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ENVIRONMENTAL ASSESSMENT OF THE MUDEIREJ BRIDGE RECONSTRUCTION PROJECT

FINAL REPORT

Prepared by

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List of Acronyms and Abbreviations

CDR	Council for Development and Reconstruction
CII	Contrack International, Inc. (US contractor)
EA	Environmental Assessment
EFL	Environment Framework Law (or Code of the Environment)
EMMP	Environmental Monitoring and Management Plan
EM 385-1-1	US Army Corps of Engineers Health and Safety Manual
GoL	Government of Lebanon
IEE	Initial Environmental Examination
ISF	Internal Security Forces (Police)
MoE	Ministry of Environment
OSHA	Occupational Safety and Health Administration
RFQ	Request for Quotation
TO	Task Order
UNDP	United Nations Development Program
USAID	US Agency for International Development

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1. INTRODUCTION

1.1 Background

The United States Government, through the US Agency for International Development (USAID), has offered to undertake the complete reconstruction of the Mudeirej Bridge (called "the Project") in coordination with the Council for Development and Reconstruction (CDR). USAID awarded the construction contract to Contrack International (a major US Construction Contractor). See summary of project stakeholders in box.

> The **USAID Reconstruction Team** is overseeing the reconstruction project and awarded on January 31, 2007 US contractor **Contrack International** to design and rebuild the Mudeirej Bridge. In Lebanon, Contrack is working with **Khatib & Alami** (for design works), Lebanese contractor **MAN** and Egyptian contractor **Arab Contractors**. **HNTB** is providing design supervision and **Baker** is providing overall project management. The Lebanese counterpart agency is the **Council for Development and Reconstruction** and **Socotec** is providing technical supervision for CDR.

Pursuant to the Initial Environmental Examination (IEE) conducted by USAID, the Project requires a *focused* Environmental Assessment (EA) to identify and mitigate potential adverse impacts on the environment of the repair and reconstruction of the Mudeirej Bridge. USAID chose ECODIT Liban to conduct this focused EA following a Request for Quotation (RFQ) issued in February 2007. ECODIT Liban received the Task Order (TO) on June 7 and held an Entrance Interview with the USAID mission in Lebanon on June 13 (see minutes of meetings in Appendix A). The performance period for this TO is 60 days from the date of the Entrance Interview.

1.2 Purpose of the EA

Consistent with USAID environmental regulations 22 CFR 216.3 (a) (2) (iii), the Mudeirej bridge project and auxiliary reconstruction qualify for a Positive Determination, and requires a scoping statement for an EA with stakeholder input. The objectives of this EA are to:

1) Assess and analyze the significant environmental issues related to the project;
2) Describe and compare project alternatives;
3) Identify and describe the positive and potential adverse impacts of the project on the environment;
4) Differentiate significant from less significant impacts; Propose measures to mitigate the potential adverse impacts and formulate a monitoring program with clear distribution of responsibilities

1.3 Methodology

In preparing this Environmental Assessment, ECODIT:

1. Met with the USAID mission in Lebanon (Entrance Interview) on June 13 to go over the scope of work and timetable for the EA; at that meeting, ECODIT received from USAID contact information for key design and construction contractors;

2. Conducted several visits to the project site (Mudeirej) and met with key project staff including Mr. Essam Guirguis (Team Leader for USAID) and Mr. Said Torbey (Quality Control Manager, at Contrack International); Mr. Mohammed Gouda (Safety Inspector, at Contrack International); and Mr. Ghassan Ziab (Deputy project Manager, at Baker). (See minutes of meeting in Appendix A).

3. **Consulted other stakeholders** including Mr. Elie El Helou (government focal point at the Council for Development and Reconstruction) and Mr. Ramiz Chayya (the mayor of Sofar);

4. **Conducted a scoping session** in Sofar on July 6 (see minutes in Appendix B). Guided by the IEE determination and the discussions during the scoping session, the Project team prepared and submitted to USAID a scoping statement to anticipate potentially significant from non-significant issues, and proposed how and by whom the EA study will be conducted. ECODIT submitted to USAID a final Scoping Statement on July 23, 2007.

5. **Conducted a hydro-geological survey** of the area surrounding the Mudeirej Bridge. The survey examined watershed boundaries, spring location and flow, surface runoff and soil stability at key locations where minor landslides have occurred in the past.

6. **Prepared and submitted a Draft Environmental Assessment**. The EA team visited the site and collected baseline data including), population and economic activities, important recreational, cultural and historic areas, topography, hydrogeology, climate, biodiversity (fauna, flora) and ecosystem as relevant to the defined study area and potential impacts identified in the Scoping Statement. The project activities, their impacts and specific mitigation measures are summarized in tabular format along with the necessary monitoring requirements, indicating the roles and responsibilities for implementing the mitigation measures/monitoring etc. This environmental management and monitoring plan (EMMP) is intended to guide the implementation of the EA recommendations and should be reviewed during the course of project.

1.4 Report Structure

This report is organized into nine (9) chapters:

1. Introduction
2. Description of the project
3. Analysis of project alternatives
4. Legal and institutional framework
5. Permits and approvals
6. Description of the existing environment
7. Assessment of impacts and proposed mitigation measures
8. Environmental management and monitoring plan
9. Conclusions

There are **8 appendices** at the end of the EA report:

A. Minutes of meetings
B. Minutes of scoping session
C. Map showing the 4 designated quarry zones in Lebanon
D. List of supplies needed for reconstruction
E. Agreement between MAN Enterprises and landowner of the ruble disposal
F. Safety Manuals: Table of contents for OSHA and EM 385-1-1
G. Agreement between Contrack and Hemlin Hospital
H. List of References

2. DESCRIPTION OF THE PROJECT

2.1 Project location

The Mudeirej Bridge is located near the village of Sofar, about 24 km east of the capital Beirut (see Figure 1). The Mudeirej Bridge was built in 1998 by Italian design and construction contractors, using pre-stress concrete design. The bridge complex is made up of two double lane twin bridges; the north bridge connects Chtoura to Beirut and the south bridge connects Beirut to Chtoura. Each bridge is 420 m long (measured from abutments at both ends of the bridge), rests on 10 piers and consists of 11 spans. Pier height ranges from 3 meters (near the abutment) to 72 meters at the center, making it the highest bridge in Lebanon and the Middle East. The Mudeirej Bridge is considered a vital artery for international land transport but can be bypassed using the old Damascus road that travels through Sofar.

Figure 1
Map of Lebanon showing project site

Source: Geo Projects, 2002

2.2 Scale of war damage

During the July 2006 war in Lebanon, the bridge sustained direct hits by aerial bombardment resulting in the following damages:

- **North Bridge:** one span and two supporting piers were partially destroyed forcing the total closure of the bridge. The damaged span is punctured in the middle by a 5-meter crater. The blast also damaged the road barriers and fence (figure 2, photo 1).
- **South Bridge:** more than half of the bridge collapsed into the valley (about 200 meters) including 5 piers and 6 spans. Because the bridge was built using press-stress concrete, the remaining piers (on the north side of the bridge) have skewed up to 1.2 meters from their original axis (see photo). The remaining portion of the bridge (about 200 meters) cannot be salvaged and must be demolished as well (see photos 2, 3).
- **Foundations:** The bombardment did not affect the bridge foundations. Immediately after the cease fire in August 2006, the Council for Development and Reconstruction built a

ramp to bypass the south bridge directing vehicles off the highway, under the north bridge, and onto the old Damascus Road. Traffic on the north bridge was rerouted to the old Damascus Road and therefore did not require building a ramp.

Figure 2
General photos of the project site

Photo 1: Wide angle view of the bridge looking north (courtesy: USAID Reconstruction Team)

Photo 3: Rubble from collapsed south bridge (fall 2006)

Photo 3: Construction works (spring 2007)

2.3 Reconstruction works

With grant funding from USAID, Contrack International Inc. (CII) will **repair** the North Bridge and **rebuild** the South Bridge. The reconstruction Project has three components:

1. Repair the North Bridge: CII will repair the North Bridge so it becomes fully operational. The contractor has explored several options for repairing the North Bridge including fiber-wrapping the damaged piers or demolishing and rebuilding the piers, in addition to rebuilding the deck itself.

2. Demolish the South Bridge: CII will prepare and implement a demolition plan to remove the South Bridge altogether. The plan examined two alternatives jackhammer drilling and blasting.
3. Rebuild the South Bridge: After demolishing the South Bridge and hauling the demolition waste to an approved dumpsite, CII will rebuild the bridge using the existing foundations. The new bridge will therefore follow the original bridge alignment.

The estimated completion date for the Project is May 2009. At the end of all repair and reconstruction works, the Mudeirej Bridge will look exactly like it did before the aerial bombardment.

3. ANALYSIS OF PROJECT ALTERNATIVES

3.1 The "No-Action" Alternative

If nothing is done to rebuild the bridge demolished during the Israeli assault on Lebanon, drivers using the road will face mounting difficulties. The so called old Damascus Road that bypasses the Mudeirej Bridge only has two lanes – one lane in each direction – and therefore cannot support the traffic without significantly reducing travel speed and causing significant bottlenecks (see photos 4 & 5). Increased traffic on this commercial road may lead to accidents and will cause significant noise and air pollution. On the other hand, economic activity will increase as the stores located on the old Damascus Road will benefit from increased traffic.

Photo 4: Old Damascus Road (northbound)

Photo 5: Old Damascus Road (southbound)

The no-action alternative also means that the damaged bridge will remain suspended in the air and totally idle. Vehicles cannot cross either bridge and the bridge will continue to affect the landscape for local residents and passer-byes.

3.2 Alternative Options for Demolition

The USAID Reconstruction Team requested the contractor to prepare a South Bridge demolition plan that would examine two options: jack hammer drilling and blasting, as explained below

(1) **Jack hammer drilling** is a portable percussive drill operated using compressed air, it is used to break up targeted points in building structures.

(2) **Blasting** refers to the controlled use of explosives to create an implosion that destroys building structures. This method involves removing vertical supports (the piers) in a controlled, sequential manner that then uses gravity to collapse the structure. The direction of fall can be controlled by taking out supports that force the structure to fall on a designated space. Legislation regarding the amount of explosives and the blast should be examined as part of the demolition plan. It is important to note that blasting will not affect the existing foundations (or the plinths above them); the foundations will be reused to anchor new piers.

In the case of the Mudeirej Bridge reconstruction project, blasting appears to offer several advantages over drilling, namely (summary of alternatives in table 1):

- Expediency (can be completed in a couple of weeks): blasting will only require the approval form the internal security forces. As long as the material is present, the operation will only take few hours that will be followed by rubble harvesting (this will require around 90 days and the Ain Dara road will be consequently closed).
- Safety (blasting will put workers out of harm's way): As blasting is a short operation, the number of workers exposed to hazards during blasting will be less than the number exposed to hazards during jack hammering.
- Shorter period of traffic disruption collection: As the number of demolition days will be reduced during blasting, traffic disruptions resulting from the collection of rubbles will last for a shorter period of time and the work will be performed faster than in the case of jack hammering where the road will have to be closed during all the period of demolition.

