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مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

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

A NATION WIDE STUDY OF QUARRIES

Stage II Report
Policies and Courses of Action

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1. SYNTHESIS OF MAJOR ISSUES

1. SYNTHESIS OF MAJOR ISSUES

1.1 Introduction

The Phase 1 report identified the principle issues which required addressing to ensure quarrying moved toward sustainability and that its impact on the public domain was controlled and acceptable. These issues were arranged into 3 clear categories which are:

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

1.2 Legal and Administrative

At present there are a number of ways in which a license can be obtained to quarry rock. Details of these can be found in Section 5.2 of the first report. There is a clear need to clarify the procedure for obtaining a "quarrying" license. Furthermore the license application should be adequately assessed in terms of agreed present and future planning and operational strategies. The application should include specific information on the following:

- 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 measures to be used to control environmental effects.
- Rehabilitation or site restoration.

In order for this to be effective an administration or procedure must be established to adequately assess the application for the "quarry" license and should identify.

- The government bodies responsible for the administration and execution of the system.
- The stages and processes involved.
- The process of determining different types of license application.
- The role of monitoring.
- Responsibility for technical support.

The same administration or another, as proposed in succeeding sections, should also monitor the quarrying operations to ensure that the conditions under which the license is issued are adhered to.

The cost of establishing and maintaining the legal and administrative procedures required to regulate quarries should be borne by the industry itself.

Scales of fees should be an integral part of the system, reviewed regularly and be collected annually as part of the ongoing licensing reviews.

1.3 Technical and Operational

Improvements to technical operating and management procedures in quarries are urgently required in order to improve safety and efficiency and reduce damage to the environment.

1.3.1 Improvements in Existing Quarries

There is a need for performance criteria against which standard operations can be considered and reviewed. Better working practices could greatly improve the existing condition and levels of safety presently found in quarries. Standards and performance criteria are required in the following areas of active quarries and should form the basis of an eventually legally binding code of practice:

- Improvements to the quarry access.
- Measures to prevent pollution to water courses.
- Dust suppression equipment on crushers, grades and roads.
- Controls on the use and types of explosives.
- Measures to restrict noise nuisance.
- Landscaping.
- Controls on overloaded lorries.
- Safety practices and first aid.
- Restoration and reclamation.

Wherever feasible standards and performance criteria should be targets for the industry to aim at and a mandatory element of any application for a quarrying license.

1.3.2 Standards for New Quarries

There is likely to be an increasing demand for minerals as a direct result of the reconstruction program for Lebanon. National development targets must be achieved and supplies of construction material must be reliable and of suitable quality. The need for new or upgraded quarries must not however compromise or adversely affect the natural or built environment. New quarries should comply with standards which address the following technical requirements.

- Suitable road access.
- Acceptable site sizes.
- Life of the quarry, annual production and estimated reserves.
- Minimum acceptable distances from other activities.
- Site layout and location of quarrying equipment.
- Methods of dust suppression and noise control.
- Explosives, blasting and storage.
- Pollution control.
- Safety procedures.
- Schemes of restoration.

Any application for a new quarry should show compliance with agreed standards. Each submission will require assessment prior to the issuance of a license.

1.3.3 Abandoned and Disused Quarries

Abandoned and disused quarries cause concern and are frequently considered to be environmental problems. Concerns relate to their safety, appearance and potential to cause pollution. It is therefore important that steps are taken to bring about their speedy rehabilitation or restoration.

Each abandoned or disused quarry is unique and will require individual assessment to determine the extent of action required. In general the following assessments should be undertaken:

- Determination of ownership and responsibility.
- Assessment of pollution risks.
- Site security and public danger.
- Condition of buildings and site appearance.
- Condition and appearance of quarry wastes.
- Effects on landscape.
- Future potential uses.

Not all abandoned and disused quarries will require remedial action and those that do may only require minor works. Finance must be considered as an essential part of any action as government must give consideration to funding remedial works where no direct responsibility exists. Finance obtained from the licensing procedures may be used to offset the costs of restoring the abandoned quarries.

Another option would be restore suitable abandoned quarries for other use such as industrial, residential or recreational. Such restoration could be carried out by the operator, or alternatively by another investor.

1.4 Environmental

Quarrying is an industrial activity with disruptive and dramatic effects on the landscape. Quarries in Lebanon cause damage to human habitation, through noise, dust and vibration. They also damage or destroy natural habitats, vegetation and landscape.

An assessment of environmental effects should be an essential part of any application for a license. The assessment should consider the consequences of quarrying proposals on both the natural and built environment. The following items must be considered.

- Effects on natural vegetation, flora and fauna.
- Effects on natural landforms and topography.
- Physical effects of quarrying operations like dust, noise and traffic.
- Extent of possible pollution to water sources and rivers.

Mitigation measures to alleviate the worst effects should be shown and they should include:

- Windbreaks, screen mound, planting and noise baffles.
- Dust suppression equipment for crushers, stockpiles and unpaved roads.
- Settlement tanks to encourage the removal of silt from site drainage.
- Standards for landscaping.
- Standards for ground vibration.
- Safety measures for blasting.

The mitigation measures must be incorporated into acceptable standards which reduce impacts and are achievable.

2. ECONOMIC ASPECTS

2. ECONOMIC ASPECTS

2.1 Introduction

This chapter identifies the present operating cost structure for quarrying and quarry products. It also identifies the future demand of the country for aggregates in the light of issued building licenses and envisaged projects over a period of 5-10 years. The findings will be later used to examine the impact of the proposed policy measures on the cost of products.

2.2 Present Operating Cost Structure

The operating costs were classified into the following centers:

- Salaries, wages, and social securities.
- Maintenance and spare parts.
- Blasting.
- Energy (fuel oil and electricity).
- Preparation of quarry.
- Depreciation of equipment.
- rental value, and
- General expenses.

The following distribution of expenses in terms of percentages (Table 2.1) are averages assumed to be representative of quarrying and crushing:

Table 2.1: Percentage Distribution of expenses in quarries

Cost Item	Percentage	Average percentage
Salaries, wages, and social security	20 -25	20
Maintenance and spare parts	25 - 35	25
Blasting	13 - 18	15
Energy	6 - 12	8
Preparation of Quarry	5 - 8	7
General expenses	5 - 10	5
Depreciation	20 - 25	20
TOTAL		**100**

The cost structure varies a lot between one operation and the other depending on the nature of rocks, type and age of equipment, kind of dynamite used in blasting, etc., and within the same quarry from one period to the other (in cases of major breakdowns in equipment).

Many operators were not aware of the depreciation concept, and have at the same time old equipment that are already depreciated. In such cases maintenance and spare part costs are relatively higher than in quarries that use newer equipment. Furthermore, in case quarry sites were owned by the

operators, no rental value was included in the cost structure, and if leased operators interviewed seemed not worried about the rent and considered it part of the general expenses. It should be noted that the above cost structure is an overall average keeping in mind that it varies from one quarry to the other depending on the kind of rocks(for blasting, maintenance of equipments, etc.) as well as the ways used to suppress dust, noise, etc., if any.

The existing quarry selling price/cu.m. is determined by market forces only and subjet to reductions with no recourse to quarrying expenses, which confirms the fact that profit margins are quite high in this sector. Cited prices ranged between $4 to $8 per cubic meter for existing quarry, depending on the type of rock and aggregate. Some operators mentioned that prices could go down to $2 per cubic meter for low quality aggregates especially if the demand is low, inventory is high, or there is a need for cash.

Very few quarries are adopting measures for the preservation of the environment as well as taking into account the rehabilitation costs as works progess or at the life end of the quarry (or lease term).

2.3 Estimate of future demand

Aggregates are the most important of the basic materials used in Civil Engineering (Buildings and Public Structures). The statistics of aggregates production are usually difficult to obtain and should be carefully interpreted.

In estimating the future demand for coarse aggregate the following main sources of demand ought to be taken into consideration:

i- Licensed for residential, office, commercial, tourist, etc., buildings.

ii- Construction of infra-structure facilities including new roads, highways and their maintenance.

iii- Projects that the government is planning to implement on a BOT basis like the Convention Palace, the Sports City facilities, Arab Highway etc..

2.3.1 Building Sector

The straight line approach was adopted to estimate the future growth of licensed areas for buildings in Lebanon as a whole and per Mohafaza. The following schedule presents the licensed areas for the period 1990 - 1995 (12 months adjusted):

Table 2.2: Licensed areas in Thousand square meters

GROWTH RATES FOR THE PERIOD 1990 - 1995						
YEAR/MOUHAFAZAS	**1990**	**1991**	**1992**	**1993**	**1994**	**1995***
BEIRUT	265	601	1082	1194	1678	1841
MOUNT LEBANON	834	3538	6967	9681	13433	18316
SOUTH	749	1371	1897	1919	3116	5344
BEKAA	295	502	661	524	1105	2666
NORTH	129	1389	1986	1591	2462	4073
TOTAL	2272	7401	12593	14909	21794	32240

* 10 months average

Table 2.3 below presents the percentage distribution of the licensed areas by Mohafazat:

Table 2.3: Percentage of licensed building areas per Muhafaza

YEAR/MOUHAFAZAS	**1990**	**1991**	**1992**	**1993**	**1994**	**1995***
BEIRUT	11.66	8.12	8.59	8.01	7.70	5.71
MOUNT LEBANON	36.71	47.80	55.32	64.93	61.64	56.81
SOUTH	32.97	18.52	15.06	12.87	14.30	16.57
BEKAA	12.98	6.78	5.25	3.51	5.07	8.27
NORTH	5.68	18.77	15.77	10.67	11.30	12.63
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

The function in the straight line method is of the form Y= a+bX where Y is the number of licensed areas, "a" being the Y intercept, "b" the annual estimated increase in licensed areas, and X is the time interval (years).

The respective equations for each Mohafazat and for all Lebanon are the following:

Y=	1110 + 250 X	BEIRUT
Y=	8795 + 2677 X	MOUNT. LEBANON
Y=	2400 + 618 X	SOUTH
Y=	959 + 292 X	BEKAA
Y=	1938 + 485 X	NORTH
Y=	15201 + 4322 X	TOTAL

From the above equations it is obvious that the highest rate of growth in licensed areas is in Mount Lebanon being 2677 th.sq.m./year, followed by the North at 485 th. sq.m/year. The expected rate of increase for Lebanon as a whole is 4332 th.sq.m./year.

The average executed areas, as reported by more than one source, are around 65% of licensed areas. However, there are a lot of construction activities for residential purposes that take place without a building license, especially for small dwelling units in villages that suffered displacement or remote areas. If these are to be accounted for, then it may be assumed that these will contribute about 10-20%, thus raising the average executed areas to 85% of the licensed areas.

In terms of quantity of coarse aggregate, this is translated to about 2 tonnes per capita per annum or 6 million tonnes to 10 millions tonnes annually.

2.3.2 Public Sector

This relate to the construction of infrastructure facilities including new roads and highways and their maintenance. It also includes the construction of ports and their rehabilitation and other public facilities.

The major projects envisaged over the coming 5-10 years are, but of course not limited to, the following;

Beirut Central District
The Arab Highway
Beirut Entrances and the Peripherique
Port of Saida
Coastal Boulevard in Saida
Beirut International Airport
Improvement of the Coastal Highway
Conference Center in Beirut
A2 Motorway
Rehabilitation of the Lebanese road network
Reclamation works at Dbayieh
LINOR Project
ELISSAR Project
etc.....

For the above works it is estimated that about 75 million to 90 million tonnes of rock will be required over a period of 5 - 10 years. This means that 2-3 tonnes per capita per annum of aggregates will be required. Most of the demand, however, will be in the first 5 -7 years after which the demand will gradually drop to normal consumption.

