damour West Dam or to advance with the Damour East from a feasibility study into a detailed design. In all cases Damour proposed Dams with their reduced volumes could be compensated by possible conjunctive use with ground water from underlying aquifers.

Environmental and Social Baseline Conditions

Climate

Air temperature combined with relative humidity and wind are the major determinants of how much water will evaporate from the surface of the reservoir. 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 highest evaporative demands occur during the six dry months from April to August, with a peak in July, when the reservoir is expected to reach its full storage capacity and start delivering water to GBA.

Landscape

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.

Landuse

Land to be expropriated and inundated on the completion of Bisri Dam is presently utilised as shown in the Table below.

Current Land Use within Expropriated Area

Landuse	Approximate Area - ha	% of Total Expropriation
Open Field/Fallow	148	26%
Natural Vegetation	131	23%
River Bed and Bankside Vegetation	105	18%
Open Land	99	17%
Pine Woodland	82	14%
Polytunnels	4	0.7%
Built-up Area	1	0.2%

Geology

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.

Cultural Heritage

From the available records of the 2004 and 2005 field seasons carried out by a Polish-Lebanese mission, a total of 78 sites were identified, of which 27 fall within the area of expropriation for the Bisri project and a further 10 sites are within 100 m of the expropriation boundary. The sites identified at Bisri represent almost the full span of human history, from Paleolithic times prior to 8,300 years BCE through to the present day.

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 connected with the Temple of Ashmoun, also known as Bustan El Sheikh, in the Lower Awali Valley, dating back to the 7th Century BC.

Today, the visible remains of Marj Bisri are limited to four black granite columns, 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. 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.

Of particular significance as witnesses to the relatively recent cultural heritage of the area are the sites of mar Moussa El Habchi Church and the remains of St. Sophia's Monastery, located very close to each other a short distance upstream of the proposed dam axis. The future of the church is an emotive issue for many Mazraat El Dahr residents. 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. As a result of these critical issues pertaining to cultural heritage, a detailed Cultural Heritage Management Plan, provided in Appendix I and the ESMP reflects arrangements to address these structures, as agreed with relevant GoL counterparts.

Surface Water Quality

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 drinking water standards is afforded by a conventional treatment stream. However, 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. It is therefore recommended that the projectoversees a programme of monitoring to confirm the continued presence of pesticide residues and check for any additional substances detrimental to health that may arise. This aspect will be sub-contracted to a qualified consulting firm which will report to MoE, the objective of which will be to monitor the presence of polluting substances present in surface water courses draining to the reservoir area and to investigate their sources of origin.

ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

GBWSAP area of influence is defined at two levels: the immediate surroundings of the project's infrastructure works for direct, indirect and induced impacts on the one hand and a substantial area, that extends beyond the direct vicinity of the Project itself. The critical area of influence is the reservoir area and the lower catchment whereby it is impacted by the construction activities as well as the changes that will occur resulting from dam operation be it positive or negative, direct or indirect impacts upon which affected communities' livelihoods are dependent. The upper catchment will impact the environment mainly by what it discharges into the reservoir basin. The critical GBWSAP area of influence extends from the sources of Barouk and Aariye Rivers till the outlet of the Awali River on the coast, covering the agricultural plains downstream of the dam and the villages residing in this area.

GBSWAP area of influence also follows the life cycle of the dam construction material which will be sourced from quarries within the reservoir area. The final suitability of all borrow areas will be determined by the appointed contractor. Wastes will be disposed of at licensed sites. The location of construction camps for workers is more likely to be within the valley subject to areas to be protected such as Marj Bisri. GBWSAP area of influence also encompasses Mar Moussa Church relocation, migration routes for wildlife, and induced development, to finally reaching water supply for GBA users.

Main Environmental Impacts

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 reservoir has been designed to accommodate 9 million m^3 of sediment within 50 years operation. This will be provided for by 'dead storage' capacity, the volume that can fill with sediment without impacting the normal operation of the dam.

To minimize sedimentation and the loss of capacity and sediment build-up at the dam, it is important to promote reforestation and soil conservation in the upper catchment and around the periphery of the reservoir, and also to monitor reservoir depth to assess sedimentation. The development of wetland on the main contributing watercourses as well as a reforestation scheme in the upper catchment will reduce sediment load.

Biodiversity and Habitats

Dam construction will always result in the direct loss of riparian habitats and natural vegetation within recognised 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.

For native fish fauna, artificial barriers across rivers constitute one of the major factors threatening their population in the Mediterranean region, blocking or delaying upstream fish migration. 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 Bisri dam will significantly reduce water flow downstream, which will definitely affect the freshwater blenny population surviving in the lower course of the river.

Bisri dam 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 newly created habitats.

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.

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.

Mammals will adapt and adjust their behavior, despite any permanent obstructions to their previous dispersal routes, after dam construction is completed. 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.

A preliminary Biodiversity Management Plan has been proposed and describes the mitigating measures, costs and responsibilities of the impacts described above. The biodiversity baseline, conservation management actions and mitigation have been generally identified and reflected in the Biodiversity Management Plan. The biodiversity specialist team described in the Biodiversity Management Plan section will develop a biodiversity monitoring plan to monitor biodiversity and habitat management, the results of which will inform the project on the level of degradation to the sensitive habitats and the presence of any direct or indirect activities/actions potentially degrading these habitats especially as it relates to the identified endangered species of fish (namely the blenny freshwater fish). To supplement the management/mitigation measures, the biodiversity monitoring plan will include surveys that will take place during pre-construction, construction and operational phases of the project. These surveys will measure indicators that include but are not limited to: water quality, environmental flow volume and quality, number of target species as well as numbers of indicator species, and cumulative impacts within the upstream watershed. Supplemental details to the biodiversity management plan will be included in a revised version of the ESIA.

Consumption of Materials

The consumption of materials for construction will be significant and is estimated at approximately 6 million $m^{3.}$ However all granular materials and rock products are expected to be sourced from within the reservoir site. The exception may be riprap, which because of block size and rock quality specifications may need to be sourced externally. All water consumed on site is likely to be taken from the river and given appropriate treatment prior to use.

Nearly 6 million m^3 of earth materials are expected to be consumed in the construction of Bisri Dam. The majority of these materials – building aggregate, sand and clay, are expected to be taken from temporary borrow areas within and adjacent to the area of inundation, as near as is practically possible to the construction site, thereby significantly reducing reliance on quarries.

Water and Power Supplies

Based on discussions with the designer, the proposed Bisri dam water releases will be allocated securing 5.1 m^3/s or 5.8 m^3/s for the domestic needs to Greater Beirut and 0.3 m^3/s and 0.45 m^3/s for the environmental flow to be maintained downstream the dam, in summer and winter respectively.

The production of approximately 11.2 MW hydroelectric power, is considered a "by-product" of the dam releases and as such will not be considered as consumptive usage like the previous ones.

Reservoir Stratification

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 compromise the effectiveness of water treatment streams, the meeting of regulatory water quality standards and consumer expectation, and the adequacy of environmental flow releases.

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. 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. The downstream water treatment plant at Ouardaniyeh (currently under implementation under the parallel and independent Greater Beirut Water Supply Project), has been designed to take these issues into consideration.

Dam Safety

A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. Often referred to as 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 Preparedness Plans.

Because of the steep V-shaped configuration of the valley in its middle sections between the dam and the coast, the most affected villages in the path of a dam breach flood by either seismic loading or flood failures are Bisri and Khirbet Bisri a short distance downstream of the dam, and Aalmane and Quastani a short distance inland from the coast.

Detailed dam safety plans are in an advanced stage of preparation. The Quality Assurance and Construction Supervision (CSQA) plan will be finalized by appraisal as required by OP/BP 4.37.

Advisory Panel

The Advisory Panel is composed of two panels: the Dam Safety Panel and the Environmental and Social Panel.

The role of the Dam Safety Panel is to advise on all critical aspects of the dam; its appurtenant structures, its catchment areas, the surrounding and downstream areas. It is 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. The Dam Safety Panel was appointed in early October 2013 and will remain under contract to CDR until the first fill of the reservoir.

The Environmental and Social Panel will provide independent review of, and guidance on the environmental and social issues associated with the planning, design, construction and operation of Bisri Dam and its appurtenant structures. The Panel will assess the extent to which the Bisri project complies with World Bank safeguards procedures.

Main Social Impacts

Construction will result in the loss of productive land estimated to extend to some 150 ha, about 25% of the area to be taken. The braided river bed and natural bankside vegetation occupies 105 ha, with built-up areas; farm buildings, housing and heritage, making up less than 1%. The remaining area 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 built-up structures to be inundated is estimated at 135 over a total number of 88 plots with a total area of around 1.0 ha. The majority are already abandoned (some derelict) or only provide seasonal accommodation for agricultural labourers.

Land take will also occur for other project activities and associated infrastructure like the distribution lines and access roads leading to the conveyor. These have been incorporated into the final plans for expropriation.

The total number of individual plots of land, identified from available cadastral mapping, is currently identified to be about 966, split between the various cadastral regions as shown in the Table below.

Extent of Land Take within the Reservoir Area

Casa	Cadastral Region	No. of Plots	No. of plots totally expropriated	No. of plots partially expropriated	Expropriated Area (ha)	% Area Expropriated
CHOUF	Bsaba	9	5	4	6.8	1.3%
	Mazraat El Chouf	277	225	52	120	23%
	Mazraat El Dahr	55	36	19	42	8%
	Aamatour	310	279	31	160	31%
	Bater	14	6	8	8.8	2%
	Sub-Total	665	551	114	338	65%
JEZZINE	Bisri	74	62	12	44	9%
	Bkassine	2	0	2	0.3	0.1%
	Benouati	27	19	8	4	0.8%
	Ghbatiyeh	4	1	3	6	1.2%
	Harf	69	64	5	46	9%
	Aariye	1	0	1	0.95	0.2%
	Bhannine	28	15	13	10	2%
	Midane	80	70	10	48	9%
	Deir-el-Mkhaless	3	0	3	2	0.4%
	Khirbit Bisri	13	4	9	18	3%
	Sub-Total	301	235	66	179	35%
Expropriation Grand Total		966	786	180	517	100%
Domaine Publique (river + roads)					53	
Total Land take					**570**	

Benefit Sharing Program

To ensure an equitable distribution of Project benefits, the project will establish a Benefit Sharing Program to provide the means to improve community services on the surrounding hills and throughout the dam catchment and the local environment. This shall be carried out initially through the capital funds available for the project (as reflected in the RAP budget), later through continued revenue from primary beneficiaries which are the GBA consumers. Capacity building will be ongoing to mitigate the project's environmental and social risks and to ensure inclusive communication with all project stakeholders.

Induced Development

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.

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.

Induced development will only impart positive environmental and social impacts if it complies with a well formulated and agreed Master Plan. 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.

GBSWAP *Cumulative Impacts*

The cumulative impacts assessment focuses on the interaction of the GBWSAP Project and developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could directly impact on the project area of influence. The Table below is a matrix showing those incremental impacts with some existing developments and others proposed.

Cumulative Impacts on Selected VECs

		Existing and Proposed Projects			
VECs	**Parameters**	**GBWSP**	**HEPs (Joun, Awali, and Anan)**	**Sewerage Treatment Schemes**	**Reforestation Scheme**
Water	*Water Abstraction*	0	0	0	0
	Water Quality	+	0	+	+
	Flow Rate	+	0	0	+
	Domestic Water Supply	+	0	0	0
Air	*Greenhouse Gases*	0	-	+	+
Power	*Power Supply*	0	+	0	0
Land Use	*Land Cover*	0	0	0	+
	Reservoir Sedimentation	0	0	0	+
Habitats and Wildlife	*Species Diversity*	0	0	0	+
	Species Population	0	0	0	+
Public Health	*Health Costs*	+	+	+	+

\+ Positive Cumulative Impact
\- Negative Cumulative Impact
0 No Cumulative Impact

The Table below summarises the impacts that might accrue from Bisri dam and the mitigation measures proposed for each impact, while the table that follows summarizes the estimated costs. The total cost of implementing the ESMP is about 137 million USD: comprising 132 million USD for mitigation measures, 2.2 million USD for monitoring, 2.6 million USD for monitoring reporting and 192,000 USD for capacity building.

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	Minor	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

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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. Promote reforestation of upper catchment slopes. Monitor reservoir depth to assess sedimentation. Operate reservoir to minimize sediment build-up. Allow for sediment loading in structural design.	Designer and Operator
	Loss of capacity and sediment build-up at dam	Expected	Moderate		
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
	Soil Erosion and Sedimentation	Expected	Moderate	Promote reforestation of upper catchment slopes and the expansion of existing forests.	Project Proponent
	Social unrest due to the restriction of human activity	Not Expected	n/a	Ensure new developments prioritize 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 and solid wastes systems for villages throughout the upper watershed in accordance to GoL master Plans.	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	

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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	Moderate		
	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	Minor	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	Provide fish leats, ladders and other by-passes. Protect spawning grounds; Incorporate sensitive design, i.e. allow shallow areas for spawning, etc.	Designer
	New habitats for migratory bird species	Expected	Positive	Promote reforestation and areas of dense shrub.	Operator
	New farming fish species	Expected	Positive	Ban the introduction of exotic species such as trout, bass, tilapias, and mosquitofish. Promote the user of native species.	Operator
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
Agriculture	Loss of fertile soils	Unavoidable	Major	Consider stripping highly fertile soils from reservoir area and spreading on adjacent less fertile land.	Project Proponent and Contractor
Agriculture	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
Agriculture	Derogation of downstream irrigation	Unavoidable	Major	Use agricultural extension to promote low water-use crops species and irrigation practices.	Operator
Agriculture	Fertilizer use upstream increases nutrient load	Expected	Moderate	Use agricultural extension to promote low water-use crops species and irrigation practices.	Operator
Agriculture	Increased soil salinity downstream	Expected	Major	Provide compensatory discharge to leach soil salts.	Operator
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
Settlement and Resettlement	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.	
Settlement and Resettlement	Impact on indigenous groups/lifestyles	n/a	n/a	No significant communities to disaggregate. Resettlement unlikely to result in conflict as resident Lebanese PAPs will keep within their previous communities.	
Settlement and Resettlement	Social conflict between existing residents and PAPs	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.	
Settlement and Resettlement	Competition for resources between residents & PAPs	Not Expected	n/a	None required.	

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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	Major	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	Major	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	n/a	Power generated at dam to be used at dam. New turbines for network distribution to be located at existing plant will utilise existing cableways.	
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

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Importation of contagious diseases	Expected	Minor		
	Fuel spillage and waste oil disposal	Expected	Moderate		

Likelihood

	Not Expected
	Expected
	Unavoidable
	Not Applicable

Likely Severity

	Minor
	Moderate
	Major
	Positive
	Not Applicable

Summary of Proposed Environmental and Social Impact Mitigation Measures Costs

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
Land Take and Resettlement	Archaeological rescue and safe storage of artifacts	DGA and Project Proponent	Consultant's estimates with storage site acquisition, clearance, fencing and buildings	$0.5
	Relocation of Mar Moussa Church, St. Sophia's Monastery, and architectural salvage	Maronite Diocese of Saida and Project Proponent	Deconstruction and reassembly of main walls, demolition and replacement of church interior vaulting. Included in construction costs.	$2.0
Impoundment	Increase planting around reservoir.	Operator and MoA	Tree band 12 m wide, planted on a 3 m grid, over half the reservoir periphery	$3.0
	Design and install provision for mechanical mixing where natural circulation insufficient.	Designer and Contractor	Included in construction costs	n/a
Sedimentation	Promote development of wetlands.	Operator	Promotion budget only	$0.1
	Promote reforestation of upper catchment slopes	MoA and Municipalities	Promotion budget only	Included above
Upper Watershed Management	Promote reforestation of upper catchment slopes and the expansion of existing forests.	As above	Promotion budget only	Included above
	Adopt integrated planning, a strict ESMP, and effective enforcement.	GOL, DGUP, Project Proponent & Municipalities	Of wider benefit that GBWSAP and should come from GOL budget	n/a
	Develop sewerage and solid wastes systems for villages throughout the upper watershed.	Project Proponent, MEW, and Municipalities	various documents supplied by CDR	$23
Lower Watershed Management	Design and provide for multi-level releases to avoid the discharge of anoxic water, and for downstream aeration.	Designer and Contractor	Included in construction costs.	n/a
	Design and provide for energy dissipation from dam outflow and sediment trap	Designer and Contractor	Included in construction costs.	n/a
Biodiversity and Habitats	Biodiversity Management Plan	Mitigation Activities and specialist staff.	Biodiversity specialist and species specialist part-time for pre-construction, construction and reservoir filling.	$0.7
Agriculture	Provide agricultural extension to promote low water-use crops species and irrigation practices.	MoA and MEW	Extension office for 2 years, with vehicle, admin support, etc.	$0.5
	Provide compensatory discharge to leach soil salts.	Operator	Included in construction costs	n/a
Public Health and Safety	Implement health awareness and water safety campaigns.	MoH and Operator	Awareness and safety campaigns	$0.2

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
	Spray mosquito breeding sites if necessary.	Operator	Operator, protective clothing, water-safe chemicals, labour, 3 applications/year	$2.0
	Provide for Public Safety at dam site	Designer, Contractor and Operator	Fencing and signage (Included in construction costs)	n/a
	Develop and implement an Emergency Response Procedures.	Designer, Operator, Civil Defense and Municipalities	Included in GOL costs	$1.0
Construction Issues	Contractor to develop and execute a comprehensive Construction Environmental and Social Management.	Project Proponent, Contractor and Construction Manager	Included in construction costs. 'Best Practice' construction only.	n/a
Total Costs of Mitigstion beyond normal Design, Construction and Operation				c. $34.5

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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	Total Estimated Costs
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 and throughtout operations	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	US$330,000 (including staff costs)
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	US$600,000
Biodiversity Management	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$667,000	US$667,000
Rescue Archeology and Heritage Relocation	Archaeological finds unearthed and documented	Marj Bisri	Excavation, observation and documentation	Ongoing until completion of construction	Seasonally	To make sure implementation strategy is implemented	Archaeologist	DGA	US$ 500,000	US$ 500,000
	Structures removed and reconstruction	Mar Moussa	Dismantling and reassembling	Prior to construction	Monthly	To address community concern for heritage	Building conservationist	DGA	US$ 2,000,000	US$ 2,000,000
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	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	-

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
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	US$ 5,000
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	Throughout construction and every 3-5 years, post construction	To identify early warning signs of potential failure	Dam Safety Inspection Panel	BMLWE/CDR	US$ 25,000 per inspection	US$ 25,000
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$1,000 per sample	US$ 30,000
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	US$ 30,000
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	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	US$ 50,000
Reservoir Sedimentation	Sediment build up	Reservoir	Depth or Echo sounding	Ongoing	Annually, in May or June	To check loss of dead storage and protect	Mechanical Engineer and Boatman	BMLWE	US$ 10,000	US$ 50,000

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
						intakes				
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	-
Total Monitoring Costs										**US$ 4,507,000**

Note: Total Costs are calculated for 5 years of operation

Summary of Environmental Monitoring Reporting and Costs

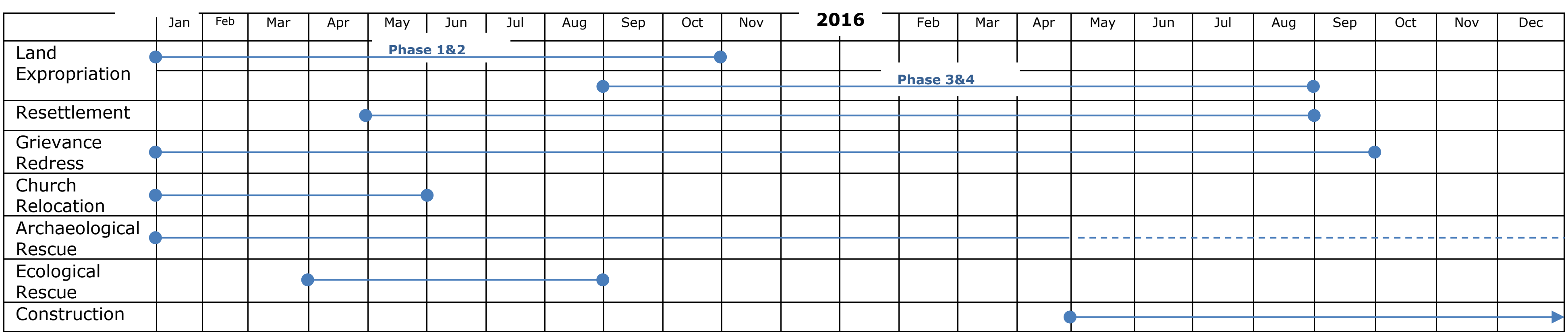
Activity	Reports	Implementation Structure	Estimated Costs	Total Estimated Costs	Budget Assignment
Site Inspections	Individual Visit Reports Summary Reports every 6 months	CM reporting to CDR	150,000$	150,000$	CM budget
Environmental Quality Monitoring	Quarterly Reports	CM reporting to CDR,and MOE	Pre-Construction 50,000$/year Construction 50,000$/year Post-Construction 30,000$/year	Pre-Construction 400,000$ Construction 1,000,000$/year Post-Construction 500,000$/year	CM EMP Budget
Monitoring by Construction Manager	Included in Monthly Construction Progress Reports	CM to CDR	Included in contract supervision	-	CM Budget
Bi-Annual Environmental Reporting	Bi-Annual Reports during construction	CM reporting to CDR and MoE	30,000$/year	300,000$	To CM EMP budget
Land Acquisition Monitoring	In accordance with RAP implementation requirements	CDR and Independent Monitor reporting to GOL and FA	Included in RAP implementation costs		To CDR RAP budget
Operational Reporting	Internal BMLWE Reports	BMLWE reporting to MEW	20,000$/ year	100,000$	To BMLWE Budget
Environmental Auditing	Annual Audit of operational EMP implementation	MOE reporting to MEW and BMLWE	20,000$/year	100,000$	To MOE budget in agreement with CDR
Total Monitoring Reporting Costs				2,650,000$	

Note: Total costs are calculated for 5 years of operation

ESMP Planned Implementation

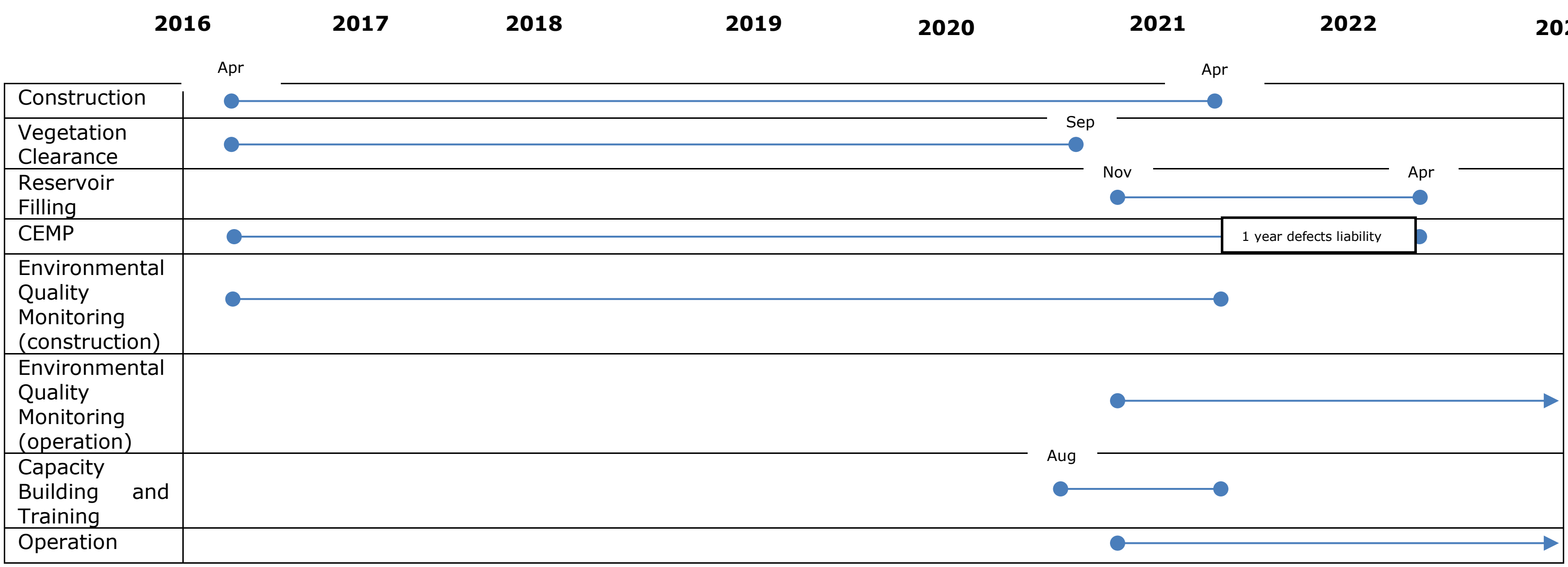
The following Tables show the proposed schedule for the implementation of the ESMP pre-construction, during construction, and during operation.

Pre-Construction ESMP Implementation



*Final Project Approval (Day Zero)

Construction and Operation ESMP Implementation



Institutional Structure and Responsibilities

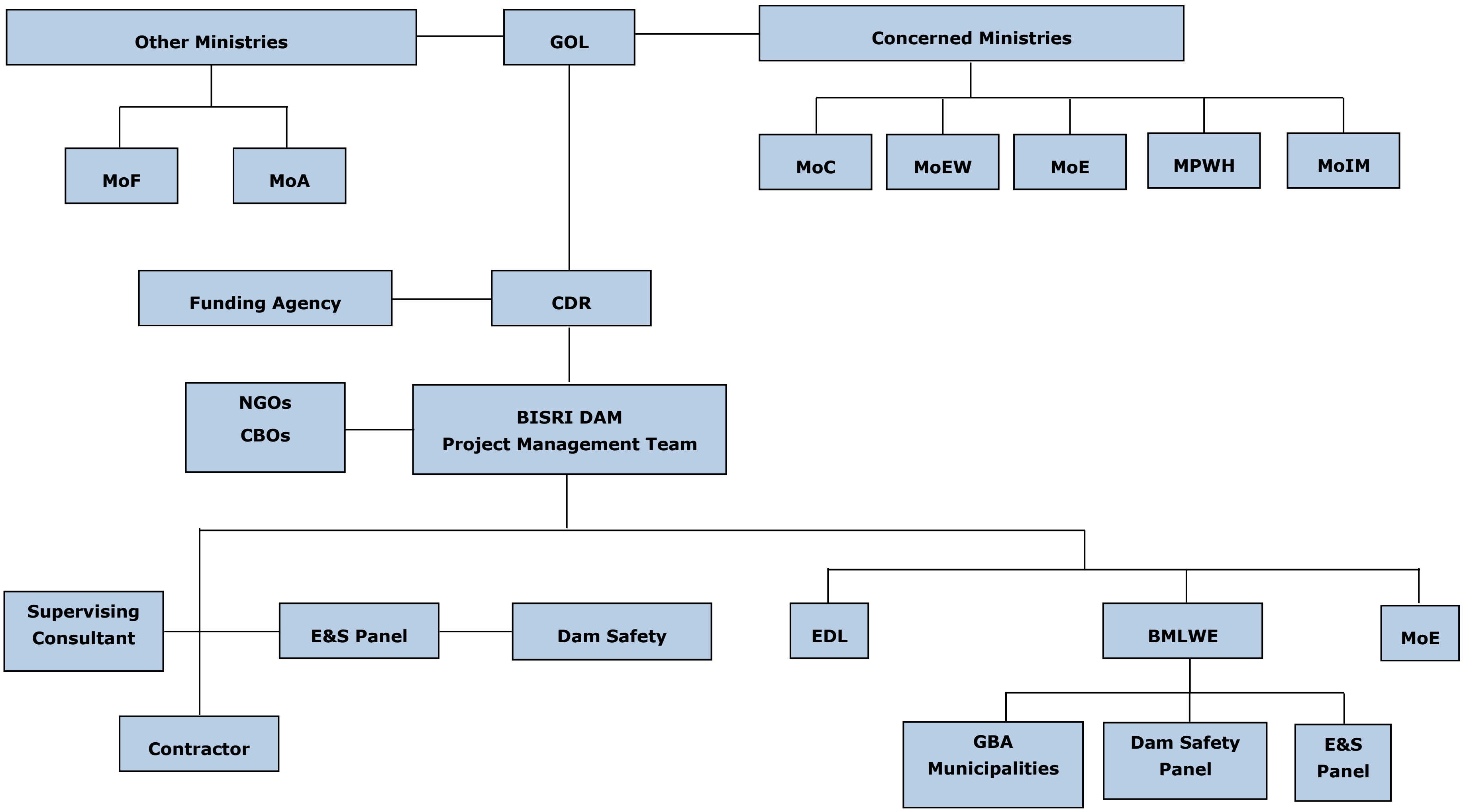
The prime institutional stakeholders in respect of expected management structure and responsibilities are shown in the Figure and Table below, respectively.

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, in coordination with CDR.
BMLWE	Day-to-day operational management of the dam and its appurtenances, implements MEW policy, ensures environmental yields are delivered to riparian owners. Maintains the dam, the reservoir shoreline and operational monitoring. Facilitates dam safety and E&S panel inspection visits. Responsible for public safety including the maintenance of warning signage. Manages structures and water resources downstream of the offtake upstream of the Joun power plant to the Awali Conveyor, the treatment plant, post-treatment distribution, leakage reduction, cost billing, etc.
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 the hydropower output and sell it on customers at a rate that at least ensures cost recovery.
MPWT	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.
LRA	Manages the two hydropower plants ancitipated through the Bisri project to offset lost hydropower at the Charles Helou power plant.

Institution	Prime Responsibilities
DGA	Collection of pottery shards, glass and other artifacts from surface soils and shallow excavations at previously identified sites; Trial pitting and/or geophysical surveying at selected sites where buried structures may be present; Major excavation and the removal of material at Marg Bisri Roman temple; Excavations in the vicinity of Mar Moussa Church and the remains of St. Sophia's monastery. Archaeological finds unearthed and documented during construction
Diocese of Saida	Deconstruction, removal and reconstruction of Mar Moussa Church and of St. Sophia's Monastery; and, Scavenging old building materials from the ruins of 19-20th century houses to provide for new construction adjoining the relocated Mar Moussa Church.
Concerned Municipalities	Implementation of Land Expropriation Procedure
MoSA	Implementation of the RAP especially regarding refugees registered at the UNHCR
UNHCR	Assist the 79 registered UN refugees (as per the date of the project cut off date on March 20, 2014 – see RAP for details) with resettlement to UNHCR designated refugees camps if they are willing to. Facilitate the other 23 non-registered refugees to get registered with the UNHCR and eventually assist them with their resettlement to refugees' camps.

Institutional Structure for Bisri Dam Management



CAPACITY BUILDING AND TRAINING

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. Selected operations staff proposed for supervisory positions should be given the opportunity to visit and receive detailed briefing, including hands-on training, at dams of similar size and purpose outside Lebanon.

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.

It is important to note that the ESMP in this document incorporating all sub-components including mitigation and monitoring measures reflects the final design. The Church relocation will be undertaken by the contractor and capacity building for chance finds will be included in general HSE briefings to staff.

Total cost of capacity building and training is estimated at $ 192,000.

Total Costs of the ESMP Implementation

The Table below summarizes the total costs of the ESMP implementation assigned for mitigation measures, monitoring, monitoring reporting, and capacity building.

Table 1.1: Total Costs of ESMP Implementation

Mitigation Measures	$34,500,000
Monitoring	$ 4,507,000
Monitoring Reporting	$2,650,000
Capacity Building	$ 192,000
Total Costs of ESMP Implementation	**$ 41,849,000**

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 are to be followed throughout the project, from site selection through to commissioning has been drafted.

From the beginning of the Project and throughout the ESIA process, institutional stakeholders have been consulted at scoping and briefing levels as described below. Additional discussions have been carried out with MoE, DGA and Maronite Diocese of Saida to reach agreement on specific issues including water quality monitoring, Mar Moussa church relocation, and archaeological recue, described in the ESIA.

At the outset of the EIA process, a series of Scoping sessions then followed by collaborative and information meetings during April and May 2012, commencing with an institutional stakeholders session at the CDR offices in Central Beirut to which stakeholder ministries, government agencies and NGOs were invited. This was followed by a consultation session held at Mazraat El Dahr Municipality in the vicinity of Bisri dam. Finally, two separate sessions were held for Beirut residents, the prime GBWSAP beneficiaries.

The safeguards (ESIA and RAP) consultant presented the results and recommendations of the ESIA study in different venues for institutional stakeholders, for local PAPs in the villages in the vicinity of the proposed Bisri dam, and for Greater Beirut residents. The date and timing of all meetings were agreed with individual municipalities. The village sessions were scheduled at weekends and early evening's week-day for Beirut Water Consumers to allow the maximum number of concerned people to attend.

Following revisions to the ESIA and RAP consequential upon changes to Dam design, land expropriations requirements, completion of the household survey and the establishment of indicative costs, further sessions of public consultation were in April 2014. The following table summarizes all public consultations carried since the beginning of the Project.

Date	Location	Time	Venue	Attendees
2012				
3 April 2012	Beirut	10am	CDR	Institutional Stakeholders
10 April	Mazraat El Dahr	10am	Mazraat El Dahr Municipality	PAPs
24 April	Hadat	10 am	Hadat Municipality	Water consumers of Greater Beirut Area
5 May	Beirut	10am	Beirut Municipality	Water Consumers of Central Beirut
2013				
30 January	Beirut	10am	CDR	Institutional Stakeholders
2 February	Midane	10am	Midane Municipality	PAPs

2 February	Mazraat El Dahr	3.30pm	Mazraat El Dahr Municipality	PAPs
6 February	Hadat	5pm	Hadat Municipality	Water consumers of Greater Beirut Area
9 February	Ammatour	10am	Ammatour Municipality	PAPs
9 February	Mazraat El Chouf	2:30pm	Mazraat El Chouf Municipality	PAPs
2014				
Friday 25 April	Ammatour	10.00am	Dar Ammatour	PAPs
	Mazraat El Chouf	3.00 pm	Municipality Hall	PAPs
Saturday 26 April	Bisri	10.00am	Church Hall	PAPs
	Mazraat El Dahr	3.00 pm	Municipality Hall	PAPs

The objectives and benefits of the Project including induced development in the area and the possibility of establishing a Benefit Sharing Program have been presented and explained to the audience. Main environmental and social impacts and mitigation measures were highlighted. The details of expropriation procedure along with compensation entiltelments have also been explained. The overall attitude of all four audiences was strongly opposed to the construction of Bisri Dam. As was always anticipated, the majority of comments raised from the floor concerned land expropriation and asset compensation.

Main issues raised by PAPs in the four villages included: (i) need to allocate water and power generated by Bisri dam to neighbouring villages and account for irrigation needs, (ii) benefit of project should go to villagers not GBA residents to encourage them to stay in their villages, (iii) loss of productive land and biodiversity, (iv) cash compensation is not enough especially that land has an inheritance value to landowners, (v) PAPs want to get involved in property valuation, (vi) municipalities should benefit from Bisri dam revenues and get yearly compensation to invest in development in neighbouring villages, (vii) need for access roads to villages, (viii) need to relocate historical and archaeological remains, (ix) study desalination as an alternative, (x) need to study risk of seismicity, (xi) need for wastewater treatment schemes in villages in the upper catchment, (xii) surface water quality, (xiii) pesticide residues in water, (xix) vector-borne diseases and bad odours in the Project area, (xx) increased water salinity and impact on agriculture and residents, (xxi) possibility of creating several ponds instead of a large dam, (xxii) possibility of passing a law for the establishment of a company for Bisri dam similar to Solidere where landowners are shareholders, (xxiii) relocate the proposed dam axis.

CDR will continue consultations throughout the period of land expropriation and beyond from a Project Information Centre (PIC). The ESIA and the RAP will be disclosed in and will be followed by disclosure at the World Bank's *Infoshop.*

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 or even less. 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]. It is projected that water shortages will become more severe and chronic starting 2020, especially during the 6 to 7 dry months due to the increasing water balance deficit.

The reasons for Lebanon's water stress include but are not limited to, the following:

- 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;
- 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.

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[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.

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 Mm^3 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, are 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 400 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 Augmentation Project* (GBWSAP) therefore evaluates options by which this might be achieved, while noting that the GBWSP is an independent project that does not require the GBWSAP to be economically or technically feasible and/or sustainable.

1.2 GBA Water Balance

Figure 1.1 simulates three water demand scenarios between the years 2011 and 2035: the first estimates gross domestic and industrial water needs assuming no reductions or savings measures are implemented, the second calculates the expected water demands once all networks leakages reduction measures are implemented, and the third quantifies those demands once all leakages are fixed and GBWSP water saving measures

[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.

are implemented[5]. The Figure shows that water supply will increase with the assumption that GBWSP with its full delivery capacity will come into implementation by 2016. While other water augmentation sources are not accounted for here, they will be discussed in the section of Analysis of Alternatives of this Report.

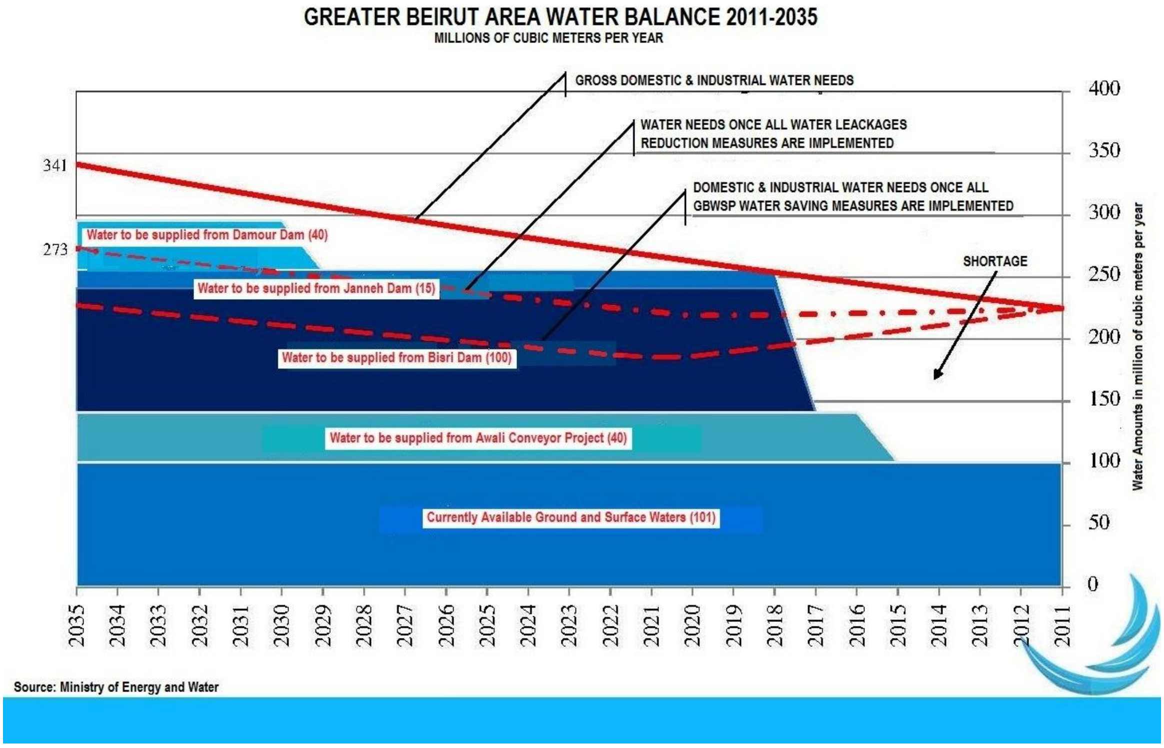

Figure 1.1: Projected Water Balance for Greater Beirut Area (MEW 2009).

Projected GBA water balance until the year 2035 (the time when GBWSP is fully operational) is summarised in Table 1.1, whereby estimates of irrigation needs have been added to domestic and industrial uses, as those were not included in the GBA water balance as suggested by MEW NWSS.

[5] The GoL National Water Strategy, in 2010, has set number of measures to be implemented towards the reduction, by 2035 down to 20%, of the excessive amounts of lost and inefficient water throughout the water supply and distribution networks. These include but not limited to: correct, rehabilitate and install of faulty, old and new networks including the installation of modern water meters; proposing optimized water layout networks and creation of water meter management areas; capacity building of WEs Personnel, the procurement of utility strengthening systems, equipment and technical advisory services, and others.

Table 1.1: GBA Domestic, Industrial and Agricultural Water Balance until they Year 2035 (MCM/year)

Water Demand & Supply for GBA		2010	2015	2020	2025	2030	2035
Demand	Domestic & Industrial Water Demands	225	240	260	290	320	340
	Reduced Domestic & Industrial demands	225	210	180	190	210	230
	Agricultural Water Demands	80	90	100	105	105	105
TOTAL DEMANDS (without losses reduction)		**305**	**330**	**360**	**395**	**425**	**445**
TOTAL DEMAND (with reduction)		**305**	**300**	**280**	**295**	**315**	**335**
Supply	Currently available water resources	100	100	100	100	100	100
	Awali Conveyor (GBWSP) future contribution	-	40	40	40	40	40
TOTAL SUPPLY		**100**	**140**	**140**	**140**	**140**	**140**
WATER BALANCE (with no losses reductions and no GBWSP)		**-205**	**-230**	**-260**	**-295**	**-325**	**-345**
WATER BALANCE (GBWSP implemented and with losses reductions)		**-205**	**-160**	**-140**	**-155**	**-175**	**-195**
Expected Water Deficit Reduction		**0%**	**30%**	**46%**	**47%**	**46%**	**43%**

As shown above, water deficit is expected to grow from 205 MCM/year in 2010 to about 345 MCM/year by 2035 in the first scenario. Water shortages will become severe as water supply can not accommodate the needs of a growing Greater Beirut population. The need to implement new projects securing additional water sources and reducing water leakages from 40% to 20%, as proposed by NWSS 2010 is therefore imperative. GBWSP will contribute to the reduction of water deficit by about 30-45% until 2035, a solution that addresses water shortages only on the short and medium terms.

Based on the above, there is no doubt that GBA water users will face serious water shortages in the next two decades. The severity of those shortages depends on a number of comprehensive initiatives to be undertaken including a proper planning, policy setting and implementation, immediate actions as foreseen under the NWSS and the integration of all components of the NWSS.

The current water imbalance in GBA, if not properly addressed will keep favouring an uncontrolled water provision and distribution practices which will further deplete water resources and degrade their quality, with a number of private water tankers companies proliferating taking the lead over BMLWE.

1.3 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 1.2.

Table 1.2: 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

1.4 Project Scope

GBWSAP aims to increase the volume of water available to the Greater Beirut and Mount Lebanon area in the long term. 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 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.

Phase Two

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

The September 2012[6] report included a comparative study of non-dam and dam options, from which it was determined that 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 priority scheme will, subject to further investigation and engineering design, be technically feasible, environmentally responsible, socially-acceptable and cost-effective.

Phase Two Project includes:

- Draft ESIA;
- Draft Resettlement Action Plan RAP;
- Final ESIA; and,
- Final RAP.

Following design review, the present Report along with a new revision of RAP are being issued to account for those design changes including transmission lines, dam axis and expropriation area.

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 Bisri scheme and presents the mechanism to ensure it is implemented without excessive environmental degradation and human suffering.

1.5 ESIA Report Structure

The structure and content of this report follows the same organization of the Final ESIA prepared in September 2013 that was 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.

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

Section 2 describes the different components of the Bisri project, its location and the proposed construction, while **Section 3** outlines the policy and legislative 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** summarises the analysis of scheme alternatives and the reasons those less favoured than Bisri were considered unsuitable at the present time.

Section 8 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 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 10** 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.

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** and **Section 2.6** summarise the proposed hydrological design and dam and reservoir construction, respectively, subject to finalization of Project design.

Finally, **Section 2.7** 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[7], 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 four dam sites, from which the project proponents concluded Bisri 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,

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

- 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.

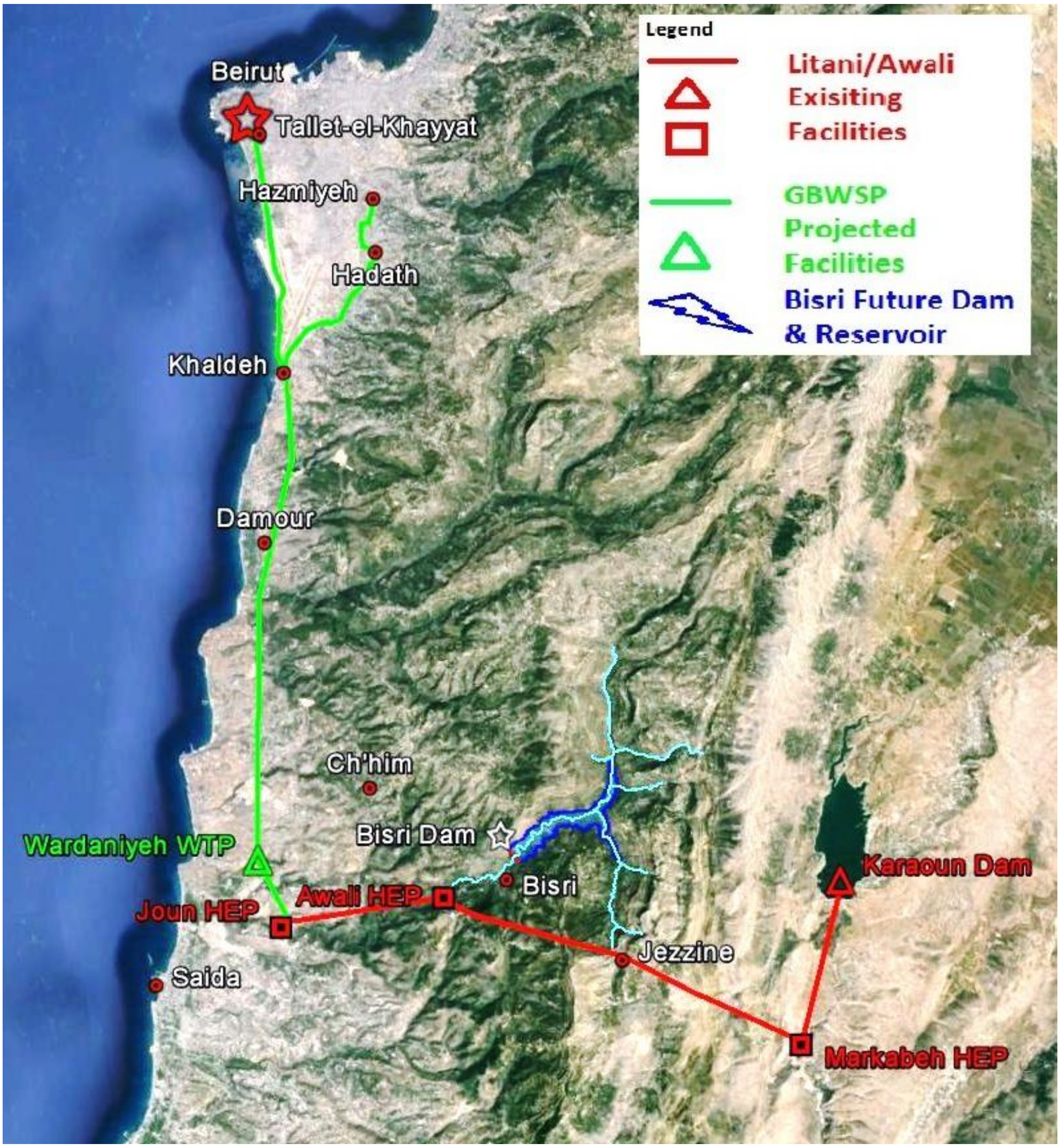

Figure 2.1: Location of the Bisri Scheme Relative to GBWSP Facilities

2.4 Project Location and Prime Characteristics

Project site as recently surveyed and shown in Figure 2.2 is in the Nahr Bisri Valley some 15 km inland from the Mediterranean coastline at Saida and 35 km[8] 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. At maximum water level, 467 masl, the total storage volume of the reservoir is estimated at 125 Mm^3 and the area expected to be inundated 434 ha including dam footprint. Transmission lines extend downstream of the dam axis to GBWSP facilities, so that Bisri dam can ultize GBWSP transmission lines, treatment plant and storage reservoirs.

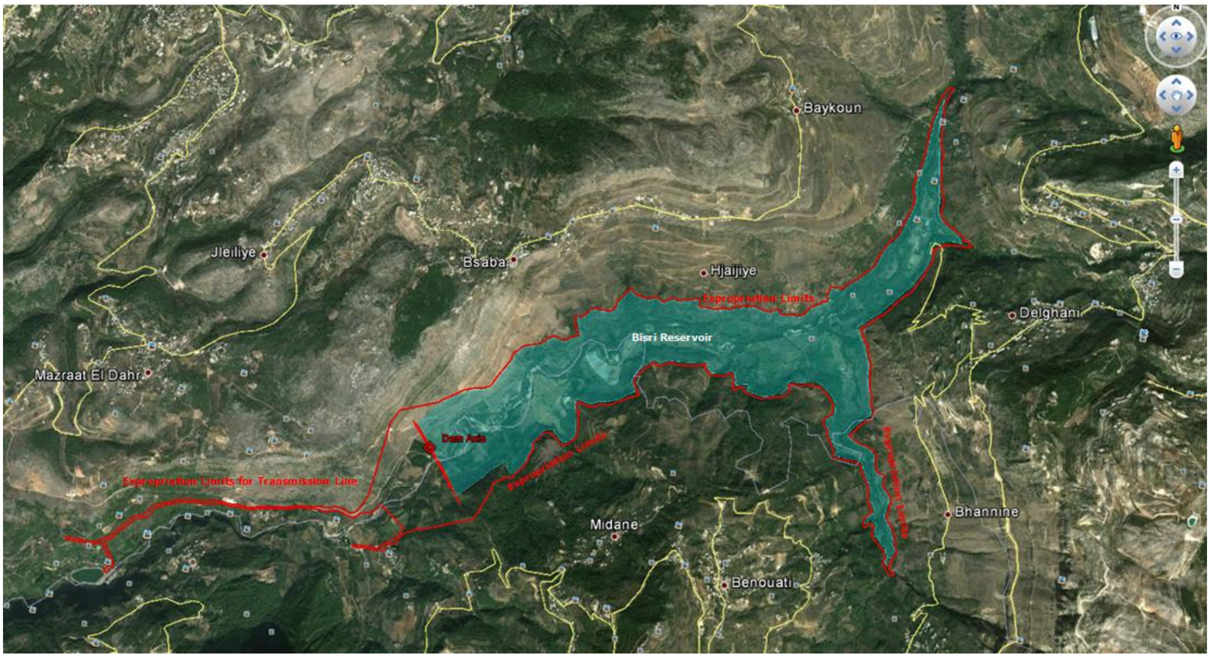

Figure 2.2: Bisri Dam and Reservoir on Nahr Bisri

Table 2.1 summarises the primary characteristics of Bisri dam and reservoir as conceived by the latest Designer's review.

[8] Measured by a straight line from Najmeh Square

Table 2.1: Primary Characteristics of Bisri Dam and Reservoir

Dam Characteristics		Elevations and Areas	
Reservoir Catchment Area[1]	Approx. 215 km^2	River Bed Elevation	392 masl
Length of Reservoir	6 km +2 km branch	Dam Crest Elevation	469 masl
Width of Reservoir	550 m	Max Water Level	466.8 masl
Type of Dam	Clay Core Rockfill Dam	Inundation at Max WL	280 ha
Maximum Height	73 m	Storage at Max WL	148 Mm^3
Crest Length	740 m	Normal Water Level	461 masl
Crest Width	12 m	Inundation at NWL	256 ha
Upstream Slope	2.5H:1V / 3.5H:1V	Storage at NWL	125 Mm^3
Downstream Slope	2.5H:1V / 3.5H:1V	Min Water Level	420 masl
Continuous Outflow	5.1 m^3/sec or 5.8 m^3/sec depending on demand	Inundation at Min WL	140 ha
Hydropower Capacity	11 MW Downstream plant 0.2 MW Upstream plant	Storage at Min WL	10 Mm^3

2.5 Proposed Hydrological Design

The proposed hydrological design based on the 2014 progress design is discussed below.

2.5.1 Climate and Meteorology

The weather stations located within and/or in the vicinity of the basin area used with respect to various climatic parameters are as follows:

Table 2.2: Weather Stations Used by the Designer

Name of Station	Weather parameter
Bhamdoun and Kfarbnabrakh	Temperatue
Bhamdoun and Kfarbnabrakh	Relative Humidity
Ksara Observatory A.U.B and College Machmoucheh	Wind
Bhamdoun and Kfarbnabrakh	Evaporation

Old and newly established stations were used in the computation and analysis of the precipitations data of Bisri site. The old stations are: Ain Zhalta (512), Kfar-Nabrakh (514), Jdeidet-ech-Chouf (516) and Jezzine (519). For more recent data, new stations

[1] While according to the ESIA Consultant estimates Bisri Dam catchment area would amount to 200 Km2, the area of 215 km2 will be adopted in the present report for consistency with the Dam Designer.

were added to the previous ones. These new stations are Jezzine (2001-2009), El-Barouk-Fraidis' Deir el-Kamar, Jbaa-el-Chouf and Mechref.

2.5.2 Precipitation

The names of the stations used for the estimation of the Basin Precipitation and the period of available records are listed below:

Table 2.3: Stations Adopted for the Estimation of the Basin Precipitation

Name of Station	Period of Available Record
Aain-Zhalta	1939-40 - 1970-71
Kfar-Nabrakh	1944-45 - 1970-71
Jdeit-ech-Chouf	1943-44 - 1970-71
Jezzine	1927-28 - 1936-37 and 1939-40 - 1970-71
Jezzine	2001-02 – 2008-09
El Barouk Fraidis	2001-02 – 2008-09
Deir El Kamar	2001-02 – 2008-09
Jbaa Ech Chouf	1964-65 – 1969-70 and 1991-92 – 2008-09
Meshref	2002-03– 2008-09

The mean annual basin precipitation calculated is 1,255 mm with an average of 1,294 mm for the old stations and 1,107 mm for the recently established stations. The average monthly precipitation varied from a minimum of zero in the month of July to a maximum of 283 mm in the month of January. Table 2.4 shows the monthly and yearly basin precipitations:

Table 2.4: Monthly and Yearly Basin Precipitations

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Total	205.77	1607.09	4538.32	8005.27	9916.19	8796.41	6712.90	3015.98	1080.53	32.79	6.99	8.39	43926.63
Av.	5.88	45.92	129.67	228.72	283.32	251.33	191.80	86.17	30.87	0.94	0.20	0.24	1255.05
Min.	0.00	0.13	0.29	52.82	53.15	42.08	41.30	7.20	0.26	0.00	0.00	0.00	715.87
Max.	97.32	127.04	354.19	571.37	688.80	514.92	451.06	441.68	236.39	7.63	2.81	3.33	2081.25
Std. Dev.	16.67	37.06	88.55	118.26	141.52	124.88	103.86	81.38	44.03	1.91	0.58	0.64	317.40

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 2.5 below.

Table 2.5: 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

The natural streamflow at Bisri Dam location characteristics are as follows:

Inter-Annual Module	:	4.1 m3/s (period 1952 - 2012);
Average annual streamflow	:	129.5 Mm^3;
Maximum	:	434 Mm^3 year 2002;
Minimum	:	55 Mm^3 year 1959.

Figure 2.3 shows the average annual streamflow between the year 1952 and 2012.

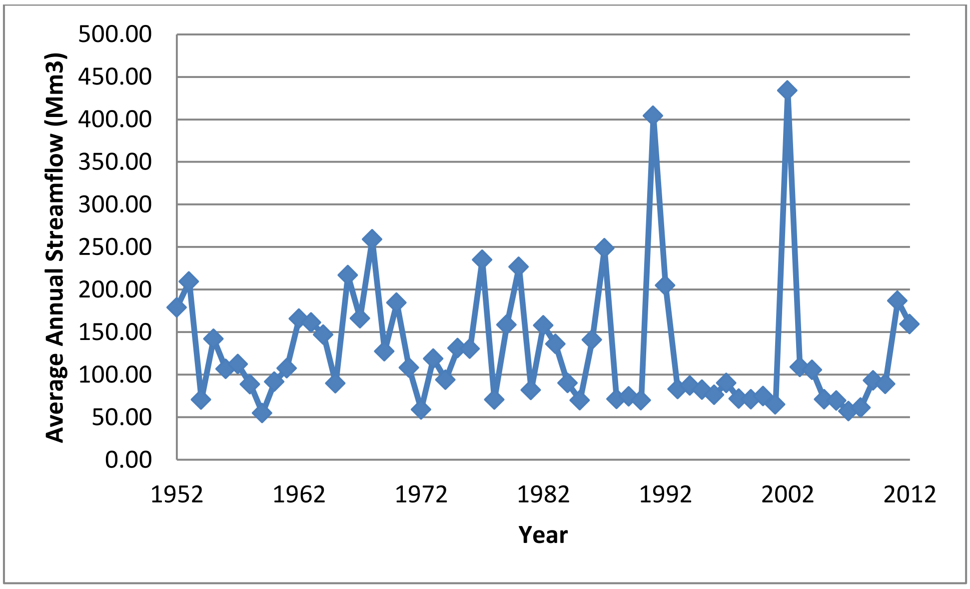

Figure 2.3: Average Annual Streamflow between the year 1952 and 2012

2.5.5 Flood Estimation

Flood hydrographs were developed for the purpose of sizing two hydraulic structures: 1) diversion facilities; and 2) spillway. By routing these inflow design flood hydrographs through available storage, either cofferdam or reservoir, the designer of each structure will thereby determine the "outflow design hydrograph". The peak of the outflow design hydrograph is the actual discharge for which the structure, tunnel, conduit, or spillway, must be designed.

The inflow flood for spillway design has a peak discharge of 2,300 m^3/s (11 $m^3/s/km^2$) and a volume of 43 Mm^3.

The inflow flood for the design of diversion facilities has a peak discharge of 600 m^3/s and a volume of 11 Mm^3.

2.5.6 Sediment Yield

Only two years' data are available for calculating river sediment load. This is 800t/km^2/yr, to which 200t/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.

In his updated report, the Designer has noted that the 1.5 g/l of sediment seems too low. He recommends, as such, an increase of 20% over the previously estimated sediments load bringing it up to 9 Mm^3 in 50-year-reservoir operation.

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.

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 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 is a Clay Core Rockfill Dam comprises an earth embankment with a rolled compacted concrete (RCC) section for the spillway, as illustrated in Appendix B.

2.7 Estimated Costs

The updated design report 2013 estimated the total cost of the project to be some US$300 million, comprising $220 million contractors' costs, $66 million contingencies, and $10 million for engineering, the latter including design, tendering, contract supervision and administration. The construction of the transmission line is estimated at $20 million, while the construction costs f the hydropower plan is estimated at $15 million.

Specifically excluded from these costs are the cost of water treatment, and onward conveyance for distribution to Greater Beirut, which will be provided under the independent Greater Beirut Water Supply project (GBWSP). Also excluded from the Bisri costs but outside the scope of the GBWSP are land clearance prior to filling, additional site investigations and studies prior to the issuing of final design drawings, and reservoir slope protection. Construction costs are distributed over 3-years; 10, 46 and 44%.

The estimated cost of land acquisition, to be covered by GoL, was estimated, by the ESIA Consultant to about $150,228,686 for around 570 ha of land (including inundation area, dam footprint and a 15 m buffer).

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. **Section 3.5** explains the main responsibilities of the Dam Safety and Environmental and Social Advisory Panels.

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 C. 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 comparative study between the different alternatives considered to identify the priority option based on an environmental, social, economic and technical assessment was undertaken in a first phase. Based on this analysis, Bisri Dam was selected to be the Priority Scheme which is the subject of the present ESIA.

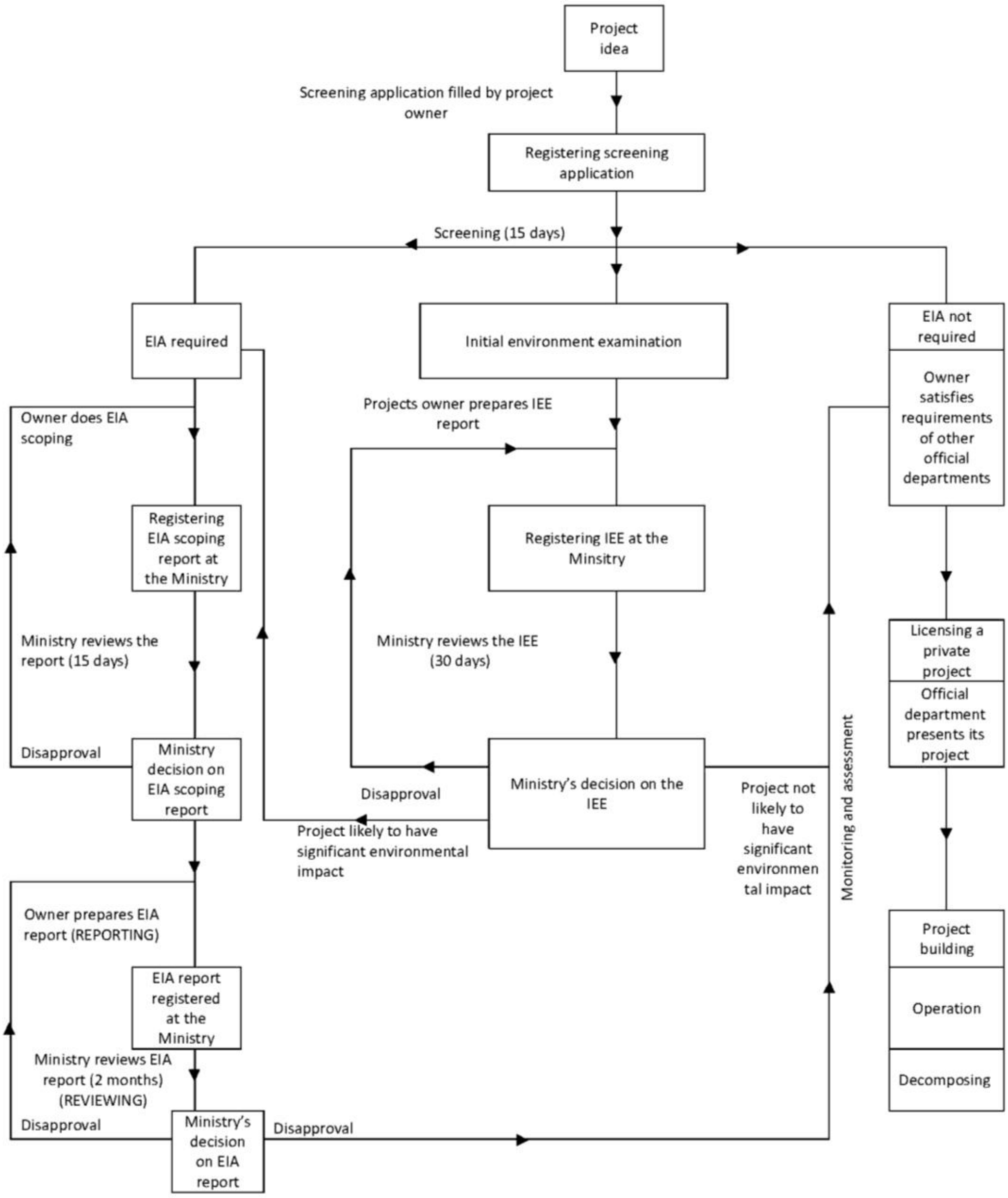

Figure 3.1: Environmental Assessment Procedure in Lebanon

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. 8633	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.
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.

Document	Subject	Content
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 and National Water Sector Strategy attempt 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[9], 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.

9 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.
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 World Bank Safeguards Policies

In accordance with CDR policy, and while simultaneously complying with MoE procedures 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 followed World Bank safeguard policies. Impacts on project affected persons (PAPs) and their environment are identified and mitigation measures are proposed. WB safeguard policies allow for the participation of stakeholders including PAPs in project design. There are 10 WB environmental, social, and legal Safeguard Policies. These are Environmental Assessment (OP/BP 4.01), Natural Habitats (OP/BP 4.04), Forests (OP/BP 4.36), Pest Management (OP/BP 4.09), Physical Cultural Resources (OP/BP 4.11), Indigenous People (OP/BP 4.12), Involuntary Resttelment (OP/BP 4.12), Safety of Dams (OP/BP 4.37), Projects in International Waterways (OP/BP 7.50), and Project on Disputed Areas (OP/BP

7.70). Only 5 of the 10 safeguard policies will be trigerred by the construction of the GBWSAP, which are:

1. **Environmental Assessment (OP/BP 4.01):**

   This policy is considered to be the umbrella policy of the WB Safeguard Policies. Environmental Assessment aims at identifying, avoiding, and mitigating the potential negative environmental impacts accruing from the Project during design, construction and operation. The policy ensures that the Project is environmentally sound and sustainable and that PAPs are properly consulted. EA also studies project alternatives and suggests methods to improve Project design, siting and planning. EA studies the social and natural baseline, the legislative and regulatory framework of the country and institutional capabilities related to the environment and social aspects, in addition to international environmental treaties and agreements the country is signatory to. EA should be initiated as early as possible during project design and should be integrated with all Project components.

   GBWSAP is classified as category A project, as it is likely to have significant adverse environmental and social impacts especially that the proposed dam is considered to be a large dam. As described above, an Analysis of Alternatives (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. An ESIA and an ESMP have been prepared, following OP/BP 4.01 guidance for a category A project.

2. **Natural Habitats (OP/BP 4.04):**

   This policy ensures that the Project takes into consideration biodiversity conservation and aims at protecting natural habitats in the Project area that are legally protected, officially proposed for protection, or unprotected but of known high conservation value. Appropriate mitigation measures should be adopted to ensure environmentally sustainable development.

   The project will have significant impacts on natural habitats, both during construction and operation of the dam. 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.

   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. 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.

A preliminary ecological survey has already been undertaken on Bisri dam site. Being the priority option, Bisri underwent a detailed ecological survey, the results of which are presented in Section 5 and the full report is found in Appendix G.

A preliminary Biodiversity Management Plan has been proposed and describes the mitigating measures, costs and responsibilities of the impacts described above. The biodiversity baseline, conservation management actions and mitigation have been generally identified and reflected in the Biodiversity Management Plan. The biodiversity specialist team described in the Biodiversity Management Plan section will develop a biodiversity monitoring plan to monitor biodiversity and habitat management, the results of which will inform the project on the level of degradation to the sensitive habitats and the presence of any direct or indirect activities/actions potentially degrading these habitats especially as it relates to the identified endangered species of fish (namely the blenny freshwater fish). To supplement the management/mitigation measures, the biodiversity monitoring plan will include surveys that will take place during pre-construction, construction and operational phases of the project. These surveys will measure indicators that include but are not limited to: water quality, environmental flow volume and quality, number of target species as well as numbers of indicator species, and cumulative impacts within the upstream watershed. Supplemental details to the biodiversity management plan will be included in a revised version of the ESIA.

Physical Cultural Resources (OP/BP 4.11):

This policy addresses any adverse impacts on physical cultural resources as a result of the Project activities. Physical cultural resources include movable or immovable sites, structures, and natural features that have archaeological or cultural value. The policy aims at avoiding and/or mitigating the negative impacts on cultural or archaeological remains to ensure their preservation.

Reconnaissance sites visits to Bisri dam site have identified various sites physical cultural resources within the reservoir limits including archaeological remains at Marj Bisri, historic remnants of St. Sophia Monastery, and the almost contemporary Mar Moussa Church. GBWSAP thus triggers OP 4.11 and agreement has been reached with the Directorate General for Antiquities and the Diocese of Saida, as to the necessary measures to be undertaken to plan and execute archaeological investigations and rescue excavation and to preserve cultural heritage.

The Maronite Church, pending archive research at Bkirki into the historical significance of Mar Moussa Church, favours the proposed relocation site for which land expropriation procedures arrangements have been reflected in the project.

Similarly, the DGA has agreed the need for rescue archaeology and the time frame proposed in the ESIA. In accordance with its normal internal procedures, it will review the situation and make arrangements to implement its responsibilities under

Lebanese law once the Loan Agreement and Project Appraisal Document have been ratified by a Decree of the Council of Ministers.

A Cultural Heritage Plan is presented in Appendix D and comprises a 'Chance Find' procedure has been incorporated included in the construction documents should any physical remains be unearthed.

Involuntary Resettlement (OP/BP 4.12):

This policy is triggered when the development project involves the involuntary land take and displacement of PAPs. It aims at assisting displaced people to restore their living standards after displacement. Particular attention is given to vulnerable groups including the elderly, women and children and the infirm. Resettlement planning includes provision of compensation and/or any other assistance that may be required during and after resettlement.

GBWSAP is expected to have direct and indirect social impacts in its area of influence and beyond. Consistent with WB safeguards policies, OP/BP 4.12 was triggered and social mitigation plans identified. A Resettlement Action Plan by broad categories of works (dam and reservoir, power plant and transmission line, access roads) was prepared to mitigate, offset, reduce negative impacts and strengthen positive impacts on the communities in the Project area. The resettlement recommendations are discussed in the RAP, which is a separate document.

3. Safety of Dams (OP/BP 4.37):

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.

A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation. Dam Safety Plans either issued to date or under preparation include:

- Construction Supervision and Quality Assurance Plan;
- Instrumentation Plan;
- Operation and Maintenance Plan; and,
- Emergency Preparedness Plan.

3.5 Advisory Panel

A dam safety panel and Environmental and Social Advisory Panel have been established by CDR to advise on dam safety, safeguards and other technical studies during dam design, construction, impoundment, and dam monitoring. These panels are expected to meet twice a year during construction and once a year during operation, and their reports will be published.

3.5.1 Dam Safety Panel

CDR has appointed a Dam Safety Panel of Experts that will undertake the following reviews:

- Review site investigations, design, construction and commissioning;
- Review all dam safety plants including (i) Construction Supervision and Quality Assurance Plan; (ii) Instrumentation Plan; (iii) Operational and maintenance Plan; and, (iv) Emergency preparedness Plan.
- Review of prequalification of construction and procurement contractors prior to tendering; and
- Undertake 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. 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 status by the Panel.

In the case of the GBWSAP, a panel of 4 internationally recognized dam experts has been established. The Panel has undertaken review of the detailed design of the dam, and will remain under contract throughout the implementation of the works and first filling of the reservoir. The TOR's of the various Panel members were reviewed by the Bank.

3.5.2 Environmental and Social Advisory Panel

The project proponent will appoint an Environmental and Social Advisory Panel that will provide independent review of, and guidance on the environmental and social issues associated with the planning, design, construction and operation of Bisri Dam and its appurtenant structures.

The Panel will comprise three eminent persons with a wealth of practical experience of the environmental and social issues concerned with dam design, construction and operation. The Panel will also assess the extent to which the Bisri project complies with World Bank safeguards procedures.

The Panel will remain in place throughout the period of construction and for a period of three (3) years operation, or whatever alternative period as appropriate.

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**.

Section 4.10 assesses the impact of the presumed climatic change over Bisri basin water resources while **Section 4.11** examines the impact of the dam project over possible sensitive receivers with respect to air and noise pollution.

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[10].

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. The 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 the distribution of Rainfall throughout the year at Bisri site.

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 a 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. 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.

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 Mediterranean 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

10Atlas Climatique du Liban, 1977 Publié par le Service Météorologique du Liban avec l'aide de l'Observatoire de Ksara Deuxième Edition.

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 inTable 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, 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, when the reservoir is expected to reach its full storage capacity and start delivering water to GBA[11]. 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.

4.3 Landscape and Topography

The two easterly lobes of Bisri Reservoir formed by Nahr Barouk from the north and Wadi Bhannine where Aari'ye River runs 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.

11Design of Bisri Dam: Updated Feasibility Report. Dar Al-Handasah (Nazih Taleb and Partners), 2011.

Looking E 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

Awali Hydropower Plant downstream the dam

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.

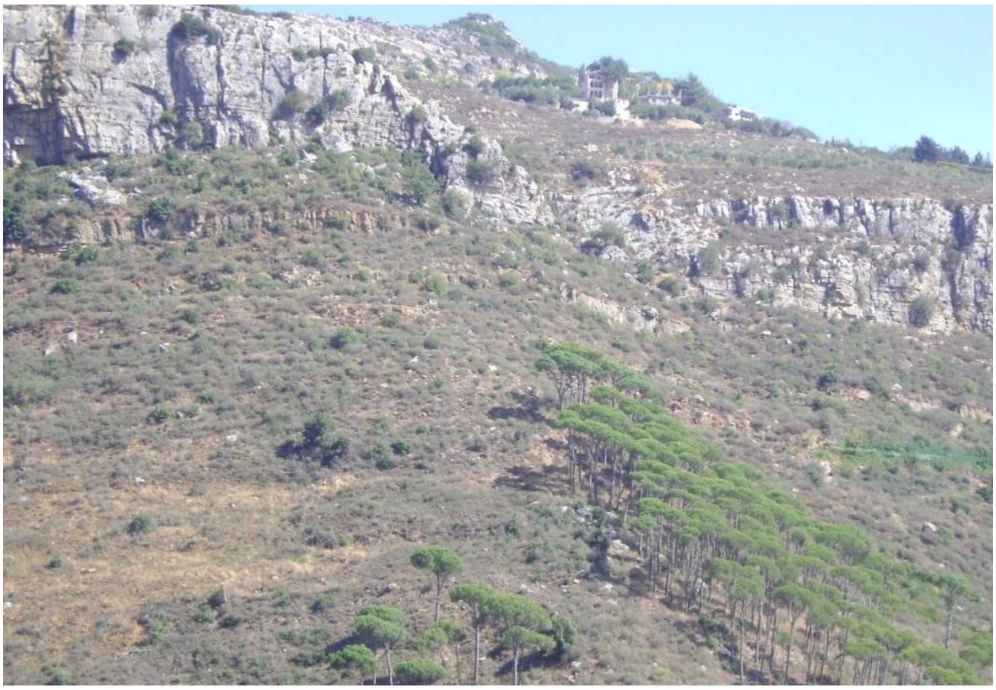

Figure 4.8: The Limestone Cliff Displaced above Wadi Bhannine

Further details of the geology and geotechnical aspects of Bisri Dam are presented in Appendix E. The Dam Safety Panel of Experts comprises a Geology Expert that has reviewed all aspects of project design as they relate to geological conditions and required mitigation measures.

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.

The Earthquake Design has recently been reviewed. The earthquake resistant design criteria prepared for the Bisri Dam (ECIDAH, 1997) essentially refer to the Operating Basis Earthquake (OBE), probabilistically associated with a return period of 144 years, and the Maximum Credible Earthquake (MCE), 84-percentile ground motion deterministically obtained from the MCE scenarios. The deterministic OBE and MCE scenarios provided by ECIDAH (1997) are respectively M7.3 and M5.7 on Roum Fault both at 2km distance from the Bisri Dam. Under the Subsection 5.1 of the Dam Review Board (DRB) Report No.1 (November 2013), it has been requested to "Perform a seismic hazard study to define the characteristics of the earthquakes that may be encountered at the site (design basis ground motion levels)". Three sets of ground motion have been provided, compatible with the MCE response spectra originally presented in ECIDAH (1997). These time domain ground motion sets are used by the engineer for the earthquake response analysis of the Bisri Dam.

Current approach for the earthquake resistant design of dams relies on the "performance based design" based on the guidelines of the Committee on Seismic Aspects of Dam Design of the International Commission on Large Dams (ICOLD, 2010). ICOLD guidelines call for a two level design based on the Operating Basis Earthquake (OBE) and the Safety Evaluation Earthquake (SEE), and also provides the associated performance objectives. In line with these requirements, the earthquake resistant design criteria were reviewed and the design basis response spectra associated with the OBE and SEE level ground motions recomputed based on the current data, knowledge and state-of –the-art methodologies. An assessment of the location, characteristics and capability of the Roum Fault, or any other neo-tectonic feature at the dam site, including the OBE and SEE fault offsets if the neo-tectonic feature crosses the dam body, through a site-specific neo-tectonic investigation was undertaken. This included an assessment of the structural and seismic characteristics of the Roum Fault in the dam site area based on existing literature and tectonic knowledge and was combined with additional field visits. This includes reviewing the mapping, OBE, SEE and offsets associated with this fault.