Table 1
Comparative Analysis of Impacts between Two Demolition Techniques

Parameter	*Jack-hammering*	*Blasting (implosion)*
Duration	Requires at least 6 months	Requires about 2 months
Noise	Moderate but long-term	High but only during blasting (<1mn)
Dust	Minor but over 6 months	High, smoke plume, very short-term
Road damage	Yes, will need speedy repair	
Groundwater	Minor, depends on management plan for demolition waste	
Occupational	High/prolonged risk of accidents	Low and only during blasting
Health & safety	Moderate because of longer duration	Minor because blasting is short-term
Demolition waste	Same volumes of demolition waste, will need disposal offsite	

3.3 Alternative Options for Repair and Reconstruction of the North Bridge

There are two alternative options for repairing the North Bridge (summary of alternatives in table 2):

(1) Demolish and rebuild the damaged piers. This option is time-consuming and technically difficult as demolition works could affect other piers.

(2) Repair the damaged piers using fiber-wrapping. This method, developed about 50 years ago, consists of wrapping and retrofitting the damaged concrete structure with fibers so that it is reinforced and strengthened. This method will increase the strength of the repaired concrete elements by adding additional reinforcement. The wrapping (about 10 cm in thickness) is then painted to match the existing concrete.

A variant to option no. 2 above would consist of:

(3) Implement expedient repair of the North Bridge by building a temporary steel bridge over the damaged deck. The steel bridge would partially restore the bridge's function and traffic would be restored until the South Bridge is rebuilt. This variant was considered by USAID and CDR but has since been scrapped.

Table 2
Comparative Analysis between Alternative Repair Options

Parameter	*Rebuild damaged piers*	*Repair damaged piers*	*Temporary steel bridge*
Duration	Would require several months		Short duration
Noise	Moderate during demolishing	No impact	Potentially high, depends on steel bridge design
Dust	Minor but during entire demolition period	Minor during repair only	No impact
Road damage	No impact as the piers are not above the road		No impact
Groundwater	Minor: Depends on management plan for demolition waste		No impact
Occupational H&S	High especially during demolition	Low and only during repair	No impact
Demolition waste	From pier demolition and deck	From deck only	No impact

3.4 Alternative options for rebuilding the South Bridge

There are two options for rebuilding the South Bridge (summary of alternatives in table 3):

(1) Rebuild the bridge using the existing foundations (and plinths if they can be salvaged); and

(2) Build a totally new bridge, not aligned to the original bridge. This option is not consistent with the Project requirements – i.e., to rebuild the bridge as it was. Also, a new bridge alignment would increase the separation distance between the two twin bridges and may warrant additional design considerations.

Table 3
Comparative Analysis between Two Options for Rebuilding the South Bridge

Parameter	*Rebuild using existing foundations*	*Rebuild a totally new bridge*
Duration	Relatively short duration	Long duration
Noise	Moderate	Long duration
Dust	High but over a relatively short duration	High but over a long duration
Road damage	High but over a relatively short duration	High but over a long duration
Groundwater	Minor, depends on management plan for demolition waste	Depends on construction plan
Occupational	Decreased risk of accidents (short period)	High and only during a long period
Health & safety	Minor because of shorter duration	High because rebuilding is is long-term
Appearance	Original alignment restored	New alignment and overall a different bridge configuration

4. LEGAL AND INSTITUTIONAL FRAMEWORK

This EIA conforms to both USAID Regulation 22 CFR 216 and the Government of Lebanon draft EIA decree. USAID environmental regulations are in accordance with sections 118(b) and 621 of the US Foreign Assistance Act of 1961 and can be found under "22 CFR 216 Agency Environmental Procedures" on the USAID website. The relevant Lebanese laws, regulations and institutions pertaining to EIA requirements and implementation of this project are discussed and cited below.

4.1 Legislation of particular relevance to the project

4.1.1 Environmental protection and EIA requirement

In addition to USAID 22 CFR 216, there are two important legal texts in Lebanon pertaining to environmental protection and EIA requirements:

(1) The GOL Environment Code 444 (dated July 29, 2002)
(2) The GOL draft EIA decree (not passed yet)

The **Lebanese Environmental Code** was approved and promulgated by Lebanese parliament in July 2002. It constitutes a pivotal legislation for environmental protection and conservation in Lebanon, covering all aspects of environmental protection and management. The Code explicitly requires an environmental impact assessment (EIA) for specific projects, including road construction projects. While the Code itself does not prescribe EA procedures per se, it calls on the GOL to develop and enact an EA decree.

The **EA decree** describes in great detail EA procedures. Those procedures to a large extent comply with the guidelines and safeguards recommended by the World' Bank Operations Directives and Sourcebooks #1. The EIA draft decree provides a list of project categories that require an EIA; included in this are projects related to road construction. The decree outlines the elements to be examined in an EIA report. These elements are consistent with the scope of work of this EIA.

4.1.2 Quarry legislation

The quarry sector in Lebanon has for many years been plagued by political interference and a conflict of prerogatives. Although quarry legislation exists (decree 8803 dated October 4, 2002 and its amendment decree 16456 dated 27 February 2006), enforcement is poor to non-existent. Most quarries are either unlicensed or extract aggregates in volumes that exceed the terms of their licenses. Additionally, only few operators rehabilitate the site during and/or after quarrying. There are an estimated 800-900 quarries in Lebanon, most of which are closed or inactive. Quarries are classified according to six categories:

1) Aggregates (for construction),
2) Sand (for construction),
3) Face stone quarries,
4) Mosaics,
5) Cement production,
6) Industrial sand (for glass and paint)

Decree 8803 (4/10/2002) and its amendment 16456 (27/02/2006) have designated four sectors in Lebanon for quarrying (see map in Appendix C):

(1) Aarsal (anti-Liban mountain range)
(2) Tfail (about 15 km south-east of Baalbeck)
(3) Qoussaya (near Rayak)
(4) Haloua (about 15 km north-east of Rachaya)

All sectors are situated in the eastern mountain range of Lebanon, a.k.a. Anti-Liban.

Using aggregates from these quarry sectors requires prior approval from the Higher Council for Quarries and Stone Crushers, presided by the Lebanese Ministry of Environment. Approval for using aggregates from other regions can only be obtained from the Council of Ministers. The Council of Ministers published in June 2006 a Circular (19/2006) requiring all government agencies to abide by Decree 8803 and its amendment 16456, and making sure that all public works (including roads and bridges) commissioned by or for the government comply with Decree 8803 and its amendment Decree 16456.

Within these sectors, MoE can issue five-year permits for quarrying (renewed yearly). In the absence of an Environment Minister (the previous minister resigned in December 2006 and has yet to be replaced) quarry operators are able to obtain from the Ministry of Interior "administrative extensions" for up to 6 months. Although these extensions are recognized by the Ministry of Interior they have not been approved by the Ministry of Environment because most of the sites fall outside the Anti-Liban mountain range. Moreover, because these extensions are short-term, quarry operators tend to overexploit the sites. One of Lebanon's largest quarries, located in Ain Dara (a.k.a. Dahr el Baidar Fattouche quarry), is currently operating using an administrative extension but does not have MOE approval.

Although the legislation is clear, in reality, the situation is very different on the ground as most quarries continue to operate with or without licenses and there is very little control over the flow of aggregates in the country, if any.

4.1.3 Other legislation

Table 4 lists other relevant laws and regulations affecting the EA, including noise, dust from quarrying activities, monitoring and penalties for illegal disposal of solid waste and rubble, occupational safety, labor laws, etc.

Table 4
List of Legislation Relevant to the Project

Legislation	Date of issue	Subject / Title
Law 16/L	30/06/1932	General health rules and regulations
Law 2761	19/12/1933	Recommendations regarding dumping wastewater and waste
Law 253/ L.R	8/11/1935	Exploitation of quarries
Law	10/12/1953	Penalty for illegal extraction of sand, gravel or stone
Decree 10121	20/7/1962	Setting specific regions and conditions for granting permits to extract gravel and sand from public marine lands
Decree 10276	7/10/1962	Protection of Surface and Groundwater Resources
Decree 1315	19/3/1965	Road network classification
Decree 5	31/1/1977	Establishment of the Council for Development and Reconstruction (CDR)
Decree 118	30/6/1977	Decree for municipalities
Decree 433	19/9/1977	Organizational structure of the CDR
Decree 383	25/3/1983	Reorganization of the CDR
Law 148	16/9/1983	Construction law
Law 88/63	12/8/1988	Protection of the environment against hazardous waste
Law 216	2/04/1993	Establishment of the Ministry of Environment
Decree 5591	8/30/1994	Organizational structure of the Ministry of Environment
Decision 2069/B, Ministry of Interior and Municipalities	29/12/1995	Warning to drivers of concrete mixers to respect maximum loading capacity of trucks
Decision 52/1	29/07/1996	Standards and emission levels for limiting air, water and soil pollution (MOE decision)
Decision 31	28/08/1997	The waste issue: promote environmental waste management
Decision, Ministry of Environment 1/191	8/10/1997	Establishment of regulations for cement production in Lebanon and the resulting environmental pollution
Decision, Ministry of Environment 1/186	7/11/1997	Setting documentation and conditions for the exploitation of quarries for the production of cement
Decision 8/1	30/01/2001	Decision of the MoE setting characteristics and standards related to air pollutants and liquid waste emitted from classified establishment and wastewater treatment plants
Decision, Ministry of Environment 1/6	5/2/2002	Methodology for reviewing Scoping Statements and Environmental Assessments
Law 444	29/7/2002	Code of the Environment (environment framework law)
Decree 8803	4/10/2002	Organizes the quarry sector and stone crushers
Decree 9222	9/12/2002	Setting up the Higher Council for Quarries and Stone Crushers
Draft decree	Not yet issued	The EIA decree; requirements and procedures for preparing EIA reports
Decree 11802	30/01/2004	Occupation health and safety for institutions subject to labor local laws
Decree 16456	27/02/2006	Amends Decree 8803 (4/10/2002)
Circular 19/2006	20/06/2006	Restriction on the use and source of aggregates for construction works in the pubic sector (Council of Ministers)

4.1.4 International treaties

Lebanon is a signatory to all major environmental treaties and conventions including:

- Convention on Biological Diversity (ratified 22/2/1994)
- Framework Convention of Climate Change (1/8/1994)
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (21/12/1994)
- Convention to Combat Desertification (8/12/1995)
- Convention on Persistent Organic Pollutants (22/5/2001)

These treaties and conventions however have no influence on the Project.

4.2 Institutions

The most relevant Project stakeholders are summarized in Table 5.

