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REPUBLIC OF LEBANON
MINISTRY OF PUBLIC WORKS
GENERAL DIRECTORATE OF URBAN PLANNING

NATIONWIDE STUDY OF QUARRIES

VOLUME 1

MAIN REPORT

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1. CONTEXT

There is a strong historical tradition of quarrying in Lebanon which can be traced back to early history. The requirements of the national recovery programme will ensure there is a high demand for quarried material for the foreseeable future and this can be met from the rich deposits of rock available within the country, however, strengthened control over the operation will be necessary to prevent further damage to the environment.

2. THE NATIONWIDE SURVEY OF QUARRIES

A survey was carried out as a major part of the study to establish a data base using official records provided by Government and field data obtained by site visits and interviews.

2.1 Review of Official Records

Initially the records indicated there were some 1800 quarries in the country. Analysis of these figures identified significant amounts of duplication and inaccuracies which when resolved showed there were about 710 operational quarries in Lebanon and these are shown below by area.

Total Number of Operational Quarries - Official Records

Muhafaza	Caza	No. of operational Quarries				Total in Muhafaza
		BS	Rock	Sand	Total	(including abandoned)
Bekaa	Baalbek	19	15	0	34	
	W. Bekaa	14	14	1	29	
	Zahleh	0	56	2	58	
		33	85	3	121	123
Mount Lebanon	Aaley	5	30	41	76	
	Baabda	3	5	9	17	
	Chouf	0	17	18	35	
	Jbail	4	14	31	49	
	Kesrouane	5	9	19	33	
	Maten	0	22	8	30	
		17	97	126	240	367
North Lebanon	Akkar	0	12	12	24	
	Batroun	18	30	8	56	
	Besharri	2	3	12	17	
	Koura	0	9	0	9	
	Tripoli	0	8	0	8	
	Zghorta	0	10	0	10	
		18	72	32	124	154
South Lebanon	Bin Jbail	1	4	1	6	
	Hasbaya	0	0	2	2	
	Jizzine	1	0	9	10	
	Marjayoun	0	0	1	1	
	Nabatieh	0	10	0	10	
	Rashaya	0	1	14	15	
	Saida	0	3	0	3	
	Sour	0	17	1	18	
		2	35	28	65	66
Total						710

3. IDENTIFICATION OF MAIN ISSUES

Information from the survey indicates that there are a number of problems which require resolution before the quarrying industry can become sustainable and have a degree of acceptance in the public domain. The issues identified by the study fall into three categories:

(i) Legal and Administrative
(ii) Technical and Operational
(iii) Environmental

3.1 Legal and Administrative

At present there are a number of ways of obtaining a license to quarry and this is causing some confusion and requires clarification. The law regarding the extraction of minerals needs to be clearly defined and fully enforced and a single authority should be responsible for quarry licenses. The responsibilities of the appointed administration in determining any license application should be clearly outlined.

An application for a quarrying licence should be uniform and consistent regardless of the applicant or the location of the quarry. The applicant should provide comprehensive details of his proposal sufficient to allow a complete technical assessment of its geological implications, operational qualities and environmental effects, including the use of crushers. A standard application form should be prepared and only applications submitted in the correct format should be regarded as acceptable. The form could include details of

- The geographical location of the proposed quarry.
- The proposed development including any phasing arrangements.
- The proposed method of operation.
- Site layout including the location of buildings, equipment and plant.
- Access arrangements including the layout of any junction with a government road.
- Anticipated traffic movements.
- Amount and type of rock to be extracted.
- Anticipated environmental effects.
- Methods to be used to control environmental effects.
- Rehabilitation or site restoration.

This information could be supplemented by detailed plans and graphic information to enable a full understanding of the processes to be undertaken during the development. It is always in the interests of the developer to clearly explain and describe his proposals.

- The establishment of locational priorities and the identification of areas where quarrying would not normally be permitted.

- Standards defining the design of suitable road access.

- Estimates of annual production, reserves and life span of the quarry.

- Geological guidelines for quarry development particularly safe methods of quarrying.

- Minimum acceptable site sizes.

- Minimum acceptable distances from other activities, land uses and features of interest.

- Site layout and location of crushers, graders, stockpiles and other activities.

- Methods of dust suppression.

- Methods of noise control.

- Schemes for temporary landscaping and the disposal of quarry wastes.

- The use and control of explosives.

- Schemes of restoration, quarry reclamation and after uses.

- Safety programmes and medical facilities.

(iii) Abandoned Quarries:

Further studies are needed to assess the individual problems and opportunities of such quarries and the extent of remedial actions needed. These include:

- Assessments of pollution hazard and risk.

- Geological stability and safety.

- Security of the site and assessment of danger to the public.

- Building condition and appearance.

- Location, quantities, type and appearance of quarry waste.

- Effects on the landscape.

- Economic potential and possible after uses.

within the Jurassic outcrops of the Jebel El Barouk, and in the East , they are located within the Upper Eocene reefal limestone outcropping in Sohmor-Kamed El Laouz syncline.

4.4 Western Slopes of Anti-Lebanon and Hermon

This area is limited by the international borders between Lebanon and Syria , from the South by a line parallel to Hasbaya, and from the West by a line separating the western edge of Anti-Lebanon from the Bekaa plain. It covers the western slopes of Anti-Lebanon in the North and the western slopes of Hermon and has been divided in two zones A and B. Zone A starts from the north Libano-Syrian boundary and extends to the international BEIRUT-DAMASCUS road in the South. It is divided into two subzones; the first one represents the northern part, and begins at the northern boundary of the zone ending at Wadi Jerban 5 Km south of Baalbek. There are three areas of potential reserves including the Aarsal region located within the C4. The upper C4 and C5 occurring on the western slopes of the Choeri, and the Upper Eocene limestone occurring in the Anti-Lebanon opposite to the region of Baalbek . The second subzone represents the southern part of the zone and contains two areas with the same formations already described above. Zone B is the continuation of zone A to the South, and contains three areas of potential reserves, area No 1 within the Upper Eocene limestone occurring on the slopes of a hilly region on the edge of Bekaa plain. Areas No.2 and 4 within the Upper C4 and C5 outcrops which form a part of the Hermon . Area No. 3 which covers the Jurassic massifs of the Hermon western slopes.

4.5 Other Areas

Notwithstanding the above delineation of potential quarry areas, it is to be noted that almost all wadis have a substantial potential for quarrying if environmental and urban considerations are satisfied.

1. CONTEXT

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1.1 General Introduction

There is an extensive historical tradition of quarrying in Lebanon dating from Neolithic times. Archeological evidence of structures incorporating locally quarried materials is found in a variety of locations across the country, and the monumental structures of Baalbeck, Tyre, Byblos and elsewhere contain the durable limestone rocks available in their localities. Quarrying practices were initially small scale and primitive having little adverse effect on the environment. Changing needs and the growing demands of the construction industry have increased the scale of these activities with significant and often serious consequences for the environment. Rapid population growth has led to increased demands for construction materials and encouraged an increase in the number of operating quarries. The wide use of stone in the construction process for such essential items as cement, aggregates, foundations, wearing surfaces and building stone is likely to maintain this demand well into the future. During the civil war quarrying activities were generally unregulated and supplied local rather than national needs. The confused conditions and overproduction resulted in a chaotic proliferation of quarries throughout the country many with extensive and elevated working faces which are clearly visible over wide areas. Present quarrying activities are dominated by the excavation of stone for concrete and asphalt aggregate and marly limestone for cement manufacture. The rapid pace of the reconstruction programme with its large number of major projects requiring significant amounts of construction material will create a considerable medium term demand for quarried rock, sand and their associated products. There is at present a proven need for increasing amounts of construction materials to maintain and support the recovery programme, but the survey work has highlighted the damage caused by uncontrolled quarrying. There is a need for compromise and balance in determining the future of quarrying in Lebanon.

1.2 Regional Geology

The Lebanon forms part of the East African Rift structure, that runs through the Red Sea, The Dead Sea, Lake Tebarius, through Lebanon and Syria, finally being caught up in the Taurus mountains tectonics in Turkey. This rift structure may be considered generally as a Horst and Graben type, which in the Lebanon trends in a NNE-SSW direction. It divides the country into four geological and geomorphological units: the two horsts forming two mountain chains, the Lebanon to the west and the Anti Lebanon to the east, between them is the Bekaa valley and on the west side of the Lebanon chain is the coastal plain.

1.3 Structural Geology

The main structural features are the graben faults. The western side - the Yammoune fault-is clearly defined and still active being the origin of many of the earthquakes in the Lebanon while the eastern side may be considered more of a less clearly defined fault zone and not as active as the Yammoune fault. Later normal faulting has tended to divide the mountain ranges into blocks, with associated tilting.

Table 1.1 - Description of Geological Units

Geological Unit	Age	Symbol	Stratigraphical Column	Description	Thick-ness	Fossils	Special Features
JURASSIC							
Kserouan Limestone	Lias ?	j_4		Crystalline, grey with brownish tint in colour, highly fissured dolomitic LIMESTONE with white veins of quartz. Variable grain size from fine to coarse depending on the degree of diagenesis. Chemically deposited. Saccaroidal texture. High content of algae showing drop-like patches on fracture surfaces. Some silicified corals.	1000 m Type section Kserouan	Corals and Algae	Jeita cave. By weathering forms sand of dolomite crystals on the mountain side along Mashnaqa - Qartaba road. Lowest and oldest formation in Lebanon
Bhannes Volcanics or Equivalent	Dogger ?	j_5		Volcanics: Black BASALT or pillow lava, not vesicular. Equivalent: Bluish clastic LIMESTONE, weathers to creamish, usually intercalated with soft bluish shale (0.5 to > 1 m thick)	20-30 m 80-85 m Type section Bhannes	echinoderms	
Bikfaya Limestone		j_6		Finely crystalline, massive, cliffy LIMESTONE including brown chert nodules, trace to abundant. Smooth fresh fracture. Chemically deposited.	60-65 m Type section Bikfaya		Limestone full of chert nodules on the road side, Baabdat - Arbanieh.
Salima Limestone	Malm ?	j_7		Composed of: Chocolate brown SHALE and bluish MARL, in parts intercalated with thick oolitic LIMESTONE bed. The marl weathers to a creamish, ochre colour	0 to few meters to 150 m Type section Salima	Crinoids	

Table 1.1 - (Cont'd)

Geological Unit	Age	Symbol	Stratigraphical Column	Description	Thick-ness	Fossils	Special Features
CRETACEOUS (Cont'd)							
Sannine Limestone	Cenomanian	C_{4a}		Dolomitic LIMESTONE	300 m	Ammonites and fish fossils. Fish fossils found particularly at Maameltain, Hjoula and Hakel	Qadisha, Afqa and Rachmaiya caves.
		C_{4b}		Bluish MARL and SHALE	80-100 m		
		C_{4c}		LIMESTONE and dolomitic LIMESTONE	300 m Type section Sannine		
				Within this formation, geodes of different sizes, filled or voided, containing crystals of quartz. Also chert nodules and bands from white to brown in colour ranging in width from mm to several cm. Limestone is highly karstified			
Maameltain or Ghazir Limestone	Turonian	C_5		Distinguished by fossils otherwise joined with C4c, except in Barkline and between Tabarja and Halat where bluish shaley (laminated) LIMESTONE is found.	200 m Type section Ghazir	Hippurites	
Chekka Marl	Maastrichtian/ Paleocene and Eocene	C_6		Cretaceous and lower Tertiary sediments indistinguishable lithologically. Stiff bluish plastic MARL with glauconite, interbedded with chalky marly LIMESTONE and nodules of black chert.	400 m Chekka thinning to 150 m elsewhere Type section Chekka	Rich in foraminifera	Weathering is sometimes rusty, concoidal fracture

1.5 Topography and Geomorphology

The topography generally follows the geology with the Lebanon mountain chain rising to a maximum height of 3088m at Quornet Al Saouda. To the east the Anti Lebanon chain forms two units, the Anti Lebanon proper in the north, and the Hermon mountain in the south reaching a height of 2814m. The Bekaa valley between the two mountain ranges is generally covered with geologically recent deposits, with Upper Cretaceous and Tertiary rocks outcroping to the east.