2.3.3 Total Demand

Based upon the foregoing, the total demand for rock extraction will be about 5 - 6 tonnes per capita per annum for the coming 5 - 7 years, after which the demand may drop down to about 3 tonnes per capita per annum. In total figures and depending on the number of population, the total quantity of extracted rock will range between 20 -30 million tonnes per annum for the first 7 years and between 9-15 million tonnes per annum thereafter.

For comparison purposes, the average yearly consumption, for the last few years, in some of the industrial countries is shown in Table 2.4 below:

Table 2.4 : Average Yearly Consumption of Aggregates in some Industrialised Countries

	Million of tonnes	T/inahabitant
U.S.A.	1900	5.2
Japan	800	6.8
F.R.G (federal republic of Germany)	490	7.9
France	330	6.0
Canada	270	10.8
United-Kingdom	220	4.0
Switzerland	70	10.9
Netherlands	60	4.2
Belgium	43	4.4

From Table 2.4 it may be concluded that the demand for aggregates in Lebanon will be comparable to those in U.S.A and France for the coming 5-7 years. Thereafter, the demand will drop to normal becoming comparable to those in the United Kingdom, Netherlands and Belgium.

It remains that it is almost impossible to reach an accurate figure on the future demand for aggregate, especially that the implementation of a lot of the activities involved depends on unpredictable factors like the availability of finance, the overall economic and political situation, the development of the peace talks, the development of the real per capita income, fiscal and monetary stability, etc. It could be the best way to meet any future demand for quarry products is through the response of the private sector and market mechanism. Through free competition, and the efficient way of licensing new quarries, any attempt to raise the price of aggregate will automatically translate in an increase in supply from the existent quarries (working more than one shift, use of more efficient ways of quarrying, modernize or upgrade the equipment, etc.).

The above estimates have excluded rock extraction for cement making or dimension stone as these are specialised industries and affect a limited number of quarries. The extraction of argillaceous rock for cement is specifically high and will bias the demand for rock extraction, hence, was excluded from this estimate.

3. POLICY GUIDELINES

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3.1 Introduction

The present priority then is to bring all present quarrying operations under control and to regulate all ongoing and future quarry work. To achieve this certain policies have to be agreed, based upon which immediate and future action can be determined and implemented.

Consequently they must address the principal priorities identified by the Phase I or II Section 1 of this Report. The Consultants consider that the most important priorities are:

(i) The maintenance of an adequate supply of mineral to satisfy the needs of the construction industry in Lebanon.

(ii) The protection of the natural environment of the country and the prevention of damage to the landscape.

(iii) To ensure quarries are safe both for those who work there and the general public who may be affected by them.

(iv) To ensure all existing and new quarries are correctly licensed to operate.

(v) To clarify and strengthen the role of a governmental body in regulating and enforcing the present or future legislation relating to quarries.

These policies can be considered to fall into 3 groups:

- National, which will define the governments attitude and its desired involvement in the quarrying industry now and in the future.
- Strategic, which will control the technical basis of the quarrying industry in terms of its location and possible impacts.
- Operational, which will regulate and control the daily working of the quarry and its final restoration.

3.2 National Policies

A national policy has to be defined regarding:

- Action to be taken for existing quarries.
- Location and management of future quarries.
- Enforcement and monitoring of quarries
- Issuing of a quarry license.
- Monitoring of the market demand.

3.2.1 Existing Quarries.

Fig 6.1 of the phase I Report shows the location of operating quarries. It can be seen that they are well distributed geographically over the country, and concentrated, or "clustered" around geologically exploitable formations. They are also close to the potential markets and urban developments. In some cases the potential reserves are substantial, but could be restricted by future developments urban planning and zoning. Those that are located along the coastal strip have an unfavorable environmental impact. Certain quarries are essential to established industries, for example Chekka and Sibline, that supply the needs of cement manufacturing. Similarly for the quarrying of decorative stone.

The decision now to be made is whether to allow such quarries to continue, or to phase them out.

Firstly with regard to the essential quarries, those at Chekka and Sibline are associated with an essential industry, and must be allowed to continue. Decorative stone on the other hand can only be quarried where the rock is found and may have to be considered as exceptions.

This leaves the aggregate quarries to be considered. If they are allowed to continue and develop within their present areas, the consequences are:

- Urban development within the areas will be restricted.
- Environmental problems already existing will remain or worsen.
- Public opinion would be very unfavorable.

If they are to be phased out, the following would have to be considered:

- A period of time would have to be allowed for implementation in order that new quarry areas are defined, so that there would be no shortage of aggregate on the market.
- New quarry areas would have to be assigned in line with the zonning regulations.
- The new quarry areas would have to be verified with regard to their potential exploitability and future reserves.
- The quarries once abandoned would have to be made safe for the public and acceptable to the environment. The responsibility for this would require definition.

If alternative quarry locations are available then there appears to be no objection to phasing out the existing quarries over a period of time.

If a phasing out of the existing quarries is accepted, it would allow closing down those quarries that are considered to be unsafe, or are considered environmentally unacceptable. This can be accomplished by requiring all present quarries to be relicensed under the existing or the new licensing procedures within a given time.

As a time span is necessary for such an operation time limits would be imposed selectively to render quarries safe or environmentally acceptable.

3.2.2 Future Quarries

A general map of potential quarry areas is also shown on Fig 6.2 from the Phase I Report. The general trend in geographical distribution is similar to that of the existing quarries. This is the result of the geological stratigraphy of the Lebanon. Within these areas the strategic criteria are more likely to be met. Assuming that such new areas are agreed upon, the question now is how these areas shall be controlled and developed under the present regulations. Shall a potential operator be free to apply for a license, and assuming that his application is acceptable can operate or would clusteing quarries in a few locations be adopted.

In the first option, the result would be a similar situation to the present, a number of large and small quarries operating independently. The drawback in this case would be the difficulty to control quarrying operations especially from an environmental point of view due to their scatter across the country and lack of enforcement. This can be overcome by introducing monitoring bodies within the various Muhafazat as proposed in subsequent sections.

The advantages, however, are:

- The proximity to the market.
- Even distribution throughout the country.
- Limited rehabilitation work within a quarry site.
- Oppurtunity for investment and work for the various public sectors in all Muhafazat.
- Distribution of traffic thus minimising their damage effect an roads.

In the clusteing option, future quarrying would be restricted to a few large quarries supplying the market. Each cluster could be operated by one or a group of operators. However, this situation could lead to:

- New legislation to allow land purchase and sale
- Stricter technical control and professional administration should be imposed.
- Development of monopolies
- Requirement of larger capital investment.
- Perhaps the imposition of price regulation.
- Traffic Problems.
- Larger environmental Import.

Advantages of such a scheme would be:

- Restriction of quarry operations to specific areas only, that fullfill the strategic criteria.
- Rehabilitation, although on a larger scale, would be concentrated.

- Urban development can be implemented considering the existence of quarries only in known areas.

The disadvantages of such a policy would be

1- Limiting the potential future development of large areas that are close and surrounding the quarry clusters as well as affect negatively the development of prices of such land for a very long period of time.

2- Introducing an unwanted increases in transport costs to areas that are further away from the quarries clusters.

3- Initiating preferences in deliveries to areas that are closer to quarry sites that may aggravate in cases of shortages in transport vehicles.

4- In case all the quarry clusters are at altitudes vulnerable to weather conditions at the same time, shortages in supply may occur and/or access may become difficult thus distrupting the flow of products to the market. Stock piling on site, even if possible, may not solve the problem.

5- Generation of traffic problems in areas close to the quarries. Road damage in such areas may be aggravated.

6- Once quarry areas are sold or leased, a monopoly situation is created with all its aspects on supply or price issues.

7- Limiting quarrying areas may lead to favor large operators thus creating an oligopoly sort of a market with the possibility of establishing cartels that will control the supply or prices of products.

8- Delocating the present quarries to the new clusters will impose costs on present operators that may not be justified as well as disrupt the present marketing practices that seem to satisfy market needs quite well.

In addition to the above, the following issues ought to be addressed as well:

a- The cost element of paving new land parallel roads and funding source.

b- The cost for maintaining these roads and at whose expense.

c- The impact of prices to final consumers in case the quarry operators are to provide the investment cost of the roads and their maintenance expenses.

d- The impact of parallel roads on the development of adjacent areas even those away from quarry clusters.

e- issue of expropriation of land for roads (cost, time, and other factors).

f- Issue of quality of products and their best suitability for the various uses.

The introduction of policies determining the location and extent of quarries would effectively change the governments role in the industry from its present one. It would require serious consideration before a commitment is made.

3.2.3 Enforcement and Monitoring

Whatever policy decisions are made a common factor will be the enforcement and control. For example few existing quarries are located or operated in accordance with the existing regulations. This is particularly evident in the case of licensing procedure. The government must initiate

- A clear and unique process for issuing a quarry license.
- A monitoring body that has the power to impose severe fines or other penalties for infringement of the regulations, both operational and environmental.

In order to ensure that proposed restoration procedures are followed during and at the end of operations, a performance bond may be introduced to make sure the work is carried out.

3.2.4 Clarification of Licencing procedure

There are at present two areas of misuse in the licensing procedures and these require clarification to ensure that all quarries are satisfactorily licensed and regulated.

(i) Individual Crusher License

Crushers at present can be licensed and operated outside a licensed quarry. The processing of rock and aggregate need not necessarily by limited to quarries and licenses for isolated crushers will almost certainly continue to be issued. No quarry however should be established or operated on the basis of a crusher license alone. To ensure compliance with this requirement monitoring procedures as described in Section 5 should be maintained.

(ii) Land Improvement License

At present, quarries and sometimes crushers are established on the basis of land improvement for agricultural purposes. Such a scheme should be encouraged by incorporating a quarrying license, where applicable, with the land improvement license. Furthermore, this could be extended to apply to land development for residential, industrial, commercial or recreational developments. It is in fact a means to define the end use of the land within the zoning and classification of G.D.U.P. However, a time limit should be set for the quarrying operation to ensure that the proposed land development will be implemented.

3.2.5 Monitoring of Market Demand

As a requirement of the annual license renewal procedures described in Section 5 operators should be required to make available data relating to:

- Annual output by type of mineral
- Purpose for which the mineral was sold.
- Stocks held on site.
- Pricing structures.

The licensing body should carry out spot checks to validate the price structure and identify the presence of any anomalies.

3.2.6 Role of the Syndicate of Quarry Owners

The present intention of the government to rationalise the controls on the quarrying industry indicates its general dissatisfaction with existing quarry operations. There is a real need for a strong and influential syndicate of quarry owners and operators to represent the industry. This body should include all quarrying interests and could be responsible for amongst other things:

- Encouraging good operating practices at all quarries.
- Ensuring consistent levels of production to meet fluctuating construction demands.
- Implementing staff training and development programs.
- Establishing and maintaining data base to determine efficiency and control productivity.
- Represent the industry in negotiations with the government in matters relating to quarries.
- Developing public relations and improving the image of the industry.

There should be a single syndicate which has an approved constitution and operates within the legal framewrok of lebanon. Such an organisation is an essential part of the quarrying industry and should be given every encouragement possible.

In Appendix B, a tentative code of good practice is included to be reviewed and amended by the syndicate as deemed necessary.

3.3 Strategic Policies

These relate to the location of the quarry and can be confirmed by reference to the license application. They identify the minimum allowable distances between the quarry boundaries and other features, activities or land uses, and are shown in Table 3.1.