Information about possible existence of the active fault under the damsite and assessment of its structural and seismic characteristics presented in the reports (location, type, offsets) was also reviewed by comparing report results with ground-based observations during field visits where the existence and mapping of such structures were verified.

Preliminary findings of the neo-tectonic study are summarized below (*Report on the Assessment of the Neo-Tectonic Setting and Seismic Sources for the Seismic Hazard Assessment of the Bisri Dam Site, Elias Ata, May 2014*). These are currently under review by the Dam Safety Panel of Experts and will be reflected in the final detailed design as appropriate:

- Some of the parameters used for characterizing the major faults were reviewed based on recent understanding of the geology and tectonics of the region. The Length of the Yammouneh Fault was originally considered equal to the length of the entire transform plate boundary between the Red Sea and Anatolia. Given the widely accepted standards and rules in Seismotectonics, this is an exaggeration of the possible rupture length. This resulted in a reduction of the MCE for the Yammouneh Fault to 7.9 in compliance with the definitions set by ICOLD 2010 guidelines.
- The MLT ramp was identified as a new seismic source that can affect the Dam site and characterized its hazard. This is a blind sub-surface thrust ramp that lies below the northern part of the Dam site and is capable of generating MCE of 7.8. Special care should be given when considering the GMPEs of this source because of its special geometry (a thrust).
- No proof of active faulting related to the inferred fault below the Dam site was found in the geomorphology or geology of the site. Neither was any convincing evidence found for the continuation of the Roum Fault under the sedimentary cover of the Bisri valley.

Given the important erosion/deposition rates within the valley, the surface expression of active, deep-seated faults may have been smoothed and covered, cannot be totally ruled out. It is suggested that a geophysical investigation of the subsurface using seismic refraction methods be undertaken in order to image the subsurface structure and check for any buried faults.

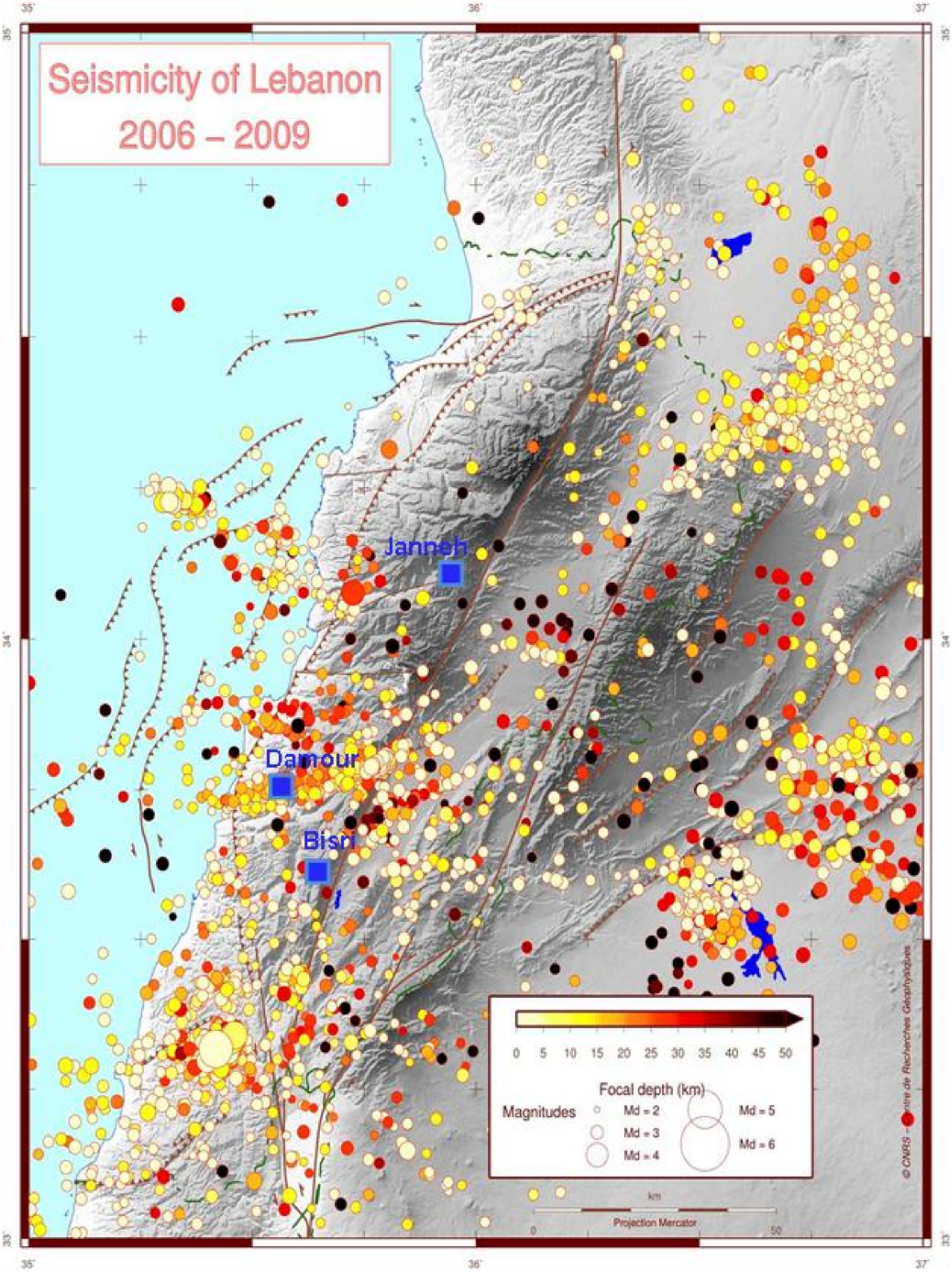

Figure 4.9: Main Centres of Seismic Activity in Lebanon (2006-2009)

4.6 Surface Water Hydrology

Nahr Bisri above the dam site has a 215 km^2 catchment area that receives 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 west 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.

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 135 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)[12] is considerably flattened in its low flow portion, indicative of significant 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.

As part of project preparation, a detailed assessment of the hydrology relating to Bisri and the associated detailed design was undertaken. This assessment reviewed in detail the quality of the runoff records at the Marj Bisri gauging station, and the methodologies used for computation of average inflow and extreme floods. The assessment indicated that that while low flows may be correctly estimated, high flows estimates are highly uncertain. The assessment therefore triggered additional parallel hydrological modeling

12 Bisri Dam Feasibility Report, Dar Al-Handassah (Nazih Taleb & Partners), 1995.

exercises, leading to new more robust hydrological characteristics that have been incorporated into the final detailed design.

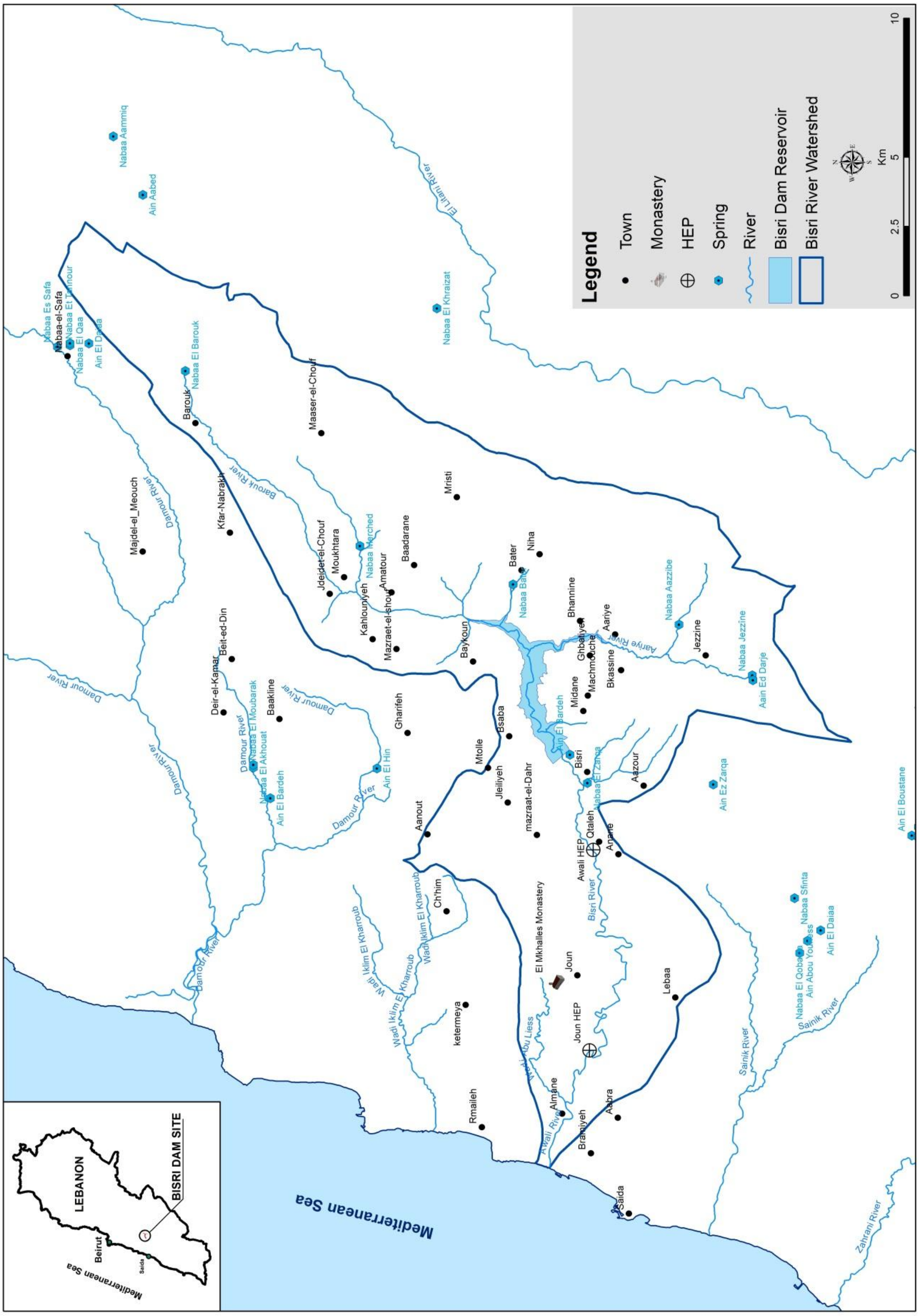

Figure 4.10: Bisri-Awali Surface Water Catchment Area

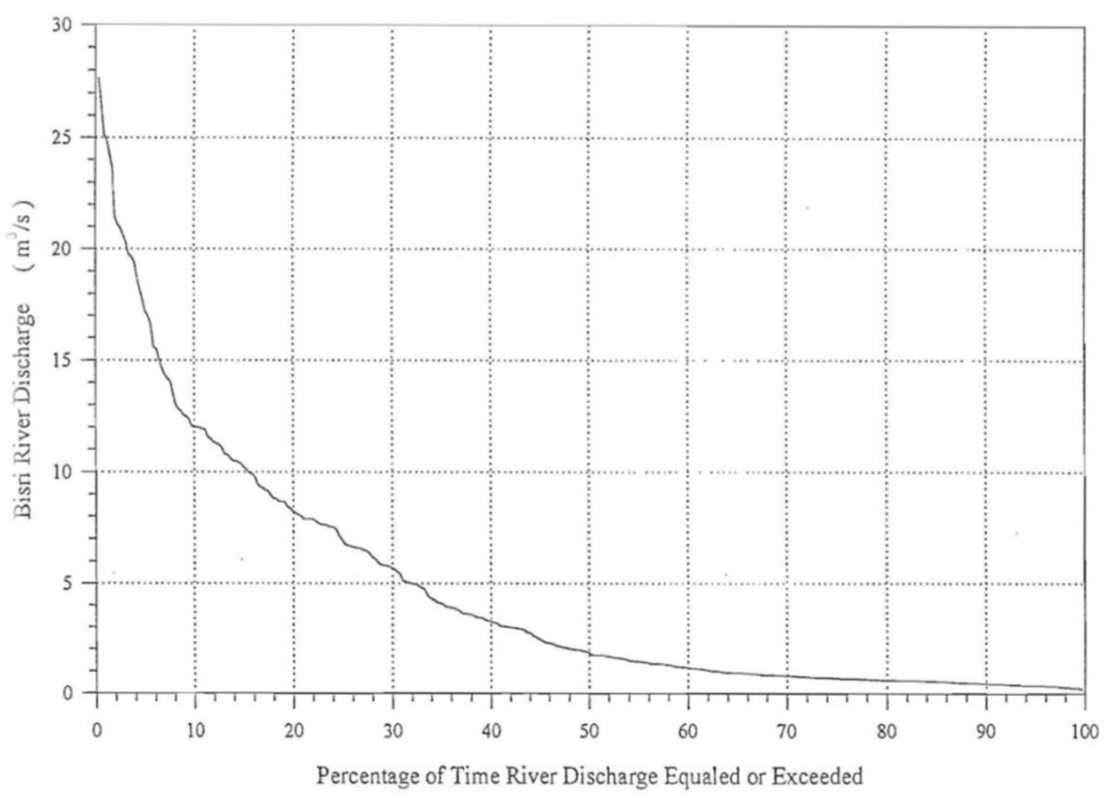

Figure 4.11: Nahr Bisri Flow-Duration Curve

A summary of the key hydrological parameters pertaining to the Bisri dam site taken from the 1995 and 2011 feasibility studies are listed inTable 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	135 Mm^3
Annual dry year yield	60 Mm^3
Annual evaporation	718 mm
Spillway design discharge	3,000 m^3/s (for PMF)
PMF estimate and safety check discharge for spillway	3,000 m^3/s
Diversion during construction (25-year return flow)	550 m^3/s
Annual sediment yield	1,000 $t/km^2/yr$
Water release	6 -7 m^3/s (June-Nov)
Dam storage	125 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[13], 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.

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.

13 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 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.

These issues were reviewed in detail by the Dam Safety Panel of Experts (which includes a dam geology specialist) and by a series of additional borehole investigations, financed by CDR as part of project preparation. Findings were reflected in the final detailed design.

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.

For Bisri Dam, the site is mainly formed by permeable karstic limestones. New boreholes are being undertaken to enrich existing and provide new data for the design of the appropriate sealing measures.

In the left abutment, the presence of the comprehensive sandstone formation C1, of overall low permeability, will not allow lateral leakages from the karstic limestones that appear at the lower part of the abutment. The water table with a gradient towards the valley is an assuring fact. The leakages through these limestones will take place only under the dam, and these leakages may be stopped or significantly reduced by the grout curtain under the embankment.

In the right abutment, leakages can take place under the dam and also by passing it "au large". Those leakages have to be stopped or controlled by a grout curtain under the dam and its extension inside the abutment. In this abutment, the water table is recognized to be under the riverbed elevation. This means there is a possibility for lateral leakages towards a distant exit. The area where these limestones will be inundated in the reservoir zone extends about 600m upstream of the axis, including the more karstic "Falaise Blanche". From there on, the sandstone formation of low permeability appears and seems to persist.

A positive feature is the presence of interlayers of marlylimestones or marls inside the main limestone mass. They should intercept the potential lateral leakages. The structural orientation of these interlayers with a strike almost parallel to the valley slopes is a contributing factor, provided they are fairly persistent. This is one of the purposes of the proposed investigations together with the inspection of the piezometry and its fluctuations.

Even after the results from the additional boreholes are available, there will be some uncertainty about the watertightness of the right bank. Therefore, consideration should be given to the construction of gallery/galleries that could be used for post-construction grouting, if that should prove to be required.

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, water quality 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 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.

The purpose of the 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.

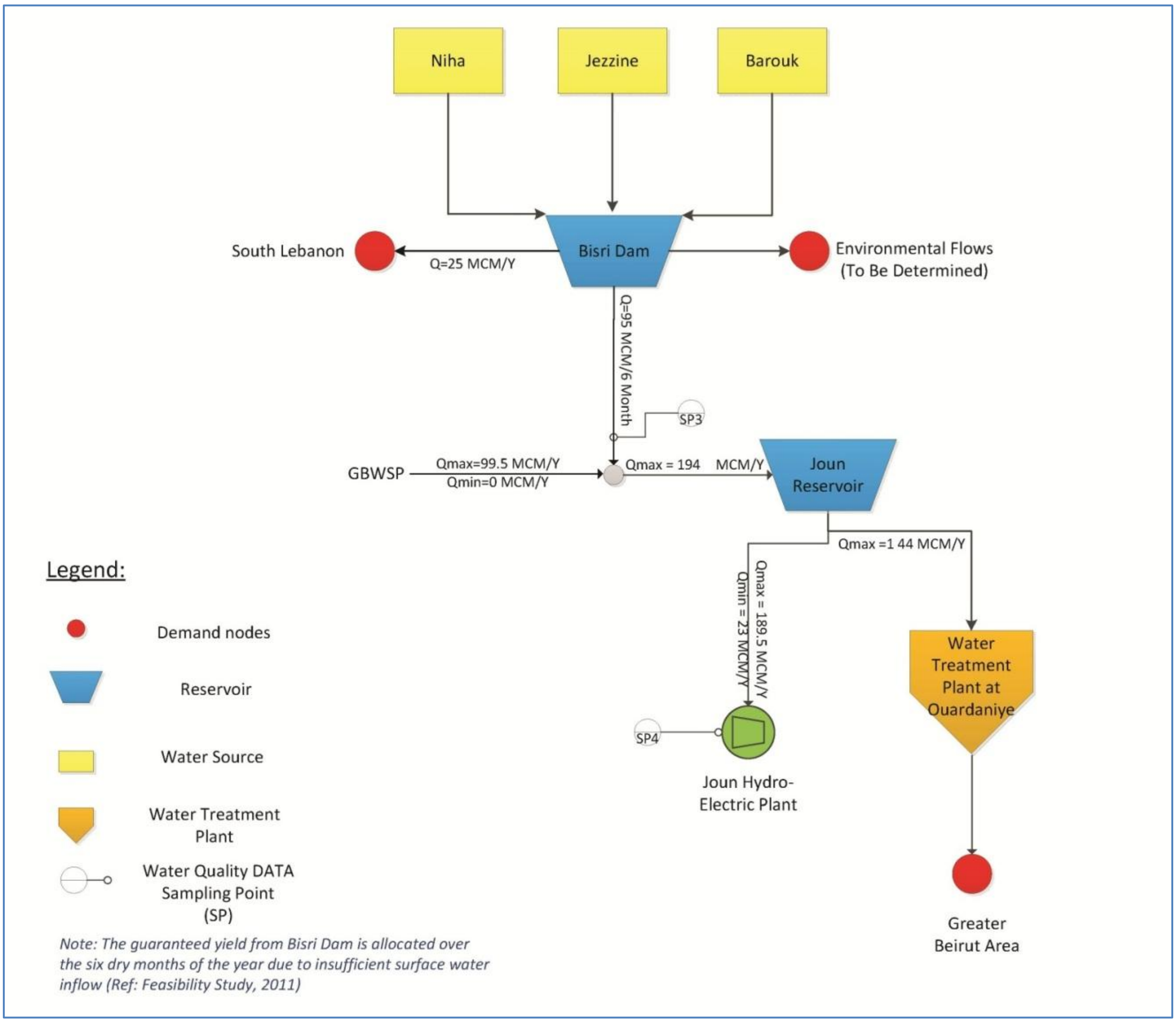

Figure 4.12: The Bisri Scheme within the Awali/GBWP Scheme

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[14]	LIBNOR Standards[15]	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

14 Ministry of Environment Decree No. 52/1- Standards for Minimization of Pollution of Air, Water and Soil 1996"
15 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 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 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 are given in Appendix F.

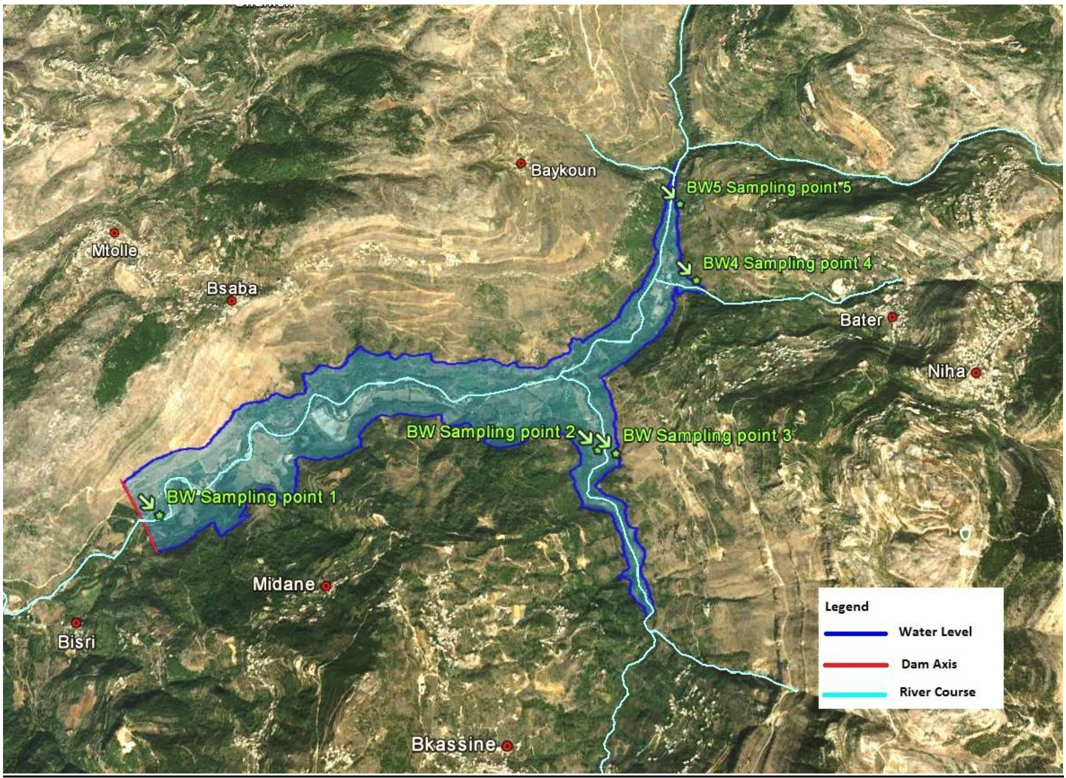

Figure 4.13: September 2012 Water Quality Sampling Locations

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 before 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.

The project will thus oversee a programme of monitoring to confirm the continued presence of pesticide residues and check for any additional substances detrimental to health that may arise. Because MOE does not have the capacity to undertake this work itself, this aspect be sub-contracted to a qualified consulting firm which will report to MoE. The objective is to monitor the presence of polluting substances present in surface water courses draining to the reservoir area and to investigate their sources of origin. To this end, a Terms of Reference for Consultancy Services to Monitor Water Quality Entering Bisri Reservoir, is given herein as Appendix G. current proposals are for the contract to run until such time as the dam and reservoir are commissioned and routine operational monitoring commences.

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 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.

A BMLWE study reviewed water quality data from Joun, Bisri (Awali river), Anane and Qaraoun (Karoun) Reservoirs. Samples were collected from December 2011 to November 2012 and includes 24 rounds of physical, chemical and microbiological data; 3 rounds of metals and organics. Results are summarized as fllows:

- Qaraoun Reservoir has the highest values of COD and TOC, followed by Anane and then Joun Reservoir with Bisri having the lowest level. The organic analysis also followed this trend.
- Nitrite at Joun, Anane and Qaraoun Reservoirs are elevated and is a contaminant of concern. However, ozone followed by GAC filtration should be able to treat this. Bisri has low nitrite but is elevated for bacterial load (total and fecal coliform, and E coli). While bacterial loads are high, conventional water treatment followed by chlorine disinfection should provide 4 log removal and inactivation.
- For metal analysis, only barium and beryllium were detected with regularity and these were at very low levels.
- Organics analyses detected polynuclear aromatic hydrocarbons (PAH), phthalates (plasticizers), pesticides, chloro-benzenes, trihalomethanes and xylenes. Of these compounds, typically Qaraoun Reservoir shows the highest concentration of detects and has more compounds detected. These chemicals are indicative of farming and industrial contamination.

Details of this study are included in Appendix F.

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 [16].

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

16 Assuming no extraordinary adverse change in water quality during reservoir storage.

Parameter	Conventional Treatment	Advanced Treatment
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
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

Parameter	Conventional Treatment	Advanced Treatment
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

Notwithstanding the results show no advanced treatment may be required, the Ourdaniyeh Water Treatment Plant includes oxidation and Granular Activated Carbon Filtration. Both will be incorporated into the design of the water treatment plant, currently in advances stages of preparation for tendering.

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[17]. 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 are planned. 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.

17 All human deaths accorded to cyanobacteria have been due to intravenous exposure during renal dialysis.

A conventional water treatment plant, which comprises the treatment processes included in the Ouardaniyeh treatment plant, will treat the water from Joun Reservoir to international drinking water standards. Granular Activated Carbon (GAC) has been substituted for anthracite in the filtration step. Ozonation followed by GAC filtration will help to lower nitrite levels and mitigate against the low levels of organics. An optimum pH for residual disinfection and to minimize calcium scale formation potential should also be investigated during the design phase. Every effort should be made to protect the watershed from further contamination.

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, Granular Activated Carbon and disinfection.

4.10 Climate Change and Water Resources

4.10.1 Introduction

The world over the last few decades has been witnessing number of unusual and more frequent weather extreme events. Among these events are: i) spectacular floods and extended drought in many regions; ii) an increase of +0.6°C in average global temperature; iii) a decrease of the snow cover worldwide of about 10%; iv) a mean sea water level rise of 10-20 cm; and v) more frequent, severe and long-lasting Nino events.

The increasing pace of these events triggered a number of researches and studies in the attempt to elucidate their origin. While the various studies may disagree about the impacts and extent of these phenomena, they do all seem to attribute these events to anthropogenic activities such as Greenhouse Gas (GHG) emissions that contribute to global warming. A number of mathematical models have been developed to simulate climate conditions under increased GHGs emissions. Despite the inherent limitations in these models they remain the primary only tool to predict in a simple mathematical way future events within a complex and uncertain science.

Over the last few years there were several attempts in the Mediterranean Basin to observe closely the likelihood of climate change using mathematical models. While some models used worldwide were applied to the Mediterranean Basin to probe the future trends in the region average temperatures, more region-specific models such as HADCM3, ECHAM4, CISRO-MK2, etc were developed to predict the regional change in precipitation. If the models predicting the future precipitation trends remain inconclusive due to intrinsic limitations, the predicted temperatures increase seem better aligning with the last 50 years global temperatures increase (EUWI 2009). For Lebanon, climate change scenarios have been developed through the application of the PRECIS model (MoE/UNDP, 2011)[18].

Water resources are a main component of natural systems that might be affected by climate change [19]. Key climatic parameters like precipitation, temperature and evaporation are the controlling factors of freshwater availability and quality, surface water runoff and ground water recharge. The recharge of natural and/or artificial water bodies, like Bisri Dam, are governed by these hydrological parameters.

A recent collaborative work on climate change impact on Bisri reservoir yield between CDR and an independent hydrology expert, has shown an average decrease of flow of about 3.5% for the precipitation change and an additional 0.5% for the temperature increase. Mitigation measures are in place to meet water demand in the GBA during periods of increased drought as a result of climate change. These include diversion of a limited volume of water from the Litani river (as per Presidential decree 14522) and the use of other sources of water supply in the GBA region.

4.10.2 Temperature

An increase in average air temperature in Lebanon of 1.3-1.8°C for the period 1961-1990 was reported by IPCC-DCC (1999)[20]. By the same trend it is believed Lebanon will witness, in the coming four decades, further increase in average temperature. Such increase in temperature will have an impact on reducing the availability of water, be it the source aquifer, spring, lake or river. Additional 2°C by 2050 and 4°C by 2090 will cause the snow/rain limit line to rise from 1500 m to 1700 and 1900m respectively, affecting the recharge of Lebanese mountain springs from where the coastal rivers originate (MoE-UNDP 2011).

A water balance model WATBAL[21] applied to two locations in Lebanon used to assess the significance of climate changes over the water resources, showed a potential of 5-15% reduction in water resources in Lebanon. In the same line, Bakalowicz (2009) [22] revealed that a reduction of 6-8% of the total volume of water resources is expected with an increase of 1°C, and 12-16% for an increase of 2°C. Therefore, the national annual water resources currently estimated to be between 2800 and 4700 MCM, are expected to drop to 2500-4400 MCM with a temperature rise of 1°C and to 2350-4100 MCM for a 2°C of temperature rise (EUWI, 2009).

As previously mentioned, and according to the hydrology assessment described above, temperature rise will result in an average decrease of Bisri flow of about 0.5%.

18 Lebanon's Second National Communication to the United Nations Framework Convention on Climate Change.MoE, Gefand UNDP, 2011.
19Climate Change and Water Resources in Lebanon and the Middle East E. Bou-Zeid and M. El-Fadel, 2002.
20Intergovernmental Panel for Climate Change, Data Distribution Center (IPCC-DCC), 1999.
21 WATBAL: a model for estimating monthly water balance components including soil water fluxes. " Proc., 8th Annual Report, UN ECE ICP 1999.
22M. Bakalowicz, Assessment and Management of Water Resources with an emphasis on prospects of climate change, 2009.

4.10.3 Precipitations

Using the available data and analytical means, Bakalowicz (2009) has demonstrated that precipitation over the Mediterranean Basin, most specifically the eastern part, have not experienced any particular increasing or decreasing trends over the past century. Long-term rainfall records, however, do reveal wide multiannual variations, where lengthy humid periods follow lengthy dryer periods. These variations are often mistakenly perceived as climatic changes. The MoE/UNDP National Communication 2011 reached to the same conclusion.

On the other hand Shaban 2009[23] argues that Lebanon is witnessing signs of decreasing precipitation and increasing drought and desertification. His study relied on a disparate number of gauging stations during three periods of time. From 1966 to 1978 rainfall data were collected for 70 gauging stations while for the period from 1978 to 1997 there were just 11 stations available. For the period from 1998 to 2005 the number of gauging stations was 24.

While various sources may disagree about the decreasing trends in precipitation over Lebanon, they all confirm that seasonal variability and changing precipitations patterns will be experienced. Some months of the year (December and January) will receive less water than now, while other months (November to September) will become rainier[24]. Noda and Tokiota (1989) noted that in some situations, changes in variability and distribution are potentially more significant and detrimental than changes in mean levels[25].

Climate Change impact on Bisri reservoir yield previously discussed has estimated an average decrease of flow of about 3.5% for the precipitation change. Resulting indices and their variations will be ultimately discussed when the hydrology model is rerun with the revised allowance for climate change.

4.10.4 Evapotranspiration

The evapotranspiration is the losses of water to the atmosphere from the ground and vegetation cover. The key climatic factors that govern the rate of evapotranspiration are precipitation and air temperature. The volume of water not absorbed or evaporated otherwise runs off or infiltrates to recharge surface and groundwater resources.

At the scale of Lebanon, Bakalowicz (2009)[26], using the Turc equation model, predicted future evapotranspiration trends, assuming that +1°C and +2°C temperature rise scenarios over three Lebanese mountain altitudes. He concluded the evapotranspiration

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[23] Indicator and Aspects of Hydrological Drought in Lebanon, Water ResourcesManagement, Shaban A. 2009.

[24] Climate Risks Vulnerabilityand Adaptation Assessment, Final Report ELARD 2010.

[25] Noda, A., and Tokiota, T., "The effect of doubling the CO2 concentration on convective and non-convective precipitation in a general circulation model coupled with a simple mixed layer ocean model." 1989.

[26] M. Bakalowicz, Assessment and Management of Water Resources with an emphasis on prospects of climate change, 2009.

rate will increase by an average of 4.6% for an increase of 1°C, while 2°C will cause an average increase of 10% of the currently recorded rate.

4.10.5 Surface Water

A direct impact of global warming will be the change in the patterns of precipitation, with more rain than snow, hence more water running off as soon as it falls and less being held in snow that will only melt slowly and better percolate the karstic aquifers.

River flow regimes will therefore be greatly impacted. Peak flow is expected to move backwards, from the end of April to the end of February, and will increase between December and February. With snow melt decreasing from April to June, flows during this period, one of high demand for irrigation water (MoE/UNDP 2011) will dramatically decrease.

Under such conditions, surface water will be less easy to exploit without retention, and with rainfall concentrated in time, the risk of flooding may dramatically increase.

4.10.6 Ground Water

As discussed above, the shift of snow-rainfall balance towards greater rainfall will cause more run off with proportionally less recharge to Lebanon's karstic aquifers. According to Shaban study (2009) in which 193 Cenomanian and 122 Jurassic wells were monitored between 1987 and 2005, there was clear evidence of water table decline. The Cenomanian and Jurassic aquifers in the Litani River basin (Bekaa) dropped 20-25 m and 5-10 m respectively. Furthermore, many wells and boreholes in the coastal cities have experienced irreversible saltwater intrusion.

4.10.7 Bisri Basin and Climate Change

Under any climate change regime, the hydrological parameters should be handled carefully in designing any water supply scheme. While the sections above presented detail about how the hydrologic regimes of water resources may be affected by changing climate, those below address the likely impact on Bisri dam design parameters.

There are four major parameters for which final dam design must take account of climate changes. The design must ensure that there will be sufficient safe yield to fill the reservoir with least shortage. There should be provision for predicting any change in flood flow by appropriately sizing spillways and other diversion structures. The increase in evapotranspiration rates will have a decisive impact on Bisri reservoir, with more water loss during the hot summer months. Finally global warming will impact reservoir water quality, since there will be less water to dilute any contamination present. Hence, the implementation of comprehensive waste water collection and treatment, and solid waste management schemes throughout the dam catchment area will be a major contribution to the success of the Bisri project.

Dam Safe Yield

In the latest update of hydrometric data the dam designer highlights a decrease in the river flows of 5% over the last twenty years of record compared to the previous 59 years.

In proposing the 125Mm^3 reservoir capacity, the designer has assumed that the historical data showing decreasing trends are more representative of future river flows.

Two basic monthly water demand scenarios were evaluated in the water supply yield analyses:
- 6-month delivery period between June and November at constant releases of 5.1 m^3/s. No release in other months.
- 6-month delivery period between June and November at constant releases of 5.8 m^3/s. No release in other months.

The above flow rates are based on the Master Plan of the Awali Water Project. Flow covers the followingareas:

1. Zone A (area situated to the East of Beirut City, extending from Wadi Chahrour Village in the south to Hazmieh Village to the North and ranging in elevation from 40m and rising to approximately 400m above sea level. The main villages included in the project are: Haret El Fghaliye, Haret Es Sitt, Wadi Chahrour, Merdash, Boutchai, Louaize, Baabda, Hadath, Hazmieh, Chiah, Furn El Chebbek). The demand for this zone is estimated at 3.3 m^3/s.

2. Zone B (The works cover an area situated to the East of Beirut City, extending from Wadi Chahrour Village in the south to Hazmieh Village to the North and ranging in elevation from 40m and rising to approximately 400m above sea level. The main villages included in the project are: Haret El Fghaliye, Haret Es Sitt, Wadi Chahrour, Merdash, Boutchai, Louaize, Baabda, Hadath, Hazmieh, Chiah, Furn El Chebbek). The demand for this zone is estimated at 0.6 m^3/s.

3. Zone C (coastal area situated to the south of Beirut City, extending from Damour Village in the south to Kfarshima Village to the North and ranging in elevation from sea level and rising to approximately 250m. above sea level. The main villages included in the project are: Damour, Naameh, Choueifet (including Aaramoun and Khaldeh) and Kfarshima). The demand for this zone is estimated at 0.8 m^3/s.

4. Zone D (The works cover an area situated to the East of Beirut City, extending from Jisr El Basha Village in the south (North of Hazmieh) to Jdeideh Village in the North and ranging in elevation from 50m and rising to approximately 300m above sea level. The main villages included in the project are: Mkalles, Jisr el Bacha, Mar Roukoz, Cap Sur Ville, Sabtiyeh, El-Aamariyeh, Fanar). The demand for this zone is estimated at 1.1 m^3/s.

It should be noted that Zone D is divided into two subzones Upper and Lower with respective demands of 0.4 m^3/s and 0.7 m^3/s. The lower zone will be connected to the Awali system as a back-up source and not as a primary source.

Design Flood Flow

As discussed above, under climate change conditions it is expected that river peak flows will be altered. The peak flows might be shifted from spring to winter months with the reduced snow cover period. The seasonal stream flow regime will be modified where snowfall and snowmelt contributions are significant (Impacts 1999)[27]. Snow makes a significant contribution to the Bisri Basin resources and as such any change in snow/rain amounts and seasonality will impact reservoir performance.

The most devastating flood recorded at Bisri was on 13 April 1971, when 620 m^3/s swept away the gauging station at Bisri Bridge and disrupted the operation of Awali and Joun Hydro-Power plants. While the 3000 m^3/s design flow of the dam spillway is sufficient to accommodate such a large flood event, the 550 m^3/s design flow of the diversion structures may be of concern given the tendency of global warming to increase climatic extremes. Moreover, any shift in the timing of floods must be well considered by the designer and contractor when preparing the schedule for construction works.

Evaporating Water

Climate change will result in higher evaporation losses from the reservoir surface and consequently, reduced storage. At the normal water level of 461 m the water surface will be some 398 ha. Using the figures cited in Section 4 above, the annual loss will be about 4 Mm^3 from the total volume of 125 Mm^3 stored. With evapotranspiration expected to increase by between 4% and 10% due to global warming, as discussed above, losses may be expected to increase significantly.

Water Quality

The water sampling and analyses for Nahr Bisri conducted during October 2012, showed that while river water is not immediately of potable quality, it requires only conventional treatment to render it so. Thus Bisri river quality conforms to the Lebanese and international standards for pre-treated source water for potable use.

Of no surprise in a predominantly agricultural catchment there was some presence of pesticide residues. That, these were lindane and dieldrin, was of a surprise as both are classified as POPs (persistent-organic pollutants) and as such banned under the Stockholm convention, which Lebanon signed in 2001 and came into force in 2004, although lindane has a partial exemption for use as a pharmaceutical for the treatment of lice and scabies. As part of the environmental management of Bisri dam, this and other aspects of water quality will be monitored and action taken to reduce the use of polluting substances.

In respect of other undesirable water quality parameters, nitrate was slightly above acceptable potable water limits, but the majority of heavy metals were not detected. While other studies have shown traditionally high organic and bacteriological contaminations of Bisri River due to sewage discharges from the surrounding villages, the October 2012 gave only low concentration. One reason for this may be that by the time the samples were taken the summer residents of surrounding villages had already departed contributing less to nutrients discharges into the river.

[27] Impacts of climate change and climate variability on hydrological regimes. J. C. Van Dam, eds., Cambridge University Press, Cambridge, U.K - 1999.

With global warming expected to reduce the natural inflow to the reservoir, waste water discharges, which will increase with population growth, will be less diluted and hence enhance water quality problems such as eutrophication within the reservoir.

4.11 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 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.

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. A preliminary Biodiversity Management Plan was also produced to mitigate the impacts on the natural environment as described below.

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.

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 are 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

Freshwater blenny shown in Figure 5.5 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 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 may put their survival in peril.

European eel or Anguilla Anguilla

The European eel shown in Figure 5.6 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.

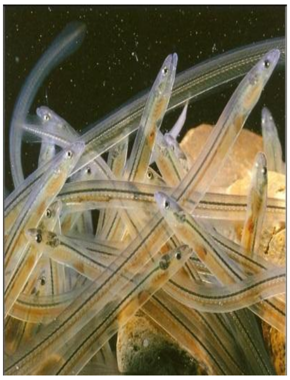

Figure 5.6: The European eel Anguilla Anguilla; adult (left) and Larvae (right)

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

Middle Eastern Green carp shown in Figure 5.7 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			+	


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.	

Details of a Biodiversity Management Plan are discussed in Section 9.2.3.

6. SOCIO-ECONOMIC BASELINE CONDITIONS

6.1 Introduction

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

Table 6.1: Cadastral Regions in the Vicinity of Bisri Reservoir

Caza	Cadastral Regions
Chouf	Mazraat El Dahr, Bsaba, Mazraat El Chouf, Aamatour, Bater ,and Khirbit Bisri and Deir El Mkhalles.
Jezzine	Bisri, Harf, Midane, Ghbatiye, Benouati, Aariye, Bkassine, 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 developed land ownership records. Data available for the ESIA issued back in September 2013 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.

The ESIA has undertaken a full socio-economic survey on which proposals for land expropriation and the development of a Resettlement Action Plan have been based.

Cadastral information along with topo maps showing cadastral plots have been provided by the Design Consultant, based on which a revised version of the Resettlement Action Plan has been prepared as a separate document.

Section 6.2 outlines the key social indicators, while **Sections 6.3 & 6.4** discusses population and employment. **Section 6.5** discusses household structure and tenure; **Section 6.6** education and health, and **Section 6.7** access to public utilities and community services. **Section 6.8** identifies and discusses vulnerable groups within the community that may require special attention during the execution of the Bisri project.

Section 6.9 discusses land utilization, with **Section 6.10** summarises the cadastral information collected to date.

Finally, **Section 6.11** discusses in some detail the interesting archaeological, historical and recent cultural heritage findings in the Bisri reservoir and its environs.

6.2 Key Social Indicators

The key social indicators for 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 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)[28] 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[29] 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[30]. Growth rates vary between organisations 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[31].

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28 UNDP (2011). Lebanon: HDI values and rank change in 2011, Human development Report
29 The government of Lebanon has not held a national Census since 1932
30 Central Administration of Statistics, 2010.
31 ESCWA, UN. Population Information Network. Lebanon Demographic Profile.

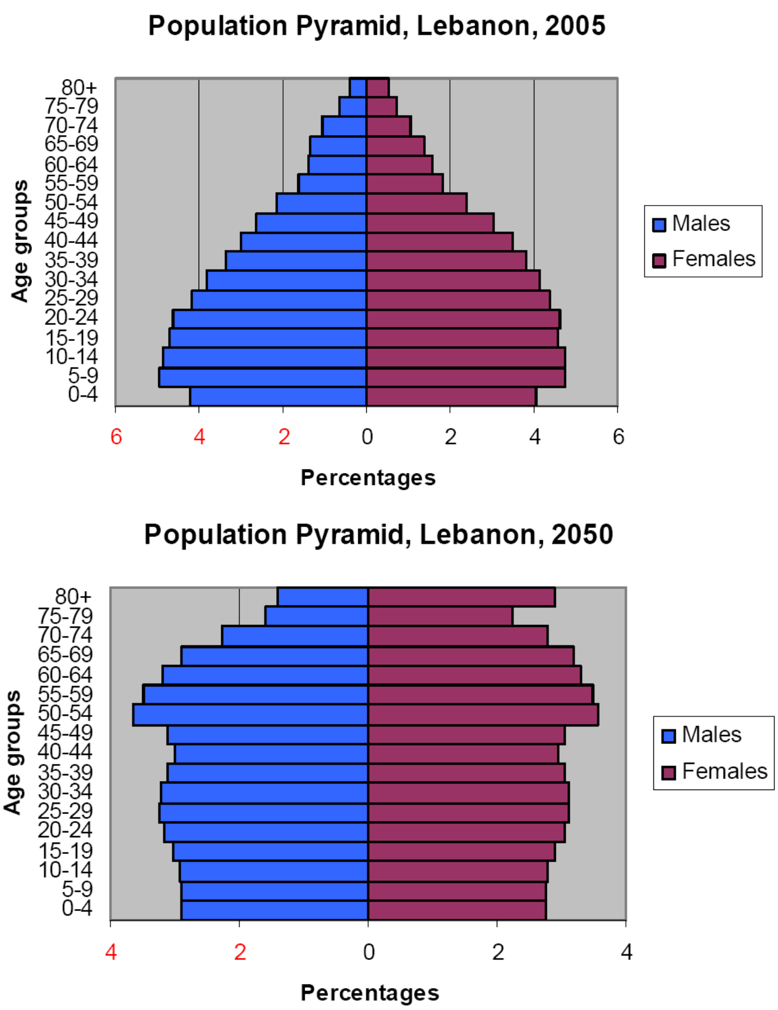

Figure 6.1: Population Pyramids in Lebanon over Years 2005 and 2050

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 events in 2000[32].

With the lack of official recent census for the populations nationwide and more particularly in the project area, the 2012 populations for the concerned villages were estimated based on a 0.8% population growth applied on year 2001 confirmed figures[33]. A summer/winter population ratio varying between 1.5 to 2.0 was assumed to estimate the seasonal populations for various villages. In fact, the 1.5-2 summer/winter ratio was established further to ESIA team discussions with villages Mayors and Mukhtars, on both sides of the river that confirmed the summer population have been, since always, greater than the winter populations in various villages. 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;

32 UNDP (2005) Development of Mapping of Living Conditions in Lebanon, 1995-2004
33 www.baldati.com

- 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'.

As such the estimated summer and winter populations for 2012 of the villages, in the immediate surrounding of Bisri Reservoir, are presented in Table 6.2 where a total over 35,000 in the summer and more than 21,000 in the winter are reported.

Table 6.2: Approximate Population Surrounding Bisri Reservoir

Caza	Village	Estimated 2012 Population	
		Winter	Summer
Chouf	Aamatour	2,435	3,652
	Ain Qani	1,100	1,649
	Baiqoun	395	791
	Bater	1,717	2,575
	Bsaba	1,380	2,069
	Haret jandal	337	506
	Kahlouniyeh	824	1,236
	Khirbit Bisri	27	54
	Mazraat eDahr	960	1,919
	Mazraat El Chouf	4,208	6,313
	Moukhtara	1,259	1,889
Sub-Total - Chouf		*14,642*	*22,654*
Jezzine	Aariye	585	1,171
	Benouati	530	1,061
	Bhannine	223	446
	Bisri	301	603
	Bkassine	2,472	4,945
	Ghbatiyeh	256	511
	Harf	312	623
	Machmouche	268	536
	Midane	826	1,653
	Taiid	82	163
	Wadi jezzine	638	1,276
Sub-Total - Jezzine		*6,494*	*12,989*
GRAND TOTAL		**21,136**	**35,643**

6.4 Employment

The pursuing of UN's Millennium Development Goals[34] in Lebanon reported an increase in the employment-to-population ratio from 31.1% 1997 to 35.7% in 2004, still weak when 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[35], 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. Eighty six percent of workers are employed by private sector companies and institutions, 13% by the public sector and 1% by international organizations, civil or partisan organizations.

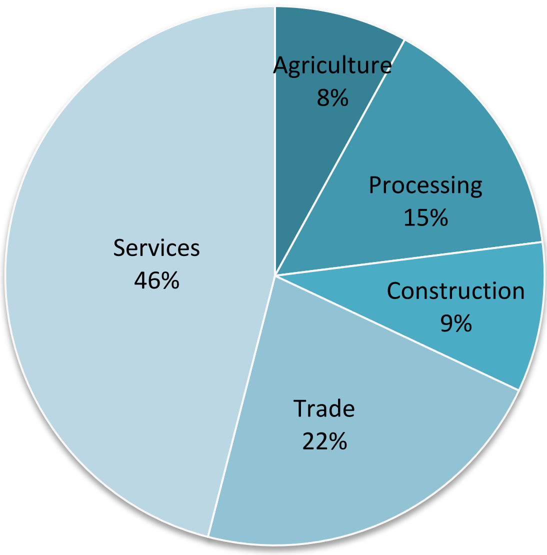

Figure 6.2: Distribution of Labour Force by Economic Sector

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

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34 UNDP. The Millennium Development Goals. Lebanon. http://www.undp.org.lb/WhatWeDo/MDGs.cfm.

35 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[36], 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 show that the majority of land holdings are large but within a family-holding may be sub-divided among individuals. Land owners are commonly absentee landlords, and 71% of the total residing households that were surveyed, in winter 2014, were non-Lebanese tenants. While only one tenant, of these 35 foreign households, has a legal tenancy right, the remaining 34 do not have any formal tenancy right to the property they are occupying and, hence, have declared themselves present on the property based on an In-Tolerance agreement with the landowner.

[36] The term deprivation and its derivatives are used to denote the situation of households or individuals whose overall Living Conditions Index, are below the threshold. UNDP (2005) Development of Mapping of Living Conditions in Lebanon, 1995-2004.

No squatters found among residents according to the socio-ecnomic survey. 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.

6.6 Education and Health

The World Bank reports [37] 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[38]	86.9%
Secondary	74.9%
Tertiary[39]	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%

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[40], the average life expectancy in Lebanon is 73. The country has witnessed significant improvement in pre/post-natal care and the under-five

37 The World Bank EdStats Database 2011". http://go.worldbank.org/ITABCOGIV1.
38 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
39 The Status and Progress of Women in the Middle East and North Africa, The World Bank, 2009

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) according to the same 2008 UN report.

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[41] 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

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

40 UNDP, The Millennium development Goals. Lebanon 2008.
http://www.undp.org.lb/WhatWeDo/MDGs.cfm
41 NSSF (National Social Security Fund) is a health insurance and end-of service pension

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 Awali 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 Churches	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 including Syrian refugees.

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. Lebanese law requires offspring to take the nationality of the father; a Lebanese mother is unable to pass on her nationality to children of 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, 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.

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 unlikely for elderly or infirm person to live there alone or with their family.

Young People

Young people under 25 years of age comprise 47% of the population. While few will now remember the years of civil unrest and invasion, their formative years have coincided with a period 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.

UNICEF recognises child labour to be one of the most significant social problems in Lebanon, especially in underserved urban neighbourhoods in the major cities and in rural areas. In the area impacted by Bisri reservoir, most if not all of children present are those of migrant farm laborers and tenants. While few of these children are enrolled in education they generally work along side their siblings and adult family members working the fields rather than being employed outside the family in industry, commerce, or in informal services. Despite the poverty, Bisri children are cared for as best as their family circumstances allow and do not normally suffer the same conditions as their urban cousins.

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.

Foreign Farm Labourers

During the frequent site visits, a number of non-Lebanese farm labourers, including Syrians, Syrian Kurds, Palestinians and Egyptians were met. 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, under Lebanese law, 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 Expropriated Area

Landuse	Approximate Area – ha	% of Total expropriation
Open Field/Fallow	148	26%
Natural Vegetation	131	23%
River Bed and Bankside Vegetation	105	18%
Open Land	99	17%
Pine Woodland	82	14%
Polytunnels	4	0.7%
Built-up Area	1	0.2%
Total	**570**	**100%**

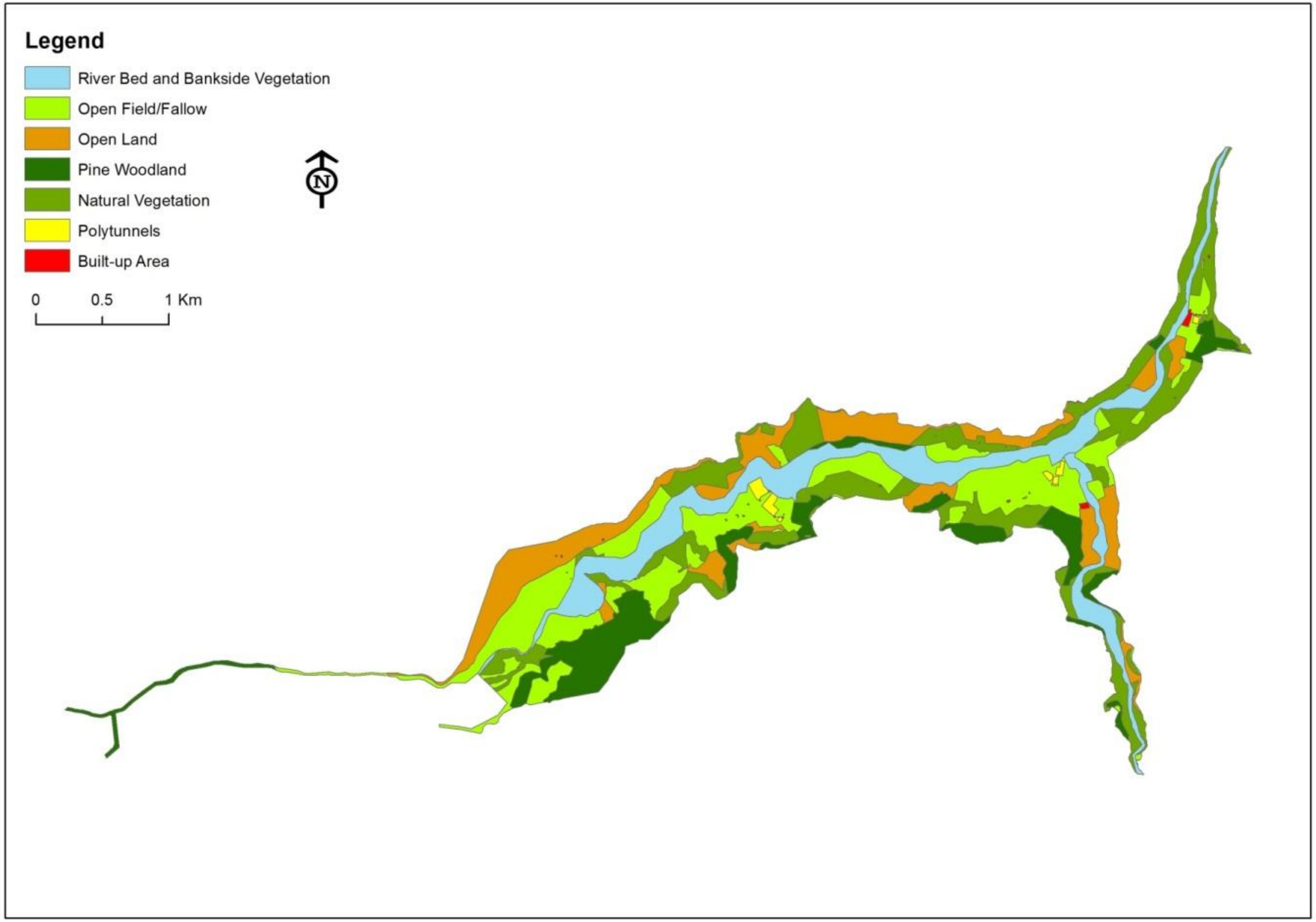


Figure 6.3: Current Land Use within Bisri Reservoir from GE Imagery

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

Figure 6.4: Current Land Utilisation within Bisri Reservoir

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 (cont'd): 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.

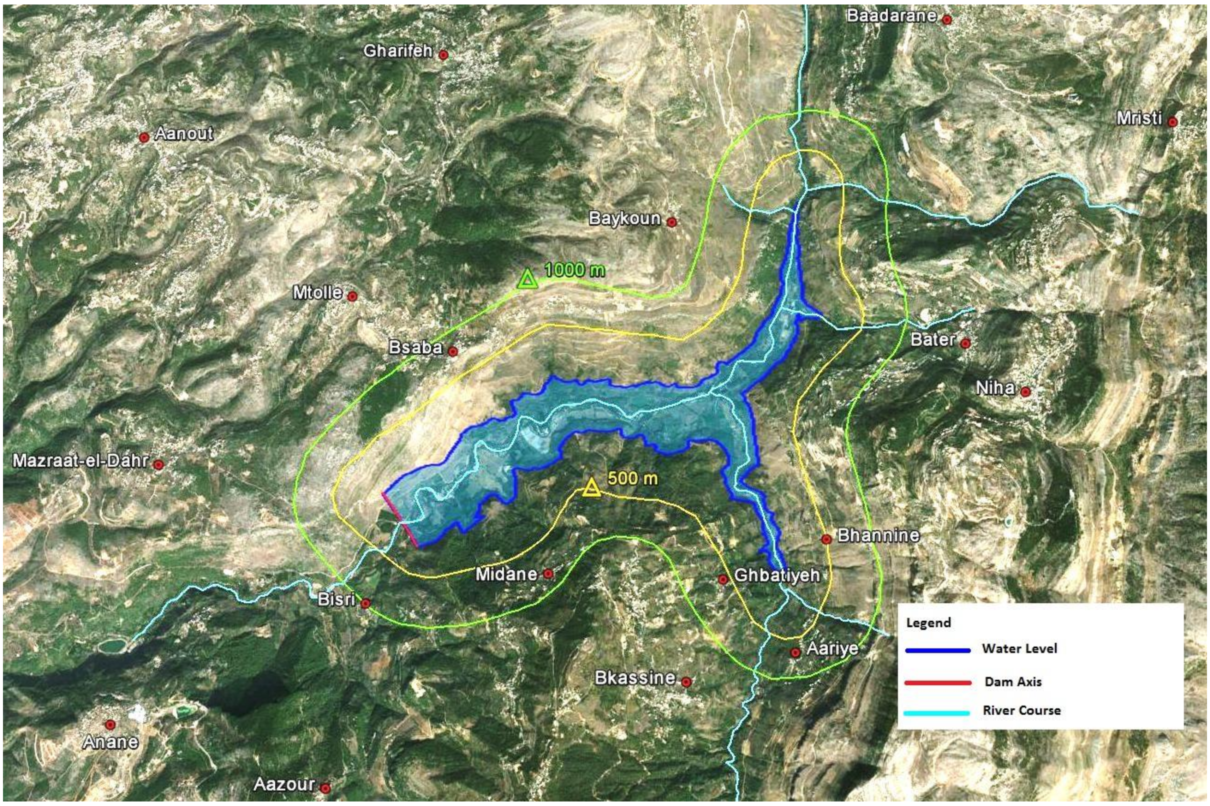


Figure 6.5: Buffer Zones around Bisri Reservoir

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 in each is 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 El Chouf having equally the biggest shares of 31% and 23% respectively.

A detailed topographic survey of the whole area has been conducted by the Design Consultant and expropriation files of cadastral plots have been collected. However, cadastral mapping showing individual plots is available for 98% of the project area, the remaining 2% are unmapped because some plot boundaries are not available for small parts of the project area and ownerships of the plots are yet to be defined by the cadastral judge. These regions are Bsaba and Bater.

The expected land take extends to some 570 ha, of which 434 ha is the inundated area including reservoir and dam footprint and 136 ha corresponds to the 15 m buffer zone. Some 53 ha of *Domaine Publique*, almost all within the reservoir area contain the river course and roads. The split of land take between cadastral regions is shown in the Table here below.

Table 6.9: Cadastral Regions Imposed upon by Bisri Reservoir

Casa	Cadastral Region	No. of Plots	No. of plots totally expropriated	No. of plots partially expropriated	Expropriated Area (ha)	% Area Expropriated
CHOUF	Bsaba	9	5	4	6.8	1.3%
	Mazraat El Chouf	277	225	52	120	23%
	Mazraat El Dahr	55	36	19	42	8%
	Aamatour	310	279	31	160	31%
	Bater	14	6	8	8.8	2%
	Sub-Total	665	551	114	338	65%
JEZZINE	Bisri	74	62	12	44	9%
	Bkassine	2	0	2	0.3	0.1%
	Benouati	27	19	8	4	0.8%
	Ghbatiyeh	4	1	3	6	1.2%
	Harf	69	64	5	46	9%
	Aariye	1	0	1	0.95	0.2%
	Bhannine	28	15	13	10	2%
	Midane	80	70	10	48	9%
	Deir-el-Mkhaless	3	0	3	2	0.4%
	Khirbit Bisri	13	4	9	18	3%
	Sub-Total	301	235	66	179	35%
Expropriation Grand Total		966	786	180	517	100%
Public Domain (river + roads)					53	
Total Land take					**570**	

**plus those in areas not mapped. Percentages are rounded.*

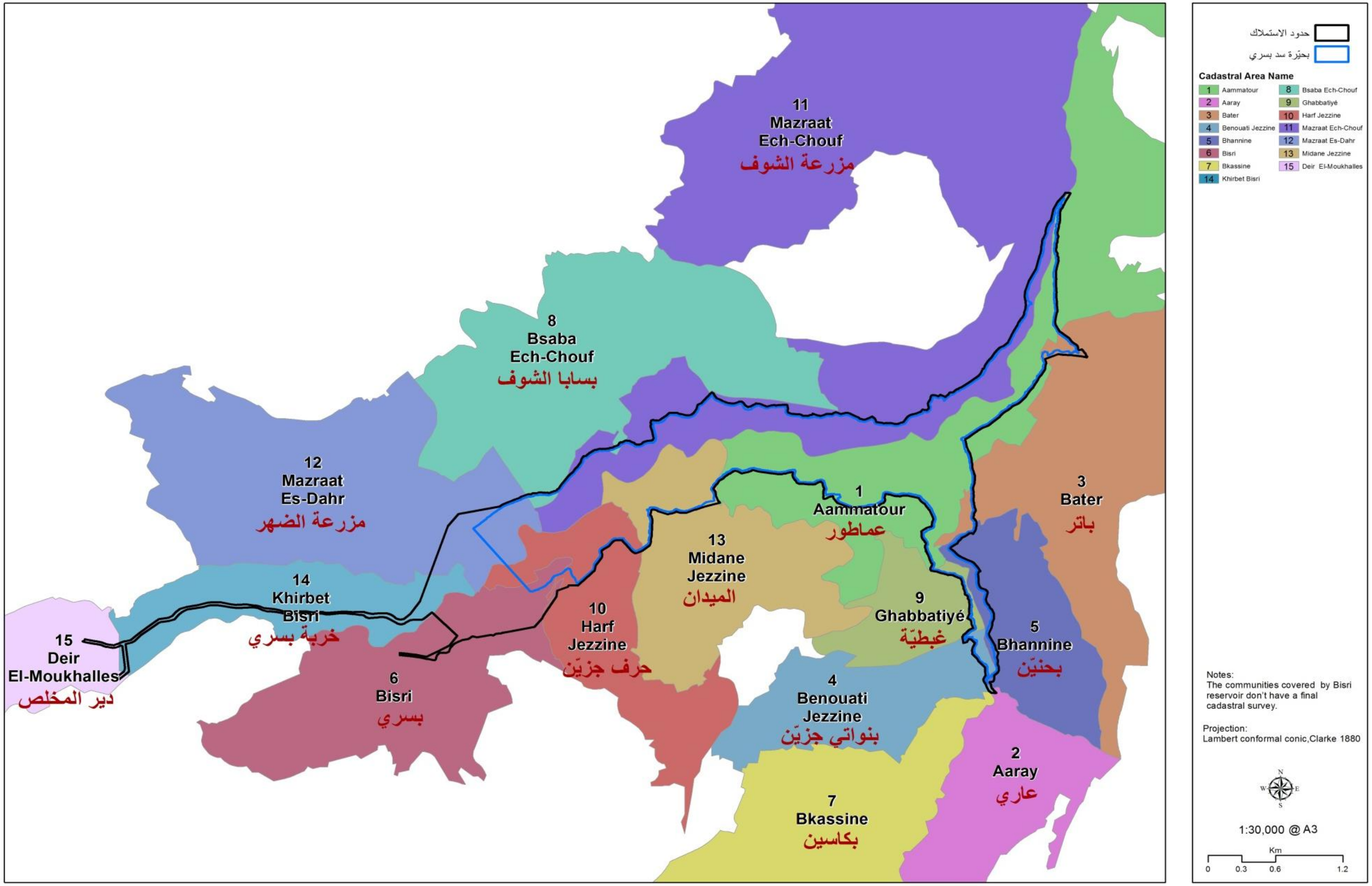


Figure 6.6: Cadastral Regions of Bisri Project

6.11 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 have been a hive of human and community activity. Repeated site walkovers, discussions with municipalities, moukhtars and residents as well as investigations of available maps from DGUP and survey data from DGA have revealed the wealth of historical and cultural heritage that will be affected by Bisri dam.

6.11.1 Archaeology

In 2004 and 2005, a Polish-Lebanese team from the Institute for Archaeology and the Polish Centre for Archaeology at the University of Warsaw and the Directorate General of Antiquities (DGA) at the Ministry of Culture undertook a survey of sites throughout the valley and surrounding hills[42].

From the available records of the 2004 and 2005 field seasons, a total of 78 sites were identified, of which 27 fall within the area of expropriation for the Bisri project and a further 10 sites are within 100 m of the expropriation boundary. Of the others, a further 30 sites are less than 1km from the proposed reservoir, while another 10 are further than 1 km. The locations of the sites are shown in Figure 6.7 and listed, together with the prime remains discovered and distance from the expropriation line, in Table 6.10. A short report prepared following the 2008 field season suggests no further work on the sites or the material collected has thus far been undertaken. This report together with copies of the 2004 and 2005 field season data sheets as provided by DGA are given herein as Appendix H.

The sites identified at Bisri represent almost the full span of human history, from Paleolithic times prior to 8,300 years BCE through to the present day, as shown in Table 6.11. The oldest sites, of Paleolithic and Neolithic, are generally outside the immediate valley to be inundated and have yielded a series of stone and flint tools.

[42] Institute of Archaeology and Polish Centre for Archaeology. *The Polish-Lebanese Expedition to the Eshmoun Valley (Wadi Bisri): The Preliminary Report after the Third Season Activity in the Field and Study Season Survey 2008*. University of Warsaw.

Table 6.10: Sites Recorded by DGA in the Vicinity of the Bisri Valley

Site No.	Longitude	Latitude	Nature of Find	Distance from Expropriation Limit
Sites identified during the 2004 field season				
1	35,32,38.8284	33,35,26.0664	Pottery, wall, olive crusher, Persian-Roman	Within
2	35,32,50.5	35,35,30.5	Pottery, wall, olive crusher, Persian-Roman	Within
3	35,32,53	33,35,27.8	Pottery pieces, Recent	Within
4	35,33,1.3	33,35,34.5	(Unrecorded)	Within
5	35,33,5.1	33,35,36.4	(Unrecorded)	Within
6	35,33,30.4	33,35,53.9	Pottery pieces, Roman	80 m
7	35,33,31.1	33,36,0.4	Regular stone blocks, Undated	120 m
8	35,33,51.2	33,35,52.7	Pottery, Undated	Within
9	35,35,2.2	33,35,59.7	House, C20	15 m
10	35,34,15.5	33,36,6.4	Village, C19-20	100 m
11	35,34,43.8	33,35,38.3	Pottery, glazed, C19-20	Within
12	35,35,1.9	33,36,6.4	Pottery, C19-20, one fragment C2BC	190 m
13	35,35,3.2	33,36,12.8	House, Undated	340 m
14	35,35,18,6	33,36,18.7	House with large stones , Undated	270 m
15	35,35,24	33,36,13.7	Houses, Pottery, C19-20	60 m
16	35,35,6.1	33,36,9.3	House, Undated	170 m
17	35,35,15.1	33,35,52.8	Marj Bisri Temple, Roman	Within
18	35,36,4.1	33,36,39.6	Rock shelter, stone tool, Paleolithic	260 m
19	35,35,52.7	33,36,43.8	House, C19-20	Within
20	35,35,29.2	33,36,0.1	House, C20	Within
21	35,35,50.7	33,37,7.8	Stone arch, Undated	90 m
22	35,35,50.1	33,37,8.6	Cave, Use Recent	110 m
23	35,35,30.1	33,35,19.9	Ceramics and pottery pieces, Undated	130 m
23	35,35,30.4	33,35,19.8	(Unrecorded)	130 m
24	35,35,37.9	33,35,7.6	Pottery, C18-19; flint flake, Paleolithic-Neolithic	130 m
25	35,35,44.1	33,35,4.1	(Unrecorded)	270m
26	35,35,33.6	33,34,42.3	House, C19-20	Within
27	35,34,17.1	33,35,36.5	Settlement, pottery, Recent, some older	180 m
28	35,34,11.9	33,35,24.1	Pottery, Undated	570 m
29	35,35,6.7	33,33,35.1	House, Undated	2 km
30	35,35,6.1	33,35,27.5	House, pottery, C19-20	170 m
31	35,35,0.4	33,35,26.5	Settlement, pottery, C2BC to C3-4	230 m
32	35,35,1.1	33,35,15.8	Rock blocks, glazed pottery, C19-20	290 m
33	35,35,1.3	33,35,11.3	Possible stone borer, possibly Paleolithic	300 m
34	35,35,16.7	33,35,8.1	House, pottery, Undated	130 m
35	35,35,24.8	33,35,26.7	House, C20	Within
36	35,35,23.2	33,35,55.9	Rock-cut tomb (looted), pottery, C3-4	Within
37	35,34,32.1	33,35,46	Settlement, pottery, 2C BC	Within
38	35,33,44.2	33,35,26.1	Settlement, pottery, 2C BC	100 m
39	35,33,44.5	33,35,11.1	House, C19-20	340 m
40	35,33,24.3	33,35,11.5	Village, glazed pottery, C19-20	160 m

Table 6.10: Sites Recorded by DGA in the Vicinity of the Bisri Valley (Cont'd)

Site No.	Longitude	Latitude	Nature of Find	Distance from Expropriation Limit
41	35,33,24.4	33,35,19.4	Small stone fortress, pottery, Undated	50 m
42	35,35,58.2	33,37,4.7	Stone steps, pottery, Undated	70 m
Sites identified during the 2005 field season				
43	unrecorded	unrecorded	Pottery, Roman-Present	Not known
44	E 35,33,23.9	N 33,35,26.9	Stone mill, Undated	Within
45	E 35,33,9.08	N 33,35,14.0	House or checkpoint, Undated	Within
46	E 35,32,49.2	N 33,35,3.9	Rock-cut tombs, Roman to C2-3	Within
47	E 35,32,49.7	N 33,35,8.9	Village, pottery, Roman-Ottoman	Within
48	E 35,32,36.6	N 33,34,55.8	House or checkpoint, Undated	Within
49	E 35,32,35.2	N 33,34,51.0	House, Undated	Within
50	E 35,33,4.7	N 33,34,33.3	Settlement, pottery, ?Roman	700 m
51	E 35,32,33.3	N 35,32,33.3	Necropolis, pottery, Late Roman	3 km
52	E 35,33,21.9	N 33,35,23.8	(Unrecorded)	Within
53	E 35,32,29.3	N 33,34,25.1	Settlement, pottery, Roman	600 m
54	E 35,33,16.5	N 35,33,16.5	Settlement, pottery, Ottoman-Recent	4 km
55	E 35,33,59	N 33,35,51.7	Necropolis, pottery, Undated	Within
56	E 35,32,29.6	N 33,34,44.9	Possible rock-cut tomb, Undated	90 m
57	E 35,32,27.7	N 33,34,12.2	Pottery, Undated	1 km
58	E 35,32,46.9	N 33,34,1.6	(Unrecorded)	1.5 km
59	E 35,32,17.9	N 33,35,59.4	Settlement, pottery, Chalcolithic-Bronze Age	120 m
60	E 35,33,31.4	N 33,35,19.6	House, Undated	Within
61	E 35,30,42.8	N 33,34,12.9	Pottery, Undated	780 m
62	E 35,31,37.3	N 33,34,45.5	House, C19-20	360 m
63	E 35,34,50.3	N 33,35,45.9	(Unrecorded)	Within
64	E 35,31,3.6	N 33,34,46.7	Settlement, Roman-Recent	390 m
65	E 35,30,2.3	N 33,35,3.6	Settlement, Roman	640 m
66	E 35,30,32.3	N 33,34,58.9	House, pottery, ?Roman	330 m
67	E 35,32,9.2	N 33,35,14.4	(unrecorded)	300 m
68	E 35,31,36.6	N 33,35,1.9	Settlement, flints, ?Neolithic	120 m
69	E 35,31,41.1	N 33,34,55.1	Settlement, pottery, Recent	50 m
70	E 35,29,48.9	N 33,33,47.7	Necropolis, pottery, glass, Roman	1.9 km
71	E 35,29,19.6	N 33,34,17.7	Settlement, pottery, Undated	1.8 km
72	E 35,29,47.1	N 33,33,57.5	Rock-cut tombs, ceramic fragments, Roman	1.7 km
73	E 35,31,25.7	N 33,35,55.3	Mill, C19-20	1.8 km
74	E 35,31,26.5	N 33,34,58.7	Pottery, glass, Roman	Within
75	E 35,32,24.8	N 33,35,16.2	Settlement pottery, glass, coin, Roman	Within
76	E 35,32,32	N 33,35,16.5	(Unrecorded)	Within
77	E 35,28,40.9	N 33,34,14.9	Settlement, flints, pottery, Neolithic	2.8 km

Data taken from DGA record sheets. There are two sites designated 23.No location is given for Site 43. Those sites shaded red are within the area of expropriation, while those shaded green are outside.

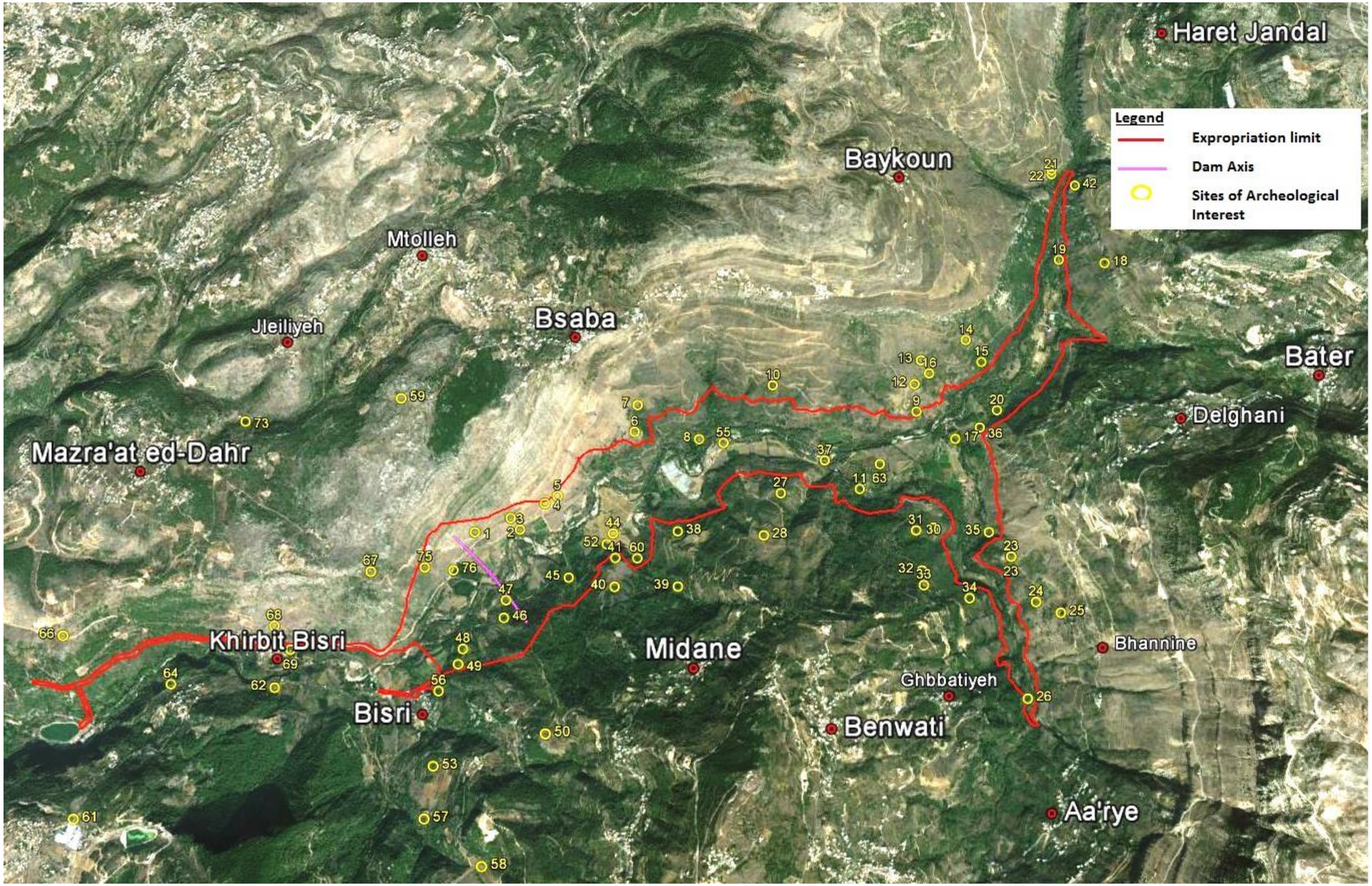


Figure 6.7: Sites of Archaeological Interest Recorded by DGA during the 2004 and 2005 Field Seasons.