1.6 Legal Context

Regulations for the control of quarries has existed in Lebanon since 1935 when they were defined under the French Mandate Administration. These regulations formed a simple legal framework requiring any operator to:

- Submit an application to the authorities showing the location of the quarry site and its access and give details of activities within 100 m of its boundaries.

- Maintain a minimum distance of 10 m between the boundary of the quarry site and any building.

- Obtain permission for the use of explosives.

- Work the quarry retaining benches or berms of 3 m x 3 m.

- Ensure the quarry was either fenced or surrounded by a ditch or soil heap which would provide a natural barrier.

No record is available regarding the success of these regulations or of the administration which serviced it. However the criteria are still relevant and their spirit is incorporated in the present regulations which are currently used as criteria for the issuance of quarry licenses.

1.7 Role of the Syndicate of Quarry Owners

The syndicate is primarily an interest group which does not have any effective control over the actions of its members nor assumes any role in quality control. This is related to the fact that not all quarry operators are obliged to become members of the Syndicate. It is essentially concerned with rock quarrying and the present membership is understood to include only 50 rock quarries. It has acted as a mediator between the government and quarry owners in order to uphold the specific interests of the latter and general interests of the industry. It has recently made technical proposals relating to the rehabilitation of both existing and new quarries intended to maintain the value of land in their ownership when extraction is complete.

(x) The quarry site and buildings should not cause damage to the natural landscape and the following should be avoided:

- Quarries should not be located on tops of hills from where they would overlook international highways or the sea or be very apparent. The distances are likely to be up to 5km.
- The general layout and operation of the quarry should not damage the landscape.
- Retaining walls should be covered in soil and landscaped.
- Trees should be planted along the site boundaries to provide screening.
- The method of operation should not produce material which are hazardous to health and the environment. This includes such items as smoke, dust, odour, noise and fumes.
- The quarry should not be located in areas with value for tourism. This includes the coastal parts of the Damour, Beirut, Ibrahim and Kadisha rivers and on overlooking hills within 2000 m of important areas and buildings used for tourism. All such proposals should be referred to the Higher Council of Urban Planning for consideration.

b Details to be submitted with the application should include:

(i) The site location and its plot area.
(ii) The movement of cars and lorries between the quarry and the main road and an estimate of their numbers, size and frequency.

These criteria were originally intended for works relating to the construction of industrial structures or factories within zones where planning schemes were not yet defined. The effectiveness of the system is however, restricted by the lack of an adequate supporting administrative framework and by the use of other less appropriate methods of obtaining licenses.

1.9 Previous Studies

Only a limited amount of research has been undertaken into quarrying and its associated problems. Three studies have been carried out by various government and non government bodies between 1972 and the present date. The first methodological and comprehensive study of quarrying at a nationwide scale was undertaken by Dr. G. Sabbagh between 1972 and 1974. The work was funded by the Conseil National des Recherches Scientifiques (CNRS) and related to the whole of Lebanon, unfortunately it was not completed and the work was not published. A detailed study of quarrying in the Kesrouane and Maten areas initiated by the General Directorate of Urban Planning was completed by Mr. E. Batal in 1984. It included a limited questionnaire and site visits to about 100 rock and sand quarries and formed the basis of actions regarding the closure of a small number of quarries, the renewal of a number of licenses and the delineation of further potential quarrying sites. The study addressed a range of contextual issues and offered recommendations toward a new and expanded regulatory framework for the organisation of quarries. A research study undertaken by Khawlie and Hinai published in 1980 dealt with the subject from a geological point of

2. SURVEY METHODOLOGY

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2.1 The Questionnaire

This was needed to collect the information required to prepare the database. Because of the extensive range of information a team of specialists including an economist, geologist, environmentalist, planner and transport engineer was formed to prepare the questionnaire. The seven sections and the information requested are described below.

Section A	General Information; addresses quarry location, ownership, license details and resources.
Section B	Details of the Quarry; type of quarry, products and economic aspects.
Section C	Geological Setting; identifies the exploited geological formations.
Section D	Quarry Operation; addresses the methods of working within the quarry and future plans.
Section E	Environmental Aspects; assesses the impact of the operations on the environment including the adjacent urban and archaeological surroundings.
Section F	Transportation; identifies proximity to roads, mode and type of transport and possible damage to pavements.
Section G	Site Layout

A total of 119 questions were asked and each section was subdivided for ease of reference. A typical questionnaire is included in **Appendix 2**.

2.2 Field Work

Three teams of geologist headed by a senior geologist were formed to carry out the field survey work and each team was assigned a Muhafaza. Field work started on 6th February 1995 and was completed on 20th April 1995. The teams were provided with topographic and geological maps of Lebanon and unknown quarries were located with assistance from the local inhabitants, quarry operators and visual search through the various Cazas. The local inabitants were very cooperative and where necessary additional assistance was obtained from official records.

3. RESULTS OF THE REVIEW OF OFFICIAL RECORDS

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3.1 Scale of the Review

At the outset of the review, scattered official records were obtained which indicated that there were some 1800 quarries, however further scrutiny of the records showed that there was duplication and occasionally triplication of some records. This appears to have resulted from the improper maintenance and lack of updating of the official records particularly as some deceased quarry operators and investors were still registered as active. Subsequent investigations revealed further inaccuracies and deficiencies in some of the records and these were corrected following interviews with officials, operators and investors and by checking available applications and license files on site. The official records now indicate there are a total of 710 quarries and sand sources throughout the country. Of these 464 sites are for the extraction of rock and 246 for the extraction of sand, these figures being inclusive of operational and abandoned sites. The total number of quarries in each Caza and Muhafaza is shown in **Table 3.1** which indicates that the Muhafaza of Mount Lebanon contains the greatest number of quarries, more than twice the Muhafaza of North Lebanon which has the second highest number of quarries. This is reasonable as the largest consumers of quarry products are in Beirut which is adjacent to the Muhafazat of Mount Lebanon and Tripoli in the North.

A complete listing of the Official Records made available is included in **Part 1 of Volume 2. "Survey Outputs"**.

Table 3.1 : Total Number of Quarries - Official Records

Muhafaza	Caza	No. of Quarries	Total
Bekaa	Baalbek	36	
	Western Bekaa	29	
	Zahleh	58	123
Mount Lebanon	Aaley	81	
	Baabda	20	
	Chouf	38	
	Jbail	87	
	Kesrouane	82	
	Maten	59	367
North Lebanon	Akkar	28	
	Batroun	59	
	Besharri	19	
	Koura	14	
	Tripoli	21	
	Zghorta	13	154
South Lebanon	Bint Jbail	6	
	Hasbaya	2	
	Jizzine	11	
	Marjayoun	1	
	Nabatieh	10	
	Rashaya	15	
	Saida	3	
	Sour	18	66
TOTAL			**710**

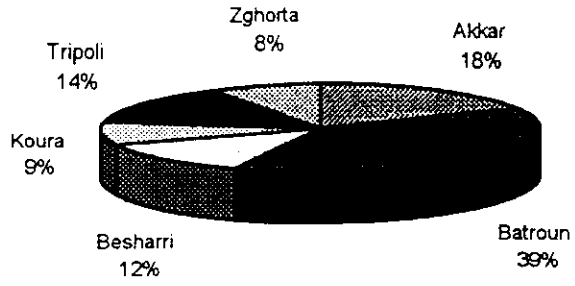


Figure 3.4 Distribution of Quarries in North Lebanon

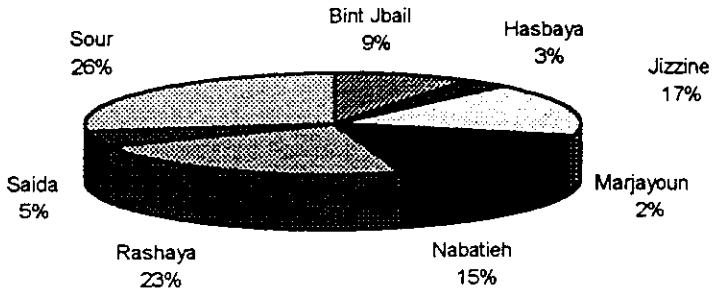


Figure 3.5 Distribution of Quarries in South Lebanon

The type of product produced in each Muhafaza is shown in **Figure 3.6** from which it is apparent that Mount Lebanon is the major producer of sand in the country as well as rock whereas the production of rock is the main product of all other Muhafaza's. The production of building stones is the highest in Bekaa, a little higher than in Mount Lebanon. Production of building stones is almost nill in the South and production of sand is negligible in Bekaa.

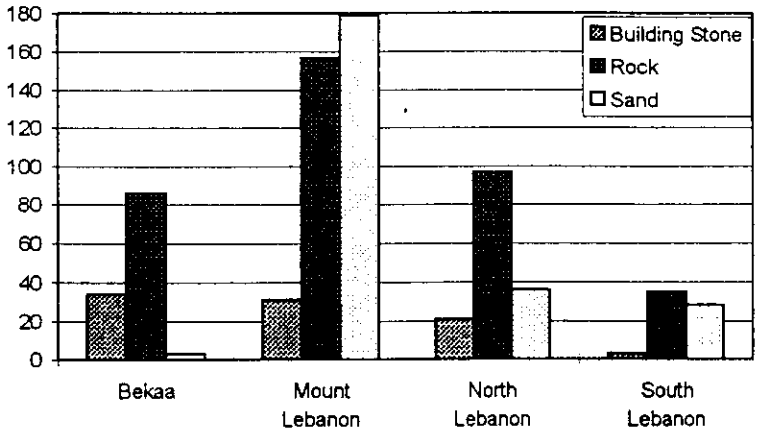


Figure 3.6 Distribution of Quarry Types in Lebanon

Table 3.2 indicates that about 65% of the quarry sites in Mount Lebanon are operational, about 80% in the North and almost all quarries in Bekaa and South Lebanon.

3.3 Legal Aspects

It is understood that temporary licenses are currently granted to quarries for a period of 6 months. Some quarries have licenses for a long a duration extending to 5, 15 and 25 years. From the official records made available during the study, it was not always possible to differentiate between a license to operate a quarry or a license to operate a crusher therefore the conclusions drawn should be treated with care. **Figure 3.8** is a bar chart showing the number of licensed and unlicensed quarries and those under study. These relate to both rock and sand quarries.

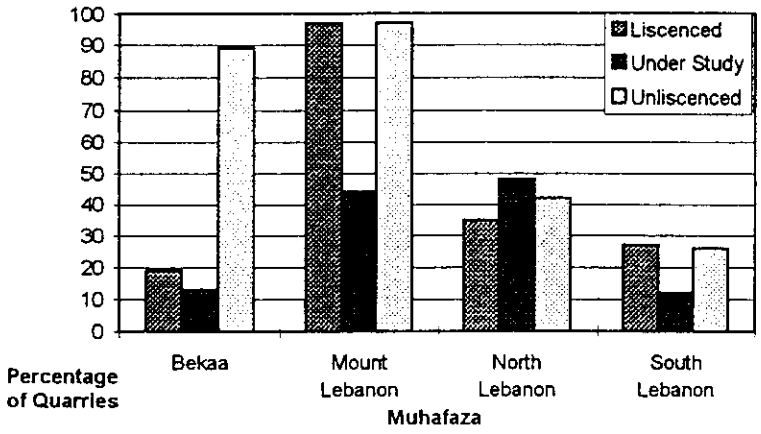


Figure 3.8 Legal Status of Quarries per Muhafaza

Mount Lebanon has the highest number of licensed quarries and an equivalent number of unlicensed quarries. Within Mount Lebanon, the highest number of licensed quarries is in the Caza of Jbail. Bekaa has the lowest number of licensed quarries and is the highest in the number of unlicensed quarries. **Table 3.3** shows the percentage number of the legally operating quarries in each Muhafaza.