Table 3.1 - Minimum Acceptable Distances between the Quarry and other Activities Features and Land Uses

Feature	Minimum Distance (m)
International Roads	200
National Major Roads	100
Minor and Local Roads	10
Rivers or streams	50
Intermittent Wadis	25
Communal facilities such as schools, hospitals, clinics, nurseries	1000
Residential areas - houses, shops and all other land uses (ex industry)	1000
Industrial buildings	500
Archaeological site or natural habitat defined by special decree	1000
The plot area of any quarry shall not be less than	
for facing stone 2500 m^2	
for aggregate producing quarries 10,000 m^2	

No quarries shall be allowed in areas allocated as:

- Natural Heritage.
- Public, municipal or governmental property.
- Coastal areas of rivers and wadis.
- Hills over looking the coastal strip.

The criteria in Table 3.1 are within the framework of the existing temporary regulations concerning industrial installations, which also cover quarry locations. However due to the size and topography of Lebanon, it would be possible that some potential locations would be environmentally suitable, but do not fullfill all the above criteria. Such cases must be considered as 'special' cases. Examples of such locations could be such as quarries in wadis where their visual intrusion is minimal.

3.4 Operational Policies

These are based on internationally accepted standards of development. They are proposed in order to minimise any adverse effects and ensure the quarries operate in an efficient and satisfactory mamer.

3.4.1 Criteria for Proper site Operations

i *Access, Traffic and Protection of the Public Highway*

- The access between any quarry and a government highway should provide for visibility splays of at least 100 m in either direction from a point 3 m back from the edge of the carriageway.

- The quarry access at its junction with a goverment highway should be designed to incorporate a kerb line defining the boundary of the junction and should be surfaced in tar macadam or other suitable material to prevent dust or other debris being carried onto the public highway.

- A weighbridge should be introduced and used at all quarries so as to ensure that vehicles leaving the site do not exceed the legal weight limits.

- Maximum axle load for trucks leaving the quarry shall not exceed 12 tonnes.

ii *Pollution of Water Courses*

- Any surface water run off resulting from the operation of the quarry, including seasonal floor water, shall be passed through a series of settlement tanks and/or lagoons prior to their discharge to any water course.

- Where a quarry is within 100 m of any watercourse, an on site drainage system shall be provided to ensure that no surface water run off is discharged directly to the watercourse prior to its treatment in order to remove silts and other pollutants.

- Tanks containing fuel oils and other pollutant liquids used within the quarry area shall be confined to " bunded or protected " areas to prevent their release and possible contamination of water courses and wells. The " bunded or protected " areas shall have a capacity of 150% of the total volume of any tanks.

iii *Sitting of buildings and Equipment:*

- Construction of crusher structures shall be within the quarry site at a minimum distance of 10m from any side of the plot and screened.

- Where buildings or structures exist around a quarry site, the minimum distance of the crusher from the side of the plot should be increased to 25m at the side where buildings or structures exist.

- Office buildings may be placed within the 10m or 25m clearance limits stated above.

iv *Stockpiles and Quarry Wastes*

- Stockpiles of quarried materials awaiting removal from the quarry should not exceed 3 meters in height and should be located in a well defined area or areas of the quarry so as to minimise disturbance from dust and noise.

- Temporary screening mounds and noise protection barriers throughout the operating life of the quarry shall be provided. Quarry wastes may be utilised for this purpose and for use in the final restoration.

v *Blasting and the Use of Explosives:*

- No blasting should take place in any quarry except between the hours of 11.00 and 13.00 hours on any working day. No drilling or blasting should take place on a Sunday or National Holiday.

- Audible and visual warnings should be given prior to the commencement of any blasting operations.

- Ground vibration resulting from blasting should not exceed the peak particle velocities indicated in the table below:

Type of Structure	PPV (mm/s)
Historical buildings or monuments and buildings od special value	2
- Houses and low-rise residential buildings	10
Commercial and industrial buildings or structures	25

- Cover blasted surface, particularly in populated areas and when distance to roads is less than 200 m. Covers could consist of industrial felt, mesh nets or heavy mats that could be made out of used tires. It reduces dust and flyrock impacts.

vi *Dust Suppression*

- All equipments such as crushers, graders and conveyors used to process and transport rock within the quarry should be fitted with effective dust suppression equipment.

- Unsurfaced quarry roads, stockpiles or processing areas should be treated to reduce dust emissions.

- All access roads to and from the quarry shall be surfaced

vii *Landscape*

- Tree planting a maximum spacing of 7.0 m with a minimum height of 1.5 m at planting date.

- The construction of an embankment of 1.5 to 2.0 m delineating the quarry site. The embankment shall be protected from erosion and planted with shrubs and/or creepers

- Vegetative growth on all reduntant quarry faces shall be implemented. Various pratical measures can be adopted using wiremesh, geotextile, hollow mesh mats, compost material, etc.... No redundant face or berm shall remain without vegetative cover for more than six months.

viii *Quarrying Operations*

- No quarry face shall be taken higher than 25 m. Higher quarry faces shall be subject to a detailed geologicaland geotechnical studies.

- A bench of minimum 3.0m width shall be provided at every 25m height interval or at lower height intervals or as revealed by the geological and geotechnical study.

- All trucks leaving the quarry shall be adequately covered. The cover should fold on the vertical sides at least 50 cm and to be tightly roped to avoid dusting or dropping of load.

ix *Safety Measures*

- Sign posts at and ahead of quarry sites for at leat 200m shall be installed.

- A boundary fence delineating quarry boundaries of a minimum height of two metres shall be erected.

- Safety helmets and shoes shall be used.

- First aid kits and fire extinguishers of minimum 5 Kg shall be available on site at all times.

- Explosives shall be stored in stores away from the working face and at a minimum distance of 100 m from any public path, road etc. and at least 50 m from any structures within the quarry.

3.5 Effect of Policy Measures on Cost Structure

3.5.1 Introduction

This is aimed at identifying the impact of the policy recommendations on quarries related to issues of environment, safety, quality of products (coarse aggregates), noise, etc., on the prospective quarrying operating costs and ultimately the final cost to consumers (private and public sectors), excluding any costs outside quarries (transport, handling, etc.).

To be able to reach logical results, the approach followed focused on the present operating cost structure of quarrying in terms of percentages, as quarry owners or operators were reluctant to quantity such costs in terms of currency. To this end, visits were undertaken to some quarrying sites and interviews were conducted with owners and/or operators. Not all interviewed parties were well aware of all the cost elements involved in their operations or at least this is the impression they gave. Depreciation concept seemed meaningless for some, where as some others had no idea on the rental value of land.

It was very obvious from the questions asked to some operators of quarries that are closed or abandoned that the ratio of net after profits to sales ranged between 40% and 60%. Operating quarry owners did not deny the 40% net profit ratio although they complained from unfair competition from operators in Bekaa and Daher El Baidar areas.

3.5.2 Effect of Recommended policy Measures on cost of Quarrying

In trying to estimate the cost effect on the existing quarries selling price per cu.m. the factors taken into consideration are the following:

- Noise reduction,
- Dust suppression,
- Rehabilitation and restoration.

Assuming that:

1- The selling price of a good quality aggregate is $6.00/cu.m. in existing quarries.
2- That the achieved net profit margin is 40% of selling price.

3.5.2.1 Exercice

Assume we have a quarry that produces 40,000 cu.m/year. The average selling price existing quarries is $6/cu.m., then the total gross revenue is estimated at $240,000/year.

The factors that will be effected by the above mentioned policy recommendations are:

- Dust suppression.
- Blasting process,
- Rehabilitation and cultivation.

1- If quarries were asked to install water system on benches and a truck to spray water on the inner roads to reduce the dust caused by the movement of trucks and other equipments in the quarry, it will cost an average size

quarry an investment of around $20th. Canopying the crushers with a system to suck the emitted dust would cost around $50th.

Therefore an additional investment of around $70th. would solve the problem of dust emission. Such an investment would basically add to the depreciation allowance an equivalent of around $10.5 th./year (15% depreciation rate). Add to this $4.5 th in terms of maintenance. The total additional cost would be 15th./year, or Cents/cu.m. (this figure decreases with higher production and vice versa).

2- As far as blasting is concerned, and if the average cost is around 15% of total cost at present, i.e., 54 Cents/cu.m., then using kinds and procedures in blasting raises the figure by one third as many operators mentioned. This means an addition in costs by around 18 Cents/cu.m.

3- As for rehabilitation and cultivation expenses, it is assumed that for each cu.m. extracted, an allowance of 10 to 20 Cents must be put aside for later rehabilitation and cultivation expenses. We shall take the average as 15 Cents/cu.m.

Accordingly, the additional costs to quarry operators for implementing policy measures that will suppress dust, reduce noise and vibrations, in addition to rehabilitating the quarry site is estimated at $0.71/cu.m.

Assuming that prices do not rise as a result of these policy measures, then the assumed net profit for quarrying and crushing would become:

- Present estimated net profit/cu.m. : $ 40.
- Less addition in expenses : ($ 0.71)
- Expected net profit : $1.69

The expected profit amount/cu.m. still makes 28.16% to sales price of $6.00/cu.m.

The expected rate of profit is an excellent one for any kind of activity in Lebanon.

It is concluded that the addition in costs will not be shifted forward to the consumer if the future policy in licensing quarries is flexible and open enough to maintain and even encourage competition among investors in this sector.

3.6 Application for License

Whatever policy measure or licensing procedure is followed, it is essential that an application for license should include:

1- General Information; this relates to such information as:

- Name of Applicant.

- Address.
- Cadastral Plot number.
- Plot area.
- Cadastral Area.
- Muhafaza, town or village.
- Topographic map showing location of the quarry at a scale of 1:20,00.
- Type of product envisaged.
- Nearest archeological site.

2- Geological Report; this is to include:

- Type of material to be extracted.
- Purpose or use of material.
- Topographic details of the quarry site.
- Geological map and of the site and surroundings at a scale of 1:10,000 and for a radius of 500m beyond site limits indicating lithology and attitude of beds and prevailing structural features.
- Proposed face heights width of berms, stability measures, if any.
- Slope stability studies indicating safety of the proposed slope generally to neighboring plots and structures private and public.
- An estimate of depth to groundwater table.
- Estimated reserves.

3- Environmental Report:

This should include:

- Effect of the quarry on nearby habitats, groundwater table, streams, etc...
- Proposed final land use of the quarry sites.
- Rehabilitation measures to be implemented and their phasing.
- Prominent natural features on and around the site.

Both reports shall be prepared and certified by professionals in their respective fields; a geologist for the geological report and an environmentalist for the environmental report.

4. LICENSING PROCEDURES

4. LICENSING PROCEDURES

4.1 Introduction

To ensure an improvement in standards of operation it is essential that all quarries are subjected to an initial review of operations and that existing licenses are brought up to date. To do this and consider applications for new quarries it will be necessary to establish appropriate procedures. These should include all the relevant Government departments in an efficient and logical process which enables a comprehensive review of each licensed application.

4.2 Institutional Requirements

The process of determining licenseapplications should be as simple as possible so as to minimise the complexity of the institutions required to carry out the work. Four Ministries are presently involved in the process as listed below:

- Ministry of Public Works

  General Directorate for Urban Planning

  Responsible for:

  - Strategic controls
  - Land use zoning

- Ministry of Electricity and Water Resources

  Responsible for:

  - Geology
  - Site operations

- Ministry of Environment

  Responsible for:

  - Restoration of quarries
  - Control of Pollution

- Ministry of Interior

  Responsible for:

  - Issue license
  - Enforcement

It is important that any Institutional structure is efficient enough to allow the work to be completed quickly and to be followed up. Two alternative structures have been prepared which develop the principles of individual and joint responsibilities.

4.3 Existing Procedure

At present the licensing procedure is as follows:

1- Applications are submitted to the Muhafez or deputy Muhafez who are part of the Ministry of the Interior.

2- Three copies of the applications are sent to the Department of Miring and quarrying at the Ministry of Mineral Resources and Electricity for the technical assessment - Decree N°. LR/253 dated 08.11.1935.