Table 6.11: Spread of Bisri Archaeological Sites

Origin of Finds	Age	Number of Sites
Paleolithic	Before 8300 BCE	3
Neolithic	8300-4500 BCE	3
Chalcolithic	4500-3300 BCE	1
Bronze Age	3300-1200 BCE	1
Iron Age	1200-586 BCE	-
Babylonian/Persian	586-332 BCE	2
Hellenistic	332-37 BCE	4
Roman	37 BCE-324	21
Byzantine to Arab	324-1516	1
Ottoman and Modern	After 1516	24

Sites where finds from two periods are recorded are counted twice. Sites left undated are not counted. BCE: Before Common Era (Year 1)

On the basis of recorded sites, the valley seems to have prospered during Roman times, when their ability to travel would have resulted in the valley becoming a major route between the important cities of Tyr and Sidon on what is now the Lebanese coast, and Damascus. Twenty-one of the Bisri sites show evidence of Roman presence or occupation. Thereafter, the remains are primarily dressed stones from traditional Ottoman and Lebanese houses. Table 6.12 summarises the most significant finds.

Table 6.12: Common Finds from Bisri Sites

Prime Finds	Number of Sites
Dressed stones	48
Pottery sherds	49
Stone tools and flints	5
Glass	3
Rock-cut tombs/necropolises	7

Notwithstanding the large number of sites throughout the Bisri valley, which is expected to be the most significant is Marj Bisri Roman Temple, Site 17 of the DGA sites discussed above.

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 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 Figure 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 Figure 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.

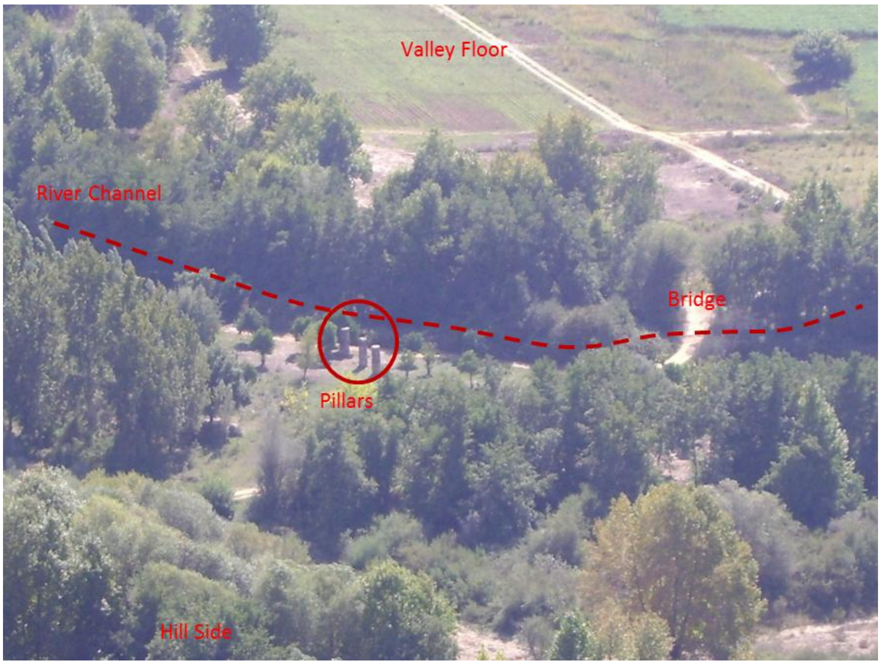


Figure 6.8: View across the Marj Bisri Site, Looking Southwestwards

Mar Bisri columns

Large stones in river bed

Mar Bisri bridge

Dressed stones in river bank

Figure 6.9: Photographs of Marj Bisri

6.11.2 Cultural Heritage

That life in the valley continued since Roman times are evidenced by the remains of old stone houses, commonly called traditional Lebanese houses, constructed during the period of Ottoman rule and after. Many of these houses have now fallen into disrepair and the population of the valley today may be one of the lowest throughout its history.

Of particular significance as witnesses to the relatively recent cultural heritage of the area are the sites of Mar Moussa El Habchi Church and the remains of St. Sophia's Monastery, located very close to each other a short distance upstream of the proposed dam axis, as shown in Figure 6.10.

On the lower slopes of the valley, Mar Moussa 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.

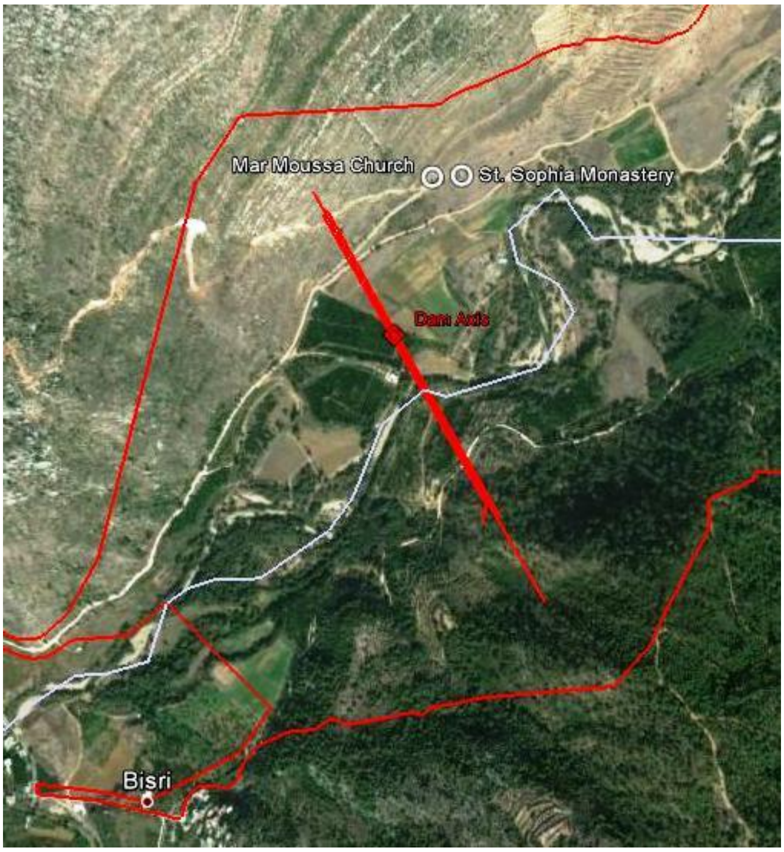


Figure 6.10: Location of Mar Moussa Church and St. Sophia Monastery

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, and relocating the church may be an acceptable solution.

Mar Moussa Church

Engraved lintel over one of the windows

Part of the interior

Broken engraved stone indicating the church has been rebuilt

Figure 6.11: Images of Mar Moussa el Habchi Church

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

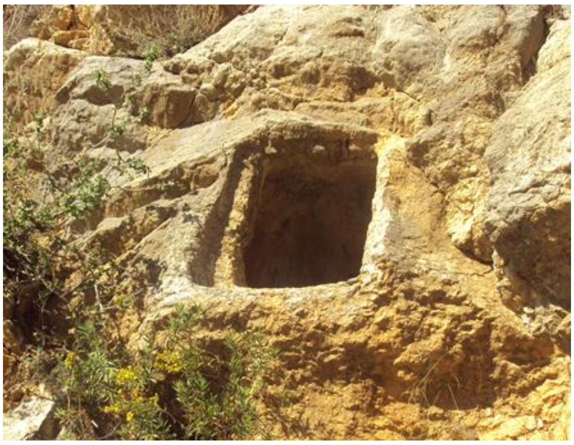
The other sites within the area to be inundated by Bisri reservoir appear to be of much less significance but nevertheless contribute to the overall heritage value of the site and aid our understanding of life in the valley in times past. These sites, illustrated below are all in the vicinity of Mar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

Remains of the monastery stables

The Byzantine wall to the monastery

Figure 6.12: Remains of St. Sophia Monastery

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 6.13: Other Sites of Historic and Cultural Interest

6.11.3 Physical Cultural Resources Management Plan

To address the need for rescue archaeology in the Bisri valley as a result of the project, the DGA, CDR and other stoakeholders held extensive discussion around the procedures to be followed for relevant rescue archaeology of the cultural heritage in the project area, including the Marj Bisri site. These are summarized below and detailed Physical Cultural Resources Plan (see Appendix D).

7. ANALYSIS OF ALTERNATIVES

7.1 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 Analysis of Alternatives of the Preliminary Draft ESIA.

In accordance with standard environmental assessment procedure, **Section 7.2** summarises the 'Do Nothing' or the 'Without Project' Alternative.

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 **Section 7.3** discusses the advantages and disadvantages of the following:

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

The Analysis of Alternatives also compared 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 dam alternatives, sites at Damour on Nahr Damour (two sites) and at Janneh on Nahr Ibrahim have been studied; the advantages and disadvantages of each alternative are summarised in **Section 7.4**.

7.2 The 'Without Project' Alternative

With the Greater Beirut area 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[43]. The World Bank estimate for the same year was significantly higher, 0.73%. The highest among all was the rate of 0.8% estimated by the Central Administration for Statistics in 2010. Whichever is correct, Lebanese population growth is lower than near neighbours Egypt (1.9%), Jordan and Syria (1%).

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[44];
- Increased wastewater seepage, hence in the prevalence of water-borne diseases;
- Social discord within families[45]; and,
- Conflict between those with access to potable quality water and those without.

7.3 Non-Dam Alternatives

7.3.1 Desalination

Desalination, the removal of salts from seawater or saline/brackish groundwater, is widely used in countries such as the UAE, Saudi Arabia, and Qatar for the production of water for public supply. Two primary technologies are in common use; the Membrane Filtration, also called Sea Water Reverse Osmosis (SWRO), and Thermal Technology of which the most common processes are the Multi-Stage Flash Desalination (MSF) and the Multi-Effect Distillation (MED). The major drawback of both processes is that they are energy intensive, MSF requiring 12-15 kWh/m^3, RO 3.5-5 kWh/m^3, respectively[46] accounting for up to 60% and 45% of total production costs[47]. Perhaps not surprisingly given the insufficiency of the energy sector in Lebanon, the GOL generally regards desalination as the *source of last resort*, when no other potential source of water is available.

MSF technology is more mature and robust, and well suited to the high salinity and often turbid water of the Arabian Gulf. Although, unlike Lebanon, these countries have access to cheap hydrocarbons, the overall cost remains very expensive and some plants operate

43 From Index Mundy.
44 Estimated to be US$28/month over the summer (World Bank 2010 GBWSP Project Appraisal Document)
45 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.
46 L. Awerbuch 2009. Desalination: The Vision of Today and the Future. Recent Advancements in Desalination.
47 FWR 2011: Desalination for Water Supply. The Foundation of Water Research.

on co-generated power with solar or waste-to-energy. In contrast, RO technology is more suited to source waters of relatively lower salinity and in respect of energy consumption is significantly cheaper. RO does however require the water to be pre-treated for the removal of suspended particles and micro-organisms that quickly cause the membranes to deteriorate.

Lebanese source 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. Processes applicable to low salinity source waters, such as ion-exchange and electro-dialysis are unlikely to be applicable. The use of co-generating thermal power with solar energy might look feasible but the overall contribution of solar would be significantly lower than elsewhere in the region and the high investment costs of solar power plants remain of serious concern. While the generation of desalinating power using refuse-derived fuels could benefit both power demand and solid waste management, large scale incineration of waste has long been a subject of political discord. Wind energy is potentially viable for small-medium RO units but impractical for large high-energy demand thermal desalination[48].

Given that Lebanon has a sustainable source of water from the Mediterranean Sea and plentiful coastal saline groundwater with which to blend the distillate to render it palatable, desalination would, at least theoretically, afford a technically-feasible solution to water supply for Greater Beirut. While such a facility might not be designed, developed and efficiently operated locally, a long-term DBO or DBOO contract with an energy supplier with a proven track record may be used to cover the cost of construction, the high levels of energy input, and the high quality O&M.

Environmental impacts include the need to locate an industrial complex on or near the coast, land expropriation, carbon and other atmospheric emissions from both the power plant and the process, and particularly the production of large quantities of wastewater, much of it in the form of super-saline brine that will adversely impact coastal and near shore communities and habitats. Of the water the desalination plant would take in from the sea, 40% will be processed as drinking water while 60% will be expelled with a salinity approximately twice that of sea water. Disposal of this in the Eastern Mediterranean where the circulation is already problematic and water quality generally poor, will only exacerbate environmental problems. Depending on the technology used and a number of other factors, a desalination plant producing 100,000 m^3/d could require a land take of 20-30 ha. The economics of desalination has improved in recent years but is still largely related to the cost of energy. Small-scale plants using RO and similar processes may afford little economy with scale.

The cost/m^3 varies significantly from one plant to another depending on location to source water and demand centre, energy source, and technical complexities. Based on data reported by Karagiannis and Petros in 2006 for the Agricultural University of Athens, 1 m^3 of conventionally desalinated seawater ranges from $0.5 to 3.75. For a

48 Spang, E. The Potential for Wind Powered Desalination in Water-Scarce Countries. Fletcher School at Tufts University, February 2006

system relying on renewable energy sources and thereby requiring large scale RE installations, this can reach as high as \$18.75.

MSF is the most widely used process for seawater desalination of seawater worldwide, particularly in the Gulf countries (ESCWA 2001) with access to cheap energy. Given the likely opposition to constructing a desalination complex on the Mediterranean coast, the absence of a cheap energy source – indeed, the frequent absence of any energy source – yet the increasingly widespread availability of saline ground water, RO may be much more amenable for Lebanon. This however would require a large number of separate plants feeding into the distribution network at different locations. The number required to produce adequate quantities to supply Greater Beirut would be excessive, but in the longer term, when natural sources have been developed to the maximum sustainable, additional contributions from one or two medium to large MSF or several RO plants my prove a viable option.

For an MSF plant developed through a DBO or DBOO to be feasible, the present law under which EDL, have the monopoly on power generation in Lebanon will need to be rescinded.

Desalination would also afford the opportunity to reduce the illegal abstraction from adjacent coastal aquifers, thereby enabling the exploration of saline ground water in the most technically efficient and cost-effective manner.

Given the expected increase in water salinity over time, shifting from low salinity treatment to medium or high salinity desalination could increase the cost between 1.7 and 5.3 times, respectively. 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. Similarly, the RO system modelled by Dore (2005) gives costs of 0.22-0.28 \$/m^3 for brackish water desalination versus 0.5-0.7 \$/m^3 (2004 equivalent) for seawater desalination. Hence, a significant economic burden can be expected with aggravated saltwater intrusion and increased groundwater salinity. Replacing small RO systems with a larger (city-scale) facility can reduce desalination cost per capita by as much as 55% (Dore 2005).

Table 7.1 compares energy and electricity requirements among the commonly used technologies with estimates of their Capital Expenditures (CAPEX), while Figure 7.1 compares the Operational Expenditures (OPEX) of the three discussed technologies[49].

49 MENA Regional Water Outlook Part II – Desalination Using Renewable Energy Final Report, March 2011.

Table 7.1: Energy Requirements and CAPEX of MSF, MED, and SWRO

Description	Unit	MSF	MED	SWRO
Maximum Concentrate Temperature	°C	< 115…120	< 70	< 45
Typical Steam Pressure	*bar*	~ 2.5…3.0	~ 2.5 …3.0(a) ~ 0.3 …0.5(b)	0
Typical Present Day Heat Demand	*MJ/m³*	~ 233…258(c)	~ 233…258(c)	0
Typical Present Day Electricity Demand	*kWh/m³*	~ 3.0…5,0	1.5 – 2.5	~ 3.0…5,0
CAPEX	*$ / m³ per day*	1700 – 2900	1700 – 2700	1300 - 2500

Source: MENA Water Outlook 2011
(a) MED-TVC (b) "plain" MED (c) Corresponding to a performance ratio of 9 to 10 kg/2326 kJ

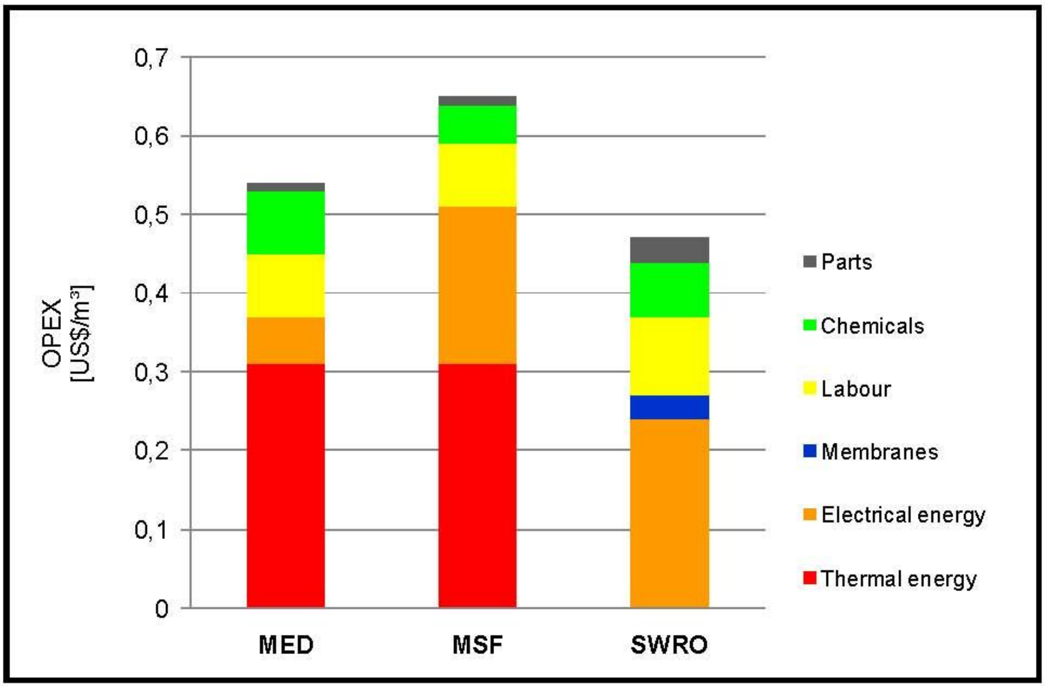


Figure 7.1: Operational Expenditures for three Desalination Technologies (MENA Water Outlook 2011)

The above Figure shows that all three technologies are either energy and/or electricity intensive processes. While SWRO does not require any energy for steaming, MSF requires about double the electricity that MED consumes. Given that energy and electricity supplies are not sustainable and not available at low costs in Lebanon, this raises serious doubts about the feasibility of the desalination option to augment water supply to GBA. The Lebanese electricity sector has indeed been struggling for more than two decades to meet population increasing demands, especially with the aging thermal plants and networks, insufficient supply and poor maintenance. The Energy sector remains highly dependent on GoL capabilities to cover the high costs of importing oil and other fossil fuels to meet the demand especially thermal Power plants consumptions. The sharp increase in international oil price during most of 2008 has in fact highlighted Lebanon's fiscal vulnerability[50].

The CAPEX and OPEX data shown above are only estimates and do not reflect the real cost expected scenarios for various sites. These costs may vary substantially depending on project specifics.

7.3.2 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 near-coastal aquifers over-exploited, the potential for additional resource development from deep bedrock aquifers inland is believed to be extensive; yet, the associated political, technical and administrative issues often appear too onerous to afford optimum development of what would otherwise be a major renewable resource.

The present development of ground water for Greater Beirut may be summarised as follows:

- The shortcomings of the existing public supply networks and shortages have resulted in many individual buildings having their own borehole supply;
- The coastal aquifers are consequently over-exploited and increasingly saline;
- In the absence of comprehensive sewerage, shallow aquifers are often polluted;
- There is no effective control of well drilling and/or abstraction licensing. MoE estimates there may be 42,000 wells in Lebanon[51], of which only 620 are legally licensed;
- Given the inability and lack of political will to control resource development, GoL has placed a moratorium on new water wells, which like the existing laws, lacks adequate enforcement.

The last national groundwater assessment study dates back to 1970. Since then, more than 43,000 wells[52] have been drilled on top of which a total of 650 public wells to be added. While the annual natural recharge rate of ground water is 500 MCM, the groundwater extraction nationwide, from these wells, totals 705 MCM as shown in Table below, resulting hence, in 205 MCM yearly deficits (NWSS 2010).

50 Social Impact Analysis – Electricity and Water Sectors World Bank, March 2009.
51 Others will put the figure much higher.
52 Number and volumes of private wells are feared to be much higher than the 2010 NWSS reported figures due to the limited access to those private wells premises and the reluctant owners of sharing their true wells data.

Table 7.2: Groundwater Extractions by Water Establishment (NWSS 2010).

Water Establishment	Public Wells (MCM/yr)	Private Wells (MCM/yr)	TOTAL (MCM/yr)
BMLWE	89	119	208
NLWE	54	109	163
SLWE	71	70	141
BWE	53	140	193
TOTAL	**267**	**438**	**705**

In an attempt to assess the groundwater resources in Lebanon, an UNDP project at the MEW has established the Lebanese Center for Water Management and Conservation (LCWMC) whose one of the key tasks is to set a national database for the use of groundwater. According to the preliminary findings of the LCWMC survey[53], there are totals of 20,537 and 56,276 of licensed and unlicensed wells respectively with a distribution all over the WEs territories as shown in the Table below.

Table 7.3: Groundwater Wells Distribution by Water Establishment (LCWMC 2013).

Water Establishment	No. of Private Licensed Wells	Estimated No. of Private Unlicensed Wells	TOTAL No.
BMLWE	12,306	15,001	27,307
NLWE	3,138	14,876	18,014
SLWE	2,361	8,171	10,532
BWE	2,732	18,228	20,960
TOTAL	**20,537**	**56,276**	**76,813**

The reported total private wells number by the LCWMC (76,813 wells) exceeds by 70% the estimated number of wells, as found under the NWSS (43,000 wells), suggesting that the above estimated groundwater extractions could be much higher than 705 MCM per year and increasing as such the estimated annual recharge deficit (Table 7.2).

Amid uncertainties about the actual number of wells and extraction volumes, there is a general consensus that groundwater resources in GBA and its environs is an over-exploited resource. BMLWE has the highest volumes of water wells extraction among other WEs (Table 7.2) and the same establishment counts for the highest number of drilled wells (Table 7.3), imposing as such quantitative and qualitative constraints over groundwater resources.

The concept that water is only assured if they see it in a reservoir rather than when it is stored underground is prevalent among many political activists. While a number of papers, research projects and consultancy assignments have addressed the availability and development of ground water resources, Lebanon still lacks a comprehensive understanding of aquifer potential and resource availability. Those previous studies that have been undertaken have often assumed the boundaries and extent of ground water

53 Groundwater Assessment and Database Project in Lebanon, Lebanese Center for Water Management and Conservation LCWMC, 2013.

catchments reflect those of surface water catchments, and reserves are calculated accordingly. This represents a fundamental flaw in the understanding of all Lebanese aquifers, not only in the major karstic limestone aquifers of the Sannine and Kesrouane Formations, but it is also untrue of the minor aquifers, in which water storage and flow is predominantly controlled by fracture permeability rather than primary intergranular permeability. In order to realise the potential of ground water, for present and future projects, for Greater Beirut and elsewhere, intense effort is needed to delimit and understand the physiologies and workings of the various aquifer systems.

The identification of specific areas for ground water abstraction to enhance water availability in Greater Beirut is beyond the scope of the present project. In respect of the dam areas under consideration, Damour would seem to afford the best opportunity for ground water exploitation. Information from existing wells in the area, such as Dmit Municipal Well, suggest that 1,000 m^3/day or more for each well in a wellfield tapping the Kesrouane Limestone (J4) confined under the Bhannes Formation (J5)may not be unreasonable, subject of course to confirmation exploratory drilling, well testing and aquifer modelling prior to scheme design.

The subcrop of the Jurassic limestones at Bisri is complicated by faulting and the cover of recent lacustrine deposits, but if a dam is constructed here, long-term demands, might be supported by the conjunctive use of ground water pumped from the adjacent aquifer. Alternatively, the GBWSP 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.

Again, a programme of exploratory drilling, testing and modelling will be required prior to scheme design. Such a scheme would be most efficient if the level ground water abstracted were designed to reduce piezometric pressure such that the flow from otherwise unutilised springs rising within the area of inundation were curtailed, thereby controlling ground water outflow, maintaining higher water quality and marginally increasing surface flow storage capacity[54].

Any substantial development of ground water resources for public supply should be accompanied by a programme of institutional strengthening and capacity building, together with legislative and judicial review to see how existing laws and regulations can be implemented and enforced. A priority 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.

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.

For ground water to become a substantial contributor to Greater Beirut's future water supply, existing abstractions will need to be retrospectively licensed for a set rate

54 Clearly, any new abstraction would need to preserve existing legal uses of spring outflow and ground water.

determined against the intended use, and actual abstraction charged against a restructured tariff structure that combines a fixed annual license renewal fee with an incrementally increasingly volumetric fee. The licensing authority, MEW, will need to use aquifer modelling to determine the safe yield of individual aquifer units and to ensure the total licensed abstraction from wells in that unit do not exceed what can be sustained through annual recharge, be it natural or artificial.

The opportunity costs associated with extracting and using the water immediately rather than leaving it in the ground for future use, when water table lowering with increase future costs can be substantially avoided if (i) well and aquifer yields are set at their long-term sustainable yields shown by ground water modelling, and (ii) wellfields are designed with minimum interference between adjacent wells.

Expansion of ground water abstraction also requires 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 caused ground water pollution.

7.3.3 Rainwater Harvesting

In many areas of water scarcity, where ground water is polluted, too deep to extract economically, and surface water resources are seasonal, the collection of rainfall from the surfaces onto which it falls, *rainwater harvesting*, may be a viable option. Whilst common in developing countries where rain is plentiful, water demands low, and water quality has to meet only minimum standards, this means of securing water supplies is very common. In developed urban areas it is not common due to the large number of discrete catchment areas, often individual roofs, which require intense and often tortuous collection networks to channel the water to centralized storage tanks in volumes that render treatment to potable standards technically feasible and cost-effective.

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 in any case 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 requirements of the Greater Beirut Area.

With the exception of small hill ponds for local agriculture outside the urban area, government investment in rainwater harvesting is unlikely to be cost-effective. As water bills rise with the introduction of a consumption-based tariff structure, individual householders throughout Greater Beirut can be expected to install small catchment schemes to reduce their consumption of municipal water for non-potable uses such as yard washing and garden watering. In some of the modern residential compounds in upland areas with higher rainfall than the coastal plain, rainwater use might be extended to WC flushing, chiller make-up, fire fighting reserve and the irrigation of public open space.

Within many areas of greater Beirut, there is likely to be social resistance to both the installation of rainwater harvesting facilities and its use.

For the purpose of investigating the potential use of harvested rain water in GBA, the present report has estimated the amounts of rain water that could potentially be collected all over Greater Beirut Area that extends over an area of about 253 km^2. With an average annual rainfall of 800 mm and a run-off coefficient of 0.8 corresponding to the estimated built-up area of 40%, water harvesting volume, by 2035, can reach to a total of about 120 MCM/year including all storage and distribution losses. An annual water collection increase rate of 4% is assumed. The projected rain water harvesting volumes with their gradual increase until 2035, based on the above assumptions are presented in Table 7.8 hereafter.

7.3.4 Wastewater Reuse

MEW predicts[55] 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 is reduced to 229 Mm^3. However, it is unlikely that leakage will be reduced below 25% and that public awareness and metering, on their own or together, will have little effect without the introduction of a consumption-led tariff structure and improved billing and revenue collection.

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, the expected volume of wastewater ending up in GBA treatment plants is 198 Mm^3. During the treatment process, a small proportion of the fluid content of incoming sewage will be incorporated with the sludge, lost to leakage from process tanks and pipework, evaporated from storage tanks, and utilized for filter backwashing and landscape irrigation. These losses are small and the treated TSE outflow may reasonably be expected to comprise 95-98% depending on the treatment of sludge, of the raw sewage inflow, i.e. a minimum of 188 Mm^3. Subsequent loss due to 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 may be somewhat less than this since treatment will need to be provided at several sites around the service area.

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

[55] Ministry of Energy and Water. *Potable Water Balance in the Greater Beirut Area 2011-2035*.(MS PowerPoint presentation)

fodder and tree crops, there is significant social resistance against its use. The application of TSE is not formally permitted for irrigating crops that may be eaten raw, or for public parks where children might play.

In several areas suffering extreme water stress - Singapore, Australia, Namibia, and a number of US States, have 'Toilet to Tap' schemes in which wastewater is treated to potable standards, using a process that includes microfiltration, RO, and disinfection, after which the treated effluent is added to a surface reservoir or injected into an aquifer where it undergoes natural treatment for a period of some months. The process is considerably more expensive than desalination and the consumption of such water will, in Beirut, meet with significant social objection.

The cost of a wastewater reuse system 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, reparation, and network maintenance.

A study by Asano (1998) estimated the total wastewater reuse system life-cycle cost by combining amortized capital cost with annual operation and maintenance costs and converting to $/ m^3$ (by dividing the estimated life cycle cost, $/yr, by the reclamation facility capacity, m^3/year). The life cycle analysis is based on a 20-year facility life and return rate of 10%. Wastewater reuse system costs are presented as a function of facility capacity, end-use option and treatment process configuration. Costs have been identified by Asano (1998) estimating facility construction costs, equipment purchases and operation and maintenance fees. Initially, wastewater reuse systems are analysed in terms of individual components based on design criteria. Cost data are derived for each element of a wastewater reuse system at various capacity levels and unit sizes. Site development and electrical cost are assumed as 10 and 15 percent of the total facility cost, respectively. A summary of the results found by Asano (1998) is presented in Table 7.4.

Table 7.4: Estimated Wastewater Reuse Treatment Life Cycle Costs (Asano, 1998)

Reuse Alternative	Recommended Treatment	Annual costs ($/m^3)[a, b]
Agricultural irrigation	Activated sludge	0.20-0.55
Livestock and wildlife watering	Trickling filter	0.21-0.57
Power plant and industrial cooling	Rotating biological contactors	0.31-0.58
Urban irrigation – landscape	Activated sludge, filtration of secondary effluent	0.24-0.73
Groundwater recharge – spreading basins	Infiltration – percolation	0.09-0.21
Groundwater recharge – injection wells	Activated sludge, filtration of secondary effluent, carbon adsorption, reverse osmosis of advanced wastewater treatment effluent	0.94-2.64

(a): 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.
(b): Annual costs include amortized capital costs based on a facility life of 20 years and a return rate of 7 %.

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 at three large wastewater plants withih the GBA region to allow GoL to meet its responsibilities under the Barcelona Convention. The existing Ghadir Wastewater Treatment Plant serves 1 million population equivalent since 1997 in the Ghadir catchment, covering the area from Municipal Beirut to Damour River on the coast and up to Alley, Bhamdoun and Abey at 900 masl. CDR is to commission Design Consultants to complement the existing network and upgrade the existing plant to afford for secondary treatment. The proposed Wastewater Treatment Plant for Northern Greater Beirut will cater for 2 million population equivalent for the year 2025 in the Dora Catchment covering the area extending from Karantina to Nahr El Kalb on the coast, to a number of towns in Mount Lebanon at an elevation of 800 masl between Damascus International Road and Nahr El Kalb. The Project is composed of main and secondary collectors, a secondary treatment plant with a capacity of 3.75 m^3/sec, and the rehabilitation of the existing sea outfall facing Dora area.

While both existing and proposed wastewater treatment schemes in Beirut afford for primary and seconday treatments, the necessary facilities and resources required for wastewater reuse are not currently available and will not become available in the short-medium term unless provided through a BOO, BOT or similar funding agreement. Treatment plants need to be designed and constructed for tertiary treatment; 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[56].

7.3.5 Reduction of Unaccounted-for-Water

Unaccounted-for-Water (UfW)[57] is all the water that 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[58] identifies the different categories of UfW, those relevant to the present project listed in Table 7.5. 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 7.5: 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,

[56] *MoE Policy for the Above Ground Use of Reclaimed Domestic Wastewater*. Draft 2, July 2004
57 Also sometimes referred to as 'Non-Revenue Water'
58 International Water Association.

	Leakage on service pipe before consumer meter.

Water Authority in GBA

As mentioned previously, the Beirut Mount Lebanon Water Establishment BMLWE is the direct project beneficiary. The Establishment has the key role in Water Supply and treatment operations, distribution to consumers, billing and cost recovery for the Beirut and Mount Lebanon service area.

According to the law no. 221 and its amendments, the BMLWE, as any other regional Water Establishment should:

- Design, implement, operate and maintain potable and irrigation distribution schemes based on the National Water Master Plan and resources as allocated by the MEW;
- Collect, treat and dispose of wastewater based on treatment and outfalls approved by the MEW;
- Propose water supply, irrigation and wastewater tariffs;
- Monitor the quality of domestic and irrigation water that is distributed to consumers.

BMLWE groups together the formerly six water authorities that were in charge of the water supply and distribution systems of the six Mount Lebanon districts (Cazas) in addition to the capital Beirut. The Establishment came into operation only in 2005 and covers now a total area of c. 2025 km^2 that is a home to about 2 million inhabitants with total registered connections of c. 475,000 and an estimated annual water production of 176 MCM from a number of springs, well fields, surface storage facilities, etc. The area that will benefit from the GBWSAP is part of the BMLWE regional coverage with an estimated area of 253 km^2 extending between Damour and el-Kalb Rivers in south-north direction and bounded by the Mediterranean Sea and the contour-line hills up to 300-400m from the West and East respectively.

While the irrigation demand volumes in the area under BMLWE coverage are the smallest compared to other Regional Establishments, the highly developed urban centers in Greater Beirut pose a great challenge to the water authority to meet an estimated annual domestic and industrial demands of 300 MCM (2009) that is almost the half of the national consumption for domestic and industrial water needs.

The key water facility that is under the management and operation of BMLWE is the Water Treatment Plant WTP at Dbayeh where Jeita/Qashqoush springs and ground waters are treated before being conveyed to GBA (60-85% of GBA supplies). The conveyance system, between Jeita springs and Dbayeh, has a capacity of c. 3 m^3/s while Dbayeh WTP, at full operation efficiency, could deliver 320,000 m^3 daily.

"Un-accounted-for-Water" in GBA

It is estimated that the water losses of the conveyor between Jeita spring and Dbayeh WTP could reach 30% due to an old and fissured canal, whereas the 60,000 m^3 of water, that are diverted from the tunnel for irrigation between the months of May and October are not demand-driven but in continuous delivery, increasing hence the inefficient water supply.

On the water head-works and distribution sides and in the aftermath of the civil war in early nineties, the GoL had planned, undertaken and completed number of rehabilitation and upgrading works for the water networks in many places in the country and more particularly in the GBA, under the umbrella of the National Emergency Recovery Programme NERP that fostered the reconstruction and development works in the country after years of war hostilities. Given the large scale of war damages more particularly afflicted to all infrastructures, including domestic water, the NERP has been divided into more than one phase. It is mainly under the NERP 2 and 3 where the bulk of the defective distribution networks were rehabilitated in the GBA. Whilst the rehabilitation works under the NERP helped in reducing the losses of water throughout the various networks decreasing to some extent the "UfW", many of the expected rehabilitation works did not either take place or yet to be completed, which created large disparities in the "UfW" estimates among various regional offices of the BMLWE as shown in Table 7.6.

Table 7.6: The Estimated Technical and Non-Technical Losses by Regional Office in BMLWE (EUWI 2009).

BMLWE	Technical Losses %	Non-technical Losses %
Beirut North & South	15 – 28%	10%
Baabda Office	>55%	>35%
High Metn Office	30%	<15%
Kesrwan Office	30%	15%
Alley Office	30 – 40%	>15%
Jbeil office	>50%	15%

Major rehabilitation and installation of water networks had taken place where the new ductile Iron water mains came to replace the defective old and leaking head-works and water mains, and/or the community service lines that used to be galvanized steel were replaced by PE or DI new piping. These rehabilitation works are reflected in the lowest "UfW" estimates (<20%) for a number of areas, namely in the city of Beirut, coastal and southern Metn, like for instance the Bourj-Hammoud network that was fully rehabilitated under the NERP 2 and 3.

On the other hand, there are still major rehabilitation works to be carried-on for many other areas in GB where the losses due to "UfWs" are still significantly high, namely in areas under Baabda, Alley and Jbeil offices jurisdiction. The two latters unfold for old and overused networks with frequently missing as-built plans making it hard to connect efficiently the newly installed headworks/piping network to the existing ones.

Baabda district includes, among others, the southern suburb of Beirut that witnessed over the last three decades an impressive demographic growth[59] that the old and undersized networks were unable to accommodate. Despite many undertakings to upgrade the existing networks in this area (c. 170km of water-mains and 11 km to connect to Khalde area), the "UfW" estimates may still report values as high as 80% for piping installed in the seventies that could drop down to 25% for the newly installed sections of the network.

Amid of varying estimations among different regional offices, the BMLWE puts the average of the "UfW" in GBA at 40% that is 8% lower than the national average.

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. Some consumers receive water for as little as 3 hours each day or even less in dry months, while many others have no mains water connection, preferring to utilise local wells or

59 The population of the southern suburbs went from 140,000 inhabitants at the end of sixties to about 526,000 in early nineties accounting for at least one sixth of the Lebanese population. These exclude the population of the Palestinian refugees camps.

tankered supplies. The majority of GBA residents, whether connected to the system or not, buy bottled water for drinking.

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, this latter figure is already a great improvement on the collection rate for previous years. It is to be expected the 38% of bills not collected include many individuals and organisations that are among the highest consumers.

Under GBSWP, it is proposed 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. This includes the requirement for all government personnel and establishments to settle their water bills. The capacity building required to execute metering will afford significant employment opportunities.

In the longer term, as the adequacy and quantity public water supplies improve, private wells that are illegal and/or yield non-potable water should be phased out in favour of legislated mains connection, thereby improving operational efficiency and revenue collection.

Economically, a volumetric or rising bloc tariff has direct and indirect advantages. First it will ensure financial sustainability for the BMLWE improving furthermore its operation and maintenance capabilities towards detecting and better reducing the technical types of losses throughout the networks. In fact a "Demand and Tariff"[60] study in 2002 has shown that BMLWE has the potential of increasing tariffs either through the volumetric or rising bloc tariffs. The study showed BMLWE consumers have the highest financial capabilities nationwide in purchasing water at the price set back that time and roughly equalling 525,000 LBP/year. Their average (1,140,000 LBP/yr.) and minimal (633,000 LBP/yr) purchasing powers for water remain higher than the national average and minimal respectively. Secondly, the new tariffs structure will provide an incentive to conserve water as higher levels of consumption impose higher costs.

Tariff cost structures differentiate from one country to another. Saudi Arabia implements a progressive tariff structure, whereas in the UAE, Kuwait and Qatar a flat rate tariff is implemented. In Saudi Arabia a 5 category tariff is imposed with the first two categories having an extremely low rate of \$0.03/m^3 and \$0.04/m^3 for the 0-50 m^3/month and 50-100 m^3/month categories respectively. Categories rates then increase quickly and reach \$1.6/m^3 for all consumption exceeding 300 m^3/month. That tariff is equally implemented on different types of use (residential, governmental, agricultural and industrial).

60 Demand and Tariff Report, Jacobs Gibb, 2002.

By way of contrast, the UAE implement a unified flat rate on the different type of water usage. But the tariff rate differentiate from one Emirate to another with the lowest in Abu Dhabi and the highest in Dubai, \$0.6/m^3 and \$2.1/m^3 respectively. Having a similar structure, Kuwait implements a flat rate tariff structure with a variable rate depending on the type of water usage. The Lebanese water tariff is a flat rate which can promote more wasteful water consumption. Currently the tariff in Beirut and Mount Lebanon is 0.43\$/m^3.

The economic and social gains to 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 behaviour when under a flat rate system.[61]

In addition to measures to enforce reduction in demand, major public awareness campaigns are required to prevent some of the more excessive wastages by consumers, such as over-irrigation of gardens, and the watering of roadways in front of shops in the mistaken belief it has a significant impact of dust suppression.

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.

Finally it is worth noting some of the BMLWE undertakings towards better managing the Non-Technical-Losses causes all over its territory as it follows[62]:

- Asset Valuation of the Water Supply Infrastructure;
- Business Plan for BMLWE (jointly with the USAID-funded Lebanon Water and Wastewater Sector Support);
- Customer water metering and water balance in Keserwan;
- Development of O+M contract for the wastewater treatment plant in El-Ghadir;

Standard procedures and vocational training for installation and repair of water supply networks.

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 fittings such as valves, meters and other pipeline fittings, are usually observed by operators and

61 Study of Project Cost Estimates, Financial and Economic Analysis, World Bank, p. 20
62 http://german-lebanese-ta-water.org.

can be substantially controlled providing the equipment, materials and expertise are available. The imposition of consumption metering will largely curtail domestic tank overflow and provide the impetus for consumers to maintain their pipework.

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 issuing water infiltrates to ground water. Some leakage reduction is therefore relatively easy to attain and even on the networks the provision of GBWSP bulk meters should substantially reduce losses.

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 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 in leakage to 25%.

Applying a gradual reduction of the current 40% "UfW" rate until the projected 25% by 2035, would lead to the estimated water savings shown in Table 7.7.

Table 7.7: Projected Water Saving by Reducing "UfW" until 2035.

Water Demand for GBA (MCM/yr.)		**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Demand	Domestic & Industrial Water Demands	225	240	260	290	320	340
	Gradual "UfW" reduction	40%	37%	34%	31%	28%	25%
	Domestic & Industrial Reduced Demands – Adjusted	225	233	252	281	310	330
Water Saving Achieved (MCM/yr.)		**0**	**7**	**8**	**9**	**10**	**10**
WATER BALANCE (with no losses reductions & no supplies augmentation)		**-205**	**-230**	**-260**	**-295**	**-325**	**-345**

Reducing "UfW" rates to 25% would spare a cumulative amount of water of 44 MCM 25 years time that is equivalent to six times the Chabrouh dam storage. Nevertheless this extra water amount will remain a meagre contribution in filling the gap of the next 25 years water deficit that is expected to reach 1660 MCM if no major dam or non-dam water supply schemes are put in place by that time.

In consequence, the NWSS estimates of the volume of water gained from all sources of leakage reduction may need to be revised downwards, from 85,000 m^3/day (31 Mm^3/y) to 64,000 m^3/day (23 Mm^3/y) and the consequential shortfall of 21,000 m^3/d (8 Mm^3/y) made up within additional resource development under GBWSAP.

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 relatively 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. While the saving in water supplied can be significant, it will at best contribute to delaying the need for investment in new sources.

7.3.6 Summary of Non-Dam-Alternatives

It is obvious that the Non-Dam-Alternatives, with all their inherent limitations within Greater Beirut context, as discussed above, will remain immature solutions towards augmenting the supply resources to GBA, under the short and medium terms if taken all together. Number of technical, social, economic, policy etc, constraints have to be overcome first for these alternatives to become reality. While seeing as a more realistic path way some of these Non-Dam-Alternatives applicable within the context of the studied area, the combination of all the proposed water supply solutions remain just conceptual with the mere objective of investigating the full potential of these sources and their impact on the water deficit of the Capital as shown in the Table 7.8.

Table 7.8: Water Balance relying on "Non-Dam-Alternatives" until 2035.

Water Demand & Supply for GBA (MCM/yr.)		**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Dema nd	Domestic & Industrial Water Demands	225	240	260	290	320	340
	Agricultural Water Demands	80	90	100	105	105	105
TOTAL DEMANDS (without losses reduction)		**305**	**330**	**360**	**395**	**425**	**445**
Supply	(1) Currently available water resources	100	100	100	100	100	100
	(2) Desalination Sources	-	-	No limit	No limit	No limit	No limit
	(3) Rain Water Harvesting Sources	53	63	75	87	102	120
	(4) Waste Water Reuse	122	114	98	103	114	125
	(5) The Unaccounted-for-Waters Contributions	0	7	8	9	10	10
TOTAL SUPPLY		**275**	**284**	**281**	**299**	**326**	**355**
WATER BALANCE without supply augmentation		**-205**	**-230**	**-260**	**-295**	**-325**	**-345**
WATER BALANCE with augmented Non-Dam-Supply		**-30**	**-46**	**-79**	**-96**	**-99**	**-90**
Expected Reduction in Water Deficit		**85%**	**80%**	**70%**	**67%**	**70%**	**74%**

(1) Ground water supplies cannot be considered as an infinite source. The forecasted scenarios of the NWSS tend to put a 500 MCM cap on the ground water extractions nationwide to reduce the current recharge deficit of 200MCM. As such any potential

increase of other currently available sources would be balanced out by the ground water national decreasing forecasted supply, hence maintaining the same amounts of available resources in two decades from now.

(2) While the desalination of water alternative puts no constraints over the amounts of water that potentially could be supplied from the Mediterranean Sea, the desalination solutions to Lebanon, as discussed above, prove to be the most non-cost-effective due to the absence of inexpensive energy sources in Lebanon and to the long-time struggling electricity sector in the country. As such, no contributing volumes from desalination will be accounted for into the water balance table above, leaving Desalination solution as the "Source of Last Resort" with absence of any alternative solution.

(3) The potential of collecting all the rainfall water harvesting is assumed to take some time until the needed infrastructures and facilities will be all in place. As such an annual water collection increase rate of 4% is assumed until all the gradually installed infrastructures will be able to collect all what could be collected than used, i.e 120 MCM/year by 2035.

(4) Assuming that the social and religious barriers over the use of TSE water in GBA would be overcome, the potential of TSE water volumes that could be generated over the next decades will be included in the water balance of the Non-dam-supply-alternatives. However, the current state of the sewage networks with the lack of adequate connections between the treatment plants and the collection networks, when these are found, make the advanced TSE water figures only conceptual for the purpose of quantifying the potential of that water that could be used.

(5) As discussed earlier, the national target of reducing a total of 20%, by 2035, of the UfW in GBA looks impractical considering all the constraints imposed by the technical and non-technical shortcomings over the GBA networks. Correcting the reduction factor to more realistic and gradually reduced figure of 15% by year 2035 would spare modest water amounts.

With all inherent limitations and constraints unrealistically overcome, the non-dam-alternatives, would conditionally contribute in reducing GBA imbalance over the next 30 years. While the unconventional water sources will go mainly for non-potable water use, the augmented supplies will not eliminate the persisting water deficit that will keep on showing an annual water deficit varying between 30 and 100 MCM over the next 20 years.

The Table 7.9 summarizes the major advantages and/or setbacks that may facilitate or deter these solutions from being realistically achieved for the long-term supply of potable water to Greater Beirut.

Table 7.9: 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 very expensive. For current consideration, the 'Source of Last Resort'
Ground Water	• Most discharge to supply; • Suitable for conjunctive-use; • Better quality than surface water; • Diverse source locations; • Modest carbon footprint.	• Limited future use due to over-exploitation • 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 alternative but with limited volumes to be used in the future
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, but of course at the highest cost. The Ground Water cannot be considered as an infinite source. The forecasted scenarios under the National Water Sector Strategy put already a 500 MCM cap on the ground water extractions nationwide to reduce the current aquifers recharge deficit of 200MCM.

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. In addition of facing strong cultural and societal objections, the Waste water supplies lack drastically the needed production and conveyance infrastructures, despite the GoL attempts to develop this resource since the end of war years. The major constraints towards developing massively exploited Rain

Water Harvesting resources are the highly urbanized nature in most of GBA sectors, the high pumping and conveying costs if these are developed outside GBA in addition to the highly seasonal falling rain all over the Lebanese territory.

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.

7.4 Dam Alternatives

7.4.1 Introduction

As discussed above, desalination, currently the 'Source of Last Resort' technically, economically and politically, may be the only non-dam alternative capable of sustaining long term water supplies to Greater Beirut and this only in the case where the Lebanese energy sector is substantially improved to sustain large scale desalination. 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.

To meet the medium and long term requirements to augment Greater Beirut's water supply it will therefore 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.

As discussed previously, the potential for impounding surface water flows has long been recognised, and broader investigations to identify the most feasible river basins were completed as long ago as the 1950s. Subsequent work identified potential dam sites and more recently, as part of the National Water Sector Strategy and National Surface Water Storage Strategy, GoL has commissioned feasibility studies incorporating among others a range of technical considerations for the three sites listed below and located as shown in Figure 7.2:

On the Awali River upstream of Bisri village;

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

Also as discussed previously, the present project is also looking at a second site in the Damour valley, a short distance further upstream and hereafter referred to as Damour East Dam, while the site cited above is Damour West Dam. Damour East has never been subject to any feasibility study but has long been argued by a group of concerned Beirut residents to be superior to either Damour West or Bisri dams.

While these impoundment schemes are not the only sources that may be viable for the long-term augmentation of Greater Beirut water supply, the detail to which three of the four have been previously studied renders it relatively straight forward, subject to additional detailed studies, to progress to final design and construction within an acceptable time frame to the project proponents.

Figure 7.2: Dam Locations

7.4.2 Damour Dams

The layouts of both Damour reservoirs are shown in Figure 7.3 and the outline of both for comparison in Figure 7.4.

Figure 7.3: Damour East and Damour West Reservoirs

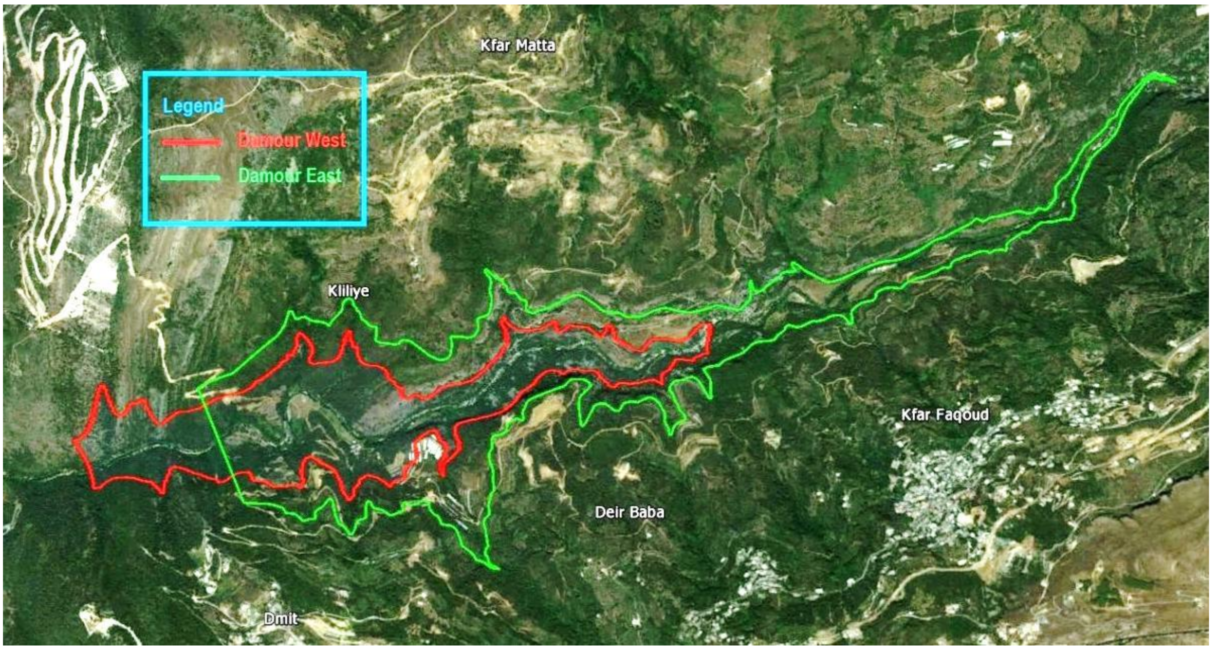


Figure 7.4: Comparison of Damour West and Damour East Reservoirs

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 2009.

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. As mentioned 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 recommended 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.

7.4.3 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 7.5. 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 in 2006.

Figure 7.5: 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.

Possible leakage recently suggested by various studies would render the dam infeasible. 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. In 2013, the Ministry of Energy & Water has actually launched the first construction phase of the Janna dam along the Nahr Ibrahim River. The dam will serve the Norther areas of Greater Beirut Mount Lebanon.

7.4.4 Summary of Dam Alternatives

In assessing each of the options for augmenting Greater Beirut water supply, the Analysis of Alternatives has conducted an options-prioritization-exercise, looking at both the fundamental considerations and the detailed impacts. In summarising the conclusions to recommend the priority scheme option on which to progress more comprehensive assessment and environmental management proposals, two approaches 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 7.10.

Table 7.10: Trade-Off Matrix Major Issues Weightings

Issue	Parameter	Weighting
Natural and Human Heritage	Area of natural beauty; Ecological value; Archaeology/history inundated.	**1**
Lower Catchment Impacts	Flood protection; Loss of irrigation.	
Ground Water	Aquifer at outcrop; Downstream recharge zone; Hydraulic gradient reversal.	**2**
Upper Catchment Impacts	Erodibility of strata; Population contributing wastewater.	
Land Take	Loss of natural landscape; Loss of productive land; Loss of public infrastructure; Loss of Agricultural infrastructure; Household and business relocation.	

Table 7.10: Trade-Off Matrix Major Issues Weightings (Cont'd)

Issue	Parameter	Weighting
Hydroelectric Power	Supplied from dam.	
Dam Construction	Dam design; Construction materials.	
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 7.11.

63 Full details of trade-off matrix development, and the scoring regimes are given in the Analysis of Alternatives of the PD ESIA (August 2013)

Table 7.11: 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;	• 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; • High Potential of hydropower generation.	• 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. Futher investigations need to be carried out to address the concerns about dam and reservoir geology and water tightness.

By assessing the likelihood and severity of each of the dam construction facilitating and/or hindering conditions, the Alternatives Analysis was able to show that the three dams could well stand together in the following priority order and under the assumptions as discussed previously and as proposed in the MEW's National Water Sector Strategy and associated Surface Water Storage Strategy:

- Given its size, cost effectiveness, and all combined favourable geological settings, Bisri Dam is considered the priority option. The large size of the dam resulting in lengthy period of time of the project to be completed, Bisri dam construction could be started while other dam options would afford further investigations as was raised in the Alternatives Analysis Report.
- Janneh Dam could be constructed in phases with a reduced capacity, catering on short term for Jbeil and Kesrwane needs, until the reservoir geology and water tightness will prove to accommodate for higher storage capacity for longer term contribution to GBA.
- The first years of construction of Bisri and Janneh Dams will allow for a more in depth study about the feasibility of Damour West Dam, the outcome of which should indicate the way forward either to proceed with Damour West Dam or to advance with the Damour East from a feasibility study into a detailed design. In all cases Damour proposed Dams with their reduced volumes could be compensated by possible conjunctive use with ground water from underlying aquifers.

8. ENVIRONMENTAL AND SOCIAL IMPACTS

8.1 Introduction

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

As is the case with any ESIA, the spatial area for which the study or assessment would be conducted should be determined. This is known as the **area of influence** of the project, also called the impact area of the project, and could extend for considerable distances and well into the future. It includes, as defined by the WB, all project ancillary aspects, such as power transmission corridors, HEP, pipelines, canals, relocation and access roads, borrow pits/quarries and disposal sites, and construction camps, as well as unplanned induced developments that can occur later or at a different location. The area of influence may include the watershed within which the project is located, any affected estuary and coastal zone, off-site areas required for resettlement, migratory routes of wildlife, and areas used for recreational activities or religious or ceremonial purposes of a customary nature. The International Finance Corporation (IFC) adds on the definition of the area of influence to encompass "cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned, or reasonably defined developments at the time the risks and impacts identification process is conducted."

GBWSAP area of influence is defined at two levels: the immediate surroundings of the project's infrastructure works for direct, indirect and induced impacts on the one hand and a substantial area, that extends beyond the direct vicinity of the Project itself. The critical area of influence is the reservoir area and the lower catchment whereby it is impacted by the construction activities as well as the changes that will occur resulting from dam operation be it positive or negative, direct or indirect impacts upon which affected communities' livelihoods are dependent. The upper catchment will impact the environment mainly by what it discharges into the reservoir basin. The critical GBWSAP area of influnece extends from the sources of Barouk and Aariye Rivers, incorporating the villages above and surrounding the reservoir, till the outlet of the Awali River on the coast, covering the agricultural plains downstream of the dam and the villages residing in this area. The Lower catchment measures to about 90 Km^2 and the upper catchment is about 200 Km2, as shown in Figure 8.1

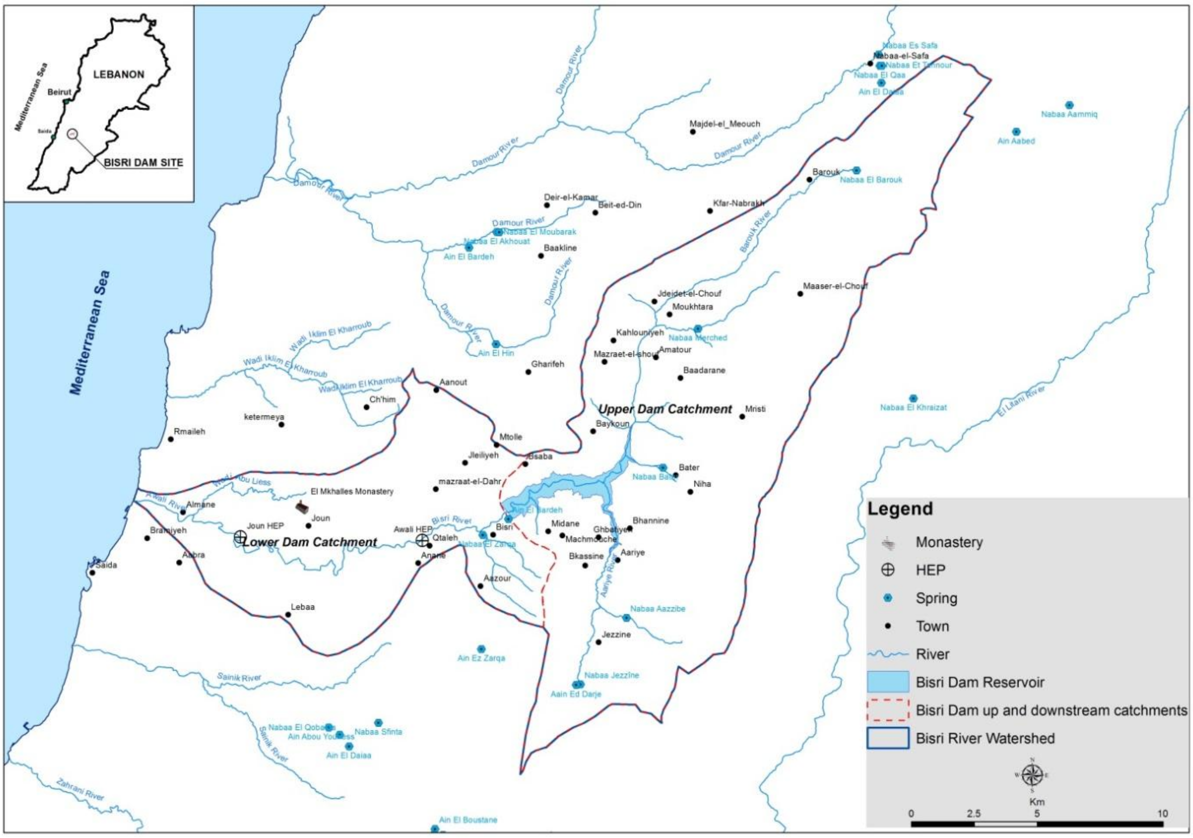


Figure 8.1: Upper and Lower Dam Catchments

An estimated 80% of the dam construction material (estimated at 6 million m^3 of fill) will be sourced from within the reservoir area, significantly reducing reliance on external quarries and subsequently minimizing the negative environmental impacts associated with the construction of new quarries or use of existing commercial quarries.

Clay is expected to be taken from the areas within two large meanders in the current flow channel, respectively 150-250 m and 550-700 m upstream of the dam axis. Between these two areas on the northern bank are significant outcrops of limestone that will be worked for crushed stone. Areas from which sand and gravel may be obtained extend between the dam site and the confluence of Nahr Barouk with Wadi Bhannine. The final suitability of all borrow areas will be determined by the appointed contractor through site investigation and the testing of materials prior to commencement of construction.

Rip rap material is expected to be sourced from outside the immediate project area, most likely from an existing commercial quarry located near the Saida area, approximately 15 Km from the dam site. Access to any quarry in Lebanon requires a permit from the Ministry of Environment which also imposes strict environmental controls and mitigation measures (including limitations on noise, air pollution mitigation measures, restricted access times to roads for traffic reduction etc).

Materials such as cement and reinforcing steel will also be obtained from existing licensed manufacturers. The dry cement will probably be procured from Sibline, which is the closest to the project site thus contributing less to the transportation-related greenhouse gases. Wastes will be disposed of at licensed sites yet to be determined by the Contractor, following approval of the concerned authorities.

The location of construction camps for workers is yet to be identified as it is a sole decision of the Contractor. However it is more likely to be within the valley subject to areas to be protected such as Marj Bisri. Mixed waste from the construction offices, workers' camps and messing areas, will need to be disposed of outside the dam catchment at the Naameh landfill, currently the prime repository for Beirut municipal refuse.

GBWSAP area of influence also encompasses Mar Moussa Church relocation for religious and ceremonial purposes, migration routes for wildlife in case a capture and rescue plan is needed, induced development including new access road, touristic attractions, recreational activities, to finally reaching water supply for GBA users.

The potential environmental impacts accruing from the project are discussed in **Section 7.2**, while the social impacts are discussed in **Section 7.3**. Cumulative impacts that might accrue from the combined effects of GBWSAP and other existing and proposed projects in the zone of influence are discussed in **Section 7.4**. The last section is a summary table of potential impacts, each with their likelihood and likely severity.

In each section, impacts are divided into permanent, temporary and operational impacts. Impacts considered potentially permanent are generally inherent in project design. 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). Operational impacts accrue from the use, management and maintenance of the completed project.

8.2 Environmental Impacts

8.2.1 Potentially Permanent Impacts

8.2.1.1 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 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 7.3.4.

The presence of a new body of standing water will result in 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.

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. GHG emissions from large impoundments are discussed further under section 7.2.3.

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. This issue has been studied in detail through the recently completed neotectonic seismicity study, supervised by the Dam Safety Panel of Experts Seismology expert.

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 7.2.1.

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.

8.2.1.2 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 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 8.2.

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 8.2: 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. Sedimentation rate is estimated at 1,000 $t/m^2/yr$, a relatively high rate for Lebanon, reflecting the occurrence of sandstone outcrop across the upper catchment. To overcome the main effects of this, the detailed design of the dam has incorporated a dead storage volume of 9 Mm^3 at Bisri. This design criteria has been confirmed by the Dam Safety Panel of Experts.

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 8.3.

Figure 8.3: Eboulis Material above Bisri Reservoir

8.2.1.3 Upper Watershed Management

The major negative impacts upstream of the dam are 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. The construction of a private access road will better control those impacts and will indeed not allow the public to gain access to the dam site without permission of concerned parties.

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 150 ha of prime productive land to Lebanon’s fertility bank. This land will be compensated as per the detailed provided in the RAP.

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[64], 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[65]. 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.

Over the years, there have been a number of sewerage studies undertaken under the auspices of CDR, and the Ministry of Environment by a variety of local and international consultants. Schemes have been proposed, plants prioritised and costed and have been compiled into the "***Plan D'Amenagement du Territoire Libanais***" which incorporates specific Catchment Management Plans, including for those areas included in the upper and lower catchment area of the Bisri dam. Detailed implementation plans for the project area will thus be developed in parallel to dam construction, to align with the Plan D'Amenagement du Territoire Libanais, and ensure sustainable operation of the dam and reduction of water quality risks post construction.

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 El 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 are unlikely to seriously impede runoff to Bisri Reservoir.

64 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.
65 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.

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 previously discussed in Section 4 evaporation at Bisri, using the Class A pan method 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.

8.2.1.4 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; and,
- 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. 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 most significant risk can 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. The project incorporates technical assistance to the Ministry of Energy and Water and BMLWE in integrated water resources management of all water sources used for distribution. This review of options to balance demands of urban and rural consumers, with those of the environment 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 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.

8.2.1.5 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 updated detailed design reports, 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.

8.2.1.6 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 8.1 summarises the assessment of the expected impacts on the flora in Bisri dam and reservoir areas.

Table 8.1: 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

The construction of artificial barriers across rivers is one of the major factors threatening the native fish fauna of the Mediterranean region, blocking or delaying upstream fish migration. As a matter of fact, dams causing the fragmentation of rivers are contributing to a decline in the number of a native fish species *Salaria fluviatilis*, known as freshwater blenny. Moreover, a major concern nowadays is that the Mediterranean area is progressively losing its biodiversity. In fact, studies have shown that around 70% of freshwater species within the region are catalogued as already extinct or threatened by extinction.

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 Bisri dam will significantly reduce water flow downstream, which will definitely affect the freshwater blenny population surviving in the lower course of the river.

For the conservation of freshwater blenny population, it may be necessary to protect specific components of the flow regime to keep stream ecosystems healthy. Base flow or environmental flow which is the minimal volume of water that the stream needs to support the fish, plants, insects, and protect water quality, and maintain healthy aquatic ecosystems in terms of biota, should be maintained. Special purpose flows should also be considered. These are flows designed for a particular ecological need, for example the flow needed to encourage breeding of the freshwater blennies.

Setting ecological objectives for rivers and streams allows specific ecological values to be protected by components of the environmental flow regime. In addition, ecological objectives can be used to assess the effectiveness of environmental flows.

Continuously running unpolluted water would help preventing the disappearance of the species. Freshwater should be kept running between the dam and the sea in order not to hamper the blennies from migrating back and forth.

The construction of the dam will not, however, pose 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 newly created habitats.

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.

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 bases. 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.

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 a 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.

8.2.2 Potentially Temporary Impacts during Construction

8.2.2.1 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.

8.2.2.2 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.

8.2.2.3 Disruption to Existing Traffic Routes

There are no metalled public rights-of-way in the immediate vicinity of the Bisri dam site or 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.

8.2.2.4 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.

8.2.2.5 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.

8.2.2.6 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.

8.2.2.7 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.

8.2.2.8 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 8.2.

Table 8.2: 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.

8.2.2.9 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.

8.2.2.10 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 previously highlighted. 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.

8.2.2.11 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' are yet to be determined, the relative quantities are summarised in Table 8.3, 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 8.3: 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 430 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.

8.2.2.12 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 8.2.2.3 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 8.2.2.5 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.

Waste Disposal Sites

During construction, some quantities of waste will be generated, primarily inert and/or non-hazardous, but also some hazardous materials. Inert waste will include surplus spoil and excess or spoilt earth materials, non-hazardous will include mixed municipal waste from site offices, accommodation blocks and site clearance, while hazardous waste will include the effluent from workers' facilities, waste construction chemicals, waste oil and spilt fuel.

Mixed waste from the construction offices, workers' camps and messing areas, will need to be disposed of outside the dam catchment. Preferably, this should be a licensed dump site or any other site that meets the national regulations for waste disposal of this nature and approved by MoE.

Large quantities of soil and rock will be generated during the excavation of dam foundations and diversion channels, but much of this is expected to be reusable on site.

The area of inundation should be cleared of organic matter prior to filling in order to avoid deteriorating water quality from subsequent biodegradation. The soils of Bisri are deep and fertile and while of little use for construction will be well suited to shoreline landscaping, or for transporting to parks and gardens where good conditioned soils are at a premium. On the basis of stripping a minimum of 0.5 m of fertile soil over an area of 430 ha, more than 2 million m^3 will be available for reuse. While timber such as pine trees will be felled by the owners and sold, undergrowth, natural and abandoned vegetation should be shredded, composted and made available to adjacent horticulturalists. No open burning of vegetation should be permitted. The take of unharvested crops will be minimised within the land clearance schedule.

Site clearance will also give rise to considerable quantities of demolition waste, primarily concrete, but also timber (fence posts), ceramics (sanitary ware); pipes, cables and plastics. Most irrigation pipes are surface laid and will be removed by owners. Concrete may be crushed, stripped of steel reinforcement and crushed for use as general fill for access roads and similar low specification uses. Surplus concrete may be disposed of in borrow pits, as may surplus spoil.

Potential disposal options to be investigated by the contractor in developing his Construction Waste Management Plan will include but not necessarily be limited to:

- Use on other concurrent construction projects;
- Use as landfill daily and/or final cover;
- The regrading of borrow areas;
- The reinstatement of existing quarries; and,
- Use on on-going reclamation projects.

All redundant and spend construction machinery and equipment shall remain the responsibility of the contractor until disposed of off-site.

The movement of waste materials out of the project area will increase haulage costs, fuel consumption, traffic congestion and atmospheric emissions. Wherever possible, waste should be reused or disposed of on-site. Where the export of waste from the project area is unavoidable, the contractor shall endeavor to utilise the return trip of vehicles consigning inbound construction materials. All vehicles leaving the site should undergo wheel washing, and deliveries in and out should be scheduled late at night or early morning. On no account will construction labour be permitted to sell waste and/or surplus materials to local residents.

8.2.2.13 Consumption of Materials

The consumption of materials for construction will be significant 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.

Based on Table 8.3 above, the preliminary consumption of materials, with no allowance for wastage, is expected to be as given in Table 8.4.

Table 8.4: 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

As discussed in the table above, nearly 6 million m^3 of earth materials are expected to be consumed in the construction of Bisri Dam. The majority of these materials – building aggregate, sand and clay, are expected to be taken from temporary borrow areas within and adjacent to the area of inundation, as near as is practically possible to the construction site.

Clay will be taken from the thick sequence of lacustrine deposits known to be present below the valley floor. Sand will be excavated from the Chouf Sandstone formation that crops out on the side of the reservoir area in which there is an existing quarry, and will be graded for use. If necessary, sand and gravel will be taken from the recent alluvial deposits adjacent to the main river flow channels. The limestone beds in the valley sides will be worked, crushed and graded to produce building aggregate.

The dam designer has investigated the potential source of material from within the reservoir area. Clay is expected to be taken from the areas within two large meanders in the current flow channel, respectively 150-250 m and 550-700 m upstream of the dam axis. Between these two areas on the northern bank are significant outcrops of limestone that will be worked for crushed stone. Areas from which sand and gravel may be obtained extend between the dam site and the confluence of Nahr Barouk with Wadi Bhannine. The final suitability of all borrow areas will be determined by the appointed contractor through site investigation and the testing of materials prior to commencement of construction.

All these activities will be subject to the permitting requirements of the Higher Committee for Quarries. These will include the formulation and presentation of both an Excavation Plan and a Reinstatement Plan. For those borrow area that will be completely submerged, the excavated volume will contribute to reservoir storage and may also be considered, subject to appropriate safeguards, for the disposal of surplus spoil unsuitable for construction and other inert construction waste.

In designing the borrow areas, sheer faces should not be left where they will give rise to excessively deep water adjacent to the periphery of the reservoir, thus providing a risk to both maintenance workers and the public. Consideration should be given to locating the quarry floor just above maximum water level so it can subsequently be utilised for shoreline development, and the systematic benching of the upper slopes used for access and hillside development.

The Contractor can expect his proposals for borrow areas, wherever they are located, to be subject to Environmental and Social Impact in accordance with MOE regulations and for this to be approved by the Ministry prior to Higher Committee consideration of his proposals. The contractor will be responsible for all negotiations with land owners and the payment of compensation compatible with the provisions of World Bank OP.4.12 and other relevant safeguard policies. Residents within a distance of 500 m of the outer limits of the borrow area and within any greater area identified from seismic modelling to be impacted by blasting, shall be meaningfully consulted.

The only material for which there remains significant uncertainty is the rip-rap, which required thickly-bedded poorly fractured beds of limestone from which large blocks of rocks can be obtained. While there are several quarries in southern and central Lebanon producing this material, the geology can vary and sites can pass into thinly bedded fractured beds that will be unsuitable. The sourcing of rip rap will therefore be determined shortly before, rendering the site unsuitable. Rip rap is expected to be sourced from outside the immediate project area, most likely from an existing operation with all relevant permits and licenses already in place.

Materials such as cement and reinforcing steel will also be obtained from existing licensed manufacturers. The cement is expected to be obtained from Sibline, the closest cement works to Bisri, thus saving significant transport costs, fuel consumption and consequential exhaust emission and global warming.

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 be 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.

8.2.3 Potential Post-Construction Operational Impacts

Water and Power Supplies

At the time of the current report update, and based on the ESIA consultant discussions with the designer, the proposed Bisri dam water releases will be allocated securing 5.1 m^3/s or 5.8 m^3/s for the domestic needs to Greater Beirut and 0.3 m^3/s and 0.45 m^3/s for the environmental flow to be maintained downstream the dam, in summer and winter respectively. The production of hydroelectric power, is considered a "by-product" of the dam releases and as such is not considered as consumptive usage like the previous ones.

Domestic and Industrial Supplies

Based on the river guaranteed flow over 30-year-monthly records, the dam design is proposing two storage/supply scenarios:
-6-month delivery period between June and November at constant releases of 5.1 m^3/s. No release in other months.
-6-month delivery period between June and November at constant releases of 5.8 m^3/s. No release in other months.

The rainy season in Lebanon extends from November to April each year leaving the other months almost dry. It is generally acknowledged that the purpose of any dam is to regulate the high winter/spring inflows to be in part stored and released during the dry summer. The dam supply volume would meet some of the GBA domestic water needs during the dry months of the year, generally from April to October.

Power Supply

One main advantage of Bisri dam is its geographic overlapping with the Litani Hydro-power plants network that is composed of three plants: Marakabeh plant located in South Bekaa; Awali Plant located in the valley of Bisri river and finally Joun plant that is located about 10km downstream of Awali facility and all three connected by mean of tunnels network. Only Awali and Joun plants are located downstream of the proposed Dam. The three plants produce in total 190 MW of hydro-electric power that is sold out to the "Electricite du Liban" and contributing about 10% of total produced electricity by the national company.

It is expected that future dam release of 5.1 m^3/s or 5.8 m^3/s will be conveyed by a mean of tunnel to Awali plant that is about 4km downstream its location. By proposing such conveyor routing, the released dam flow could be potentially used to generate additional power in Awali plant, estimated to be 8-10 MW, as per the designer preliminary estimates, while it will be diverted to Wadaniyeh WTP before it reaches Joun Plant. As such, in constructing Bisri dam and related infrastructures the way they are conceived now, one of the Litani three hydropower plants could be extended leaving the two others solely dependent on releases from Karaoun Lake. The two hydropower plants included in the Bisri project will also offset losses in hydropower at the downstream Joun plant.

Irrigation Needs

Farmers of the upper Bisri watershed rely on the upstream watershed diversions to meet their irrigation water needs in the agricultural lands extending between Barouk and Moukhtara villages.

There is an estimate of 300 ha of irrigable lands, downstream the dam, that are currently relying on the Litani-Bisri water scheme. Assuming an average irrigation consumption rate of 7000-9000 m^3/ha, the irrigable lands downstream the dam would require some 2.0-2.7 Mm^3 (0.12-0.15 m^3/s) during the seven months irrigation season that are well covered by the 0.6m^3/s as accounted for in the dam design[66].

The detailed design of Bisri Dam must ensure that downstream irrigation needs, as estimated above, are met given the high importance of these water releases to communities that rely heavily on agriculture for their income source.

Environmental Flow

Environmental flows are critical for the area below any dam, where the natural hydrological regime is substantially changed and may result in a better downstream flood control while altering 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 maintain the key ecological values of the stream.

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 impractical.

Using the Q95 percentile of the river flow duration curve, accounting for four ecological elements that are the river physical characteristics, fisheries, macrophytes and macro-invertebrates, the Flow-Duration-Analysis for Bisri River estimated the base flow to be 0.3 and 0.45 m^3/s for summer and winter, respectively. The estimated environmental flows should only be used to sustain freshwater and estuarine ecosystems and the human livelihoods that depend on these ecosystems.