Table 3.3 : Legal Aspect of Quarries - Official Records

Muhafaza	Licensed (%)	Unlicensed (%)	Under study (%)
Bekaa	15.7	73.5	10.8
Mount Lebanon	40.4	40.4	18.3
North	28.2	33.9	38.7
South	41.5	18.5	40.0

Although Mount Lebanon has the highest number of licensed quarries, the Muhafaza of South Lebanon has the highest percentage of licensed quarries. The highest number of quarries "Under study" are in South and North Lebanon with the least being in Bekaa.

4. RESULTS OF THE FIELD SURVEY

4. RESULTS OF THE FIELD SURVEY

The field survey considered a representative sample of quarries from all the territories of the Republic of Lebanon excluding the Occupied Strip and the Buffer Zone in the South. The survey concentrated on rock quarries, but a few sand sources were visited and some 280 quarry sites were surveyed of which 22 involved sand extraction. The survey included operational as well as abandoned rock quarry sites. Reporting is based on 274 quarries which means that about 60% of all rock quarries identified by official records were visited implying the statistical conclusions drawn are valid and have a relatively high level of confidence.

A complete list of the quarries visited is included in **Part 2 of Volume 2 "Survey Outputs".**

4.1 Quarry Locations

The locations of surveyed quarries are shown on the map of Lebanon at a scale of 1:200,000 and included in **Appendix 4 (drawing L9467/G01)**. The location of the quarries is shown on topographic maps at a scale of 1:50,000. All relevant maps are located in **Volume 3 " Location Maps "** From these drawings, it is clear that quarries are either scattered or exist in agglomerations such as at Deir Al Ghazal - Raait in Bekaa, Abu Mizan, Antelias, Nahr Al Maout and Chouf in Mount Lebanon and Deir Ammar and Chekka in North Lebanon. The quarries are mainly located along the western mountain range of Mount Lebanon and on the western flank of Anti-Lebanon. All quarries are located at an altitude of less than 1650 m above mean sea level (msl). Normally the larger quarries are at elevations of less than 1000 m above m.s.l. In Bekaa, almost all quarries are at elevations higher than 1000 m above m.s.l. Quarry operators, favour locations at lower altitudes so that work can be continuous throughout the year and hauling distances are shorter especially to the coastal strip. Although it is contrary to the interests of quarry operators, there seems to be a tendency to establish quarries in wadis at higher elevations to avoid congested urban areas. This is reflected by the fact that most abandoned quarries are at altitudes less than 1000 m (such as in Mount Lebanon) which were abandoned due to the encroachment of urbanism and most active recently established quarries are located inland.

4.2 Quarry Area and Size

The plot area of quarries ranges from a few hundred meters to more than 10,000 m^2 and occasionally hundreds of thousands of square metres. However, their size does not relate to the plot area owned by the investor or owner. The largest quarries in the various Muhafazat are presented in **Table 4.1** according to their visual impact.

Table 4.2 : Classification of Quarries by Exploited Volume (m^3)

	Bekaa	Mount Lebanon	North Lebanon
1.	B037	ML010	N032
2.	B013	ML018	N029
3.	B110	ML008	N021
4.	B061	ML026	N004
5.	B014	ML019	N022
6.	B058	ML001	N042
7.	B073	ML037	N003
8.	B059	ML012	N041
9.	B015	ML020	N008
10.	B053	ML013	N011

For classification purposes, in terms of size, the following criteria were used:

Small quarry	Volume (m^3) $\leq$ 15,000
Medium size quarry	15,000$\leq$ Volume(m^3) $\leq$ 40,000
Large quarry	Volume(m^3) > 40,000

On the basis of the above criteria, large rock quarries in Lebanon form 19.8% of the total. The distribution of quarries by size in each Muhafaza is shown in **Table 4.3**:

Table 4.3 : Distribution of Quarries by Size per Muhafaza

Muhafaza	Small	Medium	Large
Bekaa	78	21	13
Mount Lebanon	63	19	11
North Lebanon	13	7	24
South Lebanon	5	1	3
Total in Lebanon	159	48	51
Percentage Distribution	61.6%	18.6	19.8

Some 60% of rock quarries in Lebanon are considered to be small the remaining 40% are divided almost equally between medium and large quarries.

Complete lists of quarry sizes is included in **Appendix 3** to this report.

4.3 Type of Organisation, Current Operational Status and Type of Product

Almost all quarries in Lebanon are independent in nature only a few extract rock for a associated industry. For instance, the quarries of Chekka and Sibline extract the marly limestone for the sole use of the dependent cement factories.

The survey revealed that clay is being extracted for pottery in one quarry in Chouf, Mount Lebanon and that the extraction of rock for the production of building stones is concentrated in Aarsal, Baalbek with scattered quarries in Mount Lebanon and the North.

Of the surveyed quarries only 45 sites are abandoned and 26 sites are temporarily stopped. Most of the abandoned quarries are in Mount Lebanon and Bekaa with only 2 in North Lebanon and one in the South.

Table 4.4 shows the number of quarries in each Caza per Muhafaza with the type of product and current operational status.

4.4 Legal Aspects

Table 4.5, shows that about 93% of the quarries in North Lebanon are licensed and only 7% unlicensed. In Mount Lebanon 78.6% are licensed and 21.4% unlicensed, similarly in South Lebanon 75% of the quarries are licensed and 25% unlicensed. The lowest percentage of licensed quarries is in Bekaa where 50% of the quarries are licensed. These findings do not agree in terms of figures with those from official records which is to be expected as the survey covers only 60% of all quarries. The trend within each Muhafaza, however, is the same if those applying for a license i.e. "Under Study" cases are considered to be licensed quarries. The North and South Muhafazat have the highest percentage of licensed quarries, more than 60%, whereas Bekaa has the lowest.

Table 4.5 : Total number of licensed and unlicensed quarries in each Muhafaza and Caza.

Muhafaza	Caza	Licensed	Unlicensed	No Answer
Bekaa	Baalbek	13	35	9
	Hermel		6	
	Western Bekaa	4	2	
	Zahleh	27	11	5
		44	54	14
Mount Lebanon	Aaley	9	5	6
	Baabda	3		
	Chouf	8	5	7
	Jbail	11	1	4
	Kesrouane	11	4	9
	Maten	16	6	2
		58	21	28
North Lebanon	Akkar	8		
	Batroun	12	1	
	Besharri	3		
	Koura	9		1
	Tripoli	5		
	Zghorta	5	2	
		42	3	1
South Lebanon	Nabatieh	1	2	
	Saida	3		
	Sour	2	1	
		6	3	
Total		**150**	**81**	**43**

Table 4.7 and Figure 4.1 show a high number of workers in the Muhafaza of Mount Lebanon almost twice as much as the Muhafazas of North Lebanon and Bekaa. Within Mount Lebanon the highest number of quarry workers are in the areas of Chouf (318), Maten (299) and Kesrouane (130). In the Bekaa most quarry workers are in the areas of Zahleh (245) and Baalbek (179). In North Lebanon staffing is equally distributed in Batroun and Zghorta (154).

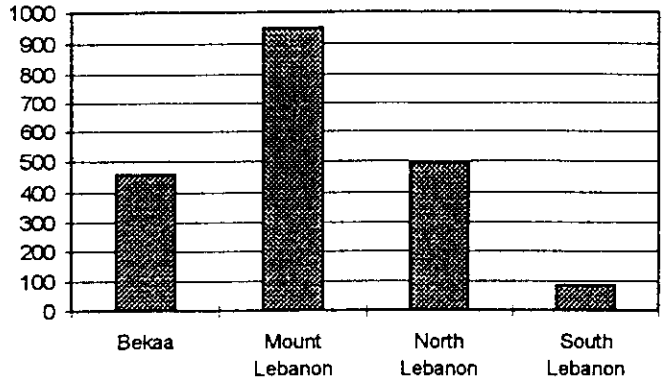


Figure 4.1 Distribution of Quarry Workers by Muhafaza

The equipment available within quarries is used for the proper operation of the site. This equipment includes:

- Bulldozers
- Compressors
- Generators
- Trucks
- Wagon drills
- Loaders

A few quarries have cranes , water tanks, excavators, graders and jack hammers Details of all equipment is shown in **Table 4.8.**

Table 4.8 : Details of Equipment used in Surveyed Quarries

Type	No.	Type	No.
Bulldozers	290	Generators	43
Compressors	54	Graders	4
Cranes	2	Jack Hammers	2
Cutters & Saws	3	Loaders	229
Excavator	1	Trucks	395

- The Eocene (e2)is mainly exploited in Bekaa both in the north east and West.

- The Turonian (C5b) and Senonian (C6) rocks are mainly exploited by the cement factories in Chekka and Sibline.

- The upper and middle levels of the Cenomanian (C4) are extracted in the Chouf area of Mount Lebanon and north east Bekaa with limited exploitation in the Caza of Jbail.

- The Jurassic (J4/J6) is exploited almost solely in Mount Lebanon.

4.7 Production and Marketing

Details of production and marketing are included in questionnaires presented in **Part 2 of Volume 2 " Survey Output "**. Most quarries in Lebanon extract rock for the production of concrete and asphalt coarse aggregates but the finer particles produced as a by-product of the quarrying operations are also sold either as filler, quarry run for reclamation, sand for concrete or powder for the mosaic industry. Whereas the production of aggregates is widely spread throughout the country, building stones are produced in a few Cazas such as Aarsal in Bekaa, Batroun in North Lebanon and Jbail in Mount Lebanon. Marketing of aggregates is normally within the Muhafaza and for small quarries it is within the caza. Muhafazat Beirut being deficient in rock outcrops and consequently quarries, imports its needs from Muhafazat Mount Lebanon.

For classification purposes , the following criteria were used:

Production/annum	Class of Quarry
<250,000m3	Small
250,000 - 500,000 m3	Medium
500,000 - 1,000,000 m3	Large
> 1,000,000 m3	Very Large

On the basis of the above criteria, the following quarries are considered very large; two of which extract marl or marlstone for the making of cement:

N032	S.C.L Societe des Ciments Libannaise	- Chekka
N029	N.C.F National Cement Factory	- Chekka
ML009	John A1Kaai - Abu Mizan	- Bikfaya
ML091	Hoechtief - CCC J.V	- Sibline

The large quarries are:

ML081	Tannious Youssif Abi Hanna
ML011	Joseph Sebaali - Abu Mizan / Zabougha
ML034 & ML031	The Lebanese Company for Construction, Crushers and Construction Material.
ML019	Ibrahim & Joseph Mereib - Halat
ML008	Jamil Al Kaai - Abu Mizan

All large quarries are in Mount Lebanon with concentration in Abu Mizan and Chouf.

The medium quarries are:

ML025	Jean & Georges Zeinoun - Nahr El Maout
ML098	Shammaa & Hammoud Company - Alman
ML027	Ahmad Kojok - Alman
ML028	Al Shark for Construction and Trading - Debbieh
ML013	John Salem & Habib Hakim - Qurtada
ML010	Haykal Al Khazen - Abu Mizan
N007	Joseph Khoury & Abdul Karim Al Masri - Zghorta

Most of the medium sized quarries are in Mount Lebanon with one in the North.
The remaining quarries are considered to be small in relation to their quantity of production.

It should be noted that the above classification is based on quantities claimed by the quarry operators. However, other large quarries such as those at Deir Ammar, Bezbina and Tweeteh may also exist especially in relation to their visual impact.

All quarries for the production of aggregates in Bekaa are considered to be small according to this survey.

In terms of building stones, the following criteria may be adopted:

< 1000 m3	Small
1000 m3 - 5000 m3	Medium
5000 m3 - 10,000 m3	Large
> 10,000 m3	Very large.