3- A copy of the application is sent to the G.D.U.P. for comments as an advisory body in the light of the general zoning of the proposed area of the quarry - law N°. 69 dated 09.09.1983.

4- The G.D.U.P. will send the application back to the Department of Mining and Quarrying. The department in tern will send the decision to the Mohafez.

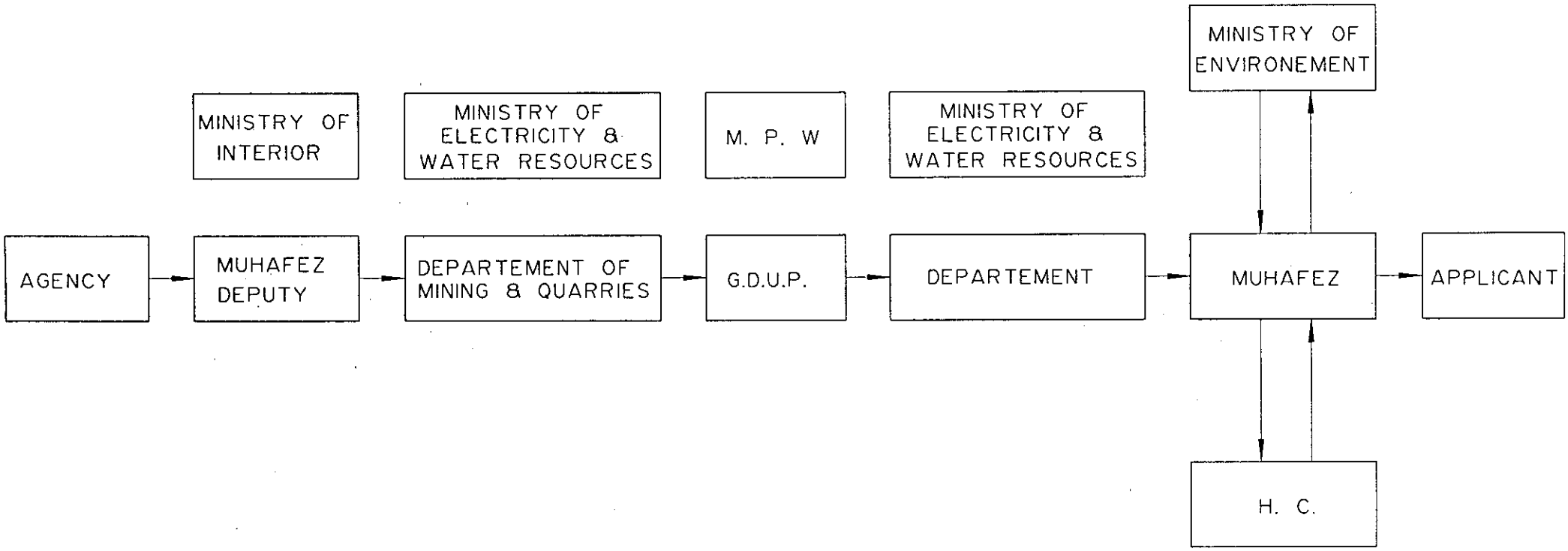
5- At this stage, the Muhafez will seek the advice of the Ministry of the Environment whose decision is not mandatory. He may also seek the advice of the Health Council in the Muhafazat after which the Muhafez will issue or reject the licensing.

Figure 4.1 shows the existing institutional structure and licensing procedure.

4.4 Alternative One : Independent Departments

In this arrangement the departments having an interest in the process remain separate and each deal with their own particular responsibilities independently. Figure 4.2 identifies the individual responsibilities of the various bodies and shows how the license application is determined. The application is initially submitted to the Ministry of Interior who register it and pass it to the General Directorate of Urban Planning in the Ministry of Public Works who assess its conformity with the strategic criteria described in Section 4.3. In the case of non-conformity the application is rejected and is not considered by the other bodies. If it conforms, it is then considered by both the Ministry of Electricity and Water Resources and the Ministry of Environment who assess it against the Operational criteria shown in Appendix A. Should either of these bodies reject the application it is not granted a license. If they both accept the application it is passed to the Ministry of the Interior who give a notice of the decision and issue the license.

The Ministry of the Interior has overall responsibility for the administration of the system. It receives, registers and notifies applicants of the decision. The license is monitored by a dedicated body with responsibility to establish a data base and ensure operators comply with their license.



- ACTIONS
- RECEIVING APPLICATIONS
- CARRY OUT TECHNICAL EVALUATION
- ASSESS THE LOCATION IN THE LIGHT OF PLANED ZONING OF THE QUARRY AREA AND SURROUNDINGS
- FORMULATE A FINAL DECISION
- SEEK THE ADVISE OF THE M.O.E. AND THE HEALTH COUNCIL IN THE MUHAFEZ
- ISSUE/REJECT LICENSE

FIGURE 4.1
EXISTING INSTITUTIONAL STRUCTURE AND LICENSING PROCEDURE

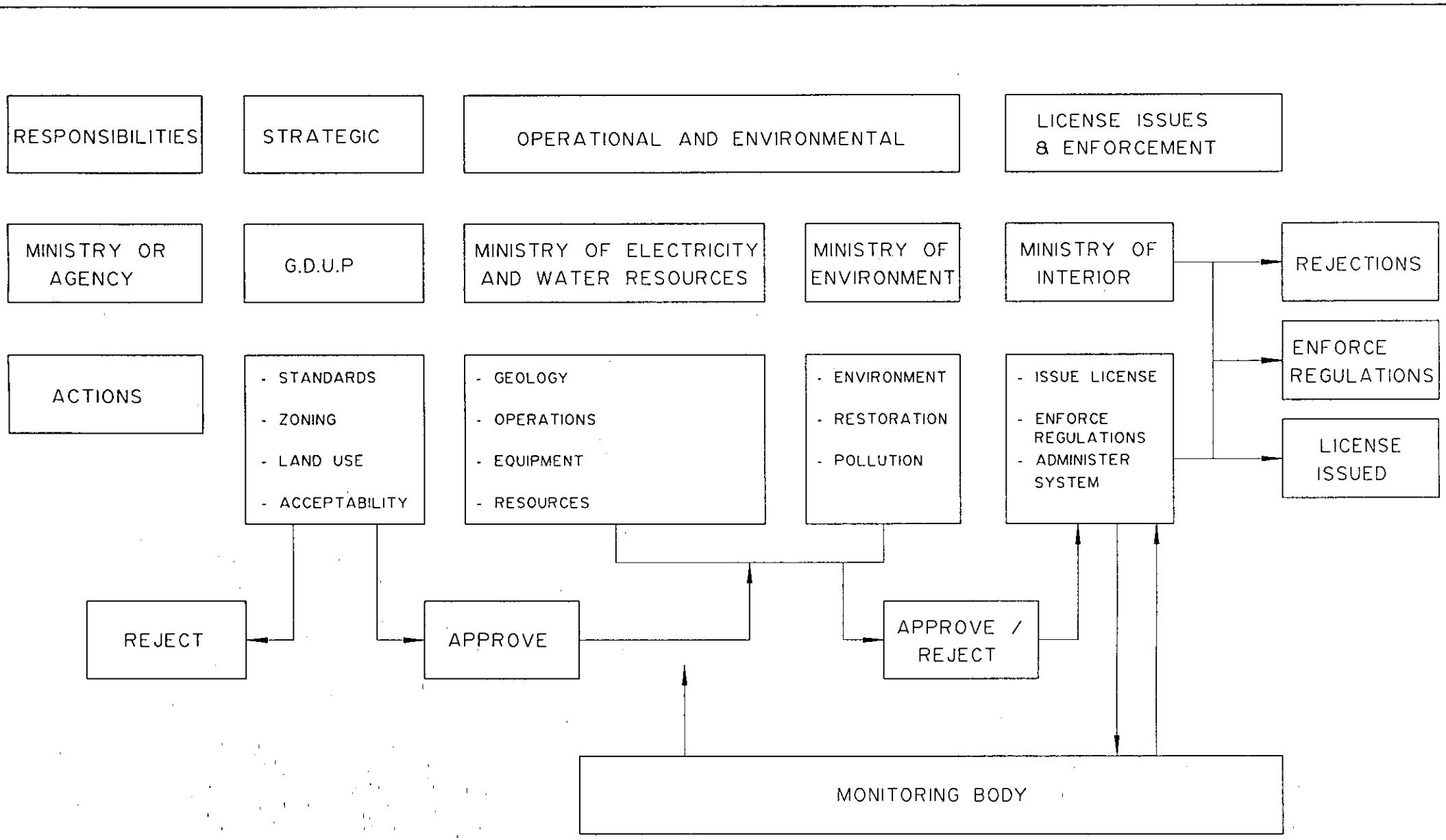


FIGURE 4.2
INSTITUTIONAL STRUCTURE
ALTERNATIVE I: INDIVIDUAL DEPARTMENT RESPONSIBILITIES

4.5 Alternative Two : Technical Secretariat

This Institutional system, shown diagramatically in Figure 4.3, involves the same organisation as described in the Section 4.3 but the responsibilities are pooled to form a single jointly staffed body which shares responsibility for the work. The Technical Secretariat becomes totally responsible for the technical assessment of licensing applications including:

- Strategy
- Environment
- Operations
- Pollution
- Monitoring

The Ministry of the Interior retains individual control of administration, issuance of licenses and enforcement of decisions.

The benefit of operating a Technical Secretariat is greater accessibility making administration more efficient. It further allows for a closer relationship between members enabling more comprehensive technical assessments to be made.

4.6 Alternative Three : A Quarrying and Mining Authority

This alternative is the closest to the currently practiced institutional procedure. As the Ministry of Interior has an enforcing power of regulations, it is envisaged that it is given a wider role in the licensing procedure. This system involves the introduction of a new Authority under the Ministry of the Interior called the "Mining and Quarrying Authority". This Authority will have representative offices in each of the Muhafaza's to follow up and monitor quarrying operations.

The procedure in this system is shown diagramatically in Figure 4.4 and described in the following paragraphs.

Application are received in the offices of the Muhafazat; these offices would:

- Accept Applications.
- Seek the advise of the Muhafez.
- Seek the advise of the local Municipality, if available.
- Forward applications to the Mining and Quarrying Authority.
- Monitor quarrying operations in the licensed quarries.

As applications are received at the Authority they are reviewed in terms of:

- Slope geometry; cut heights and bern width.
- Stability hazard to neighboring properties.
- Equipment used.
- Blasting materials and tehniques.
- Seck the advise of the G.D.U.P.
- Seck the advise of the Ministry of the Environment.