Other components of environmental flows are also to be considered, such as; the small and larger flood flows and the special purpose flow. While the flood flows purpose is to flush away fine sediments that accumulate into the river course, inhibiting the

66 The lower and higher irrigation consumption rates correspond on one hand to the reduced irrigation demands thanks to efficient agricultural extension and on the other hand to the currently applied amount of water with no water conserving measures.

development of fish and water plants habitats, the special purpose flow is needed for particular ecologic needs such as to support breeding of a species of fish or to protect of a frog species. The flood and special purposes flows could be obtained by a sufficient volume of water flowing over the dam spillway, a release through the dam valves or the combination of the two sources. While no national and regional guidelines or similar dam experiences in Lebanon would suggest the flood and special flows, it is believed that site specific and detailed ecological survey would help in setting the threshold values of these flows.

8.2.3.1 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 downstream the dam 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.

Probable Maximum Flood is estimated at 3,000 m^3/s for the design of the spillway. This flow is equivalent to more than ten-times the peak annual flow 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[67] 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 Plan would be in addition to that developed following Dam Break Analysis, which will cover the ultimate disaster.

8.2.3.2 Dam Safety

Dam safety is a vital consideration and one that must be taken extremely seriously. As mentioned in Section 3.4, 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.

A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer[68]. Often referred to as Dam Break Analysis or DBA, this primarily hydrological modelling exercise

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[67] Tobin, Graham A. and Burrell E. Montz. 1997. *Natural Hazards Explanation and Integration.* Guilford Press.
[68] CDR. *Detailed Design of Bisri Dam Project: Dam Breach Model*. Dar Al-Handasah (Nazih Taleb)), August 2013.

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 Preparedness Plans.

The development and implementation of an Emergency Preparedness Plan (EPP) is a positive step dam owner can take to accomplish dam-safety objectives, to protect their investment, and to reduce the potential liability associated with a dam failure. The purpose of this Emergency Action Plan is to identify emergency situations that could threaten the Bisri Dam, and to plan for an expedited, effective response to prevent failure of the dam.

The High Relief Commission has the authority to direct the Dam Operator to take immediate and appropriate action to remedy situations posing serious threat to human life or health, or risk of property damage.

When conditions at the dam have caused the declaration of an emergency, actions are to begin immediately with the notification of the Emergency planning Manager. An Emergency Operations Center will be set up in the Dam Administration Building to monitor the progression of the situation and to coordinate remediation activities.

The Prime Minister (High Relief Commission), the South-Lebanon Governate, Saida municipality, Er Rmaile municipality, Karkha municipality, Joun municipality and the Dam Operator will be notified.

The South-Lebanon Governate officials will in turn notify the internal security forces, army personnel and the Fire Department for appropriate action.

The Emergency planning Manager or his or her designated representative will be responsible for on-site monitoring of the situation and for keeping local authorities informed of developing conditions at the dam from the time that an emergency starts until it ends. The internal security and army shall maintain security at the dam. The Emergency planning Manager shall be responsible for declaring the situation terminated and for a follow-up evaluation of the emergency.

Local officials and downstream residents will be notified by landline telephone or internet if available; otherwise via cell phones or emergency personnel (in person or using their radios). Notification procedures have been formulated for four different levels of alert: "abnormal" condition, "watch" condition, Possible Dam Failure, and Iminent Dam Failure.

Bisri Dam has been designed as a clay-core rock-filled dam 790 m long and 73 m high impounding a reservoir of 125 million m^3. The model therefore adopted the US Army core of Engineers HEC_RAS software and calculated the breach formation time using a US Bureau of Reclamation recommended procedure. Model runs were undertaken for both a seismic loading failure and a flood overtopping failure, the prime modes of breach for Bisri Dam.

The results from the model show a peak flow of 43,000 m^3/sec at the dam and 41,000 m^3/sec at the coast. The flood wave initially generated as 28 m in height, but due to the configuration of the valley does not significantly reduce until it reaches the coastal plain, becoming 10 m at the coast. The lag time between peak flow at the dam and peak flow at the coast was 30 minutes, the speed therefore more than 43 km/hr. Comparing the one-dimensional US Corp of Engineers model with a three-dimensional CDF flow model the results were not significantly different. Using Google Earth images in the absence of a detailed asset survey to estimate damage, the cost is estimated to be 110 to 130 million US Dollars.

Because of the steep V-shaped configuration of the valley in its middle sections between the dam and the coast, the most affected villages in the path of a dam breach flood by either seismic loading or flood failures are Bisri and Khirbet Bisri a short distance downstream of the dam, and Aalmane and Quastani a short distance inland from the coast.

Dam safety plans and Quality Assurance are in an advanced phase of preparation and should be finalised by Project Appraisal.

8.2.3.3 Ouardaniye Water Treatment Plant

After passing through the new Joun HEP, water from Bisri Dam will be directed to the Awali Conveyor and thereafter to Beirut via the new Ouardaniya Water Treatment Works[69]. The initial construction of the works will comprise two parallel treatment process streams, each with a capacity of 1.5 m^3/sec, but layout and design will provide for total capacity to be doubled, to 6 m^3/sec, when the Bisri scheme is commissioned. Each process stream is expected to comprise the following:

- Flow splitting (controlled);
- Flash mixing (for full treatment);
- Flocculation;
- Lamellar clarification;
- Aeration;
- Flash mixing (for direct filtration);
- Rapid gravity filtration;
- Disinfection through Contact Tanks;
- pH adjustment;
- Granulated Carbon Filtration; and,
- Sludge and filter backwash treatment.

The performance of treatment streams is required to comply with *EU Council Directive 98/83/EC Standard for Water Intended for Human Consumption*, as listed below

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69 The conveyor and the WTW are being constructed under GBWSP, not GBWSAP (the present project) and are expected to be operational prior to the completion of Bisri Dam.

Table 8.5: Ouardaniye WTW Final Treated Water Quality Requirements

Parameter	Unit	Parametric Value
Microbiological Parameters		
Escherichia coli	colonies/100 ml	0
Enterococci	colonies/100 ml	0
Chemical Parameters		
Acrylamide	µg/l	0.10
Antimony	µg/l	5.0
Arsenic	µg/l	10
Benzene	µg/l	1.0
Benzo(a)pyrene	µg/l	0.010
Boron	mg/l	1.0
Bromate	µg/l	10
Cadmium	µg/l	5.0
Chromium	µg/l	50
Copper	mg/l	2.0
cyanide	µg/l	50
1,2-dichloroethane	µg/l	3.0
Epichlorohydrin	µg/l	0.10
Fluoride	mg/l	1.5
Lead	µg/l	10
Mercury	µg/l	1.0
Nickel	µg/l	20
Nitrate	mg/l	50
Nitrite	mg/l	0.50
Pesticides	µg/l	0.10
Pesticides - Total	µg/l	0.50
PAHs	µg/l	0.10
Selenium	µg/l	10
Tetra- & Tri-chloroethane	µg/l	10
Trihalomethanes – Total	µg/l	100
Vinyl chloride	µg/l	0.50
Indicator Parameters		
Aluminium	µg/l	200
Ammonium	mg/l	0.50
Chloride	mg/l	250
Clostridium perfringens	number/100 ml	0
Colour	Acceptable to consumer. No abnormal change	
Conductivity	$\mu S.cm^{-1}$	2,500
pH	units	6.5 - 9.5
Iron	µg/l	200
Manganese	µg/l	50
Odour	Acceptable to consumer. No abnormal change	
Oxidisability	mg/l O_2	5.0
Sulphate	mg/l	250
Sodium	mg/l	200
Taste	Acceptable to consumer. No abnormal change	
Colony count 22C	No abnormal change	
Coliform bacteria	Colonies/100 ml	0
Total Organic Carbon	No abnormal change	
Turbidity	Acceptable to consumer. No abnormal change	

Depending on operational conditions, the designer shall consider granulated activated carbon filters in place of rapid sand filters and the provision of ozonation after clarification. Should further raw water quality tests indicate the presence of pesticide residues such as dieldren and lindane, the designer will need to reconsider the appropriate treatment stream, with activated carbon filters being an option.

8.2.3.4 Greenhouse Gas Emissions

With increasing concern about the global impact of Greenhouse Gas (GHG) emissions[70] 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

70 Primarily, according to the IPCC, carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O)

discharge[71]. The various sources of the main GHGs, carbon dioxide (CO_2) and methane (CH_4), associated with reservoirs, are illustrated in Figure 8.4.

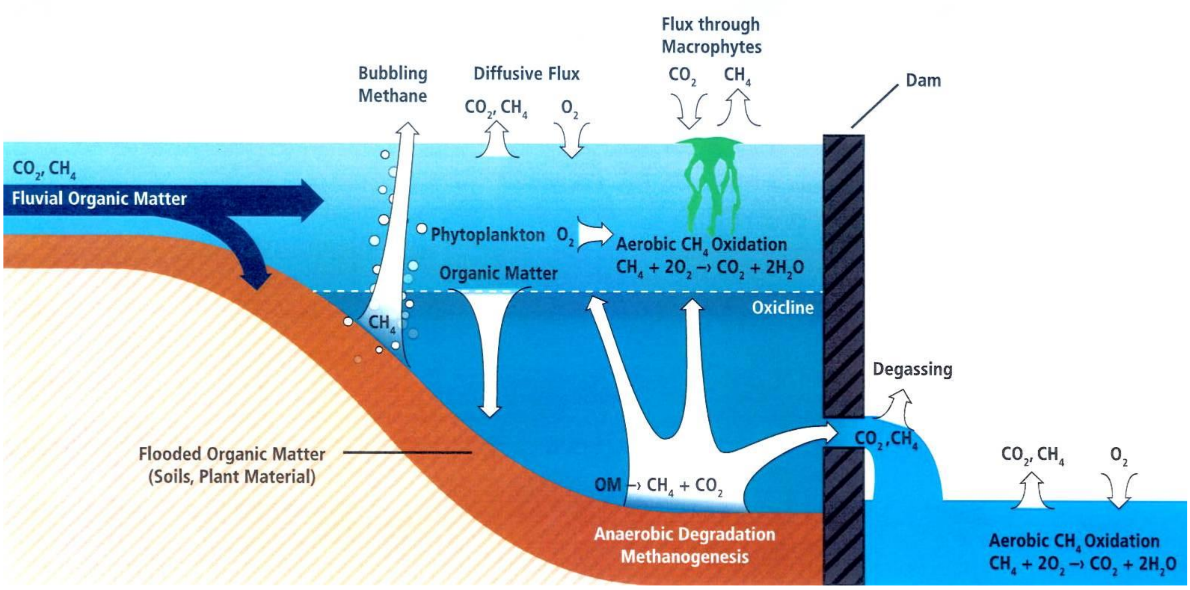


Figure 8.4: CO2 and CH4 Pathways in a Freshwater Reservoir (After Guerin, 2006)

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 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 8.6.

71 The impact of stratification on water quality is discussed elsewhere.

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 [72, 73], 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.

Table 8.6: 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.

[72] Consensus suggests hydro-plants emit 35-70 times less GHGs than conventional fossil-fuel plants.
[73] Kumar, A., et al. 2011. *Hydropower*, In IPCC Special Report on Renewable Energy Sources and Climate Change.

8.2.3.5 Local Climate Changes

Large dams and their corresponding impounded reservoirs are types of infrastructure that most often trigger a large-scale change in Land Use and Land Cover (LULC), where more arable land may be irrigated and downstream areas more urbanized due to reduced risk of floods and increased availability of products and electricity. Such systematic changes in land cover can induce changes to local climate through increased availability of moisture and impact on local and mesoscale circulation patterns. More specifically, large water bodies exhibit different sensible and latent heat fluxes from terrestrial lands, which may result in a spatial gradient in humidity and wind patterns. However, the latter remains uncertain and area-specific as it depends on the general/regional climate, size of the reservoir and its surrounding. For instance, humid regions are forested and exhibit comparable moisture fluxes due to transpiration as from evaporation from open water bodies. Thus the clearing of a forest to create an artificial lake is unlikely to create a distinctly different local climate. For semi-arid and Mediterranean regions, the open water body of a reservoir, however, adds sufficiently more moisture than the sparsely vegetated surroundings, resulting in spatial gradients of water vapor. A typical example of such possible changes was studied around the Ataturk dam lake and its surrounding, which is part of the Southeastern Anatolia Project (Turkish initials "GAP") in Turkey[74]. The dam reservoir has a surface area of 817 km2 with a capacity of 48,700 Mm3. The recent study around the dam reservoir concluded an increase in local temperature and thereby Relative Humidity in two stations close to the dam lake. The study used records from two nearby stations for 30 consecutive years (1972 to 2002) for statistical analysis of trends in six climate variables. While total annual precipitation appeared to be unaffected by the construction of the dam and reservoir filling, mean annual temperature increased from 170C to 190C which resulted in increase in relative humidity from 48% to 55%. Nevertheless, such increases highly depend on the size of the reservoir, which is manifested by another study conducted on Pornariou dam in Greece. The study revealed that the dam reservoir, with a capacity of 865 Mm3 had little to negligible influence at two nearby meteorological stations, one few meters away from the reservoir shoreline and another 4.5 km away[75].

8.2.3.6 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

[74] Hüsamettin BULUT, Bulent YESILATA*,M. Irfan YESILNACAR. Trend Analysis for Examining the Interaction between the Atatürk Dam Lake and Its Local Climate. *International Journal of Natural and Engineering Sciences 1 (3): 115-123, 2008*.
[75] *http://itia.ntua.gr/getfile/595/1/documents/2003Lagadinou.pdf.*

expectation, and the adequacy of environmental flow releases. The different strata that typically develop and the characteristics of each are illustrated in Table 8.7.

Table 8.7: 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.

8.3 Social Impacts

8.3.1 Potentially Permanent Impacts

8.3.1.1 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 has been carried out after all cadastral and land ownership information had been gathered, and an updated survey is currently underway. The survey consists of structured interviews at all available households, businesses and agricultural holdings, the results and systematic analysis of which are detailed in the Project 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 been previously discussed in Sections 6.9 to 6.11 above. Bisri reservoir area and the 15 m buffer extend over some 570 ha located across 15 cadastral regions. Construction will result in the loss of productive land estimated to extend to some 150 ha, some 25% of the area to be taken. The braided river bed and natural bankside vegetation occupies 105 ha, with built-up areas; farm buildings, housing and heritage, less than 1%. A compensatory planting of natural tree cover around the reservoir is suggested which involves the 1:1 replacement of the main forests in the expropriated area including oak, pine and poplar trees. The remaining area 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 built-up structures to be inundated is estimated at 135 over a total number of 88 plots with a total area of around 1.0 ha, the majority already abandoned (some derelict) or only providing seasonal accommodation for agricultural labourers.

Land take will also occur for other project activities and associated infrastructure like the distribution lines and access roads leading to the conveyor.

The total number of individual plots of land, identified from available cadastral mapping, is currently identified to be about 966, split between the various cadastral regions as shown on Table 8.8.

Table 8.8: Extent of Land Take within the Reservoir Area

Casa	Cadastral Region	No. of Plots	No. of plots totally expropriated	No. of plots partially expropriated	Expropriated Area (ha)	% Area Expropriated
CHOUF	Bsaba	9	5	4	6.8	1.3%
	Mazraat El Chouf	277	225	52	120	23%
	Mazraat El Dahr	55	36	19	42	8%
	Aamatour	310	279	31	160	31%
	Bater	14	6	8	8.8	2%
	Sub-Total	665	551	114	338	65%
JEZZINE	Bisri	74	62	12	44	9%
	Bkassine	2	0	2	0.3	0.1%
	Benouati	27	19	8	4	0.8%
	Ghbatiyeh	4	1	3	6	1.2%
	Harf	69	64	5	46	9%
	Aariye	1	0	1	0.95	0.2%
	Bhannine	28	15	13	10	2%
	Midane	80	70	10	48	9%
	Deir-el-Mkhaless	3	0	3	2	0.4%
	Khirbit Bisri	13	4	9	18	3%
	Sub-Total	301	235	66	179	35%
Expropriation Grand Total		966	786	180	517	100%
Domaine Publique (river + roads)					53	
Total Land take					**570**	

8.3.1.2 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. Enforced relocation can cause alienation in a socio-cultural milieu, leaving them severely disadvantaged. A fundamental principle 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, or increased irrigation, to restore and improve their standard of living.

A Resettlement Action Plan (RAP) for the Bisri scheme presents the results of the detailed topographic survey and socio-economic survey comprising structured questionnaires for households, agricultural establishments and commercial enterprises.

As previously discussed with social baseline conditions, GBWSAP has the advantage that no significant settlements lie within the area to be inundated or within at least 500 m of the expected reservoir shoreline. While land take will be extensive within the proposed area of inundation, some 570 ha, residential properties are few and there are no commercial or industrial premises and no significant public infrastructure or community facilities within the impoundment area. In total, 966 separate cadastral plots will be expropriated, which include around 135 building structures that could be residential, water tanks, storage rooms, generator rooms, religious places, or animal refugees. The residential accommodations that are occupied are house seasonal farm workers that will need to be relocated. Payments will also be made to tenants, employees and others who may suffer loss, each considered on case-by-case. This type of compensation will be based on the following:

a) ***Loss of Tenancy Rights*****:** Any tenant with a legally valid tenancy will be entitled to compensation in accordance with Lebanese Laws and the terms of the tenancy.
b) ***In- tolerance or Work Accommodation*** : PAPs living in tolerance or work-related accommodation, estimated to be 42 housejolds, are entitled to compensation even where they have no formal tenancy agreement or land use rights, as is in most cases of Bisri residents.
c) ***Illegal Occupants:*** none of the surveyed 49 households declared itself as squatter. Therefore, such occupant category does not apply to the project.
d) ***Loss of Access to Common Property*****:** All PAPs losing access to common land, such as traditional grazing rights, will be entitled to a portion of the compensation available in proportion to their share. Such rights are absent within the project area.

PAPs are expected to be compensated for their loss of livelihood, land take and resettlement. Most landowners are absentee landlords.

Workers are mostly non-Lebanese, mainly Syrian, Syrian Kurd, Palestinian and Egyptian, the majority of which may stay on the land till the next planting season.

Those who lose employment will be entitled to compensation for their loss of earnings and potential loss of livelihood. The more legally settled and longer the employment history of any worker is, the higher will be the compensation the worker will get. There could be number of employment categories as it follows:

a) ***Full-time Employee***: Based on the latest Households survey, none of the 70 full-time employees, works based on a formal employment contract. In all cases, the Project will compensate full-time contractual workers at a rate of 20USD daily for total of 245 days, whereas full-time workers under no contract, if any, will be entitled for a compensation at a rate of 10USD daily for a total of 156 days.
b) ***Part-time / Occasional and Seasonal Workers***: The Survey revealed a total number of 33 part time seasonal workers in the area of the project. These workers will be compensated at their current wage for a period of 3 months.

Transitional costs will be included as part of the compensation to help all the above PAPs in moving their movable goods and assets.

Consideration of Foreign Nationals

A high proportion of Bisri PAPs are foreign nationals working as farm labourers, predominantly Syrian, with some Kurds and a few Egyptians, together with Palestinians from the refugee camps in Saida[76]. Some Syrian seasonal workers have chosen not only to remain on site and not to return to the present turmoil of the on-going Syrian uprising but also to bring some of their relatives into the Valley fleeing the continuing civil unrests back home.

Among other objectives, the 2014 Jan-Feb Households Survey aims at updating the statistics and socio-economic situation with respect to the foreign population in the Bisri Valley to accord with the latest refugees movement particularly related to the Syrian war refugees.

Table 8.19 below summarizes the findings of the 2014 Social Survey with regard to the foreign population and Refugees distribution.

Table 8.9: Bisri Valley Foreign Population and Refugees Distribution

Valley Foreign Population	individuals	households
Other Arabs Non-Refugees	72	14
Other-Arab Refugees Registered with UNCHR	79	17
Other-Arab Refugees not Registered	23	4
GRAND TOTAL	**174**	**35**

The 2014 Social Survey revealed that there were at the time of the survey, 174 declared non-Lebanese residents. While 72 individuals have considered themselves non-refugees, the remaining 102 individuals have declared themselves war refugees; but not all these are registered with the UN High Commission for Refugees. The total of 102 individuals will not be entitled to any compensation according to the World Bank OP 4.12 because of their Refugees status[77].

The remaining 72 residing non-refugees in the Valley, will either be compensated, as their Lebanese counterparts under the Lebanese Law or to the World Bank O.P 4.12 Policy on the Involuntary Resettlement. This depends on their residency, employment, tenancy, status etc as explained above.

In accordance with CDR policy, the assessment complies with the structure and guidelines of World Bank Policies, as well as with the requirements of the Government of Lebanon (GOL). Despite the availability of such clear guidelines there are often problems with the implementation of these programmes. A common reason for this is that World Bank guidelines are more stringent and socially-responsible than national practices.

[76] While the 2010 Labour Law permits Palestinian refugees in Lebanon to work outside their camps, the provisions for issuing work permits have never been implemented.

[77] While the 79 registered UN refugees will be assisted by the Project covering their transportation costs to UNHCR designated refugees camps if they are willing to, the Project will facilitate to the other 23 non-registered refugees to get registered with the UNHCR and eventually to cover their transportation costs to refugees camps.

Eagerness of governments to accord with Bank guidelines comes from political commitment. A specific problem with Lebanese expropriation law is that it affords no provision for those who derive a livelihood from land to which they have no title, a category into which the majority of those displaced by the project fall. 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, on the other hand, 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.

This gap will be handled using World Bank requirements OP 4.12 which, in this case, would prevail above the Lebanese law.

8.3.1.3 Public Health and Wellbeing

Despite the obvious adverse impacts such as inundation, dam projects are generally perceived to assist socio-economic development and poverty reduction 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 45 existing towns and villages will eventually be required. Given the importance of sewering the upper catchment villages to the success of the project, it is recommended that CDR revisit existing plans and expedite a Bisri Catchment Sewerage Master Plan before Project construction.

Albeit the positive impacts that dam projects bring to maginalised villagers especially in terms of better access to health facilities, the impacts of dams on environmental and social determinants often worsen the health status of vulnerable communities; they transfer hidden costs to the health sector and they undermine the project's sustainability. Negative health impacts often incur costs that are not accounted for in the project. Preventive actions significantly help in reducing suffering of affected communities and economic burden on the health sector. WHO has always expressed concerns about the impacts of dam projects on human health, particularly regarding contagious and vector-borne diseases. WHO perceives human health as not only the absence of disease and infirmity but also *a state of complete physical, mental and social well-being*. Public awareness campaign should be carried out to inform affected communities about the possible impacts of dam projects on their health.

Often with dam projects there is no equitable distribution of the benefits. Benificiaries are usually in an urban area far from the actual dam site, leaving local and downstream communities suffering from adverse health impacts including increased transmission of vector-borne disease, exposure to higher concentrations of pesticides, and decreased water quality and quantity.

8.3.1.4 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 unfulfiled demand locally. While conflict does arise, it needs 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. Each of these opportunities will also create considerable employment, as will dam operational management and maintenance. It should be MEW/BMLWE responsibility to prioritise the employment of local residents, particularly those resettled by inundation of their land or otherwise severely impacted by the project. However, no such policy has been initiated to date in that respect.

8.3.1.5 Lower Watershed Management

Beneficiaries of dam projects are often in an urban area far from the actual dam site, leaving local and downstream communities suffering from adverse health impacts including increased transmission of vector-borne diseases and decreased water quality and quantity.

Water flow will be significantly reduced downstream of the proposed dam, increasing the concentration of not only wastewater discharges, but also fertilizers and pesticides, increasing the risk of poor quality of water irrigating crops downstream. Irrigation water may contain *E. coli* strain and may have chemical residues above allowable limits. This may bring residents in the upper watershed into conflict with those abstracting further downstream. Also, reduced flow will make soil salinity increase, potentially leading to conflict between downstream users. MEW should undertake a detailed study of existing water use and establish a public register of Water Rights prior to Dam operation, whereby water abstractions for downstream users are quantified and earmarked.

8.3.2 Potentially Temporary Impacts during Construction

8.3.2.1 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.

8.3.2.2 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. Occupational health and safety programs will be supported by staff training for the project and the appointment of the Assistant Project Manager. Details of the required training are discussed in the Capacity Building and Training Section.

Instructions on emergency measures necessary to safeguard employees and the wider environment will be prepared as part of the Operations Manual for the project.

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.

A comprehensive Health and Safety Plan shall be developed by the project proponent and the contractor, in accordance the World Bank's Environmental and Health Safety Guidelines. Special attention presented should be paid to Health and Safety measures, due to extensive civil works associated with Dam construction and associated facilities. Below listed items indicate Actions and Indicators of health and safety item:

1. **General conditions**

- Establish general guidelines on potential safety and accident risks;
- Establish safety and security notices for hazardous materials;
- Prepare specific emergency operating instructions;
- Provide sufficient potable water for drinking, cooking and personal hygiene purposes;
- Adhere to all applicable speed limits and implement speed limits for trucks entering and exiting the site;
- Provide a comprehensive first aid kit and train staff members onsite to use it;
- Comply with the World Bank and local Health and Safety Requirements, specially the Decree

  No. 7964/2012 that is the amendment of Decree No. 14293/2005 related to the general conditions of public safety in structures, and fire prevention & earthquakes;
- Ensure that contact details of the local medical services are available to the relevant construction personnel prior to commencing work by displaying them in very visible places on the site;
- Ensure that all employees receive and utilize appropriate personal protective equipment (e.g. hard hats, steel toe boots, respirators) and are trained on these as required;
- Restrict access to the construction site by proper fencing and provide guards on entrances and exits to the site;
- Establish buffering safety zone surrounding the sites;
- Install warning signs at the entrance of the site to prohibit public access and stress on utilizing the appropriate personal protective equipment;
- Provide training to a dedicated staff about the fundamentals of occupational health and safety procedures;
- Provide personal ID cards for all employees;
- Provide adequate loading and off-loading space and respect minimum clearance requirements;
- Provide appropriate lighting during night-time works;
- Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the plant;
- Conduct a fire-fighting and leak checks training drills for the operating staff;
- Prohibit smoking as well as litter or weed build-up in the area as these may pose fire risks.
- Provide roads inside the project with speed limits signs of 25 km/hr to decrease risks of collisions and accidents;
- Provide all contained locations such as mechanical and technical areas with proper ventilation system. Such action will help to avoid excess humidity that contributes to damp musty air, odors, mold and mildew. Moreover, ventilation of the closed car parks prevents the build-up of toxic fumes and flammable gases from motor exhaust and also clears smoke in the event of a fire;
- Develop an emergency response plan;

- Properly rate electrical installations and equipment and where applicable, protecting them against use in a flammable environment;
- Proper labeling and storing chemicals, oils, and fuel to be used on-site.
- Provide internal road and project entrance with necessary guidance to enhance avoid accidental collation.

2. Specific conditions

- All workers involved shall prior to commencing the works receive a health and safety instruction where the special risks are described and rules are established in case of incidents.
- All workers shall be submitted to an initial medical check, focused on the specific risks of this operation. This medical check shall be repeated upon termination of the works.
- A sufficient stock of the personal protection equipment will have to be kept at every working site. The minimum personal protection equipment shall consist of:

1. Industrial protection helmet;
2. Appropriate working clothes;
3. Eye goggles, respiration equipment and ear plugs;
4. Safety boots and gloves for protection against mechanical and chemical risks.
5. Mobile phones shall be switched off during working time

3. Fire prevention

A fire protection and emergency procedures plan shall be developed in collaboration with the local fire department. The plan shall, among others, provide information on:

- Ensure that all employees are aware of the location of safety and rescue equipment available at the site. A clear emergency response plan panel should be fixed at several locations that indicate the safety and fire fighting equipment;
- Provide all areas with sufficient fire detectors (heat and smoke) and adequate fire fighting equipment (sprinklers, hoses, distinguishers, etc);
- Provide an automatic fire suppression where necessary;
- Ensure that the emergency response plan panel includes the floor map and the evacuation directions, exists and stairs with respect to the reader location (this should be written in languages understood by all workers at stuff);
- Ensure that contact details of the local fire fighting services are available to the relevant stuff and worker personnel;
- Provide all escape routes with appropriate artificial lighting to illuminates when main electricity supply fails. Such supply should be derived from the project main electricity supply;
- Every escape route should be distinctively and conspicuously marked by emergency exit sing of adequate size and languages;
- Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the project;

- All fire safety equipment and fixtures shall be regularly serviced and maintained. The owner or their agent shall certify annually that each of the fire safety measures specified in this statement has been assessed by a properly qualified person;
- Conduct annual fire-fighting and leak checks training drills for the operating staff; and, prohibit smoking to avoid health problems and possible fires occurrence.

4. Traffic

Land transport

- Use non-peak traffic times or provide alternate routes when needed and when feasible;
- Use of properly trained flagmen and road side signs, and when needed coordinate will local authorities for a proper traffic flow;
- Proper planning and development of a traffic control plan that takes into account the reservations and inputs of residents;
- Adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the project sites;
- Restrict movement and transportation of construction machinery outside construction sites to off-peak traffic hours and during night-time;
- Independent access roads to construction sites accommodating for heavy duty vehicles of up to 40 tons brut weight.
- Provide proper traffic flow management plan within the project and at the access points;
- Control traffic management plan by installation of proper distributed road signage and monitoring devices; speed limitation signs in the project and at the access points;
- Ensure the presence of adequate parking areas;
- Apply continuous roads and pavements maintenance;
- Provide crossovers be with signals to facilitate safe crossing;
- All trucks entering or leaving the site shall have their trays suitably covered to prevent spillage of any material from the truck onto the road;
- All vehicles being loaded or unloaded shall stand entirely within the property;
- Vehicles leaving the premises shall be sufficiently free from dirt, aggregate or other materials such that materials are not transported onto public roads;
- All trafficable areas and vehicle maneuvering areas on the site shall be maintained in a condition that will minimize the generation or emission of windblown or traffic generated dust from the site at all times.
- Contractor shall provide all necessary Lebanese licenses and documentation required for transport of the hazardous waste to the Lebanese border
- Road transport in Lebanon shall be limited to daylight outside the rush hours, due to safety reasons and transport in bad weather shall be avoided;
- Vehicles transporting wastes shall be under surveillance at any time. Under the supervision of the MoE the trucks transporting the wastes shall be escorted by a

firefighter vehicle in accordance with the civil defense and lead by internal security forces to provide free road access and uninterrupted routing in order to reduce time spent on the road.

Contingency plans and emergency procedures shall be developed to cover events due to operational failures, natural causes and acts of third parties. The plans and procedures will cover, as a minimum, fire, explosion, bomb alerts, leaks and spills of hazardous materials, structure or equipment failures; injuries and illnesses; risk from natural disasters (wind, sandstorm, earthquake); and third-party risks (potential impacts of an accident occurring at another Industrial facility which may impact upon the transmission line or the substations).

All accidents, injuries and incidents should be recorded and investigated and information and feedback from employees should be evaluated.

8.3.3 Potential Post-Construction Operational Impacts

8.3.3.1 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 8.3.1.3 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, 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 malaria, filariasis, 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.

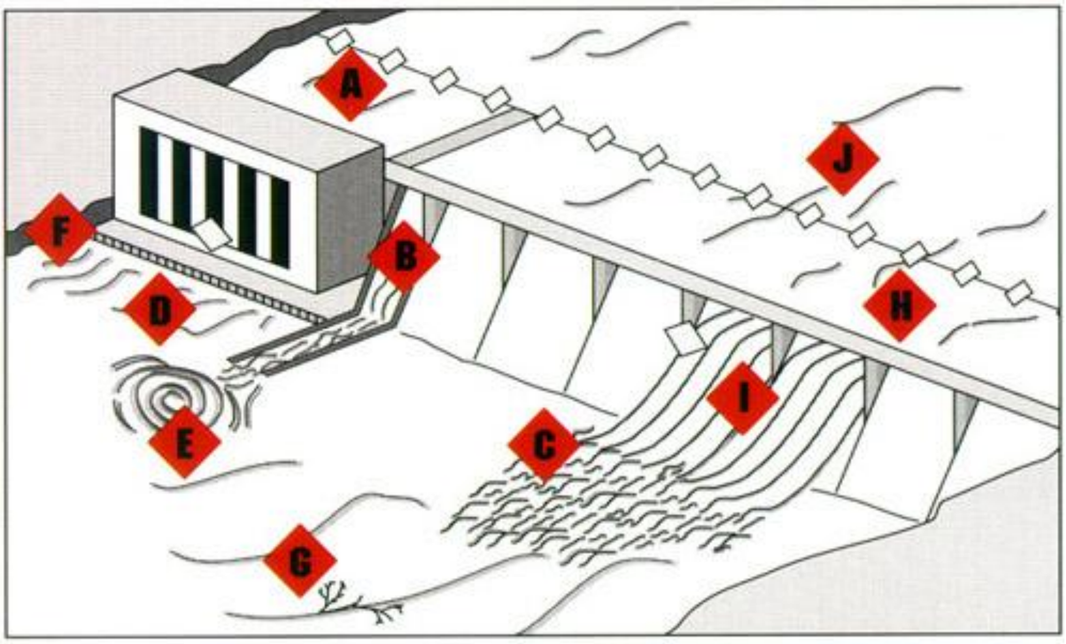
In semi-arid regions like Lebanon, new dams can quickly be subject to eutrophication due to over-enriching by organic nutrients from wastewater discharge and fertilizer runoff. Increase deforestation to increase water yields also contribute to increased sediments and nutrients in the reservoir. The most 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. Indeed, the artificial impoundment of water in the hot climate creates the perfect environment for the growth of cyonabacteria. Low level exposure to some of these toxins in drinking water, food, or during swimming 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.

Large reservoirs like the one of Bisri elevate sub-soil affecting the level of calcium and trace elements. This might lead to fluorosis which can affect teeth and the skeleton, the latter leading to a crippling syndrome of knock-knees among villagers. The maximum allowable limits of Fluor in Lebanon are 1.5 and 0.7 mg/L at 8-12 ^{o}C and 25-30 ^{o}C, respectively.

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[78] are shown in Figure 8.5.



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 8.5: 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 8.4.

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;

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

- 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 8.6: Examples of Dam Public Safety Information and Warning Notices

As the surrounding areas are developed, particularly if facilities such as restaurants, resort hotels, boatyards 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.

8.3.3.2 Upstream and Downstream Impacts on Agriculture

The continued increase in population worldwide is increasing the risks to global food security, leading to increased demand for crop production and irrigated agriculture. Therefore there is more need to store water and the construction of dams is one of the main schemes to achieve this goal. Dams are supposed to help farmers manage water supply and boost their crop yields. According to the International Commission on Large Dams (ICOLD), the main purpose of the construction of dams worldwide is the provision of irrigation water as shown in Figure 8.7. A major portion of water stored behind dams in the world is indeed withdrawn for irrigation.

A report from the International Water Management Institute (IWMI) indicates that even with the best irrigation efficiency, the world needs an extension of irrigated areas by building more dams and storages.

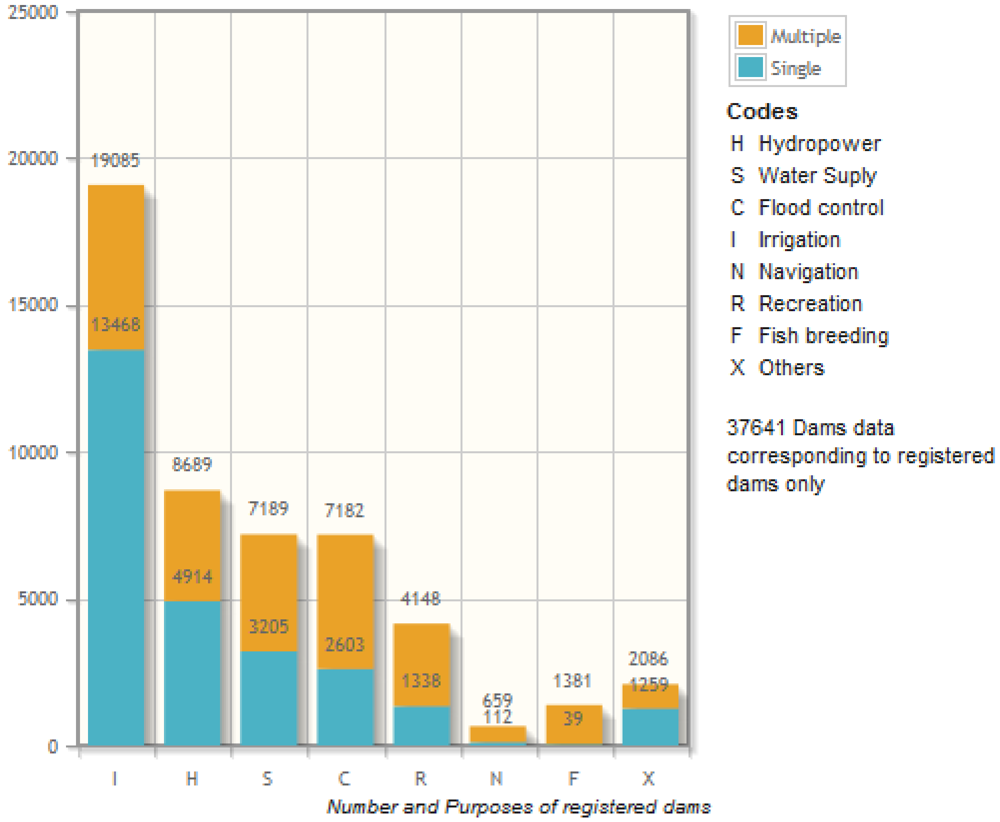


Figure 8.7: Number and Purposes of Registered Dams Worldwide according to International Commission on Large Dams

For Bisri dam however, water supply for the inhabitants of Greater Beirut Area is the main purpose and irrigation is only a secondary benefit from its construction.

The following will discuss the upstream and downstream impacts of Bisri dam on Agriculture in the affected area.

Upstream Impacts

Bisri reservoir development will inundate 150 ha of productive land, resulting in external costs to Lebanon's soil fertility bank. This loss of land for agriculture cannot be compensated for on the steep adjacent slopes that are relatively of low quality as regards soil fertility.

Dam designers have accounted for irrigation withdrawals from Bisri reservoir for irrigated agriculture extending between Barouk and Moukhtara villages in the upper Bisri watershed. Productive land includes apple orchards and summer vegetables grown in open field.

According to the World Commission on Dams and in order to fill the dam reservoir, water use upstream is often restricted, especially in rain-scarce years. This however is not currently part of the reservoir operation policy. Restricted water use upstream would increase the vulnerability of upstream agricultural production to rainfall shocks.

A significant impact will be the discharge of pesticides and fertilizers from upper catchment agriculture, directly or via leaking holding tanks, to the rivers feeding the reservoir, substantially increasing the nutrient load and resulting in eutrophic conditions.

Therefore, it is primordial to ensure continued good water quality through improvement and extension of agriculture, calling for capacity building and institutional strengthening in MoA's department of Agricultural Extension.

Downstream Impacts

The most significant positive impact of almost any dam to downstream land owners is the ability to control flow and reduce or curtail seasonal flooding. Downstream from dams, farmers can benefit from a steady year-round controlled water flow. This helps increase output of agricultural commodities, which require inputs from other sectors such as energy, seeds and fertilizers.

It is estimated that about 300 ha of irrigable lands, downstream the dam, are currently relying on the Litani-Bisri water scheme. Assuming an average irrigation consumption rate of 7000-9000 m^3/ha, the irrigable lands downstream the dam would require some 2.0-2.7 Mm^3 (0.12-0.15 m^3/s) during the irrigation season, which is well accounted for by the Dam Design.

In dry years, insufficient surface water will encourage farmers to abstract greater quantities of ground water, and increase saline intrusion to the aquifer. Ground water may cease to be suitable for irrigation unless treated, thereby increasing costs and decreasing farmers' competitiveness.

Reduced flow downstream of Bisri dam 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. This results in poor quality of irrigation water for downstream farmers, with possible detection of *E. coli*, thus affecting quality of irrigated crops.

8.3.4 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 road, 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 that 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 with touristic services not located in the direct vicinity of construction site, but 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. There will be considerable demand for land, on the surrounding hillsides for the construction of villas, apartment blocks, hotels, hill resorts,restaurants, access roads and public infrastructure. 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. No development plans have so far been officially put in place and a *Master Plan for Shoreline Management* shall be endorsed by CDR with the collaboration of DGUP.

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 and discharge of wasterwater and agrochemicals is regulated. 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.

New access roads and pipelines for the dam and the power plant will open up areas previously poorly accessible to the general public which will lead to exploitation of the natural resources such as illegal fishing, haphazard settlement construction, and landscape deterioration, unless a proper Shoreline Development Master Plan was implemented and access was restricted to previously remote areas.

8.4 Cumulative Environmental and Social Impacts

Environmental Assessment is essential in identifying and mitigating environmental and social impacts that might accrue from engineering projects to better manage those impacts on areas, resources and people directly or indirectly affected by a given development. However, individual projects should not be assessed as stand-alone developments isolated from their spatial and temporal contexts, and understanding the cumulative environmental and social impacts from multiple projects or even the same project over an extended period of time is indeed crucial to identify and manage incremental impacts on the project area of influence. Hegmann et al. (1999) defines cumulative impacts as "changes to the environment that are caused by an action in combination with other past, present and future actions". They are the combined effects of a development or project coupled with those of other existing or planned ones. Projects may be of the same type like several hydroelectric projects on the same river or within the same watershed, or cumulative impacts might occur because of the project itself and other induced developments including access roads, touristic attractions, recreational and economic activities, in addition to other adjacent land uses. Examples of cumulative impacts include the following:

- Multiple water abstractions leading to reduced water flow in a watershed;
- Bioaccumulation of pollutant concentrations in a water body or in the soil;
- Increased sediment loads on a watershed;
- Increased erosion in a watershed;
- Interference with wildlife migratory routes;
- Wildlife population reduction caused by increased hunting, road kills, and forestry operations; and,
- Secondary social impacts, such as more traffic congestion and accidents in the project's area of influence owing to increased transport activity.

Methodology
Environmental and social impacts of a given project, combined with the incremental impacts resulting from other existing and/or future developments, may result in significant cumulative impacts that would not be expected in the case of a stand-alone development.

Cumulative impacts occur as interactions between different projects, between the projects and the environment, and between components of the environment. The magnitude of the combined effects can be equal to the sum of the individual effects or can be an increased effect on the valued environmental and social components, or VECs. VECs are sensitive or valued receptors directly or indirectly affected by a specific development, and can also be affected by the cumulative effects of several developments. They are the ultimate recipient of impacts because they tend to be at the ends of ecological pathways, as shown in Figure 8.8.

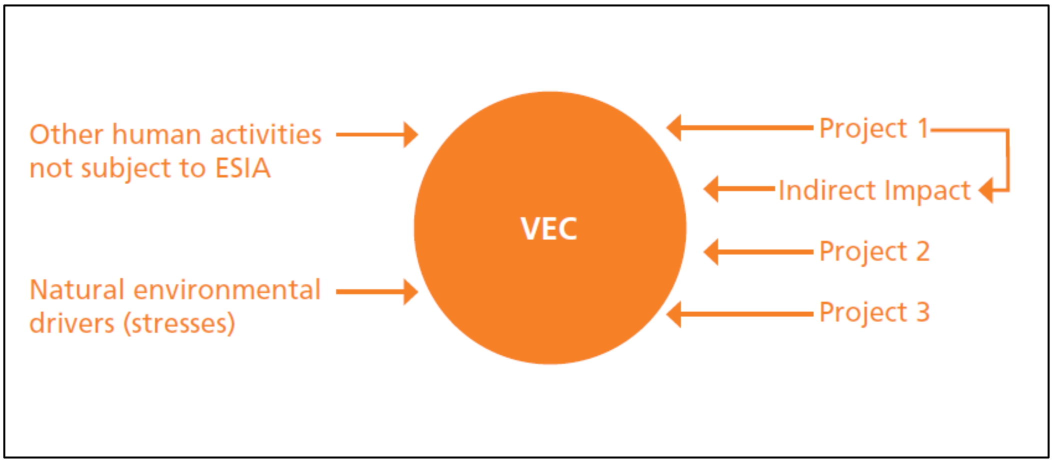


Figure 8.8: VEC-Centered Perspective

GBSWAP Cumulative Impacts

The cumulative impacts assessment reported in this section of the ESIA Report focuses on the interaction of the GBWSAP Project and developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could directly impact on the project area of influence. A set of VECs has been selected as shown in Table 8.9.

Table 8.9: Most Significant VECs for GBWSAP

Environmental and Social Component	Subcomponent	Parameter	Examples of VECs
Water	-Water Abstraction -Water Quality -Hydrological Flow -Domestic Water Supply	-MoE Water Quality Standards - Flow rate	-Water Resources -GBA water Consumption -Downstream Flow
Air	-Ambient Air Quality	-Greenhouse Gases	-Sensitive Receptors -Terrestrial Environment
Power	-	- Power Supply	-Power Supply
Land Use	-Natural Use -Human Use	-Land Cover -Reservoir Sedimentation	-Agriculture and Reforestation
Habitats and Wildlife	- Terrestrial Habitats - Riverine Habitats	- Species Diversity - Species Population - Wetland Development	-Flora species -Fish Species -Amphibians -Reptiles -Birds -Mammals
Public Health	-	-Health Costs Incurred (diarrhea, chronic illnesses)	-Sensitive Receptors -GBA water users

Table 8.10 is a matrix showing those incremental impacts, whereby the sign (+) means positive cumulative impact, (0) means no cumulative impact, and (–) means negative cumulative impact. Developments that could have cumulative impacts on the project area of influence have been identified; the existing ones namely GBWSP and Joun, Awali

and Anan HEPS, and the proposed ones mainly the Shoreline sewerage treatment schemes and a reforestation scheme in the upper catchment.

Table 8.10: Cumulative Impacts on Selected VECs

		Existing and Proposed Projects			
VECs	**Parameters**	**GBWSP**	**HEPs (Joun, Awali, and Anan)**	**Sewerage Treatment Schemes**	**Reforestation Scheme**
Water	*Water Abstraction*	0	0	0	0
	Water Quality	+	0	+	+
	Flow Rate	+	0	0	+
	Domestic Water Supply	+	0	0	0
Air	*Greenhouse Gases*	0	-	+	+
Power	*Power Supply*	0	+	0	0
Land Use	*Land Cover*	0	0	0	+
	Reservoir Sedimentation	0	0	0	+
Habitats and Wildlife	*Species Diversity*	0	0	0	+
	Species Population	0	0	0	+
Public Health	*Health Costs*	+	+	+	+

+ Positive Cumulative Impact
- Negative Cumulative Impact
0 No Cumulative Impact

The cumulative socio-economic impacts resulting from GBWSAP and other development projects such as GBWSP will, if well managed afford an overall increase in domestic water supply to GBA consumers, providing them with better water quality treated in the proposed Ourdaniyeh WTP. Hence, the combined effect will be positive. The main benefits will be decreased health costs as incurred by incidences of diarrhea and other health conditions, some of which are chronic as a result of the current impaired water quality. Also of benefit to GBA residents is curtailing the costs burden of securing water from private tankers. Improved water infrastructure, treatment, and metering will definitely lead to a better water management system, decreased water losses and a more sustainable water supply.

The results of the study carried out for this assessment indicate that the existing HEPs in the Project Area will have a positive impact on power supply as GBWSAP has the potential to generate additional power in the Awali plant estimated at 1.5 MW. This will definitely enhance livelihoods thus having a positive cumulative impact on public health through improved sanitation, hygiene, and hospitalization. GHG emissions will increase adding on the ones afforded by GBWSAP.

As to the proposed sewerage treatment schemes in the upstream villages, the assessment has determined that the major changes that can be expected will occur as a result of better discharge quality to the valley, thus resulting in better water quality to GBA users and reduced GHG emissions from the reservoir. However, emissions from the wastewater treatment plants should be taken into account. Villagers in the upper watershed will *de facto* benefit of enhanced sanitation, improved public health, and better livelihoods.

Another scheme, which may alter the suspended sediment flux in the reservoir, is upstream reforestation discussed in Section 9.2.6 of this report, a key element for watershed management and protection. The effect of reforestation programmes on the sediment transport into the Bisri reservoir reduces the sediment flux from bank erosion and landslides, contributing to longer life span of the dam itself. Although large concrete dams have a theoretical design life of 80-100 years, the actual lifespan of a dam is determined by the rate at which its reservoir fills with sediment.

Other cumulative impacts of upstream reforestation programmes are offsetting carbon dioxide emissions by increasing storage of carbon in terrestrial pools or carbon sequestration. In addition, these forests will contribute to reduced evaporation in the upper catchment leading to increased runoff down the valley into the reservoir. Forests also provide alternative habitats and migration routes for some bird and mammal species, otherwise impacted by Bisri dam.

Induced Development

Clearly with the construction of Bisri Dam there is potential for a large number of planned developments in the vicinity of the Project. Induced development, discussed in more details in section 8.3.4 of this report, will only have a positive cumulative impact if a well-planned and agreed Master Plan is adopted. If development is chaotic and piecemeal, or certain interests are allowed to violate the Plan, cumulative impacts may be entirely negative. Unless appropriate public utility infrastructure is put in place and discharge of wastewater and agrochemicals is regulated, flow of surface runoff and wastewater to the reservoir will rise. This will increase eutrophication in the reservoir with the propagation of algal blooms that will impact power generation equipment and water treatment plant operation, and derogate the quality of water available for downstream irrigation.

Examples of induced development for GBWSAP include the access road to a dam opening up areas previously poorly accessible to the general public which may lead to over-exploitation of the natural resources, in addition to the construction of villas, apartment blocks, hotels, hill resorts and restaurants on the overlooking hillsides with their associated access roads and public infrastructure. 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. Atmospheric emissions and noise and dust from power generators, vehicles and boats, etc. will be a negative cumulative impact. In addition to visitor and recreational activities, the reservoir will also afford the opportunity to expand local irrigated agriculture.

8.5 Summary of GBWSAP Potential Impacts

Table 8.11 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 8.11: 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	Minor
	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	None
	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	Moderate
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 8.12: 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	Moderate
	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 (Positive)	Moderate
	New farming fish species	Expected (Positive)	Moderate

Table 8.12: 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
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	Not Expected	n/a
	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 8.12: 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

8.6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN Introduction

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

It is important to note tha under Lebanese law the Council of Ministers (CoM) is the starting point for each new investment project in all sectors and under all circumstances. Whether raised externally or by a specific minister, CoM assigns the proposal to the appropriate government agency. Major projects beyond the capacity of government funding, such as GBWSAP, are usually assigned to CDR, which in coordination with all concerned departments do whatever is necessary to progress the project towards implementation, including negotiating foreign funding institutions.

Upon completion of all preparatory work, including those procedures required by foreign financial institutions, CDR raises to the CoM a draft financing agreement and all documentation on project components; identification, cost, implementation program, legal/administrative/financial conditions, the appraisal document agreed with the foreign funding agency, as well as the road map for all stakeholders responsible for the project implementation and, later on, its service performance.

Having approved these components, CoM authorizes the concerned minister and CDR to sign the Loan Agreement, and then transmits this Agreement and its enclosures, via a Presidential Decree, to the Chamber of Deputies for passage into Law.

Only after the President of the Republic has signed the Law and it is published in the Official Gazette is the Government of Lebanon, its responsible ministries and their executive agencies committed to implement the project in accordance with the terms and conditions stated in the Loan Agreement, including adherence to the ESIA and RAP.

Thereafter, other ministries will assess their level of involvement and make representation to CDR for funds to undertake any further studies and works to fulfil their responsibilities under the Law. For example, at this stage the Ministry of Culture will seek funds for the DGA to plan, initiate and supervise archaeological rescue; the MOE will approve the project, subject to approval of an EIA study, and CDR will initiate the issuing of bid documents for construction. The detailed plans for each mitigation measure has been discussed in depth with each stakeholder and roles and responsibilities for funding and implementation agreed.

8.7 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

Details of land acquisition and resettlement are discussed in the Resettlement Action Plan, which has been prepared as a separate report.

8.7.1 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 was 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.

Geological conditions

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, detailed analysis of the impact of potential seismic risk on the dam was studied in detail through a neotectonic assessment of seismic risk, reviewed by the Dam Safety Panel of Experts and currently in final stages of completion.

Land take

Loss of property, assets and means of livelihood will be mitigated by providing adequate resettlement and compensation in accordance with the RAP for the project that is compliant with World Bank Operational Procedure OP 4.12 and relevant provisions of the Lebanese Law. Details are provided in the RAP, including preliminary assessments of compensation rates.

Loss of biodiversity and habitats

Construction project should neither be initiated during breeding or hibernating season of animals nor during the active season of plants. In addition, night shifts or dawn and dusk must be avoided. The breeding season in Lebanon is in spring and hibernation is in winter. Hence the construction work will start during summer where the disturbance that might occur will deter birds from their nesting sites as well hibernating reptiles and mammals will keep away from these places, thereby reducing the negative effect of the construction. This applies to flora relocation as well.

A preliminary Biodiversity Management Plan has been developed, and builds on a detailed ecological assessment of sensitive biodiversity in the project area. The Biodiversity Management Plan is presented below. The implementation of the plan will be monitored by a biodiversity specialist. This will minimize the negative effect on the population size and decrease causalities, and any other disturbances towards the natural environment. The Biodiversity Management Plan will be finalized to accurately reflect the contractor’s CEMP and construction schedule.

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 regarding vegetation communities and plant diversity is the control of water flooding, niches destruction of important plant species and the disturbance imposed within the demographic structure of riparian forest (age structure and sex ratio).

The timing of the implementation of the mitigation strategy for managing impacts on vegetation communities should take into account the three phases of the project implementation: pre-construction, construction and post construction phases of the project. Consequently, the suggested mitigation measures are the following and are reflected in the Biodiversity Management Plan:

The 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. The sex ratio of dioecious species such as *Populous* and *Salix* must be monitored to ensure the re-establishment of the tree populations (pollination and seedlings recruitment). The translocation of endemic and species with critical conservation status such as *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.

Management practices of the dam must foresee steps to reduce the disturbance intensity and allow the mimic of the natural conditions that existed before the dam construction in order to increase biodiversity in the newly established river banks and lake formation.

Individual trees and patches of vegetation to be retained close to busy construction zones shall 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. 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.

Fish

The dam is an artificial newly formed ecosystem that will have a certain impact (negative and positive) on aquatic organisms. The most important issue that should be taken into consideration is to allow a year-round river inflow and outflow and prevent contamination with sewage or polluted water of any sort. Continuously running unpolluted water would help preventing the complete disappearance of many species.

For eels which are catadormous species (spawning in the sea and returning to fresh water) blocking their migration will affect their reproduction hence their population. Freshwater keeps running between the dam and the sea in order not to hamper the eels from migrating back and forth. Hence, a side water flow should be taken into consideration when constructing the dam to allow the connection between the fresh water stream and the sea.

A small population of an endangered freshwater blenny (*Salaria fluviatilis*) has been detected in the lower part of Nahr Awali. This fish lives exclusively in the lower course of rivers. It is a critically endangered fish and has disappeared from all Lebanese rivers. The freshwater blenny population in the Awali is very small (about a hundred individuals) and confined to a limited space (about a kilometer). It is thus vulnerable and at high risk of extinction. The blenny does not exist in the same site of the dam but in the lower course of the river, that is in the last 1-2 kilometers of freshwater. The dam by itself does not affect this species if clean freshwater keeps running year round. The construction of the dam at the level of Bisri will modify the fluvial discharge preventing or significantly reducing water flow downstream where the fish survives. To prevent the disappearance of the fish, the lower part of Nahr Awali should never dry up as this species cannot move to another area or survive without water. If this happens once, its complete eradication will be inevitable and irreversible. Hence, canals or side water ditches allowing continuous flow of water even when the dam level drops to keep enough water running on the river bed all year round.

In addition to maintaining the environmental flow, the free passage of native fishes is an important issue for the conservation of freshwater blenny, should this be deemed necessary. Among these techniques is the fish passes technology. One or more fish-passes that connect the river to the dam shall be built, allowing the fish to enter and leave the dam. By definition, fish passage becomes a necessity when a dam is separating a species from its habitat; therefore, such facilities are required when fish like *Salaria fluviatilis* are unable to pass upstream a dam. Indeed, fish passes help attract migrant to a specific point in the river downstream and induce them actively or make them pass passively either by trapping them in a tank and transporting them upstream or by opening a waterway. The design of such facilities depends on the behavior of *Salaria fluviatilis* and their effectiveness relate to the presence of attraction flow, suitable location of the entrance, adequate maintenance and the adaptation of hydraulic conditions such as velocity, turbulence, flow patterns and aeration levels to the target *Salaria fluviatilis*. Indeed, the water velocity in the facility should comply with the behavior of freshwater blenny and its swimming capacity, keeping in mind as well that excessive aeration could act as a barrier for it. In addition, like any other type of fish, *Salaria fluviatilis* is very sensitive to environmental factors such as temperature, dissolved oxygen levels, light, odor and noise. Therefore it is crucial that the water quality feeding fish passage facilities be the same as the one flowing across the dam.

Seeing that little information is known in Lebanon concerning freshwater blenny, fish passes facilities should be designed in a way so that they can be changed when needed to improve and optimize their performance. Also, it is primordial to monitor their effectiveness from time to time to ensure that they are working properly and enabling *Salaria fluviatilis* to pass freely across the dam.

Amphibians and Reptiles

Amphibians and reptiles are very sensitive to the dam construction. Amphibians depend on the water habitat for their survival and reproduction. Fresh water reptiles like snakes and fresh water turtle depend on this water source for survival.

The construction process should be conducted outside the breeding and hibernating period. Similarly, the filling process should be conducted outside the breeding season and not during the hibernation period. The most appropriate period for filling the reservoir is between July and October. During that period, the filling process will be slower allowing the animals to escape and move with the rising water level. Some reptiles, however, will not have the eggs hatching before August, and this will incur a waste of reproductive effort for that year.

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.

The following mitigation measures have to be taken into consideration for the conservation of *Bufo cf bufo*:

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 *Bufo cf bufo* from returning or accessing to the most hazardous parts of the construction site and,
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.

Birds

Birds are sensitive group and can be easily disturbed. Disturbance by dam construction might have a negative impact on their status. The following mitigation measures should be considered:

- Blasting should be kept to a minimal and scheduled during the daytime. In this case night resting birds in the area will not be disturbed.
- Transport machinery should be kept to minimal and used in efficient and optimal way. Proper vehicle maintenance is important to avoid noise and air pollution. Drivers of vehicles as well as workers have to understand the fragility of the ecosystem and should deal with it carefully.
- Restrict accee to hunters through appropriate signage and barries
- The work should start outside the breeding season, and tree clearance should be avoided during the bird nesting season (in spring) to avoid disturbance and endangering bird species. Proper guidance from a wildlife expert should be taken on occasions when wildlife is noticed within or near the site.
- Noise creating sources should be properly lined and secured. Noise pollution should be eliminated this could be done by installing the compressor and generator in a properly constructed room, which should be enough to filter out most of the noise.
- No exotic bird species should be introduced to the wilderness of the site without guidance from a natural resourced approved specialist.
- Proper guidance should be taken from a wildlife expert on occasions when wildlife is noticed within or near the site.
- 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.
- 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.
- Wherever possible, undertake vegetation clearance outside the bird nesting season, March to August inclusive.

Mammals

Mammals wander long distances in search for food, mate and water. The fragmentation of the dam area will affect the animal feeding sites, habitat, and potential mating; in addition to posing threats on animals’ life, in particular for young animals. To ensure animal safety, decrease causalities, decrease the effect of fragmentation, the following measures will be implemented:

1- Fence the most exposed edges;

2- Grow bushy hedges around the dam and on the road side; and, 3- Dig a ditch surrounding the most accessible edge of the dam or the road to obstruct animal crossing

Moreover, the above mentioned should be built taking into consideration funneling the animals towards a safe crossing points along the narrow edge of the dam. Such crossing points could be in the form of bridges or tunnels.

Visual deterrents could be installed but these will have a short term effect as the animals will get used to their presence and the effect of these deterrents will be questionable. Road signs will help drivers to be more cautious and avoid crossing animal over.

Habitat and/or species translocation for this project might not be necessary or could be a last resort if some very critical species might be affected.

Biodiversity Management Plan

A preliminary Biodiversity Management Plan has been proposed and is summarized in the table below. The plan describes the mitigating measures, costs and responsibilities of the impacts described above. The biodiversity baseline, conservation management actions and mitigation have been generally identified and reflected in the Biodiversity Management Plan. The biodiversity specialist team described in the Biodiversity Management Plan section will develop a biodiversity monitoring plan to monitor biodiversity and habitat management, the results of which will inform the project on the level of degradation to the sensitive habitats and the presence of any direct or indirect activities/actions potentially degrading these habitats especially as it relates to the identified endangered species of fish (namely the blenny freshwater fish). To supplement the management/mitigation measures, the biodiversity monitoring plan will include surveys that will take place during pre-construction, construction and operational phases of the project. These surveys will measure indicators that include but are not limited to: water quality, environmental flow volume and quality, number of target species as well as numbers of indicator species, and cumulative impacts within the upstream watershed. Supplemental details to the biodiversity management plan will be included in a revised version of the ESIA

	Project Biodiversity Risk	Recommended Mitigating Measure	Responsible Party	Estimated Cost (USD)
Flora	Ccontrol of water flooding may lead to destruction of important plant species and disturbance imposed within the demographic structure of riparian forest	Translocation of endemic and species with critical conservation status such as 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	CDR	N/A
		Implement environmental flows to reduce the disturbance intensity	Dam Operator (BMLWE)	N/A
		Install fencing around trees and patches of vegetation close to construction zones	Works Contractor	10,000
		Signs indicating the area is a "sensitive environmental area" will be clearly and securely affixed to the fencing	Works Contractor	
Fish	Reduced volumes of year-round river inflow and outflow, and possibility of water contaminiation with sewage or polluted water will seriously deteriorate the environmental conditions of various fish species and/or block reproduction	Ensure connection of water between dam and downstream water resources.	Dam Operator (BMLWE)	N/A
	Significant reduction in water flow downtream of Bisri river may seriously impact the identified endangered **freshwater blenny fish**.	Construct a fish pass to connect the river to the dam, allowing the fish to enter and leave the dam.	Works Contractor as advised by Biodiversity Management Specialist	15,000
		Ensure regular monitoring of effectiveness of fish passes and viability of fish population in the downstream stretches of the river	Biodiversity Management Specialist	498,000
Amphibians and Reptiles	Risk of sudden reduction in water availability to hamper viability of amphibians and reptiles	Schedule filling of the dam during the July - October season to minimize disruptions to breeding season. Schedule site clearance works during non-vulnerable periods.	Dam Operator (BMLWE)	N/A
	Reduction in water availability will impact the environmetnal conditions of the populations of the rare **Bufo cf bufo**, whose habitat appears to consist mostly of rocky terrain and riparian trees	Implement a construction site drainage system to reduce pollution to water resources	Works Contractor as advised by Biodiversity Management Specialist	50,000
		Install reptile-proof fencing to prevent *Bufo cf bufo* from returning or accessing the most hazardous parts of the construction site	Works Contractor as advised by Biodiversity Management Specialist	10,000
Birds	Disturbance to natural environment may lead to a reduction in bird colonies	Schedule any required blasting during the day	Works Contractor	N/A
		Tree clearance to avoid spring nesting seasons	CDR	N/A
Mammals	Fragmentation of natural environment as a result of dam construction may obstruct mammal routes and expose animals to drowning and other risks	Fence exposed edges and install bushy hedges along exposed roads	Works Contractor as advised by Biodiversity Management Specialist	10,000
		Construct crossing points for strategic animal crossings	Works Contractor as advised by Biodiversity Management Specialist	15,000
			Total Estimated Cost of Biodiversity Management Plan	**608,000**

Monitoring of Biodiversity Management Plan

As seen above, the Biodiversity Management Plan will be implemented in close coordination with the construction schedule. The Plan will thus be updated to reflect the contractor's CEMP and to reflect construction implementation details, as agreed post tendering and contract award.

The Biodiversity Management Plan will also need to monitored to ensure that the objectives of the plan, ie to safeguard the various species impacted by the project. In particular, the Plan will monitor the safeguardsing of those species that are endangered (such as the blenny freshwater fish).

The Supervision of the Biodiversity Management Plan will be led by a Biodiversity specialist with a team of specialist support staff as follows: flora (including trees), fish and aquatic invertebrates, amphibians and reptiles, mammals, and birds. The time each of these is expected to be engaged on the project will be as follows:

- Biodiversity Specialist/Team Leader: 35% of time over 2 years, followed by 20% for the remaining period of construction and reservoir filling, assumed to be 3 years (Total input; 16 man-months)
- Specialists (4 persons) in fish and aquatic vertebrates, amphibians and reptiles, mammals and birds: 4 man-months each prior to commencement of construction, and 3 man-months each during reservoir filling (Total inputs; 28 man-months)
- Specialist in flora including trees: 6 man-months prior to and during early construction, 3 man-months on-call during reservoir clearance, and 4 man-months during post-construction during reservoir filling (Total input: 13 man-months)

The budgetary allowance for implementation of the Biodiversity Management Plan is therefore estimated as given below and included in the project financing.

Staff Costs:
Biodiversity Specialist: $160,000
Species Specialists (5): $328,000
Transport and Expenses: $10,000

TOTAL Biodiversity Management Plan BUDGET: $608,000

The Biodiversity Management Plan Schedule is proposed in Table 8.12.

Table 8.12: Best Times for activities Affecting Biodiversity

Activity	J	F	M	A	M	J	J	A	S	O	N	D
Start construction												
Site clearance												
Flora relocation												
Tree relocation												
Reservoir Filling												
Staff Deployment												
Biodiversity Specialist Years 1-2 Years 3-5												
Fauna Specialists (4) Year 1-2 Year 3-5												
Flora Specialist Years1-2 Years 3-5												
Further details of inputs are discussed in Section 9.2.2.												

Mosquito Breeding and Control Measures

In a public health context, mosquito breeding and growth of disease vectors in and around impounded reservoirs remains of concern and necessitates proper management. Stagnant water bodies in puddles along the shores of a dam reservoir and pools forming in the river channel immediately downstream may constitute, depending on many environmental conditions, ideal breeding habitats for mosquitos. While the latter poses a public health risk, management and mitigation of such risks starts with the elimination of those factors that are conducive to mosquito breeding. At a pre-impoundment stage, site clearance should be aimed at creating a clean shoreline including removal of underbrush, trees, vines, sheds, etc., especially within the normal fluctuation zone of the reservoir. Marginal drainage ditches may be required for this purpose and to provide access for small boats for inspection of potential mosquito breeding sites during breeding seasons. In addition, they provide access and escape for top-feeding fish which are important predators of mosquito larvae

Cultural Heritage Management Plan

The significance and extent of archaeological, historic and recent cultural heritage throughout the Bisri project area has been considered in depth as part of this study.

The nature of the various sites, location, age and content, have previously been identified in Section 6 above. While there is much overlap between the archaeological and cultural – it is convenient to separately discuss the measures to be undertaken to rescue and preserve them, as two separate exercises will be required, each under the control of different organisations; the DGA and the Maronite Diocese of Saida.

The primary elements of work to be undertaken are;

DGA Responsibility:

- Collection of pottery shards, glass and other artifacts from surface soils and shallow excavations at previously identified sites;
- Trial pitting and/or geophysical surveying at selected sites where buried structures may be present;
- Major excavation and the removal of material at Marg Bisri Roman temple; and,
- Excavations in the vicinity of Mar Moussa Church and the remains of St. Sophia's monastery.

Maronite Diocese Responsibility:

- Deconstruction, removal and reconstruction of Mar Moussa Church and of St. Sophia's Monastery; and,
- Scavenging old building materials from the ruins of 19-20th century houses to provide for new construction adjoining the relocated Mar Moussa Church.

The old houses that lend themselves to the salvage of traditional building blocks are of the type shown in Figure 8.9.

Figure 8.9: Potential Architectural Salvage

Archaeological Rescue

Given the long and honourable history of the Bisri Valley, one the primary route between the regionally important cities of Saida and Damascus, each and every one of these sites is worthy of further investigation and documentation prior to inundation, and where appropriate of rescue excavation. The potential loss of Mar Moussa and Marj Bisri raised emotive comment at public consultation and attendees expressed their requirement to see the church relocated and the temple excavated and moved.

Under Lebanese law, only the DGA is authorized for the planning and execution of archaeological investigations and rescue excavation, following their own policies and procedures and with little assistance from others than from the funding agencies, in this case GBWSAP, and archaeological specialists, such as the University of Warsaw, with whom they associate.

The re-siting of the rescued remains, particularly those of Marj Bisri temple, will both aid heritage preservation and provide a valuable educational resource on the historic associations of the Bisri Valley. While the dam designers have yet to determine sites for borrow areas, most are expected to be in the valley floor. The sites of archaeological interest within the area to which the dam construction contractor will expect to have unfettered access will need to be investigated prior to commencement of construction. Given the distance of Marj Bisri from the dam site, it is expected excavation here will continue throughout construction, but the site will require protection from malicious damage by the large temporary workforce that will be present in the vicinity.

At the present time, the most suitable site for re-erecting and displaying any rescued archaeological remains will be adjacent to any future Visitor's Centre for the dam and reservoir, perhaps with an adjacent Heritage Park if justified by the nature of the finds and available funding.

Rescue archaeology will commence as soon as the Expropriation Decree is published. Those sites within the area of construction or related activities such as labour camps and borrow pits, shall be dealt with prior to these sites prior to the contractor moving onto site. Thereafter, rescue work will continue until suchj time as reservoir filling curtails activity.

DGA will readily identify partners to partake in the rescue work, noteably universities offering training for their students and staff, and also to provide funding, such a bilateral aid and cultural exchange. The funding for rescue archaeology expected to be provided by the project is estimated to be US$500,000.

Architectural Heritage Preservation

Heritage preservation, as distinct from archaeological rescue, is primarily concerned with the relocation of Mar Moussa Church, St. Sophia's Monastery and architectural salvage from some of the old ruined houses throughout the valley.

While formulating the Environmental Management Plan for the project and in preparing the Resettlement Action Plan, meetings have been held with Bishop Elias Nassar of the Maronite Archdiocese of Saida, the Church's architectural advisors, the head of Mazraat El Dahr municipality and the priest responsible for Mar Moussa.

In summary, the outcome of these meetings and discussions has been as follows:

- Mar Moussa Church must be re-erected so as to retain its present appearance;
- The Church authorities will consider the remains of St. Sophia's Monastery being re-erected on the same site depending on the outcome of research they will undertake in the historical archive at Bikirki;
- Any religious artifacts found during the removal of these structures of from archaeological investigation of these and adjacent sites should be returned to the Church authorities for preservation and safe keeping;

- The Church may also be interested in undertaking architectural salvage from the old houses in the valley to collect old building stones. stone lintels, etc, that could be used to construct other buildings on the new Mar Moussa site;
- The preferred new site is one at a higher elevation directly above the present site;
- If this is not possible, Mar Moussa must in any case remain within the municipality of Mazraat El Dahr;
- The plot on which the church is re-erected must be either *domaine publique* or owned by the Maronite Archdiocese;
- The ESIA/RAP consultant assessed possible relocation sites for the Bishop's consideration;
- The Bishop will handle all negotiations with CDR and the municipality/local community/religious endowments;
- The Bishop will appoint a specialist to be involved in the relocation.

Further to the initial meeting with the Bishop, DAH's GBWSAP environmental team undertook repeated walkovers of the area to identify possible Mar Moussa relocation sites. Four potential sites, Options 1-4 on Figures 9.2 and 9.3, were identified, all within a relatively short distance of the existing site, all substantially above highest possible water level in Bisri Reservoir, and all within the cadastral region of Mazraat El Dahr. Option 1 has been selected as the most appropriate option, following concurrence by stakeholders. The distance of the present Mar Moussa site from the existing river bed is approximately 200 m.

Figure 8.10: Plan View of the Four Site Options for the Relocation of Mar Moussa Church

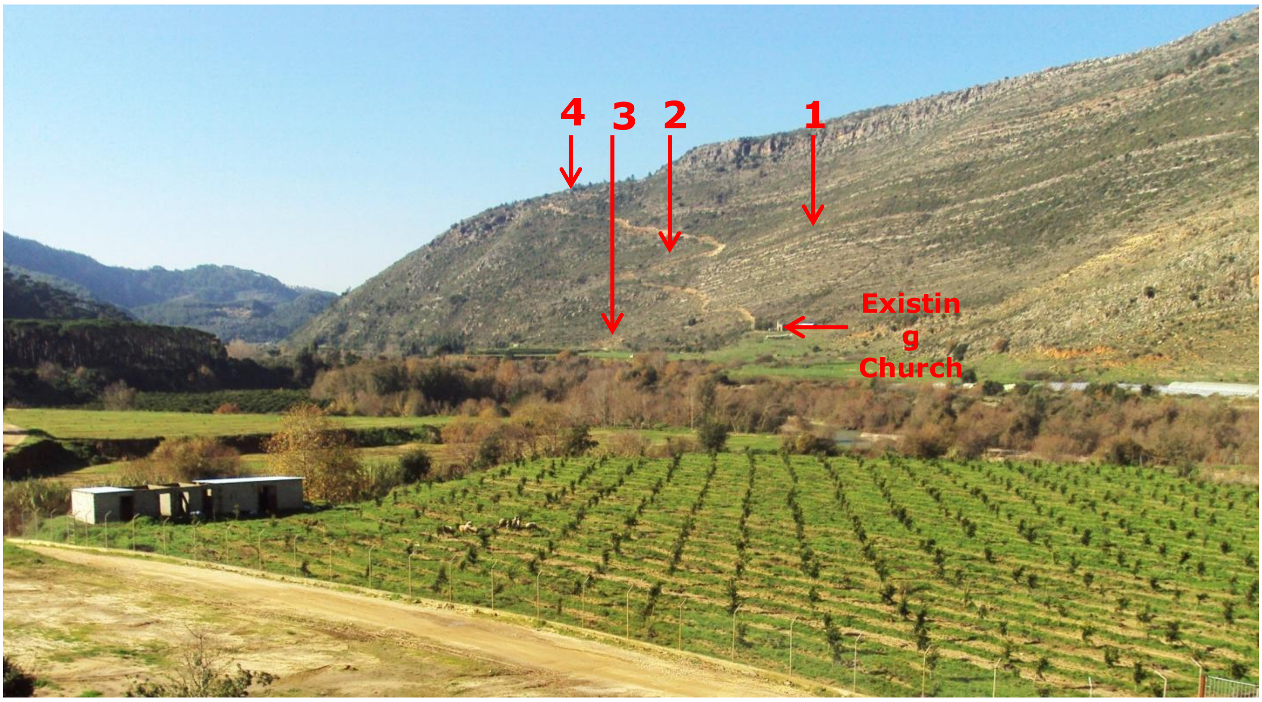


Figure 8.11: Ground View of the Four Site Options for the Relocation of Mar Moussa Church

Each site affords a number of advantages and disadvantages, as listed in Table 8.13. In terms of criteria for site selection, the most significant features are ranked from 1 (most advantageous) to 4 (least advantageous), in Table 8.14 according to the preliminary consideration of the Consultant.