Table 5
Overview of the Most Relevant Project Stakeholders

Institutions	Mission/ Responsibility
Ministry of Environment	• Ensure environmental protection, prevention of pollution, protection of wildlife and preservation of environmental balance. • Set environmental standards, specifications and guidelines for sectors that might have an impact on the environment and for the management of natural resources and amenities. • Issue and approve EIA permits for the reconstruction of the bridge. • Prepare plans and enforce policies, laws and regulations for the protection of public health and environment • Define the environmental policy and ensure that it is appropriate to nature, scale and environmental impacts of the activities • Approve scoping statements and EIA • Reduce intentional and unintentional harm to the environment • Recognize quarrying sites and the source of reconstruction material • Approve the sites used for the deposition of rubles and demolition waste
Council for Development and Reconstruction	• Approve the plans of reconstruction operations • Act as a link between the contractors and the Internal Security Forces in order to obtain approvals for blasting the South bridge • Decide about road diversions and bridge usage during the repair and reconstruction stage • Approve on the disposal and use of demolition waste and rubbles generated form the reconstruction activities
Local municipalities	• Communicate to citizens traffic diversions • Communicate to the citizens the day and time of blasting • Make sure the reconstruction activities do not affect the citizens and the economic activities inside the villages • Protect land ownership and landlord inside the municipalities and make sure no one appropriates them • Make sure the construction works do pollute the municipalities of affect their environment
Internal Security Forces (ISF)	• Approve blasting methods, plans and material used • Provide permits for the use of explosives (implosion of the bridge)

In relation to the Mudeirej Bridge Reconstruction Project:

- **The Ministry of Environment** is mandated to review, comment and approve this EA;
- **Council for Development and Reconstruction** is the lead government agency responsible for managing, supervising and facilitating international grants and loan agreements related to the construction sector. CDR is hence the counterpart agency for this Project.
- **Five local municipalities** are potentially affected by the project: Sofar, Ain Dara, Hammana, Charoune and Chbanieh. These municipalities must be kept appraised during the project period and receive prior notice of critical construction activities including blasting. Municipalities in Lebanon have a very modest police force.
- **Internal Security Forces (ISF)** must be notified on all matters related to blasting, hauling demolition waste, transport of construction waste and road diversions.

5. PERMITS AND APPROVALS

The Project will require a number of permits and approvals including:

1. **Army approval for blasting operations.** The Contractor, in coordination with the Council for Development and Reconstruction, must obtain relevant approvals for using explosives. At least three government/security agencies are involved in this process including the Lebanese Army, the Internal Security Forces, and the Council of Ministers (in that order) (see more details in Section 07.2.6).
2. **Permit for the disposal of demolition waste.** The contractor has already negotiated and obtained the approval of the municipality of Ain Dara to haul the waste to a designated site near the village (see more details in Section 7.2.5).
3. **Ministry of Environment approval on the source of construction aggregates.** Pursuant to Lebanese legislation, the supply of construction aggregates for public infrastructure works must come from a designated quarry zone (see more details in Section 4.1.2).
4. **Approval to implement a road diversion.** The demolition of the South span will damage the road from Mudeirej to Ain Dara. While the Contractor reopens and resurfaces the road, traffic will be rerouted through Sofar to Ain Dara (see more details in Section 7.2.1). This requires prior approval from the Ministry of Public Works and Transport and/or Internal Security Forces.

6. DESCRIPTION OF THE EXISTING ENVIRONMENT

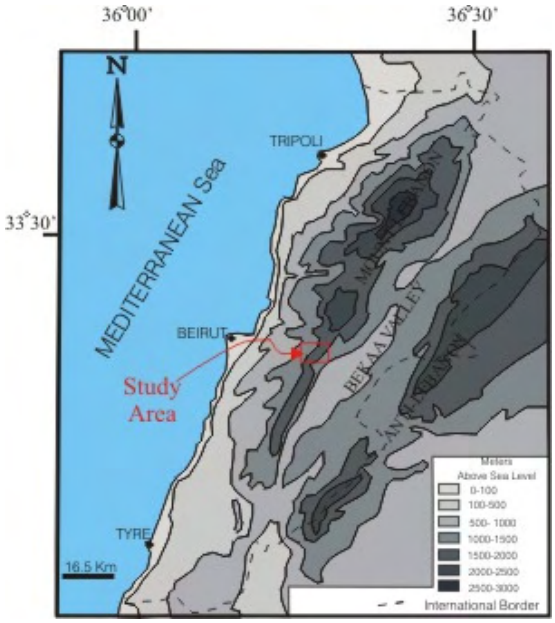
This chapter defines the project area potentially affected by the reconstruction project and describes the environmental and social receptors in relation to the Project.

6.1 The site

6.1.1 Location

The project site is located about 24 km east of the capital Beirut at an altitude of 1320 m above sea level. The project site is located on the western slopes of the central section of Mount Lebanon, one of two mountain ranges in Lebanon extending in a NNE-SSW direction (see Figure 3). The Bridge constitutes a vital commercial link between Beirut and Chtaura located in the Bekaa valley. The bridge was initially built in 1998 to ease traffic from Beirut to Chtaura. A small army barracks and checkpoint is located near the northern abutment.

Figure 3
Topographic Map of Lebanon showing the study area.



6.1.2 Land-use near the bridge

The bridge is surrounded by barren lands. There is very little agricultural activity in the vicinity of the bridge. Moreover, most of the private lands on both sides of the highway cannot be accessed because there are no dedicated exits or service roads on either side of the highway north and south of the bridge. While the nearest village, Sofar, is about 2 km from the site, there are a dozen scattered houses and unused structures near the bridge. There are five villages located within a 5 km radius of the site; they are all road-linked. These roads are in good shape, narrow in most places and regularly used by local inhabitants.

6.1.3 Pre-fabricated offices

CII has setup two mobilization areas on site (see photos 6 & 7):

1. Mobilization #1: located on the highway south of the bridge. This area consists of four pre-fabricated units used by the USAID Reconstruction Team, MAN Enterprises, Arab Contractors and Contrack International, Inc.
2. Mobilization #2: located in the valley, below the bridge. This area is used by workers on site and for storage of equipment and construction materials.

Photo 6: Mobilization area # 1 (on the bridge)

Photo 7: Mobilization area # 2
(below the north span of the bridge)

Each office site is supplied with:

- 2 diesel power generators of 220KVA (including one standby generator). Each generator is equipped with a day tank and a general tank to intercept leaking oil and prevent percolation into the ground.
- 2 septic tanks for toilet facilities. The tanks (1 x 2,000 liter and 3 x 8,000 liters) are emptied weekly and sanitized every two weeks to prevent the buildup of bacteria.

6.1.4 Archeology and other cultural monuments

There are no known archaeological or historical monuments within a 1-km radius of the site. In Falougha, at a distance of 2 km from the bridge ("as the crow flies"), is a historical site where the Lebanese flag was raised for the first time in 23 September 1943.

6.2 Human environment

6.2.1 Surrounding villages

The following villages are located near the Bridge: **Hammana**, El Khraibe, **Ech Chebbaniye,** Qoubhaya, **Sofar**, Majdel Baana, **Charoun**, El Azzouniye, and **Ain Dara**. The population in those villages ranges from 6,000 in Sofar to 13,000 in Charoun. Population size can fluctuate seasonally; for example, it will significantly increase during summer as coastal populations relocate to mountain areas to enjoy cooler and milder temperatures.

6.2.2 Affected roads

The closure of the Mudeirej Bridge in July 2006 diverted all traffic to the Old Damascus Road. This situation prevailed before the construction of the bridge in 1998. Traffic in this part of the country, from Beirut to Chtoura, can be very intense and dangerous due to the incessant flow of trucks and long-wheel vehicles. **Figure 4** shows a general view of the bridge and associated roads, using GoogleEarth.

6.2.3 Economic activities in the vicinity of the bridge

There is very little urban construction activity in the immediate vicinity of the bridge. Moreover, the absence of service roads and exits leading to the surrounding lands has prevented urban sprawl on both sides of the highway. In Sofar, there are a number of small businesses such as grocery stores and snacks/restaurants, as well as abandoned hotels which had former glorious days before the civil war in Lebanon (1975-1990) and were never revamped since then. Most of the people living in those villages commute daily to Beirut for work.

Falougha is home to Lebanon's largest water bottling plant, Sohat/Nestlé, with a total workforce of about 260 employees.

Figure 4
Roads linking Beirut to the Bekaa

6.3 Physical environment

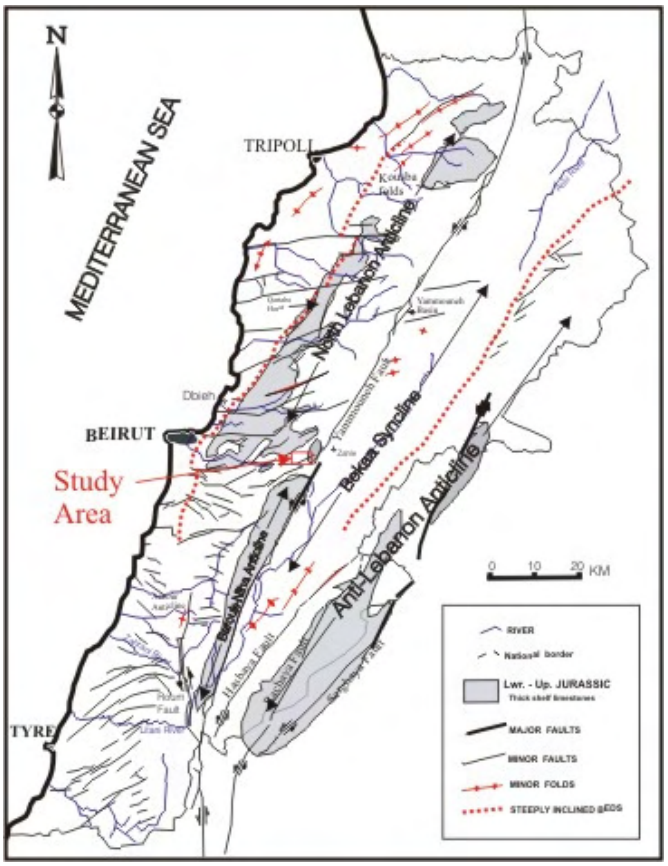
6.3.1 Climate

The climate in Sofar / Ain Dara is typically Mediterranean, warm and dry in summer to cool and wet in winter when there can be intense downpours and snowfall. Summers (May through October) are usually hot and dry. Temperature in the summer will fluctuate from hot during the day (30+ degrees Celsius) to fairly cool at night (10-15 degrees Celsius); humidity is very low (30-50%). For this reason, coastal populations (including tourists) prefer to spend their weekends in the mountains to escape the oppressive humidity of the coast. Temperatures in winter will range between 5-10 degrees Celsius during the day and drop to sub-zero temperatures at night with frequent occurrence of frost.