In accordance with the above set of criteria , there are three very large quarries; two in Bekaa and one in the North ,namely:

B078	Tony Abu Haidar - Zahleh
B053	Riyad Al Hujairy - Aarsal
N037	Karim Al Ahmajani - Majdal

4.8 Geotechnical Aspects

4.8.1 Slope Geometry

In general most quarry faces are near vertical to vertical. However, in a few quarries faces slope at about 45°. Except to provide for a temporary working space no quarry provides berms or benches for stability purposes. Face heights range from about 20m to as high as 100m or more. Berms, where temporarily provided , range in width from 3.0m to about 36m, and where provided, only 1 or 2 berms are made. However , a few quarries have more than 2 berms such as ML008, ML091, and N032.

4.8.2 Overall stability and impact on adjacent structures

In terms of the slope geometry, visits to quarry sites revealed that most quarries have areas of instability. This instability is mainly in the form of overhangs, loose rock blocks and loose debris on slopes. During the field survey, many quarry operators reported frequent accidents leading to the death of workers due to rockfalls or local failures.Fortunately, owing to the nature of the rock and favourable geological conditions, the overall geological stability of quarries was adequate in almost all the surveyed quarries. The survey did however, reveal a number of quarries where stability problems require immediate attention. These are:

N013	Turki Al Turk - Bezbina
ML025	Jean & Girgis Zeinoun - Roumieh
N021	Shaiban Al Ghazal - Miziara
N022	Simon Antar - Miziara
N023	Antoine Makhlouf - Miziara
S002	Adnan Ghandour - Kfar Milki

4.8.3 Quarrying Methods

Most quarrying is carried out by excavating rock slopes in wadis or at the tops of hills. The only open pit quarrying method was observed in Bezbina (N013) and is reported to be used in Hoechtief - CCC JV quarry in Sibline (ML091) . Galleries are rarely used for rock excavation , however, they are used for blasting rock to form the open faces. Excavation of the rock from quarry faces is almost entirely carried out by blasting, ripping or both.

4.8.4 Material Testing

Almost all quarries carry out the Los Angeles Abrasion test using the American Standards for Testing of Materials (ASTM). This test is used almost exclusively to judge the quality of the product. Other tests are carried out by the larger quarries upon the request of customers but none of the quarries maintains a quality control strategy or procedure. According to the survey results, six of the quarries follow the American testing procedures (ASTM) and three follow the British standard **(Table 4.11)**.

a. Vibration transmitted through the ground and pressure waves. Through the air (overpressure) shake buildings and people and may cause damage and nuisance. The amount of vibration affecting the settlements near the quarry sites is directly related to the amount of explosives used per delay and the distance from the blast. About 13% of the settlements are less than 100 m away from quarries, 29% are between 100 and 500 m and 24% are between 500 m and 1.0 km. On the other hand, 29% of quarries have buildings less than 100 m away, 35% between 100 and 500 m and 17% between 500 and 1.0 km. **Table 4.12** represents a guideline of the recommended distance from the nearest quarry with the use of explosives adopted from Handbook of Quarrying, Department of Mineral and Energy. The actual distances between the nearest settlements and buildings and the quarries are shown on **Figures 4.3 an 4.4** respectively.

Table 4.12: Explosives and Distances from nearest Residence

Distance from nearest residence (m)	Maximum explosive per delay (Kg)
20	0.9
40	3.6
60	8.2
80	14.5
100	22.7
150	51.0
200	90.7
250	141.7
300	204.0

Since around 42% and 64% of the quarries have settlements and buildings respectively less than 500 m away from their site the use and amount of explosives used should be monitored.

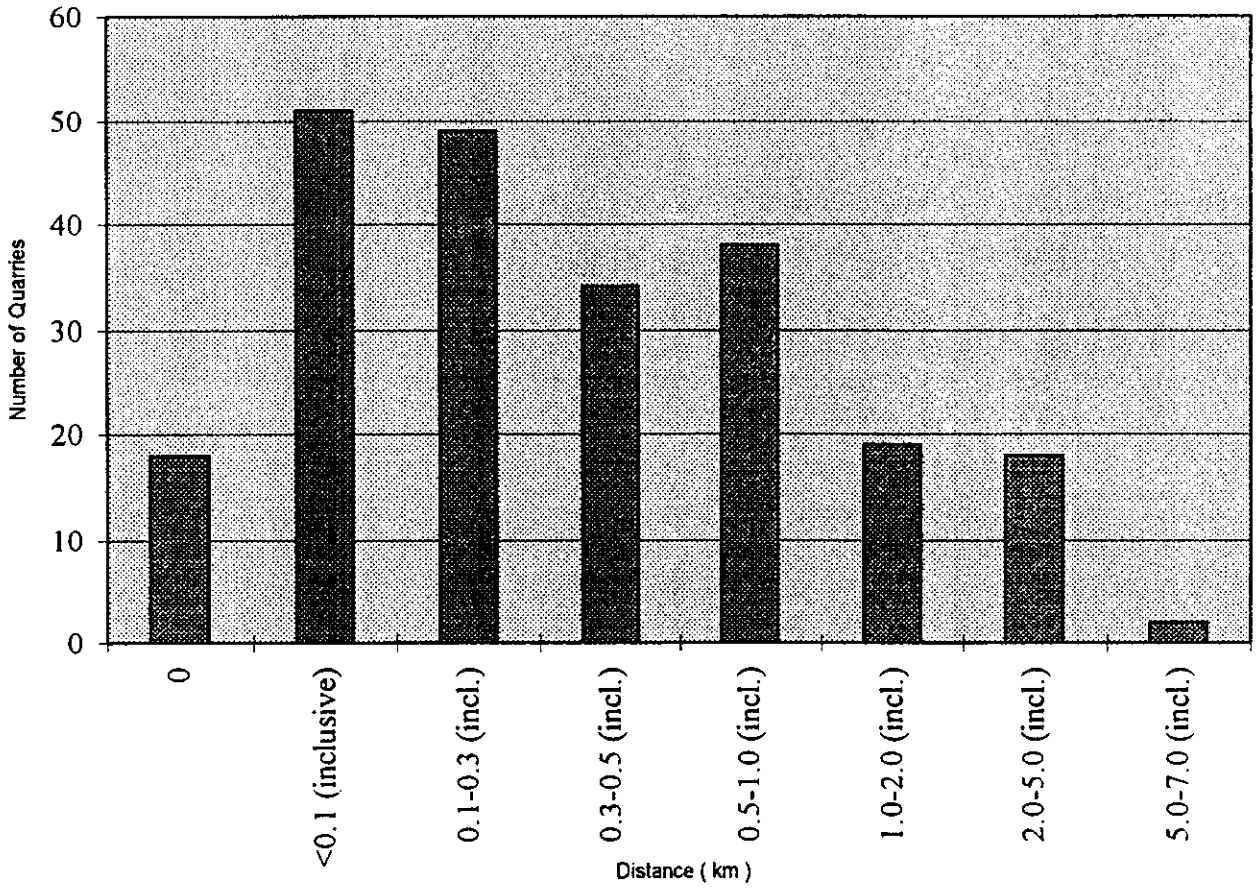
b. Audible noise, because it is part of the pressure wave, occurs at the same time as overpressure. In urban areas, it is augmented by the rattling of windows, etc. caused by the overpressure.

c. Fly rock which is fragments of rocks propelled into the air by the explosions, is clearly potentially dangerous to people and property both inside and outside the site.

d. Dust is another major nuisance in the quarry operations and is caused not only by blasting but by most of the operations carried out.

Figure 4.4 : Distance from Nearest Building

Distance (km)	Number
0	18
<0.1 (inclusive)	51
0.1-0.3 (incl.)	49
0.3-0.5 (incl.)	34
0.5-1.0 (incl.)	38
1.0-2.0 (incl.)	19
2.0-5.0 (incl.)	18
5.0-7.0 (incl.)	2



- Removal of the natural filter medium thus increasing the risk of contamination to underlying aquifers,
- Decreasing aquifer recharge and increasing surface water run-off where topsoil is removed leaving bare rock surfaces:

Impacts to surface water courses include :

- Alteration of the surface over which water flows,
- Changing the pattern of surface water flows,
- Changing the quantity and chemical quality of those flows.

The number and seriousness of problems vary significantly with the site location and the method of working. The main problems are changes in surface water flows and their contamination by particulate matter, partial blockage of streams, rerouting of streams and changes in hydrological characteristics. This was reported at El Taybeh (Bekaa), Muknet El Bekaa (River Nahle) and Takrit (Akkar).

Greater and quicker run-off, especially in storms, from de-vegetated or impervious areas (rock surfaces, plant hardstandings) and uncontrolled pumped discharge of surface water and groundwater may upset land drainage, overload and erode receiving watercourses. These flows lead to increased flows in winter and after storms and reduced flows in summer. Waste materials deposited on river banks can also adversely affect the flood regime and water quality. There is major risk of site run-off water containing large quantities of suspended solids. Storm flows are difficult to settle and many workings discharge contaminated water in wet weather when the receiving watercourse is already heavy with silt. It has been reported that waste material discharge from Abu Mizan and Zabougha is increasing the rate of suspended materials in the water extracted from Jeita Spring to the treatment plant at Dbayeh.

Quarry operators are constructing roads over natural streams to access their sites. The culverts are undersized causing blockage to streams and flooding risks. Crushers are also being constructed within the right-of-way of streams. This was observed in Abu Mizan, Qurtada, Tweeteh and others.

The results of the survey indicate that:

- In 59% of the quarries there was no observed water seepage through fissures..
- In 40% of the quarries the water quality of the nearby source was not adversely affected.
- In 34% of the quarries flooding due to rain and runoff does occur.
- 39% and 37% reported that the quarries neither cause pollution nor increase turbidity in water courses.
- 43% of quarries have nearby water supply which is mostly used for domestic purposes.
- 59% gave no answer to their source of water used on site. Most of the others extract their water from nearby rivers or wells.

affected. Residents of communities nearby tend to turn their attention to more tangible day to day matters such as noise, dust and other effects related to blasting.

Planting trees has only a local effect. The mountainous topography of Lebanon make the quarries more obvious from a distance or from across the wadi.

Crushers are usually constructed at the entrance of the quarry sites, directly on local roads. These have an important negative visual effect as well as presenting a danger. Crusher structures are not demolished or removed when quarries are abandoned.

(v) Ecosystem

The negative effects on flora and fauna from quarries are primarily due to noise, breakage of natural habitat, water pollution, increase in the presence of people, dust emissions and removal of feeding areas. Only 1% of quarry operators considered that there was a natural existing habitat around their quarries.

(vi) Archaeology

The survey indicated that there are some 13 archaeological sites close to quarries. These include Ain Aanoub and Al-Mashnaka Forts in Sibline Area, Kalaat El Hosn, various Romanian remains , and the two most important Kanater Zbeide and Msailha Fortress. According to law No. 166 of 7th November 1933, the Directorate General of Antiquities should be notified in the event of the discovery of any item of archaeological interest. Such an approach is endorsed by decree 5616 concerning regulations for quarries and crushers which stipulates that quarrying must stop immediately if archaeological ruins or remains are found and the Ministry of Environment and the Department of Antiquities be informed. There is no evidence that this requirement is observed and Msailha Fortress is at present seriously affected by an active quarry.

(vii) Other Impact Areas

In 13% of the quarries there are important features close by. They include urban areas like the Antelias, main rivers like Nahr el Maout, Nahr Ibrahim and Nahr Zandukah, infrastructure like main roads, high voltage electrical lines (Takrit) and I.P.C., fuel tanks in Tripoli and cultural and tourist areas including the various archaeological sites mentioned above, NDU University and the ski resort of Laklouk.

The predominant local land use around quarries is agriculture at 48% a complete list is shown in **Figure 4.5**.

Abandoned quarry sites often include a large depression which collecte rain water creating a good breeding environment for mosquitoes with increased health risks to nearby communities.

4.10 Rehabilitation and Regeneration

The survey questionnaire included 3 questions seeking specific information on progress achieved toward the restoration or rehabilitation of the quarries. Information was sought on the numbers of trees planted at any quarry, whether any form of restoration had been commenced or whether natural regeneration was occurring. The results shown in **Table 4.13** are disappointing in that they show that there has been little positive effort toward achieving any quarry restorations and that very few quarries have begun to show signs of natural regeneration.