Table 8.13: Advantages and Disadvantages of the Mar Moussa Relocation Sites

	Advantages and Opportunities	Disadvantages and Treats
Option 1 300 m NNW of present site, 500 m from river. Plots 391 and 395, or 392 and 394.	• As near vertically above the old site as is possible; • Good view upstream over the reservoir; • Lower expropriation costs due to steepness of slope.	• Plots are not within present expropriation Decree; • Steep slopes (>50%) make site preparation costly; • A new access route 400 m in length is needed; • The new access track will increase expropriation to 6 plots, 2 not otherwise be fully expropriated; • Site will look unattractive and mar the landscape; • Cost of reconstruction will increase due limited working space and difficult access; • No provision to expand current facilities.
Option 2 600 m WSW of present site, 500 m from river. Plots 870, 411 and 412.	• The topography is less steep and site clearance will be easier; • A larger area is available for the future development of church facilities.	• 300 m downstream of the dam and 30-40 m higher than the crest, the view from the site will primarily be the dam and its concrete apron with only limited views of the reservoir beyond; • Site is outside the present expropriation, although the plots needed are being partially taken; • Reinforced concrete walls will be needed along the site's long sides to provide stability.
Option 3 750 m SW of present site, 200 m from river. Plots 410, 413,	• The site is already to be expropriated; • Site is adjacent to the existing access road; • Site is at a similar elevation to present site; • Most convenient for reconstruction; • Available land provides for additional facilities in the future.	• The existing access track will be heavily used by construction traffic for a period of 5 years from commencement; • The site may be more susceptible to vandalism than the other sites; • The site is in the highest dam break risk area, i.e. the

	Advantages and Opportunities	Disadvantages and Treats
414 and 416.		church will be totally destroyed should the dam suffer structural failure; • The vista from the site will be overwhelmed by the height of the dam and its downstream apron.
Option 4 900 m WSW of present site, 700 m from river. Plots 778, 786, 1832 and 2-3 others	• The highest of the site options, giving long vistas up and down stream without being overwhelmed by the dam structure; • The existing track from Mazraat El Dahr contains no very steep sections; • Land available for the future expansion; • Site may require limited retaining walls; • Being relatively close to the village, the church may attract larger congregations than is possible at the present site.	• Part of the site is outside the present expropriation area; • Site clearance may be difficult due to in-situ rock; • Less available area to accommodate for both church and monastery • Very expensive cost of land for land reclamation and terracing

Table 8.14: Rating of Mar Moussa Relocation Options

Option No.	1	2	3	4
Steepness of slope	4	3	2	1
Pleasant views	2	3	4	1
Ease of access	4	3	2	1
Ease of site clearance	4	3	1	3
Need for r/c retaining walls	4	2	3	1
Proximity to M el D	3	2	4	1
Need for additional land expropriation	1	1	1	4
Space for future facilities	4	2	3	1
Security	1	2	4	2
Ease/cost of Reconstruction	4	3	1	2
TOTALS	31	24	25	17

1 most advantageous, 4 least advantageous

On the basis of the preliminary assessment, Option 4, some 900 m from the present location, is recommended for the reconstruction of Mar Moussa Church.Church relocation has also been discussed at Public Consultation sessions with CDR and PAPs, and villagers showed no objections to Option 4 as being the recommended location. Option 4 has been reflected in the expriation documents to be financed and implemented under the project RAP.

If Mar Moussa is relocated where there are good views over the valley and the future reservoir, it will increase its current function from once annually to more frequent religious celebrations. It may become the locally preferred site for the celebration of religious festivals such as Christmas and Easter, and for family events such as weddings and christenings. The potential to readily increase land availability is therefore included in the selection criteria above.

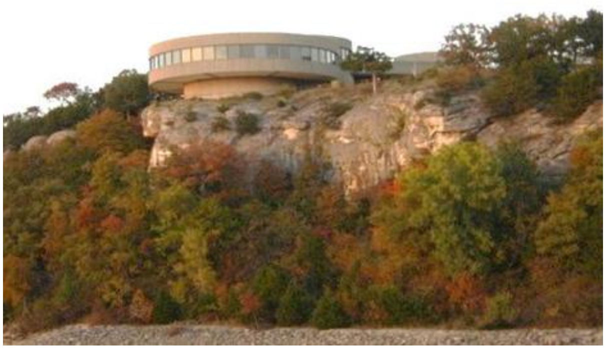
The relocation of Mar mousa Church and of the remains of St. Sophia Monastery will need to be expedited prior to commencement of dam construction. The cost of deconstructing and reassembling the outer walls, and othe demolishing and constructing anew the interior, is estimated at US$ 2,000,000 and is reflected in the EMP. The work will be included within the tender documents for dam construction and will be completed by the contractor prior to commencing the main contract.

Visitors Center

The nature of the Bisri project prevents any of the heritage sites being conserved, preserved, restored, adapted or maintained in-situ. The viable approach to conserve significant structures and artefacts excavate, deconstruct, relocate and reconstruct. In previous sections of the present report the benefits of a Bisri Visitors Centre have been expounded. The Centre should be conceived in the Ottoman or traditional Lebanese vernacular styles and built to contemporary standards.The complex should incorporate the Ottoman Arches and even perhaps the remains of St. Sophia Monastery if the Church authorities decide it is inappropriate to locate it with the Mar Moussa into the functionality of the facility. If the community so desired, Mar Moussa Church might be relocated on the same site.

Archaeological remains from Marj Bisri might form the centre of a Heritage Park, perhaps located adjacent to the Visitors Centre, exhibiting the history of the valley, a photographic record of the pre-inundation landscape, and other worthy features that would serve to both preserve the heritage and inform future generations. Ideally, the centre would be located where it afforded views over the dam and reservoir.

In common with large water bodies around the world, Bisri Dam will attract visitors. It will therefore be inherent upon BMLWE to manage visitor numbers, the types of activities undertaken, and the sites utilised. Failure to do so will ensure inappropriate activities in inappropriate places contribute to the impairment of water quality and public danger. Experience worldwide has shown that a Visitors Centre, such as those illustrated in Figure 8.12, are successful in providing a focal point to visitor attraction and access control, and promoting the facilities as a touristic and recreational destination in its own right.



Stunning views make Truman Dam Visitor Center as destination in its own right.

Access and signage to Truman Dam Visitor's Centre.

Educational exhibits at Dworshak Reservoir Visitor Center

Environmental Education Center at Kerr Reservoir Visitors Centre

Figure 8.12: Examples of Visitors Centres at Lakes and Reservoirs

While Bisri dam and reservoir will in time become an accepted part of the landscape and a destination for visitors, its attraction will start with construction. Not only will the raising of the dam be impressive, the steadily change in landscape during reservoir filling will also be of interest to many. In addition to providing for a Visitors Centre to cater for this interest, such a facility will enable the project proponent to promote the project, display progress, encourage good behaviour towards maintaining water quality, and public safety. At the outset of construction, the Visitors Centre may need be little more than a simple prefabricated structure with display boards, a picnic area and car parking without which visitors will attempt to gain unregulated access, clutter public roads and partake of otherwise unwarranted behaviour.

With time and growing visitor numbers, the site may be further developed with environmentally-sustainable and iconic buildings and may, like many others at similar attractions, provide some or all of the facilities and attractions listed below. Many Visitors Centres are established as charitable NGOs, the profits generated being dedicated to the provision of facilities, educational activities and promotion of sustainable lifestyles.

Potential facilities within the Bisri Dam Visitors Centre might include:

- Reception/information desk;
- Dam and Reservoir viewing platform;
- Fixed informative and educational displays of pre-reservoir landscape, dam construction, hydropower generation, water treatment and distribution, Bisri Valley history, Marj Bisri rescue archaeology and artifacts, Mar Moussa Church relocation, Bisri Reservoir ecology;
- Temporary display space available for hire for craft shows, art exhibitions, etc;
- Lecture theatre and work rooms for visiting school groups;
- Snack bar and café facilities; and,
- Public utility services.

The grounds of the Visitors centre might afford:

- Security checkpoint;

- Adequate car parking;
- Heritage Park with the structures removed from the reservoir;
- Picnic area;
- Craft and traditional trades exhibits; and,
- Children’s play area.

Equally importantly, the Visitors Centre will deter activities that will disrupt the peace and tranquility of the reservoir, such as Quad bike riding, the lighting of fires, loud music, littering and hunting. As induced development around the margins of the reservoir progresses, the centre might take on an administrative role, such as selling tickets for particular activities, or become the base for water bailiffs and biodiversity wardens caring for new shoreline and wetland communities.

Notwithstanding the development potential, it should remain outside the scope of the present project. Current governmental responsibility should be limited to the construction and commissioning of the dam and its appurtenances, and resolving in as amicable manner as is possible and in accordance with Lebanese Law and World Bank requirements the issue of resettlement and asset loss. However, the project can support the development of the preliminary framework and plan that GoL can develop further outside the project. The development of a Visitors Centre and Heritage Park will, given Lebanese entrepreneurship, be left to the private sector when market conditions are deemed appropriate.

Benefit Sharing

The overwhelming beneficiaries of GBWSAP will be the water consumers of the Greater Beirut conurbation.

In order to more equitably spread the benefits, GOL will establish the means to help the communities on the surrounding hills and throughout the dam catchment, initially through the capital funds available for the project, later through continued revenue from primary beneficiaries. To this end, CDR will establish a Benefit Sharing Prgram to provide the means to improve community services and the local environment. The Benefit Sharing Program will be administered by CDR and will support local projects concerned with issues such as reforestation, community power supplies, eco-tourism, and assistance to NGOs as appropriate. Details of implementation of the Benefit Sharing Program will be established and operate are given in Appendix I.

8.7.2 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 principles on waste management that are applicable to many construction activities[79].

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

79 Pollution Prevention and Abatement Handbook, World Bank, 1998.

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;
- 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 risk assessment, 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 8.15.

Table 8.15: 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 as prescribed in the World Bank's Environmental Health and Safety Guidelines. Provision of protective clothing, site safety regulations, confined area working, awareness training, signage and posters, first aid facilities, accident reporting and emergency procedures

8.7.3 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 shall 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.

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 mosquito fish, 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.

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 in the upper catchment and around the periphery of the reservoir, and also to monitor reservoir depth to assess sedimentation. The development of wetland on the main contributing watercourses as well as a reforestation scheme in the upper catchment will reduce sediment load.

As discussed in the Updated Hydrological Report (DAH-NT, 2013) the reservoir has been designed to accommodate 9 million m^3 of sediment within 50 years operation. This will be provided for by 'dead storage' capacity, the volume that can fill with sediment without impacting the normal operation of the dam. Once this volume is filled, there is increased risk of incoming sediment working its way to the dam and entering the water supply transmission pipeline or the hydropower turbines.

Sediment management starts with dam and reservoir design; with the dam being designed with a low level sluice within the dead storage zone, through which the water discharged can carry some of the accumulated sediment. This will not only dispose of sediment but also flush out long-stored water that may have a tendency to turn anoxic. Also at the construction stage, areas of unstable soil and rock on the slopes of the reservoir should be excavated to reduce later collapse into the lake. Given the abrupt changes in topography between coastal plain and interior mountains, and the tendency for short duration–high intensity rainfall, the majority of Lebanese rivers yield high rates of sediment. As discussed previously, the extremities of Bisri reservoir, particularly the areas upstream of the Nahr Barouk–Wadi Bhannine confluence, where the reservoir is narrow and the water relatively shallow, may be expected to fill rapidly. Since these areas afford a minor portion of the whole storage volume, it is suggested these might be left to fill and develop wetland habitats, that as vegetation becomes established will increasingly filter out incoming sediment. Also during design, in considering upland catchment management, a series of low retention ponds, essentially walls constructed across the rivers upstream of the reservoir, that each wet season will temporarily arrest the first and often most-heavily silt-laden flood flows sufficiently to allow its coarser bed load to drop out.

Another way of reducing the impact of sediment and ultimately extending the operation life of the Bisri asset would be the construction of a series of weirs to reduce inflow velocities and promote sediment deposition before the incoming streams reach the wetlands. Much of settled material here will be coarse-grained and a potential source of building aggregate that will be (i) replenished annually, and (ii) environmentally-responsible. A portion of the turnover from the commercial exploitation of such a resource, through tariff or operating licenses or taxes on production, might be used for cultural heritage preservation and management.

Notwithstanding these measures, significant volumes of primarily silt and fine sand sediment will still reach the main body of the reservoir, and regular monitoring of sedimentation and clearance works will be needed.

The most common means of monitoring the build-up of sediment is acoustic echo-sounding on a GIS platform, allowing rapid and accurate reservoir-bottom surveys. Using proprietary software, the system can also calculate rates of accumulation and from the characteristics of the return signal, the nature of the sediment (rock, sand, silt, mud). Using different acoustic frequencies it is also possible to determine the presence of aquatic vegetation and fish shoals.

Initial geospatial data of the reservoir and its borders will be collected and digitised as a polygon shape file. From a simple stage board and fixed bench marks the water level in the reservoir will be recorded each time a survey is taken. Water temperature, which will affect the speed at which the acoustic signal will move through the water column, will be taken, and since the survey boat will be traversing back and forth over the reservoir it would be convenient to include continuously recording water quality sensors.

Correlation of survey results should be taken with spot sampling, using drop (gravity) or vibration coring to estimate sediment thickness. These samples will also provide for the analysis of sediment composition, including organic content, the origin of which will include bankside vegetation, fish excreta, upper catchment wastewater discharge, and human activities on the reservoir.

All work for an inland reservoir such as Bisri can be undertaken from a small launch fitted with an independent power supply and outboard motor and a basic navigation/tracking system working on shoreline signals.

An accurate pre-impoundment topographic map is vital if future rates of sediment accumulation are to be calculated. While a survey of the reservoir area has recently been completed, the pre-inundation topography, including borrow areas and other construction disturbance, must be undertaken immediately prior to reservoir filling. These considerations have been incorporated into the Operation and Maintenance Framework Dam Safety Plan. The project will also incorporate specific technical assistance to the BMLWE (the eventual operator of the dam) on all issues related to operation and maintenance of the dam and reservoir, including sedimentation management.

As highlighted above, the most effective means of reducing sedimentation are those measures addressed during design. When sediment build up within the main body of the reservoir does become a problem, currently expected to be only after several years of operation, the most effective means of reducing it will be by pump dredging or by bucket excavator fitted with an extended boom working off a barge. Such work should be undertaken in the autumn, when the depth of water is at its lowest, at the end of the summer supply period and before the onset of winter recharge.

Reforestation

Unregulated deforestation and expansion of cultivation practices in the upper catchment will result in progressive soil erosion leading to significant reservoir siltation, reduced ecosystem function, and more erratic downstream flows. Notwithstanding that reforestation is an expensive, labor-intensive, and time-consuming initiative, it is considered by watershed management schemes to be an effective option as to assist in stopping watershed devastation by reducing soil erosion and nutrient depletion, decreasing sediment loading in reservoirs and increase their lifespan. Forests provide with wildlife habitats, migration routes for some species, carbon sequestration, and water catchments, where they serve to maintain the hydrologic conditions required to generate hydroelectric power, irrigate crops, and supply water for industrial and household use. A judicious reforestation policy could reduce by 20% water lost into the sea and increase water availability in the country by 50-100%. Forests also supply the country with timber and may be a hub for recreational and tourism activities in the area. The reforestation plan should be of interest and benefit to the local community. It should be formulated accounting for the needs of the villagers who should be trained to recognize the importance of reforestation.

Bisri sedimentation rate is estimated at 1,000 t/m2/year, which is a relatively high rate for Lebanon. To overcome the main effects of this, designers have proposed a dead storage volume of 9 Mm3 over a 50-year period. To limit siltation and improve reservoir lifespan, some type of intervention should be undertaken, focusing on land use intervention through reforestation of the upper reaches of the catchment. Reforestation of denuded rangelands will provide improved land cover which would afford the largest sediment reductions. This provides improved catchment hydrology and water quality by reducing sediment into the lower portions of the Awali River basin. When sediment build up within the main body of the reservoir does become a problem, the most effective means of reducing it will be by pump dredging or by bucket excavator fitted with an extended boom working off a barge. Although seemingly clear that land use changes, reforestation, and corrective works affect sediment dynamics, the relative importance of each of these factors remains unclear, which is proposed for further research.

Forests are an important carbon sink for greenhouse gases. Trees naturally sequester carbon dioxide, contributing about 90% of the earth's surface carbon storage. A cubic foot of timber retains approximately 15 kg of carbon. The UN recognised carbon trading as mitigating greenhouse gas emissions. The approximate international market value of one tonne of carbon is $ 19.

Irrigation schemes, urban consumers, and hydroelectric power supply would all benefit from reforestation activities in the upper catchment areas. Reforestation would also improve water routing and channeling and hence helps control flooding events.

Because reforestation requires upper catchment producers to change their land use, economic incentives are required to redirect decision making towards more environmentally prudent production practices (Johnson et al., 2002). Whenever possible, it is wise to select lands that are *Domaine Publique* which saves the GoL the whole expropriation procedure and costs.

The success of reforestation will require a collaborative effort on the part of various stakeholders: Ministry of Agriculture, municipalities, local communities, forest managers, and ecologists. Together they would need to develop a meaningful plan to implement reforestation. This is expected to include an education outreach effort to inform the public about the issues facing the entire catchment. The implementation plan shall be based on a multi-criteria analysis taken into account benefits to local communities, location, tree types, accessibility, and ecology among others listed in the Table 8.16.

Table 8.16: Selection Criteria for a Reforestation Plan

Primary Selection Criteria	Interest of and benefits to the local community
	Public lands over which municipality has control
	Tree species that thrive in the Project area climatic and ecological conditions
	Depth of soil more than 40cm
	Soil type conductive to successful growth
	Topography conducive to planting and ensuring access to planting site
	Availability or accessibility to irrigation water
	Geographic distribution and social diversity
	Significant land area available to reforest, with a preference for more than 25 ha
Secondary Selection Criteria	Site history, favoring sites of biodiversity or watershed significance
	Grazing pressure, including the need for fencing

Large stem diameter seedlings are preferred as they resist damage caused by movement of soil, rocks, debris. They resist attacks by pests, and are more likely to survive and grow after deer browsing, are more resistant to heat stress or sunscald, and have a large amount of foliage and a corresponding large root system. Tall, well-branched seedlings grow above competing vegetation and may better overcome the ill effects of animal browse due to their many branches and buds. However, they may be more likely to topple if the site is windy or has shallow soils. Short seedlings may offer advantages on sites without vegetation competition that are droughty or very windy. However, animal browsing can be a problem, if stems have few branches or buds. Large root systems help anchor seedlings in windy sites and they offer better growth in moist or dry sites. Transplanting should be done in early spring and trees are nurtured through the summer with some assisted irrigation but very limited in the case of forest trees. For rocky sites, container seedlings are recommended.

Selection of Tree Species for GBWSAP

Given that the main forests in the Project Area are Oak and Pine woodlands, in addition to olive trees, it would be advisable to have a mix of *Quercus sp.* (like *Quercus calliprinos* or *Quercus infectoria)* in rocky sites and *Pinus pinea* and varieties of Olive trees in non-rocky ones for the reforestation plan, as they would thrive well in the established ecosystem and climatic conditions. Careful attention should be given as to the special handling and planting needs of each species taking into account different site requirements. Good quality, high vigor and healthy seedlings which can be obtained as bare root or in container should be procured from a certified nursery in Lebanon.

Characteristics of *Quercus sp.* are summarized as follows:

- Evergreen;
- Naturally found from sea level to 1800m;

- The tough evergreen leaves of the lower slopes keep water inside, with thick coverings, necessary to survive the blasting heat of summer;
- Under the canopy of trees there is an understorey of shrubs and a ground cover of plants;
- Kermes Oak (*Quercus calliprinos*) with its long thin acorns is a common part of the lowland forests as shown here at Bentael Nature Reserve in Figure 8.13
- The seeds of the oak trees - acorns are a special food for a number of animal species including the Jay, a common bird found in the Project area; and,
- The refuge for several mammals including the Badger (*Meles meles canescens*), which is a rare species that is expected to be present in the Project Area.


Figure 8.13: Kermes Oak and its Long Thin Acorns at Bentael Nature Reserve

Characteristics of *Pinus pinea* shown in Figure 8.14 are summarized as follows:

- Coniferous evergreen;
- Can exceed 25 m in height, but 12–20 m is more typical;
- In youth, it is a bushy globe, in mid-age an umbrella canopy on a thick trunk, and, in maturity, a broad and flat crown over 8 m in width;
- The bark is thick, red-brown and deeply fissured into broad vertical plates;
- Thrives well in soils derived of sandstone;
- "Flowers" in the late spring, and in the summer produces hard cones;
- In late summer, it is possible to hear the cones cracking open in the midday sun;
- New stands of *Pinus pinea* should be planted with 10% *Pinus brutia* for proper pollination; and,
- When properly cared for in its first few years, can grow surprisingly fast in the right habitat, and new trees will reach a decent size within the lifetime of today's middle-aged people.

Pine trees have high economic value because of its edible pine nuts. A single tree of stone pine can produce about 40 kg of cones. One ha of stone pine forests comprises

200 to 260 trees, from which 8,000 kg of cones are produced and 320 kg of edible pine nuts are extracted, sold at $70/kg. Pine nuts are a staple ingredient in the Lebanese cuisine used in many dishes like kebbeh, sfiha and many Lebanese sweets. The pruned wood is used for firewood, the cone shells and the nuts peel are used for heating as well, and the resin is used as a snake repellent and for medicinal purposes for goat.

Figure 8.14: Pine Trees in Bkessine-Jezzine Area

Characteristics of Olive trees, shown in Figure 8.15 are summarized as follows:

- Evergreen tree or shrub native to the Mediterranean area, Asia and Africa;
- It is short and squat, and rarely exceeds 8–15 m in height;
- The silvery green leaves are oblong, measuring 4–10 cm long and 1–3 cm wide;
- The trunk is typically gnarled and twisted;
- The fruit is a small drupe 1–2.5 cm long;
- Trees show a preference for calcareous soils, flourishing best on limestone slopes.
- Olives grow very slowly, and over many years the trunk can attain a considerable diameter.

Figure 8.15: Olive Picking in Jezzine Area

Like Pine trees, Olive trees have high economic value because of its oil and olives production. A single olive tree produces 5 kg of olives sold at 5$/kg and 10 L of olive oil sold at $6/L. One ha of olive trees comprises about 300 trees, from which 1,500 kg of olives are produced and 3000 L olive oil is extracted.

Dam Safety

A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation. Dam Safety Plans either issued to date or under preparation include:

- Construction Supervision and Quality Assurance Plan;
- Instrumentation Plan;
- Operation and Maintenance Plan; and,
- Emergency Preparedness Plan.

Details of the above mentioned reports are included herin in Appendix J.

Discharge of Waste Water from Upper Catchment Villages

One of the prime adverse impacts on the operation of Bisri dam and reservoir will be the influx of wastewater discharged from villages across the upper catchment. Since the end of the civil war, many sewerage schemes have been implemented, and collection and treatment improved elsewhere. Nonetheless, in rural catchment such as that of Nahr Bisri and its tributaries domestic wastewater makes up a high proportion of summer base flow. With the retention of water in Bisri Reservoir it will be vital for those villages still discharging to contributing surface watercourses to have a comprehensive collection networks and at least primary and secondary treatment facilities. Not to do so will risk anoxic conditions to develop within the reservoir and for the waters to become eutrophic, with the propagation of algal blooms.

Over the years, there have been a number of sewerage studies undertaken under the auspices of CDR, and the Ministry of Environment by a variety of local and international consultants. Schemes have been proposed, plants prioritised and costed, and have been compiled into the National "***Plan D'Amenagement du Territoire Libanais***", currently under implementation by CDR, which incorporates specific Catchment Management Plans, including for those areas included in the upper and lower catchment area of the Bisri dam. Detailed implementation plans for the project area will thus be developed in parallel to dam construction, to align with the Plan D'Amenagement du Territoire Libanais, and ensure sustainable operation of the dam and reduction of water quality risks post construction. The Ouardaniyeh water treatment plant has also been designed to treat water taken from the upper Bisri catchments, as they stand today. This will significantly minimize risks to public health and the environment.

With the advent of Bisri dam, it is imperative that schemes for the upper catchment area, on both the northern (Chouf) side and the southern (Jezzine) side be prioritised and completed prior to the Bisri water coming on stream. As part of the present ESIA, the consultant has looked at various documents supplied by CDR that purport to confirm that wastewater master plans for either side of the river are in place and that project execution can expedited to meet the necessary time frame.

It is impractical and uneconomic to treat each village separately and adjacent villages are grouped together into sewerage service areas to deliver their collected sewage to a centralized treatment plant. CDR's latest proposal for Chouf sewerage[80], shows sewage collection schemes serving 97 villages transmitting sewage flows to 25 separate treatment plants. Within these villages, those listed in Table 8.17 are located within the Bisri catchment.

Table 8.17: Bisri Catchment Villages in Chouf Sewerage Proposals

Benouati	Bsaba
Barouk	Mazraat ed Dahr
Balloon	Mazraat ech Chouf
Khraibe	Ain Ouzain

Proposals for sewerage of villages in South Lebanon[81] include none in the Bisri catchment.

While there are clearly sewerage plans, there has been little documented evidence that a comprehensive approach to the sewering of Bisri catchment villages is in place, has an agreed timetable for implementation, and an approved budget.

[80] CDR. *Region du Chouf: Etude du Plan Directeur et du programme des Stations d'Epuration du Chouf*. Contrat 6973 Rapport Final. Schema Directeur. Libanconsult/Cabinet Merlin, Juillet 2007.
[81] Le Bureau de Cites et Gouvernements Locaux Unis Liban, Syrie, Jordanie. Etude Portant definition de Schemas *Directeurs d'Assainissement dans 3 Federations du Sud Liban; Federation d'Iklim al Toufah*. Rapport de Prestations 5 et 6, Resume, Decembre 2012.

Given the importance of sewering the upper catchment villages to the success of the project, CDR have committed to updating existing plans and expediting a Bisri Catchment Sewerage Master Plan before Project construction.

Investment in establishing new and/or enhanced sewerage collection, conveyance and treatment facilities is key to ensuring the sustainability of GBWSAP investment. The estimated total population, by year 2020, of the 41 villages of the Bisri upper reservoir catchment will be around 85,000 based on a population growth rate of 0.8% as set by the CAS in 2010. According to the 2003 National Wastewater Strategy, some 55,000 inhabitants of these villages will already be served, although perhaps not to the extent and security of service required to sustain Bisri water quality.

Working from the 2003 strategy and applying an increase of 90% over predicted 2005 costs, the required sewerage schemes may be expected to cost approximately 190 $ per capita served and 190$ per linear meter of pipe installed. Taking the unsewered communities separately, 30,000 people in 2020 be served and an estimated 90 km of pipeline, the total cost of sewering these villages is estimated to be US$23 million, rising to US$32 million when enhanced facilities in already served villages are included to bring all catchment sewerage up to the standard that will adequately protect GBWSAP reservoir.

Land Acquisition and Resettlement

CDR will provide 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 RAP, which was informed by a detailed socio-economic survey of impacted households and business enterprises.

Grievance Redress Mechanism

Once PAPs have been notified of their compensation and a valuation prepared and received, further discussions and negotiations between individual PAPs and the PIC will be initiated. Details of the Grievance Redress Mechanism are discussed in the RAP.

Costing Environmental Degradation

Over recent years, significant interest has been paid by environmentalists to Valuing Natural Capital as well as Costing Environmental Degradation, which according to OECD (2001) [82] is defined as *"the deterioration in environmental quality from ambient concentrations of pollutants and other activities and processes such as improper land use and natural disasters."* It is therefore important that not only the impacts of projects are considered, but also the cost of these impacts relative to the value of benefits that will accrue for the project.

A case study carried out by the World Bank[83] has laid out some estimates of the cost of Environmental Degradation in Lebanon. In 2000, the cost of environmental degradation

[82] Organization for Economic Co-operation and Development.
[83] World Bank Environment Department in June 2004 on the 'Cost of Environmental Degradation- the Case of Lebanon and Tunisia'

was estimated at 2.8-4.0 percent of GDP per year, with a mean estimate of close to USD$565 million per year, or 3.4 percent of GDP[84]. With a GDP of almost $43 billion in 2012 for a population of 4.425 as per World Bank figures, the mean estimate of environmental degradation is estimated at USD$1,462 million per year. This is considered relatively high, in the order of 1.5 times higher than high-income countries. The reasons for this are manifold: (i) health costs incurred by low water quality and poor sanitation facilities, (ii) poor air quality and its impact on health, (iii) soil degradation and loss of productivity, and (iv) significant coastal zone degradation. In addition, the cost to the global environment is estimated at about 0.5 percent of GDP, that is $ 215 million using WB figure for GDP of 2012.

Economists model individual decision-making as measurement of costs and benefits. Pure private costs are the costs that the buyer of a good or service pays the seller. External costs also called externalities, in contrast, are the costs that people other than the buyer are forced to pay as a result of the transaction. The bearers of such costs can be either particular individuals or society at large. External costs are often difficult to quantify in terms of monetary values. Social costs are the sum of private costs and external costs. Figure 8.16 shows the different components of the total economic value of forests.

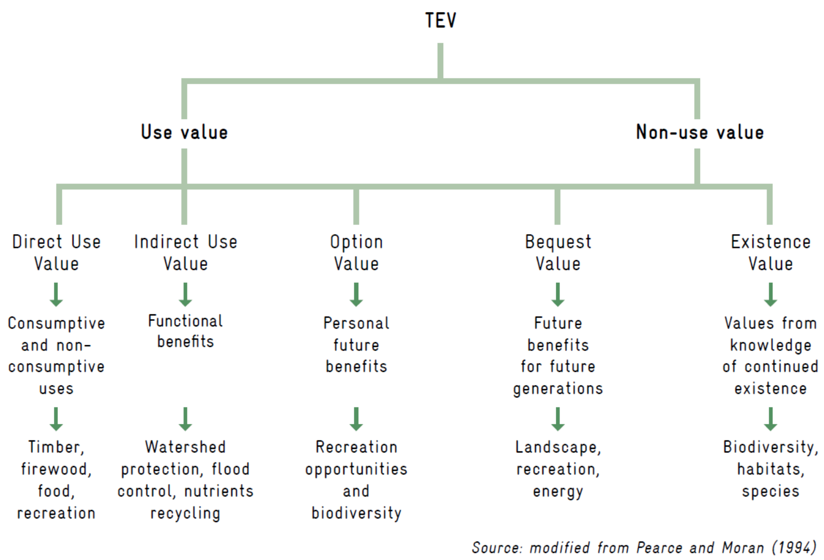


Figure 8.16: Total Economic Value of Forests85

When valuating the cost of environmental degradation, both private costs and externalities should be accounted for. In discussing the issue with the Ministry of Environment, current practice in Beirut seems to take the private cost as the real estate values as those capitalize benefits stream from different land uses be it agricultural, natural vegetation or woodland. The extent of land acquisition to include the dam site,

[84] Sarraf, M., Larsen, B., and Owaygen, M. Cost of Environmental Degradation- The Case of Lebanon and Tunisia. The World Bank Environment Department. Environmental Economic Series, Paper NO. 97, June 2004.
85 Pearce, D. and D. Moran. 1994. The Economic Value of Biodiversity. Earthscan, London.

the area inundated by the impounded reservoir, and a 15 m buffer zone around the remaining reservoir periphery to provide for shoreline access, is some 570 ha, the cost of expropriation of which may be expected to approach some $ 150 million.

Table 8.18 shows value estimates of Bisri Dam expropriation area according to land use.

Table 8.18: Value Estimates of Bisri Dam Expropriation Area

Category	Value (USD)
Expropriation Area	$120,751,312
Structures to be demolished	$1,054,590
Trees losses	$24,659,727
Other Lands attachment losses	$3,763,058
Total	**$150,228,686**

Social damage caused by environmental degradation is crucial to quantify especially in vulnerable Mediterranean ecosystems countries in general and Lebanon in particular. With a better understanding of public externalities generated by forests and natural ecosystems it becomes critical for governments to account more effectively and transparently for the cost of environmental degradation.

Despite the difficulty in estimating the current capacity for net oxygen production at Bisri, a strategic starting point would be to determine the amount produced from 1 ha mixed vegetation and multiply this by the vegetated area to be lost to the dam and reservoir. However, the determination of net oxygen production is very imprecise. Internet searches reveal a plethora of unsubstantiated figures, primarily for mature forest trees, which vary with species, condition and prevailing climate. Assuming this could be accurately determined, the monetary value of this oxygen then needs to be established. Similar imprecise strategy surrounds assigning a monetary value to vegetative carbon sequestration.

Environmental degradation within the Dam and reservoir in addition to land acquisition costs will include but not necessarily be limited to the following:

- Loss of some 150 ha of mostly prime or potentially prime Lebanese agricultural land;
- Loss of produce to local food supply chains, produce perhaps only replaced by imported produce;
- Loss of some 230 ha of natural terrestrial habitat throughout naturally-vegetated areas;
- Loss of more than 100 ha of riverine habitat, to be balanced against newly-imposed and more extensive lacustrine habitat;
- Loss of some 80 ha of productive pine woodlands and its annual crop of pine seeds;
- Loss of almost 500 ha of vegetation (area calculated as total area estimated at 570 ha minus non-vegetated area) with varying capacities to photosynthesise oxygen and sequestrate atmospheric carbon.

In the case of Bisri Dam, external costs may encompass grazing, recreation, watershed protection, carbon sequestration and biodiversity, the value estimates of which are summarized in Table 8.19

Table 8.19: Value of Natural Ecosystems Benefits in Lebanon (US$, 2010 prices)

	Total Economic Value ($/ha)
Wood Forest Products (WFPs) [a]	-10
Grazing and Non-Wood Food Products (NWPs) [b]	187
Recreation, hunting	125
Watershed Protection [c]	n.c.
Carbon Sequestration [d]	-15
Biodiversity	8
Total	**296**

Sources: Croitoru and Merlo (2005) [86] *updated to 2010 prices by GIZ*[87]

Notes: [a] *The aggregated value of WFP removals, net growth of standing timber and WFP losses to forest fires.*
[b] *The aggregated value of NWFP use benefits and losses to forest fires. NWFPs such as grazing, cork, fruits, nuts and plants, are the most important forest benefit and can contribute 40% of household income.*

[c] *the aggregated value of watershed protection benefits and the value of erosion, floods and landslides due to poor forest management.*
[d] *The aggregated value of carbon sequestered in forest growth and carbon losses from deforestation and forest fires; the monetary estimates are based on carbon prices on international markets in the year of reference, updated to 2010.*
The negative values in the table mean that the estimated social costs due to poor forest management are higher than the estimated forest benefits.
n.c. = Not calculated due to insufficient information.

The total area of lands with environmental social benefits which include forests, natural vegetation and open land is about 500 ha. Environmental costs for Bisri Dam are therefore estimated at $148,000.

The cost of environmental degradation will not simply be the cost of land and asset acquisition balanced against the cost of dam construction, or indeed the cost of those impacts expected to accrue throughout the upper and lower catchment areas. In the upper catchment, for example, the effective and efficient operation of Bisri Dam requires that each of the villages draining into Nahr Bisri have effective sewage collection and treatment to prevent the development of anoxic conditions in the reservoir. The cost of this is put at US$23 million. While the necessary construction projects will now be given a higher priority that they may have had if the dam was not to be built, they had previously been identified for future sewerage schemes under the National Wastewater Action Plan.

[86] Croitoru, L. and M. Merlo. 2005. Mediterranean forest values. In: Merlo, M. and L. Croitoru (Eds.) Valuing Mediterranean forests: towards total economic value. CABI Publishing. Wallingford.
[87] Contribution of Forests to a Green Economy in the Middle East and North Africa- Evidence, Drivers and Policy Orienta tions. GIZ. March 2013.

Also to be factored into consideration of environmental degradation costs are those associated with not implementing the Bisri project; the cost of continuing with the present dire public water supply in the face of growing demand and growing population, the environmental and social cost of not supplying 2 million Greater Beirut residents, the cost of allowing the present 120 Mm^3 annual deficit in supply increase towards 200 Mm^3 by 2020. The lack of safe potable water has an additional cost in terms of expenditure on bottled water, estimated at 0.5% of GDP per year[88] equivalent to $ 215 million. The cost of diarrheal illness and mortality is estimated at 0.5-0.6% of GDP totaling to $ 215-258 million caused by a lack of access to safe potable water and sanitation, and inadequate domestic, personal and food hygiene. Most of those impacted are children.

The cost is not simply that of alternative sources, which the present study has shown not to be as effective as Bisri, but also the cost of potential political unrest during long, hot and waterless summers.

Artificial lakes and reservoirs almost anywhere in the world attract induced development – hotels and villas on the overlooking hillsides, shoreline properties, resorts and water sports centres, together with attendant public infrastructure and community services. Bisri may be different, but the severity, and ultimately the cost, of the additional degradation will depend on the degree of control, the formulation and strict imposition of environmentally-responsible development guidelines.

These additional costs will apply equally to areas upstream and downstream of Bisri reservoir where similar losses occur. More specifically, dam construction will cause ecological changes due to the alteration in the natural environmental flows below the dam with direct impacts on water user abstractions and the environmental flows needed to maintain bankside vegetation and aquatic ecology. Most noticeably perhaps, the dam will affect irrigation practices by reducing the access of crops to water. If the soil dries out in the summer months, the structure will weaken and subject it to wind erosion. Irrigated areas will progressively reduce and once productive land will be abandoned and the cost of subsequent rehabilitation will be high. The lower controlled flows below of the dam may also severely impact any recreational use of the river and reduce the aesthetic appeal of riverside restaurants.

Large reservoirs commonly trigger a change in the local microclimates by increasing air humidity and altering wind patterns, perhaps influencing changes to crops and living conditions on adjacent hillsides. Houses on the lower slopes of the reservoir may see an increase in air-conditioning costs. Mosquitoes and other vectors that favour damp humid breeding sites may increase in numbers and potentially impact human health.

It is reasonable to assume that Bisri reservoir will eventually have a peripheral road skirting its shoreline, be it an unsurfaced track for BMLWE operatives to access the shoreline to clear seasonal vegetation, or a major highway serving waterside properties. Dam construction will therefore increase car and vehicle use in a once remote area,

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88 Sarraf, M., Larsen, B., and Owaygen, M. Cost of Environmental Degradation- The Case of Lebanon and Tunisia. The World Bank Environment Department. Environmental Economic Series, Paper NO. 97, June 2004.

contributing ozone-depleting exhaust emissions as CO_2, CO, CH_4, NO_x, SO_2, and HFC. According to the USEPA, the annual emission of a passenger car travelling 19,000 km per year is 5.1 tonnes of CO_2 equivalents (USEPA, 2011). In Lebanon most cars do not travel more than 8-10,000 km/year, suggesting annual CO_2 emissions around 2.5 metric tons per Km. The cost of 1 tonne of CO_2 equivalent is estimated at $15-19[89]. Once road usage is determined and a *Master Plan for Shoreline Development* is in place, the contribution of vehicular traffic, currently almost zero in the reservoir area, can at least be estimated.

In summary, the costing of environmental degradation in Lebanon in general and for the Bisri project in particular is hampered by a dearth of reliable information and cost significance. Nevertheless it is clear that the cost of degradation resulting from the construction of Bisri dam and the inundation of a large area of land will be substantially less than the failure to supply the growing population of Greater Beirut with a reliable good quality public water supply.

8.7.4 Summary of GBWSAP Impact Mitigation

In summarizing the mitigation measures proposed for the Bisri scheme, Table 8.14 builds on the risk of individual impacts previously given in Table above, and provides an assessment of the risk associated with post-mitigation residual. 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.

summarises the costs of the major proposed environmental and social impact mitigation measures.

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.

[89] Ecosystem Marketplace, 2011. Back to the Future. Bloomberg New Energy Finance based on 2010 Market. New York, US.

Table 8.20: 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
Land Take	Loss of natural landscape	Expected	Moderate	Locate reservoir to minimize land take and loss of natural landscape per unit volume impoundment.	Designer
Land Take	Land take for `resettlement and/or relocation of PAPs	Unavoidable	Minor	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
Land Take	Loss of existing communities	Not Expected	n/a	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
Land Take	Loss of individual homes	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
Land Take	Loss of non-agricultural business premises	Not Expected	n/a	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
Land Take	Loss of productive land	Unavoidable	Major	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
Land Take	Loss of temporary employment	Unavoidable	Major	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
Land Take	Loss of permanent employment	Expected	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
Land Take	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
Impoundment	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
Impoundment	Loss of natural vegetation	Unavoidable	Moderate	Increase planting around reservoir;	Designer
Impoundment	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

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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. Promote reforestation of upper catchment slopes. Monitor reservoir depth to assess sedimentation. Operate reservoir to minimize sediment build-up. Allow for sediment loading in structural design.	Designer and Operator
	Loss of capacity and sediment build-up at dam	Expected	Moderate		
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
	Soil Erosion and Sedimentation	Expected	Moderate	Promote reforestation of upper catchment slopes and the expansion of existing forests.	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 and solid wastes systems for villages throughout the upper watershed in accordance to GoL master Plans.	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	

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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	Moderate		
	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	Minor	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	Positive	Promote reforestation and areas of dense shrub.	Operator
	New farming fish species	Expected	Positive	Ban the introduction of exotic species such as trout, bass, tilapias, and mosquitofish. Promote the user of native species.	Operator
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
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.	

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	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	Major	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	Major	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	n/a	Power generated at dam to be used at dam. New turbines for network distribution to be located at existing plant will utilise existing cableways.	
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

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Importation of contagious diseases	Expected	Minor		
	Fuel spillage and waste oil disposal	Expected	Moderate		

Likelihood

	Not Expected
	Expected
	Unavoidable
	Not Applicable

Likely Severity

	Minor
	Moderate
	Major
	Positive
	Not Applicable

Table.8.21: Summary of Proposed Environmental and Social Impact Mitigation Measures and Estimated Costs

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
Land Take and Resettlement	Archaeological rescue and safe storage of artifacts	DGA and Project Proponent	Consultant's estimates with storage site acquisition, clearance, fencing and buildings	$2.0
	Relocation of Mar Moussa Church, St. Sophia's Monastery, and architectural salvage	Maronite Diocese of Saida and Project Proponent	Deconstruction and reassembly of main walls, demolition and replacement of church interior vaulting.	$0.5
Impoundment	Increase planting around reservoir.	Operator and MoA	Tree band 12 m wide, planted on a 3 m grid, over half the reservoir periphery	$3.0
	Design and install provision for mechanical mixing where natural circulation insufficient.	Designer and Contractor	Included in construction costs	n/a
Sedimentation	Promote development of wetlands.	Operator	Promotion budget only	$0.1
	Promote reforestation of upper catchment slopes	MoA and Municipalities	Promotion budget only	Included above
Upper Watershed Management	Promote reforestation of upper catchment slopes and the expansion of existing forests.	As above	Promotion budget only	Included above
	Compensatory planting of natural tree cover	Project Proponent	As RAP	$1.5
	Adopt integrated planning, a strict ESMP, and effective enforcement.	GOL, DGUP, Project Proponent & Municipalities	Of wider benefit that GBWSAP and should come from GOL budget	n/a
	Develop sewerage and solid wastes systems for villages throughout the upper watershed.	Project Proponent, MEW, and Municipalities	various documents supplied by CDR	$23
Lower Watershed Management	Design and provide for multi-level releases to avoid the discharge of anoxic water, and for downstream aeration.	Designer and Contractor	Included in construction costs.	n/a
	Design and provide for energy dissipation from dam outflow and sediment trap	Designer and Contractor	Included in construction costs.	n/a
Biodiversity and Habitats	Biodiversity Management Plan	Ecological Consultant	Biodiversity specialist and species specialist part-time for pre-construction, construction and reservoir filling.	$0.7
Agriculture	Provide agricultural extension to promote low water-use crops species and irrigation practices.	MoA and MEW	Extension office for 2 years, with vehicle, admin support, etc.	$0.5
	Provide compensatory discharge to leach soil salts.	Operator	Included in construction costs	n/a
Public Health and Safety	Implement health awareness and water safety campaigns.	MoH and Operator	Awareness and safety campaigns	$0.2

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
	Spray mosquito breeding sites if necessary.	Operator	Operator, protective clothing, water-safe chemicals, labour, 3 applications/year	$2.0
	Provide for Public Safety at dam site	Designer, Contractor and Operator	Fencing and signage (Included in construction costs)	n/a
	Develop and implement an Emergency Response Procedures.	Designer, Operator, Civil Defense and Municipalities	Included in GOL costs	$1.0
Construction Issues	Contractor to develop and execute a comprehensive Construction Environmental and Social Management.	Project Proponent, Contractor and Construction Manager	Included in construction costs. 'Best Practice' construction only.	n/a
Biodiversity Management Plan (Implementation and Monitoring)	As detailed in the Biodiversity Management Plan	As per Biodiversity Management Plan		0.64
Total Costs of Mitigation beyond normal Design, Construction and Operation				c. $35.1

8.8 Environmental and Social Monitoring

8.8.1 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.

8.8.2 Key Performance Indicators and Standards

The Key Performance Indicators and Standards for the project are listed in Table 8.22.

Table 8.22: 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 World Bank Health and Safety Guidelines 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

8.8.3 Environmental Monitoring and Reporting

The mitigation measures to be adopted to minimise potentially negative impacts during construction can only be determined via an appropriate monitoring programme. Such programme involves the objectives below:

- Monitor any significant changes to the project physical, chemical, biological and social 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 focuse on the safety and development of the upper catchment of dams, the quantity of reservoir inflows and outflows, and water quality within the reservoir and delivered to supply, in addition to the installation of infrastructure especially wastewater and tree planting to reduce soil erosion.

Baseline Condition Monitoring

Baseline measurements of existing surface water flows, their quality, and sediment loading should be taken to provide values against which to measure the expected future impacts of the project and thus to which operational monitoring can be assessed.

The proposals for the baseline monitoring of water quality and flow have been highlighted in Section 4.9 *Water Quality*, above. The TOR for an appropriate Consultancy Contract to run up to the time the dam is commissioned is given in Appendix K.

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. Visual inspections by water establishments should be provided monthly around the reservoir and weekly around the dam.

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. Areas of high impact sites will be inspected monthly. Other major activities of less impact level should be inspected every 3 months, while a general site inspection will be undertaken twice per year.

Daily site reports will be tabled at monthly Progress Meetings, at which *Environmental Issues* will be a specific agenda item specifying details on the location, activities, facilities as well as proposing remedial actions. 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. During the preparation of any or all reports, access will be granted to the more routine and more frequent site inspection records retained by the construction manager as part of his normal duties.

Financing of the environmental site inspections and their reporting 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 on a regular basis and will be reported as part of the project quarterly progress reports. 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 CDR.

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.
- If the PAP is not satisfied with his award and according to the standard appeal procedures, a representation to Appeals Committee may be made, but both the cost of representation and the time to receive a decision may be a significant deterrent, particularly to poorer PAPs.

To overcome additional costs and delays in solving compensation disputes, often experienced in adopting the standard appeal procedures, a Grievance Redress Mechanism (GRM) could be initiated once PAPs have been notified about his compensation value and before any Appeal recourse. This procedure helps in settling grievances amicably through Local Authorities. It genrally precedes the appeal to the court and is readily accessible to all PAPs. Each complaint is assessed on a case by case basis. GRM could challenge the compensation value but neither the Expropriation Act nor the Land-Take over decision. PAP that is deemed significantly affected by the Project may claim additional forms of assistance.

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, the Ministry of Environment, and Ministry of Energy and Water. Bi-Annual reports should also be uploaded to the CDR GBWSAP web page. Copies shall also be made available for public consultation.

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.

Two types of land acquisition monitoring exist, the internal and external monitoring.

Internal Monitoring:

The internal monitoring of the Resettlement Action Plan (RAP) will be undertaken by the Community Liaison Officer (CLO).

The CLO and his staff will:

- Facilitate the work of the external and independent monitors through effective record keeping and the preparation of periodic Project Progress Reports; and,
- Monitor the progress of the RAP implementation against predetermined performance targets.

External Monitoring:

Progress in the implementation and monitoring of the RAP and associated mitigation measures will be reviewed as a key element of project supervision missions undertaken by the World Bank and other agencies. These missions would include field review of implementation efforts and identification of problems, which may occur. Review of RAP implementation will also be included in the Mid-Term Review and the Implementation Completion Report, which are prepared for all World Bank supported projects.

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. Effective auditing will be established by the environmental and Social Advisory Panel.

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. The 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.

Environmental and Social Advisory Panel

As previously discussed, an Environmental and Social advisory panel will be appointed to provide independent review of, and guidance on, the treatment of environmental and social issues associated with planning, design, construction and operation of Bisri dam and reservoir from the date of their appointment, which should be imminent, to a period expected to be not less than 3 years into dam operation. The Panel will meet twice each year and make its findings and recommendation to the project proponent and the World Bank, for whom they will also provide oversight of safeguard policy requirements.

Monitoring Programme

The proposed programme of environmental and social monitoring is summarized in Table 8.23 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.

Summary of Environmental Monitoring Requirements

A summary of environmental monitoring reporting and costs is given in Table 8.23.

Table 8.23: **Environmental Monitoring Reporting and Costs**

Activity	Reports	Implementation Structure	Estimated Costs	Total Estimated Costs	Budget Assignment
Site Inspections	Individual Visit Reports Summary Reports every 6 months	CM reporting to CDR	150,000$	150,000$	CM budget
Environmental Quality Monitoring	Quarterly Reports	CM reporting to CDR,and MOE	Pre-Construction 50,000$/year Construction 50,000$/year Post-Construction 30,000$/year	Pre-Construction 400,000$ Construction 1,000,000$/year Post-Construction 500,000$/year	CM EMP Budget
Monitoring by Construction Manager	Included in Monthly Construction Progress Reports	CM to CDR	Included in contract supervision	-	CM Budget
Bi-Annual Environmental Reporting	Bi-Annual Reports during construction	CM reporting to CDR and MoE	30,000$/year	300,000$	To CM EMP budget
Land Acquisition Monitoring	In accordance with RAP implementation requirements	CDR and Independent Monitor reporting to GOL and FA	Included in RAP implementation costs		To CDR RAP budget
Operational Reporting	Internal BMLWE Reports	BMLWE reporting to MEW	20,000$/ year	100,000$	To BMLWE Budget
Environmental Auditing	Annual Audit of operational EMP implementation	MOE reporting to MEW and BMLWE	20,000$/year	100,000$	To MOE budget in agreement with CDR
Total Monitoring Reporting Costs				2,650,000$	

Note: Total Estimated Costs are calculated for 5 years of operation

Table 8.24: Environmental Quality Monitoring Requirements

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
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 and throughtout operations	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	US$330,000 (including staff costs)
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	US$600,000
Biodiversity Management	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$667,000	US$667,000
Rescue Archeology and Heritage Relocation	Archaeological finds unearthed and documented	Marj Bisri	Excavation, observation and documentation	Ongoing until completion of construction	Seasonally	To make sure implementation strategy is implemented	Archaeologist	DGA	US$ 500,000	US$ 500,000
	Structures removed and reconstruction	Mar Moussa	Dismantling and reassembling	Prior to construction	Monthly	To address community concern for heritage	Building conservationist	DGA	US$ 2,000,000	US$ 2,000,000
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	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	-

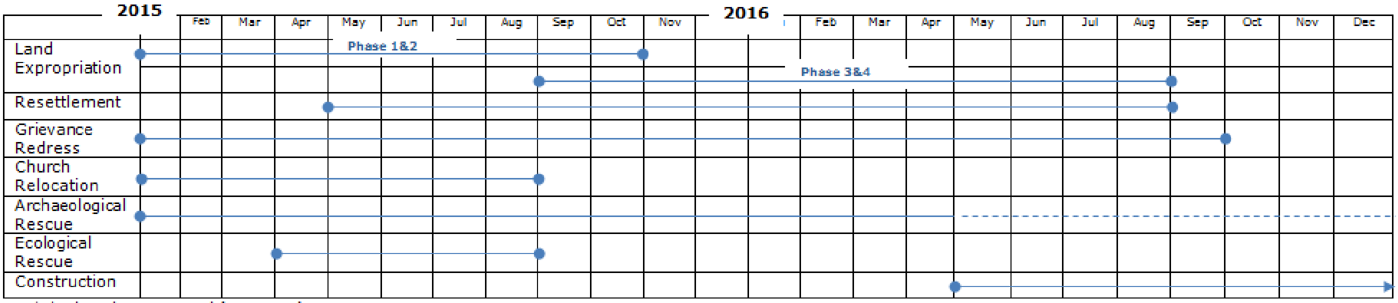
Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
Noise	Lebanese ambient noise standards	At selected sensitive receptors	Ambient noise monitoring equipment of approved manufacture	Over 1 hour during the working day	On 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	US$ 5,000
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	Throughout construction and every 3-5 years, post construction	To identify early warning signs of potential failure	Dam Safety Inspection Panel	BMLWE/CDR	US$ 25,000 per inspection	US$ 25,000
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$1,000 per sample	US$ 30,000
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	US$ 30,000
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	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	US$ 50,000
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	US$ 50,000
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	-
Total Monitoring Costs										**US$ 4,507,000**

Note: Total Estimated Costs are calculated for 5 years of operation

ESMP Planned Implementation

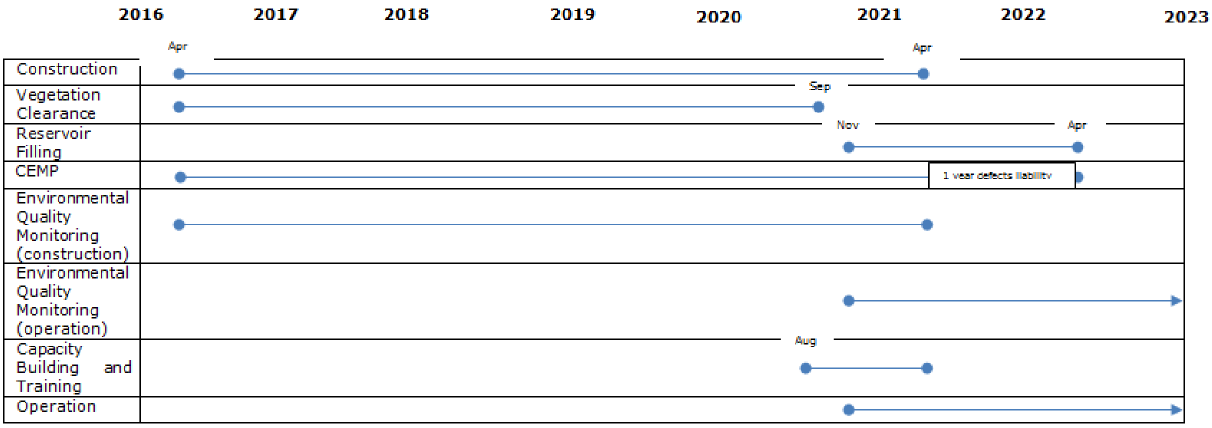
The following Tables show the proposed schedule for the implementation of the ESMP pre-construction, during construction, and during operation.

Pre-Construction ESMP Implementation



*Final Project Approval (Day Zero)

Construction and Operation ESMP Implementation



8.9 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. It is therefore expected that the BMLWE will also take responsibility for the operational management and maintenance of Bisri Dam and Reservoir.

8.9.1 Institutional Structure and Responsibilities

The prime institutional stakeholders in respect of expected management structure and responsibilities are shown in

Figure 8.17 and Table 8.25, respectively

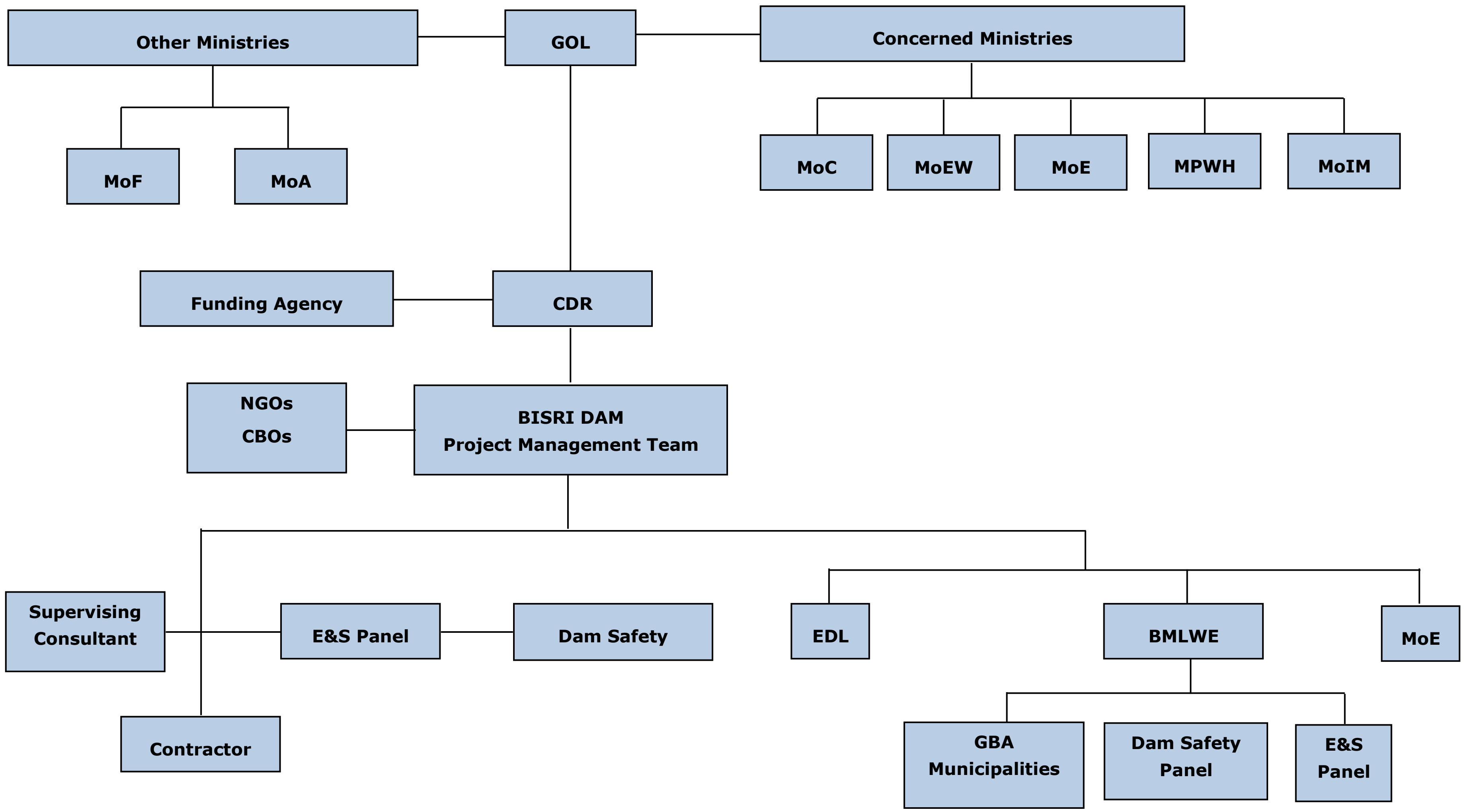


Figure 8.17: Institutional Structure for Bisri Dam Management

Table 8.25: Prime Institutional Stakeholders for ESMP implementation and 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 of the dam and its appurtenances, implements MEW policy, ensures environmental yields are delivered to riparian owners. Maintains the dam, the reservoir shoreline and operational monitoring. Facilitates dam safety and E&S panel inspection visits. Responsible for public safety including the maintenance of warning signage. Manages structures and water resources downstream of the offtake upstream of the Joun power plant to the Awali Conveyor, the treatment plant, post-treatment distribution, leakage reduction, cost billing, etc.
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.
DGA	Collection of pottery shards, glass and other artifacts from surface soils and shallow excavations at previously identified sites; Trial pitting and/or geophysical surveying at selected sites where buried structures may be present; Major excavation and the removal of material at Marg Bisri Roman temple; Excavations in the vicinity of Mar Moussa Church and the remains of St. Sophia's monastery. Archaeological finds unearthed and documented during construction
Diocese of Saida	Deconstruction, removal and reconstruction of Mar Moussa Church and of St. Sophia's Monastery; and, Scavenging old building materials from the ruins of 19-20th century houses to provide for new construction adjoining the relocated Mar Moussa Church.
Concerned Municipalities	Implementation of Land Expropriation Procedure
MoSA	Implementation of the RAP especially regarding refugees registered at the UNHCR
UNHCR	Assist the 79 registered UN refugees with resettlement to UNHCR designated refugees camps if they are willing to. Facilitate the other 23 non-registered refugees to get registered with the UNHCR and eventually assist them with their resettlement to refugees' camps.
LRA	Manages the two hydropower plants ancitipated through the Bisri project to offset lost hydropower at the Charles Helou power plant.

Operational Management

While CDR will oversee the implementation of dam construction and associated activities, MEW will become the de facto 'owner' on behalf of GOL. Two entities, both working under the tutelage of the Ministry will be involved in operational management; the BMLWE will take responsibility for operating the dam, discharging water to the treatment works and power plant, maintaining environmental flows, maintenance of the reservoir and the management of water quality, operation of the transmission system and the treatment plant. BMLWE will also be responsible for all aspects of onward supply and distribution to greater Beirut consumers.

BMLWE has the key role in water supply and treatment operations, distribution, billing and cost recovery for a service area that extends to 2205 km^2 and more than 2 million customers. Under Law No. 221 of 2000 and subsequent amendments water establishments are responsible for:

- Planning, building,, operating and maintaining potable and irrigation water transmission and distribution networks;
- Planning, building,, operating and maintaining domestic sewage collection networks and treatment plants;
- Ensuring the quality of water supplied to consumers;
- Recommending to GOL tariffs for water, irrigation and wastewater on the basis of prevailing socio-economic conditions;
- Oversee works, studies, and operations by private service providers.

BMLWE came into operation in 2005 and has managed 475,000 registered connections and supplies an estimate 176 MCM of water annually from springs, wellfields and surface reservoirs. The area that will benefit from the Bisri scheme covers some 210 km^2 between Nahr Damour and Nahr el-Kalb Rivers, and between the Mediterranean coast and an elevation of 300-400m.

The key water facility currently under BMLWE management is the water treatment plant at Dbayeh where Jeita/Qashqoush spring and ground waters are treated before being conveyed to Greater Beirut. In addition, BMLWE is assigned responsibility for distributing potable water from Chabrouh WTP to Kesrwane and Metn.

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 releases for the generation and distribution of hydropower. GBWSP initiatives in water saving such as household metering, a volumetric tariff structure and reduce leakage will greatly improve operational efficiency and increase cost-recovery. With the Ministry of Agriculture, improved agricultural extension services need to be established to help upstream farmers reduce agro-chemical use, and downstream farmers to improve irrigation efficiency and reduce the volumes of water taken from the river. Premiums might be introduced for the production of organic crops, and compensation in kind; perhaps priority planning permits for landowners relinquishing their Rights to Water, introduced.

Day-to-day dam managerial tasks required throughout the year, despite the expected 6-month-operational period, 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 and Environmental and Social Advisory Panel inspections and implement their recommendations.

The tender documents will state clearly that it is the Contractor's responsibility to get all necessary permits from the concerned authorities and the CDR will only help in releasing the necessary letters to the concerned authorities. Some of these permits are:

- Environmental permit from the Ministry of Environment
- Permit for road construction from Ministry of Public Works
- Permit for deforestation from Ministry of Agriculture
- Building Permit from Urban Development Department, a subdivision of the Directorate General of Urbanism
- Permit for Quarries exploitation from the High National Council of Quarries, which is part of the Ministry of Environment

Operational Employment

The operation of Bisri dam and reservoir will necessitate a wide range of different skill sets. The types of staff required are expected to include those listed in Table 8.26. 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 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 8.26: Likely Requirement for Bisri Dam Operational Staff

Position	No.	Prime Responsibilities
Bisri Site Manager	1	Overall management and organisation. Oversight of development proposals

Position	No.	Prime Responsibilities
Deputy Manager Water Supply	2	Oversight of all water supply activities and the release of environmental flows
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 all electrical equipment including the small hydropower unit at the dam
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. Additional employment is also likely to be generated by the expansion of hydropower generation at the existing Awali plant.

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

BMLWE must be *statutory consultees* 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 applications as they arise.

8.9.2 Institutional Strengthening

MEW and BMLWE will each need to establish specialist departments to oversee the management and efficient execution of their various responsibilities in respect of Bisri

Dam, and to provide for the operation and management of future dams projects 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.

8.9.3 Capacity Building and Training

In addition to the requirements for institutional strengthening identified in the previous section, the lack of dam management and operational experience extends to individuals. The operation and maintenance of Bisri dam will require a substantial programme of capacity building, particularly in the following activities:

- The operation and maintenance requirements of installed equipment;
- Operational management and supervision of large dams;
- The legal aspects of 'Rights to Water' and their practical implementation;
- Master planning development and oversight; and,
- Agricultural extension.

These requirements will need to be satisfied through a range of mechanisms including:

- The new employment of suitably qualified managers and maintenance staff;
- Training schemes for selected existing staff; and,
- Subcontracting 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 relevant 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. On completion of construction, the contractor will be expected to compile a comprehensive Equipment Manual giving details of every item of mechanical, electrical and electronic equipment installed. This will include details and specifications of each item together with information on its operation and maintenance. The Contractor should ensure pre-identified BMLWE staff be trained on O&M procedures for the installed equipment. For selected items, generally the heavier duty and/or more sensitive items, the construction contract should allow for relevant staff to travel overseas for on-the-job training or for representatives from the manufacturers to be brought to Lebanon to train staff locally, as is appropriate for the particular equipment.

Notwithstanding the potential for training O&M overseas, selected BMLWE operations staff proposed for supervisory positions should be given the opportunity to visit and receive detailed briefing, including hands-on training, at dams of similar size and purpose outside Lebanon. Such training may be best undertaken in countries such as Algeria, France, Morocco, and Turkey, each of which have a large number of operational dams and also afford little or no language barrier to Lebanese workers. Such training may be provided through unilateral aid.

With few large master planning exercises outside the Beirut Central District, undertaken and managed by Solidere, and various urban expansion plans for the main cities and towns, capacity building in managing and executing urban plans in the public sector in While for the development of comprehensive Master Plans for both the development of the Bisri Reservoir Shoreline and adjacent hillsides, if this is indeed to be permitted, and for the installation of sewerage throughout all upper catchment villages, may be expected to be let to suitably qualified and experienced consultants, it will be necessary for CDR, MEW, DGUP, MOE, MOSA and municipalities to have staff trained in the oversight of such projects with the capability of making a meaningful and appropriate contribution to plan development.

Internal capacity building is likely to be required within MEW's legal team, to allow them fully understand the issues surrounding the 'Right-to-Water' in Lebanon, in particularly the rights of downstream riparian owners.

While MOE and the construction manager can be deemed to already have a good understanding of the environmental quality monitoring required under the CEMP, the CM environmentalist and the contractor's environmental specialist will arrange a seminar for MOE oversight staff on site. Held during the mobilisation period, this training will provide familiarity with the site, confirm the parameters to be measured, the equipment to be used and other details of the monitoring programme. Prior to commissioning, BMLWE staff responsible for operational environmental monitoring will also need to be trained, by the CM environmentalist and/or as part of the operational training of installed equipment, as is seen to be appropriate at the time.

While MoA already provides extension services, the consensus among experienced agriculturalists is that this 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 should therefore be provided.

Of particular concern during both construction and operation will be Health and Safety. Aspects of Dam Safety and Public safety have been respectively discussed in Sections 8.4.3 and 8.4.4 above, the capacity for which is primarily provided for through the Dam safety Panel and the public signage and limitations on access incorporated into construction requirements. Of particular concern in respect of the need to build capacity will be occupational health and safety, for both temporary construction workers and for the permanent operational staff of Bisri Dam and reservoir.

As part of Dam design, Emergency Preparedness has been addressed in respect of dam failure and discussed in Section 8.2.3.2 above, but the response mechanism established will also serve other emergencies such as fire, explosion, bomb threats and spillage of hazardous materials into the reservoir. Plans for individual incidents will be determined by the dam operator.

Extensive capacity building will be required in respect of occupational health and safety during construction and the Contractor's CEMP for the project will contain detailed H&S requirements and procedures. The appointed contractor and the construction manager (supervision consultant) will have dedicated H&S officers attached to their teams on site.

In unison, these officers will hold training courses for all contractors and construction management staff at all levels from project manager through site supervisor and foreman to labourer. Approved sub-consultants and sub-contractors will undergo the same training, as will regular visitors from CDR, MEW, DGA, MOE, BMLWE and other organisations. Occasional (day) visitor's will be briefed on H&S requirements before they are allowed to pass from the reception area to construction areas. The contractor's H&S provisions will also include his activities in respect of labour camps and borrow areas, and staff using these will also undergo the training courses.

Training will also be given to relevant staff for specifically hazardous duties, such as handling hazardous materials, working in confined spaces, and electrical safety.

8.9.4 Cost of Capacity Building

Although significant capacity building has been identified, much of the cost will be inherently included via the application of 'best practice' construction and operational procedures. Much will also be achieved with time and covered by increased revenue from BMLWE consumer subscriptions.

As part of the establishment costs, the dam operator will immediately need to build capacity in dam management and operation. As recommended above, it is expected that the Deputy Managers for Dam Safety and reservoir operation, listed in Table 9.14, will need a minimum of two-month on-the-job training with an experiences dam O&M organisation outside Lebanon. The Senior Engineer, specialist engineers and technicians, also listed in Table 9.14, 15 persons in total, should be seconded to work with the contractor's M&E team and specialist supplier's sub-contractors during equipment installation, testing and commissioning.

The cost of this training and capacity building is estimated as follows:

For the Deputy Managers:
2 persons each sent for 2-month dam management training overseas
at $18,000/person/month: US$72,000.

For the Engineers and Technicians:
15 persons each seconded to the contractor for 1-month
at $8,000/person/month: US$120,000.

Total capacity building costs specific to Bisri Dam immediate requirements: US$ 192,000.

8.9.5 Total Costs of the ESMP Implementation

Table 9.16 summarizes the total costs of the ESMP implementation assigned for mitigation measures, monitoring, monitoring reporting, and capacity building.

Table 8.27: Total Costs of ESMP Implementation

Mitigation Measures	$34,500,000

Monitoring	$ 4,507,000
Monitoring Reporting	$2,650,000
Capacity Building	$ 192,000
Total Costs of ESMP Implementation	**$ 41,849,000**

9. CONSULTATIONS AND COMMUNICATIONS

9.1 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*[90] (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 the whole period of the ESIA study. **Section 10.4** summarizes the public sessions held to disseminate the findings of the ESIA.

Section 10.5 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.

9.2 Scoping Consultations

At the outset of the EIA process, the preparation of the 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 2012. Finally, two separate sessions were held for Beirut residents, the prime GBWSAP beneficiaries, at Hadath Municipality on Tuesday 24 April 2012 for southern suburb residents and in Downtown Beirut at Beirut Municipality on Saturday 5 May2012 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 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 are given in Appendix L herein.

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[90] GBWSAP Consultations and Communications Programme. Dar Al-Handasah (Shair and Partners) Doc. No. L12002-0100D-RPT-ENV-01 Rev1, February 2012.

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.

9.3 ESIA Consultations

One of the difficulties in undertaking 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 Analysis of Alternatives, 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, Moukhtars 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.

The safeguards (ESIA and RAP) consultant presented the results and recommendations of the ESIA study in different venues for institutional stakeholders in 2013, for local PAPs in the villages in the vicinity of the proposed Bisri dam, and for Greater Beirut residents. The date and timing of all meetings were agreed with individual municipalities. The village sessions were scheduled at weekends and early evening's week-day for Beirut Water Consumers to allow the maximum number of concerned people to attend.

The series of ESIA consultation sessions carried out by the Consultant in 2013 is summarized in Table 9.1.

Table 9.1: List of ESIA Consultation Sessions in 2013

Time	Place	Audience
30/12/2013	CDR	Institutional Stakeholders
02/02/2013	Midane Municipality	PAPs
02/02/2013	Mazraat El Daher	PAPs
06/02/2013	Hadath Municipality	GBA consummers
09/02/2013	Ammatour Municipality	PAPs
09/02/2013	Mazraat El Chouf	PAPs

Key issues raised in the consultations included: (i) need to gain access to drinking water, (ii) ensuring access to jobs and other opportunities for tourism, (iii) need to preserve archaeological, historic and cultural heritage such as Mar Moussa church and other historical ruins, (iv) need to access productive land upstream and downstream of Dam; and need for people living in the vicinity of Dam to benefit from water supply as the Beirut residents, (v) means of compensation for land take and fairness of compensations for expropriated lands, (vi) the returns for such project on local residents in economic and employment terms, (vii) issues of sewage, sanitation and wastewater before and after Dam construction, and (viii) protection of environment from pollution. These issues have been addressed in project design through detailed planning in the compensation/resettlement process, and environmental management aimed at sustainable use of resources (water, land, etc.,)

Following revisions to the ESIA and RAP consequential upon changes to Dam design, land expropriations requirements, completion of the household survey and the establishment of indicative costs, further sessions of public consultation were held as follows:

Date	Location	Time	Venue	Attendees
Friday 25 April 2014	Aamatour	10.00am	Dar Ammatour	PAPs
	Mazraat El Chouf	3.00 pm	Municipality Hall	PAPs
Saturday 26 April 2014	Bisri	10.00am	Church Hall	PAPs
	Mazraat El Dahr	3.00 pm	Municipality Hall	PAPs

In addition to the attendees noted above and given on the list of attendees, the following were also present to undertake the presentations and respond to comments from the floor:

Organisation	Persons
ESIA/RAP Consultant	4
CDR	2
World Bank	1
Dam Design Consultant	2

Attendees were predominantly male. Those females that did attend were as follows:

Location	Number	Details
Aamatour	None	-
Mazraat El Chouf	2	1 municipality office employee 1 young daughter with her father
Bisri	4	1 wife accompanying her husband 2 sisters
Mazraat El Dahr	None	-

One month prior to these sessions, on Wednesday 26 February, copies of plans showing the extent of proposed expropriation together with a list of plot numbers was posted in each of the four meeting venues for public reference. The scale of these diagrams was such that plot numbers could easily be distinguished. During each of the sessions, the ESIA/RAP consultant erected special display panels showing the plots affected. At two locations, Mazraat Al Chouf and Bisri, the original diagrams were still in place but considerably faded. At the other two sites the municipality had removed the diagrams from the walls but kept them available for public reference. At all four sites on the day of the sessions new copies of the plans were given to each municipality for future public reference.

Each of the four sessions followed the same general format:

- Distribution of hand-outs and attendance sheet;
- Short introduction by CDR;
- Introduction by ESIA/RAP Consultant, explaining the purpose of the session, introducing those present from CDR and the consultants, and explaining the current status of the project;
- PowerPoint slide presentation of ESIA study and its outcome;
- PowerPoint slide presentation of the RAP, with specific details of land expropriation procedures, grievance redress and indicative rates of compensation;
- The majority of each session was then open to receive comments and concerns from the floor.

The main comments received are given below. In addition, two of the municipalities (Mazraat El Chouf and Bisri) submitted pre-prepared comments, while one of the attendees at Bisri, a lawyer representing several landowners, drew up a petition at the end of the session to which several landowners appended their signature. The petition stuggests the possibility of passing a law regarding the establishment of a company for Bisri Dam where landowners are shareholders. A small number of people, refused to sign the attendance sheet, while some other refused to acknowledge their comments in writing.

The overall attitude of all four audiences was strongly opposed to the construction of Bisri Dam. At Aamatour, barely has the introduction to the session been completed when for several minutes the meeting descended into uproar as attendees stood and shouted their opposition. At the other three sessions the presentations were received more politely, but at each, mild uproar again resulted when the indicative rates of compensation, everywhere considered far too low by attendees, were displayed. As was always anticipated, the majority of comments raised from the floor concerned land expropriation and asset compensation.

Main issues raised by PAPs in the four villages included: (i) need to allocate water and power generated by Bisri dam to neighbouring villages and account for irrigation needs, (ii) benefit of project should go to villagers not GBA residents to encourage them to stay in their villages, (iii) loss of productive land and biodiversity, (iv) cash compensation is not enough especially that land has an inheritance value to landowners, (v) PAPs want to get involved in property valuation, (vi) municipalities should benefit from Bisri dam revenues and get yearly compensation to invest in development in neighbouring villages, (vii) need for access roads to villages, (viii) need to relocate historical and archaeological remains, (ix) study desalination as an alternative, (x) need to study risk of seismicity, (xi) need for wastewater treatment schemes in villages in the upper catchment, (xii) surface water quality, (xiii) pesticide residues in water, (xix) vector-borne diseases and bad odours in the Project area, (xx) increased water salinity and impact on agriculture and residents, (xxi) possibility of creating several ponds instead of a large dam, (xxii) possibility of passing a law for the establishment of a company for Bisri dam similar to Solidere where landowners are shareholders, (xxiii) relocate the proposed dam axis.

Details of Public Consultation sessions are given in Appendix L.

9.4 ESIA Findings Dissemination Consultations

Following the submission of the present ESIA report, the Consultant, on behalf of the project proponents, organized a series of meetings to disseminate the findings 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.

The ESIA consultant presented the results and recommendations of the ESIA study in different venues for institutional stakeholders, for local PAPs in the villages in the vicinity of the proposed Bisri dam, and for Greater Beirut residents. Full Details of these meetings are given Appendix L of this report.