6.3.2 Tectonic structure

The topographic features in Lebanon are surface expressions of the tectonic structure of Lebanon. This fault system forms a restraining bend and has several surface expressions, represented by major faults (Yammouneh, Roum, Hasbaya, Rashaya and Serghaya faults), uplifts in the form of high mountainou (Mount Lebanon and Anti Lebanon), and by the seismic activity records. This restraining bend in Lebanon is part of the Dead Sea Transform fault system. Recent work has categorized the Lebanese section of the Dead Sea Transform fault as being a zone of strong seismic activity (Khair *et al.*, 2000). The project site lies west of the Yammouneh Fault (**Figure 5**). Harajli *et al.* (1994) proposed ground acceleration in this part of Lebanon, where the project area lies, to be 0.20g.

Figure 5
Tectonic Map of Lebanon (Modified from Dubertret, 1955 Not to Scale)



6.3.3 Geological Site Setting

Geologically the piers of the Mudeirej Bridge close to the northern abutment are located on the *Mudeirej Formation*, which is hard massive limestone. In the middle section of the bridge the piers are positioned on the *Abeih Formation*, which is locally formed of friable to hard sandstone, clay and detrital limestone. As observed during a visit to the site, the thin layer of reddish brown soil was stripped before placement of the footings.

The ten piers of the Mudeirej Bridge are not positioned on any major aquifer. They are located on the Mudeirej semi-aquifer and Abeih aquiclude. The first real aquifer underneath the site is the Chouf Sandstone Semi aquifer. The water table in this aquifer is at a depth greater than 200 m below the ground level underneath the bridge footings.

Two minor springs are located south of the bridge at a distance of less than 300 m. Their source area is located south of the bridge piers and spans. A third spring is located further south from the bridge at a distance of approximately 450 m. The site therefore is not located inside the catchment area of any major spring.

6.3.4 Water resources and hydrogeology

ECODIT conducted a preliminary assessment of the geology and hydrogeology of the project site using available maps, published literature, and field observations. The result was the generation of a geological/hydro-geological map at a scale of 1:10,000 covering a 5 km2 area surrounding the bridge situated within grid coordinates: 208 000 and 206 000 Northing, and 148 000 and 151 000 Easting (see full map in figure 6). One geological cross-section (AB) that illustrates the subsurface stratigraphy and structure, underneath the proposed reconstruction site was developed. There are four outcropping formations in the project area, that all belong to the Cretaceous periods (see summary in **Table 6** and descriptions below).

Chouf Sandstone Formation (C1)

This formation outcrops in the southwestern and northern parts of the project area and in the valley of Zahaba. It is Tithonian to early Aptian in age and it is mainly composed of cross bedded, hematitic friable to hard sandstone and sands with impermeable lenses of bluish gray clay, marl and peat. This formation reaches a thickness of more than 100m in the area of study.

The Chouf Sandstone Formation is a complex unconsolidated semi-aquifer. A series of leaky aquifer units of sands are found in this system, and they are confined between semi-permeable clay horizons. These clays restrict the flow between the various water-bearing horizons. The permeability of the formation varies significantly from one region to another whereas pore spaces are the major flow paths of groundwater in this unconsolidated semi-aquifer.

Table 6
Hydro/Geological stratigraphic table of study area

Period	Formation	Lithology	Thickness (m)	Hydrogeological Characteristics	Remarks
Quaternary	Quaternary (Q)	Soil, Conglomerates Limestone, marly limestone	1-4m	Semi-Aquifer	Trivial thickness
Cretaceous	Chouf Sandstone (C_1)	Sandstone, impermeable gray clays and marl. Ferruginous sandstones	50-100	Semi-Aquifer	May yield quantities of water which are sufficient to households.
	Abeih (C_2a)	Variable units of ferruginous sandstones, limestones, marls, and clay	~50-150	Aquiclude	Low porosity units seepage zones and small springs
	Mdairej (C_{2b})	Grayish massive micritic limestone	~50	Aquifer	Insignificant reserves due to limited thickness surface exposure
	Hammana (C_3)	Thinly bedded marly limestone, marls, sands and detrital limestone and distinctive green beds of marls with volcanic layers	~100-150	Aquiclude	Low porosity units with seepage zones and small springs

The Abeih Formation (C2a)

The Abeih Formation is outcropping in the central, northern and south eastern parts of the study area. It is lower Aptian in age. In general, this formation consists in its upper part of yellowish and brownish fossiliferous friable marly limestone, in the middle section thick hard beds of sandstone and brown oolitic fossiliferous limestone while it consists in its lower parts, of intercalations of blue and green friable marls, and yellowish limestone. The Abeih Formation reaches a thickness of about 150m in the study area.

The Abeih Formation forms an aquiclude with poor hydraulic properties. The low hydraulic conductivity for argillaceous limestone, clays, and marls in present in this formation result in its poor hydraulic properties. Therefore, forming impermeable boundaries, which prohibit exchange of water between the different hydrostratigraphical units. According to the UNDP (1970) report, the infiltration coefficient of this aquifer does not exceed 10-15%.

Nevertheless, it is worth mentioning that the middle and upper units of the Abeih Formation may have small semi aquiferous layers, since it consists of thin beds of limestone and sandstone bounded by marl and clay. Several small springs issue from these units two of which are present in the middle part of the area (Spring 1 and 2, See geological map).

The Mdairej formation (C2b)

This formation forms a cliff overlying the Abeih Formation. The Mdairej Formation outcrops as steep cliff below and above the Mdairej road. This formation is upper Aptian in age and is formed of hard grayish micritic massive limestone rich in calcite veins. This formation is approximately 50m thick (see Figure 6).

The Mdairej formation being located between two aquicludes; namely the Abeih Formation at the bottom, and the Hammana Formation at the top, forms and aquifer that has a high potential of water bearing capacity, which remains, however limited due to the relatively small thickness reaching approximately 50 m in the study area. Its position between two aquitards improves its ability to maintain all water infiltrating in the form of recharge. This aquifer might contribute to the recharge of springs 1 and 2 identified in the central part of the study area (See photos 10 & 11).

The Hammana Formation (C3)

This formation overlies the Mdairej Formation. It outcrops in the eastern and western parts of the area on top of major ridges like Ras el Brayj and near Ain el Jamal area. It is upper Aptian to Albian in age. This formation starts with thinly bedded friable limestone marls and sandstones of variable colors (green, red and brown) and grades into harder fossiliferous limestone. This formation has a relatively limited thickness that reaches approximately 150 meters in the study area.

The Hammana Formation constitutes aquicludes with poor hydraulic properties because of the low porosity, consequently the low hydraulic conductivity for argillaceous limestone, clays, and marls. According to the UNDP (1970) report, the infiltration coefficient of this aquifer does not exceed 10-15%.

Nevertheless, it is worth mentioning that the middle units of the Hammana Formation may have a semi-aquiferous layer, since it mostly consists of thin beds of limestone and sandstone bounded by marl and clay. Several small springs may issue from this unit on example is Spring 3 (Ain Jamal Basha).

Quaternary Deposits (Q)

Quaternary deposits are mainly loss unconsolidated to partly consolidated surface material and reworked, cultivated surface material covering the different formation in several parts of the study area. The geological map was stripped of these surface soils to reveal the underneath formations. They are loose red to brown clay to sandy soils. A good example is the terraced and abandoned land underneath the Mudeirej Bridge.

6.3.5 Disposal site for excess unconsolidated material

ECODIT located an area measuring approximately 450 m^2 west of the project site (downstream) that was used as a repository for excess cut material produced during highway construction in 1998. This material is unconsolidated and remains unstable almost 10 years after the highway was built (see photo 8). The disposal of demolition waste from the Mudeirej Reconstruction Project must be implemented differently.

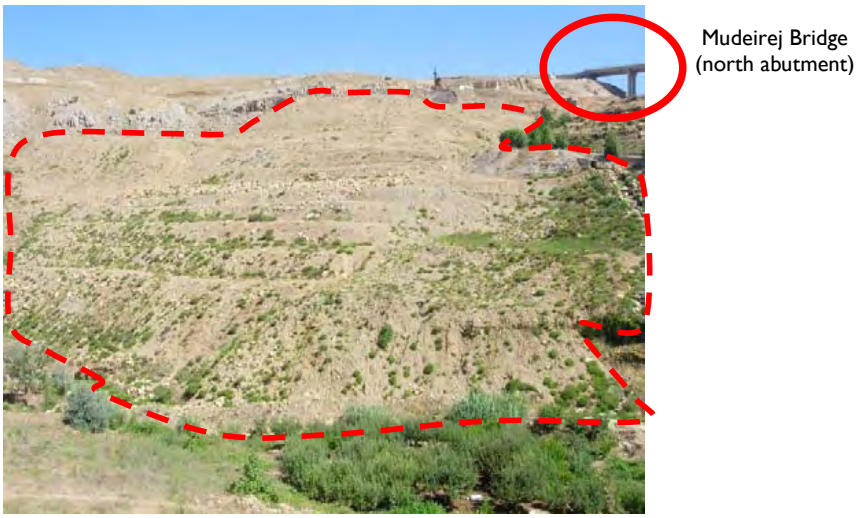
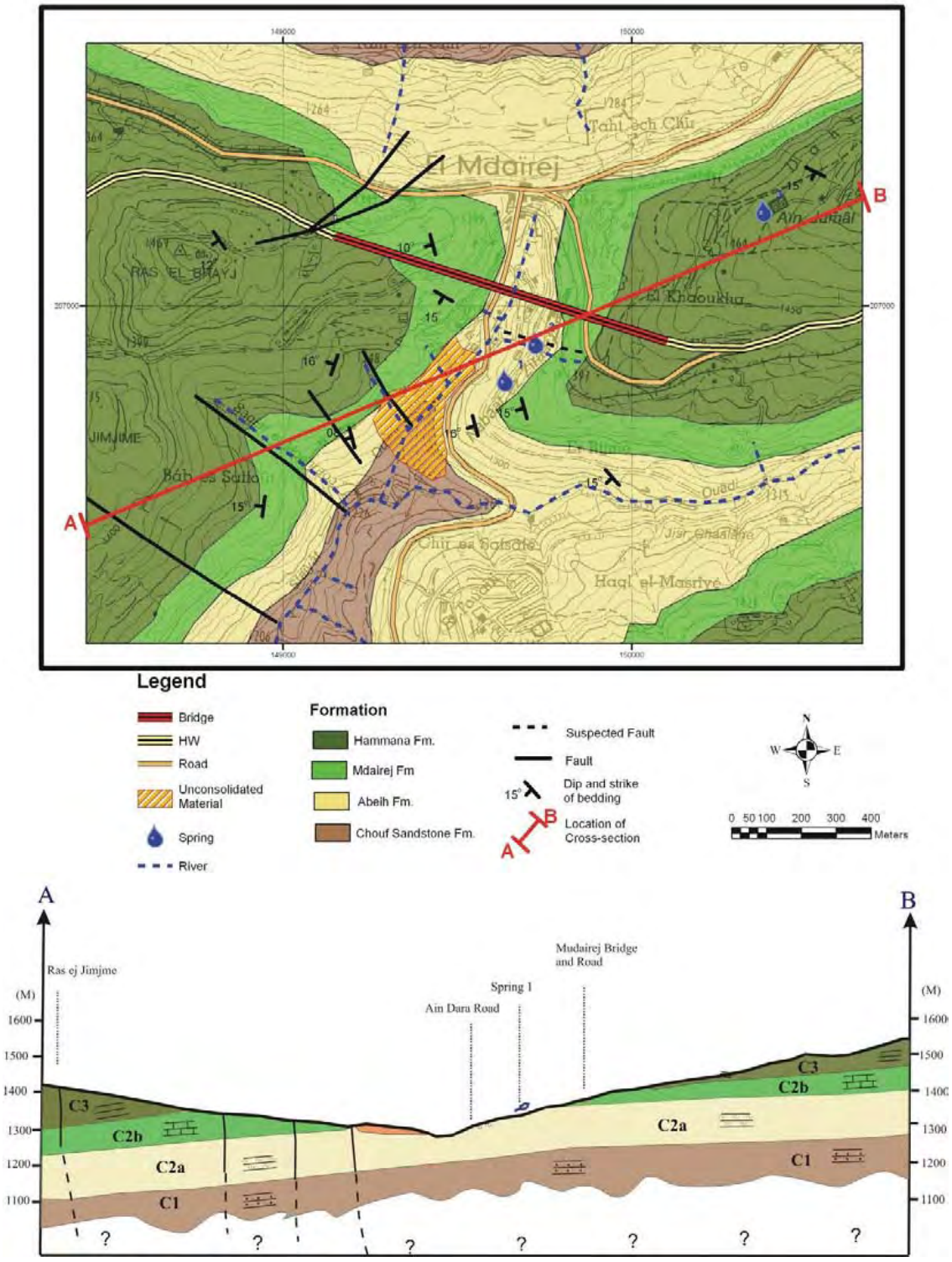