Table 4.13 : Restoration and Regeneration in Quarries

Areas	Trees Planted		Restoration		Natural Regeneration		Total
	Yes	No	Yes	No	Yes	No	
Bekaa	-	112	-	112	-	112	112
Mount Lebanon	2	100	1	96	4	94	109
North	1	42	2	43	-	38	49
South	1	8	-	9	-	9	10
Total	**4**	**262**	**3**	**260**	**4**	**253**	**280**
(%)	**1.5**	**98.5**	**0.4**	**99.6**	**1.6**	**98.4**	**100**

Organised tree planting has been undertaken at only 4 of the 280 quarries surveyed which is less than 2% of the total of all quarries surveyed. Attempts at restorations or landscape rehabilitation have been made at only 3 quarries and natural regeneration which is inevitably a very slow process has become noticeable at 4 quarries. The survey indicates that very little activity toward rehabilitation is taking place and that the greater majority of quarries in the country remain in a condition which has a detrimental effect on the landscape. Operators did however indicate their readiness to implement any restoration or rehabilitation measures that may be imposed by the relevant authorities provided they are applicable to all quarry sites without exception.

4.11 Transportation

According to the survey, more than 2500 trucks are transporting the extracted material throughout the country. The trucks are mainly Mercedes and Volvo with 3 axles. The maximum load, according to information from the operators, is 30 tonnes with an average of about 15 tonnes. However, according to information available from an independent study on traffic in Lebanon, block stones are transported on 26 tonnes/axle trucks and aggregates on 20 tonnes/axle trucks. The maximum weight of trucks is 65 tonnes and 42 tonnes for the building stones and rock aggregates respectively.

4.12.2 Employment and Equipment

Quarrying is not a major employer of labour in Lebanon with around 6000 persons being directly employed nationally. Staffing levels vary from about 3 employed at small or family operations to over 70 at the very large quarries with yearly outputs exceeding 1 million m^3. However quarries are generally located in rural areas where employment opportunities are particularly important and in the absence of other jobs they provide a disproportional high rate of rural employment.

Modern quarrying involves the use of a wide range of heavy equipment. The survey identified substantial numbers of such equipment being operated nationally to physically quarry rock and also to distribute it.

4.12.3 Geology and Geotechnics

The field surveys indicate that most quarries in Lebanon exploit the Cenomanian and Jurasic formations. Faces are vertical or near vertical and except for the provision of temporary working space berms or benches are not used. Some areas of instability are present in virtually all quarries principally in the form of overhangs, loose rock blocks and debris. Despite this the overall stability of quarries was found to be generally satisfactory and not a danger to the public.

Excavated materials are usually tested before sale by use of the Los Angeles Abrasion test and the method of testing was generally the American Standards for Testing of Material (ASTM).

4.12.4 Production and Marketing

The principal output of Lebanese quarries is rock for the production of concrete and asphalt coarse aggregates. Secondly materials resulting from the processes involved are also sold for bulk fill, concreting sands and rock powder for the mosaic industry. A small number of quarries specialise in the production of dressed building stones. Aggregate production is widespread nationally but dressed building stone production is restricted to Aarsal in Bekaa, Batroun in North Lebanon and Jbail in Mount Lebanon.

The marketing of aggregates is usually carried out in small areas, whereas building stones are sold nationally. Larger markets like Beirut obtain stone from a wide area because of the broad range of market requirement and high level of demand. Survey questions relating to production output were answered by only 60% of respondents and this produced figures indicating an average annual production of around 51 million tones. Extrapolation of this figure to account for the area of non-response indicates a likely total average annual production output for Lebanon of between 80 to 90 million tones.

5. IDENTIFICATION OF MAIN ISSUES

5. IDENTIFICATION OF MAIN ISSUES

5.1 Introduction

The previous sections of the report have presented the results of the analysis of both the official government records on quarries and the field surveys carried out by the Consultant. From these results it is now possible to identify the principal issues which require addressing in order to ensure the quarrying industry can become sustainable having a minimum acceptable level of impact on the public domain. These issues fall into three clear categories which are:

(i) Legal and Administrative.
(ii) Technical and Operational.
(iii) Environmental.

This part of the report highlights possible approaches toward establishing an appropriate and achievable system for controlling quarrying.

5.2 Legal and Administrative Issues

At the present time a license to operate a quarry can be obtained in anyone of the following ways.

(i) An application can be made to operate a rock crusher. The license, if approved is issued through the Deputy Muhafez. The crusher can then operate within or adjacent to a site of rock extraction.

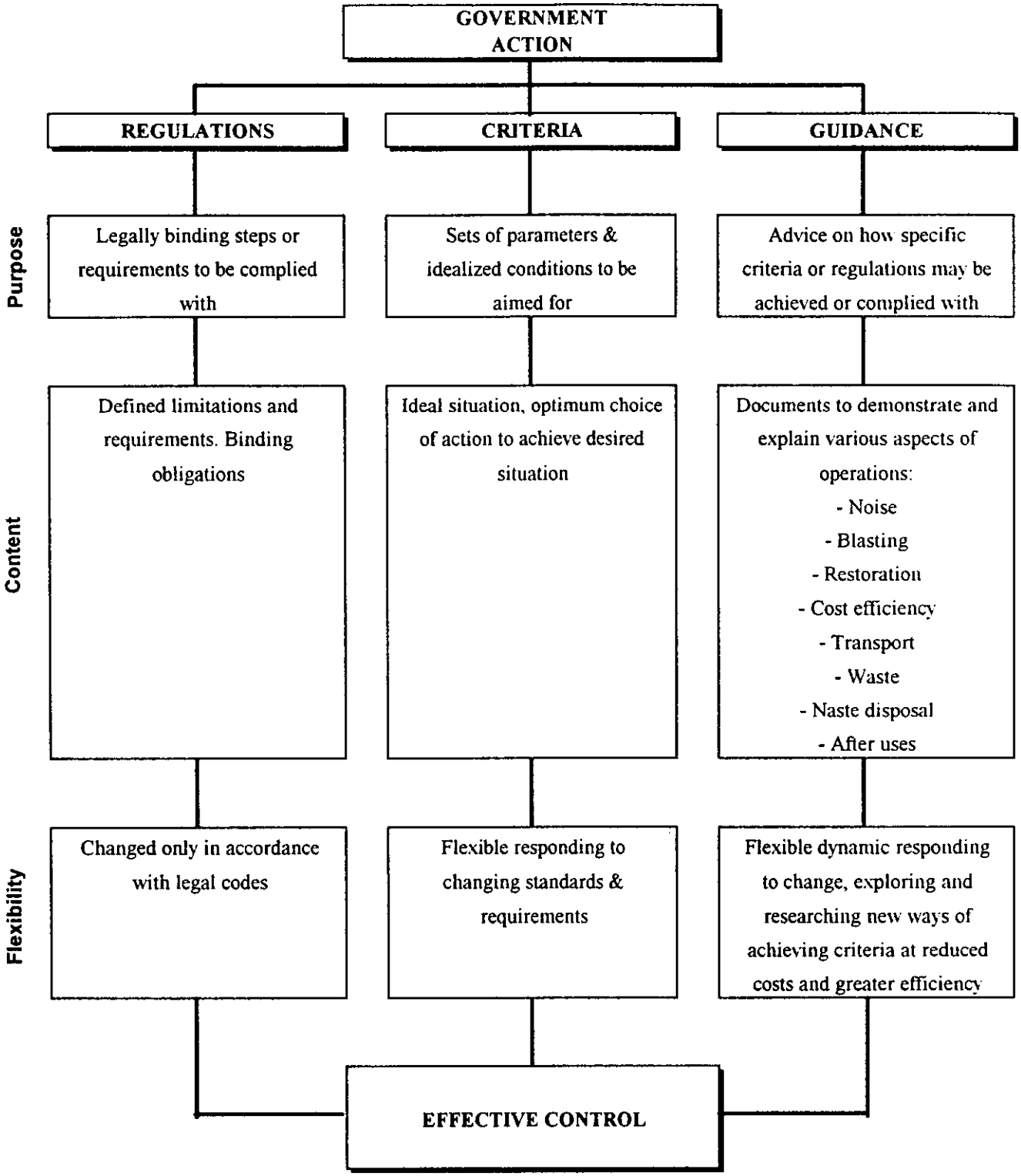
(ii) An application can be made for "land improvement", where rock is removed in order to "improve" the land for agriculture. This license is issued through the Deputy Muhafez. Although the rock removed cannot be "exploited" it can be removed from the site to a crusher located elsewhere.

(iii) An application can be made for a license for quarry in accordance with the 1974 regulations and procedures described in Section 1 of this report. The license would be issued by the Muhafez following the advice of the Department of Mining and Quarrying.

Clearly the situation requires clarification and the law regarding the extraction of minerals needs to be clearly defined and fully enforced. A single authority should be responsible for quarry licenses and the responsibilities of the appointed administration in determining any license application should be clearly outlined.

Any system for the control of quarry operations should be comprehensive in character and commence with the application for a quarrying license. For this reason any proposal for which rock is to be extracted for aggregate, building stone or other purpose should be regarded as quarrying. Such clarification would ensure that proposals involving the removal of rock to facilitate other sorts of development like housing or industry would be considered in accordance with the appropriate zoning

Figure 5.1: Outline of a Possible Regulatory System for Quarrying



5.3.2 The Establishment of Standards and Criteria for Opening New Quarries

The reconstruction programme for Lebanon will maintain the demand for quarried stone and aggregates over the next 10 years at least. It is of national importance that these programmes of development be achieved and consequently further quarries are likely to be required to provide the rock. It is important however that this urgent requirement for stone is not provided at the cost of the natural and built environment. Consequently any new quarries should be required to comply with an agreed set of standards and criteria which will address the following technical issues:

- The use of a single method of considering applications for quarries and issuing licences.
- The establishment of a single government body with full responsibility for new quarries.
- The establishment of locational priorities and the identification of areas where quarrying would not normally be permitted.
- Standards defining the design of suitable road access.
- Estimates of annual production, reserves and life span of the quarry.
- Geological guidelines for quarry development particularly safe methods of quarrying.
- Minimum acceptable site sizes.
- Minimum acceptable distances from other activities, land uses and features of interest.
- Site layout and location of crushers, graders, stockpiles and other activities.
- Methods of dust suppression.
- Methods of noise control.
- Schemes for temporary landscaping and the disposal of quarry wastes.
- The use and control of explosives.
- Schemes of restoration, quarry reclamation and after uses.
- Safety programmes and medical facilities.

5.4 Environmental Issues

Quarrying is a primary industrial activity which has disruptive and often dramatic effects. The conclusions of the survey indicate that the consequences of quarrying affect both the natural and built environment causing quantifiable levels of damage to human habitation through noise, dust and vibration and drastically altering or destroying natural habitats, vegetation and landscape.

The assessment of environmental effects should be carried out in an objective way if it is to identify the real consequences of quarrying. Subjective assessments, often stimulated by public opinion are frequently unbalanced and lead to exaggerated and misleading claims regarding the true nature of the effects. Section 4.9 of this report provides a definitive assessment of the reported effects of the quarries on the environment. Mitigation measures are already available and utilised elsewhere in the world and these could significantly reduce the damaging effects of quarrying in Lebanon.

Further studies relating specifically to the mitigation of the identified effects will be undertaken as part of the Phase 2 studies. Particular attention being given to resolving the perceived effects like landscape disruption and loss of natural habitat as well as the more quantifiable industrial effects such as noise, dust and vibration.

6. POTENTIAL QUARRYING AREAS

6. POTENTIAL QUARRYING AREAS

6.1 Methodology

Phase I of the Scope of Work requires the broad delineation of potential sites for quarrying operations considered only from a geological point of view. The necessary work was undertaken as a desk study using the geological map compiled by L. Dubertret at scale 1:200,000 and spot check site visits for verification purposes. These were made at various locations starting from the coastline in the west in land to the summits of the Mount Lebanon mountains in the east. This ensured that the geological succession; from the youngest, close to the coastline and oldest inland, were considered. Potential rock outcroppings coupled with a knowledge of topographical features and known quarry locations were used as further guidance.