The date and timing of all meetings were agreed with individual municipalities. The village sessions were scheduled at weekends and early evenings on weekdays for Beirut Water Consumers to allow the maximumm number of concerned people to attend.

Each session commenced with the introduction by the Project Proponent in which the scope, objectives and an update about GBWSAP advancement were shared with the audience. The Consultant (Dar Al-Handasah) then gave a power point presentation covering the project base line conditions, the potentially expected impacts and mitigation measures and the study recommendations. The floor was then 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.

9.5 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 are 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

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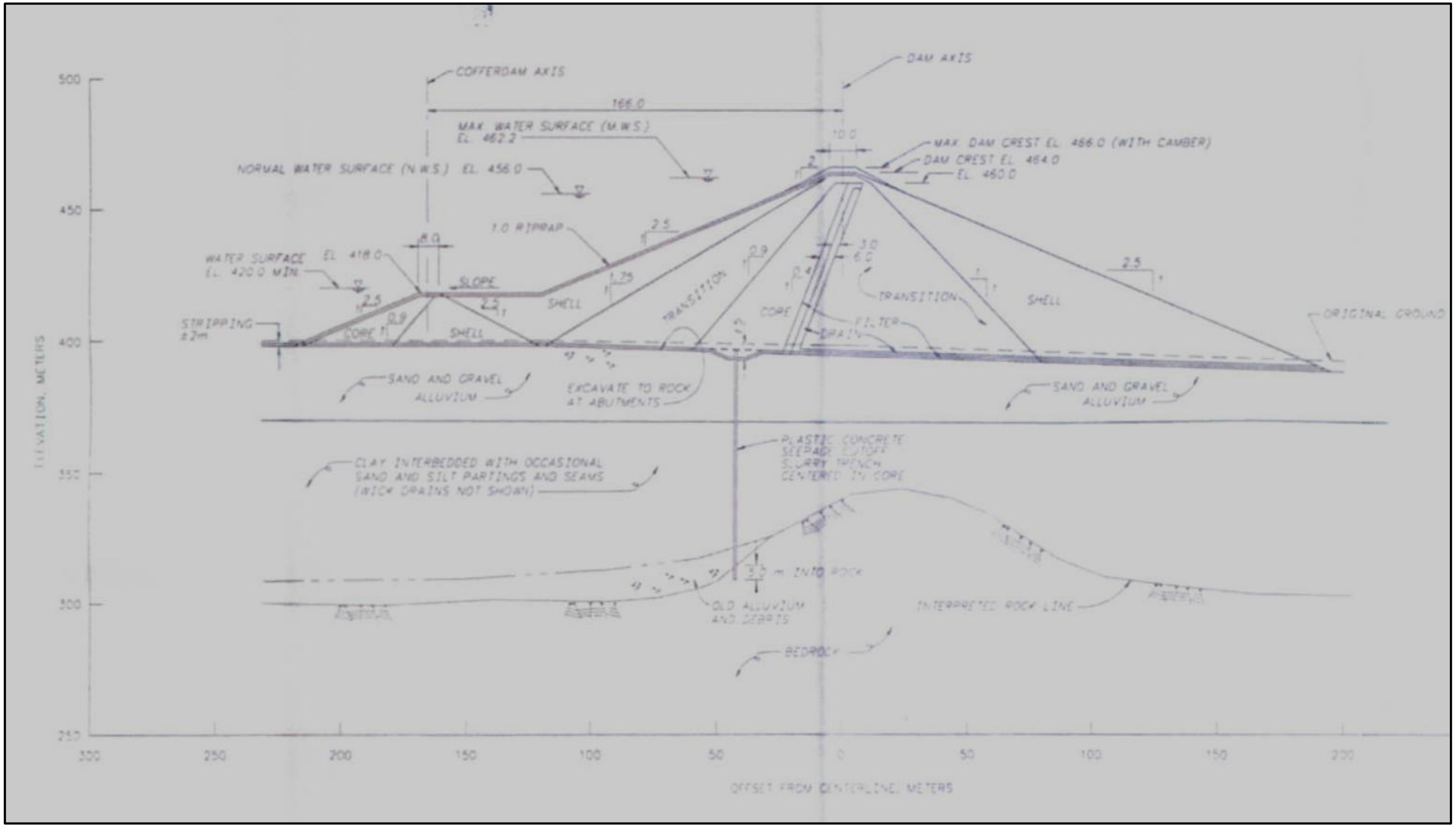
APPENDIX B

DAM DESIGN


NAHR BISRI
ACCESS ROAD
DISCHARGE CHANNEL
S.W. STA. 0+352.5 END OF RIPRAP
S.W. STA. 0+322.5
EL. 398.0
EL. 410.0
EL. 390.0
SPILLWAY
OUTLET WORKS DISSIPATION STRUCTURE
OUTLET WORKS VALVE STRUCTURE
DAM STA. 0+614.00 S.W. STA. 0+100 N 62173.92 E 334461.33
℄ OUTLET WORKS
STEPPED SPILLWAY CHUTE
DAM STA. 0+576.5 O.W. 0+155.53 N -62145.04 E -334485.25
CREST EL. 464.0 PLUS CAMBER
DAM STA. 0+909.065
LIMIT OF RCC
WIRE ROPE HOIST
WIRE ROPE
EL. 450.00
℄ SPILLWAY CREST AXIS EL. 456.00
OUTLET WORKS GATE CHAMBER
OUTLET WORKS INTAKE STRUCTURE O.W. STA. 0+000
EL. 418.0
CP1 DAM STA.
CP2


COFFERDAM AXIS
DAM AXIS
166.0
MAX. WATER SURFACE (M.W.S.)
EL. 462.2
10.0
MAX. DAM CREST EL. 466.0 (WITH CAMBER)
DAM CREST EL. 464.0
EL. 460.0
NORMAL WATER SURFACE (N.W.S.) EL. 456.0
1.0 RIPRAP
WATER SURFACE
EL. 420.0 MIN.
EL. 418.0
8.0
SLOPE
STRIPPING
±2m
CORE
SHELL
TRANSITION
CORE
FILTER
DRAIN
TRANSITION
SHELL
ORIGINAL GROUND
SAND AND GRAVEL
ALLUVIUM
EXCAVATE TO ROCK
AT ABUTMENTS
SAND AND GRAVEL
ALLUVIUM
PLASTIC CONCRETE
SEEPAGE CUTOFF
SLURRY TRENCH
CENTERED IN CORE
CLAY INTERBEDDED WITH OCCASIONAL
SAND AND SILT PARTINGS AND SEAMS
(WICK DRAINS NOT SHOWN)
m INTO ROCK
OLD ALLUVIUM
AND DEBRIS
INTERPRETED ROCK LINE
BEDROCK
ELEVATION, METERS
OFFSET FROM CENTERLINE, METERS

APPENDIX C

Unofficial Translation of Law NO. 8633 of august 2012

FUNDAMENTALS OF ENVIRONMENTAL IMPACT ASSESSMENT

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 within 15 days 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 <u>30 days</u> 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 ❑Agricultural :

❑Private ❑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:

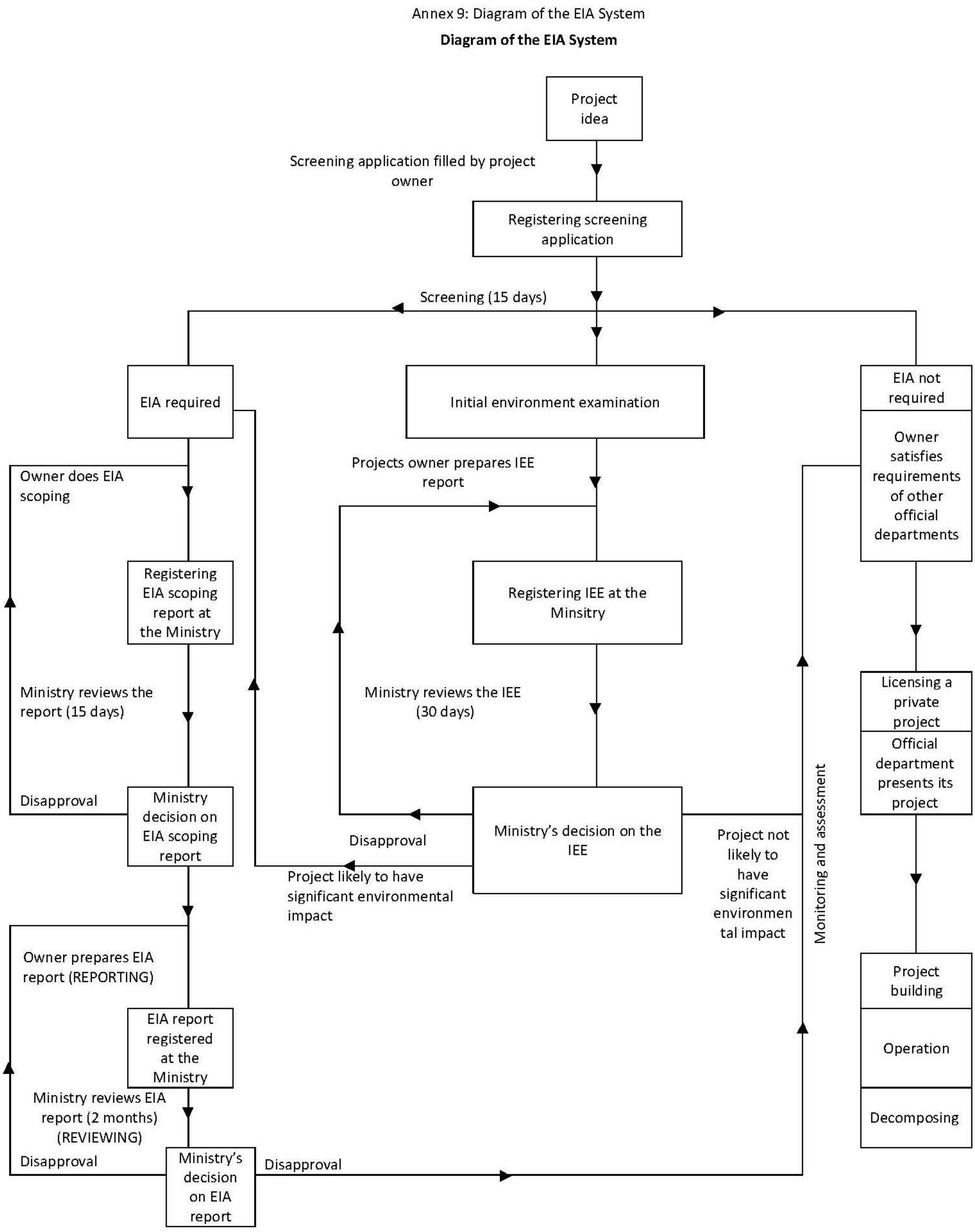
- Net profit justifying the establishment of the project
- Explanation of how to mitigate negative impact
- Prior preparations for following up control and supervision

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



Contents

Appendix D

PHYSICAL CULTURAL RESOURCES PLAN

Introduction and Background

The ESIA documented the need to address the need for rescue archaeology in the Bisri valley as a result of the project. Consequently, the Physical Cultural Resources Plan detailed below was developed and will guide the implementation of agreed arrangements for the full, effective and sustainable implementation of rescue archaeology, relocation of the Mar Moussa church as well as establish acceptable procedures to deal with eventual "Chance Find Procedures". The action plan below has been agreed between the DGA, CDR and other stakeholders and will be updated throughout project implementation as required.

Part A - Rescue Archaeology – Data Collection and Assessment

The Physical Cultural Resources Plan for rescue archaeology on the project was based on the findings of a widely referenced study on the Bisri valley (provided in Appendix J): Building on detailed archaeological field survey work undertaken in 2005, a field based survey update of archaeological and historical sites of the site of the dam and impoundment area, and sites of all associated facilities was undertaken in 2008 by partnership between the General Directorate of Antiquities and the Polish Center of Archaeology at the University of Warsaw. The Polish Center of Archaeology at the University of Warsaw is a widely established institution with demonstrated experience in archaeology of the Middle East.

Rescue Archaeology – Physical Cultural Resources Mitigation

The field survey was jointly issued by the General Directorate for Antiquities (housed within the Ministry of Culture) and by the Polish Center for Archaeology. As a jointly issued report, the field survey and its major findings are therefore endorsed by DGA, which is the only agency in Lebanon with authority to undertake rescue archaeology. The field survey results are provided in Appendix I above and are disclosed as part of this ESIA.

The field survey and associated report focused on the need to (i) undertake rescue archaeology of certain particularly important archeological relics in parallel with dam construction and (ii) to prevent looting of archaeological remains. Mitigation measures include the implementation of a Rescue Archaeology Plan for the Bisri valley and the installation of security and protective facilities around ongoing (open) digs.

The rescue archaeology will be undertaken by a team of specialists that will be appointed by DGA and will be recruited and financed by CDR. As DGA is the only Government agency with the authority to implement any rescue archaeology in Lebanon, this is the common and established procedure that is in line with Lebanese laws and regulations on archaeology.

For the actual rescue works, these will be undertaken by the dam contractors as part of the works contract. A specific line item in the Bill of Quantities (BOQ) will be dedicated to rescue archaeology and will be supervised by the DGA-appointed team of specialists.

To address the looting risk, areas will be fenced off and security personnel hired in the event of increased risk of looting or during periods of low activity on site.

Mitigating Activity	Responsibility	Estimated Cost (USD)
Establish rescue archaeology team of specialists	DGA to appoint specialists, CDR to recruit them.	120,000
Implement rescue archaeology works as required by DGA	Archeology specialists	500,000
Install fencing and security as required to prevent looting	Dam works contractor as per the guidance of the archeology team	10,000

Part B - Mar Moussa Church – Data collection, assessment and endorsement

Specific date regarding Mar Moussa church is limited. The assessment thus relied primarily on field surveys and extensive consultations with communities and religious authorities (primarily the Maronite Diocese) to discuss options for the dismantling and reconstruction of the church, which has high cultural value to local communities. It is important to note that the church is not original construction. Nonetheless, it holds significant cultural importance to local communities and will thus be dismantled and reconstructed at a site that is not submerged. No graveyards were identified as part of the survey work in this area.

Mar Moussa Church – Physical Cultural Resources Mitigation

The Mar Moussa Church will be dismantled and relocated to a site at a higher elevation that has been considered in detail (and compared to 3 other options) and has been agreed upon by all stakeholders. The estimated cost of the dismantling and reconstruction of the church is 2 million USD and will be implemented by the dam works contractor and financed by the project through CDR. Specific line items in the works contract Bill of Quantities (BOQ) will be added to reflect this line of work. The Maronite Diocese will appoint a representative to oversee the implementation of works. The dismantling and relocation of the church will use international best practice standards for World Heritage sites and naturally protected areas.

Mitigating Activity	Responsibility	Estimated Cost (USD)
Dismantle and reconstruct Mar Moussa church	Works contractor under guidance from the Diocese representative	2,000,000
Expropriate land for Mar Moussa church relocation	CDR	500,000
Planned transfer ceremony	Diocese	N/A
Ad hoc monitoring	Diocese	N/A

Part C - Chance Find Procedures

The following chance find procedures will be included in the contract documents of the works contractor and will guide the implementation of any ad hoc rescue archaeology that may arise in the case of chase funds:

The Contractor shall take note that the Directorate General of Antiquities of the Ministry of Culture (DGA) is to be afforded the opportunity to monitor work in the vicinity of known and suspected archaeological sites. As such, the Contractor shall grant access for DGA representatives to all parts of the project site throughout the period of construction. In this respect, the term archaeological site shall refer to all cultural property of an archaeological or historic interest to the DGA.

The DGA shall be considered the Utility Owner of all the sites having declared or suspected archaeological value whether they are found on private or on public property, within or outside the Right of Way.

Prior to commencing work, the Contractor shall prepare a checklist of actions his Foremen and workers shall follow in the event they unearth unrecorded archaeological remains. The list shall be vetted by the DGA and will include contact details for the local DGA Inspector and relevant Construction Management staff. Copies of the list will be circulated to all Discipline Managers, Shift Leaders and Foremen, and posted in places such as Site Offices, Time Keepers Offices and Messes.

Prior to any work on or in the vicinity of known archaeological sites, the Contractor shall coordinate with the Engineer and DGA representatives to ensure adequate measures as specified by DGA are taken to protect these sites.

All known or newly discovered archaeological sites shall be ‘off-limits’ to construction crews, whether on or off duty, except with the express permission of the Engineer. Such permission will only be given where access is needed for site protection or to ensure public and/or worker’s safety.

The Contractor shall make provision in his work program to accommodate the requirements for DGA inspection of any archaeological sites encountered during construction.

If new archaeological remains are discovered during execution for the Works, the Contractor shall immediately inform the DGA and the Engineer. In all such cases, the Contractor shall adjust and/or reschedule his activities in the vicinity of such sites, and/or use other sources of materials if the site falls within a borrow area or quarry, to allow the DGA to carry out surveys and emergency salvage excavations. Work in the vicinity of remains investigated by DGA shall not recommence until written permission to do so has been granted by the DGA.

With regard to the relevant clauses of the Conditions of Contract, no extension of time or payment of costs will be granted for adjusting the sequence of work. The Engineer will only grant an extension where work is suspended as a result of archaeological investigation.

The Contractor’s liability in respect of archaeological sites extends to damage by construction workers, on or off duty, the reparation of which shall be undertaken at the Contractor’s cost. Repeated violation of sites by workers shall render the Contractor liable for the erection of a fence around the site at his own cost

APPENDIX E

GEOLOGICAL AND GEOTECHNICAL REVIEW REPORT

APPENDIX E GEOLOGICAL AND GEOTECHNICAL REVIEW REPORT

Geotechnical Review Report for Bisri Dam

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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)	USBR 1952-1954 Study Range or Average	USBR 1952-1954 Study High(s)	ONL 1975-1978 Study Low(s)	ONL 1975-1978 Study Range or Average	ONL 1975-1978 Study High(s)	ECIDAH 1982-1984 Study Low(s)	ECIDAH 1982-1984 Study Range or Average	ECIDAH 1982-1984 Study 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

A DIVISION OF
FREDERIC R. HARRIS
ENGLEWOOD, COLORADO USA

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).

<u>C2-Comments</u>:

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

C3-Comments:

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; 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

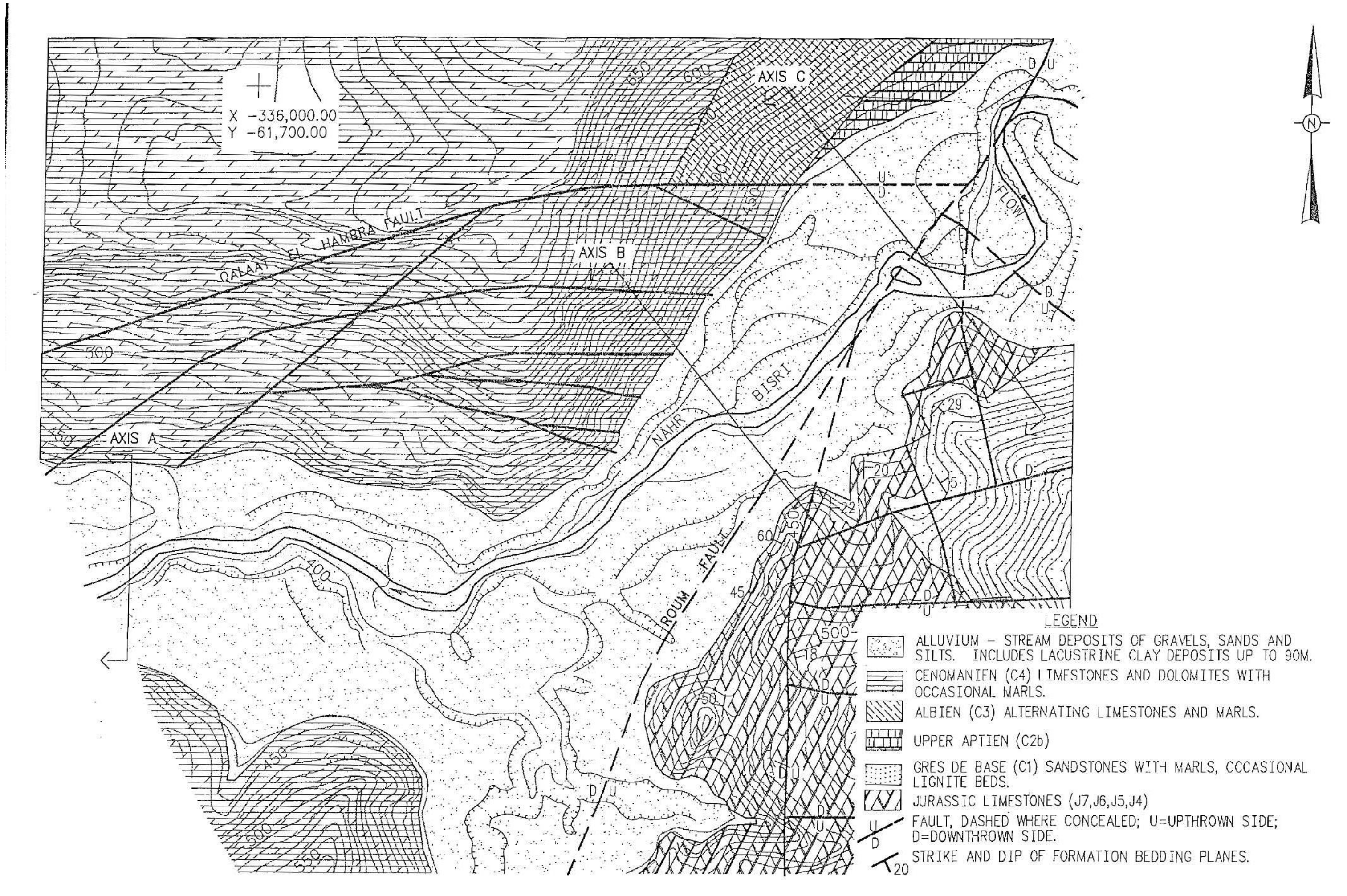
1. The findings of the submitted feasibility study and annex reports are summarized as follows:
    a. The complex geologic and structural setting of the proposed dam was highlighted. In addition, the different geologic formations exposed at the dam axis and reservoir were described.
    b. The feasibility 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.

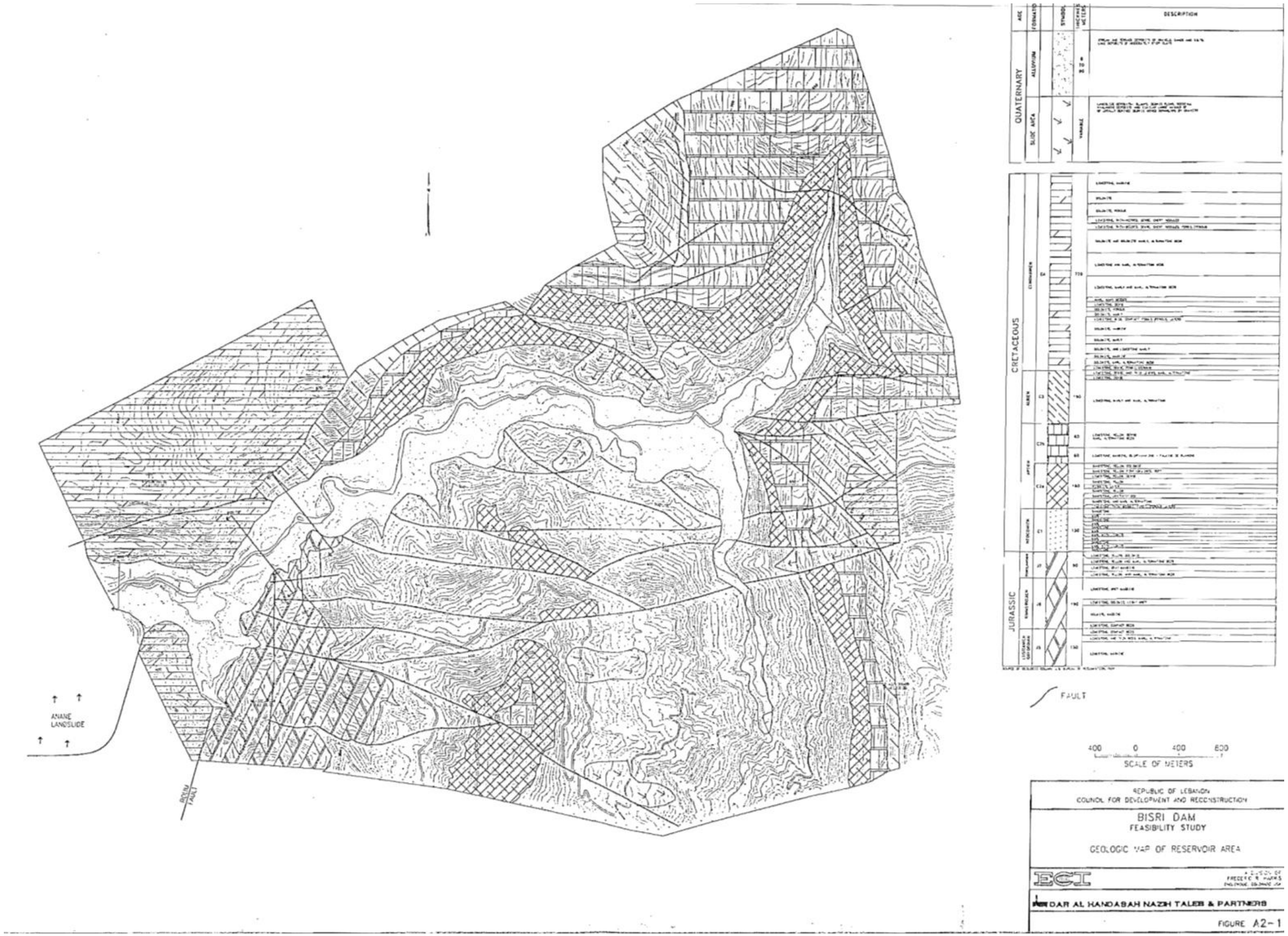
i. The proposed completion date proposed is unrealistic; it is expected that the dam construction requires at least five years taking into consideration the delay caused by the wet seasons and the extensive foundation treatment works.
j. The study of the dam requires a detailed risk identification and assessment in order to decide how the dam design can further proceed.

ATTACHMENTS



BISRI DAM
FEASIBILITY STUDY
GEOLOGIC MAP OF DAMSITE
FIGURE A2-2

Attachment 1 : **geologic map of the proposed dam site as reported in the feasibility study (R2).**



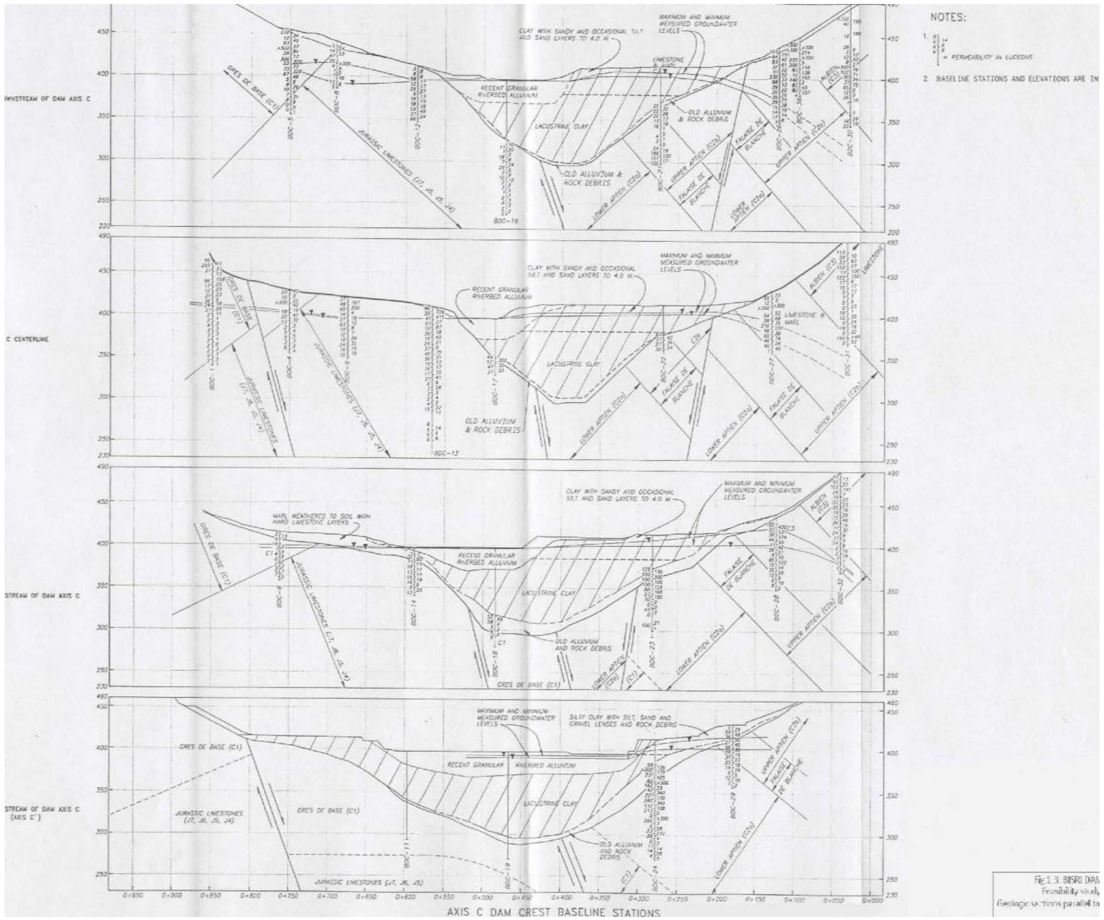
Attachment 2 : Geologic Map of the Dam Reservoir Area as Reported in the Feasibility Study (R2).

1

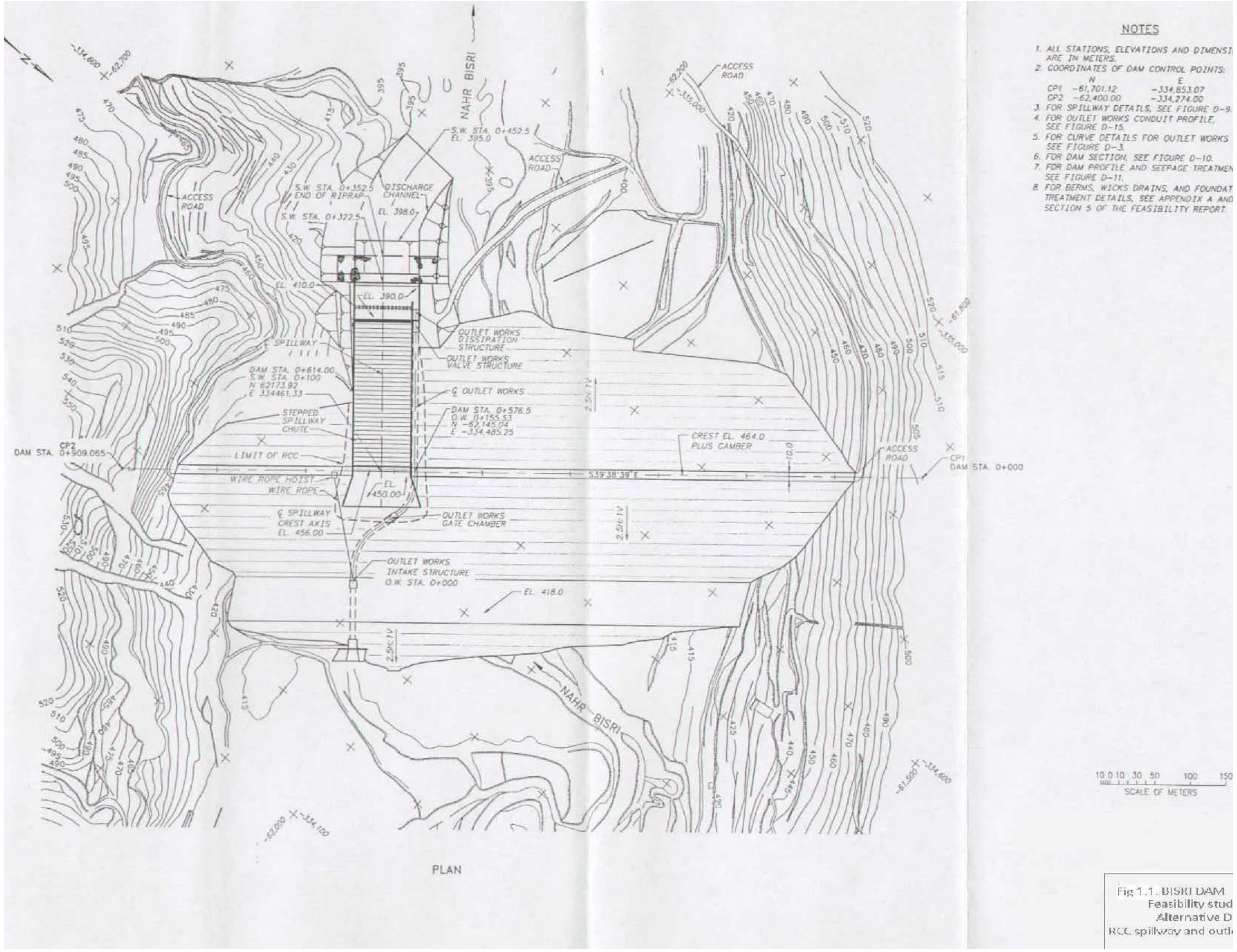
2

3

4



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 F

WATER QUALITY

Appendix F1: 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 NH_4^+	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
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 F2: 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	
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 F3: 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 F4: 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.	
	Sample ID: **BW 1**		
Nature of Test:	**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.

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 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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Telephone: +961-1-350000 Extensions: 4858/59/60
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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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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. 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.	
	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

American University of Beirut, Department of Civil and Environmental Engineering, Engineering Service Laboratories

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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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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW 2

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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1902

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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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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Engineering Service Laboratories
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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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E-mail: corelabs@aub.edu.lb

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

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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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.
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.

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 سلمت إلى المختبر
ولن يتم إعطاء هذا التقرير إلا كاملاً .

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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 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**

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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Date **11/10/2012**

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**

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 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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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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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.
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. HABB
Dr. Zuheir Habbal
Director of Clinical Chemistry Laboratory
Director of Environment Core Laboratory

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Faculty of Engineering and Architecture
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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 5**
Nature of Test:	**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

AMERICAN UNIVERSITY OF BEIRUT · Department of Civil and Environmental Engineering · Engineering Service Laboratories
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CERTIFICATE OF TEST

Requested by:

Dar Al-Handasah (c/o Elie Abou Rejaili)
(Shair and Partners)

Date

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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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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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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1902

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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Environment Core Laboratory Test Report Reference no:ECL121004-547-BW5

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Analysis as Total per metal	MDL (mg/L)	Sample BW 5 Result (R) mg/L	Method	UR	EPA / WHO MCL	MOH MCL
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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
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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
ولن يتم إعطاء هذا التقرير إلا كاملاً .

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APPENDIX G

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

Prepared by:

Dr. Mounir R. ABI-SAID/ Mammalogist

Dr. Elsa SATTOUT/ Plant Ecologist

Dr. Michel BARICHE/ Fresh water

Dr. Riyad SADEK/ Herpetologist

Dr. Mona KARAKIRA/ Ornithologist

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.

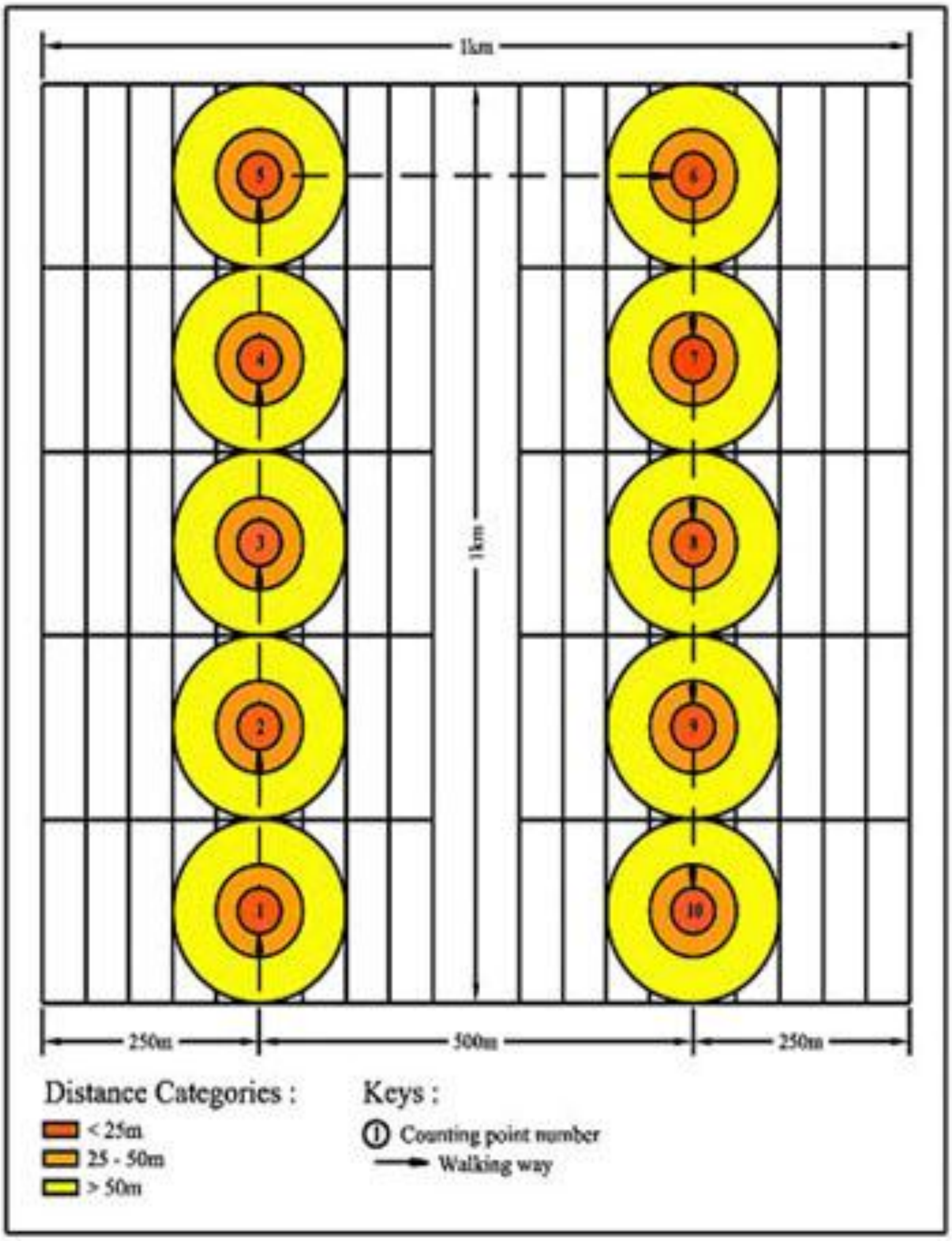


Figure 1. Point counts combined with transects.

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:

Type 1. 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.

<u>Type 3.</u> 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.

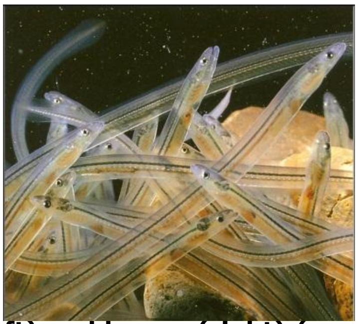


Plate 9. The European eel *Anguilla anguilla.* Adult (left) and larvae (right) (source internet)

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.


a


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*

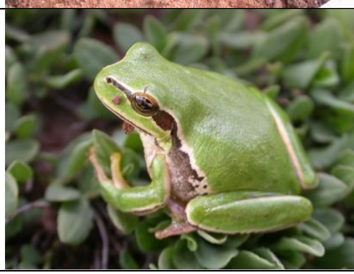
*Conservation status:*The species is widespread and can tolerate a wide range of habitats. It does not seem to be endangered.

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.

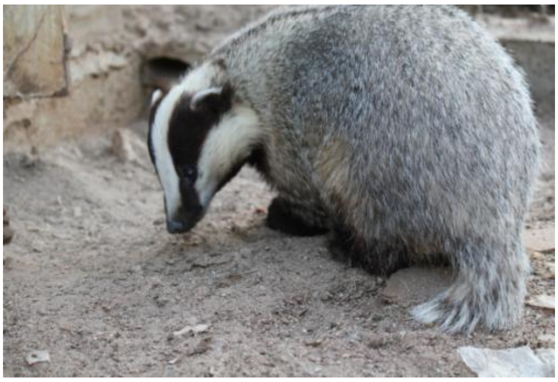
Table 5. List of mammal species present on the three sites (R= recorded, E = Expected, c= common, r = rare, endemic or endangered on the National level)

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.

7. Water flow downstream should always be maintained at levels that do not harm the riparian vegetation or destroy general and breeding habitats.
8. 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.

9. Measures should be taken to avoid drying-out amphibian breeding sites through local disruptions to hydrology.
10. Pollution of amphibian breeding sites should also be prevented, by the sensitive design of construction site drainage and the implementation of pollution control measures.
11. 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.
12. 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 H

PRELIMINARY REPORT OF POLISH – LEBANESE EXPEDITION TO THE ESHMOUN VALLEY (WADI BISRI)

ESHMOUN VALLEY
PRELIMINARY REPORT ON THE SECOND SEASON OF THE SURVEY, 2005

Krzysztof Jakubiak, Michał Neska

The second season of the Polish-Lebanese survey[1] *of the upper part of the Awali (Eshmoun) river valley commenced on September 1, 2005. Fieldwalking was completed by the end of the month. The area covered this year extended from where the survey had finished last year at a point west of Marmousa Chapel to the convents of Deir es-Saide and Deir er-Rabbat near Joun. Several places surveyed last year were rechecked owing to new information about the existence of rock-cut tombs collected in the last days of the first season of fieldwalking. Another pursuit was to explain the total absence of surface finds in the vicinity of the Roman temple at Bisri, tentatively attributed to river erosion.*

The actual surveying was divided into two zones, the bottom of the valley being fieldwalked by one group and the slopes by another one, the latter team having to deal with heavy bush cover, which hardly made the prospection easy. The following report is by necessity brief and presents only the most important observations made during the survey.

1 The Polish team included the present writers co-directing the effort, accompanied by Mrs. Olga Wasilewska, Mrs. Zofia Zakrzewska, Mr. Maciej Mielecki and Mr. Piotr Witkowski, archaeologists; and Mr Maciej Krajcarz, geologist. The Lebanese team headed by Mr. Asa'ad Seif, who is also Project Director on the Lebanese side, included Dr. Corine Yazbek, archaeologist; Mr. Abdallah Ala'Eddine, ceramologist; and Mr. Wissam Khalilin, archaeologist. Sedimentologist and speleologist Dr. Fadi Nader, Director of the Institute of Geology of the American University of Beirut, kindly consulted our findings.
The project is grateful to Mr. Frédéric Husseini, Director General of Antiquities in Lebanon, for permission to continue the survey and for his unfailing support at every step of the project.

MODERN STRUCTURES

Only six stone cottages of recent date were located this year, compared to at least 27 last year. These rectangular constructions were built of stone blocks, in one case (site 45, cf. map in *Fig. 1*) taking advantage of the steep rock valley slope, approximately 4 m above the modern road. Another house observed in Bisri village (site 60) was located almost on top of the mountain peak where the modern village is located. Several other severely destroyed structures, possibly dwellings, were recorded in Bisri. Unlike these first two buildings, the ones from sites 62 and 66 had vaulted substructures. The house from site 62 is one of the best preserved of its kind, permitting observations concerning the interior layout. In no. 66, lime mortar was observed bonding the stones, the first case of mortar bonding to be recorded during the survey. The remaining two stone houses located this year were found on sites 48 and 49.

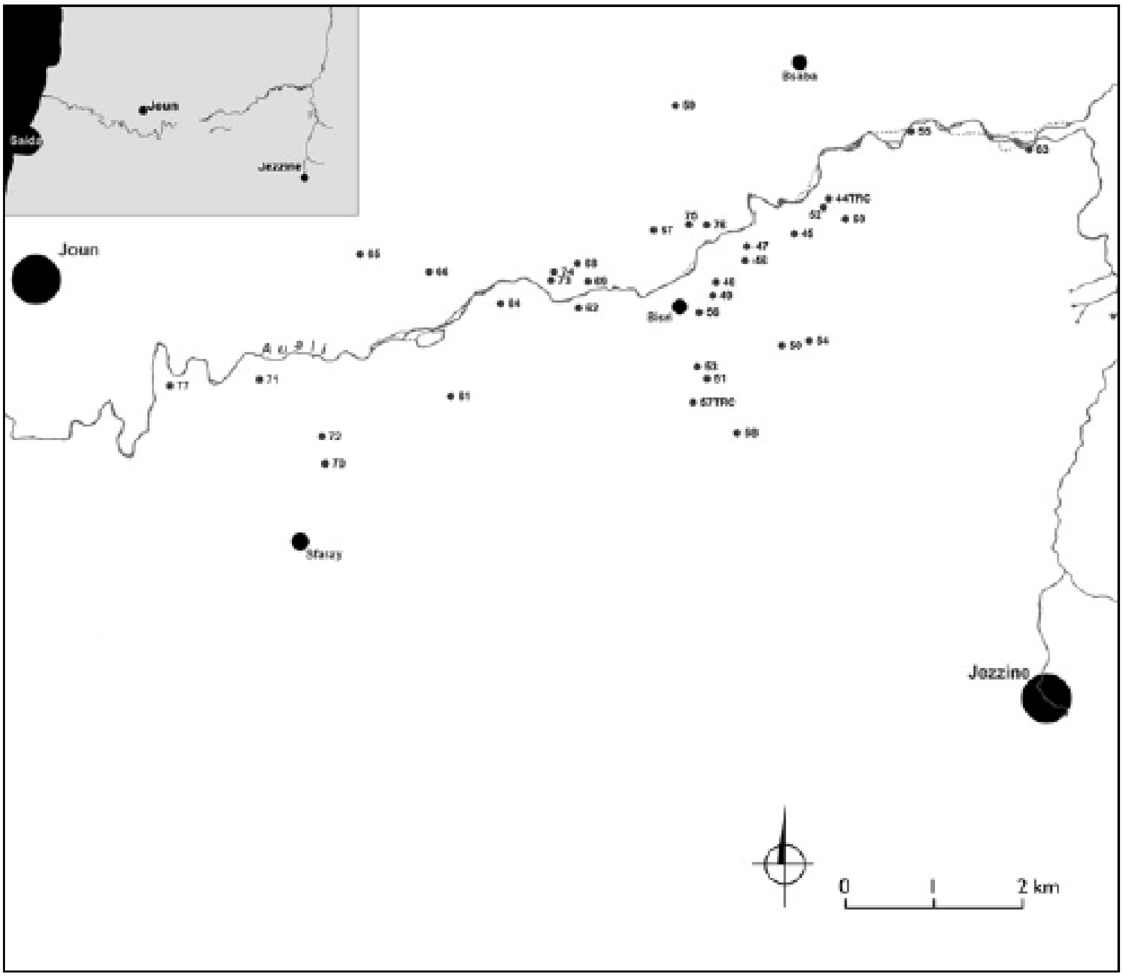

Fig. 1. Map of the surveyed area in the Awali (Eshmoun) Valley, 2004-2005 (Drawing P. Witkowski)

ARCHAEOLOGICAL SITES

The oldest of the archaeological sites discovered this year have been attributed tentatively to the Pre-pottery Neolithic period. The first of two such sites (no. 68; N 33°35'01.9"; E 35°31'36.6"; 493 m a.s.l.) was localized on the northern slopes of the valley above El Kherbe village. A concentration of flint material was observed, approximately 1.5 ha in area, but no traces of any constructions or related material except for some modern ceramics. Considering the size of the site, it could be interpreted as a village or big workshop. The other site with abundant flint material (no. 77; N 33°34'14.9", E 35°28'40.9", 211 m a.s.l.) was found on the southern slopes of the valley. It covered about half a hectare. The surface collection included several potsherds.

One Chalcolithic or Bronze Age settlement was also localized on the southern valley slopes. The site (no. 59; N 33°35'59.4"; E 35°32'17.9"; 659 m a.s.l.) lies on a jutting rise west of El Baabe village. A modern villa with swimming pool erected on the spot has all but obliterated the ancient remains and more testing will be needed (possibly during the next season) to confirm the presence of the site.

Rock cut tombs, nine in all, were identified on five different sites (nos 46, 51, 55, 70, 72). The sepulchers were either chamber tombs with niches for burials or rock-cut pits for single burials. All were of the Roman period, most likely from the 3rd-4th century AD judging by the overall shape and cutting technique.

Site 46 (N 33°35'03.9", E 35°32'49.2"; 438 m a.s.l.). Two chamber tombs. The western of the two [*Fig. 2*] had a square entrance with the sides recessed to fit a closing slab. The entrance was set inside a recessed frame with vaulted top and a step threshold. Inside the chamber there were two burial niches, one opposite the entrance and another one to the right. The niches were cut as arcosolia with arched vaults.

The other tomb was prepared for four internments [cf. *Fig. 2*]. The entrance was again of square shape. One burial niche was located to the left of the entrance, two others to the right and the fourth further to the back of the chamber. The ground plan of the tombs could not be documented because of the thick accumulations inside the chambers.

Site 51 (N 33°34.2' 21.0"; E 35°32' 33.3"; 539 m a.s.l.). Similar tomb located near the modern road, cut not in the valley slopes as is the rule, but in a freestanding grey rock. The entrance was generally rectangular in shape with recesses for the closing slab. Inside the chamber were two burial niches with vaulted tops. Stones and earth accumulated inside the tomb precluded full documentation.

Site 55 (N 33°35' 47.6", E 35°34' 19.5"; 432 m a.s.l.). Three tombs, each with several burial niches, located on the southern slopes of the valley. In each of the tombs several places for sarcophagi were localized. On the wall of one of the tombs, just inside the entrance to the right, there are some rock carvings: an apparent palm branch and a naked human male figure [*Fig. 3*]. A palm branch carving can be seen in another of the tombs, where it is hewn on the wall near the burial niche. This is unusual iconography as far as the decoration of rock-cut tombs in the area is concerned. It is unfortunate that a few days after our discoveries the tombs were vandalized.

Site 72 (N 33°33'57.5"; E 35°29'47.9"; 476 m a.s.l.). Chamber tomb found below a modern road several hundred meters north of site 70. Almost square entrance and three

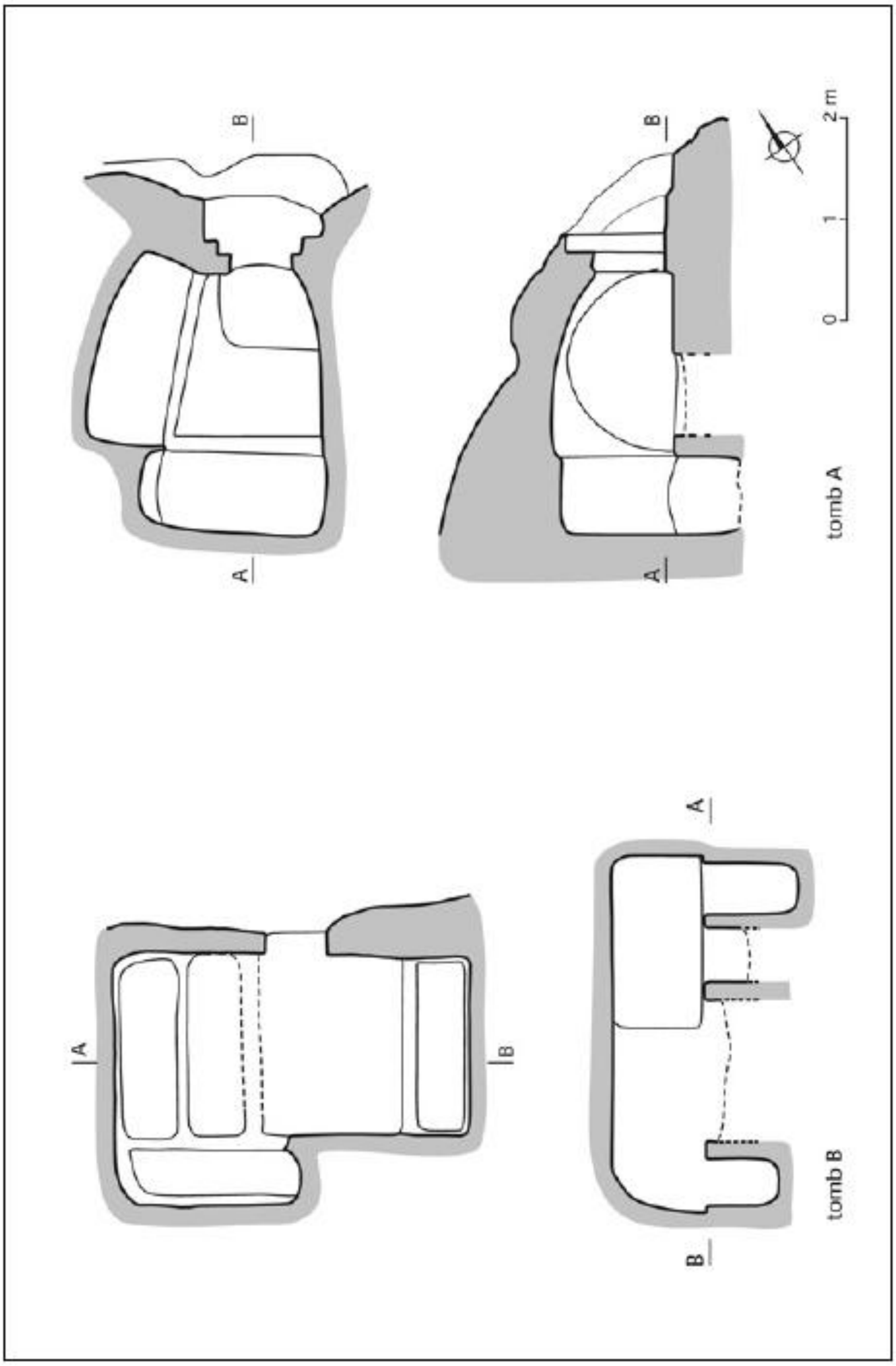

Fig 2. Rock cut chamber tombs A and B from Site 46 (Drawing O. Wasilewska)

burial niches inside the chamber, identified only tentatively because of severe damages. The crudeness of the stone-dressing suggests that the tomb was never finished.

Pit graves cut into the rock and possibly containing lead coffins were found on sites 51 and 70. On the former of the two, the trench had been cut in a piece of grey rock sticking out in the middle of a cultivated field. As for the other site (N 33°33'47.7"; E 35°29'48.9"; 506 m a.s.l.), believed to be a settlement or village, pit graves were found cut in the rock inside a recent stone construction used as a keep for goats or sheep. Two of these graves were oriented N-S and were equipped with recesses around the edges for fitting covering slabs. A third pit was oriented E-W, but it was so severely damaged that its identification as a grave is purely tentative.

Remains of Roman-age settlements or farmsteads were discovered on eight sites, identified from the surface pottery and glass collection (nos 47, 53, 62, 65, 70, 71, 74, 75), augmented with Roman coins on sites 62 and 75. Typical water cisterns were localized on sites 65, 70 and 71. As it is only natural that cemeteries did not exist in a void away from settlements, it can be assumed, for example, that the necropolis on site 46 was connected with the village on site 47. (We were told by the local inhabitants that the locality on site 47 had once been called Maloulith or Maloula, which was apparently the name of the village in Aramaic). Other connected settlements and burial grounds include 53 and 51, 37 and 55. In the case of site 70, some graves were found near the settlement. Four sites are presumed to date to the Late Roman Period, two on the northern slopes and two on the southern ones. Site 66 was located on the edge of the slope west of El Kharbe. The site and the location were discussed above. Several Late Roman potsherds found among modern ceramics within the limits of El Kharbe village located site 69 there. On the opposite side of the valley, potsherds from the same period were found north of the modern village of Mazraat el-Mathane. Meriting special attention is site 63 located on the flat

Fig. 3. Carved decoration inside the chamber of a tomb from Site 55 (Photo K. Jakubiak)

ground of the second geological terrace. About four dozen distinctive potsherds of the Late Roman and Early Byzantine period were discovered scattered over an area of approximately 3500 m². Since the area is cultivated, there exists the risk that the sherds were brought there with fertile soil trucked in from elsewhere.

Other sites identified by the survey team (nos 50, 52, 54, 57, 58, 60, 61, 67 and 73) could not be attributed safely for lack of distinctive material in the surface collections. The ruins of a stone mill at site 73 dated to the 19th-20th century. Most other sites appeared to be recent (like site 60 localized in Bisri village), but it cannot be excluded that at least a few of them contained also ancient vestiges.

Site 25 found in 2004 was examined as part of the rechecking program. It lies in steep terrain north of Bhannine Village on the eastern side of Wadi Bhannine. It is overgrown with grass except for the cultivated terraces. At about 8 hectares of area it is the biggest site detected by the expedition so far. The pottery surface collection represents virtually all periods from the Hellenistic through Ottoman times with the nearby Bhannine Village still being inhabited today.

Continued geological reconnaissance resulted in geological and geomorphological maps being prepared for the middle part of valley, called the Bisri Plain, between Bisri village and Nahr El Barouk stream. Three superposed accumulation-erosional terraces were found. The upper two constitute two different erosional surfaces of the first, lowest accumulation terrace, which is built of lacustrine silts and represents a lake stage of valley development. The upper part of the second terrace is made of sands and gravels which covered the silts. The boundary between the two demonstrates erosional character with sands and gravel being deposited in high-energy conditions representing a flood facies (distinct near the water course and particularly in the geological sections cut by water in the erosional deposits). The uppermost terrace is also built of sands and gravels, and is of alluvial origin.

The geological development of the valley can now be reconstructed. The first important episode in historical times was the appearance of a lake, which built up behind a natural dam in the form of a huge landslide tongue. The lake filled all of the Bisri Plain, giving rise to the lacustrine silt deposits which accumulated on its bottom. It went through different stages before drying up finally sometime in the Late Hellenistic or early Roman period. The lacustrine silts proved to be highly fertile agricultural soil used throughout Roman times. A second important change in river regime occurred in the Late Roman period. From a stabilized river with low flows, it changed to an annual cycle with floods. Deluges presumably damaged or destroyed Roman buildings, like the Bisri Temple, for example. It was then that the river finally cut through the natural dam, forming a deep eroded channel. In the end effect, the river regime and water level were stabilized once again.

The dating of erosional episodes and accumulation cycles depends generally on archaeological finds. The creation of the lake, however, and the rate of late lacustrine sedimentation will be determined once a thermoluminescence analysis is carried out of samples that the team has taken from the sediments.

APPENDIX I

BENEFIT SHARING PROGRAM

BACKGROUND

Many dams are located far from their supply areas, sometimes in different countries. Notwithstanding that Bisri Dam is just 25-30 km from its water consumers, the benefits from the project, both increased water supply and additional power supply, will primarily benefit the residents of Greater Beirut rather than landowners in the valley whose land will be inundated or the villages in the surrounding hills that will potentially suffer noise, dust and traffic congestion during construction and perhaps the adverse impacts of induced development afterwards.

To overcome this, a fund to be established that will fund projects and in some small way spread the sharing of derived benefits to local communities in the vicinity of main project activity.

Thus GOL will thus establish the Benefit Sharing Program. Within the context of the present environmental assessment, the objectives of the Program, the type of structure envisaged, and the variety of projects it might execute have been considered. The establishment of such a program under Lebanese Law is a complex process that should be vigorously pursued throughout the period of dam construction and enable benefit-sharing to commence at about the time the water and power benefits also start to become available to Greater Beirut.

Pending this, the primary concepts of the Benefit Sharing Program are discussed below.

MISSION STATEMENT

To extend and share the benefits of Bisri Reservoir beyond water supply consumers in Greater Beirut.

AIMS AND OBJECTIVES

The aims and objectives of the Benefit Sharing Program are:

- To improve community services and social welfare throughout the areas impacted by construction and inundation;
- To ensure the surrounding communities share the benefits from subsequent development of the reservoir shoreline and adjacent areas;
- To enhance power and water supply to reflect the benefits provided elsewhere by the Reservoir;
- To promote employment opportunities.

AREAS OF OPERATION

The areas of operation within which projects meeting the aims and objectives of the Benefit Sharing Program may be eligible for funding are those areas falling within the administrative jurisdiction of the municipal authorities within reservoir surface water catchment area, and areas downstream impacted directly or indirectly by dam construction and operation. The municipalities currently expected to benefit from the Fund are as follows:

Caza	Unions of Municipalities	BSP Municipalities within the Unions
Chouf	South Iqlim El kharroub	Bsaba; Mazraat El Dahr
	Chouf El Souayjani	Mazraat El Chouf
	Chouf El Aala	Aamatour; Bater
Jezzine	Jezzine	Aariye; Benouati; Bkassine; Midane

Excluded from this list are the villages of Bisri, Khirbet Bisri, Harf, Ghabatiye, and Bhannine that are not municipalities and are not included in any union, but are administered by the *Ka'em Maqam* for Jezzine. In respect of the ministration of the BSP, the *Ka'em Maqam* should therefore be treated as a Union. With time, shared interests based on the proximity of villages to Bisri reservoir will become paramount and those villages not a member of a Union are likely to choose to do so as they become municipalities.

ESTABLISHMENT

The BSP will be established under the auspices of a Federation of Municipalities within the area of operation.

FUNDING

The BSP will initially be funded through an injection of 1.5 million US Dollars from the GoL project budget for GBWSAP. Other sources of local funding will need to be identified in the long term. These may include contributions from the following:

- A small levy on GBWASP consumers relative to the volumetric consumption;
- A contribution from the annual municipal charge levied on new construction within the Bisri catchment;
- Voluntary donations, which may be project-related, from individuals and organisations.

BOARD OF TRUSTEES

Members of the Board of Trustees shall be elected by agreement between the BSP municipalities. The Chairman shall be elected by a simple majority of the trustees.
The BSP boards will comprise the following:

- The Emeritus Head of one of the BSP's union of municipalities, who will act as the Chairman;
- Representatives of the other BVCP union of municipalities and the *Ka'em Maqam*, one of whom will act as Secretary;
- A representative of a third union of municipalities;
- A Judge or Magistrate of at least the 8th degree;

- A qualified Accountant, who will also act as Treasurer;
- Representatives of NGOs and CBOs active in the BSP area of operations.

The Board shall appoint a Clerk to undertake day-to-day administrative duties and other staff as agreed.

The Board shall retain the services of a qualified and experienced Auditor unconnected to any Board member or the organisation they represent, to annually prepare audited accounts.

OPERATIONS COMMITTEE

The Operations Committee will distinguish the policy, revenue and financial oversight responsibilities of the Board of Trustees from those of fund allocation and project monitoring undertaken by the Committee.

- A Trustee representing one of the BVCP's union of municipalities, who will act as Chairman;
- A representative of the Ministry of Environment, who will act as Secretary;
- Representatives from each of the BVCP municipalities and the *Ka'em Maqam*;
- Rotating representation of the NGOs and CBOs represented on the Board; and,
- Other members elected by a simple majority of sitting members.

The Committee shall be responsible for developing and implementing the criteria used to assess funding applications and to ratify completion.

DISBURSEMENT OF FUNDS

Any municipality, commercial enterprise, NGO, CBO or individual resident within the BSP's area of operations may apply to the Operations Committee for funding of projects that further the aims and objectives of the BSP.

The maximum disbursement to any single project shall be US$ 300,000 unless a higher disbursement is approved by the Committee and confirmed by a majority of the Board of Trustees.

All applications for funds shall be made in the prescribed manner and give full and unambiguous details of at least the following:

- The name of the project and its location;
- Contact details of each and every project proponent;
- Details of the project objectives;
- Confirmation that these objectives meet those of the BSP;
- A list of beneficiaries and the extent of their benefit;
- An environmental statement identifying significant environmental and social impacts during project construction and operation, and the measures to be taken to mitigate them;
- A schedule of construction and operation;
- A schedule showing the drawdown of BSP funding and any other funding.

PROJECT ELIGIBLE FOR BSP FUNDING

The type of projects deemed to further the aims and objectives of the BSP will be determined on a case-by-case basis by a simple majority of the Operations Committee. Applications for funding will be submitted according to a specific format as agreed by the Board.

Projects likely to be suitable for BSP funding may include, but not be limited to, the following:

- Reforestation not exceeding 2 ha where there is limited public access;
- Reforestation projects up to 500 ha where there is open public access;
- Run-of-river hydroelectric schemes using hydrokinetic turbines and axial tube turbines;
- Community halls and meeting rooms with seating capacity up to 100 persons;
- Performance and display of traditional arts and crafts, music and local produce;
- Promotion of eco-tourism/educational facilities, such as those in the Damour Valley;
- Heritage conservation activities, including traditional cultural industries and production
- Visitor facilities overlooking Bisri Reservoir;
- Promotion of non-commercial fishing on the reservoir;
- Grant aid to other NGOs and CBO also pursuing BSP aims and objectives;
- Promotion of community wind and solar energy power; and,
- Conversion of public planting irrigation schemes to drip irrigation

Appendix J

DAM BREACH REPORT

CONSTRUCTION SUPERVISION & QUALITY ASSURANCE PLAN

APPENDIX K

TOR for Consultancy Services to Monitor

Water Quality Entering Bisri Reservoir

Background

Bisri Dam in the Nahr Awali catchment is currently in the final stages of detailed design. Construction is expected to commence in 2015, with final commissioning in 2020.

Water quality analyses undertaken as part of the Environmental Impact Assessment in 2012 and 2013 identified that some inflow to the area to be inundated contained constituents detrimental to human health; specifically Dieldrin and Lindane, organo-chlorine insecticide residues that are highly resistant to natural environmental degradation. While the recorded concentrations of these compounds was at or near the threshold of analytical determination and mostly below the Maximum Contaminant Level (MCL) set by the US EPA and WHO or the Lebanese Ministry of Health[91], both are substances whose production and use is restricted or banned under the 2001 *Stockholm Convention on Persistent Organic Pollutants* (POPs), which the Government of Lebanon (GOL) signed on 23 May 2001 and Parliament ratified on 3 January 2003. The ban on POPs for agricultural use in Lebanon came into force in 2009.

There is therefore concern that (i) stocks of POPs are still in use in contravention of both GOL's international commitment and Lebanese law, and (ii) that residues remaining within the catchment environment will continue to pollute Bisri Reservoir.

While the concern is raised in respect of Dieldrin and Lindane, it is prudent to consider other POPs, such as Dioxins and Furans that are also common by-products of waste incineration and vehicle exhaust, as well as other forms of pollution that may adversely impact reservoir water quality and afford a risk to public health.

Overall Objective

The objective of the present contract is to monitor the presence of polluting substances present in surface water courses draining to the reservoir area and to investigate their sources of origin.

Consultant's Qualification

To pursue this objective, the Ministry of Environment seeks to engage a specialist water and environmental consultancy practice registered to operate in Lebanon and having appropriately qualified and experienced staff to provide *Consultancy Services to Monitor Water Quality Entering Bisri Reservoir*.

The Consultant's project team shall include but not be limited to:

- Environmentalist, who will also be Project Manager;
- Water quality specialist;
- Field hydrologist;
- Water treatment process engineer; and
- Field technicians and sample-takers.

[91] Ministry of Health Decision No 8/1 March 1 2001.

The Consultant shall identify sources of pollution only insofar as is possible from field observations and analytical results. There will be no requirement to become involved with, nor to challenge, individual polluters or polluting enterprises.

Period of Assignment

The period of the assignment is expected to be 3-years from the date of commencement, currently expected to be November 2014.

Major Stakeholders

While the water quality monitoring contract shall be implemented through the Ministry of Environment, the Consultant's Interim Reports will be circulated by the Ministry to other major stakeholders, which are expected to include but not necessarily limited to, the following:

- Council for Development and Reconstruction;
- Ministry of Electricity and Water;
- Ministry of Health;
- Beirut and Mount Lebanon Water Establishment;
- Litani River Authority;
- Union of Municipalities;
- Concerned Heads of Municipalities;
- Internal Security Force.

Scope of Work

The Consultant is required to establish a network of monitoring sites on each of the most significant inflows to the Bisri Reservoir area and to sample each site four times throughout the hydrological year, on or about the middle of the months of January, April, July and October. As each sample is taken, the rate of flow at the site will be estimated. Each sample is be analysed for a broad range of water quality parameters at a laboratory accredited for the purpose by the Ministry of Environment, and strict 'chain-of-custody' procedures shall be observed.

For those parameters deemed to impart potentially significant public health risk after accounting for any degradation during reservoir storage or treatment and disinfection, the present study has defined 'Actionable Results'. These vary from any presence of the worst pollutants, such as POPs, to exceedance of Maximum Permissible Limit (MPL) where these are defined. An 'actionable result' triggers additional sampling upstream to more clearly identify the pollutant source.

The exact nature of the work; the sites to be sampled, the frequency of samples, and the parameters to be analysed may need to vary over the period of the contract in response to accumulating data and interpretation. At the present time the scope of activities on which shall be based offers of consultancy services are envisaged to be as follows:

1. Establish a water sampling and flow monitoring network with sampling protocol that covers all significant inflows to the reservoir area;

2. Undertake water quality sampling at each network site on or about the middle of January, April, July and October each year for three years. An estimate of flow at each site shall be made at the time of sampling;
3. For each sample for which one or more 'Actionable Results' are obtained, a repeat sample shall be taken within 3 days of receipt of the first sample results from the laboratory[92];
4. At the same time, the Consultant shall take up to 4 additional samples upstream of the original sample site and in tributary streams to more closely identify the source of pollution;
5. In early December each year, hold a Stakeholder's Conference with major stakeholders and other concerned parties to present the results to date, and discuss any recommendations for changes to network locations, the timing of samples or the analyses undertaken. Any reduction in the parameters monitored is likely to be restricted to POPs and heavy metals. Additional determinations may also be added.

The numbers of samples to be collected and analysed, on which the Consultant's offer shall be based, is estimated as follows:

Sample	January	April	July	October	Annual Total
One at each of up to 12 network sites	12	12	12	12	48
Repeat samples of those of the 12 with 'Actionable Results' (estimate)	3	3	5	5	16
Additional samples to more fully identify sources of pollution (estimate)	12	12	20	20	64
Contingency	3	3	3	3	12
TOTAL	30	30	40	40	140

Reporting Schedule

During the study the following reports shall be generated.

- *Inception Report*, to include details of the proposed monitoring network (to be submitted one month after commencement);
- *Interim Reports* giving details of the samples collected, the flows estimated, and the results of analyses (to be submitted within one month of receiving the laboratory report sheet for last samples in the set – i.e. February, May, August and November);
- Recommended Remediation Reports, summarising the remedial measures recommended to address identified pollution (to be submitted separately from but concurrently with Interim Reports);
- Annual Summary Report and PowerPoint presentation of results to date (Summary Report to be submitted one week before the annual Stakeholders Conference, the presentation to form the basis of conference hand-outs);
- Monitoring Scheme Revision Report detailing the proposals (if any) for revising the monitoring network, the sampling programme or the parameters analysed, as agreed

[92] The repeat and additional samples to be analysed for the full suite of parameters.

at the Stakeholder's Conference (to be submitted within one month of the Year 1 and Year 2 Stakeholders' Conferences;
- Final Project Report detailing the work undertaken throughout the project, the results, conclusions and recommendations, together with all analytical results appended, if necessary as a separate volume.

Water Quality Analyses

The water quality analyses to be undertaken shall include at least those parameters listed below. Where standard sampling procedures require parameters to be measured in the field, or samples to be treated prior to submission to the laboratory, the cost shall be included in the cost of sampling. All field measurements of water quality shall be repeated by the laboratory.

Physical Parameters	Chemical Constituents	POPs	Others	Heavy Metals
pH Conductivity Colour Turbidity Total Alkalinity Total Hardness TDS TSS	Calcium Magnesium Sodium Potassium Chloride Sulphate Fluoride Nitrate Nitrite Ammonia Ammonia-N Orthophosphate Total Phosphorous	Aldrin Chlordane DDT Dieldrin Endrin Lindane Endosulphan Heptaclor Hexachlorobenzene Mirex Hexachlorocyclohexane Toxaphene PCB PCDD (Dioxins) PCDF (Furans) Pentachlorobenzene	PAH Suite VOC Suite Dissolved Oxygen BOD COD TOC Faecal coliforms Total coliforms	Aluminium Arsenic Barium Cadmium Chromium Cobalt Copper Cyanide Iron Lead Manganese Mercury Nickel Selenium Zinc

All samples submitted for analysis shall include a waterproof label on which will be entered, in water repellent media, the following:

- Site Name;
- Date and Time of collection;
- Weather conditions;
- Estimated flow rate;
- Preservatives used (if any)
- Suspected hazards (if any)
- Name of Sampler
- Name of Consultant

Samples sets submitted by the Consultant for analysis shall include equipment, field and trip blanks (the latter for VOCs only) in accordance with *best practice* procedures. The Consultant shall ensure the laboratories QA/QC procedures include for the provision of method and instrument blanks and that these are used.

Contractual Arrangement

The monitoring study will be the subject of a standard consultant contract between the appointed Consultant and the Ministry. As shown in the table above, the majority of field sampling and hence also the majority of laboratory analyses, is dependent upon previous results. In order to attain expeditious response to contamination when identified, it is important that the responsibility for the appointed Consultant to authority to undertake Due Diligence on the results and implement follow up sampling according to the contract schedule is not delayed due to the prior need for formal Ministry approval.

Budget Estimate (US$)
Staff costs: 70,000 (including field equipment and transport)
Lab costs: 260,000 (including sample bottles)
Total: US$ 330,000.

APPENDIX L

RECORDS OF PUBLIC CONSULTATIONS

APPENDIX L1

April 2014

PUBLIC CONSULTATION SESSIONS

Introduction

Following revisions to the ESIA and RAP consequential upon changes to Dam design, land expropriations requirements, completion of the household survey and the establishment of indicative costs, further sessions of public consultation were held as follows:

Date	Location	Time	Venue	Attendees
Friday 25 April	Aamatour	10.00am	Municipality Hall	
	Mazraat El Chouf	3.00 pm	Municipality Hall	
Saturday 26 April	Bisri	10.00am	Church Hall	
	Mazraat El Dahr	3.00 pm	Municipality Hall	

In addition to the attendees noted above and given on the list of attendees, listed above, the following were also present to undertake the presentations and respond to comments from the floor:

Organisation	Persons
ESIA/RAP Consultant	4
CDR	2
World Bank	1
Dam Design Consultant	2

Attendees were predominantly male. Those females that did attend were as follows:

Location	Number	Details
Aamatour	None	-
Mazraat El Chouf	2	1 municipality office employee 1 young daughter with her father
Bisri	4	1 wife accompanying her husband 2 sisters
Mazraat El Dahr	None	-

One month prior to these sessions, on Wednesday 26 February, copies of plans showing the extent of proposed expropriation together with a list of plot numbers was posted in each of the four meeting venues for public reference. The scale of these diagrams was such that plot numbers could easily be distinguished. During each of the sessions, the ESIA/RAP consultant erected special display panels showing the previously. At two locations, Mazraat Al Chouf and Bisri, the original diagrams were still in place but considerably faded. At the other two sites the municipality had removed the diagrams from the walls but kept them available for public reference. At all four sites on the day of the sessions new copies of the plans were given to each municipality for future public reference.

Each of the four sessions followed the same general format:

- Distribution of hand-outs and attendance sheet;
- Short introduction by CDR;
- Introduction by ESIA/RAP Consultant, explaining the purpose of the session, introducing those present from CDR and the consultants, and explaining the current status of the project;
- PowerPoint slide presentation of ESIA study and its outcome;
- PowerPoint slide presentation of the RAP, with specific details of land expropriation procedures, grievance redress and indicative rates of compensation;
- The majority of each session was then open to receive comments and concerns from the floor.

The comments received are given below. In addition, two of the municipalities (Mazraat El Chouf and Bisri) submitted pre-prepared comments, while one of the attendees at Bisri, a lawyer representing several landowners, drew up a petition at the end of the session to which several landowners appended their signature. A small number of people, refused to sign the attendance sheet, while some other refused to acknowledge their comments in writing.