Photo 8: Disposal site for unconsolidated cut material from the highway project

Figure 6
Map showing geological setting and springs



6.3.6 Structure of the site

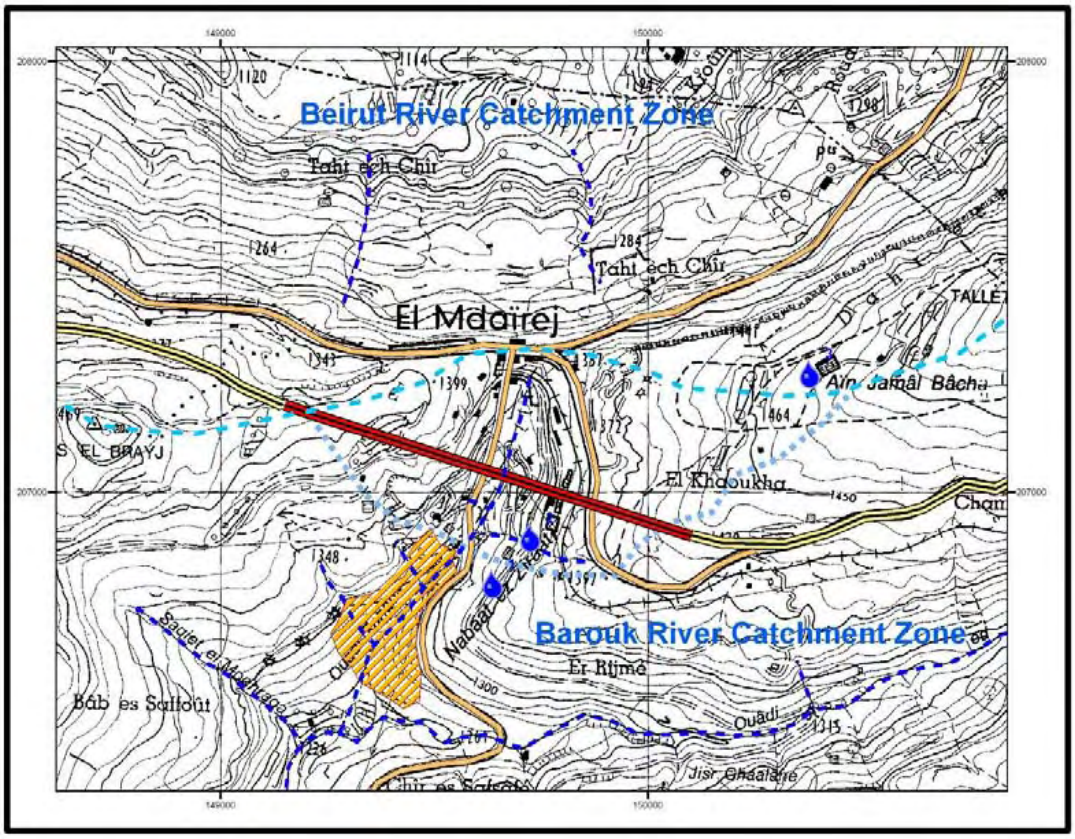
Formations in the study area are moderately dipping towards the southwest. Dips range between eight and sixteen degrees. Structural disturbances mainly faults have a slight influence on the bedding attitude near the project site.

Two faults trending NW-SE and NE-SW dominate the project area. An example of the NW-SE faults is the series of faults in the southwestern part of the project area. These faults are clear breaks in the Mudeirej Formation cliff. An example of the NE-SW fault system is present in the northwestern part of the project area.

6.3.7 Hydrological Site Setting

The Mudeirej Bridge is located in the minor catchment zone of the Barouk River drainage basin, only 200 m west of the basin boundary. The basin east of the Barouk River is the Beirut River (see Figure 7). The Barouk River basin covers approximately 600 km^2. The valley of the basin is known as Ouadi Zahâba where a small seasonal river (see photo 9) flows during high precipitation and snow-melt periods.

Figure 7
Topographic map showing catchment zones in relation to Project Site



Source: Based on Lebanese Army Map (scale 1:20000)

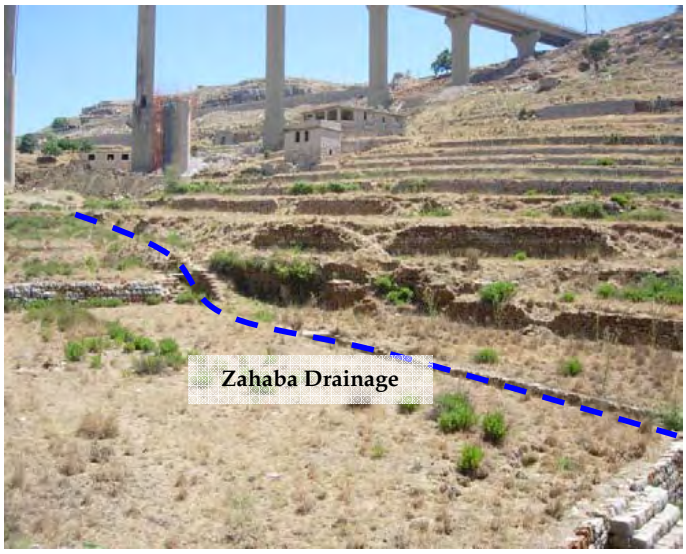


Photo 9: The small Zahaba drainage under the Mudeirej Bridge

6.3.8 Nearby springs

There are three springs within a 500-meter radius of the project site; all three have a very small outflow and are therefore considered insignificant (**Table 7**). These springs discharge water from the semi-aquiferous levels in the Abeih and Hammana Formations. See spring locations in **Figure 6** (geological setting and springs).

Two of those springs (denoted "Spring 1" and "Spring 2") are located within 250 meters of the bridge. These springs tap water from the top of the Abeih Formation, close to the boundary with the Mudeirej Formation. Photograph 10 shows the interbeds of limestone, and clay above the location of the spring. They discharge approximately 0.5 l/s (July measurement). The discharge will drop further towards the end of the dry season (September to mid October). Local shepherds use both springs, mainly for domestic purposes. A third spring (denoted "Spring 3") is located in the northeastern part of the project area and taps water from a zone in the Hammana Formation.

Table 7
Results of surveyed springs

Spring name	Aquifer	X coordinate	Y coordinate	Z coordinate (m asl)	Discharge (l/sec)*
1	C2a-C2b	149626.16	206780.50	1,330	0.51
2	C2a-C2b	149724.06	206888.97	1,330	0.52
3 (Ain Jamal Basha)	C3	150369.65	207262.04	1,470	0.60

*Spring discharge was measured in July 2007

Photo 10: Spring 1

Photo 11: Spring 2

There are no other major springs within 1-km of the project site.

6.4 Biological environment

6.4.1 Habitats

The project area represents a rich blend of geologic formations, diverse plant and animal species, and ancient human history. A variety of habitats can be found near the bridge site, due to seasonal weather and high altitude. The following sections describe succinctly the biological diversity in and around the project site. The bulk of the information is based on published literature, some of which was observed and confirmed during our site visits.

6.4.2 Flora

Plant cover changes as a function of altitude, exposure and soil type. ECODIT conducted an assessment of the most common plants, shrubs and trees near the bridge area and grouped them according to their prevalence and level of threat: common, endemic, rare threatened, medicinal and/or indicator species.

- *Cedrus libani,* (restricted to the East Mediterranean)
- *Gagea sp.,* (common)
- *Ornithogalum billardieri,* (common)
- *Hyacinthus orientalis,* (common)
- *Phlomis sp.,* (common)
- *Anemon blanda,* (common)
- *Asphodelus microcarpus,* (common)
- *Daphne oleoides,* (common)
- *Prunus ursina,* (common)
- *Urginea maritime,* (Threatened specie, bulb)
- *Iris sofarana* (endemic)

It is important to note that the bridge is located 5 km west to the Chouf Cedars Nature Reserve, the largest reserve in Lebanon, measuring almost 200 km^2.

6.4.3 Fauna

Lebanon is a country with strong contrasts in its vegetation, thus, it is natural to find animals with varied nutritional and climatic needs. The land topography, composition, microclimate, vegetation and human interaction have all influenced and transformed biodiversity for generations (i.e., species, density and distribution). Today, many plant and animal populations in Lebanon are declining, some have disappeared altogether. Contributing factors include:

- destruction of habitats (due to rampant urbanization)
- fragmentation of ecosystems as a result of modern agricultural practices,
- pollution, over-grazing, deforestation, forest fires, hunting, etc.

Animals that are potentially found in the general project area are:

- Striped hyenas, *Hyaena hyaena*
- Wild boar, *Sus scrofa*
- Red fox, *Vulpes vulpes*
- Jackals, *Canis aureus*
- Porcupine, *Hystrix cristata*

The wolf, *Canis lupes pallipes* was previously common in Lebanon. Remnant wolf populations can still be found in the eastern mountain range (Anti-Liban). It is unlikely to find any wolves near the project site.