6.2 Geological Context

From the geological maps of Lebanon, it is apparent that most of the surface area is covered by rocks belonging to the Jurassic , Cretaceous and Upper Eocene formations indicating that huge reserves of rock exist compared to the area of the country. However, this is only true from a geological view point once economic, environmental and urban issues are taken into account , the complexity of the situation becomes apparent and the actual reserves diminishes. From the stratigraphic point of view , except for the basalt formation which covers limited areas of the country , the rest of the surface of Lebanon is occupied by marine sediments. The oldest rock formation exposed is the lower Jurassic (LIAS) outcropping at Nahr Ibrahim Valley. The succession continues to the uppermost Quaternary and Recent deposits. The surface area of the various formations in square kilometer are approximately as follows:

Jurassic	1,500	km^2
Cretaceous	5,200	km^2
Eocene	400	km^2
Basalt	200	km^2
Neogene , Quaternary and Recent	2,700	km^2

The Jurassic formations cover approximately 15% from the total of the surface area and form the central part of the western range of Mount Lebanon occurring as limestone massifs surrounded by the more recent Lower Cretaceous formations. Apart from the limited dolomitic zones, the whole of the Jurassic outcrop can be considered as the major potential reserve for aggregates. At the present time, some important production centers are located in the central zone of the Lebanon range, as well as in Jebel El Barouk mountain.

Following the stratigraphic column from the oldest upwards, the Cretaceous formations from C1 to C6, overlying the Jurassic , contain a number of production horizons or series of limestone. Some of these are reefal facies producing good quality aggregate, like the " Falaise de Blanche " cliff in the upper Aptian C2b. In the past, the " Falaise de Blanche " cliff , was the main source of aggregates, and natural building stone for the regions located east of Beirut, where morphology is favorable for its exploitation. The next overlying production horizons are in the Cenomanian C4. They

(i) Akkar Sir ed Danieh:

The section starts with the Miocene deposits at Al Abdeh coastal area and continues through the Middle Cretaceous at Berkael and Qornet Al Hamra to the Jurassic outcrops at Sir ed Danieh . The outcrops of the Jurassic massif at Sir ed Danieh are the most important potential reserves for rock in North Lebanon

(ii) Chekka - Al Koura - Qadisha:

This section reveals upper Cretaceous deposits at Chekka which continues through the Koura plain and extends to Kousba. From Kousba, the Middle Cretaceous outcrops parallel to Qadisha valley until Aintourine. The section terminates with the Jurassic massif at the top of the mountain range. Potential areas across this section are located within some horizons of the Middle Cretaceous and within the Jurassic outcrops.

(iii) Jbail Area - East:

From Jbail area, the cross section starts with the Middle Cretaceous passing through the Cenomanian limestone Upper Series (Allita Series) at the level of Kafar Qouas. Between Tourzaya and Ehmej , the section passes across the lower Cretaceous which extends to El Hrazmine. This is followed by the Jurassic massif of the Qartaba Host. The Jurassic massif is locally dolomitised in an irregular pattern at various locations, for which the potential areas shown on the map of 1:200, 000 were adjusted. Along this section, the prominent potential reserves are in the Allita Series of the Cenomanian limestone and the Jurassic massif.

(iv) North of Nahr Ibrahim - Mashnaka Axis:

From Nahr Ibrahim inland the Cenomanian rock is outcropping. Along the road to Qartaba , the Allita limestone series is exposed until Mashnaka where the lower Cretaceous formations crop out. These are followed by the Jurassic massif of Qartaba Host. Again the potential reserves are the Allita Series of the Cenomanian and the Jurassic limestone.

(v) Batroun - Tannourine:

The Middle Cretaceous formations are exposed in the town of Batroun and extend through Abrin - Baksmaya - Jaba in the South and parallel to Nahr El Jaouz valley. West of Tannourine el Tahta the section crosses the lower Cretaceous formations and continues through the partially dolomitised limestone of the Jurassic Qartaba Host. The potential quarry areas are within the Cenomanian , Upper Turonian and Jurassic rock outcrops.

As a first remark at this stage, in zone A which supplies the material to Tripoli and the whole zone, the sources seem to be limited, and the access to the potential areas are very difficult, while the two other zones B and C are more promising with a good geographic and stratigraphic positions. At the present, some quarries located on both sides, namely south and north of Tripoli, provide the aggregate to their surrounding areas. They are quarrying the reefal Vindobonian limestone of the Miocene.

(ii) Unit II - Mount Lebanon Southern Range

As the name indicates , this unit represents the continuation of unit I to the South, and consists of the southern occidental slopes of Mount Lebanon. It is limited from the West by the coastal line of the Mediterranean sea, from the North by the international road BEIRUT-DAMASCUS, from the East by a line following the summits or peaks of the range, and from the South by the valley of Nahr El Awali north of Saida, which is the boundary of the only zone A inside Unit II.

In zone A the important potential reserves are located in the Jurassic massive of Jebel El Barouk. Nevertheless, some series or horizons in the lower Cretaceous like the FALAISE de BLANCHE (C2b), as well as some series of limited reserves in the C4 outcrops could be useful for local needs.

(iii) Unit III - Eastern Slopes of Mout Lebanon

This unit covers all the Eastern slopes of Mount Lebanon , plus the Sohmor - Kamed El Laouz syncline with Jebel Bir Ed Dahr south of the Bekaa Valley. It is limited in the north by the Syrian border, from the east by a line generally oriented NE-SW separating the edge of Mount Lebanon from the Bekaa Valley plain in the East , in the South it stops parallel to Jezzine and from the West by the same summits or peaks line separating this Unit from Unit II. This unit is divided in two zones, A and B . In zone A, the main potential reserves belong to the Middle Cretaceous namely C4-C5b. In zone B, the potential areas are spread in the West within the Jurassic outcrops of the Jebel El Barouk, and in the East , they are located within the Upper Eocene reefal limestone outcropping in Sohmor-Kamed El Laouz syncline.

(iv) Unit IV - Bekaa Plain

Covered by recent continental sediment , the Bekaa plain has no potential except for scattered Miocene conglomerate.

APPENDICES

APPENDIX 1

EXISTING REGULATIONS IN ARABIC

جدول مقارنة بالشروط الواجب توفرها
في المؤسسات المصنفة بالمناطق غير المنظمة

الشروط المفروضة لانشاء المؤسسات المصنفة وفقا لقرار المجلس الاعلى للتنظيم العمراني رقم ٣٧ تاريخ ٧٤/١١/٦ ورقم ٦ تاريخ ١٩٧٥/٢/٥	نتيجة الكشف المحلي	مطابق	غير مطابق
١ ـ مساحه العقار لا تقل عن ٢٥٠٠/م٢			
٢ ـ ابتعاد اقرب نقطه من البناء عن حدود المناطق الاثريه والطبيعيه المحدده بمرسوم خاص بمرسوم تنظيمي سافه ١٠٠٠/م على الاقل			
٣ ـ ابتعاد اقرب نقطه من البناء ٥٠/م على الاقل عن حدود مجارى الانهر الكبيره المحدده بالمحضر .			
٤ ـ ابتعاد اقرب نقطه من البناء ٢٥/م على الاقل عن حدود المجارى الشتويه .			
٥ ـ ابتعاد اقرب نقطه من البناء ١٠٠٠/م على الاقل عن حدود العقارات الواقع ضمنها المستشفيات والمدارس او دور الحضانه او الماوى .			
٦ ـ بالنسبه للمناطق السكنيه يحدد البعد الادنى لبناء المؤسسه المصنفه كما يلي : أ ـ ٥٠٠/م على الاقل من اخر حدود منطقه امتداد سكني في المناطق المنظمه . ب ـ ١٠٠٠/م على الاقل عن اقرب منزل من تجمع سكني مؤلف من خمسه مساكن على الاقل في المنطقه .			
٧ ـ ابتعاد البناء مسافه لا تقل عن ٢٠٠/م عن حدود الاوتستراد او الطرق الدوليه المذكوره بالقرار			
٨ ـ ابتعاد البناء مسافه لا تقل عن ١٠٠/م عن حدود الطرق الدوليه غير المذكوره في البند ٧ والطرق الرئيسيه والثانويه و ١٠م عن حدود الطرق المحليه و ٦م تراجع عن جميع حدود العقار .			
٩ ـ ان لا يقوم البناء على منعطف طريق بشكل يعطل الرؤيه ويهدد السلامه .			
المنطقه العقاريه :			
رقم العقار :			

	نتيجة الكشف المحلي	مطابق	غير مطابق
يبين على الخرائط كيفية تأمين مدخل ومخرج السيارات والشاحنات من والى الطريق العام بحيث لا تشكل اية عرقلة او خطر على سلامة السير تقدم مع الطلب ودراسة عن حجم المواد الاولية المستعملة وكافة السير من جراء انشاء المؤسسة . كما يقدم مع الطلب مشروع تخطيط حسب المواصفات المعتمدة من قبل المديرية العامة للتنظيم المدني وذلك من العقار المطلوب انشاء المؤسسة فيه ومن الطريق العام .			
لا ينتج عن بناء المؤسسة ضررا بالمناظر الطبيعية وتشويه الا في الموقع حسب الشروط المذكورة في القرار	أ" — ب — ج — د — هـ —		

اسم وتوقيع الموظف الذي قام بالكشف المحلي

دقـــق
مهندس المنطقة

نظـــر
رئيس المكتب او رئيس الفرع

APPENDIX 2

A TYPICAL QUESTIONNAIRE

Republic of Lebanon
General Directorate of Urban Planning
Beirut - Lebanon

A Nation Wide Study on Quarries
Questionnaire

DAR AL-HANDASAH
Shair and Partners
Beirut Cairo London
L9467 January 1995

A NATION WIDE STUDY ON QUARRIES

A. GENERAL INFORMATION

Date of Visit _____
Surveyor _____

Quarry Location

1. Serial No _____
2. Muhafazah _____
3. Caza _____
4. Town _____
5. Village _____
6. Quarry Area _____ m^2
7. Coordinates X_____
   Y_____
   Z_____
8. Plot No. _____
9. Cadastral Map No. _____
10. Official Serial No._____

Ownership

11. Name (Operator) _____
12. Address _____
    _____
13. Investor (Owner) _____
14. Address _____
    _____

15. Type of Organisation ☐ *Independent* ☐ *Non-Independent*

License Details

16. Licensed ☐ *Yes* ☐ *No*
17. Date of initial license _____
18. Duration of License _____months/years
19. Last renewal of License _____

20. Location of license ☐ *Available* ☐ *Not Available*
21. Current Status ☐ *Operational* ☐ *Abondoned*
22. Licensed Area of Quarry _____ m^2

Employment

23. Number of personnel employed? Management _____ Skilled _____ Unskilled_____
    Total staff _____

A NATION WIDE STUDY ON QUARRIES

Equipment

24. Crusher Available ☐Yes ☐No
25. Number of crushers _____
26. Type of crusher _____
27. Licensed? ☐Yes ☐No
28. Date of License _____
29. Duration of License _____
30. Date of installation on site _____
31. Production of crusher(monthly) _____ Tonnes/m^3

32. Other equipment available

Equipment	No.	Model/Type
Trucks	_____	_____
Bulldozers	_____	_____
Loaders	_____	_____
Wagon drills	_____	_____
Other(specify) _____	_____	_____

33. Product handling is by ☐Stockpiling ☐Direct loading

B. DETAILS OF THE QUARRY

34. Type of Quarry ☐*Sand* ☐*Rock* ☐*Clay*
☐*Other(Specify)* _____

Production Details

35. Total Annual Production _____ m^3 / Tonnes
36. Total Estimated Reserves _____ m^3 / Tonnes

37. Areas worked ☐*0 - 10%* ☐*10 - 20%* ☐*20 - 30%* ☐*30 - 40%* ☐*40 - 50%*
☐*50 - 60%* ☐*60 - 70%* ☐*70 - 80%* ☐*80 - 90%* ☐*90 - 100%*