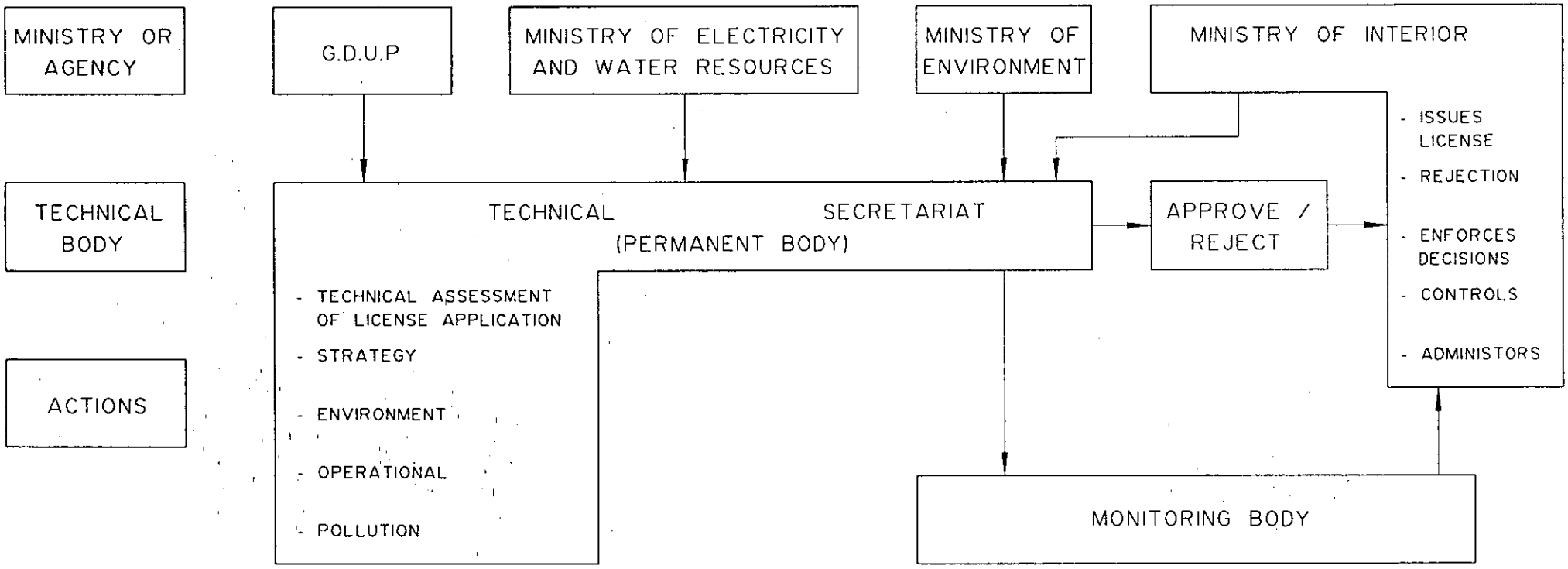
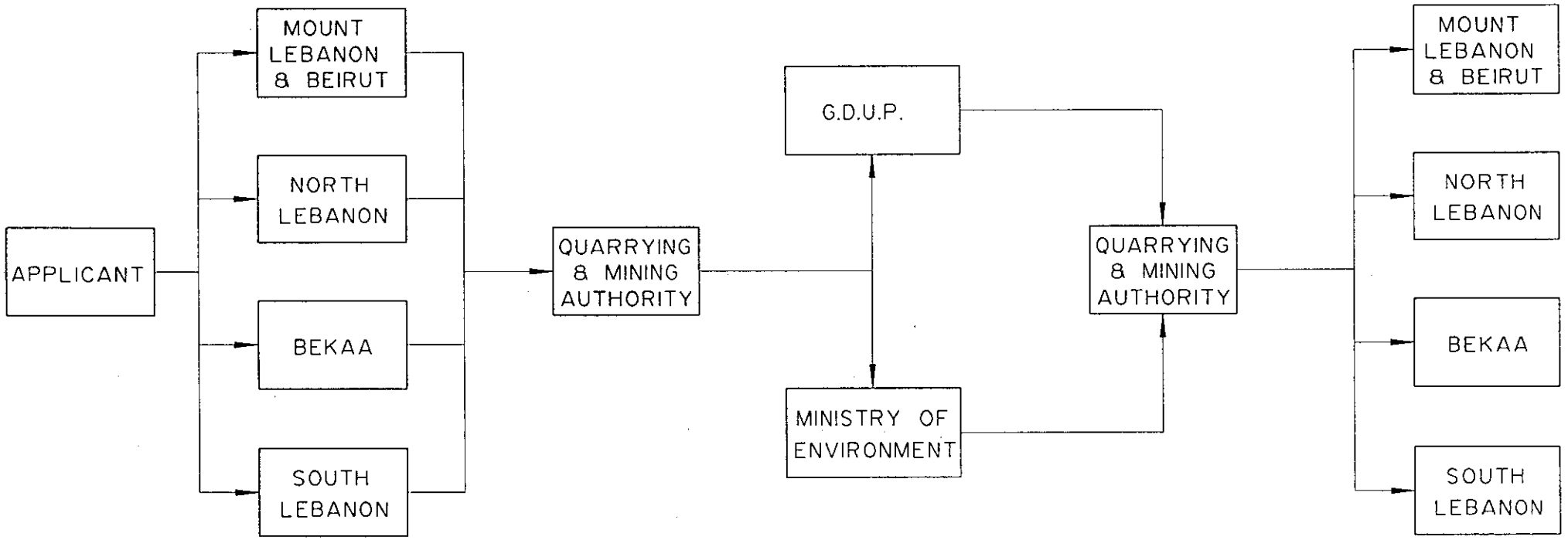


FIGURE 4.3
INSTRUCTIONAL STRUCTURE
ALTERNATIVE 2: TECHNICAL SECRETARIAT



- ACCEPT APPLICATIONS
- LIAISE WITH THE MUHAFEZ
- SEEK OPINION OF THE LOCAL MUNICIPALITY
- FORWARD APPLICATION WITH COMMENTS TO QUARRY & MINING AUTHORITY

- REVIEW DOCUMENT
- SLOPES & BERMS
- EQUIPEMENT
- BLASTING MATERIAL & TECHNIQUES
- ENFORCE REGULATIONS

- REVIEW DOCUMENT
- G.D.U.P.
  STRATEGIC
    - ZONING
    - LOCATION
- M.O.E.
  ENVIRONMENTAL
    - RESTORATION
    - VISUAL IMPACT

- QUARRY OUT FINAL
- EVALUATION & ASSESSEMENT
- ISSUE/REJECT
- LICENSE

- INFORM APPLICANT
  MUHAFEZ
  MUNICIPALITY
- MONITOR QUARRYING OPERATION
- MONITOR RESTORATION WORK

FIGURE 4.4
ALTERNATIVE 3: A QUARRYING AND MINING AUTHORITY APPROACH

Both the G.D.U.P. and the Ministry of the Environment will review the documents and inform the Authority of their comments, recommendations and decisions. The role of each will be the following:

G.D.U.P. will evaluate the strategic requirements in the light of the potential quarrying areas, the general zonning of the area in question, and the final land use policies. The Ministry of the Environment will assess the environmental aspects in the light of the end land use and restoration methods proposed by the applicant.

Therefrom, the Quarrying and Mining Authority will assess and evaluate the application as a whole and a final decision will be taken. The decision will be sent to the offices of the Authority in the respective Muhafaza who will inform the Muhafez, the Municipality and the applicant.

4.7 Other Alternatives

All the above three alternatives involve the introduction of new bodies or an authority either to assess and evaluate applications or to monitor the quarrying operations. This implies new governmental staff, new offices and consequently additional expenses. Although these expenses can be covered by the fees and taxes on application and production of a quarry, the government may opt to maintain the existing system as an alternative to the above.

If , however, it is envisaged that in the long run the number of licenses issued will be limited, then the government may seek the assessment of a privately owned specialised firm. In this case, applications will be submitted to the G.D.U.P offices who will assign a specialised firm to assess the applications in the light of the applicable regulation. The decision will then be sent to the Ministry of the Interior who will enfore the decision. The role of the government, in this case, will be to monitor the quarrying operations.

4.8 Licensing Procedures for New Quarries

At this time quarries countrywide can be divided into three categories: existing, abandoned and proposed. The procedures for licensing must apply to all such possibilities. The administration could be simplified into two procedures.

4.8.1 Proposed or New Quarries

The term "new quarries" describes completely new development, rather than existing quarries which for other reasons may require a new license. No development will have taken place and a comprehensive assessment of the potential effects of the proposal will be required. Copies of the license application containing the details, reports and plans described in Section 1.2 of this report will be submitted to whichever government institution is given the responsibility for their consideration.

The process of assessment is illustrated in Figure 4.5. It shows that the application is initially considered against the strategic requirements described in Table 3.1 should it fail to meet the stated requirements it is formally rejected and receives no further consideration. If it satisfies the criteria it is then considered against the Operational and Environmental criteria described in Section 3.4.

These can be considered simultaneously to save time, but non compliance with any of the individual criteria would generate an automatic rejection of the whole license application.

If the proposal satisfies all the criteria and the assessment is considered satisfactory the application is approved and the license issued. The process should be completed within a 3 month period.

4.8.2 Existing and Abandoned Quarries

This incorporates a process for reviewing the present status of existing quarries and deciding what action should be taken. It also enables an assessment to be made of the strategic and operational issues allowing remedial requirements to be incorporated into the license.

Existing quaries which are at present operating will need a determination about whether or not they satisfy the strategic requirements described in Table 3.1. This will be considered at the start of the process shown in Figure 4.6 and if the application complies it passes directly to be considered against the operational, environmental, and restoration criteria. If the application appears not to satisfy the strategic requirements the applicant is given 3 months to resubmit a clarifying application. If this is satisfactory it is then also considered against the operational criteria.

If the application clearly does not comply with strategic requirements, and even after resubmission is unlikely to, a notice is given that it should be phased out over a 3 year period. A restoration report must be submitted within 6 months of the date of the notice or the quarry will be closed immediately.

Apart from the above the process is as for new quarries.

Abandoned quarries are not normally subject to an application process unless an operator wishes to re-open them. The restoration of these quarries will be considered on an individual basis and action will either be taken by the owner or the Government.

4.9 Future Action

There are many ways in which the licensing of quarries can be carried out. The Consultants have put forward three possible administrative procedures for consideration. Whichever system is finally implemented it is imperative that the administration responsible should be technically qualified and have the resources for enforcement readily available in order to regulate and organise the industry. It is for this reason that the consultant has introduced more involvement of the Ministry of the Interior which is the body which has the resources and more importantly the legal power for enforcement.