7. ASSESSMENT OF IMPACTS AND MITIGATION

This chapter identifies and describes the positive and potential adverse impacts of the Project. The ECODIT EA team has considered a Project area that includes the bridge, surrounding basin catchment and nearby villages. It is important to note that the significance of the impacts will depend on the construction method and safety practices adopted by the Contractor(s).

7.1 Positive impacts and their enhancement

Rebuilding the Mudeirej Bridge will generate a number of positive impacts on local communities and Lebanon in general. The Project will:

1. Rebuild the "tallest bridge in the Middle East"
2. Restore traffic on the Bridge and improve environmental conditions in Sofar
3. Reduce accidents and travel time
4. Create jobs and economic activities (during construction)

7.1.1 Rebuild the "Tallest Bridge in the Middle East"

Before the Mudeirej Bridge was built in 1998, cars used the Old Damascus Road to travel from Beirut to Chtaura (in the Bekaa Valley). After the bridge was built, it quickly became the easiest and fastest road linking the capital to the Bekaa Valley, easing traffic on the Old Damascus Road. When the Bridge was hit during the war and put out of service, the conditions that prevailed before 1998 were reinstated. Rebuilding the Mudeirej Bridge therefore will restore the expressway to its original condition (before the war of July 2006). The Bridge will gradually resume its function; the North span will be repaired by the end of 2007 and reopened to traffic (either one-way to two-ways), and the South span will be rebuilt by mid 2009 and reopened to southbound traffic (from Beirut to Chtoura). By the end of the Project, the "Tallest Bridge in the Middle East" will be standing once again.

7.1.2 Restoring the traffic on the Bridge will improve environmental conditions in Sofar

When the bridge was put out of service in July 2006, all traffic between Beirut and Chtoura was rerouted to the Old Damascus Road. Increased traffic poses an environmental hazard to local residents and shopkeepers on both sides of the road (noise, particulate matter from exhausts and accidents). Reckless honking is disturbing local residents, especially at night. When the Project rebuilds the Mudeirej Bridge and restores traffic to it, the number of vehicles on the Old Damascus Road (through Sofar) will decline drastically. Noise and air pollution in Sofar will significantly decrease.

7.1.3 Reduce accidents and travel time

The Mudeirej Bridge was designed and built with the highest safety standards (traffic barriers, safety barrier, fence, road marking). When traffic is restored on the Bridge, accidents occurring on the Old Damascus Road will be mitigated as there are no shops or exits/entries on the highway north and south of the Bridge. Although the distance from Sofar to Mudeirej using the Old Damscus Road versus the Bridge is almost equal (about 3.5 km when using the bridge and 5 km when using the Old Damascus Road), the Bridge reduces travel time between these two points from 5 mn (using the bridge) compared to 10 mn (using the Old Damascus Road).

7.1.4 Create jobs and economic activities during reconstruction

The Project will, at its peak, need up to 150 workers. To the extent possible/available, most of these workers will be hired locally in an effort to benefit local communities (see estimate number of skilled workers/technicians needed for the Project in **Table 8**).

Table 8
Breakdown of Local to Foreign Workers by Work Category [a]

Contractor	*Category*	*Local*	*Foreign*
Contrack International, Inc.	Engineers	2	4
	Administration	3	-
	Drivers	2	-
MAN (subcontractor)	Engineers	11	-
	Skilled Labors	7	-
	Non skilled Labors	-	16
TOTAL		**25**	**20**

a/ As of August 2007

Moreover, USAID is committed to buying more than 70 percent of construction materials locally (from Lebanon or through Lebanese suppliers). Since this is a $30 million project, it is reasonable to conclude that a sizeable amount of that budget will be spent in Lebanon and benefit the local economy (see source/origin of selected construction materials in **Table 9**).

Table 9
Source of Construction Materials

Description	*Source*	*Country*
Bituminous Construction	EMSB-JALKH ET FILS	Lebanon
Marking	GUBELLA-VIA, LIBAN	Lebanon
Studs	GUBELLA-VIA, LIBAN	Lebanon
Concrete Components	TBD	
Cement	Sabba/Chekka	Lebanon
Aggregate	Fattouch/Bekaa	Lebanon
Sand	Beirut	Lebanon
Water	Ain Dara	Lebanon
Prestressing Cables	TBD	
Steel Reinforcement	Demco/Yared	Lebanon

See full list of construction materials in Appendix D.

7.2 Potential adverse impacts during demolition

Demolition may have the following potential adverse impacts on the environment:

1. Damage to road infrastructure (mainly in Ain Dara)
2. Deterioration of air quality
3. Noise
4. Effect on surface water hydrology
5. Occupational accidents

7.2.1 Physical damage to Ain Dara road

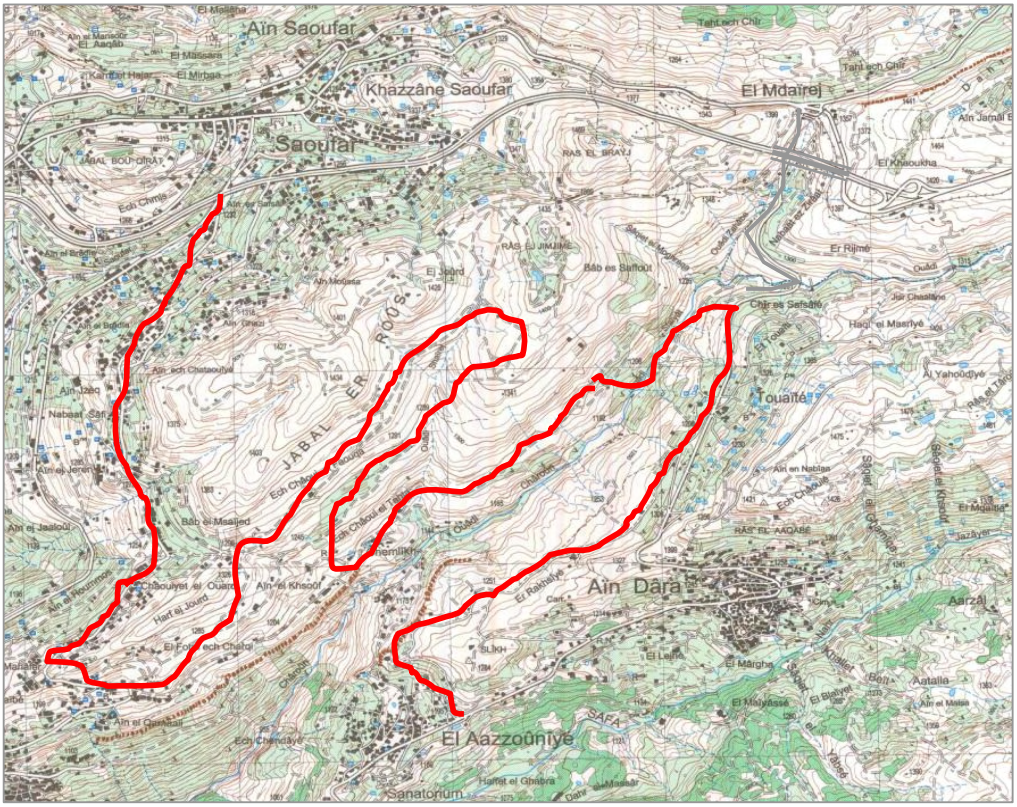
Brining down the south span will damage the Ain Dara Road (located directly under the bridge) and put it out of service for 2 to 3 days. Demolition will also damage electricity poles located immediately under the bridge.

Mitigation: The duration of the closure of the Ain Dara road will depend on the demolition method adopted; blasting will necessitate shorter period of closure than jack-hammering (jack hammering is a very slow demolition process that will require more time and lead to longer closure period). In the case of blasting the Contractor should:

- Apply a 1.5 m layer of sand to protect the road below the bridge
- Close traffic on the Old Damascus Road from 30 minutes before the implosion to 30 minutes after the implosion (one hour)

During the period of closure, CDR and the Project contractors must provide an alternative road from Mudeirej to Ain Dara (see proposed diversion in **Figure 8**). Working with CDR, the Project must install proper signage to divert vehicles to the substitute road connecting Sofar to Ain Dara. The regular road from the hospital of Ain Dara to the brige necessitates 5 mn, with the diversion through Soufar, it will take 12 mn.

Figure 8
Map showing proposed diversion during closure of Ain Dara road



*In **Yellow**; the Mudeirej Bridge, in **Black**: the road from Mudeirej to Ain Dara that will be closed during the demolition phase, and in **Red**: the proposed diversion from Sofar to Ain Dara (and El Aazzouniye)*

7.2.2 Deterioration of air quality

Blasting the South span will generate a plume of smoke for 20 to 40 minutes. The concentration of dust will depend on the method used to demolish the South span. Blasting will generate a lot of dust for a short period of time at implosion; while jack hammering will generate a small amount of dust over a longer period of time. Hauling the rubble offsite will also generate dust:

1. At the loading site (below the bridge),
2. On the roads leading to the disposal site, and
3. At the disposal site (near Ain Dara).

Mitigation: Regardless of the demolition method used, it is important to contain the dust. In the case of jack hammering, workers must wear goggles and masks to minimize dust inhalation. In the case of blasting, the Contractor should:

- Setup a 200-meter safety perimeter (called restricted area) measured from the boundaries of the bridge to keep people and workers a safe distance away from where the south span will fall
- Choose a day/time of the day when wind conditions are calm and relative humidity is high (damp air)
- Mobilize a sufficient number of truck-mounted water canons to spray water at implosion to contain the dust and prevent dispersion

To minimize dust during hauling operations, the Contractor should:

- Make sure that all dump trucks leaving the site are adequately covered
- Wash the wheels of the trucks before leaving the site
- Sweep the road that leads from the site to the disposal area and remove debris, if any

7.2.3 Noise pollution

Exposure to noise can damage ears cumulatively and irreversibly. The three things to consider about noise are: How loud? How long? How close? Blasting will generate a loud noise for about 6 to 10 seconds at about 127 decibels (glass breaks at 160 decibels, the sound pressure of a Boeing 747 at take-off is about 140 decibels, and a NASA space shuttle at lift-off is around 200 decibels). Jack hammering will produce noise levels of 130 decibels over a prolonged period of time; trucks hauling waste offsite will produce noise levels of about 90 decibels.[1] It is important to note that an increase of six decibels equals a doubling of noise produced (e.g., a noise level of 96 decibels is twice as harmful as a noise level of 90 decibels). **Prolonged exposure to noise levels above 90 decibels can cause gradual hearing loss.**

Mitigation: Hearing loss can be prevented by:

- Increasing the separation distance between the worker and the noise source,
- Decreasing the exposure time to the noise source, and
- Using personal protective equipment.

[1] Source: OSHA Safety Manual, 29 CFR 1926.101 Also, it is customary to mention decibels "at a certain distance from the source" – please check!