Details of Product

38. Type of Product — Size(s) Produced

☐*Concrete Coarse Aggregate* _____
☐*Roads aggregates* _____
☐*Crusher run sand for concrete* _____
☐*Cement making* _____
☐*Mosaic industry* _____
☐*Ceramic industry* _____
☐*Sand for glass industry* _____
☐*Rip - rap* _____
☐*Dimension/face stone* _____
☐*Other (Specify)* _____

39. By-Products _____
40. Waste Material (% of total production) _____

A NATION WIDE STUDY ON QUARRIES

Marketing

41. Marketing destinations ☐Local within Caza ☐Local within Muhafaza
☐Country wide
☐Exported, to where _____

42. Which product most marketed? _____

43. Unit price for each stone produced (last month price)

Product	*Price(US $)*	*Stocks*	*Unit*	*Standard*

44. Unit price variations over last 12 months

Product	*Month(s)*	*Price (US $)*

46. Amount of material presently stockpiled by product type:

Product	*Quantity on stock*	*Unit*

C. GEOLOGICAL SETTING

47. Geological Formation _____
48. Symbol _____
49. Lithology _____
_____

50. Number of faults ☐*None* ☐*1* ☐*2 - 3* ☐*Over 3*

51. Spacing of joints/fissures ☐*None* ☐*< 1.0m* ☐*1.0 - 3.0m* ☐*> 3.0m*

52. Weathering

Depth

☐*0.5 - 1m* ☐*1 - 2m* ☐*2 -5m* ☐*>5m*
☐*Variable(give range)* _____

Intensity

☐*Fresh* ☐*Slight* ☐*Moderate*
☐*High* ☐*Complete*

53. Overburden

Type

☐*Sand* ☐*Sandy Clay* ☐*Clayey Sand* ☐*Clay*
☐*Other* _____

Thickness

☐*< 0.5m* ☐*0.5 - 2.0m* ☐*2.0-5.0m* ☐*> 5.0m*
☐*Variable(give range)* _____

Use

☐*Sold for* _____
☐*Re-used as* _____
☐*Dumped, where* _____

For **sand sources**, type of sand

☐*Calcareous* ☐*Silicious* ☐*Mixture*

For **sand sources**, source of sand

☐*Gres de Base* ☐*Borrow Pit* ☐*Seashore*
☐*Other(Specify)* _____

54. Other remarks and geological sketch

D. QUARRY OPERATION

55. Quarry Faces
Number _____
Height _____
Slope _____

56. Condition of slopes
☐ *Stable* ☐ *Unstable* ☐ *Dangerous*

57. Berms
Number _____
Width _____
Slope _____

58. Condition of berms
☐ *Stable* ☐ *Overhangs* ☐ *Unstable*

59. Overall quarry Stability
☐ *Adequate* ☐ *Inadequate*
☐ *Immediate stabilisation measures required*

60. Any water seepage or signs of water seepage through fissures into quarry? ☐ *Yes* ☐ *No*

61. Method of operation ☐ *Blasting* ☐ *Ripping* ☐ *Combination*
61a. Quarrying Method ☐ *Open Pit Excavation* ☐ *Tunnelling* ☐ *Combination*

Safety

62. Type of explosives, if used _____

63. If used where stored? ☐ *On site* ☐ *Off site* ☐ *Guarded* ☐ *Unguarded*

64. Are there warning signs close to dangerous zones? ☐ *Yes* ☐ *No*
65. Are there safety procedures followed? ☐ *Yes* ☐ *No*
66. Are first aid facilities available? ☐ *Yes* ☐ *No*
67. Is safety clothing used? Helmets ☐ *Yes* ☐ *No*
Shoes ☐ *Yes* ☐ *No*

Quality of Product

68. Is the product tested? ☐ *In an on site Lab* ☐ *An Independent Lab*
☐ *Not tested*

69. Type of tests used (Give typical values, if available)

☐ *Gradation* _____
☐ *Specific gravity* _____
☐ *Moisture content* _____ %
☐ *Soundness* _____ % $MgSO_4$ / Na_2SO_4
☐ *LA Abrasion* _____ %
☐ *Unconfined compressive strength* _____ kg/cm^2
☐ *Other (Specify)* _____

A NATION WIDE STUDY ON QUARRIES

70. What Standards are used? ☐*None* ☐*ASTM* ☐*BSI* ☐*French* ☐*DIN* ☐*Other (Specify)*_____

71. Are standards followed? ☐*Routinely* ☐*As requested*

Future Development

72. Are there plans to extend the quarry? ☐*Yes* ☐*No*
73. If yes, which direction? ☐*North* ☐*South* ☐*East* ☐*West*
74. Are ther plans to open new quarries? ☐*Yes* ☐*No*

75. If yes, where? ☐*Close by* ☐*Nearby Village* ☐*Elsewhere*_____

E. ENVIRONMENTAL ASPECTS

76. Nearest Settlement _____
77. Distance from quarry _____ (m / km)
78. Distance from nearest occupied building _____ (m / km)
79. Are there any features of importance close by ☐*Yes* ☐*No*
80. Type/name of feature _____
81. Distance from quarry _____ (m / km)
82. Predominant local land use
☐*Agricultural* ☐*Forestry* ☐*Urban*
☐*Touristic* ☐*Waste fill*
☐*Other (Specify)*_____

83. Any nearby archeological Site? ☐*Yes* ☐*No*

84. If yes,
Name _____
Distance _____
Importance ☐*High* ☐*Low*

85. Any existing natural habitat of importance? ☐*Yes* ☐*No*
86. Type of Habitat _____
87. Does the quarry have a negative impact on the landscape? ☐*Yes* ☐*No*
88. Can the quarry be seen from;
☐*Nearby Communities*
☐*Tourist sites and facilities*
☐*Restaurants*
☐*Archeological sites*
☐*Roads*
☐*Other features of importance*_____

89. Do nearby areas have touristic / picnic potential? ☐*Yes* ☐*No*
90. If yes, specify location and potential

Location	**Potential**

A NATION WIDE STUDY ON QUARRIES

Ground Water

91. Is there a nearby water supply? ☐ *Yes* ☐ *No*
92. Is this supply for ☐ *Domestic* ☐ *Industry* ☐ *Irrigation*
☐ *Other(Specify)* _____
93. What is the source of supply?
☐ *Water well* *Stream* *Lake*
☐ *Other(Specify)* _____
94. Distance of source from quarry? _____ *m*

95. Does the quarry adversely affect quality of supply? ☐ *Yes* ☐ *No*

Surface Water

96. Does the quarry flood? ☐ *Yes* ☐ *No*
97. What months does flooding occur? _____

98. Is flooding due to: ☐ *Rain* ☐ *Seepage* ☐ *Run-off*

		Name	**Distance**
99. Is the quarry near a	☐ *Stream*	_____	_____
	☐ *Wadi*	_____	_____
	☐ *River*	_____	_____
	☐ *well*	_____	_____
	☐ *Aquifer*	_____	_____

100. Does the quarry cause pollution in water courses? ☐ *Yes* ☐ *No*
101. Does the quarry cause increased turbidity? ☐ *Yes* ☐ *No*
102. Does the quarry cause increased sediment load? ☐ *Yes* ☐ *No*
103. Does this cause local flooding? ☐ *Yes* ☐ *No*
104. Has this caused diversion of water courses? ☐ *Yes* ☐ *No*

Noise

105. Is noise from the quarry a problem? ☐ *At Day?* ☐ *Yes, Distance* _____ *m* ☐ *No*
☐ *At Night?* ☐ *Yes, Distance* _____ *m* ☐ *No*

Remedial Measures

106. Have any trees been planted at the quarry? ☐ *Yes* ☐ *No*

107. If yes, what percentage? ☐ *0 - 20%* ☐ *40 - 60%* ☐ *80 - 100%*
☐ *20 - 40%* ☐ *60 -80%*

108. Have any works of restoration been carried out? ☐ *Yes* ☐ *No*
109. If yes, describe naturer and extent
_____
_____
_____

110. Is the quarry regenerating naturally? ☐ *Yes* ☐ *No*

F. TRANSPORTATION

Details of Quarry Access Roads

111. Classification ☐ *International* ☐ *Primary* ☐ *Secondary* ☐ *Local*

112. Type ☐ *Paved* ☐ *Unpaved* ☐ *Single* ☐ *Dual*
*No. of lanes*_____

113. Horizontal Geometry ☐ *Straight* ☐ *Curved* ☐ *Sharp* ☐ *Flat*

114 Vertical Geometry ☐ *Mild* ☐ *Moderate* ☐ *Steep*

115. Pavement Condition
☐ *Longitudinal cracks* ☐ *Transverse cracks*
☐ *Potholes* ☐ *Swells* ☐ *Rutting*
☐ *Others (Specify)*_____

116. Other Features
Side slopes of embankments _____
Side slopes of cuts _____

Ditches provided ☐ *Yes, Width*_____ ☐ *No*
Shoulders provided ☐ *Yes, Width*_____ ☐ *No*

117. Mode of Transport

Trucks

Type	*Ave. No.*	*No. of axles*	*Max. Truck Loading*	*Max. axle Loading*

Routes Followed_____

Trucks and Trailors

Type	*Ave. No.*	*No. of axles*	*Max. Truck Loading*	*Max. axle Loading*

Routes Followed_____

G. SITE LAYOUT

118. Provide a sketch of the quarry site indicating distance to and names of communities, natural habitat, natural streams, touristic and archeological sites and roads.

105. Visual Documentation? *Film Roll No.* _____
Photo(s) No. _____

*By*_____ _____*Signature*_____*Date*_____

APPENDIX 3

QUARRY SIZES BY EXPLOITED VOLUME

Size of Quarries by Exploited Volume - Bekaa

Searial No.	No. of Faces	Height of Faces	Width of Faces	Length of Quarries	Area	Volume	Class
		(m)	(m)	(m)	(m2)	(m3)	
B001	1	15	60	25	1500	11250	S
B002	1	15	35	10	350	2625	S
B003	1	18	50	30	1500	13500	S
B004	1	20	100	30	3000	30000	M
B005	1	35	40	15	600	10500	S
B006	1	5	40	28	1120	2800	S
B007	1	3	8	5	40	60	S
B008	1	7	50	8	400	1400	S
B009	1	3	25	10	250	375	S
B010	1	20	55	15	825	8250	S
B011	1	20	25	30	750	7500	S
B012	1	20	15	15	225	2250	S
B013	1	45	125	100	12500	281250	L
B014	1	45	100	25	2500	56250	L
B015	1	40	40	60	2400	48000	L
B016	1	18	30	10	300	2700	S
B017	1	3			0	0	S
B018	1	30	30	45	1350	20250	M
B019	1	20	100	12	1200	12000	S
B020	1	10	25	12	300	1500	S
B021	1	20	80	30	2400	24000	M
B022	2	7	50	10	500	1750	S
B023	1	30	20	50	1000	15000	S
B024	1	3	20	10	200	300	S
B025	2	30	50	20	1000	15000	S
B026	1	10	20	8	160	800	S
B027	1	8	25	5	125	500	S
B028	1	8	15	10	150	600	S
B029	1	5			0	0	S
B030	1	3	8	9	72	108	S
B031	1	30		40	0	0	S
B032	1	10	10	10	100	500	S
B033	1	20	25	10	250	2500	S
B034	1	6	30	10	300	900	S
B035	1	5	50	40	2000	5000	S
B036	1	10	15	12	180	900	S
B037	1	25	50	800	40000	500000	L
B038	2	30	40	10	400	6000	S
B039	1	4	15	5	75	150	S
B040	1	12	60	10	600	3600	S
B041	2	12	50	30	1500	9000	S
B042	2	10	50	30	1500	7500	S
B043	1	3	20	4	80	120	S
B044	2	10	30	20	600	3000	S
B045	1	8	40	35	1400	5600	S
B046	1	12	100	60	6000	36000	M
B047	2	18	40	50	2000	18000	M
B048	1	15	30	20	600	4500	S
B049	1	6	15	10	150	450	S
B050	1	15	20	12	240	1800	S
B051	1	25	40	30	1200	15000	S
B052	1	2	35	10	350	350	S