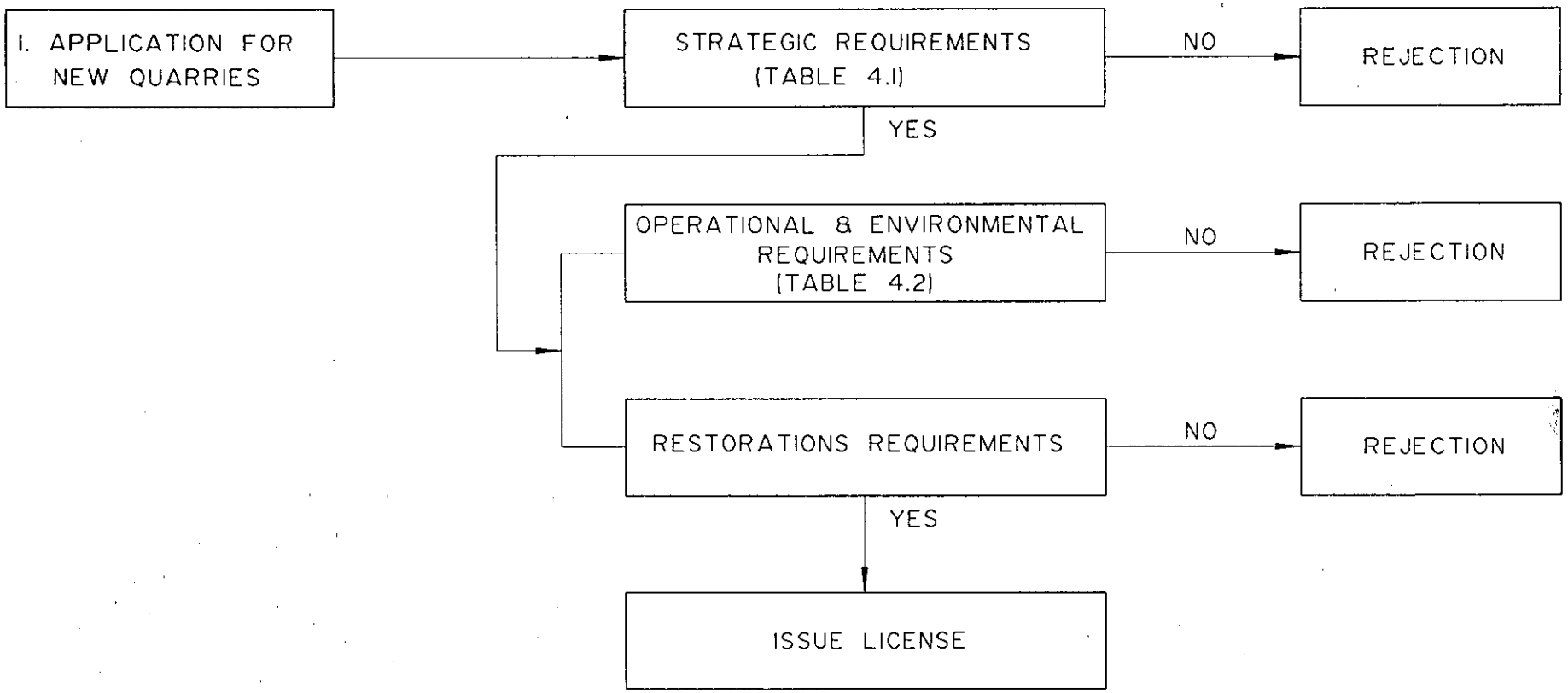


FIGURE 4.5
LICENSING PROCEDURE FOR NEW QUARRIES

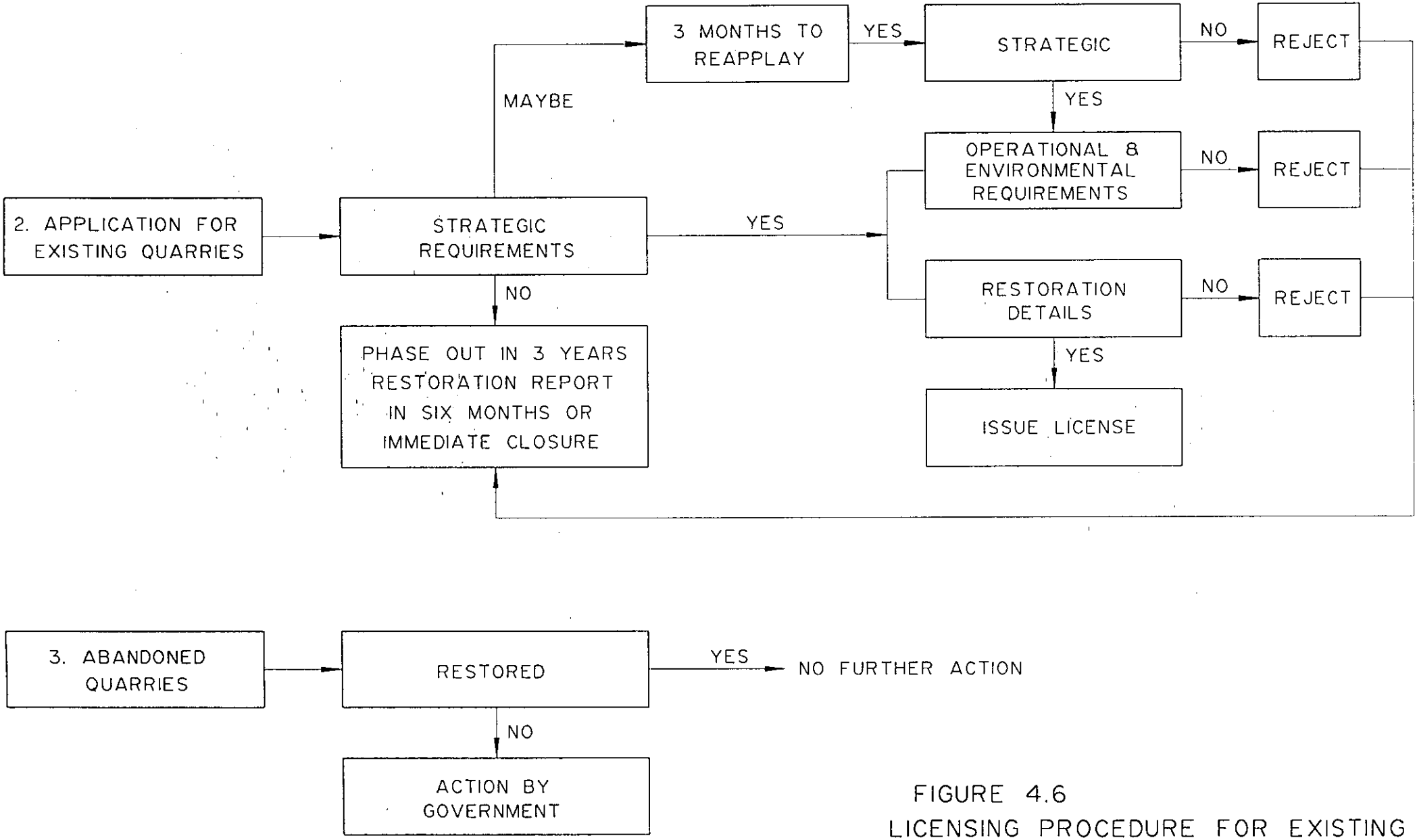


FIGURE 4.6
LICENSING PROCEDURE FOR EXISTING AND ABANDONED QUARRIES

5. RANDOM CASE STUDIES

NORTH LEBANON

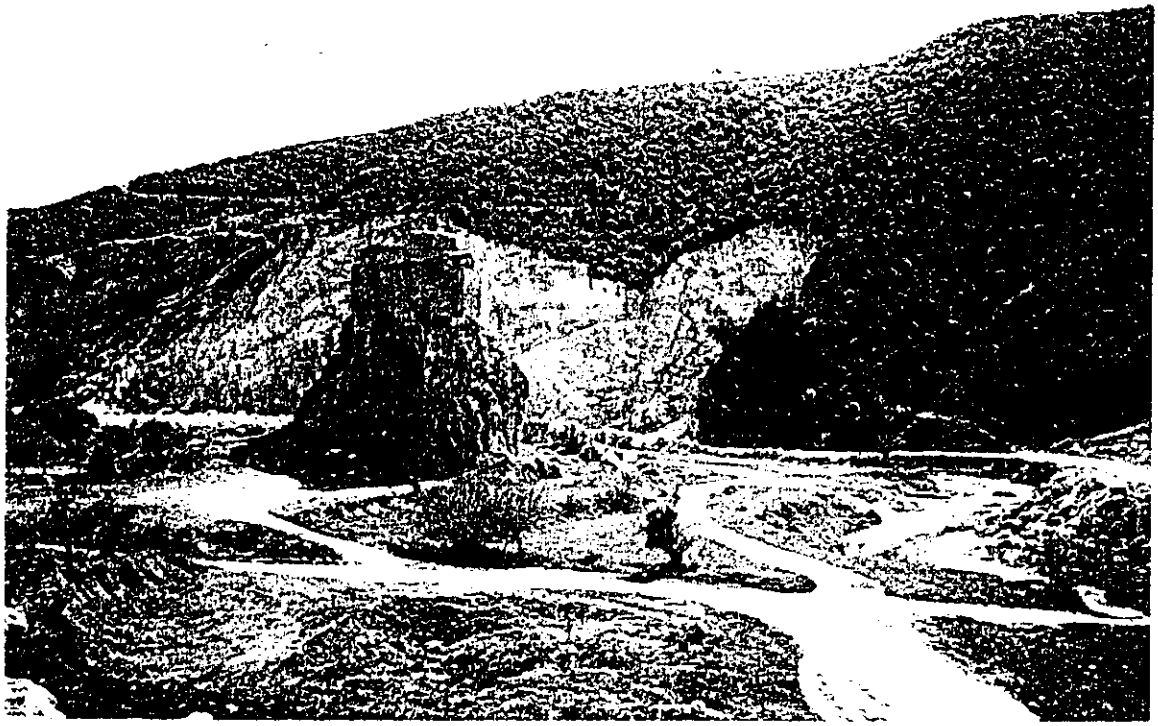
N011 George Yamine Batroun - Al Musailaha

This quarry is next to the International Coastal highway. It is close to an archeological castle and the river Nahr Al Jouz. Quarrying was carried out around the castle in such a manner that the castle is standing on a stack of rock The quarry operator, however, stated that the excavation around the castle was done long ago, during the crusaders period. This is an area of archeological importance and is suitable for picnics.

The operator intends to establish a new quarry in the valley at the back. For this, the operator is opening an access road beneath the water pipe to Batroun.

Quarrying in this stretch should be stopped and the proposed recommendations of this study implemented. The new quarry location should be checked whether it conforms to the proposed strategic criteria.

Batroun - Al Musailaha



N011 - Note archeological castle and Wadi Al Jouz River.

N011 - Access road being opened beneath existing water pipe. The road will lead to Karawona potential quarry site.

N013 Turki Al Turk & Nuhad Khaled Ali Bazbina - Takrit

This quarry is being used as a sand source as well as rock blocks. The quarry is forming a deep pit about 70 m with vertical sides slopes.

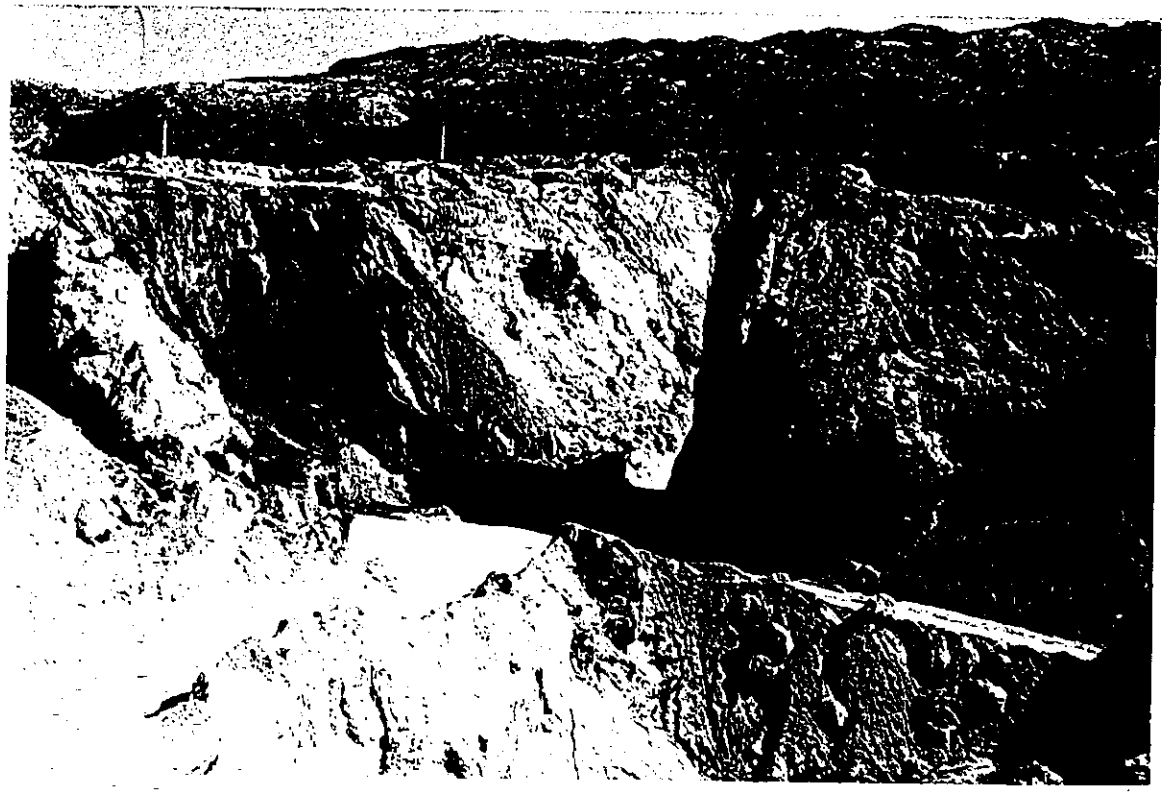
The quarry floor has reached the groundwater table. At the time of the visit, March 1995, water was still gushing. The operator is dumping fill material to conceal the water.