The overall attitude of all four audiences was strongly opposed to the construction of Bisri Dam. At Aamatour, barely has the introduction to the session been completed when for several minutes the meeting descended into uproar as attendees stood and shouted their opposition. At the other three sessions the presentations were received more politely, but at each, mild uproar again resulted when the indicative rates of compensation, everywhere considered far too low by attendees, were displayed. As was always anticipated, the majority of comments raised from the floor concerned land expropriation and asset compensation.

While Figure here below shows how these meetings were notified to the public via the national press, the Tables, that follow, report the details of these venues.

مجلس الإنماء والإعمار
إدارة التخطيط والبرمجة
التاريخ: ٢٠ آذار ٢٠١٤

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
CDR/PR4.1A2
Rev.00

PROJECT : *مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب / وضع محيط الموقع المقترح لسد بسري تحت الدرس*

I- NETCOM

MEDIA		NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	NAHAR	2	THU 20/03/14		SAT 22/03/14	4 COL. X 5.5
2.	LIWA'A	1		FRI 21/03/14		4 COL. X 5.5
3.	HERALD TRIBUNE					
4.	LE MONDE					

II- MEDIA MARKET LEADERS (MML)

MEDIA		NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	MUSTAQBAL	1	THU 20/03/14			4 COL. X 5.5
2.	DIYAR	1		FRI 21/03/14		4 COL. X 5.5
3.	AL-BALAD	1			SAT 22/03/14	4 COL. X 5.5
4.	L'ORIENT LE JOUR					
5.	HAYAT					
6.	ASHARQ AL AWSAT					
7.	AL-RIYADH (RIYADH)					
8.	AL-ANBA'A (KUWAIT)					
9.	AL-KHALIG (U.A.E.)					
10.	OKAZ (JEDDAH)					
11.	AL SEYASSAH					
12.	AL-RAY- AL –AM (KUWAIT)					
13.	AL QABAS					

III- ALLIED

MEDIA		NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	SAFIR	1	THU 20/03/14			4 COL. X 5.5
2.	ANWAR	1		FRI 21/03/14		4 COL. X 5.5
3.	ASHARQ	1			SAT 22/03/14	4 COL. X 5.5
4.	DAILY STAR					

III- AL-ADIB

اعلانات استملاك عائدة لمنطقة الشمال	NO. OF INSERTIONS	DAY (1)	DAY (2)	DAY (3)	SIZE

رئيس إدارة التخطيط والبرمجة
ابراهيم شحرور

نسخة إلى : دائرة المناقصات لنشر الإعلان على صفحة الإنترنت العائدة للمجلس
نسخة إلى: إدارة التخطيط والبرمجة - إدارة المشاريع – إدارة التمويل - المكتب الإعلامي – القلم

- نسخة للسيد علي
- نسخة للسيد ميداوي
- الحفظ

٢٠/٣/٢٠١٤

REPUBLIC OF LEBANON · COUNCIL FOR DEVELOPMENT & RECONSTRUCTION

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Session 1: Aamatour

25 April 2014

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: دار بلدة عماطور الزمان: ٢٥/٤/٢٠١٤

جدول الحضور

البريد الإلتروني	الهاتف	المؤسسة	الإسم	
—	٠١/٧٩٠٠٠٢	دار الهندسة - [illegible]	ايلي ابو جيلي	21
	70 74 7480	مالك	علي حسن مراد	22
	03/708524	ملاك	ذوقان عبد الصمد رئيس البلدية	23
	03/200654	وزارة الاشغال	سعيد فايز مرسل	24
salim.salem@usj.edu.lb	78/829114	ملاك	سليم سالم	25
	05/310670	ملاك مجاور	انور فؤاد ابو شقرا	26
	03/389525	ملاك	اكرم رافع ابو شقرا	27
	03/355297			28
	03/813303	مشارك مستمع	وليد حسن ابو شقرا	29
	70278987	ملاك مجاور	مكرم عبد الصمد	30
	03/925386	مشارك مستمع	وفيق ابو شقرا	31
الحوالي [illegible] الى شريع / نظام [illegible]	03/232311	وكيل املاك	حكمت فارس	32
	٧٠/٨٦١٩٩٢		عباس ابو شقرا	33
MaamounAbouChakra@live.com	٧٠-٧١٠٠٢٦٠	وكيل املاك	مأمون بديع ابو شقرا	34
robert.bounahed@daralhandasah.com	03/312663	دار الهندسة نزيه طالب	روبير بو ناهض	35
	03/892746	دار الهندسة نزيه طالب	لؤي لحود	36
majidehachem@hotmail.com	03/214621	وزارة الداخلية والبلديات	مجيد هاشم	37
mfadel@aub.edu.lb	٠٧/٥٠٢١٢٦	عضو بلدية	[illegible]	38
	٠٣/٤٤٨٤٤٨	الجامعة الامريكية في بيروت	[illegible]	39
	03/970312	ملاك	نصار ابو شقرا	40

سليم حفظ / جرجي فارس

Name	Company / Position	المؤسسة	الاسم
Ali Hasan Mourad	Owner	مالك	علي حسن مراد
Zoukan Abdel Samad	Head of Municipality / Owner	رئيس البلدية / ملاك	ذوقان عبد الصمد
Saed Fayez Moursel	Ministry of Public Works	وزارة الاشغال	سعيد فايز مرسل
Salim Salem	Owner	ملاك	سليم سالم
Anwar Fouad Abou Chakra	Landowner	ملاك مجاور	انور فؤاد أبو شقرا
Akram Rafea Abou Chakra	Owner	ملاك	اكرم رافع أبو شقرا
Walid Hasan Abou Chakra	Participant	مشارك مستمع	وليد حسن أبو شقرا
Makram Abed Al-Samad	Landowner	ملاك مجاور	مكرم عبد الصمد
Wafic Abou Chakra	Participant	مشارك مستمع	وفيق ابو شقرا
Hikmat Abou Chakra	Landowner representative	وكيل املاك	حكمت فارس
Abbas Abou Chakra			عباس أبو شقرا
Maamoun BAdia Abou Chakra	Landowner representative	وكيل املاك	مأمون بديع أبو شقرا
Majid Hachem		وزارة الداخلية والبلديات	مجيد هاشم

Jihad Abou Chakra	Municipality Member	عضو بلدية	جهاد أبو شقرا
Nassar Abou Chakra	Owner	ملاك	نصار أبو شقرا

Summary of issues raised at Aamatour Session and Client Responses

Zoukan Abdel Samad **Head of Municipality/Landowner**	**Response**
The main affected people from Bisri dam are the farmers.	Farmers will be compensated for the loss of their lands, assets and livelihoods according to Lebanese Law and RAP. While loss of agricultural employment and income will be unavoidable, new economic opportunities will result.
People are worried about the side effects of the dam. (i.e: In France, the collapse of a dam killed lots of people)	Dam Safety Plans have been formulated based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation.
The project is refused by several Aamatour citizens; therefore it is important to find alternatives.	An Analysis of Alternatives has been undertaken and based on a multi-criteria comparative assessment Bisri dam was recommended to be the priority scheme for Greater Beirut Water Supply Augmentation.
People of Aamatour and the region should not face the consequences of supplying Greater Beirut citizens with water. Amatour citizens are themselves facing water shortage and need water as much as Beirut.	It is common practice to move water from rural areas with plentiful resources to urban areas that suffer shortages. Surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from the economic opportunities provided by future development. A Benefit Sharing Fund may be established to fund projects in the surrounding villages.
Maamoun Badia Abou Chakra **Landowner representative**	**Response**
From the very beginning, the project is being refused by most of the citizens in the area. The land to be expropriated constitutes a property of material and sentimental value.	Compensation to landowners will be undertaken according to Lebanese Law and the provisions of World Bank Operating policy OP 4.12, both of which are described in the RAP, which when approved will be disclosed publically.
The Project will be done without any compensation that gives material entitlement to the landowners and their heirs and without compensation to the community benefiting from the land, especially the Municipality of Aamatour which is entitled to collect taxes.	There are established project-specific eligibility criteria incorporating all persons deemed affected by the project and establishing eligibility for compensation or other assistance as a result of all project-related impacts. All these were included into the Compensation Matrix in the RAP. If the PAP remains unsatisfied with the compensation offered, there is a Grievance Redress Mechanism that provides for independent review. It is proposed to establish the Benefit Sharing Program to share Project benefits with local

	communities. It is also expected that contractors will favour local residents with employment opportunities that will be generated by the Project.

It deprives the area of a valley and a plain that are favorable for the environment, for agriculture and more.	This is understood, and the project has investigated environmental degradation, the results of which are accepted by the Ministry of Environment.
Will this project be able to compensate the profit of 90 million L.L/ year that my pine trees provide?	All lost assets will be compensated on the basis of Lebanese Law and World Bank OP 4.12 as described in the RAP. All land and assets will be compensated at current market prices.
Hikmat Abou ChaKra Landowner representative	**Response**
I refuse the project since it is the main source of income for farmers.	Farmers will be compensated for the loss of their livelihoods, lands and assets according to Lebanese Law and RAP. While loss of agricultural employment will be unavoidable, new economic opportunities will result. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
I wonder if the dam has really been studied environmentally and whether it has been approved internationally especially that the Project is a massacre to the trees and crops animals, reptiles, birds, and fish, as well as the community and their livelihoods. Emphasize more on the environmental aspect especially that the dam side effects is considered to be a massacre.	The ESIA identifies a wide range of potential environmental and social impacts, and proposes measures to avoid mitigate or manage each during both construction and subsequent operational life. Extensive environmental quality monitoring and reporting is proposed to ensure the adequacy of these measures. A 1:1 tree planting programme has been proposed to compensate for the trees lost. A Biodiversity Management Plan has also been proposed for the rescue of any species that might need this. Livelihoods will be compensated for according to the provisions of the RAP.
Study desalination as an alternative.	Desalination was one of the considered alternatives. While it may be feasible, it has many disadvantages, such as requiring a heavy industrial plant located on the coast, the generation of large quantities of highly saline brine that will impair seawater quality, and a significant increase the cost of water to consumers.
Ali Hasan Mrad Landowner	**Response**
Are there going to be access roads from the villages to the dam area? Severance needs to be considered.	There will be a service road to the dam. The need for additional roads will be considered by the Master Plan for catchment development.
Why is the price of agricultural lands less than 100 m and more than 100 m from the river the same price?	The rates given are only indicative for the purpose of estimating RAP budgets. It will be the responsibility of the Expropriation Commission to set the fair and appropriate values of land based on site inspection.
The last two slides showing prices lack kidney beans.	For indicative purposes only, kidney beans are grouped under the Grains

Session 2: Mazraat El Chouf

25 April 2014

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: بلدية مزرعة الشوف الزمان: ٢٥/٤/٢٠١٤

جدول الحضور

البريد الإلتروني	الهاتف	المؤسسة	الإسم	
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			يوسف ذبيان	2
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			عفيف ذبيان	4
	70-098976	بلدية مزرعة الشوف	عايدة ذبيان	5
	03-842755	عضو بلدية	بشارة عزام	6
	70 320230	موظف	أيوب بوكروم	7
	05 320296	متقاعد	غسان بوكروم	8
	03 892746	دار الهندسة طالب	نديم محمود	9
robert.bounahed@daralhandasah.com	03312663	دار الهندسة طالب	روبير بو ناهض	10
	70 320426	تجارة	محمد يوسف العفيفي	11
	03 601703	تجارة	نادين يوسف العفيفي	12
	٠٧/٤٧٢٢٧٢٥	متقاعد	فاروق أحمد ذبيان	13
	٠٧/٢٩٩٤٤٠	كاتب البلدية	جهاد محمد	14
	٧٠٠٢٨٦٤٤	عضو بلدي	شفيق الغفيني	15
			دوري بوكروم	16
haisambk@gmail.com	٧٠/٨٢٠٤٧٤	عضو بلدي ملاك	هيثم أبو كروم	17
	٠٥/٣٢٠٧٦	مزارع ملاك	علي ذبيان	18
	٠٧/٧١١٠٨٧	مختار البلدة ملاك	مليكة بوكروم	19
	٧١/١٩٠٤٤٤	متقاعد	نبيل الغفيني	20

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: الزمان:

جدول الحضور

البريد الإلتروني	الهاتف	المؤسسة	الإسم	
	٠٧/٧٠١٩٤٧	موظف	عدنان العفيني	21
	٠٧/٨٢٥٤١٦	موظف	مروان العفيني	22
	٠٧/٧١٧٢٥٦	موظف	رها العفيني	23
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	03747981	ملاك	سعيد بوكروم	25
	05350339	ملاك	عماد بوكروم	26
	٠٥/٥٠٧٥٥	ملاك	رحمه ذبيان	27
	٠٥/٣٢٠٨٠٥	[illegible]	عفيفة ذبيان	28
	٠٥/٣٢٠٦٦٧		يوسف ذبيان	29
marwan@westlakevp.com	03-959590	ملاك	مروان ذبيان	30
	71-883113	ملاك	طارق بوكروم	31
		دار الهندسة	ايلي ابو ملهب	32
				33
				34
				35
				36
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				39
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Name	Company/Position	المؤسسة	الاسم
Youssef Zibyan			يوسف ذبيان
Afif Zibyan			عفيف ذبيان
Ayda Zibyan	Mazraat Al-Chouf Municipality	بلدية مزرعة الشوف	عايدا ذبيان
Bechara Azam	Municipality member	عضو بلدية	بشارة عزام
Ayoub Bou Karoum	Employee	موظف	ايوب بو كروم
Ghassan Bou Karoum	Retired	متقاعد	غسان بو كروم
Mohamad Youssef Al-Beaini	Trading	تجارة	محمد يوسف البعيني
Ghandi Youssef Al-Beaini	Trading	تجارة	غاندي يوسف البعيني
Farouk Ahmad Zebyan	Retired	متقاعد	فاروق احمد ذبيان
Jihad Ajab	Municipality Clerk	كاتب البلدية	جهاد عجب
Chafik Al-Beaini	Municipality member	عضو بلدية	شفيق البعيني
Youssef Bou Karoum			يوسف بو كروم
Haitham Abou Karoum	Municipality member/ Owner	عضو بلدية / ملاّك	هيثم أبو كروم
Ali Zebyan	Farmer/ Owner	مزارع / ملاّك	علي ذبيان
Walid Bou Karoum	Mukhtar/ Owner	مختار البلدة / ملاّك	وليد بو كروم
Nabil Al-Beaini	Retired	متقاعد	نبيل البعيني
Adnan Al-Beaini	Employee	موظف	عدنان البعيني
Marwan Al Beaini	Employee	موظف	مروان البعيني
Rajaa Al-Beaini	Employee	موظف	رجا البعيني
Shawki Al-Beaini	Owner	ملاّك	شوقي البعيني
Saed Bou Karoum	Owner	ملاّك	سعيد بو كروم
Afaf Bou Karoum	Owner	ملاّك	عفاف بو كروم
Rajab Zibyan	Owner	ملاّك	رجب ذبيان
Afif Zibyan	Inheritance	ميراث	عفيف ذبيان
Youssef Zibyan	Inheritance	ميراث	يوسف ذبيان
Marwan Zibyan	Owner	ملاّك	مروان ذبيان
Tarek Bou Karoum	Owner	ملاّك	طارق بو كروم
Elie Abou Rejaili	Dar Al-Handasah	دار الهندسة	ايلي ابو رجيلي

Consultation seesion underway in Mazraat El Chouf Municipality

25 April 2014.

Summary of issues raised at Mazraat El Shouf Session and Responses

Ali Zebyan	Response
The dam will not benefit the village since the project aims to improve Greater Beirut area only.	It is common practice to move water from rural areas with plentiful resources to urban areas that suffer shortages. Surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from the economic opportunities provided by future development. Also, a Benefit Sharing Fund may be established to fund those projects in the surrounding villages.
The fertile land, which is the main source of income for farmers, will be destroyed by the construction of the dam.	Agricultural land will be compensated according to its value established under Lebanese Law and World Bank OP 4.12. For persons directly and significantly affected by the project, there will also be provision for the restoration of incomes or livelihoods. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
Shawki Al Beani **Landowner**	**Response**
Lebanon is in need of dams and the people are willing to accept the project only if it benefits the area and its people (such as provide electricity to Jezzine)	Bisri Dam will include additional provision to generate hydropower to the national grid and a Benefit Sharing fund will be established to spread the benefits to the areas most affected.
Is still possible to change the project?	Yes. The objective of public consultation is to note the comments and concerns of the affected population and to take these views into account during project design, construction and execution.
Haitham Abou Karoun Municipality member/ Landowner	**Response**
The project opposes the government law which states that people should remain attached to their lands and properties.	The RAP stipulates that every reasonable effort is to be made to avoid or minimize the need for land acquisition and resettlement. Where they are unavoidable, the RAP lays out the policy and procedures to ensure persons subjected to adverse impacts are fairly compensated for all lost land and assets, and otherwise provided with other assistance to provide sufficient opportunity to at least restore their incomes and living standards.
The proposed dam project should stipulate benefits for the village of Mazraat Al-Chouf since the properties that are up for expropriation are mostly owned by the local community.	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.

Walid Adib Bou Karoum Mukhtar/ Landowner	**Response**
There was no mention of a seawater desalination project given that we own a long stretch of coast on the Lebanese border.	Desalination was one of the considered alternatives. While it may be feasible, it has many disadvantages, such as requiring a heavy industrial plant located on the coast, the generation of large quantities of highly saline brine that will impair seawater quality, and a significant increase the cost of water to consumers.
The town of Mazraat Al-Chouf is supposed to benefit from water and electricity; and we insist on this.	Bisri Dam will include provision to generate hydropower and deliver it to the national grid.
The creation of the dam constitutes a great loss for agriculture since this is the best land we have in terms of agriculture + natural beauty + compensations are much lower than the value of the land.	Farmers will be compensated for the loss of their livelihoods, lands and assets according to Lebanese Law and RAP. While loss of agricultural employment will be unavoidable, new economic opportunities will result. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
Shawki Al-Beaini Landowner	**Response**
The landowners' consent or lack thereof depends on the services supplied by the dam. If it will not supply electricity to the surrounding villages, what is the use of the dam? If it will not supply water to the people who need it, why should we build it?	Bisri Dam will provide both water and electricity. While this will not go directly to local consumers, it will free up resources currently dedicated to Greater Beirut for distribution to more rural communities.
Representatives of landowners from Mazraat Al-Chouf and Aamatour should be added to the Expropriation Commission to discuss fair remuneration for the land.	The Purpose of the Public Consultations is to convey PAPs concerns to the Project Proponent and to voice their ideas. Moreover, and as explained to public consultations audience the Expropriation Commission will include one independent observer to ensure that no-biased compensations will be decided.
Nabil Chahine Al-Beaini Landowner	**Response**
I object to constructing the dam at this particular site because the land that will be expropriated, especially the plain, has been our ancestral land for 400 years. Therefore, we ask that the dam be moved somewhere else.	All views will be considered by the project proponent and funding agencies.
Nabil Ali Qassem Zibyan	**Response**
Instead of serving Beirut, kindly supply services to Mazraat Al-Chouf and the neighboring villages to encourage people to stay and cultivate the land instead of migrating.	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.

Saed Bou Karoum **Landowner**	**Response**
The dam should be moved from its current location to a site below Moukhtara – Ain Qeni which will provide the needed water supply to the neighboring villages and prevent expropriation of agricultural land.	The proposed dam location has been studies from all standpoints including geology, seismology, water tightness, etc. The site below Moukhtara-Ain Qeni is very karstic, therefore water leakage at this site is expected to be very high.
I own and operate a park during the summer and that it constitutes my livelihood.	For persons who are directly and significantly affected by the project, there is provision to at least restore, their incomes or livelihoods. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
Mohamad Al-Beaini **Landowner**	**Response**
While the city of Beirut is supplied with water for 3-4 hours per day, while our town, Mazraat Al-Chouf, is supplied with water for an approximate 3-4 hours, twice a week.	Water from Bisri Dam will help release currently oversubscribed resources for less fortunate areas. The benefit Sharing fund will also focus on community projects such as water and electricity supplies.
Create a special committee of landowners for Mazraat Al-Chouf and Aamatour given the proportion of landowners, in order to follow up on all details.	The Purpose of the Public Consultations is to convey PAPs concerns to the Project Proponent and to voice their ideas. Moreover, and as explained to public consultations audience the Expropriation Commission will include one independent observer to ensure that no-biased compensations will be decided.

Farouk Ahmad Zebyan **Landowner**	**Response**
I agree with everything that was mentioned in the explanation. I support the construction of the dam.	Your comments are noted with many thanks.
Marwan Zebyan **Landowner**	**Response**
What are the direct benefits for the town community?	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.
Participation of the municipality in the valuing committee.	The composition of the various commissions and committees is laid down under Lebanese law. Local municipalities have a role in the special grievance Redress procedure formulated for this project at the behest of the World Bank. They will therefore play a major role in achieving the levels of compensation PAPs to which PAPs feel entitled.
Roads should be created to connect towns and reap economic benefit. We need water and electricity from the dam.	The need for new roads will be considered by the Master Plan for catchment development. Water from Bisri Dam will help release resources for less fortunate areas. The Benefit Sharing fund will focus on community projects such as water and electricity.
A percentage or amount should be supplied and added to the revenue of the municipality instead of using part of the town properties (e.g. telephone and electricity).	A Benefit Sharing Program will be created to spread the benefits of the project to local communities. Initially this will utilise the capital funds for the project, but later will continue through continued revenue from primary beneficiaries and other sources.
Where will the archeological monuments be transferred? Identify the location before proceeding with expropriation.	The directorate of Antiquities will be responsible for rescue archaeology and the project will fund all necessary activities to preserve heritage remains.
Establish the location to which fertile soil will be transferred and the beneficiaries.	The transfer of fertile soil to less-fertile areas is a proposal already included in the ESIA.
Propose a different location between the towns of Mazraat Al-Chouf, Aamatour and Moukhtara.	The proposed dam location has been studies from all standpoints including geology, seismology, water tightness, etc. The site below Moukhtara-Ain Qeni is very karstic; therefore water leakage at this site is expected to be very high.

Mazraat Al-Chouf Municipality	Response
The expropriated properties constitute the most productive land and the principal source of livelihood of many of the landowners. The compensation that we will receive for our land will not cover the deficiency that will occur after expropriation.	Farmers will be compensated for the loss of their livelihoods, lands and assets according to Lebanese Law and RAP. While loss of agricultural employment will be unavoidable, new economic opportunities will result. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
The Bisri site is environmentally vital and is unique in the Chouf region.	The ESIA identifies a wide range of potential environmental and social impacts, and proposes measures to avoid, mitigate or manage each during design, construction and subsequent operation. Extensive environmental quality monitoring and reporting is proposed to ensure the adequacy of these measures.
The Bisri site is located on a seismic risk zone and the presence of a lake increases the threat in this concern.	Protection against seismic effects have been incorporated into dam design to the maximum it is possible. Dam Breach modelling and inundation analysis have been undertaken by the dam designer. This work includes an Emergency Action Plan.
The area is home to an archeological Roman city buried underground, some monuments of which are still visible above ground.	The DGA will execute and archaeological rescue plan in accordance with their responsibilities under Lebanese law.
The Mazraat Al-Chouf town will not benefit neither from the dam's water nor from the generation of electricity.	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.
The water level elevation and expropriation of a 50 meter zone on the borders of the lake include hills that are significant for investment.	The ESIA Consultant has recommended the development of a Master Plan for the Development of the Bisri Lake Shoreline and Surrounding Areas.
Many townspeople were born in this area; thus the area is of sentimental value to them.	The comment is noted.
It is worth mentioning that there are other sites that are not fit for agriculture where the project can be built, including, for example, the valley located between the towns of Aamatour and Al-Mazraat and the valley of Damour.	The proposed dam location has been studies from all standpoints including geology, seismology, water tightness, etc. many other possible sites are very karstic; therefore water leakage at this site is expected to be very high.

Session 3: Bisri

26 April 2014

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: كنيسة سيدة بسري الزمان: ٢٠١٤/٤/٢٦

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني
1	رشيد ابو عيشه	مختار بلدة مشموشه	٠٧/٧٦٠٦١٢	
2	المهندس سيزار ابو عيشه	مكتب استشارات هندسية	03363744	
3	جميل جران	مالك	01/326672	
4	انطوان [illegible]	بلدية [illegible]	3/770250	
5	طانيوس حبيب	مهندس	03/759787	
6	ريمون جرجس توبيليان	امن الدولة	03/438694	
7	هادي جرجي توبيليان	هاتف	71914830	
8	جوزيف جرجي توبيليان	وزارة الاتصالات	70/824379	
9	[illegible] جرجي توبيليان	[illegible]	70/543732	
10	[illegible] جرجي توبيليان	وزارة الاتصالات	76/35873 86	
11	هارون [illegible]	مختار الميدان	٠٣/٩٤٤٣٧٧ ٠٧/٨٠٠٢١٤	
12	مارون ابو الخوري	نائب رئيس البلدية الميدان	٠٣/٨٥٦٨٥٩ ٠٧/٨٠٠٠٥٥	
13	[illegible]	مختار [illegible]	٠٧/٨١٠٨١٢	
14	الخوري بشير المغبغب	[illegible]	03/418774	
15	سيمون عيد	مختار مزرعة بسري	07/452747	
16	المهندس مروان امين	وزارة الاشغال العامة	03/358734	
17	التلميذ عيد قطار	مدرسة الحكمة	76/614757	
18	جهاد قطار	موظف - ملاك في بسري	03721129	
19	[illegible] سنان	عضو بلدية الميدان	70373490	
20	ماري دومينيكو عواد فرحات	ملاكة في مرج بسري	70/810400 الميدان	mariedofarhat@gmail.com

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: كنيسة السيدة بسري الزمان: ٢٠١٤/٤/٢٦

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني
21	كرازييلا عواد شباط	ملاكة في مرج بسري	01/280630	Graziella.aouad.chbat@Gmail.com
22	نظيرة عواد صباغة	ملاكة في مرج بسري	01/336159 الميدان	2Azisabbagha@Gmail.com
23	جان [illegible]	مالك - عماطور	03/844423 الميدان	
24	يوسف شاكر سنان	مالك - الميدان	70/542479	yusef.Sanan@gwail.com
25	الاب لويس ضعيف	ملك دير المخلص بحنين	03/793450	
26	هنري الصايغ	مستثمر عقارات بزحنين	03/369707	
27	يوسف بطرس العجيل	مالك في عماطور وبحنين	03/800811	
28	طنوس بطرس العجيل	مالك في عماطور	03/800482	
29	وفاء معروف بعقر	مالكة في مرج بسري	03/243513	WafaKadi@gmail.com
30	عادل سليم القاضي	مالك في مرج بسري	03/775791	adelskadi@gmail.com
31	انطوان [illegible]	مالك و مختار	03583037	
32	غادة جرجس حرب	مالكة - عماطور	03/984255	
33	ايلي شربل عواد	مالك - الميدان	03/787022	awadelie@gmail.com
34	مارون سليمان كرم	مالك عماطور بحنين - عماطور	07/800185	
35	الياس جورج [illegible]	مالك بسري	٠٣/٢١٥٢٢٧	[illegible]
36				
37	[illegible]			
38	جورج نجم الدويهي	مالك مزرعة الضهر	٠٣/٧٠٤٤٧١	[illegible]
39	نشلة دياب عقل	مالك	٠٣/٤١٦٢٧	[illegible]
40	المحامي شربل جرجس مرعي	مالك	٠٧/٧٥٤٥١٥	[illegible]

Name	Company / Position	المؤسسة	الاسم
Rafic Abou Atmeh	Mukhtar - Machmouchy	مختار بلدة مشموشي	رفيق أبو عتمة
Engineer Micheal Abou Atmeh	Engineering Consultant	مكتب استشارات هندسية	المهندس ميشال أبو عتمة
Jamil Jebran	Owner	ملاك	جميل جبران
Emil Mourad	Binwati Municipality	بلدية بنواتي	أميل مراد
Toni Youssef Habib	Engineer	مهندس	طوني يوسف حبيب
Remond Gergy Bou Sleiman	Government Security Agent	امن الدولة	ريمون جرجي بو سليمان
Fady Gergy Bou Sleiman			فادي جرجي بو سليمان
Joseph Gergy Bou Sleiman	Ministry of Telecommunication	وزارة الاتصالات	جوزيف جرجي بو سليمان
Ghassan Gergy Bou Sleiman	Ogero	هيئة أوجيرو	غسان جرجي بو سليمان
Toni Gergy Bou Sleiman	Ministry of Telecommunication	وزارة الاتصالات	طوني جرجي بو سليمان
Maroun Houbaika	Mukhtar – Al-Midan	مختار الميدان	مارون حبيقة
Maroun Abou Samra Al-Khoury	Vice head of Municipality – Al-Midan	نائب رئيس البلدية – الميدان	مارون ابو سمرا الخوري
Shafic Boulos	Mukhtar Bisri	مختار بسري	شفيق بولس
Priest Peter Al-Khawand	Bisri Priest	خادم رعايا	الخوري بيتر الخوند
Chafic Eid	Mukhtar - Bisri	مختار خربة بسري	شفيق عيد
Engineer Marwan Amine	Ministry of Public Works	وزارة الاشغال العامة	المهندس مروان امين
Student Eid Khatar	Sagesse School	مدرسة الحكمة	التلميذ عيد خطار
Jihad Khatar	Employee / Owner Kherbet Bisri	موظف – ملاك خربة بسري	جهاد خطار
Chaker Sinan	Owner – Al-Midan	ملاك بلدة الميدان	شاكر سنان
Marie Dominic Awad Farhat	Owner – Marj Bisri – Al-Midan	ملاكة في مرج بسري - الميدان	ماري دومينيك عواد فرحات
Krazella Awad Chebat	Owner – Marj Bisri	ملاكة في مرج بسري	كرازيلا عواد شباط
Nazira Awad Sabagha	Owner – Marj Bisri – Al-Midan	ملاكة في مرج بسري - الميدان	نظيرة عواد صباغة
Jean Houbaika	Owner – Aamatour – Al-Midan	مالك – عماطور - الميدان	جان حبيقة
Youssef Chaker Sinan	Owner – Al Midan	مالك – الميدان	يوسف شاكر سنان
Louis Afif	Owned by Deir Al-Mukhales	ملك دير المخلص – بحنين	الاب لويس عفيف
Henry Al Sayegh	Investor - Deir Dhanin	مستثمر عقارات دير بحنين	هنري الصايغ
Youssef Boutros Al Ajeil	Owner – Aamatour and Bhanin	مالك في عماطور وبحنين	يوسف بطرس العجيل
Tanous Boutros Al Ajeil	Owner Aray	مالك في عاراي	طانوس بطرس العجيل
Wafaa Maarouf Saad	Owner – Marj Bisri	مالكة في مرج بسري	وفاء معروف سعد
Adel Salim Al Kadi	Owner – Marj Bisri	مالك في مرج بسري	عادل سليم القاضي
Antoine Wehbeh	Owner / Mukhtar	مالك ومختار	انطوان وهبة
Ghada Gerges Harb	Owner – Aamatour	مالكة – عماطور	غادة جرجس حرب
Elie Charbel Awad	Owner – Al-Midan	مالك – الميدان	ايلي شربل عواد
Maroun Sleiman Karam	Owner – Aamatou, Bkasin, AL-Ghabatiyeh	مالك عاماطور - بكاسين –	مارون سليمان كرم

Name	Company / Position	المؤسسة	الاسم
		الغباطية	
Elias George Assaf	Owner – Bchary	مالك بشري	الياس جورج عساف
Asaad Btaich			اسعد بطيش
George Nadim Abou Samra	Owner – Mazraat Al-Daher	مالك في مزرعة الضهر	جورج نديم ابو سمرا
Chadi Akel	Owner	مالك	شادي عقل
Lawyer Charbel Gerges Harfouch	Owner	مالك	المحامي شربل جرجس حرفوش
Remon Habib Abou Samra	Owner – Al-Harf	ملاك – الحرف	ريمون حبيب ابو سمرا
Wissam Akel	Owner – Al Harf, Al-Midan	مالك (الحرف – الميدان)	وسام عقل
Najib Akel	Owner – Al Harf, Al-Midan	مالك (الحرف – الميدان)	نجيب عقل
Maroun Akel	Owner – Al Harf, Al-Midan	مالك (الحرف – الميدان)	مارون عقل

Consultation seesion underway in Bisri Church Hall

26 April 2014.

Summary of issues raised at Bisri Session and Responses

Sleiman Bou Seiman	**Response**
I am against the project especially that people live from this land and educated their children from it. I am vehemently opposed to the project.	The Purpose of the Public Consultations is to convey PAPs concerns to the Project Proponent and to voice their ideas. You comment is noted.
George Nadim Abou Samra **Landowner**	**Response**
What were the feedbacks of other public consultations and is still the possibility to stop the project?	Opinion is variable. The Purpose of the Public Consultations is to convey PAPs concerns to the Project Proponent and to voice their ideas.
Charbel Harfouche **Lawyer**	**Response**
Building the dam is not considered to be fair for people living from this land (especially that many of the people living in the area are poor and overcame many wars thus need this land for survival).	For persons who are directly and significantly affected by the project, there is provision to at least restore, their incomes or livelihoods. Where land acquisition is extensive, affects a person's means of livelihood, or requires the physical relocation of households, additional compensation will be made available.
Create a company of shares as the best solution for fairness in compensation-creation of a joint-stock company, like Solidere, whereby landowners are given shares in the company capital and funding parties given shares based on their financial contributions. Fairness predicates the participation of landowners by holding company stock, collecting dividends and trading on the stock exchange.	This idea for a joint-stock company may have merit but encompasses a range of legal issues beyond the scope of the present ESIA and RAP. Your comment is noted and has been passed to the project proponent for further consideration.

Adel Salim Al Kadi	Response
Provide yearly compensation for all farmers in the affected area. Create an agenda for improving and enhancing the Jezzine/Chouf area instead of supplying Greater Beirut.	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.
Create an organization to protect the dam and water quality.	The dam will be designed with a degree of earthquake projection and an Emergency Action Plan will be put in place. Water quality monitoring will be routine throughout dam operation and improved sanitation in the surrounding villages will improve the quality of inflowing streams.
The study did not stipulate payment of annual compensation for developing the area around the dam The study did not stipulate the creation of a body to monitor the protection of the dam from pollution and preservation of fishery resources.	An Environmental and Social advisory panel will be appointed to provide independent review of, and guidance on, the treatment of environmental and social issues associated with planning, design, construction and operation of Bisri dam and reservoir from the date of their appointment to a period expected to be not less than 3 years into dam operation.

Jamil Jebran **Landowner**	**Response**
I: Seismic Risk The planned dam is to be constructed over the Room fault line and an "earthquake of high magnitude" is expected. Certain historical literature and ancestral accounts passed down through generations tell of a strong earthquake that occurred in the mid-6th century (probably the year 556) which resulted in a massive collapse that blocked the riverbed and prevented the flow of water for fourteen months, thus creating the fertile, sedimentary Bisri plain irrigated by the river and the springs issuing from its banks. The villages of Mazraat Al-Mathaneh and Kherbet Bisri were built on the debris left by the aforementioned earthquake. Any flash flood that leads to the dam collapsing will have as a consequence the destruction of the greatest part of the two villages and may carry them away entirely. A flood occurred in the early seventies due to abundant, late rainfall. It caused considerable destruction on the outskirts of Mazraat Al-Mathaneh and mudslides that buried Al-Awali power plant (Boulos Arqash plant). The dangers created by the collapse of the dam due to an earthquake are not limited to the volume of water rushing down suddenly. One must consider the soil, rocks and trees that will be carried by the sudden onslaught, which will raise the water level even further. The riverbed would be too narrow to hold it all in and the banks would collapse. This increases the risk that the villages of Kherbet Bisri and Mazraat Al-Mathaneh will be carried away, given that, as we mentioned earlier, they stand on the debris left by the earthquake in ancient times, and will surely destroy the two power plants located along the riverbed, downstream from the dam. The explanations offered by the engineer responsible for designing the dam and its earthquake resistance were somewhat reassuring. Early warning and population evacuation plans in the event of a collapse, however, were vague. Indeed, the Lebanese State lacks an adequately equipped service or facility to handle natural disaster management. Moreover, the measures established in the study for the maintenance of the dam were merely theoretical.	Protection against seismic effects have been incorporated into dam design to the maximum it is possible. Dam Breach modelling and inundation analysis have been undertaken by the dam designer. This work includes an Emergency Action Plan.
II: Archeological Monuments There are visible archeological monuments along the banks of the river, from its source to Moltaka Al-Nahrayn, including: the Eshmun Temple; Abu Al-Hisn Fort (probably a remnant from the Crusades) located on a hill in the riverbed, and a stone bridge standing nearby, opposite Deir Al-Mukhales; a historical mill in the village of Kherbet Bisri, which was recently classified by virtue of a decree; the Church of Our Lady of Bisri; the Mar Moussa Church; the convent of St. Sofia; an old Roman temple and historical bridge at Moltaka Al-Nahrayn. The area, from the village of Kherbet Bisri to Moltaka Al-Nahrayn, is certainly the site of buried archeological monuments because the Bisri plain was densely populated before and after the earthquake of old. This is evidenced by the visible vestiges of religious monuments (the temple at Moltaka Al-Nahrayn) and is further	The DGA will execute and archaeological rescue plan in accordance with their responsibilities under Lebanese law. Heritage preservation, as distinct from archaeological rescue, will be implemented to relocate Mar Moussa Church, St. Sophia's Monastery and similar structures throughout the valley.

corroborated by the tales of senior members of the community who say that people from the coast would come to the temple in horse-drawn carriages by way of a path adjacent to the riverbed.	
III: Expropriation Expropriation is, of course, subject to the law. Nevertheless, some comments are necessary on the conducted study that will constitute the actual basis for the expropriation decree. • Valuation of the land based on its distance from or proximity to the river is not sufficient to establish its value. The type of land (flat or steep), type of soil (fertile sedimentary, sandy or rocky), whether the land is irrigated or not, and the type of crops actually cultivated on it are all factors that should be taken into account to determine its value. Therefore, the stipulated prices are far below the real value of a flat, sedimentary, fertile, irrigated, cultivated citrus orchard. Furthermore, the prices stipulated for equipment are lower than their actual cost. • Compensation is due to resident and non-resident landowners and covers the land, tenancy, built structures, trees, crops, etc. However, if there is proof of sharecropping, investment or similar contracts, the content of such contracts should be examined to apportion compensation accordingly. • Compensation should be made in cash exclusive of any other previous payment mode (payment in treasury bonds). The study does not state whether the money for compensating expropriation is available or not. This is a cause for concern among rightful beneficiaries, especially given that it has been years since a budget was ratified in Lebanon. • No matter how fair the compensation, forcibly taking a property by expropriation, in particular lands which are mostly inherited, involves not only considerations of material gain but sentimental value that should be taken into account. Allowing landowners to uproot or cut down trees, uninstall equipment and perhaps transferring soil, all within a certain period (e.g. 6 months) from the date on which the Expropriation Commission’s decision is issued, may alleviate the sentimental damage.	The compensation rates provided are indicative only and the actual levels of compensation will be determined by the Expropriation Commission on the basis of land and asset inspections and evaluations. One of the key tasks of the Commission is to examine all claims relating to contracts, agreements, bills and other documents. Share cropping agreements will certainly be accepted for consideration. The ESIA has identified the presence of archaeological remains and cultural heritage and there will be a programme of rescue archaeology and heritage relocation prior to filling the reservoir in order to preserve their cultural heritage and any other meaningful asset to the local people memory. Landowners will be allowed to remove whatever assets they wish to retain, including plants and soil without affecting compensation payments.
IV: Post-Construction In addition to seismic risk, climate and overall environmental changes will have a considerable impact, least of all the rise in humidity, insects and diseases resulting from stagnant water and the discharge of wastewater, especially given that the towns and villages along the riverbanks lack sewage networks and treatment plants. Growing tourism due to the dam and lake will create tremendous human, health, pollution, noise and other pressures on an environment that used to be rural, quiet and wholesome. The environment will lose its characteristics and will change forever. We are not entirely confident that the various State services (Directorate-General of Urban Planning and other such) will take	The ESIA identifies a wide range of potential environmental and social impacts, and proposes measures to avoid mitigate or manage each during both the period of construction and subsequent operations. Extensive environmental quality monitoring and reporting is proposed to ensure the adequacy of these measures.

measures to ensure proper management of the land surrounding the dam and lake. We would prefer for the Council for Development and Reconstruction to contact the competent administrations to develop as of the present a comprehensive management plan that would enter into effect upon the issuance of the expropriation decree or, at least, before the land take decision. The same applies for studies on the flow of water downstream from the dam, allocation of water for land irrigation, forestation and other plans on distributing the benefits of the project. These should be ready and disseminated to the community by land take. A sole management should be created for the dam, lake and basin as a whole. Local committees should take part in this management. Dividing responsibilities among State administrations, especially under the current situation, will result in no accountability, failure to implement the set plans, neglect of maintenance and undermining the natural, environmental and community resources, and perhaps the collapse of the dam, even without the contribution of an earthquake.	The ESIA Consultant has recommended the development of a Master Plan for the Development of the Bisri Lake Shoreline and Surrounding Areas.

Maroun Hobeika **Mukhtar**	**Response**
Will there be compensation for the sand quarries?	Yes. Compensation for those plots to be expropriated will include consideration of any and all commercial activities undertaken.
The town of Al-Midan (Jezzine Caza) lacks a sewer network. A study was previously conducted by the Ministry of Energy and Water, but has not been implemented yet. There are sewer projects in several towns and area, but no treatment plants; mostly, sewage is discharged into the Bisri River.	In order to protect water quality in Bisri reservoir it is intended to fast-track the installation of sewerage and sewage treatment across all villages within the catchment.
A public road project connecting Al-Midan to the town of Bisri has been studied and planned, and a Presidential decree issued in its regard. The road is 6 kilometers long and its established width is 12 meters. The road is highly vital; it connects Jezzine and the upper South to Marj Bisri. The project should be carried out to connect and facilitate access from and to Marj Bisri through Deir Al-Mukhales, Joun and the coastal highway to the capital city of Beirut. The road will not be blocked by snow during the winter. It facilitates summer and winter travel to the coastal highway and is shorter than the Room – Saida road and the Beirut main road by 30 kilometers.	The needs for new roads will be a major element of the proposed Master Plan for the development of the upper catchment area.

George Nadim Abou Samra **Landowner – Mazraat Al-Daher**	**Response**
The project is inequitable; a different location should be sought for the project.	The objective of public consultation is to note the comments and concerns of the affected population and to take these views into account.
Marie Dominique Awad Farhat **Landowner – Marj Bisri – Al-Midan**	**Response**
We request that compensation per square meter be reconsidered because it is very low.	The compensation rates provided are indicative only and the actual levels of compensation will be determined by the Expropriation Commission on the basis of land and asset inspections and evaluations.
We request that the dam be kept clean, i.e. that dedicated infrastructure be created in neighboring towns. We also request that the surrounding area be well maintained in terms of planting fruit and natural tree cover.	BMLWE shall maintain the dam the reservoir shoreline and operational monitoring.
Is it possible to build ponds instead of a dam since it will be constructed on an earthquake prone site?	A series of ponds would not offer the storage potential of a dam and hence fail to satisfy the demand for water that has to be served.
Shafic Boulos **Mushtar, Bisri**	**Response**
Deteriorating water quality and sewerage	Sewerage schemes will be executed in all villages discharging into the Bisri valley. Monitoring of water quality will be undertaken throughout dam operation.
Lack of oxygen	Dam design provides for multi-level releases to allow for deeper water to be circulated and oxygen levels maintained.
Discharge of mineral water; manganese, iron, sulphur, arsenic, phosphorus, ammonia, etc.	It is assumed the questioner refers to the potential for water pollution. Water pollution studies have previously been undertaken and water quality monitoring will extend throughout the period of dam operation. Current water quality is such that it can be rendered suitable for public consumption with conventional treatment, i.e. without special treatment.
Testing showed traces of organophosphate pesticides – Lindane and Dieldrin – the use of which is internationally prohibited	The project will fund a programme administered by MOE to monitor water quality and find and curtail any remaining sources of any potentially polluting substances.
Rise in diseases and multiplication of mosquitoes	The proliferation of mosquitoes is a potential threat to any standing water body. Mitigation is primarily achieved through efficient design that does not allow high water levels to overtop reservoir sides, and yet permits efficient shoreline drainage, both aimed at reducing mosquitos breeding sites. Bankside vegetation will be managed.
Odors and impact on the environment	Odour currently arises in the vicinity of sewage discharge into the river from surrounding villages. CDR's proposals for fast-tracking the execution of sewerage schemes in all catchment villages will prevent this type of odour in the future.

Salinity downstream from the dam will rise and negatively impact agriculture and the population – insects will increase	Compensatory discharges from the dam will be sufficient to maintain existing irrigation efficiency and prevailing ecological conditions.
Rise in seismic risk; what will happen to the community living downstream from 125 million cubic meters of water? What measures will be taken to reduce these risks?	Dam Safety Plans have been formulated based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation.
Document prepared by Lawyer at the end of the Session and signed on behalf of 25 landowners	**Response**
We propose that a law on the construction of the Bisri dam be issued via a joint-stock company whereby landowners obtain their compensations and entitlements based on shares in the proposed company, allowing them to collect dividends and trade the stock exchange to protect their rights and as fair distribution of entitlements resulting from the project.	This idea for a joint-stock company may have merit but encompasses a range of legal issues beyond the scope of the present ESIA and RAP. Your comment is noted and has been passed to the project proponent for further consideration.
Prevent traditional expropriation methods based on the applicable law for a vast area of 520 hectares in which the State does not own any public or state-owned land.	Land expropriation will be undertaken in accordance with Lebanese law modified as appropriate by the provisions of World Bank OP 4.12, as defined and discussed in the RAP. Some 50 ha of the land to be taken by the project is already *domaine publique*.
The community welcomes the project on this fair basis and based on sharing project profits with landowners, the community and future generations, given that the area has been underserved since before independence. One should take into account the chronic state of deprivation and the need to revive the area but not at the expense of the local community by giving them the lowest compensations possible through the traditional approach; rather, the community should be allowed to share in the considerable profits that the State and the administration stand to make off of their land which is proposed for expropriation in exchange for minimal return.	Compensation to landowners will be undertaken according to Lebanese Law and the provisions of World Bank Operating policy OP 4.12, both of which are described in the RAP, which when approved will be disclosed publically. The compensation rates provided are indicative only and the actual levels of compensation will be determined by the Expropriation Commission on the basis of land and asset inspections and evaluations. All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from opportunities provided by future development. A Benefit Sharing Fund will be established to fund those projects in the surrounding villages.
The Jezzine community, particularly the landowners here present, wishes success to the endeavor to create the Bisri dam construction company by virtue of a law that stipulates the establishment of such a company, without full objection to the currently proposed mechanism.	This idea for a company may have merit but encompasses a range of legal issues beyond the scope of the present ESIA and RAP. Your comment is noted and has been passed to the project proponent for further consideration.

Shafiq Eid **Mukhtar, Kherbet Bisri**	**Response**
The appended map does not allow us to identify in detail the expropriations and projects downstream from the dam where our village is located. We ask to be provided with a detailed map showing the number of each property affected by expropriation.	Larger scale maps on which it is possible to identify individual plots and their numbers were displayed at the public consultation sessions. Copies of these maps for public reference have been given to the municipalities where consultation sessions were held. The expropriation map is also available at CDR website: www.cdr.gov.lb
On the outskirts of our village, or perhaps within the scope or in the vicinity of expropriations, is located a historical mill that was recently classified as an archeological site (please find attached a copy of the classification decree). No reference was made in this regard in the executive summary. Please clarify.	The ESIA/RAP Consultant has reported the presence of the mill to the consultant preparing the Expropriation File. So far as we are aware the transmission pipeline corridor is some 50 m from the mill. In any case, all lands and assets will be inspected prior to the deliberations of the Expropriation Commission.
Valuation of land based on its proximity to the river is not a reasonable or scientific method for establishing land price. The type of soil, the type of land, whether irrigated or not, etc. should constitute the criteria adopted in determining the sum paid for expropriation. In any case, the price of irrigated land cannot be equivalent to the price of non-irrigated land.	The rates given are only indicative for the purpose of estimating RAP budgets. It will be the responsibility of the Expropriation Commission to set the fair and appropriate values of land based on site inspection.

It is well known that the site where the Bisri dam will be built is a high-seismic-risk zone. The construction of the dam will increase the risk multifold. The executive summary merely confirmed the rise in seismic risk – which is expected – and its great potential magnitude, and simply mentioned general guidelines on protection against the consequences of earthquakes which will inevitably worsen if the dam were to collapse as a result. This threatens the very existence of our village and may lead to the village being destroyed and carried away, for the precise reason that it is built on the debris left by past earthquakes which are said to have occurred in the mid-6th century. Therefore, we should be informed of the practical measures that you will take to prevent the collapse of the dam in the event of an earthquake and the population safety, prevention and rescue procedures in case the dam collapses. At present and for the foreseeable future, the State does not have any qualified service or staff for rapid intervention in the event of natural disasters. Whatever the adopted methods and established plans, we will have, after the dam is constructed, to live in our village in constant fear and concern about the occurrence of a disaster that is prone to wipe out our village and, perhaps, its residents, too.	Dam Safety Plans have been formulated based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation.

Session 4: Mazraat El Dahr

26 April 2014

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة – المكان: بلدية مزرعة الضهر الزمان: ٢٦/٤/٢٠١٤

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلتروني
1	الياس الحداد	دار الهنوية طالب	01-863533	
2	شاهين محمد نعيم عيد	نائب رئيس البلدية	01-297858	Chahine.m.eid@hotmail.com
3	سامي عيد		70/270140	
4	أسعد وديع عيد		03/301634	
5	شاهين نعيم عيد		03/297858	
6	فادية عيد		03/140699	
7	خولة عيد		03/998836	
8	شادي عيد		03/500949	
9	شادي عصام عيد		70/845289	
10	حسن عيد	رئيس البلدية مزرعة الضهر	03/305057	~~[illegible]~~
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Name	Company / Position	المؤسسة	الاسم
Elias Al-Haddad	Dar Al-Handasah Taleb	دار الهندسة طالب	الياس الحداد
Chahine Naim Eid	Vice Head of Municipality	نائب رئيس البلدية	شاهين نعيم عيد
Safi Eid			صافي عيد
Asaad Wadia Eid			اسعد وديع عيد
Fadi Eid			فادي عيد
Charbel Eid			شربل عيد
Chadi Eid			شادي عيد
Chadi Isam Eid			شادي عصام عيد
Hasib Eid	Head of Municipality – Mazraat Al-Daher	رئيس البلدية – مزرعة الضهر	حسيب عيد

Consultation seesion underway in Mazraat El Dahr Municipality

26 April 2014.

Summary of issues raised at Mazra'at El Dahr Session and Responses

Chahine Naim Eid Vice Head of Municipality	Response
Wonders whether there is enough time to invest in snail farming before the Expropriation Decree.	The Project Proponent formally adopts a project cut-off date after which persons settling in the project area or initiating improvements to property may not be considered eligible for compensation or other assistance. For Bisri, the cut-off date is 20 March 2014.
The Bisri dam project should not only supply Greater Beirut with water but also Bisri.	All surrounding villages in Chouf and Jezzine will benefit from improved infrastructure such as sanitation and from the economic opportunities provided by future development. Also, a Benefit Sharing Fund may be established to fund those projects in the surrounding villages.
A modern economic feasibility study undertaken for the construction of a farm on the land located within the scope of the project reveals an annual income of USD 4,500-5,000 for 1000 sqm of land, i.e. a minimum USD 45,000-50,000 in income per year for 10,000 sqm. We will begin construction within a month of the present date. Therefore, we find that the compensation schedule is unfair and should be reconsidered to set the prices based on the productive value of the land, which has always constituted the livelihood of the community of Mazraat Al-Dahr. I hereby propose that the project be reexamined to take into account the value of the agricultural land which, no matter how high the compensation and no matter its value, will remain, as the heritage of our ancestors, priceless, because it was the reason why they resisted in the face of adversity and was the source of their livelihood throughout their lives. We will today be economically and morally affected and no amount of money can compensate for the land that we love and which we have farmed and cultivated.	The rates given are only indicative for the purpose of estimating RAP budgets. It will be the responsibility of the Expropriation Commission to set the fair and appropriate values of land based on site inspection.
We support the irrigation project, but hope that it does not end up depriving our children of an indispensable and irreplaceable natural resource.	Compensation will be undertaken according to Lebanese Law and the provisions of World Bank Operating policy OP 4.12, both of which are described in the RAP, which when approved will be disclosed publically.

Asaad Nadia Eid	Response
Some people are wondering whether compensation will apply for Bisri citizens.	Those loosing land or other assets, or whose livelihood is affected by the project will be eligible for compensation as identified in the RAP. Compensation will be undertaken according to Lebanese Law and the provisions of World Bank Operating policy OP 4.12, both of which are described in the RAP, which when approved will be disclosed publically.
Suggest employing locals in operating the future dam.	Construction contractors are encouraged to prioritise the employment of those residing within the project area.
Hasib Eid **Head, Municipality–Mazraat Al-Daher**	**Response**
It is important to make sure the relocation of the church will involve Mazraat el Dahr citizens. People along with the municipality should have their say in moving the church.	The relocation of Mar Moussa Church has been discussed with the Diocese of Saida which in turn has discussed the issue with the municipality. The relocation was also discussed during public consultation in the Municipality, whereby the 4 proposed locations have been discussed and the best option recommended based on a multi-criteria analysis.
Asaad Wadia Eid	**Response**
I am currently conducting a study for an agricultural and farming project on the property that I own in Sabil Bisri, which will be implemented in June 2014. Is the date set in the study, 20 March 2014, a dividing point between the currently expected compensation and the amount I will incur in the future – which will amount to a considerable difference?	20 March 2014 is the cut-off date currently established by CDR after which persons settling in the project area or initiating improvements to property may not be considered eligible for compensation or other assistance. It is possible this date will change, but at the present time this cannot be confirmed.
What is the benefit to the town of Mazraat Al-Dahr in terms of irrigation, electricity or other such…?	While surrounding towns and villages will not receive water or electricity directly from the dam, they will benefit from improved infrastructure such as sanitation and from the economic opportunities provided by future development. Also, a Benefit Sharing Fund may be established to fund projects such as renewable energy and community facilities throughout surrounding villages.

PowerPoint Presentation

dar al-handasah shair and partners

مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه

دراسة تقييم الأثر البيئي والإجتماعي
وخطّة إعادة الإسكان

Greater Beirut Water Supply Augmentation Project

Environmental and Social Impact Assessment (ESIA)
and Resettlement Action Plan (RAP)

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dar al-handasah | مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Presenters | المقدّمون

سيقوم كلّ من **السّيّدة روى درباس والسّيّد إيلي أبورجيلي** بدور المقدّمين الرئيسيّين لهذه النّدوة.

كما حضر للاجابة عن أسئلتكم:
الدّكتور سهيل سرور - الذي سيقوم بدور رئيس الجلسة
الدّكتور جون دايفي - قائد فريق تقييم الاثر البيئي والاجتماعي

السّيّد عاصم فيداوي- مدير مشروع *زيادة تغذية منطقة بيروت الكبرى بالمياه* لدى مجلس الإنماء والإعمار.

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dar al-handasah | مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Objectives of this session | أهداف النّدوة

أهداف النّدوة اليوم هي:

- عرض ملخّص عن **المستجدّات الأخيرة** للمشروع.
- عرض ملخّص عن **نتائج تقييم الأثر البيئي والإجتماعي** للمشروع وفقاً للمرسوم رقم ٨٦٣٣ الصّادر من وزارة البيئة (آب ٢٠١٢)، وقانون البيئة رقم ٤٤٤.
- عرض ملخّص عن **العقارات الخاضعة للإستملاك وشرح عمليّة دفع التّعويضات** للأشخاص المعنيّين.
- **الحصول على تعليقاتكم وآرائكم** بشأن المشروع، **وتسجيل إقتراحاتكم** لأخذها بعين الإعتبار في المراحل النّهائيّة للدّراسة.

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dar al-handasah | مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Outline | العناوين

نتائج تقييم الأثر البيئي والإجتماعي

- ❑ الوضع الحالي لامدادات المياه
- ❑ معالجة مشكلة شحّ المياه على المدى القصير والمتوسّط
- ❑ معالجة مشكلة شحّ المياه على المدى البعيد
- ❑ مراحل المشروع
- ❑ موقع المشروع
- ❑ سدّ بسري
- ❑ الإستخدام الحالي للأراضي
- ❑ إعتبارات خاصّة
- ❑ المشاورات والدّراسات المتخصّصة
- ❑ الآثار المتوقّعة والإجراءات للتّخفيف منها
- ❑ تعميم فوائد المشروع
- ❑ متطلّبات مراقبة الجودة البيئيّة
- ❑ استشارات العامّة

خطّة إعادة الإسكان

- ❑ المسح الإجتماعي الإقتصادي
- ❑ مسح العقارات و المساحات المتأثرة
- ❑ آلية التعويضات ومستحقيها
- ❑ آلية الإستملاك وإعادة الإسكان
- ❑ المراحل الزمنية
- ❑ مؤشر التعويضات المادية
- ❑ إنقاذ المواقع الأثرية

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dar al-handasah | مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Present Water Supply Situation | الوضع الحالي لامدادات المياه

- يعاني لبنان من **نقص في كمية المياه المتوفرة سنوياً** لتلبية احتياجات المواطنين.
- قُدّر عدد سكان بيروت الكبرى وجبل لبنان في العام ٢٠١٠ بـ **١,٩مليون** ومن المتوقع ان يصل العدد الى **٢,٣ مليون** بحلول العام ٢٠٣٥.
- حالياً يتلقى سكان بيروت الكبرى المياه من جعيتا عبر محطات المعالجة في ضبية، وآبار الدامور، وعدّة مصادر ثانوية.
- **ولكن الإمدادات غير كافية بحيث تتلقّى بعض الاسر المياه لأقلّ من ٣ ساعات يومياً خلال فصل الصّيف في منطقة بيروت الكبرى.**
- لذلك يلجأ العديد من الأسر الى مصادر بديلة:

(أ) **الآبار الإرتوازية** والتي أصبحت تستخدم بشكل مفرط وغالباً ما تكون غير قانونية وذات جودة متردّية
(ب) **شراء المياه المنقولة بالصهاريج** العائدة للقطاع الخاص، منها ما هو غير صالح للشرب
(ج) **مياه الشرب المعبئة** ذات الكلفة العالية ومنها ما لا تحظى بتراخيص من وزارة الصحة

	٢٠١١	٢٠٢٥	٢٠٣٥
العجز المائي الواجب تغطيته (مليون م³)	205	155	195

المصدر: موازنة مياه الشفة التي أعدتها وزارة الطاقة والمياه لمنطقة بيروت الكبرى للفترة الممتدة بين ٢٠١١ و٢٠٣٥.

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dar al-handasah | مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Addressing Water Stress (long-term) | معالجة مشكلة شحّ المياه على المدى البعيد

لمعالجة مشكلة شحّ المياه على المدى البعيد، أوكل الى مجلس الانماء والاعمار وبالتعاون مع وزارة الطاقة والمياه ومؤسسة مياه بيروت وجبل لبنان، مشروع: **"زيادة تغذية منطقة بيروت الكبرى بالمياه" GBWSAP.**

أهداف المشروع هي:

- توفير المياه على المدى البعيد **لمنطقة بيروت الكبرى.**
- أن يكون الحلّ مقبولاً بيئياً وإجتماعياً، وممكناً تقنياً وذات جدوى إقتصادياً.

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Phases of the project

مراحل المشروع

تنقسم مهام المشروع الى المراحل التّالية:

- جلسات استشاريّة لتحديد نطاق المشروع (٢٠١٢)
- مراجعة تقنيّة، بيئيّة، اجتماعيّة، واقتصاديّة للبدائل
- دراسة تحليليّة للبدائل
- تحديد الخيار الأوّلوي للمشروع
- القيام بمسح إجتماعي
- مسودّة تقييم الأثر البيئي والإجتماعي للموقع من ضمنها خطّة إدارة بيئيّة ومسودّة خطّة إعادة الإسكان
- جلسات استشاريّة لمناقشة نتائج تقييم الأثر البيئي والإجتماعي مع العامّة (٢٠١٣)
- تقييم الأثر البيئي والإجتماعي النّهائي وخطّة إعادة الإسكان

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Project Area (1)

موقع المشروع (١)

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Project Area (2)

موقع المشروع (٢)

موقع السّدّ المقترح

مجرى النّهر

باتّجاه المصبّ

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Bisri Dam (1)

سدّ بسري (1)

- إرتفاع السّدّ: ٧٣ متراً
- الحدّ الأقصى لحجم التّشغيل الطّبيعي: ١٢٥ مليون م٣
- مساحة البحيرة والسّدّ: ٤٣٤ هكتاراً
- المساحة الخاضعة للإستملاك بما تتضمّن خطوط الجرّ: ٥٧٠ هكتاراً
- أقرب قرية هي على بعد ٥٠٠ متراً من البحيرة
- المقيمون الدّائمون هم بالإجمال عمّال موسميّون
- وجود عدد قليل من المنازل
- لا توجد طرق معبّدة تربط القرى مباشرة بمنطقة البحيرة ولا وجود لبنى تحتيّة رئيسيّة أخرى
- لا توجد أنشطة صناعيّة أو غير زراعيّة

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Bisri Dam (2)

سدّ بسري (2)

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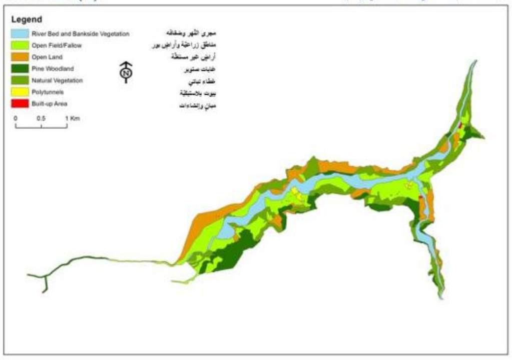
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Bisri Dam (3)

سدّ بسري (3)

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Land use(1)
الإستخدام الحالي للأراضي (1)



13

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Land use(٢)
الإستخدام الحالي للأراضي (2)


أراضٍ زراعيّة


زراعة الأشجار


بيوت بلاستيكيّة


زراعة الفراولة

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Land use(٣)
الإستخدام الحالي للأراضي (٣)




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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Special Considerations
اعتبارات خاصّة

ان أيّ دراسة هندسيّة للسدود، عليها الأخذ بعين الإعتبار المعطيات الأساسيّة لأرض الموقع والتي تتلخّص بالتالي:

- *الهزّات والزّلازل: وقد أخذت بعين الإعتبار في التّصاميم الهندسيّة*
- *جودة المياه السّطحيّة*
- *تدفّقات المياه في مجرى النّهر أسفل السدّ*
- *الإرث التّاريخي والثّقافي*
- *التّنوّع النّباتي والحيواني*
- *تحضير الأراضي*
- *النّموّ المستحثّ جرّاء بناء السّدّ*

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Special Considerations
Water Quality
إعتبارات خاصّة
جودة المياه السّطحيّة

- تمّ أخذ عينات على طول نهر بسري وبحيرة جون وأماكن مختلفة على مدار أكثر من ١٨ شهراً.
- وقد تمّت دراسة نتائج هذه العيّنات المكثّفة من قبل جهة مستقلّة من قبل خبراء دوليّين.
- أكّد الخبراء من إمكانيّة معالجة المياه وفقاً للمعايير اللّبنانية والدّوليّة لمياه الشّرب في محطّة الوردانيّة لمعالجة المياه .
- وتشمل هذه المحطّة التّقنيّات التّقليديّة اللّازمة لمعالجة المياه.
- وتشمل خطّة الإدارة البيئيّة والاجتماعيّة رصد دوري لنوعيّة المياه في البحيرة.
- على أن يقوم مجلس الإنماء والإعمار بإعداد **مخطّط توجيهي يعنى بإدارة المياه المبتذلة للقرى الواقعة في الحوض الأعلى.**

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dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Special Considerations
Downstream Abstractions
إعتبارات خاصّة
تدفّقات المياه اسفل السدّ

سوف تؤمّن تدفّقات المياه من البحيرة الى منطقة أسفل السدّ التّالي:

- توفير المياه اللّازمة للاستخدامات المطلوبة أسفل السدّ (كالرّيّ بالدّرجة الأولى، بالإضافة الى إستعمالات اخرى).
- الحفاظ على التّنوع البيولوجي والموائل الطّبيعيّة. وقد تمّ تصميم السّدّ للسّماح لمتطلّبات التّدفّق البيئي وفقاً للممارسات الفضلى للمعايير الدوليّة.
- *وقد تمّ إدراج هذه التّدفقات البيئيّة في إجراءات تشغيل السدّ.*

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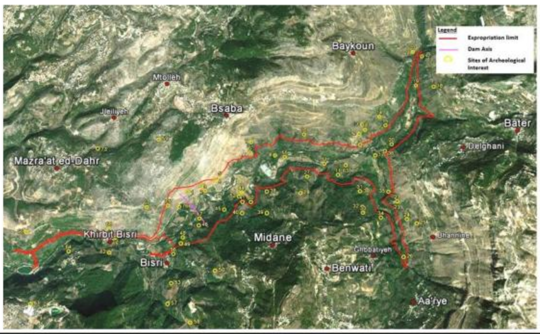
Special Considerations
Historical & Cultural Heritage(1)

إعتبارات خاصّة
الإرث التّاريخي والثّقافي (1)



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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Special Considerations
Historical & Cultural Heritage(2)

إعتبارات خاصّة
الإرث التّاريخي والثّقافي (2)


جسر حجري أثري


أعمدة رومانيّة


دير القديسة صوفيا


كنيسة مار موسى

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دراسة تقييم الأثر البيئي والإجتماعي

Special Considerations
Ecological Diversity

إعتبارات خاصّة
التّنوّع النّباتي والحيواني


أشجار حمضيّات


زهرة السّحلبيّة


ثعبان المياه


شبّوط الشرق الأوسط الأخضر (Carp)


أشجار حرجيّة


سالاريا المياه العذبة (Blenny)


النّسر القصير المخالب

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دراسة تقييم الأثر البيئي والإجتماعي

ESIA and RAP Specialist Surveys

دراسات الأخصّائيين

تمّ القيام بعدد من المشاورات والدّراسات مع الأخصّائيّين خلال تحضير تقييم الأثر البيئي والاجتماعي وخطّة إعادة الإسكان:

- **مسح ميداني عام**
- **مسح ميداني يعنى بالموارد المادّيّة والثّقافيّة** ← لقد تمّت عمليات تفتيش في الموقع وعُقدت إستشارات مع المديريّة العامّة للآثار.
- **مسح إيكولوجي تمهيدي ومفصّل**
- **مسح إجتماعي أوّل ونهائي**
- **إستشارات مع أبرشيّة صيدا فيما يختصّ بكنيسة مار موسى**

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Potential Impacts & Mitigation Measures (1)

الآثار المحتملة وإجراءات التّخفيف منها (١)

أهمّ الآثار المحتملة النّاتجة عن المشروع والإجراءات المقترحة للتّخفيف منها هي التّالية:

المسألة	الأثر المحتمل	الإجراءات المقترحة للتّخفيف من الآثار
إستملاك العقارات	الأرض لبناء السدّ والبحيرة وطرق الوصول	التّعويض عن استملاك الأراضي تبعاً للقوانين اللّبنانية وخطّة إعادة الإسكان
	الأراضي المنتجة	
	الإرث التّاريخي والثّقافي	نقل الآثار وحفظها في مواقع أخرى
التّرسّبات	خسارة في السّعة التّخزينية	مراقبة ارتفاع التّرسّبات والحفاظ على صيانة سليمة للبحيرة
تجميع المياه	خطر الزّلازل	تمّ تصميم السدّ وفقاً للمعايير المطلوبة لمواجهة خطر الزّلازل. كما وقد تمّ التّدقيق بالتّصاميم الهندسيّة من قبل خبراء عالميّين واللّجنة الّتي تعنى بسلامة السد.
	تردّي جودة المياه	تأمين محطّة لمعالجة المياه الوافدة إلى منطقة بيروت الكبرى

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Potential Impacts & Mitigation Measures (٢)

الآثار وإجراءات التّخفيف منها (٢)

المسألة	الأثر المحتمل	إجراءات تخفيف الآثار
الزّراعة	خسارة التّربة الخصبة	نقل التّربة الخصبة من موقع المشروع إلى أراضٍ مجاورة أقلّ خصوبة
	أعمال الريّ في أسفل السدّ	لقد تمّ تصميم السّدّ لتأمين إحتياجات المزارعين من مياه الرّيّ بالإضافة إلى كافّة الاستخدامات أسفل السدّ
التّنوّع الحيويّ والموائل الطّبيعيّة	تضاؤل الموائل المائيّة	تأمين المدرّجات للأسماك وغيرها من الممرّات وحماية أماكن وضع البيض.

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منظر على مرج بسري وكنيسة مار موسى من مزرعة الضهر

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

الآثار وإجراءات التّخفيف منها (٣)

Potential Impacts & Mitigation Measures (٣)

المسألة	الأثر المحتمل	إجراءات تخفيف الآثار
إدارة الحوض المائي العلوي	تلوّث البحيرة والبناء العشوائيّ جرّاء النمو المستحثّ	التنسيق مع وزارة البيئة والأطراف المعنية لوضع مخطّط توجيهي لضفاف البحيرة والمناطق المحاذية لها لتشمل
	نشاطات ترفيهيّة وسياحيّة	إرشادات تتعلق بعمليّات البناء والنّشاطات المسموحة حول البحيرة
	تردّي جودة المياه بسبب تدفّقات الصّرف الصّحّي المنزلي، الصّناعي، والزّراعي في البحيرة	وضع شبكات ومحطّات لمعالجة الصّرف الصّحّي في القرى المجاورة خطّة مراقبة نوعيّة المياه إرشاد للمزارعين

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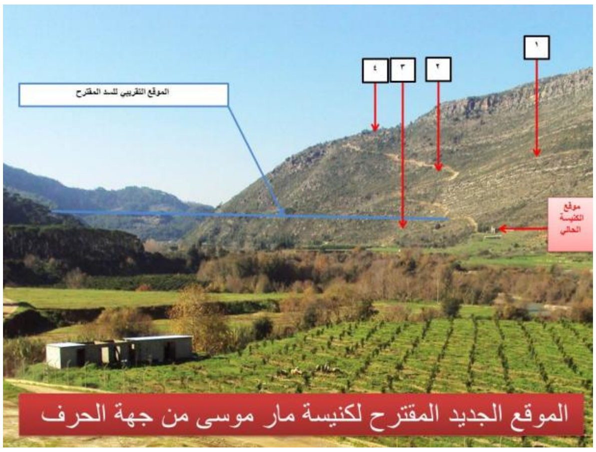

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

تقاسم فوائد المشروع

Benefit Sharing

- من أجل تحقيق تنمية منصفة لجميع الأشخاص المعنيّين بالمشروع، يدرس المشروع إمكانية إنشاء صندوق للمجتمع المحلّي في محيط السّدّ والبحيرة لنشر فوائد المشروع خارج حدود مجموعة مستهلكي إمدادات المياه في بيروت الكبرى.
- وقد تشمل المشاريع المتوقع تمويلها ما يلي:
- وضع خطط لإعادة التّشجير
- وضع مخطّطات كهرمائيّة محلّيّة
- قاعات إجتماعات
- تشجيع الفنون والحرف التّقليديّة
- تفعيل السّياحة البيئيّة والمرافق التّعليميّة
- تخصيص أماكن لمحبّي هواية صيد الأسماك في محيط البحيرة
- وضع مخطّطات لطاقتيّ الرّياح والشّمس
- تشجيع مخططات الرّيّ في الأماكن العامّة
- إنّ الآليّة التي سيتمّ إقتراحها تعتمد إلى حدّ كبير على ما **أنتم** - كمستفيدين - تريدون أن تحقّقوا من هذا الصّندوق.
- إذا كان لديكم أيّة أفكار تعنى بالإطار المؤسّساتي أو نوع المشاريع المقترح تمويلها، يرجى رفعها في وقت لاحق أو الاتّصال بنا لمناقشتها بشكل مفصّل

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دراسة تقييم الأثر البيئي والإجتماعي

الموقع الجديد المقترح لكنيسة مار موسى

عناصر المقاربة	المواقع المقترحة: موقع رقم ١	موقع رقم ٢	موقع رقم ٣	موقع رقم ٤
قوّة الإنحدار	١	٢	٣	٤
إطلالة خلّابة	٣	٢	١	٤
سهولة الوصول	١	٢	٣	٤
سهولة إعداد موقع البناء	١	٢	٤	٢
حاجة موقع البناء لحيطان دعم	١	٣	٢	٤
قرب الموقع من بلدة مزرعة الضّهر	٢	٣	١	٤
الحاجة إلى إستملاكات إضافيّة	٤	٤	٤	١
توافر المساحة الكافية لإنشاء منطقة خدمات محيطة	١	٣	٢	٤
سلامة الموقع ضد أي إنهيار بنيوي للسد	٤	٣	١	٣
سهولة و تكاليف عملية إعادة البناء	١	٢	٤	٣
المجموع	١٩	٢٦	25	٣٣

مقياس من ١ (الأضعف) إلى ٤ (الأقوى)

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Environmental Quality Monitoring Requirements

متطلّبات مراقبة الجودة البيئيّة

قبل البناء

تطبيق إستراتيجيّة التّنفيذ والتّأكّد من:

-**جودة المياه السطحيّة**
-**نسبة الترسّب**
-**إنقاذ الأجناس البيولوجيّة والحيويّة ونقلها**
-**الحفاظ على الآثار ونقلها من مكانها**
-**إستملاك العقارات وفقاً للقوانين اللبنانيّة وخطّة إعادة الإسكان**

أثناء البناء

مراقبة بيئيّة أثناء مرحلة البناء للحرص على تخفيف التّلوّث والضّجيج، والتقيّد بتوجيهات البناء السّليمة، وخطّة الإدارة البيئيّة.

بعد البناء

مراقبة بيئيّة بعد مرحلة البناء للتّأكد من الإلتزام بخطّة الإدارة البيئيّة والتّشغيليّة، والتّركيز على سلامة السدّ، جودة المياه، والتدفّق البيئي أسفل السدّ.

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

Public Consultation

استشارات العامّة

١- **تمّ عقد إستشارات للعامّة** من قِبل استشاري دراسة تقييم الأثر البيئي والإجتماعي وخطّة إعادة الإسكان على النّحو التّالي:

- ستّ ندوات لعرض نطاق الدّراسة في آذار ٢٠١٢
- ستّ ندوات لعرض نتائج الدّراسة في شباط ٢٠١٣

٢-يأتي **برنامج الإستشارات العامّة الحالي** من قِبل استشاري دراسة تقييم الأثر البيئي والإجتماعي وخطّة إعادة الإسكان على النّحو التّالي:

الزمان	المكان	الحضور المقترح
الجمعة ٢٥ نيسان العاشرة صباحاً	دار عمّاطور	الأشخاص المتأثّرين بالمشروع
الجمعة ٢٥ نيسان الثانية من بعد الظهر	بلديّة مزرعة الشّوف	الأشخاص المتأثّرين بالمشروع
السبت ٢٦ نيسان العاشرة صباحاً	قاعة الكنيسة في بسري	الأشخاص المتأثّرين بالمشروع
السبت ٢٦ نيسان الثالثة من بعد الظهر	بلديّة مزرعة الضّهر	الأشخاص المتأثّرين بالمشروع

٣- **بعد تسليم التّقرير النّهائي وخطّة إعادة الإسكان**، سيتّم إنشاء **مركز معلومات للمشروع** حيث سيتمكّن الأشخاص المتأثّرين بالمشروع من:

- الإستفسار عن إجراءات الإستملاك
- الإطّلاع على المستندات والخرائط

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

خطة إعادة الإسكان

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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

المسح الإجتماعي الإقتصادي ٢٠١٣ - ٢٠١٤

مع مشارفة التصميم الهندسي لسد بسري مع منشآته الملحقة على الإنتهاء فإن الإستشاري الهندسي للمشروع قد أتم إعداد ملف الإستملاكات الذي سوف يشكل القاعدة الأساس لمرسوم الإستملاك العتيد.