In the case of blasting, CDR and CII must communicate the exact time of blasting to surrounding municipalities at least one week prior to blasting. At least one hour before blasting, a designated team (Lebanese Army, CII, and CDR) must inspect the area inside the safety perimeter to make sure that the perimeter has been totally vacated.

In the case of jack hammering, workers should wear ear protectors at all times.

7.2.4 Effect on surface water hydrology

Demolition will produce a plume of smoke that will deposit on the ground and could affect springs located downwind. Dust may cause turbidity in the water for a short period of time. Spring water could also be affected by the disposal of hazardous waste; the Project is not expected to handle any hazardous material other than bitumen (for road surfacing), fuel for power generators and lead acid batteries for miscellaneous engines and generators.

Mitigation: The Contractor should:

- Use water-canons to contain the plume during blasting
- Remove and handle rubble disposal swiftly
- Handle all waste generated on site swiftly (designated storage area, safe disposal off-site)

7.2.5 Hauling and disposal of demolition waste

Demolition waste will include concrete, twisted steel bars, bitumen (from road surfacing) and PVC drainage pipes (running down the piers). The Contractor has already selected a site for the disposal of demolition waste and obtained the approval of the Municipality of Ain Dara (See Appendix E). The site is located approximately 2 km south of the bridge, on municipal land, near the village of Ain Dara (see location in **Figure 9**).

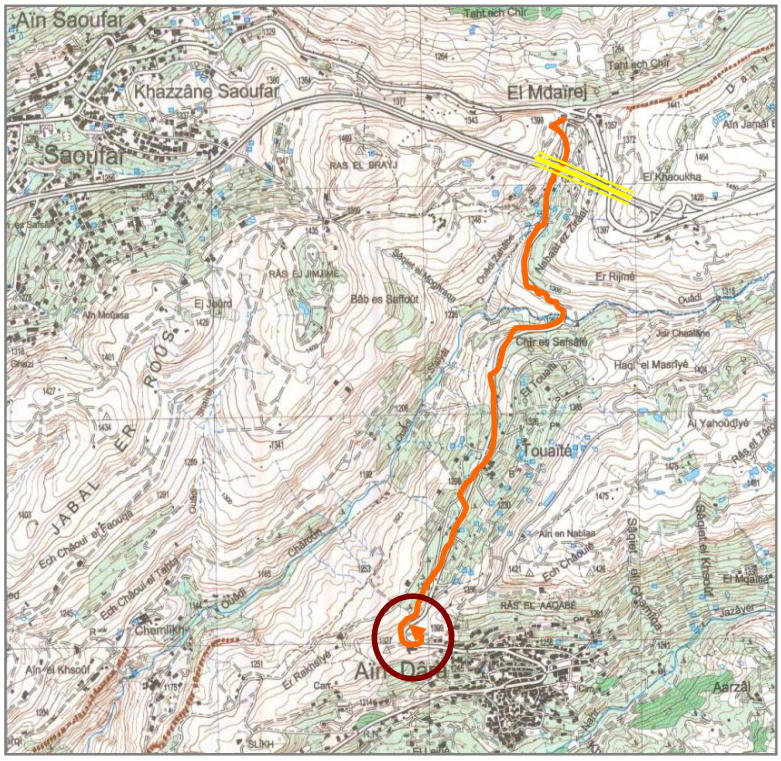


Figure 9
Approved location for disposal of demolition waste

The Contractor must develop and implement a **demolition waste hauling plan** specifying:

1. Location of the disposal site
2. Hauling route
3. Hauling schedule, number of trips per day and hauling period

Photo 12: Proposed rubble disposal site near Ain Dara

7.2.6 Occupational accidents

The south span will collapse near Mobilization Area #2. Free falling debris can injure workers. Moreover, explosives that have not detonated during blasting can lead to severe injury if not handled properly.

Mitigation:

To limit occupational accidents linked to the use of explosives, the Contractor in close coordination with Lebanese security authorities must:

- Transport the explosives (about 700 kg) to the site by military escort
- After blasting, inspect the site below the bridge (incl. the rubble) to make sure that there are no remaining explosives
- Transport any remaining explosives (that have not detonated) offsite by military escort

Additionally, the Contractor must take all engineering precautions to ensure the safety of workers during demolition of the (i) damaged deck on the North span and (ii) the damaged piers/plinths on the South span (see photos 13, 14, 15, 16 and 17).

Photo 13: Safety harnesses during demolition of damaged deck on north span

Photo 14 and 15: Demolition of piers on South span (courtesy: USAID Reconstruction Team)

Photo 16 & 17: Safety girder on north span for attaching harnesses

7.3 Potential adverse impacts during construction

Construction may have potential adverse impacts on the environment, such as:

1. Air quality deterioration
2. Noise pollution
3. Road diversions
4. Pressure on natural resources
5. Pressure on water resources and hydrogeology
6. Landslides
7. Generation of construction waste
8. Handling hazardous material and waste
9. Transportation of construction material
10. Occupational accidents

7.3.1 Air quality deterioration

Construction will generate insignificant amounts of dust that may nevertheless affect air quality on the site and a short distance downwind. Exhaust from four power generators on-site will also affect air quality in the immediate vicinity.

Mitigation: Workers must wear protective clothes at all times and masks when necessary to minimize inhalation of particular matter. Power generators must be retrofitted with scrubbers and should be inspected regularly to optimize performance (and reduce emissions).

7.3.2 Noise pollution

Noise pollution will stem from power generators, transport trucks and the operation of heavy machinery on-site. Noise from construction activities is not expected to affect nearby residents because there are no residential units near the site. The *cumulative* impact of trucks on the Old Damascus Road (noise and dust) is expected to be minimal as the road is already heavily used by trucks.

Mitigation:

Site workers must wear ear protectors when the feature of work involves high noise levels. According to OSHA, the limit value for noise exposure over an eight-hour period is 90 decibels.

7.3.3 Road diversions

Construction will not require any new road diversion other than a prolongation of the diversions that were instated by CDR before the Project. Therefore, swift Project implementation will reduce the duration of the existing diversion and associated traffic.

7.3.4 Pressure on Natural Resources

Rebuilding the Mudeirej Bridge will require an appreciable amount of aggregates, ready-mix cement and water. The aggregates will come from Lebanon and therefore inevitably exert pressure on local resources.

Mitigation:

To the extent possible, the Contractor (and relevant subcontractors) must:

- Acquire aggregates from designated quarry zones (see Section 4.1.2)
- Use a ticketing system to track the source of the aggregates delivered to the site
- Disclose upfront the amount of aggregates needed to complete the Project

7.3.5 Water resources and hydrogeology

Based on the Hydrogeological survey conducted by the ECODIT EA team, construction will not affect surface and groundwater resources if:

- Potentially hazardous materials (fuel, bitumen) are handled and stored safely
- Potentially hazardous waste (lead acid batteries) are stored in a dedicated location, far from the springs

Two minor springs are located south of the bridge at a distance of less than 300m. Their source area is located south of the bridge piers and spans. A third spring is located further south from the bridge at a distance of approximately 450 m. The site is therefore not located inside the catchment area of any major spring.

Mobilization Area #1 and #2 will generate wastewater and WCs. These units are equipped with septic tanks. It is important to maintain these septic tanks as they need to be emptied weekly and sanitized to prevent the occurrence of bacteria.

7.3.6 Landslides

Construction activities can affect the soil and potentially lead to landslides. Landslides, if any, will affect the overlying vegetation and could disturb the natural drainage regime. Landslides also degrade the landscape.

Mitigation:

The Contractor must conduct a topographic survey of the Project area. The survey should include photos of the site prior to the Project and a plan showing the final topographic profile of the site after construction. To minimize soil erosion and gully formation, the Contractor must ensure adequate drainage immediately below the bridge area. Slopes prone to landslides or differential settlement (see for example photo near Pier 3) must be protected using anchored nets or bioengineering techniques to increase stability and prevent detachment.

7.3.7 Generation of construction waste

Construction waste includes plywood, screws, concrete, garbage from offices, etc. Improper disposal of solid waste will degrade the environment. Rain can displace loose material and lead to obstruction of waterways. Also, water used to rinse the trucks carrying ready-mix concrete will dry forming concrete cakes that choke vegetation and obstruct growth.

Mitigation:

The Contractor must prepare and implement a waste disposal plan. Construction waste should be hauled to an approved disposal site. The Contractor should designate a location for concrete mixers to wash their trucks; washing can also occur at the batch plant (Redland). Some of the waste (rinse water from concrete mixers) can be used to back fill / stabilize the top soil under the bridge.

Photo 18: Close-up of anchored nets

Photo 19: Unstable ground near Pier 3

7.3.8 Handling hazardous material and waste

Inappropriate disposal of hazardous waste can contaminate surface and groundwater resources. Mishandling hazardous waste can also affect workers' health.

Mitigation:

The Contractor should avoid handling hazardous material during construction. If hazardous materials are used (paint, batteries, bitumen) then workers should be trained on how to handle the material and implement health and safety regulations. The Contractor must also install an eye wash station on-site in case of ocular accidents (see photos 20, 21).

Photo 20: Eyewash station

Photo 21: First aid kit

7.3.9 Transportation of construction material

The Project will require large quantities of materials and equipment that will reach the site by trucks. It is the responsibility of the Contractor to ensure that trucks:

- Are properly loaded and covered during transport
- Respect applicable schedules of circulation on public roads
- Respect speed limits and road regulation.

7.3.10 Occupational Accidents

One of the most critical objectives of Project performance is the occupational safety of workers. The Project is complex, requires the use of sophisticated equipment, and offers a challenging/dangerous work environment sometimes 70 meters above ground. Accidents can be fatal or lead to permanent disability. For this Project, the Contractor will follow the US Army Corps of Engineers Health and Safety Manual (EM 385-1-1) and OSHA safety guidelines for construction works (see overview in **Box 1** and contents in **Appendix F**).

Mitigation:

The Contractor should:

- Hold **periodic meetings** with site workers to explain the occupational risks involved with each "feature of work" and explain corresponding safety measures
- Provide optional **CPR training** for Project staff
- Enforce safety regulations and make sure that workers wear **protective clothing and safety equipment** including safety goggles, steel boots or rubber shoes (depending on feature of work), hard hats, safety harnesses, dust mask, ear plugs/muffs, and gloves. CDR and USAID should conduct **spot checks** on site and take corrective measures in case workers are in non-compliance.

Additional prevention measures include:

- Stop work during windy/stormy weather conditions (according to OSHA regulations, workers should **stop work** when wind speeds exceed 25 mph)
- Implement additional safety measures when temperatures fall below zero degrees Celsius (such as appropriate clothing and fur-lined gloves)

Box 1
Overview of EM385-1-1 and OSHA Safety Manuals

EM385-1-1 Health and Safety Manual

This manual prescribes the safety and health requirements for all Corps of Engineers activities and operations. It applies to Headquarters, US Army Corps of Engineers elements, major subordinate commands, districts, centers, laboratories, and field operating activities, as well as Naval Facilities Engineering Command contracts. Applicability extends to occupational exposure for missions under the command of the Chief of Engineers, whether accomplished by military, civilian, or contractor personnel.