To the east, the quarry endangers electric poles and an existing road and is close to houses.

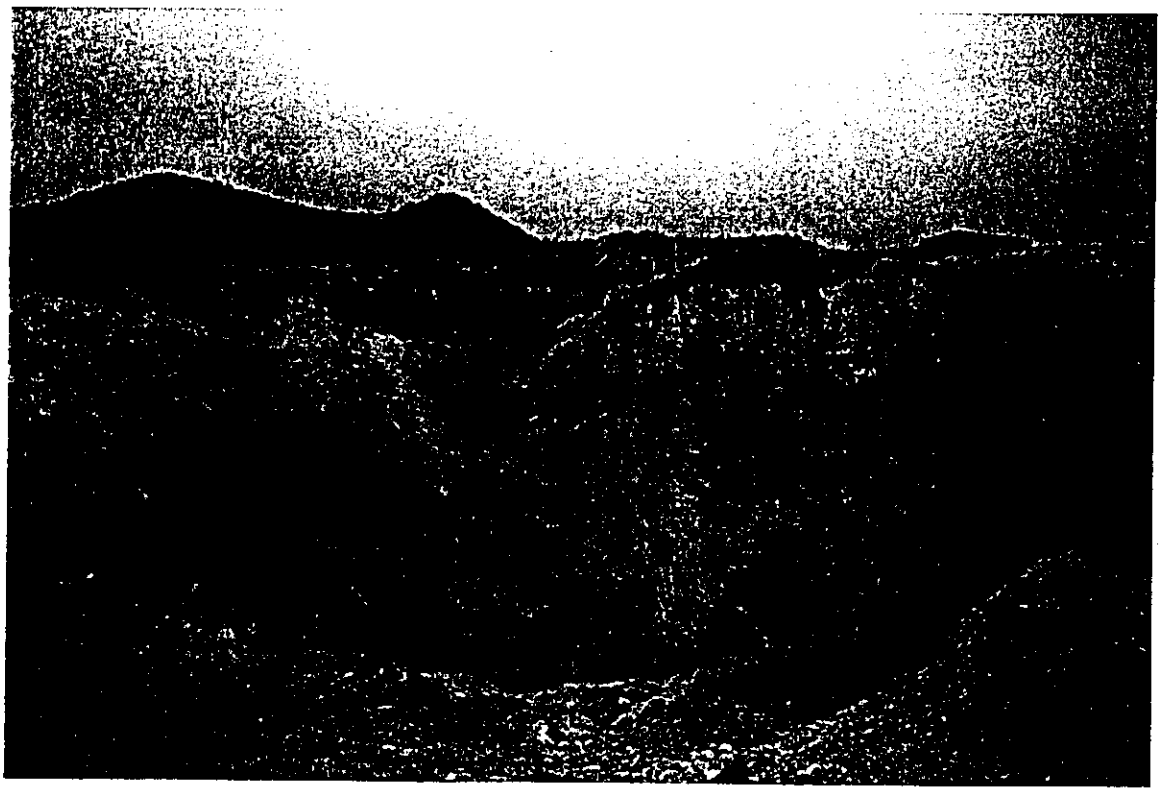
This quarry is to be stopped urgently.

Immediate measures to backfill the pit are required to:
- avoid contamination of the ground water table.
- enhance stability of the slopes.

Backfilling should be carried out in such a way so as to form a barrier against infiltrating of contaminated water into the groundwater table.



Bazbina - Takrit



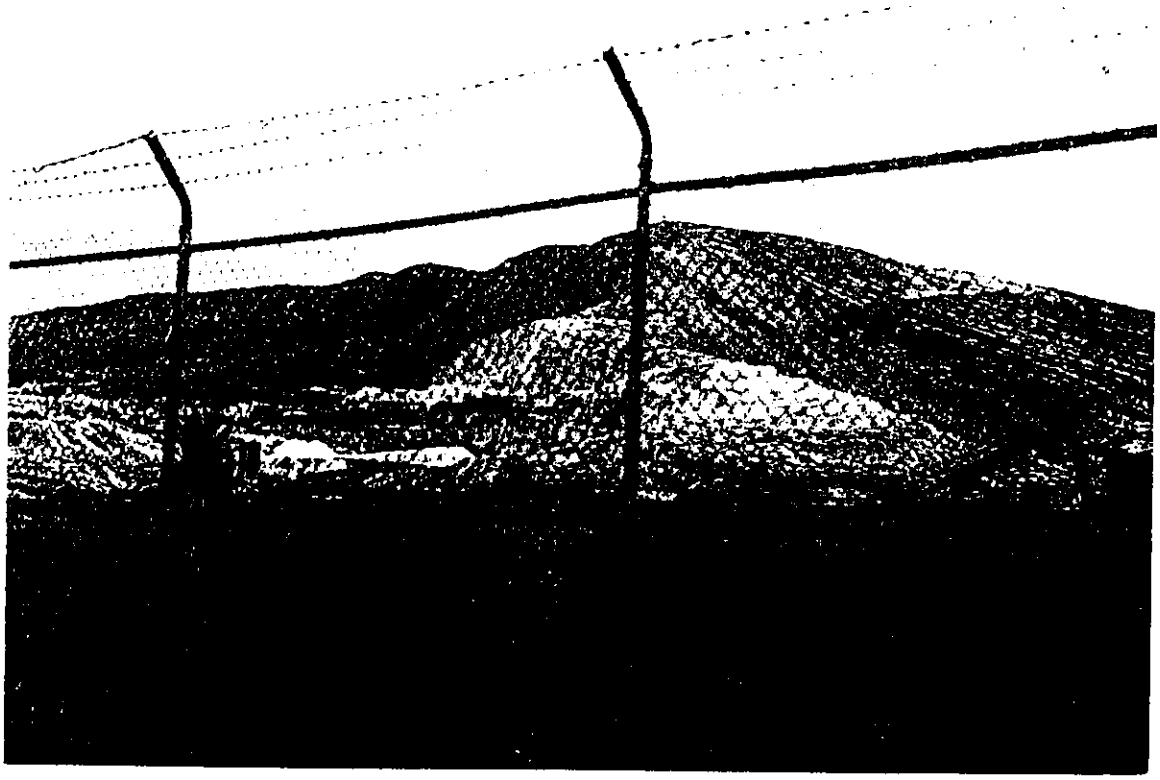
Bazbina - Takrit

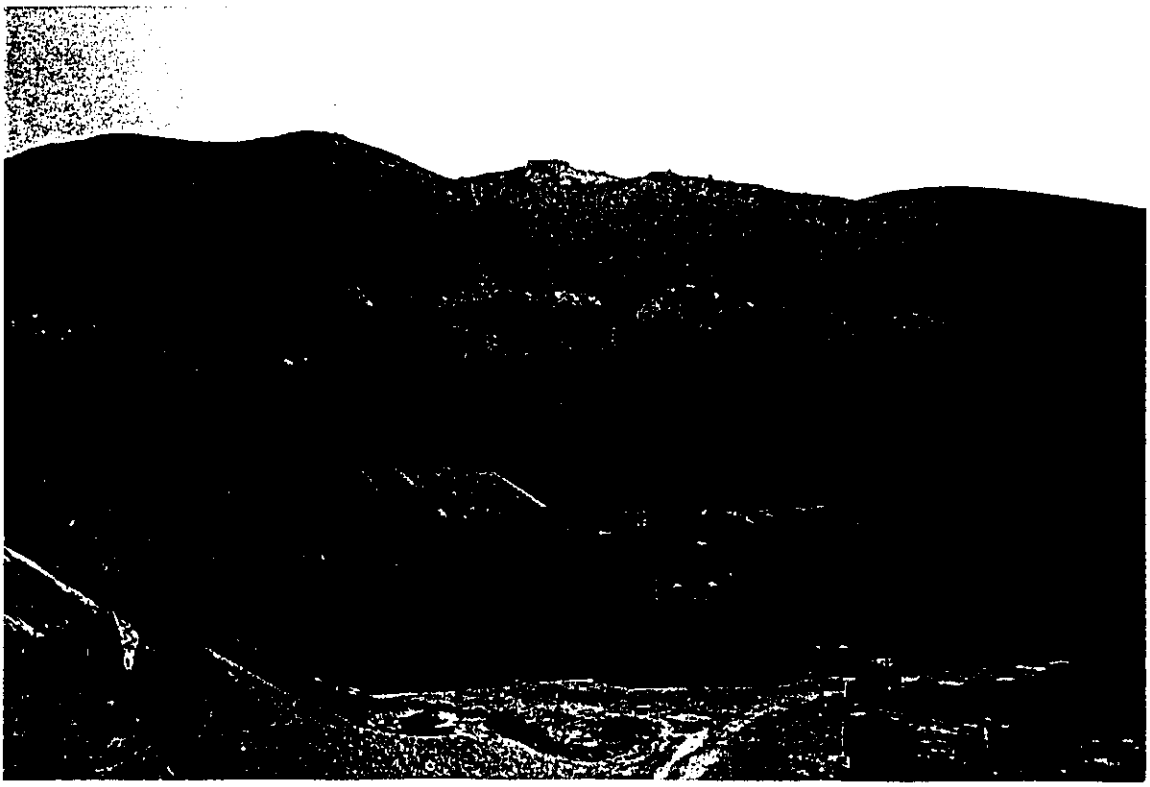
N008, N009, N025, N026 **Al Duhaiby Family** **Tripoli - Deir Amar**

There are four quarries in Deir Amar all occurred by the Lebanese Government. These quarries are leased to various members of the Al Duhaiby family.

These quarries can be seen from the International Coastal Highway and from almost anywhere in Tripoli and surrounding communities. These quarries are specifically close to the village of Deir Amar and the routes followed by the trucks are the relatively narrow roads within the village. The roads followed are highly damaged. The quarries overlook the I.P.C. Fuel tanks farm. Any uncontrolled blasting may result in sharpeners reaching the tanks. The distance to the closet tank is estimated at about 300 m. A detailed environmental survey shall be imposed to determine the damages caused to the population, village, roads and the visual intrusion. In accordance with the proposed policy under strategic criteria, operations in these quarries should be stopped immediately and restoration measures implemented. The cost of restoration shall be borne by the quarry investors.