بناءً عليه فإن إستشاري دراسة التقييم البيئي وخطة إعادة الإسكان قد أتم القسم الأول من المسح الإجتماعي-الإقتصادي لمنطقة المشروع وهو في طور إكمال القسم الثاني منه وذلك بغية:

☑ **تحديث البيانات والمعطيات الإجتماعية للدراسة التي تشتمل على خطة إعادة الإسكان وآلية للتعويضات**

☑ **التأكد من أن المسح الجديد سوف يغطي كل العقارات التي سوف يشتمل عليها مرسوم الإستملاك**

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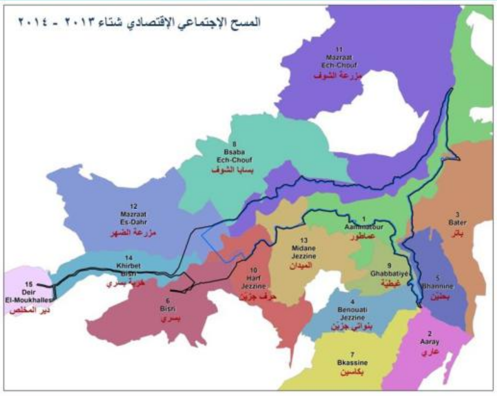
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

المسح الإجتماعي الإقتصادي شتاء ٢٠١٣ - ٢٠١٤



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مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

عدد العقارات والمساحات المتأثرة بحسب القضاء

القضاء	المنطقة العقارية	مجموع العقارات الخاضعة للإستملاك	عدد العقارات المطلوب إستملاكها بالكامل	عدد العقارات الخاضعة للإستملاك الجزئي	المساحة المطلوب إستملاكها بالهكتار	نسبة الأراضي الخاضعة للإستملاك
الشوف	عماطور / حارة جندل	310	279	31	160	31%
	مزرعة الشوف	277	225	52	120	23%
	مزرعة الضهر	55	36	19	42	8%
	خربة بسري	13	4	9	18	3%
	باتر	14	6	8	8.8	2%
	بسابا	9	5	4	6.8	1.3%
	دير المخلص	3	0	3	2	0.4%
المجموع الفرعي لقضاء الشوف		681	555	126	358	69%
جزين	الميدان	80	70	10	48	9%
	الحرف	69	64	5	46	9%
	بسري	74	62	12	44	9%
	بحنين	28	15	13	10	2%
	الغباطية	4	1	3	6	1.2%
	بنواتي	27	19	8	4	0.8%
	عازاي	1	0	1	0.95	0.2%
	بكاسين	2	0	2	0.3	0.1%
المجموع الفرعي لقضاء جزين		285	231	54	159	31%
مجموع الإستملاكات ضمن منطقة المشروع		966	786	180	517	100%
الأملاك العامة من طرقات وحرم النهر					53	
المجموع العام					570	

الإستملاكات وإعادة الإسكان

إن إستملاك الأراضي والحيازات سوف يتمّ بحسب:

✓ قانون الإستملاك اللبناني الصادر عام ١٩٩١؛

✓ سياسة العمليات وإجراءات البنك الدولي (رقم OP4.12) بخصوص إعادة الإسكان القسري.

بالرغم من أوجه التشابه العديدة ما بين المرجعيتين، إلا أن السياستين تلحظان تبايناً في خمسة جوانب والتي سوف يقوم مشروع سد بسري بسد الفجوات فيما بينها كالتالي:

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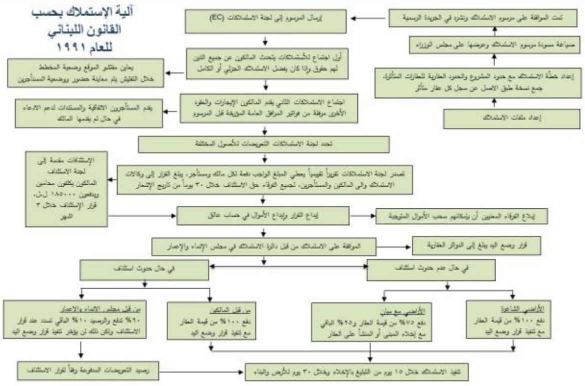
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

الإستملاكات وإعادة الإسكان

نقاط التباين	إجراءات التخفيف المقترحة لسد فجوات التباين
إستشارات الهيئات الفاعلة للمشروع	• إستشارات عامة قد عُقدت في البلدات المتأثرة حول منطقة المشروع وفي العاصمة بيروت؛ • سوف ينشأ القيمين على المشروع مركز معلومات خاص بالمشروع.
التواصل مع الأشخاص المتأثرين بالمشروع	• إستشارات عامة قد عقدت لإستطلاع رأي الأشخاص المتأثرين بالمشروع. • أعلن المشروع عن خط هاتفي للتواصل مع العامة فيما خص جلسات الإستشارات عامة التي تُعقد (03-867799) بالإضافة الى رقم فاكس (869026 - 01) وبريد إلكتروني: www.cdr.gov.lb - BSWA.12002@dargroup.com .
نطاق التعويضات	• كل العقارات سوف تعوض بحسب كلفة الإستبدال كاملة؛ • إن التعويضات سوف تدفع كاملة لمستحقيها وذلك قبل تنفيذ قرار وضع اليد على أي عقار أو أصول.
إستئناف قضايا الإجحاف	• بغية تمكين الأشخاص المتأثرين بالمشروع، ذو أصحاب الدخل المحدود، من إستئناف اي قرار إستملاك يرونه مجحفاً، سوف يقوم المشروع بتغطية التكاليف القانونية لطلبات إستئنافهم.
تعويضات للمتضررين غير المتمتعين بالحقوق القانونية	• سوف يتم تعويض هذه الفئة من الأشخاص بحسب التكاليف التي تكبدوها لتحسين ظروف السكن/الحيازة/ إنتاجية الأرض الزراعية وألخ.

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

آلية الإستملاك بحسب القانون اللبناني للعام ١٩٩١



dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

التعويض عن الإجحاف ١/٢

✓ إن آلية التعويض عن الإجحاف هي من متطلبات سياسة العمليات وإجراءات البنك الدولي بخصوص إعادة الإسكان القسري وتعتبر إجراء إضافي لما يتضمنه القانون اللبناني.

✓ شكاوى الإجحاف ترفع الى السلطات المحلية التي تقيم أهليتها.

✓ يمكن للشاكي أن يُساءل قيمة التعويض ولكن ليس عملية الإستملاك ووضع اليد.

✓ إن هذه الآلية تجنب المتضرر اعباء وتكاليف التنقل لمسافات بعيدة وتعقيدات تقديم طلبات الاستئناف لدى المراجع المختصة.

آلية الشكوى: شكاوى التعويض عن الإجحاف تسلم باليد الى السلطات المحلية كالتالي:

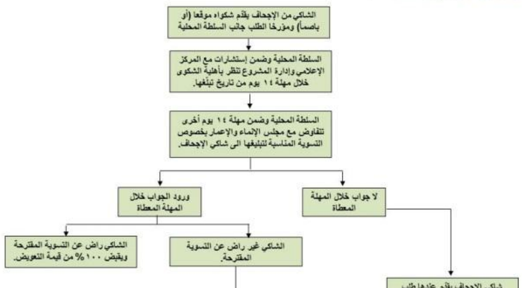
1) أشخاص ذوو حق شرعي: يمكن تقديم شكواهم بعد إبلاغهم بقرار لجنة الإستملاكات بقيمة التعويض وقبل تقديم طلب إستئنافهم أمام المراجع المختصّة إذا ما شاؤا ذلك؛

2) أشخاص من غير حق شرعي: يمكنهم رفع شكواهم في أي وقت بعد صدور مرسوم الإستملاكات.

وفي كلتا الحالتين يستطيع الأشخاص الغير قادرين على رفع شكواهم خطيا الإستعانة بالبلدية أو بفريق العمل ضمن مركز معلومات المشروع.

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

التعويض عن الإجحاف ٢/٢



dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

المراحل الزمنية

المرحلة	الفترة المخصَصة لها
الإبلاغ والإعلان	جاري التنفيذ
التخمينات	بحسب اتساع نطاق الاستملاك
تسجيل طلبات الاستئناف	٣٠ يوماً اعتباراً من تاريخ تبليغ تخمين لجنة الاستملاك
دفع التعويضات	قبل تنفيذ قرار وضع اليد والإخلاءات.
وضع اليد والإخلاءات	بعد ١٥ يوماً من تاريخ تبليغ قرار الإخلاء إذا كان العقار خالياً، بعد ٣٠ يوماً من تاريخ تبليغ قرار الإخلاء إذا كان العقار يحوي على منشاءات، وفي الحالتين، يعتمد الأمر على تسديد كامل مبلغ التعويض
الرصد والتقييم	من نشر مرسوم قرار الإستملاك لغاية تنفيذ قرار وضع اليد.

إن كافة التقارير المرتبطة بدراسة تقييم الأثر البيئي والإجتماعي وخطة إعادة الإسكان سوف تتوافر عبر التالي:

❑ الموقع الإلكتروني لمجلس الإنماء و الإعمار ومركز المعلومات التابع للمشروع سيعلن عنه لاحقاً؛
❑ في الوزارات المختصة وكذلك في بلديات القرى المحيطة بموقع المشروع.

سوف يتم الإعلان عن أماكن نشر التقارير أعلاه في وسائل الإعلام في الأوقات المحددة لها.

آلية التعويضات ١/٣

معايير الأهلية

تم وضع معايير الأهلية للتعويضات المفترضة تحمي كل من الحكومة اللبنانية والأشخاص المتضررين من المشروع.
عماد هذه المعايير هو تحديد تاريخ لتوقف الأهلية للتعويضات لمنع الإنتقال الانتهازي الى منطقة المشروع

بناءً عليه حدد مجلس الانماء والاعمار رسمياً تاريخ ال

٢٠ من آذار ٢٠١٤

كحد زمني لتوقف الاهلية للتعويضات والمساعدات الأخرى للأشخاص القادمين حديثاً الى منطقة المشروع أو الذين يقومون بإدخال تحسينات ضمن حيازاتهم الموجودة أصلاً، بعد هذا التاريخ.

آلية التعويضات ٢/٣

	الأشخاص المؤهلين	عدد الافراد	التعويض عن:	التعويضات المستحقة
اللبنانيين	المالكين المقيمين	17	الأرض الحيازة المنشأة الأشجار والمحاصيل أصول أخرى سبل كسب العيش	سوف يتم تعويض الأشخاص المتضررين، بكلفة الإستبدال وبحسب تخمينات لجنة الإستملاكات، عن: • قيمة الأرض ؛ • خسارة المدخول والأرباح؛ • تكاليف تحسين أوضاع الحيازة وإنتاجية الأرض؛ • تكاليف اعادة التأهيل والاسكان في ظروف مشابهة لما قبل التهجير؛ • بدلات لتأهيل اي أرض زراعية في نفس الظروف الإنتاجية التي كانوا يشغلون قبل المشروع؛ • بدلات إنتقال كافية لنقل كافة المعدات، التجهيزات، التركيبات وأثاث الى المكان الجديد.
	المالكين غير المقيمين	855 مالكاً	الأرض الحيازة المنشأة	سوف يتم تعويض الأشخاص المتضررين، بكلفة الإستبدال وبحسب تخمينات لجنة الإستملاكات، عن: • خسارة الأرض • أو أي خسارة لأية حيازة نتيجة خسارة الأرض.
	المقيمين من غير المالكين	47	المنزل المنشأة الأشجار المحاصيل أصول أخرى سبل كسب العيش	سوف يتم تعويض الأشخاص المتضررين، بكلفة الإستبدال وبحسب تخمينات لجنة الإستملاكات، عن: • هؤلاء المقيمين بموجب عقد ايجار، لما بعد العام 1991، ما قيمته 3 أشهر ايجار مع إشعار المالك بإرجاع أية مبالغ مدفوعة مسبقاً من قبل المستأجر؛ • هؤلاء المقيمين من دون أي حق قانوني سوف يتم التعويض عليهم بقيمة التحسينات التي أدخلوها الى الحيازة أو الارض وذلك بحسب تخمينات لجنة الاستملاكات على اساس كل حالة على حدة؛ • تكاليف اعادة التأهيل والاسكان في ظروف مشابهة لما قبل التهجير؛ • بدلات لتأهيل اي أرض زراعية في نفس الظروف الإنتاجية التي كانوا يشغلون قبل المشروع؛ • بدلات إنتقال كافية لنقل كافة المعدات، التجهيزات، التركيبات وأثاث الى المكان الجديد.

آلية التعويضات ٣/٣

		الأشخاص المؤهلين	عدد الافراد	التعويض عن:	التعويضات المستحقة
من غير اللبنانيين	العمال المقيمين	من غير اللاجئين	36	العمل بدوام كامل أو بدوام جزئي المأوى	سوف يتم تعويض الأشخاص المتضررين من جراء خسارة عملهم كالتالي: • قيمة 10$ باليوم لمجموع 156 يوم للعمال بدوام كامل؛ • قيمة ثلاثة أشهر لأجر أجر يستوفيه العامل بدوام جزئي؛ سوف يتم تعويض الأشخاص عن فقدان مأواهم كالتالي: • هؤلاء المقيمين بموجب عقد ايجار، لما بعد العام 1991، ما قيمته 3 أشهر ايجار مع إشعار المالك بإرجاع أية مبالغ مدفوعة مسبقاً من قبل المستأجر؛ • هؤلاء المقيمين من دون أي حق قانوني سوف يتم التعويض عليهم بقيمة التحسينات التي أدخلوها الى الحيازة أو الارض وذلك بحسب تخمينات لجنة الاستملاكات على اساس كل حالة على حدة؛
		اللاجئين	28	المأوى	سوف يقوم المشروع بتسهيل اتصال أولئك اللاجئين بالمفوضية العليا للاجئين التابعة للأمم المتحدة (UNHCR)
	المقيمين من غير العمال	من غير اللاجئين	36	المأوى	سوف يتم تعويض الأشخاص المتضررين من جراء خسارة المأوى كالتالي: • هؤلاء المقيمين بموجب عقد ايجار، ما بعد العام 1991، ما قيمته 3 أشهر ايجار مع إشعار المالك بإرجاع أية مبالغ مدفوعة مسبقاً من قبل المستأجر؛ • هؤلاء المقيمين من دون أي حق قانوني سوف يتم التعويض عليهم بقيمة التحسينات التي أدخلوها على المساكن التي يشغلون وذلك بحسب تخمينات لجنة الاستملاكات على اساس كل حالة على حدة؛
		اللاجئين	74		سوف يقوم المشروع بتسهيل اتصال أولئك اللاجئين بالمفوضية العليا للاجئين التابعة للأمم المتحدة (UNHCR)
		المجموع العام *	238		

مؤشر التعويضات للأراضي والحيازات الغُرضة للإستملاك

- إن مؤشرات التعويضات الواردة لاحقاً تساوي **كلفة الإستبدال** للأراضي و للأصول المصابة ولا تتعدى في الوقت الحاضر كونها قيمة توجيهية فقط
- إن هذه المؤشرات غير ملزمة لأي من الافرقاء لاحقاً نظراً الى أن قيمة التعويضات النهائية سوف تصدر عن **لجنة الاستملاكات** في مراحل لاحقة من المشروع.
- يحق لأي من الأفرقاء الإعتراض على التخمين المعطى للعقار أو الأصول وذلك بتقديم طلب إستئناف جانب **لجنة الإستئناف**.
- إن **لجنتي الإستملاك والإستئناف** هما هيئتان تتمتعان بإستقلالية تامة وغير مرتبطتان بمجلس الإنماء والإعمار

مؤشر التعويضات للأراضي والحيازات الغُرضة للإستملاك ١/٣

الأراضي	ل.ل/م^2
أرض زراعية ، محاذية للنهر	50,000
غابة صنوبر طبيعية	50,000
أرض زراعية على بعد يقل عن 100 م من النهر	40,000
أرض زراعية على بعد أكثر من 100م من النهر	40,000
أرض مهجورة	40,000
أرض مكشوفة منبسطة مع غطاء نباتي جيد	40,000
غابات طبيعية أخرى	40,000
أرض مسطحة مع غطاء نباتي طبيعي	40,000
أرض مكشوفة مع منحدرات مع غطاء نباتي ضعيف	30,000
أرض منحدرة مع غطاء نباتي طبيعي	30,000
أراض مكشوفة مع صخور على السطح	20,000
المنشاءات	**ل.ل/م^2**
بناء مشيد حديثاً	500,000
منزل من أحجار الخفان	100,000
منزل قديم مرمم	100,000
غرفة تخزين من الباطون	50,000
بناء قديم مهدم	50,000
بناء قديم	50,000
غرف عمال	50,000
مأوى من الخشب أوالبلاستيك	25,000
سقيفةللحيوانات، جدران من الباطون وأرضية	15,000
خيمة من القماش	10,000

مؤشر التعويضات للأراضي والحيازات الغُرضة للإستملاك ٢/٣

الزراعات الحقلية		ل.ل/م^2
ورد		50,000
انواع ورد اخرى		50,000
فريز		20,000
بندورة		20,000
خس		20,000
ملفوف		20,000
عرايش عنب		10,000
فليفلة حلوة		10,000
حبق		10,000
حبوب		5,000
أصول مختلفة مرتبطة بالأرض	**الوحدة**	**ل.ل**
خزان مياه بلاستيك محفظ ضمن إطار معدني	متر مكعب	600,000
خزان أرضي للمياه من الباطون	متر مكعب	100,000
معدات زراعية و شبكات الري	متر مربع	20,000
بيوت بلاستيكية زراعية،	متر مربع	10,000
خيمة حديد	متر مربع	1,500
خيمة عريشة	متر مربع	1,000
قساطل حديد	المتر الطولي	1,000
قناة مياه مفتوحة من الباطون	المتر الطولي	15,000
شبك حديد	المتر الطولي	7,000
ضميمةللحيوانات ، من الأسلاك المعاوضة وأرضية	المتر الطولي	5,000
شريط شائك	المتر الطولي	500

dar al-handasah

مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

مؤشر التعويضات للأراضي والحيازات العُرضة للإستملاك ٣/٣

ل.ل / الشجرة		أشجار
كبير	صغير	
400,000	150,000	صنوبر
400,000	15,000	سنديان
75,000	40,000	حور
75,000	40,000	سرو
75,000	40,000	صبار
75,000	40,000	صفصاف
ل.ل / الشجرة		أشجار
كبير	صغير	مثمرة
750,000	300,000	زيتون
750,000	200,000	منغا
750,000	200,000	كستنة
750,000	200,000	نخيل
400,000	150,000	لوز
400,000	150,000	كيوي
400,000	150,000	اكي دنيا
400,000	150,000	دراق
400,000	150,000	رمان
400,000	150,000	افوكا
400,000	150,000	إجاص
400,000	150,000	ليمون
400,000	150,000	تفاح
400,000	150,000	تين
400,000	150,000	حامض
400,000	150,000	مشمش
400,000	150,000	سماق
400,000	150,000	بوملي
300,000	150,000	فستق

dar al-handasah

مشروع زيادة تغذية منطقة بيروت الكبرى بالمياه
دراسة تقييم الأثر البيئي والإجتماعي

منظر على مرج من مزرعة الضهر

dar al-handasah

شكراً

مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي
(المرحلة الثانية)

Greater Beirut Water Supply Augmentation Project
Environmental and Social Impact Assessment
(Phase ٢)

dar al-handasah

شكراً لمشاركتكم

نرحّب بتعليقاتكم
تبقى فرصتكم للتعليق مفتوحة لمدة ستة أيام عمل

1. الرجاء ترك إستمارة التعليقات بحوزتنا بعد تدوين أسئلتكم وتعليقاتكم عليها
2. بإمكانكم إرسال تعليقاتكم لـ BWSA 12002، وارسالها بالفاكس على الرقم ٠١/٨٦٩٠٢٦
3. بإمكانكم ارسال تعليقاتكم على البريد الالكتروني التالي: BWSA.12002@dargroup.com
4. هاتف او رسالة قصيرة على 03-867799

نتطلّع لسماع آرائكم

Log of Calls and Emails from the Public to GBWSAP-Dedicated Phone and Email

Date	Time	Caller	Contact Details	Village	Essence of Comments	Essence of Answer	Further Action
22/04/20	8:27	Mr. Hasib Abboud	03-127762	Ghbattiyeh	Caller claims to be the owner of lands in Ghbatiyeh and objects to their not being any public session in his village or the posting of maps and other information.	Dar explained that consultation sessions had been held in those villages with most affected plots. However, all municipalities, including Ghbatiyeh had been send a copy of the Executive Summary of both the ESIA and the RAP prior to consultation, and these should be made available to interested parties, including land owners. Notwithstanding this, the expropriation map is available on the CDR website at www.cdr.gov.lb.	Dar subsequently forwarded the caller the CDR website address.
26/04/20	06:48	Mr Amine Beainy	03-509666	Not stated	Caller claimed to be one of the landowners in the valley but had not been invited to any meeting. ‘*with God's will we shall not allow the inundation of that Paradise inherited from our ancestors to supply strangers with water*.’	Answer essentially as above. The caller was thanked for his comment and ensured it would be noted.	No further action.
29/04/14	9:20	Maroun Sleiman Karam	07-800788	Benwati	Caller claimed to be a landowner and asked how he could check the numbers of plots to be expropriated.	Caller advised to check the maps displayed in Bisri village hall or he could go to the CDR website.	No further action.
29/04/14	9:40	Ghassan Abou Sleiman	01-871258	Harf	Caller claimed to be a land owner wanting to check the number of his plots and if they will be expropriated or severed.	Caller advised to check CDR website.	No further action.
28/04/14	13:09	Yusef Sanan	yusef.sanan@gmail.com	Midane	Claimant suggested that the borders of some plots as shown on the expropriation plans are incorrect.	The caller was referred to the CDR website and that notwithstanding the boundaries shown, all land boundaries and	Dar subsequently forwarded the caller

Date	Time	Caller	Contact Details	Village	Essence of Comments	Essence of Answer	Further Action
						asset take would be formally re-confirmed during expropriation.	the CDR website address.

APPENDIX L2

JANUARY/FEBRUARY 2013
PUBLIC CONSULTATION SESSIONS

Introduction

As part of the GBWSAP Consutlation and Communications programme, another set of Public consultations sessions were undertaken to dissiminate the results of the ESIA study. They presented the results and recommendations of the ESIA study in different venues for instutional stakeholders, for local PAPs in the villages in the vicinity of the proposed Bisri dam, and for Greater Beirut residents. While the Figure here below shows how these meetings were notified to the public via the national press, the Table that follows presents details of these meetings.

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
CDR/PR4.1A2
Rev.00
PROJECT : مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب / اجتماعات

مجلس الإنماء والإعمار
إدارة التخطيط والبرمجة
التاريخ: ٢٥ كانون الثاني ٢٠١٣

I- NETCOM

	MEDIA	NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	NAHAR	2	SAT 26/01/13		TUE 29/01/13	4 COL. X 8.5
2.	LIWA'A	1		MON 28/01/13		4 COL. X 8.5
3.	HERALD TRIBUNE					
4.	LE MONDE					

II- APS

	MEDIA	NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	MUSTAQBAL	1	SAT 26/01/13			4 COL. X 8.5
2.	DIYAR	1		MON 28/01/13		4 COL. X 8.5
3.	AL-BALAD	1			TUE 29/01/13	4 COL. X 8.5
4.	L'ORIENT LE JOUR					
5.	HAYAT					
6.	ASHARQ AL AWSAT					
7.	AL-RIYADH (RIYADH)					
8.	AL-ANBA'A (KUWAIT)					
9.	AL-KHALIG (U.A.E.)					
10.	OKAZ (JEDDAH)					
11.	AL SEYASSAH					
12.	AL-RAY- AL –AM (KUWAIT)					
13.	AL QABAS					

III- ALLIED

	MEDIA	NO. OF INSERTIONS	DAY (1) & DATE	DAY (2) & DATE	DAY (3) & DATE	SIZE
1.	SAFIR	1	SAT 26/01/13			4 COL. X 8.5
2.	ANWAR	1		MON 28/01/13		4 COL. X 8.5
3.	ASHARQ	1			TUE 29/01/13	4 COL. X 8.5
4.	DAILY STAR					

III- AL-ADIB

اعلانات استملاك عائدة لمنطقة الشمال	NO. OF INSERTIONS	DAY (1)	DAY (2)	DAY (3)	SIZE

نسخة إلى : دائرة المناقصات لنشر الإعلان على صفحة الإنترنت العائدة للمجلس
نسخة إلى : إدارة التخطيط والبرمجة — المكتب الإعلامي — القلم

- نسخة للسيد فيداوي
- الحفظ

25 JAN 2013

REPUBLIC OF LEBANON • COUNCIL FOR DEVELOPMENT & RECONSTRUCTION

رئيس إدارة التخطيط والبرمجة
ابراهيم شحرور

C:\Users\GISELLES\Documents\president office files\PO ARABIC\ANNOUNCE DISTRIBUTION 2013\مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب -- اجتماعات
10:04:56 AM

٢٥/١/٢٠١٣

Public Consultation Session	Venue, Date and Time	Attendees
Institutional Stakeholders	CDR, Central Beirut Wednesday 30 January 2013, 10am.	13
Local authorities and residents in the vicinity of the dam site	Midane Municipality Saturday 2 February 2013, 10am	36
Local authorities and residents in the vicinity of the dam site	Mazra'at ed-Dahr Municipality Saturday 2 February 2013, 3.30pm	15
Water consumers of Greater Beirut Area	Hadat Municipality Wednesday 6 February 2013, 5pm	10
Local authorities and residents in the vicinity of the dam site	Aamatour Municipality Saturday 9 February 2013, 10am	28
Local authorities and residents in the vicinity of the dam site	Mazra'at Echouf Municipality Saturday 9 February 2013, 2:30pm	35

The date and timing of all meetings were agreed with individual municipalities. The village sessions were scheduled at weekends and early evenings week-day for Beirut Water Consumers to allow the maximumm number of concerned people to attend.

Each session commenced with the introduction by the Project Proponent in which the scope, objectives and an update about of GBWSAP advancement were shared with the audience. The Consultant (Dar Al-Handasah), then gave a power point presentation covering the project base line conditions, the potentially expected impacts and mitigation measures and the study recommendations. The floor was then 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 content and the intent of the meeting. Shortly after the meeting commenced, to allow for late-comers. Attendance Sheets were circulated on which names, contact details and signatures were collected. As at previous sessions, 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.

Attendees generally conducted themselves in an orderly fashion. Many of those in the vicinity of the dam recognised the potential for water supply, hydropower, and waterside developments, and were generally in favour. The most opposing concerns were heard and recorded during the two public sessions held in Amatour and Mazra'at el-Chouf municipalities. This was not a surprise to the ESIA study team considering that two thirds of the reservoir area will be taken from these two villages.

In the following pages the comments and concerns raised at each of the public consultation sessions are documented and a considered written response given. While audience response was good, they were less enthusiastic about committing their comments to paper. There are therefore unattributed comments recorded by the consultant in addition to those for whom a speaker was identified.

The primary issues of public concern were:

- The commencement date of construction works;
- The extent to which local populations will be served with water and/or hydropower;
- The returns for such project on local residents in economical and employment terms;
- The need to preserve archaeological, historic and cultural heritage;
- The impact on downstream and upstream irrigation water allowances;
- The future master planning of the lake surrounding area and plots classification;
- The impact of increased humidity on local microclimate due to a large water body;
- The fairness of compensations for expropriated lands;
- The connection roads from one to the other shoreline of the lake;
- The opportunities for tourism and other job creating initiatives the lake will afford;
- The impact on water quality due to lack of wastewater treatment across the villages surrounding reservoir.

Session 1: Institutional Stakeholders Attendees

Location/Date: CDR/January 30, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مجلس الإنماء والإعمار الزمان: ٣٠/١/٢٠١٣ الساعة العاشرة صباحا

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
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3	John Davey	Dar-Al-Handasah	01-790002	John.Davey@dargroup.com	
4	منى سري الدين	مديرية الشؤون العقارية	01/648753		
5	عاصم فداوي	مجلس الانماء والاعمار	01/981430	assemf@cdr.gov.lb	
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9	حسن حطيط	وزارة البيئة	01/976555 ext 448	hhoteit@moe.gov.lb	
10	مايا مهنا	وزارة الزراعة	01/849693	mmhanna@agriculture.gov.lb	
11	رافي جرجيان	المديرية العامة للآثار	05/747105	raffi.gergian@dga.culture.gov.lb	
12	نبيل عماشة	المصلحة الوطنية لنهر الليطاني	03/280226	namacha@hotmail.com	
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14					
15					

Institutional Stakeholders, CDR – 30 January 2013		
No	**Name**	**Affiliation**
1	Fay Mushantaf	Dar Al Handasah
2	Elie Abou Rejaili	Dar Al Handasah
3	John Davey	Dar Al Handasah
4	Mona Sarieddine	Directorate of Cadastral Affairs
5	Assem Fidawi	Council for Development & Reconstruction
6	Majid Hashem	General Directorate for Administration and Councils / Ministry of Interior and Municipalities
7	Bahij Aarbid	Ministry of Health
8	Vivianne Sassine	Ministry of Environment
9	Hasan Hoteit	Ministry of Environment
10	Maya Mhanna	Ministry of Agriculture
11	Rafy Gergian	General Directorate of Antiquities
12	Nabil Aamasheh	Litani River Authority
13	Suhail Srour	Dar Al Handasah

Summary of issues raised at the Institutional Stakeholders session

Bahij Aarbid **Ministry of Health**	**Response**
It will be important to construct simultaneously the dam and the complete sewage networks of the surrounding villages currently discharging to the river.	The government recognises the problem. Most villages already have sewage collection, and the construction of sewage treatment for all those villages within the dam catchment will now be prioritised.
I would like to stress the importance of studying the future of the region around the reservoir, the possibility of development of tourism and thus develop a master plan for the next stages with the construction of roads, various infrastructures, sewerage system and other.	The ESIA included recommendations for a *Master Plan for Bisri Lake Shoreline and Surrounding Area Development*, and for sewerage schemes for all villages within the dam catchment area.
Treatment of the potential pollution emission sources: monitoring and treatment • Water source • Reservoir • Tanks • Distribution Pipes	The draft ESIA report has tackled this issue in identifying the potential sources and recommending the needed mitigation measures to counter the adversities.
Vivianne Sassine **Ministry of Environment**	**Response**
Has raised the concern about the way of cleaning such a reservoir capacity of 128 Mm3 of sediments and other unwanted materials.	This is essentially a design issue. Sluice gates will be provided at the bottom of the dam so that during periods of high inflow, water released flushes the accumulated sediment.
Will the dam construction materials such as concrete, stones, gabions, etc be excavated in-situ ?	All natural materials; rock, sand, gravel, aggregate, clay, are expected to be resourced in the vicinity of the construction site, within the reservoir area.
Majid Hashem **Ministry of Interior and Municipalities**	**Response**
The presentation was sufficiently clear enough, and questions has been discussed and answered.	The Consultant is pleased to record your satisfaction.

Session 2: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Location/Date: Midane Municipality/ February 02, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: بلدية الميدان الزمان: ٢/٢/٢٠١٣

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
1	المحامي شربل بو فاعور	بلدية الميدان	٠٢/٨٢٨٨٧٦		
2	نائب رئيس شبان	بلدية الميدان	٧٠/٣٧٣٤٩٠		
3	شربل - اوكرا عواد		03/608027		
4	د. اطلاه عواد		03/748810		
5	مارون ابو الخوري		٠٣/٨٥٦٨٥٩		
6	يوسف الغبيل	مختار الجبل	٠٣/٨٠٧٤٤٤		
7	جان حبيقة	عضو مجلس بلدي	٠٣/٨٤٤٤٥٣		
8	البرنيس عواد	خبير مالي واقتصادي	03.210730		
9	مارون شيبا حبيقه	مختار الميدان	03. 944377		
10	ريمون حبيقة		03/162086		
11	جورج فرحات		03/927920		
12	John Davey	Dar Al-Handasah	01-790002	Joh.Davey@dargroup.com	John C. Davey
13	المهندس شربل حرفوش	〃	٠٢/٧٥٤٥١٥	Ec.Harfouch@Hotmail.com	
14	[illegible]	〃			
15	عاصم فداوي	مجلس الانماء والاعمار	01-981431	assemf@cdr.gov.lb	
16	ايلي ابو جيلي	دار الهندسة	—		
17					
18					
19					
20					

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: جبيل الزمان: at 10:00am 02/02/2013

جدول الحضور

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30	شارل ابو سليمان	Petit Confort s.a.l	04/444020	charlesabsouleiman@gmail.com 70/416020	
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32	جورج ابي غفل	Business	70/300442	wgf@hotmail.com	
33	فادي حبيقة				
34	ايلي حرفوش		03/527190		
35	ادغار وهبة		03 583037		
36	وديع حرفوش		07/800201		
37	اندريه طانوس عواد		03/042922		
38	ناجي طانوس عواد		03/823711		
39	جان كلود شربل عواد		70/701602		
40	ايلي شربل عواد		03/287022		

Midane Municipality – 02 February 2013		
No	**Name**	**Affiliation**
1	Charbel Youssef Aoun	Lawyer – Midane Municipality
2	Chaker Youssef Seyyen	Midane Municipality
3	Charbel Abou Samra Ou'wad	Resident
4	Antoine Ou'wad	Doctor
5	Maroun el-Khoury	Resident
6	Youssef el-Ojeil	Mokhtar of Bhannine
7	Jean Hobeika	Council of Municipality
8	Albert Youssef Ou'wad	Financial and Economy counseling
9	Maroun Nassib Hobeika	Mokhtar of Midane
10	Raymond Habib Youssef	Resident
11	Georges Farhat	unaffiliated
12	John Davey	Dar Al Handasah
13	Charbel Harfoush	Lawyer
14	Charbel Badr	unaffiliated
15	Assem Fidawi	Council for Development & Reconstruction
16	Elie Abou Rejaili	Dar Al Handasah
17	Fay Mushantaf	Dar Al Handasah
18	Mia Nasr	Dar Al Handasah
19	Mohamad Kassem	Ministry of Interior
20	Hasan Aalawiyieh	Ministry of Health
21	Norma Tannous Feghali	Chief of Midane Municipality
22	Antoine Ou'wad	Grass Valley Company & lands owner
23	Marie-Dominique Ou'wad Farhat	Resident
24	Nazira Ou'wad Sabbagha	Resident
25	Graziella Youssef Ou'wad Shbat	Resident
26	Charles Abou Sleiman	Petit Confort s.a.r.l
27	Fadi Hobeika	Free lancer
28	Georges Abi Akl	Free lancer
29	Fadi Hobeika	Resident
30	Elie Harfoush	Resident
31	Antoine Wehbeh	Resident
32	Wadih Harfoush	Resident
33	Abou Samra Tanios Ou'wad	Resident
34	Naji Tanios Ou'wad	Resident
35	Jean-Claude Charbel Ou'wad	Resident
36	Elie Charbel Ou'wad	Resident

Summary of issues raised at Midane Session

Youssef Botros el-Ojeil Mokhtar Bhannine	Response
On the list of lands to be expropriated, there are some missing plots.	The list posted today is 'work-in-progress', intended to give landowners, tenants and other users early warning of expropriation requirements. the Consultant will be pleased to take note of errors if contacted through as indicated at the presentation.
There are buried archeological ruins to be dug up before the commencement of works.	CDR and the Consultant are working with DGA to prepare a programme for the investigation, excavation, documentation and if feasible, removal, of archaeological and other cultural heritage remains.
To allocate water from the lake to the surrounding villages.	While the majority of water will be used to supply GBA, downstream abstractors will benefit from environmental releases to maintain existing abstractions and downstream ecology. Villages upstream will receive water by gravity from the future Barouk-Beiteddine scheme. Both are included in the National Water Supply Strategy.
Masarra Jerjes Harfouche Lawyer	**Response**
Duration of project implementation and date of commencement of works.	The design consultant has suggested that the 3-year-period will be needed, while the ESIA consultant has suggested that these to be extended to a more realistic time frame of 5 years. The commencement of works will start once the designer will submit his tendered design and CDR will start then the call-for-offers procedure
What are the planned projects and works, not only in the dam-site, but in the reservoir area and its shorelines ?	The ESIA study has recommended the development of a Master Plan for Bisri Lake Shoreline and Surrounding Area, but this is currently outside the scope of the present contract.
Will there be any new land use classification for the surrounding lands?	The proposed Master Plan will include land reclassification and Parcellation for development.
What will be the mitigation measures to counter the environment pollution of surroundings areas?	As cited above, the ESIA study has proposed a Master Plan to be prepared to ensure the orderly and environmentally-responsible development of the surrounding areas. This would, need to include for effective measures to deal with sewerage, storm drainage and solid waste disposal such that it did not pose a threat to water quality. Various operational management procedures are also recommended. Further details are available from the Consultant via the contacts given in the presentation or from the ESIA report that will eventually be made public via the CDR website and World Bank *InfoShop*.

Charbel Youssef Aoun Lawyer	**Response**
Address the issue of discharging sewage into the valley.	The ESIA calls for prioritising the establishment of complete sewerage and drainage networks for all villages within the dam catchment. Most villages already have collection networks, so what is most often missing is the treatment flows prior to discharge or reuse.
To give special care for the touristic projects that will have a major contribution into the region local economy.	The ESIA discusses the various opportunities and treats from induced development. A Master Plan as cited above is recommended to ensure the orderly and environmentally-friendly implementation of a wide variety of commercial and recreational options.
WE should be in favor of supplying GBA with water from the dam area since half of Lebanese population will be living in the targeted area.	Thank you.
Provide new roads in the surrounding villages and preserve the existing from damage due to heavy lorries.	The reservoir area itself contains no metalled roads. The Contractor will improve access to the dam site from the existing road. Other roads in the area will need to be upgraded and the Contractor will have to produce a Traffic Management Plan that avoids unnecessary congestion and delay to local traffic. With most construction materials coming from within the reservoir, construction traffic on public roads will be reduced.
Norma Tanios Feghali Head, Midane Municipality	**Response**
The sewerage network is a priority before constructing the dam.	The ESIA calls for prioritising the establishment of complete sewerage and drainage networks for all villages within the dam catchment. Most villages already have collection networks, so what is most often missing is the treatment flows prior to discharge or reuse.
Who will operate and maintain the project after its completion to prevent the pollution of lake?	The dam and reservoir will be operated by BMLWE, perhaps via a service agreement with a private facilities management company. Bisri water is already of a much higher quality than Qaraoun water, and the same severity of pollution will not occur. As mentioned above, sewerage of the catchment villages and shoreline development only in compliance with a master Plan and strict development guidelines will also arrest any potential for pollution.
Who will follow up the issue of village infrastructure so as to prevent abusive construction around the lake?	MEW via BMLWE and EDL will operate and maintaining the future project facilities. The ESIA study has outlined the likely operational requirements for Bisri dam. CDR will oversee the installation of sewerage schemes. Adherence to the master Plan will prevent abusive development.

Antoine Ou'wad Grass Valley Company and landowner.	**Response**
How will land values be estimated, considering the past discouraging experiences in Lebanon?	A Resettlement Action Plan is being prepared for the project. Expropriation will essentially follow Lebanese Law, with additional safeguards where necessary to meet funding agency requirements.
What about the protection of the nature and environment from pollution?	The ESIA identifies a wide range of potential environmental and social impacts, and proposes measures to avoid, mitigate or manage each during both the period of construction and subsequent operational life. Extensive environmental quality monitoring and reporting is proposed to ensure the adequacy of these measures.
Implementation of sustainable touristic projects in the whole region in general and in Midane in particular.	The ESIA study has identified a number of development opportunities. It will be the role of the proposed Master Plan to take these further.
Maroun Nassib Hobeika **Mokhtar al-Midane.**	**Response**
The access roads to the dam and surrounding villages must be taken into account. More particularly the planned road connecting Midane, Harf, Ta'aid and Bisri villages	The Contractor will have to prepare a Traffic Management Plan to ensure his activities do not cause undue delay and congestion. The proposed road will be further considered by the Master Plan, which will revisit the scheme in the light of the added attraction afforded by the dam.
Priority must be given to sewerage networks to prevent waste water discharging into the river.	As explained above, a condition of the Bisri scheme being a success is the installation of effective sewerage collection and treatment systems for all the villages within the dam catchment
All archeological remains from Marj Bisri and Amatour should be collected and exposed in a faciltiy near the the lake as a touristic attraction.	Among other initiatives to be undertaken, the ESIA study has proposed the establishment of Visitor Center for the dam and the lake, that would have both a recreational and educational function. it would be convenient to attach to it an Archaeological or Cultural Park in which the recurred remains could be displayed. Mar Moussa Church might also be resurrected here, but that would be the decision of the community and church.

Marie-Dominique Ou'wad Farhat - Midane Resident.	**Response**
Will the financial compensations to the lands owners be fair, considering that working the lands is the main income source of too many in the area?	Land expropriation will be undertaken in accordance with Lebanese Law, amended where necessary to also meet the requirements of the project funding agency. A Resettlement Action Plan, including land expropriation, detailing the extent of land take and the procedures for expropriation, is being prepared as part of the ESIA study.
Will the soil and geological formations beneath the dam sustain such a huge load? What will be its impact in inducing earthquakes?	Clearly the loading of the dam and the reservoir on the underlying geology is a significant issue and is being addressed by the dam design consultant. It is understood a seismo-tectonic study will be undertaken during the design process. Dam Safety Inspections will be a routine feature of operational procedure.
There are concerns about the negative impacts of the lac on the local environment with respect to increasing humidity, climate change, pollution, etc, especially that we are used to the poor maintenance of projects.	The ESIA has researched the likely impact on micro-climate, including rainfall, and humidity. it is currently expected the impact in the villages will be indiscernible, but perhaps more noticeable along the reservoir shoreline, particularly during the summer months when evaporation will locally increase humidity.
Jean Hobeika **Midane Municipality**	**Response**
Will the agricultural lands, adjacent to the project site, still get their irrigation water from the dam?	The agricultural lands downstream the dam will receive their irrigation waters by gravity from the dam from the regulated discharge. Productive lands upstream of the dam will receive water from the Barouk-Beieddine irrigation scheme that will be diverted off Nahr Barouk. No water is expected to be directly pumped from the lake.
If productive land, with a water spring included, is in the expropriated area and the other part is out of it, will that other part receive its irrigation water directly from the lac?	Such cases will be reviewed individually. If part of a plot is expropriated and the remaining part is rendered unviable, perhaps because of the loss of buildings, loss of access, or loss of water source, Lebanese law requires GoL to purchase the whole plot if the owner so insists.

Session 3: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Location/Date: Mazra'at el-Dahr Municipality/February 02, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.....مزرعة الظهر.....الزمان: 02/02/2013 at 3:30 pm

جدول الحضور

الإمضاء	البريد الإلكتروني	الهاتف	المؤسسة	الإسم	
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Hayat Eid		07/980090	مزرعة الظهر	حياة عيد	3
Yolande		03/445645	جمعية الشعلة الثقافية	يولاند قزحيا عيد	4
Reine		07/980320	جمعية الشعلة الثقافية	رين عيد	5
		70/845289	مزرعة الظهر	شادي عيد	6
		03/463477	مزرعة الظهر	جاك عيد	7
	HJEIDalawfirm@gmail.com	03/305057	بلدية مزرعة الظهر	حسيب عيد	8
		٧٠٨٦١٢٠١	مياه بيروت وجبل لبنان	جعفر غصن	9
Dory		٠٢/٤٣٩٤٠٢	مزرعة الظهر	دوري حبيب عيد	10
	eidhenry@gmail.com	٠٣/٧٦٦٦٦٨	مزرعة الظهر	هاني الياس عيد	11
John C. Davey	John.Davey@dargroup.com	01-790002	Dar Al-Handasah	John Davey	12
	elie.abou rejaili@dargroup.com		دار الهندسة	elie abou rejaili	13
		01 790002	"	سهيل سرور	14
	assemf@cdr.gov.lb	01-981430	مجلس الإنماء والإعمار	عاصم فداوي	15
					16
					17
					18
					19
					20

Mazra'at el-Dahr Municipality – 02 February 2013		
No	**Name**	**Affiliation**
1	Fay Mushantaf	Dar Al Handasah
2	Michel Kfoury	Ministry of Health
3	Hayat Eid	Local resident
4	Yolande Kozhaya Eid	Al-Sho'la Cultural Association
5	Reine Eid	Al-Sho'la Cultural Association
6	Chadi Eid	Local resident
7	Jacques Eid	Local resident
8	Hassib Eid	Chief of Mazra'at el-Dahr Municipality
9	Jaafar Ghosn	BMLWE – Joun office
10	Dori Habib Eid	Local resident
11	Hani Elias Eid	Local resident
12	John Davey	Dar Al Handasah
13	Elie Abou Rejaili	Dar Al Handasah
14	Suhail Srour	Dar Al Handasah
15	Assem Fidawi	Council for Development and Reconstruction

Summary of issues raised at Mazra'at el-Daher Session

Hassib Eid **Chief of Mazra'at el-Dahr Municipality**	**Response**
The costs for dismounting, displacement, rebuilding and lands cost to relocate Mar Moussa Church and Ste-Sophia Monastery must be covered by the project.	The cost of deconstructing the Church and any of the associated remains if will be decided to relocate will be covered by the project. A budget sum for this work will be included in the Resettlement Action Plan.
The possibility of using the dam axis as a connection road between Chouf and Jezzine Cazas.	Due to security concerns, access across the top of the dam will be solely for operation and maintenance. The existing khirbit-Bisri Bisri road will remain open to the public to connect between the two Cazas. In addition, the Master Plan for surrounding development will consider if new road connections are required.
Michel Kfoury **Ministry of Health**	**Response**
Why has the possibility of using ground water resources not been considered?	The analysis of Non-Dam alternatives for GBWSAP included consideration of ground water. While the difficulties of ground water in the coastal plain are well documented, the potential for substantial abstraction in upland areas is clear from the performance of individual boreholes. Whether such potential is sufficient for supplying the quantities needed for GBA is uncertain. The comparison of alternatives concluded that ground water probably has the potential to contribute to some form of conjunctive use with surface water, but will not significantly reduce the need for dam storage to be the major source of supply. Notwithstanding this, the operational costs of pumping water from deep wells may prove prohibitive, even where saving, such as in the level of treatment prior to distribution, can be made.
Unattributed	**Response**
Concerns about the increasing air humidity that will favor the proliferation of Mosquitos during the hot summer months?	The proliferation of mosquitoes is a potential threat to any standing water body. Mitigation is primarily achieved through (i) efficient design that does not allow high water levels to overtop reservoir sides, and yet permits efficient shoreline drainage, both aimed at reducing ponding where mosquitos can breed, (ii) limiting seasonal growth of bankside and shallow water vegetation, and (iii) limiting public access to the extremities of the reservoir where wetland areas will develop, where access limitations will also promote biodiversity.
The possibility of using the dam axis as a connection road between Chouf and Jezzine Cazas?	Due to security concerns, access across the top of the dam will be solely for operation and maintenance. The existing khirbit-Bisri Bisri road will remain open to the public to connect between the two Cazas. In addition, the Master Plan for surrounding development will consider if new road connections are required.

Session 4: Water consumers of Greater Beirut

Location/Date: Hadat Municipality/February 06, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: بلدية الحدث الزمان: ٦/٢/٢٠١٣ الساعة الخامسة

جدول الحضور

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19					
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Hadat Municipality – 06 February 2013		
No	**Name**	**Affiliation**
1	Elie Abou Rejaili	Dar Al Handasah
2	Fay Mushantaf	Dar Al Handasah
3	John Davey	Dar Al Handasah
4	Ali Al-Harakeh	Hareil Hreik Municipality
5	Abboud Zahr	Design Engineering Partner
6	Michel Kfoury	Ministry of Health
7	Georges Edward Aoun	Chief of Hadat Municipality
8	Georges Haddad	Hadat Municipal Council
9	Abdo Gerges Cherfane	Hadat Municipal Council
10	Nayla Raad	Dar Al Handasah

Summary of Issues Raised at Hadat Session

Unattributed	Response
What measures will be taken to deal with the sewage water discharging from surrounding villages into the river.	The government recognises the problem. Most villages already have sewage collection, and the construction of sewage treatment for all those villages within the dam catchment will now be prioritised.
It is nonsense to augment the water supplies to GBA without addressing the critical issue of water leakages throughout the existing networks.	Indeed it is. The GBWSP currently enhancing short-term supplies make provision of extensive leak detection and network upgrading.
Can you please better explain the interface between the GBWSP and the GBWSAP!	GBWSP is an on-going project to improve the short-term availability of water throughout GBA. Some additional water will be provided, but most improvements will come from the reduction of leakage and other losses and improved metering. GBWSAP focuses on the augmentation of the post-GBWSP situation to identify sources for additional water to meet medium and longer term demand. One of the key advantages of the GBWSAP is that will use some of the GBWSP facilities and infrastructures, in delivering the additional amount of water to GBA, resulting hence in a-cost-effective project.

Session 5: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Location/Date: Aamatour Municipality/February 09, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: عماطور - دار البلدة الزمان: السبت في ٩/٢/٢٠١٣ الساعة ١٠:٠٠ صباحاً

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
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4	...... ابو		٠٥٢٨٨٩٦٢		
5	الحسن وديع ابو شقرا	-	٧٠٥٨٩٢٨٨		
6	رشيد ابو	فني	٠٣٤٨٤١٦٢		
7	حكمت فارس		٠٣٢٣٢٧١١		
8	مأمون بديع ابو شقرا		٠٣-٧٠٠٣٦٠		
9	رفعت فارس	وكيل ربيع فارس	٠٣/١٨٦٤٩٥		
10	عصام بو مهدي		٠٣/٨٧٣٥١٥		
11	سمير عبد الصمد	بلدية عماطور	٧٠-٩٢٤٨٢٧		
12	رياض ابو شقرا	مراقب صحي وزارة الصحة	03/930420		
13	جميل ابو		٠٣/٠٤٣٦٤٠		
14	انس عبد الصمد	الترشي بلدية عماطور	٧١/١٠٠٢١٨		
15	ناجي عادل عبد الصمد		03 688101		
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18	امين ابو شقرا	نائب رئيس بلدية عماطور	03/704946		
19	سعيد ابو شقرا	عضو بلدية عماطور	03/921701		
20	حسيب عبد الصمد	مختار سابق عماطور	70/817678		

نصوص إرسال PRESENTATION BY EMAIL

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: بلدية عماطور الزمان: ٩ شباط ٢٠١٣

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
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22	عدنان فرحان عبد الصمد	مختار عماطور	05/311994		
23	زياد رجاء عبد الصمد		05/311049		
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31					

Aamatour Municipality – 09 February 2013		
No	**Name**	**Affiliation**
1	Khaled Ghannam	Dar Al Handasah
2	Roger el-A'chi	Preseident of Chouf Municipalities Assembly
3	Hikmat Bilal	Chief of Haret Jandal Municipality
4	Ramez Amine Abou Chakra	Unaffiliated
5	Najib Wadi' Abou Chakra	Unaffiliated
6	Rodwan Abou Chakra	Technician
7	Hikmat Fares	Unaffiliated
8	Ma'moun Badi' Abou Chakra	Unaffiliated
9	Rif'at Fares	Rabi' Fares Representative
10	Issam Bou Mehdi	Unaffiliated
11	Samir Abdel-Samad	Aamatour Municipality
12	Riyadh Abou Chakra	Health Inspector – Ministry of Health
13	Jamil Abou Chakra	Unaffiliated
14	Anwar Abdel-Samad	Aamatour Municipality
15	Fadi Adel Abdel-Samad	Unaffiliated
16	Fouad Adel Abdel-Samad	Civil engineer and University professor
17	Bassem Camille Abou Chakra	Lecturer
18	Amine Abou Chakra	Vice-chief of Aamatour Municipality
19	Said Abou Chakra	Municipality Council Aamatour
20	Hassib Abdel-Samad	Aamatour Ex-Moukhtar
21	Anwar Badi' Abdel-Samad	Unaffiliated
22	Adnan Farhan Abdel-Samad	Aamatour Moukhtar
23	Ziad Hani Abdel Samad	Unaffiliated
24	Fay Mushantaf	Dar Al Handasah
25	John Davey	Dar Al Handasah
26	Suhail Srour	Dar Al Handasah
27	Elie Abou Rejaili	Dar Al Handasah
28	Nayla Raad	Dar Al Handasah

Summary of issues raised at Aamatour Session

Unattributed	Response
It has been now very long time the promised project has not come yet to the light will all consequences of hindering the residents locals activities in the area. Hope that will not take longer anymore to see it.	Comment noted. CDR and the ESIA consultant also hope the project will now proceed to conclusion.
The issue of balanced development is crucial. It is a big mistake to only be concerned with supplying GBA at the expenses of the area where that water will come from. If things proceed as they are, GoL will favor over populating already highly populated Beirut leaving behind the remote areas. What will the project bring to the local Chouf and Jezzine villages ?	It is common practice to move water from rural areas with plentiful resources to urban areas that suffer shortages. surrounding villages in Chouf and jezzine will benefit from improved infrastructure such as sanitation and from the economic oppoertunities provided by future development.
will the project be a copy of Qaroun Lake with all its negative impacts especially in polluting and degrading the environment ?	Both CDR and the design consultant are aware of the problems of Qarouan and are determined to avoid them at Bisri. The water quality at Bisri is in any case much improved over that from Qaroun.
The owners of the inundated lands will lose while those on the shorelines will see their lands values skyrocket. Compensation for the former should be taken from the latter.	In accordance with both Lebanese law and international funding agency procedures, all land expropriation will be undertaken at full prevailing market value.
There is No coordination between governmental institutions as lately DGUP declared 15 plots to be '’archeological reserves’’ without noticing CDR	The ESIA consultant is aware of the various land use designations across the project area, the presence of sites of cultural heritage, and has developed proposals for their rescue.
Did the project consider desalination alternative to avoid disrupting the lives of local residents?	The desalination option was one of the considered alternatives. While it might be feasible and reliable, it has many disadvantages, such as requiring a heavy industrial plant on the coast, generating large quantities of highly saline brine that will impair seawater quality, and will unacceptably increase the cost of water to consumers.
Relocating the archeological remains and buildings that are highly valued by locals is not a simple stones transfer from one to another place, as the consultant suggests.	The Consultant apologises if he gave that impression. Although the process is complex, it is one that is well practiced in many countries providing adequate budgetary allowances are set aside.
Is there any Master Plan for the whole project area?	The ESIA Consultant has recommended the development of a Master Plan for the Development of the Bisri Lake Shoreline and Surrounding Areas, but this is outside the scope of the present study.
How deep will the roman columns will submerged by water ?	At the present time the roman columns are expected to be under 50-60 metres of water.
When is the commencement of construction works expected ?	The date of commencement of construction remains to be determined.
Because agriculture is the main source of income in the area, this is a project to displace Chouf residents.	Relatively few permanent residents of the project area and its surroundings will be involuntarily resettled. while loss of agricultural employment and income will be

Unattributed	Response
	unavoidable, new economic opportunities will result.
What about the hydro-power generation?	Bisri Dam will include provision to generate hydropower and the maximum possible capacity for the available resources will be installed.
Why were local NGOs not invited to the consultations?	Local NGOs have been identified in the Draft ESIA. It is assumed that those responsible for inviting them to the public consultation sessions did so. NGOs that could not attend are welcome to contact the ESIA Consultant as advertised at the sessions.

Session 6: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Location/Date: Mazra'at el-Chouf Municipality/ February 09, 2013

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مزرعة الشوف الزمان: ٩/٢/٢٠١٣

جدول الحضور

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[illegible]		03/334732	[illegible]	سليم الخوري	8
		03/675826	رئيس بلدية [illegible]	يوسف محمود	9
[illegible]		٠٥/٣٣٠١٧٦		محمد حسن البعيني	10
[illegible]		٠٣/٤٢٩٨١٢		حسين البعيني	11
		٠٣/٧٤٤٦٨٤	جمعية التعاضد	حاتم محمد عجيب	12
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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مزرعة الشوف الزمان: ٩ شباط ٢٠١٣ - البلدية

جدول الحضور

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[illegible]	Suheil.Srour@dargroup.com	"	"	[illegible]	35
[illegible]		"	دار الهندسة	نايلة رعد	36
					37
					38
					39
					40

Mazra’at el-Chouf Municipality – 09 February 2013		
No	**Name**	**Affiliation**
1	Elie Abou Rejaili	Dar Al Handasah
2	Shawki Zebian	Retired General Army
3	Ziad Saab	Kahlouniyeh Municipality
4	Adnan Shahine al-Be’ainy	Financial Inspector at Social Security Bureau
5	Salah Bou Hadir	Central Inspection
6	Nabil el-Be’ainy	Employee at Lebanese Parliament
7	Selim Khoury	Representative of Social affairs Minister
8	Youssef Maksoud	Chief of Wadi-el-Set Municipality
9	Mohamad Hassan el-Be’ainy	Unaffiliated
10	Hussein el-Be’ainy	Unaffiliated
11	Hatem Mohamad A’jab	Al-Ta’adod Association
12	Shakib Hussein A’jab	Unaffiliated
13	Chafik Amine Zebian	Unaffiliated
14	Assem Fidawi	Council of Development & Reconstruction
15	Ghassan Bou Karoum	Citizen
16	Ghandi Youssek el-Be’ainy	Mazra’at el-chouf
17	Mohamad Youssef el-Be’ainy	Mazra’at el-chouf
18	Ghassan Mahmoud A’jab	Private business
19	Wajih Mohamad el-Be’ainy	Mazra’at el-chouf
20	Rafik Zebian	Mazra’at el-chouf
21	Yehya Bou Karoum	Social Progressist Party
22	Afif Soulaiman el-Be’ainy	Mokhtar of Mazra’at el-chouf
23	Osmat Salim el-Be’ainy	Free lancer
24	Walid Adib Bou Karoum	Mokhtar of Mazra’at el-chouf
25	Marwan Afif Zebian	Unaffiliated
26	Al-sheikh Mas’oud Bou Karoum	Unaffiliated
27	Hamdi Zebian	Land owner
28	Amine Zebian	Mazra’at el-chouf
29	Jihad A’jab	Mazra’at el-chouf Municipality
30	Fadi el-Be’ainy	Mazra’at el-chouf Municipality
31	Youssef el-Be’ainy	Mazra’at el-chouf Municipality
32	Fay Mushantaf	Dar Al Handasah
33	John Davey	Dar Al Handasah
34	Suhail Srour	Dar Al Handasah
35	Nayla Raad	Dar Al Handasah

Summary of issues raised during Mazra'at el-Chouf

Unattributed	**Response**
The project must generate direct benefits to the local residents, either in employment or new business development. Dam operational staffing should favour local residents and local equipment.	The project is expected to afford new economic opportunities. Dam operational staffing and equipment will be a matter for the BMLWE.
Will Mazra'at el-Chouf Municipality have a role in operating the dam and what would be the direct financial return of the latter?	The affected municipalities may expect to be involved in the management of the reservoir shoreline and surrounding areas. The taxes paid by new developments will enhance municipality income.
Will the compensations be fair to all involved farmers considering that farming is the main income generating activity of many of them ? and if compensation is ''not fair'' will the owner have the right to appeal?	The expropriation of all lands, property and assets will be executed in accordance with Lebanese law amended where necessary to meet international funding agency requirements. the Right to Appeal is already incorporated into Lebanese Law.
Will the negative previous experiences on Karaoun dam be avoided on this project?	Both CDR and the design consultant are aware of the problems of Karaoun and are determined to avoid them at Bisri. The water quality at Bisri is in any case much improved over that from Karoun.
What will happen to Mar Moussa church?	The community has expressed a strong desire to see the church moved to a new location and the ESIA Consultant is recommending that this is provided for within the project.
Nabil el-Beainy **Employee in the Lebanese Parliement**	**Response**
The company that will owe the project in the future must include the owners of lands under expropriation as shareholders.	The development of Bisri Dam and reservoir is a public sector project and as such will be 'owned' by MEW on behalf of GoL, and operated by BMLWE.
Marwan Afif Zebian **Lands owner**	**Response**
Will there be any power generation plant to meet at least the needs of local villages ?	A hydroelectric power plant will be provided at the dam. its capacity and service area has yet to be determined.
Shawki Zebian **Retired General of Lebanese Army**	**Response**
Re-run a new Public Consultation session showing better the economic feasibility of the project supported by all types of tables, maps, graphs, etc ?	The present PC session included a summary of the economic feasibility. For additional information, attendees are welcome to contact the Consultant as advertised in the session or await the public availability of the ESIA reports on the CDR website and World Bank *Infoshop*.
Directly involve municipalities in the construction works, equipments, etc.	This is primarily an issue for the dam construction contractor.
In addition to the fair compensations for the expropriated lands, support directly the induced development initiatives in the local villages especially in terms of touristic projects.	Expropriation will be undertaken in accordance with Lebanese Law and funding agency provisions. While the Consultant has recommended the development of a master Plan for shoreline and surrounding area development, these are most likely to be implemented by the private sector.
Favor the lake surrounding villages in terms of Hydro-power supplies from the dam.	The final capacity of the hydropower plant remains to be confirmed, but is likely to be limited by the restricted dry season river flows.

APPENDIX L3

APRIL 2012 PUBLIC CONSULTATION SESSIONS

Introduction

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. The schedule for the Scoping Consultations is presented here after.

Public Consultation Session	Venue, Date and Time	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 late-comers, 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 F to the present report. A photograph taken at each session is presented in this appendix as hereafter.

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

Location/Date: CDR/April 3, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مجلس الانماء والاعمار **الزمان:** الثلاثاء ٣/٤/٢٠١٢ الساعة ١٠ صباحاً

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Institutional Stakeholders, CDR – 3 April 2012	
Names	**Affiliation**
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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

Insitutional Stakeholders Scoping Session at CDR

Summary of issues raised during Session 1

Ziad Zakhour Advisor to the MEW on Water and Dams	Response
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 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	**Response**
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 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.	Again thank you for the information, which we will follow up in preparing the ESIA.
Unattributed Comment	**Response**
GBWSP doesn't only come from Qaraoun lake	Noted
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
It is advisable to contact the Antiquities Authority if need be	This is standard practice in any ESIA study
People living in the vicinity of the dam need to benefit as well from the water	Noted

Session 2: Local authorities and residents in the vicinity of Bisri Dam and Nahr Awali

Location/Date: Mazraat El Dahr Municipality/ April 10, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مزرعة الضهر الزمان: ١٠/٤/٢٠١٢

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		03/708524	رئيس بلدية عماطور	د. رونالد عبد الصمد	31
		71/222268	رئيس بلدية حبيا	جوزيف الحاكم	32
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		03/463177	عضو بلدية مزرعة الضهر	جان الياس عيد	35
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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: مزرعة الضهر الزمان: ١٠/٤/٢٠١٥

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
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Mazraat El Dahr Municipality - 10 April 2012	
Names	Affiliation
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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	Aamatour Municipality
Thoukan Abdel Samad	Aamatour 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

Scoping Session at Mazraat El Dahr Municipalit

Summary of issues raised during Session 2

Hassib Jamil Eid Head of Mazraat El Dahr Municipality	Response
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**	**Response**
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**	**Response**
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**	**Response**
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	**Response**
The overall attitude was positive towards the Project and they were expecting since long time	No Response required.
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.
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.
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.

Session 3: Local authorities and residents in the vicinity of Damour Dam and Nahr Damour

Location/Date: Dmit Municipality/April 12, 2012

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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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.............................الزمان:...............................

جدول الحضور

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38	[illegible]	[illegible]	٧٠/٩١٨٧٠٧		[illegible]
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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.............................الزمان:...............................

جدول الحضور

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Dmit Municipality - 12 April 2012	
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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
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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
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Assem Fiddawi	Council for Dev. & Reconstruction
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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

Summary of issues raised during Session 3

with corresponding responses by the consultant

Hassan Fouad Torbey - Deir Baba Municipality	Response
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	Response
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	Response
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	Response
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	Response
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.
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 Damour Site Held in Dmit Municipality.

Session 4: Local authorities and residents in the vicinity of Jannah Dam and Nahr Ibrahim

Location/Date: Qartaba Municipality/April 21, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: قرطبا الزمان: ٢١/٤/٢٠١٢ الساعة ١١

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان: قرطبا الزمان: ٢١/٤/٢٠١٢ الساعة ١١

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
21	[illegible]	[illegible]	٠٢٧١٠٨٤١٧		
22	يوسف طانيوس شاهين	قرطبا / صاحب تكسي	03/872851	—	
23	جورج انطون نمر	مهندس / قرطبا	03/139393	—	
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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

Summary of issues raised during Session 4

with corresponding responses by the consultant

George Najem - Engineer	Response
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	Response
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	Response
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 Response required.
Abdo Samir Francis - Electricite Du Liban	Response
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	Response
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

Joseph El Sokhn - Instructor	Response
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	**Response**
People are concerned with land slide in Saraaita	The potential for slope instability will be addressed by the ESIA.
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
Is the dam site location final?	MEW have already completed substantial site investigations and subject to detailed design, is considered final.
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
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.
We want pumps to get water to Qartaba and Lassa	Noted.
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
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

Session 5: Water consumers of Beirut southern suburbs

Location/Date: Hadath Municipality/April 24, 2012

مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:...بلدية الحدث......الزمان:...٢٠١٢/٤/٢٤.........

جدول الحضور

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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:.............................الزمان:.............................

جدول الحضور

	الإسم	المؤسسة	الهاتف	البريد الإلكتروني	الإمضاء
21	منير الريشاني	بلدية الشويفات	03/956510		
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Hadath Municipality - 24 April 2012	
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Nassim Abi Fadel	Dar Al Handasah
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

Fathi Chatila - Arab World Water	Response
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	**Response**
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	**Response**
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

Location/Date: Beirut Municipality/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:..................................

جدول الحضور

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مشروع "زيادة تغذية منطقة بيروت الكبرى بمياه الشرب"

إستشارات العامة- المكان:..................................الزمان:..................................

جدول الحضور

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Beirut Municipality - 5 May 2012	
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Fay Mushantaf	Dar Al Handasah
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

Fathi Chatila - Arab World Water	Response
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	**Response**
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	**Response**
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	**Response**
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 Response required
Basma Traboulsi - National Women's Union	**Response**
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	**Response**
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	Response
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	**Response**
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. 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	**Response**
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	Response
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	**Response**
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
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.
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
Despite considering mainly surface water, 75% of Lebanon's geology comprises karst formations. Thus we need to take into consideration ground water	Ground water is already an important source of 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

PowerPoint Presentation and Handout

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

ستقوم **السيدة روى الدرباس** 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 وآبار الدامور وعدة مصادر ثانوية، إلا ان امدادت 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

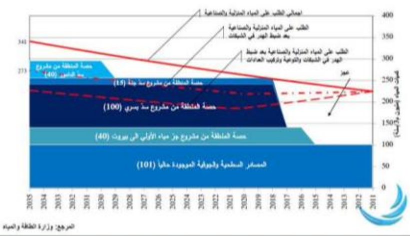
1

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 العلم 2035
- من المتوقع أن يصل الطلب على المياه المنزلية والصناعية إلى 341 مليون م^3\السنة بحلول العلم 2035
- تقدر مصادر المياه الحالية بـ 101مليون م^3\السنة
- تقدر حصة منطقة بيروت الكبرى من جر مياه الأولي إلى بيروت بـ 40 مليون م^3\السنة
- يقدر حجم المياه التي ستتوفر من سد بسري، جنّة، والدامور بـ155 مليون م^3\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)



المرجع: وزارة الطاقة والمياه

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 ***جرّ 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 ***جرّ 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 مفضّل

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

2

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

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.

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب GBWSAP (3)

إستشارات العامة الأولية
تحديد نطاق الدراسة
تقييم الأثر البيئي والإجتماعي الأولي (دراسة مقارنة)
مسودة تقييم الأثر البيئي والإجتماعي+المسح الإقتصادي والإجتماعي (الخيار المفضل)
مناقشة نتائج تقييم الأثر البيئي والإجتماعي مع العامة
تقييم الأثر البيئي والإجتماعي النهائي+ خطة إعادة الإسكان

يتضمن تقييم الأثر البيئي والإجتماعي خطة للإدارة البيئية والإجتماعية

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

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

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

Potential Dam Solutions — بناء السدود كحل محتمل

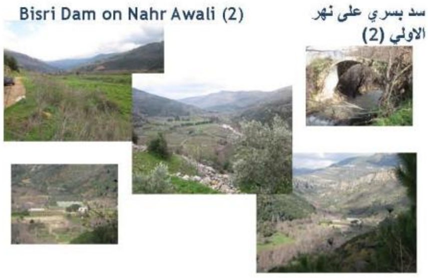
- سد بسري على نهر الاولي
- سد الدامور على نهر الدامور (موقعين)
- سد جنة على نهر ابراهيم

dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

Bisri Dam on Nahr Awali (1) — سد بسري على نهر الاولي(1)

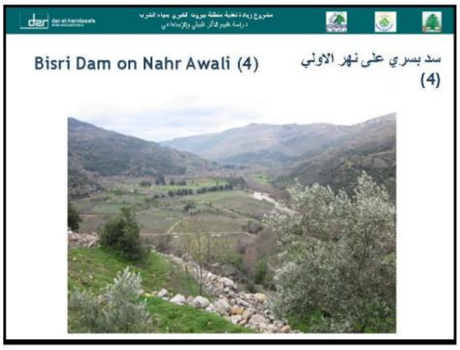
dar al-handasah
مشروع زيادة تغذية منطقة بيروت الكبرى بمياه الشرب
دراسة تقييم الأثر البيئي والإجتماعي

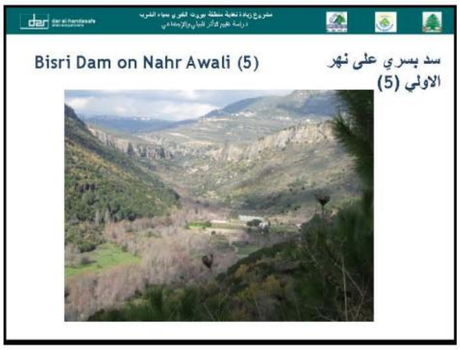
Bisri Dam on Nahr Awali (2) — سد بسري على نهر الاولي (2)

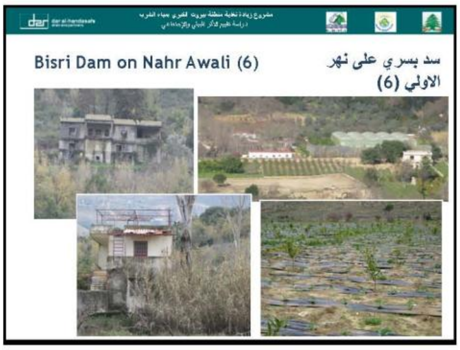


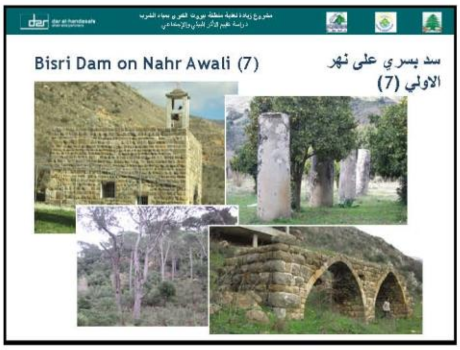
3


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)

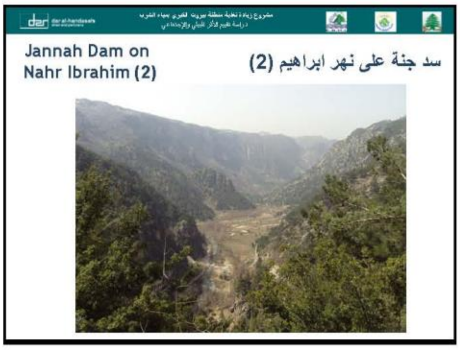

Bisri Dam on Nahr Awali (6)
سد بسري على نهر
الاولي (6)

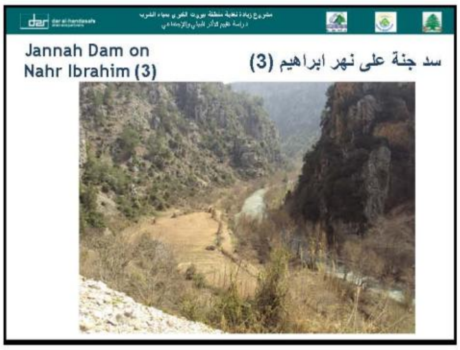

Bisri Dam on Nahr Awali (7)
سد بسري على نهر
الاولي (7)


Damour Dam on
Nahr Damour (2 sites)
سد الدامور على نهر الدامور
(موقعين)

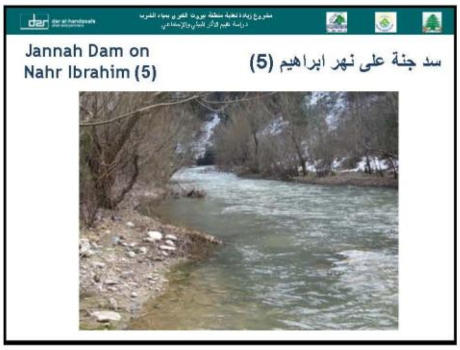
4

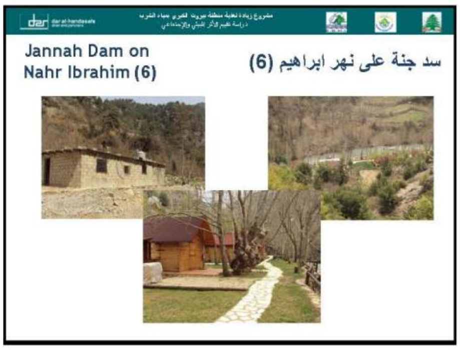

Jannah Dam on
Nahr Ibrahim (1)
سد جنة على نهر ابراهيم (1)


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	مسلحة البحيرة	حجم التجميع
بسري	نهر الاولي	74 م	5.9 كلم^2	128 مليون م^3
الدامور (موقعين)	نهر الدامور	90 م	1.2 كلم^2	32 مليون م^3
جنة	نهر ابراهيم	105 م	1.0 كلم^2	37 مليون م^3

Potential Impacts of Dams (1)

الآثار المحتملة للسدود (1)

1. الآثار الدائمة		
المسألة	ايجابي	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	ايجابي	سلبي
• ادارة الحوض الأسفل	• السيطرة على الفيضان	•نقص في موارد المياه السطحية •تخفيض موارد الري وزيادة في التلوث
• التنوع البيولوجي والموائل الطبيعية	• إيقام 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	ايجابي	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 الفياضانات الاقليمية • 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، الحدّ ، 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.

7


Land Take Mitigation
الحد من إستملاك الاراضي
• تطبيق عادل لاستملاك الأراضي وإعادة الإمكان.
• 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 أن 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


شكراً لمشاركتكم
نرحّب بتعليقاتكم
تبقى فرصتكم للتعليق مفتوحة لمدة ستة أيام عمل
1. استخدموا ورقة التعليقات المقدمة واتركوها معنا اليوم
2. بمكنكم توجيه تعليقاتكم لـ BWSA 12002، وارسالها بالفاكس على الرقم 01/869026
3. بمكنكم ارسال تعليقاتكم على البريد الالكتروني التالي: BWSA.12002@dargroup.com
4. هاتف او رسالة قصيرة على 71-137532
نتطلع للسماع منكم


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)

8

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 مليون شخصاً المياه من جعيتا عبر محطات المعالجة في ضبية، إلا ان إمدادت المياه غير كافية وغير متوازنة موسمياً. والجدير بالذكر أن بعض الأسر المعيشية تتلقى المياه من الإمدادات العامة لأقل من 3 ساعات يومياً.

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 المياه سنوياً 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 مستدامة بيئياً والمقبولة اجتماعياً 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، وذلك وفقاً 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 مكعب سنوياً 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 الإسكان وفقاً 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 الإسكا RPF* 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.