Some of the technical requirements of this manual may not always be applicable to overseas activities due to conflicting circumstances, practices, and laws or regulations of the locality or the unavailability of equipment. In such instances, means other than the ones specified in this manual may be used to achieve the required protection.

The most recent edition of the manual should be used:
http://www.usace.army.mil/publications/eng-manuals/em385-1-1/toc.htm

OSHA Safety manual

OSHA Compliance Safety and Health Officers use the OTM as a reference for technical information on occupational safety and health issues. The manual consists of 10 sections: Section #5 is on construction operations and has three chapters:

1. Demolition
2. Hazard recognition in trenching and shoring
3. Controlling Lead Exposures in the Construction Industry: Engineering and Work Practice Controls

7.4 Potential adverse impacts associated during operations

Consistent with the Scoping Statement, this EA report did not analyze potential impacts during bridge operation because those impacts, if any, existed before the Project.

7.5 Risks to the bridge structure, its operation and their mitigation

The Project will restore the bridge as it was before July 2006. Safety and quality are the most critical design considerations. In particular:

- The life span of the bridge is 75 years
- The bridge will be repaired with a quake withstanding capacity of 0.35 g (the Lebanese norm for bridges is 0.2 g)
- Each span will consist of a traffic barrier, a pedestrian barrier and a protection fence on its outside edges and a median barrier in concrete on the inside edge (see photo 22).

Photo 22: Security fence, pedestrian barrier and guard rail on north Span (Section not affected by the war)

8. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The Environmental Management and Monitoring Plan (EMMP) is a tool to implement the proposed mitigation measures and minimize potential adverse impacts. The EMMP summary table at the end of this section (**Table 10** consolidates all the mitigation measures presented in Chapter 7 (Assessment of Impacts and Mitigation), allocates responsibility for their implementation and specifies the timing required for implementation and/or the frequency required for monitoring. This summary table should be revisited and updated regularly by USAID, CDR, the Contractor, and local municipalities. The following sections describe in more detail relevant aspects of environmental monitoring requirements.

8.1 Monitoring requirements

The Contractor should monitor the following parameters during Project implementation:

- Temperature
- Health and safety measures
- Source of construction material
- Waste storage and disposal
- Haulage and disposal of demolition waste

Table 10
Summary of Monitoring Requirements

Parameter	*Location*	*Samples*	*Frequency*	*Responsibility*
Temperature	On site	Thermometer, wind station	Before blasting and during the winter season	Contractor
Health and safety	On site	Visual inspection	Daily and during all "features of work"	Contractor (spot inspection by CDR)
Source of construction material	Before delivery to site and on site	Ticketing system	At every delivery	Contractor & the Ministry of Environment
Waste storage and disposal	On site/ off site	Visual inspection	Daily	Contractor
Haulage and disposal of demolition	Designated site	Visual inspection	During demolition phase	Contractor & the Municipality of Ain Dara

8.2 Emergency response plan

The Project site is equipped with a first-aid station and one full-time nurse who can handle small injuries occurring on site (according to OSHA, construction sites with more than 250 workers would require a full-size clinic). The Contractor (CII) has signed an agreement with the nearest hospital (Hemlin) located in Hammana, only seven (7) minutes from the site. According to the Agreement, and in case of accident, Hemlin Hospital will dispatch a fully-equipped ambulance to the site within minutes (see agreement in **Appendix G**).

Table 11
Environmental Monitoring and Management Plan Summary Table

Section	*Potential impact*	*Mitigation Measure*	*Responsibility*
	A. During Demolition		
7.2.1	Physical damage to Ain Dara road	• Minimize period of road closure • Identify alternative road and seek approvals • Install signage to indicate diversion	• CDR • Contractor(s)
7.2.3	Noise pollution	<u>In the case of blasting:</u> • Communicate exact time of blasting • Inspect area prior to blasting • Wear ear plugs/muffs when handling jackhammers	• Project team • CDR • Lebanese army • Municipality of Ain Dara
7.2.2	Deterioration of air quality	<u>If jackhammer is used:</u> • Wear goggles and masks <u>If blasting is used:</u> • Choose a day with calm wind conditions and high relative humidity • Spray water immediately upon implosion	• Contractor(s) • Lebanese Army and Interior Security Forces • Civil defense (for water cannons)
7.2.4	Effect on surface water hydrology	• Inspect the springs south of the bridge after blasting • Avoid using hazardous materials • Proper handling and dispose of solid waste	• Contractor (s)
7.2.5	Hauling and disposal of demolition waste	<u>Implement a demolition waste hauling plan specifying:</u> • Location of disposal site • Hauling route • Hauling schedule, number of trips per day, hauling period	• Contractor(s) • Municipalities
7.2.6	Occupational accidents	<u>North span demolition (one deck only):</u> • Build a double security perimeter below the bridge <u>South span demolition (entire bridge):</u> • Transport the explosives by military escort • Setup a 200-meter safety perimeter all around the bridge; inspect the site to make sure there are no remaining explosives • Transport remaining explosives offsite by military escort	• Lebanese Army (Engineering Regiment) and Internal Security Forces • CDR • Contractor(s)

Section	*Potential impact*	*Mitigation Measure*	*Responsibility*
	B. During Construction		
7.3.1	Air quality deterioration	• Wear protective clothes and masks • Inspect power generators and retrofit with scrubbers	• Contractor(s) • Health and safety manual editors
7.3.2	Noise pollution	• Wear ear protectors • Do not exceed 8 working hours at 90 dB	• Contractor(s) • Health and safety manual editors
7.3.3	Road diversions	• Speedy project implementation	• Contractor(s) • CDR • Municipalities
7.3.4	Pressure on natural resources	• Acquire aggregates from designated quarry zones • Use a ticketing system to track the source of the aggregates to the site • Disclose upfront the amount of aggregates needed to complete the project	• Contractor(s) • MoE
7.3.5	Water resources and hydrogeology	• Safely handle and store Potentially hazardous materials (fuel, bitumen) • Store lead acid batteries in a dedicated location, far from the springs	• Contractor(s)
7.3.6	Landslides	• Conduct a topographic survey of the project area • Insure adequate drainage to minimize soil erosion • Use anchored nets to prevent detachment of soil particles	• Contractor(s) • Municipalities
7.3.7	Generation of construction waste	• Follow a waste disposal plan • Designate and approve a dumping site • Use a part of waste to sanitize the area under the bridge • Designate an area to wash concrete mixers	• Contractor(s) • MoE • Municipality of Ain Dara
7.3.8	Handling hazardous material and waste	• Minimize the use of hazardous waste • Train workers on how to handle the material • Properly follow health and safety manuals on hazardous waste • Install an eye wash station	• Contractor(s)
7.3.9	Transportation of construction material	• Properly follow truck regulations (schedule, time, loading, covering) • Use a tracking system to verify the source of material used in reconstruction	• Contractor(s) • Municipalities • Ministry of transport
7.3.10	Occupational accidents	• Hold periodic meetings about health and safety for workers • Provide CPR trainings for interested staff. • Wear safety equipment and protective clothing • Conduct spot checks on site • Stop work during windy/ stormy weather • Additional security measures when temperatures are below zero	• Contractor(s) • Regulations (safety manuals) • CDR • USAID

9. SUMMARY AND CONCLUSIONS

The reconstruction of the Mudeirej Bridge will entail several positive impacts. The overall net impact of the project on the environment in the wider study area will be positive.

9.1 Positive Impacts

The most significant positive impacts of the Project are:

1. Rebuild the "tallest bridge in the Middle East"
2. Restore traffic on the Bridge and improve environmental conditions in Sofar
3. Reduce accidents and travel time
4. Create jobs and economic activities (during construction)

The project may have a positive effect on forthcoming reconstruction projects in the area.

9.2 Potential Adverse Impacts and their Mitigation

Despite the overall net environmental benefit expected from the Project, potential adverse impacts, mostly limited to the area immediately surrounding the bridge, have been comprehensively identified and assessed. **All of the potential adverse impacts can be minimized and considered insignificant on condition of implementing the EMMP**. The EMMP must be continuously revisited by the project team, contractor, local municipalities and other concerned stakeholders to ensure it is being implemented, remains up to date and is adjusted where and when necessary.

9.2.1 <u>During demolition</u>

Potential adverse impacts during demolition include:

- Physical damage to Ain Dara road (significant if not mitigated and temporary road diversion required)
- Deterioration of air quality mainly from smoke plume during blasting (moderate, especially if water cannons are used to suppress the plume)
- Noise pollution mainly from trucks and blasting (insignificant)
- Effect on surface water hydrology (insignificant)
- Occupational accidents (significant unless strict safety measures are enforced)

9.2.2 <u>During construction</u>

Potential adverse impacts during construction include:

- Air quality deterioration (insignificant)
- Noise pollution (insignificant)
- Road diversion (no new diversion required)
- Pressure on natural resources / construction aggregates (Lebanese legislation requires public infrastructure projects to obtain aggregates from designated quarry zones only – this is potentially a very contested issue involved conflicting institutional mandates)
- Pressure on water resources and hydrogeology (insignificant)

- Landslides (potentially significant if soil stabilization measures are not implemented at key locations near the bridge)
- Generation of construction waste (insignificant provided storage and disposal are safe)
- Handling hazardous material and waste (insignificant provided workers are informed)
- Transportation of construction material (insignificant in relation to cumulative impact on Old Damascus Road)
- Occupational accidents (potentially significant unless strict safety measures are implemented)

Implementing the proposed mitigation measures will significantly reduce the occurrence and significance of residual adverse impacts during demolition and construction. The most pertinent mitigation measures include **adequate coordination** between the Contractor and Lebanese counterpart institutions including CDR, Lebanese Army and ISF; **careful planning of each feature of work**; mobilizing sufficient capacity to **contain the smoke plume** during blasting; **strict implementation** of relevant OSHA and EM health & safety requirements for construction sites; and **proper handling and disposal** of demolition and construction wastes.

Potential risks of erosion have also been considered and appropriate mitigations proposed.

9.3 Environmental Management and Monitoring plan

A detailed Environmental Management and Monitoring Plan (EMMP) was developed to serve as tool for environmental monitoring. It presents all the proposed mitigation measures, by Project phase and by impact, and proposes responsibilities for implementation and monitoring. Implementation of the EMMP will ensure all impacts are managed to ensure minimal potential adverse impacts and maximum enhancement of positive impacts. The EMMP will need to be revisited on a regular basis to ensure it remains up to date, addresses emerging issues and remains as effective as possible.

The project contractor will use this EMMP as a basis for incorporating various mitigation measures and responsibilities into one or more of the following binding project documents:

- Blasting plan
- Supply of construction material
- Waste disposal plan
- Health and safety protocol