Size of Quarries by Exploited Volume - Bekaa

B053	1	10	300	30	9000	45000	L
B054	1	10	30	6	180	900	S
B055	1	8	20	25	500	2000	S
B056	1	15	40	30	1200	9000	S
B057	1	20	40	35	1400	14000	S
B058	1	35	60	50	3000	52500	L
B059	1	40	40	60	2400	48000	L
B060	1	30	40	50	2000	30000	M
B061	1	40	35	90	3150	63000	L
B062	1	30	40	65	2600	39000	M
B063	1	30	50	45	2250	33750	M
B064	1	35	40	60	2400	42000	L
B065	1	15	50	60	3000	22500	M
B066	1	25	10	20	200	2500	S
B067	1	4	5	8	40	80	S
B068	1	25	30	20	600	7500	S
B069	1	8	6	20	120	480	S
B070	1	24	35	40	1400	16800	M
B071	1	15	18	25	450	3375	S
B072	1	30	20	40	800	12000	S
B073	1	40	60	40	2400	48000	L
B074	1	23	25	40	1000	11500	S
B075	1	45	20	35	700	15750	M
B076	1	15	6	20	120	900	S
B077	1	10	20	10	200	1000	S
B078	1				0	0	S
B079	1	25	70	30	2100	26250	M
B080	1	15	40	6	240	1800	S
B081	1	35	50	30	1500	26250	M
B082	1	35	40	15	600	10500	S
B083	1	35	45	25	1125	19687.5	M
B084	1	25	50	25	1250	15625	M
B085	1	35	80	30	2400	42000	L
B086	1	8	50	30	1500	6000	S
B087	1	12	35	20	700	4200	S
B088	1	8	50	23	1150	4600	S
B089	2	15	50	40	2000	15000	S
B090	1	5	30	20	600	1500	S
B091	1	10	40	25	1000	5000	S
B092	1	12	35	15	525	3150	S
B093	1	8	20	6	120	480	S
B094	1	25	20	50	1000	12500	S
B095	1	20	35	60	2100	21000	M
B096	1	12	20	40	800	4800	S
B097	1	20	20	25	500	5000	S
B098	1	13	30	15	450	2925	S
B099	1	25	60	40	2400	30000	M
B100	1	25	25	100	2500	31250	M
B101	1	30	50	45	2250	33750	M
B102	1	20	50	35	1750	17500	M
B103	2	25	30	40	1200	15000	S
B104	1	40	80	50	4000	80000	L
B105	1	20	25	18	450	4500	S
B106	1	12	20	10	200	1200	S
B107	1	20	25	45	1125	11250	S

Size of Quarries by Exploited Volume - Bekaa

B108	1	25	30	50	1500	18750	M
B109	1	15	30	25	750	5625	S
B110	1	30	50	200	10000	150000	L
B111	1	20	25	30	750	7500	S
B112	1	10	51	20	1020	5100	S

Size of Quarries By Exploited Volume - Mount Lebanon

Serial No.	No. of Faces	Height of Faces	Width of Faces	Length of Quarries	Area	Volume	CLASS
		(m)	(m)	(m)	(m2)	(m3)	
ML01	4	40	60	50	3000	60000	L
ML02	3	30	30	20	600	9000	S
ML 03	3	30	30	30	900	13500	S
ML 04	1	10	20	20	400	2000	S
ML 05	2	20	20	20	400	4000	S
ML 06	1	50	30	20	600	15000	S
ML 07	1	20	20	20	400	4000	S
ML 08	5	50	60	50	3000	75000	L
ML 09	4	30	30	10	300	4500	S
ML 10	4	60	70	50	3500	105000	L
ML 11	1	25	30	5	150	1875	S
ML 12	3	50	70	30	2100	52500	L
ML13	2	55	60	30	1800	49500	L
ML 14	1	40	50	20	1000	20000	M
ML 15	1	10	20	20	400	2000	S
ML 16	1	5	10	5	50	125	S
ML 17	1	15	20	10	200	1500	S
ML 18	3	50	60	50	3000	75000	L
ML 19	4	40	60	50	3000	60000	L
ML 20	2	40	50	50	2500	50000	L
ML 21	1	6	10	10	100	300	S
ML 22	1	30	40	20	800	12000	S
ML 23	3	50	50	30	1500	37500	M
ML 24	1	18	20	20	400	3600	S
ML 25	3	40	40	30	1200	24000	M
ML 26	4	70	50	40	2000	70000	L
ML 27	3	40	50	20	1000	20000	M
ML 28	1	30	50	30	1500	22500	M
ML 29	1	30	60	30	1800	27000	M
ML 30	2	40	60	30	1800	36000	M
ML 31	2	40	60	30	1800	36000	M
ML 32 (SS)	1	20	20	10	200	2000	S
ML 33 (SS)	3	30	40	30	1200	18000	M
ML 34 (SS)	2	20	30	10	300	3000	S
ML 35	1	30	40	20	800	12000	S
ML 36	2	40	50	20	1000	20000	M
ML 37	3	50	70	30	2100	52500	L
ML 38	2	20	30	30	900	9000	S
ML 39	1	20	20	10	200	2000	S
ML 40	1	15	20	10	200	1500	S
ML 41	2	20	20	10	200	2000	S
ML 42	1	30	20	10	200	3000	S
ML 43	1	30	30	20	600	9000	S
ML 44	1	15	20	10	200	1500	S
ML 45	2	14	15	10	150	1050	S
ML 46	4	40	60	30	1800	36000	M
ML 47	2	20	30	20	600	6000	S
ML 48	4	40	60	20	1200	24000	M
ML 50	1	15	20	10	200	1500	S
ML 51(SS)	Under	Construction					
ML 52	2	20	20	10	200	2000	S
ML 53	1	20	20	10	200	2000	S
ML 54	1	20	60	20	1200	12000	S
ML 55	3	30	20	20	400	6000	S
ML 56	1	40	50	20	1000	20000	M

Size of Quarries By Exploited Volume - Mount Lebanon

Serial No.	No. of Faces	Height of Faces	Width of Faces	Length of Quarries	Area	Volume	CLASS
ML 58	2	20	30	20	600	6000	S
ML 59	1	30	30	30	900	13500	S
ML 60	3	45	50	20	1000	22500	M
ML 61	1	30	20	20	400	6000	S
ML 62	1	25	100	30	3000	37500	M
ML 63	1	40	80	30	2400	48000	L
ML 64	1	10	20	10	200	1000	S
ML 65	2	20	20	10	200	2000	S
ML 66	2	30	50	30	1500	22500	M
ML 67	2	20	20	10	200	2000	S
ML 68	1	15	20	10	200	1500	S
ML 69	1	20	40	20	800	8000	S
ML 70	3	30	70	30	2100	31500	M
ML 71	2	20	30	10	300	3000	S
ML 72	1	6	20	10	200	600	S
ML 73	1	30	30	10	300	4500	S
ML 74	1	20	50	20	1000	10000	S
ML 75	1	5	15	5	45	112.5	S
ML 76	1	15	20	10	200	1500	S
ML 77	1	15	30	10	300	2250	S
ML 78	2	26	20	10	200	2600	S
ML 79	1	20	20	10	200	2000	S
ML 80	3	30	30	10	300	4500	S
ML 81	1	25	30	20	600	7500	S
ML 82	3	30	50	20	1000	15000	S
ML 83	2	30	30	20	600	9000	S
ML 84	3	40	50	20	1000	20000	M
ML 85	1	6	20	5 Under Cons.	100	300	S
ML 86	1	20	30	20	600	6000	S
ML 87	2	30	30	20	600	9000	S
ML 88	1	5	15	5 Reopened	75	187.5	S
ML 89	1	10	30	10	300	1500	S
ML 90	3	20	20	20	400	4000	S
ML 91						0	S
ML 92	1	15	20	10	200	1500	S
ML 93	1	40	50	20	1000	20000	M
ML 94	1	20	30	30	900	9000	S
ML 95						0	S
ML 96	1	15	20	10	200	1500	S
ML 97 (SS)	1	15	20	10	200	1500	S
ML 98	1	40	100	20	2000	40000	M
ML 99	1	35	40	20	800	14000	S
ML 100 (SS)	1	20	20	20	400	4000	S
ML 101(SS)	1	8	10	10	100	400	S
L 102(J4-SS	1	20	40	20	800	8000	S
ML103(SS)	2	20	30	20	600	6000	S
ML 104 (SS	2	30	40	20	800	12000	S
ML 105 (SS)	1	30	30	20	600	9000	S
ML 106 (SS)	1	10	20	10	200	1000	S
ML 107 (SS)	1	15	20	10	200	1500	S
ML 108 (SS)	1	10	15	10	150	750	S
ML 109 (SS)	2	20	30	10	300	3000	S

Size of Quarries by Exploited Volume - North Lebanon

Serial N	No. of Face	Height of Faces	Width of Faces	Length of Quarries	Area	Volume	CLASS
		(m)	(m)	(m)	(m2)	(m3)	
N001	1	30	450	50	22500	337500	L
N002	1	30	100	100	10000	150000	L
N003	2	30	500	100	50000	750000	L
N004	3	80	400	100	40000	1600000	L
N005	1	30	90	70	6300	94500	L
N006	1	11	20	70	1400	7700	S
N007	1	20	70	30	2100	21000	M
N008	1	30	300	100	30000	450000	L
N009	1	30			0	0	S
N010	1	40	70	30	2100	42000	L
N011	1	40	400	50	20000	400000	L
N012	1	15	80	30	2400	18000	M
N013	2	70	80	100	8000	280000	L
N014	1	7	50	20	1000	3500	S
N015	1	20	40	50	2000	20000	M
N016	1	20	400	30	12000	120000	L
N017	1	40	40	50	2000	40000	M
N018	1	40	60	30	1800	36000	M
N019	1	20	140	40	5600	56000	L
N021	1	50	500	150	75000	1875000	L
N022	1	60	500	100	50000	1500000	L
N023	1	60	50	50	2500	75000	L
N024	2	20	70	40	2800	28000	M
N025	1	50			0	0	S
N026	1	40			0	0	S
N027	2	25	60	30	1800	22500	M
N028	1	5	100	50	5000	12500	S
N029	3	60	400	200	80000	2400000	L
N030	1	20	150	100	15000	150000	L
N031					0	0	S
N032	3	60	600	200	120000	3600000	L
N033	2	30	100	50	5000	75000	L
N034	2	20	20	10	200	2000	S
N035					0	0	S
N036	1	10	20	20	400	2000	S
N037					0	0	S
N038					0	0	S
N039	1	25	40	30	1200	15000	S
N040	1	10	40	20	800	4000	S
N041	1	50	200	100	20000	500000	L
N042	2	50	300	100	30000	750000	L
N043	1	20	40	30	1200	12000	S
N044	1	10	20	20	400	2000	S
N045	1	10	50	20	1000	5000	S
N046	1	15	25	30	750	5625	S
N047	1	20	100	50	5000	50000	L
N048	1	7	30	10	300	1050	S
N049	1	7	30	15	450	1575	S

Size of Quarries by Exploited Volume - South Lebanon

Searial No.	No. of Faces	Height of Faces (m)	Width of Faces (m)	Length of Quarries (m)	Area (m2)	Volume (m3)	Class
S001	1	50	40	30	1200	30000	M
S002	1	50	100	50	5000	125000	L
S003	1	20	50	30	1500	15000	S
S004	1	40	80	50	4000	80000	L
S005	1	30	50	20	1000	15000	S
S006	1	10	40	20	800	4000	S
S007	1	10	30	10	300	1500	S
S008	1	10	50	30	1500	7500	S
S009	1	40	100	50	5000	100000	L

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Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)

APPENDIX 4

DRAWINGS