Tripoli - Deir Amar





Tripoli - Deir Amar

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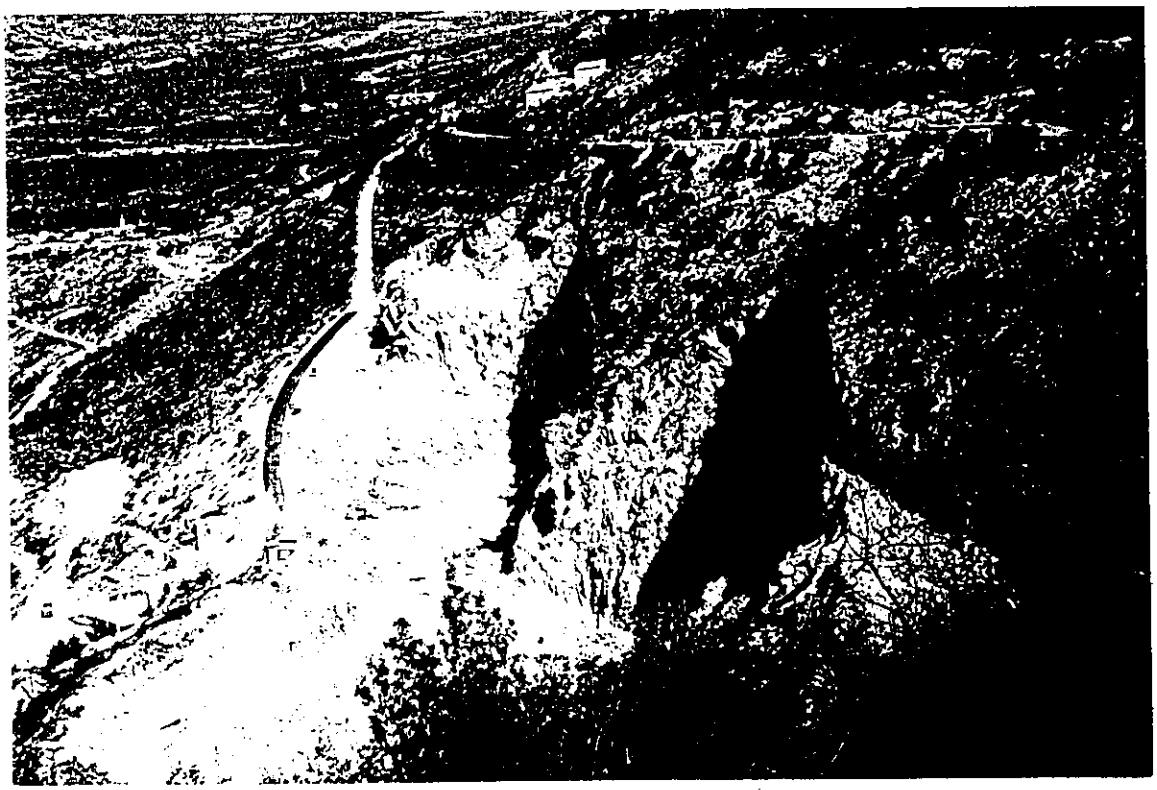
N020	**Antoine Naim Maklouf**	**Mizyara**
N021	**Shiban Al Ghazzal Mouawad**	**Zgharta**
N022	**Simon & Jawad Barbar Antai**	
N023	**Antoine Naim Maklouf**	

Three out of four quarries in Miziara are considered dangerous and require immediate actions. These quarries are bound by a main road, the quarries are encroaching on the exiting road endangering its stability. Further quarrying in the direction of the upper road should be stopped. During the visit to these quarry sites, a large rock block fell unexpectedly (quarry of Antoine Makhlouf). A gallery was being drilled just beneath the existing road in the quarry of Simon and Jawad Barbar Aantan. A new quarry is being opened by Antoine Makhlouf in the vicinity. This new quarry is equipped with a crusher filled with dust filters. The quarry, however, is near a stream with strong flowing water.



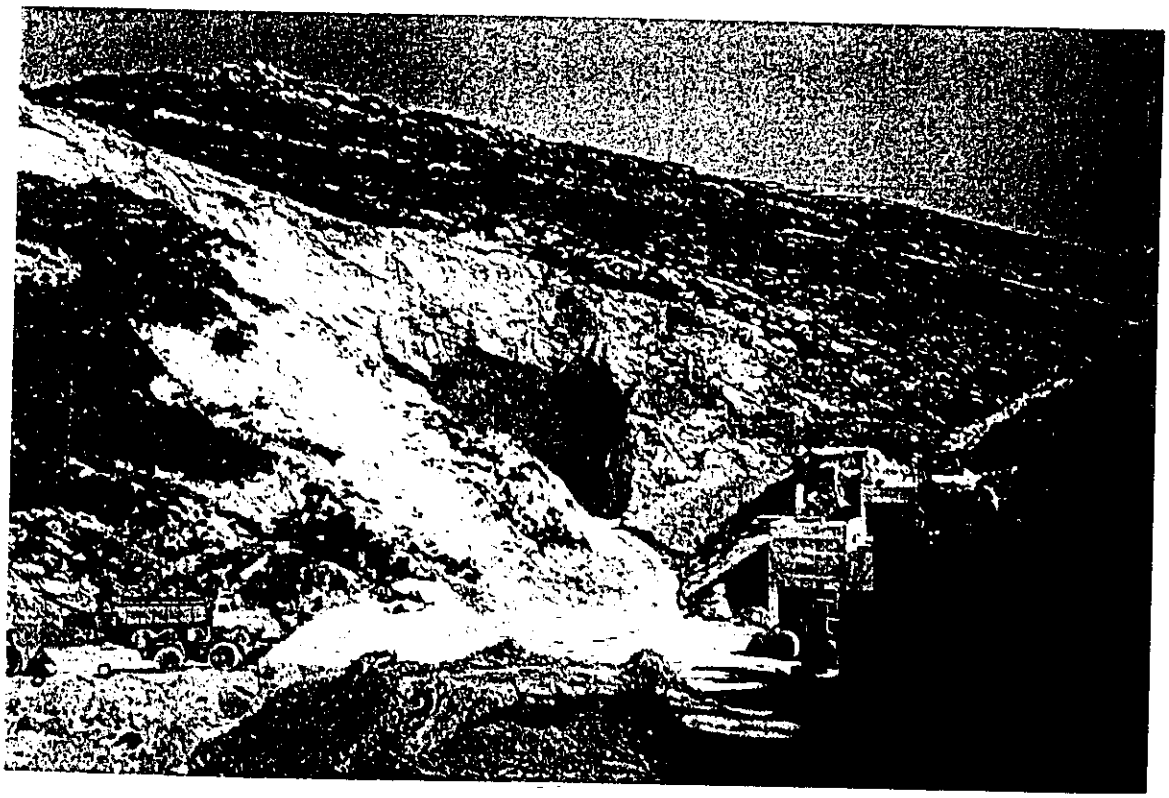
Mizyara - Zharta

Operator: **Riyadh Ali Abdul Razzak** **Bzal - Akkar**

The quarry face is all a main overhangs in critical conditions; quarrying is carried under the cliff causing undercutting. During the visit, it was understood that frequent rock falls have occurred, occasionally leading to the billing of workers.

This quarry should be slopped from further quarrying until all overhangs are removed and a adequate slope geometry is achieved.

The operator did not allow entrance into quarry site.

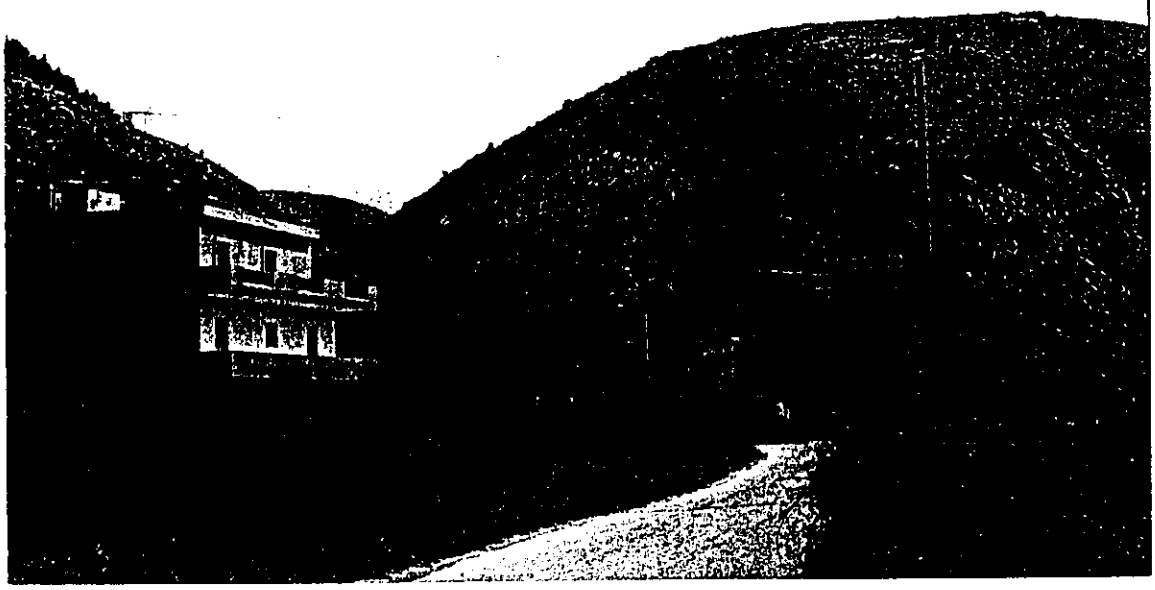


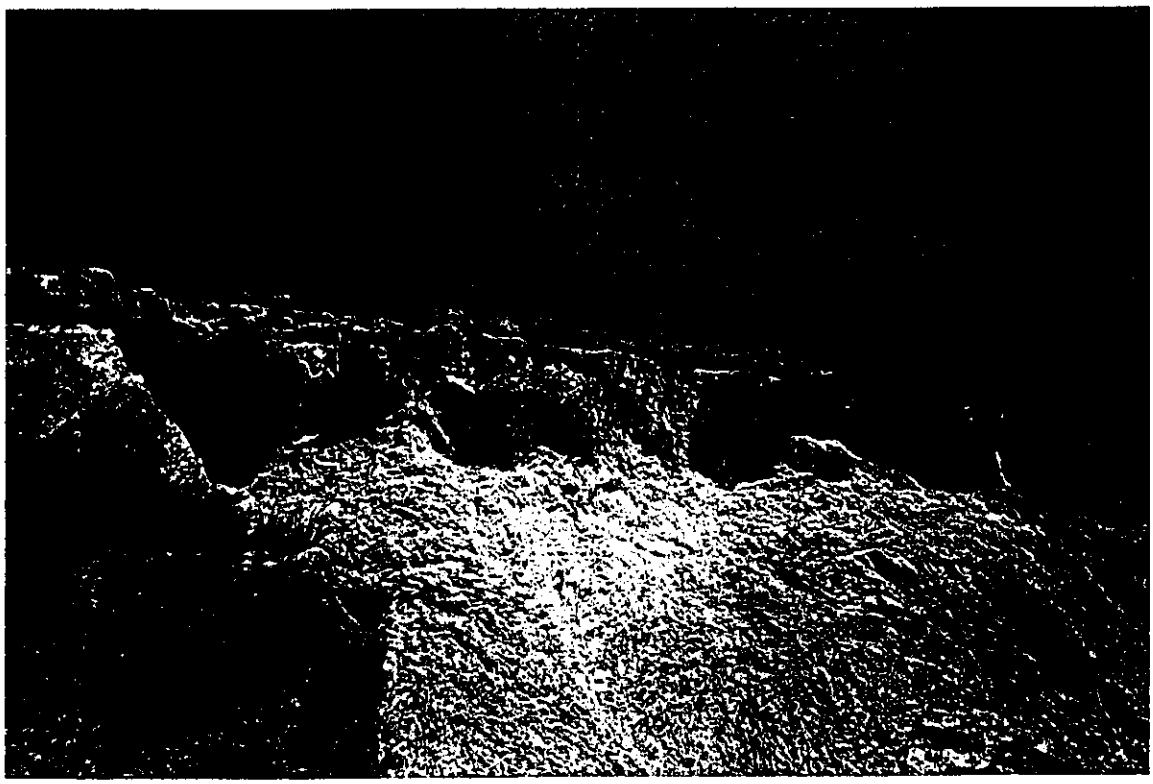
Bzal - Akkar

N039 **Abdul Karim Al Masri** **Al Humeria - Akkar**

This quarry is reported to be abandoned. The quarry face, however, is unstable in the sense that loose rock blocks and overhangs exist. The quarry face should be cleared from all unstable blocks and minimal restoration measures implemented.

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



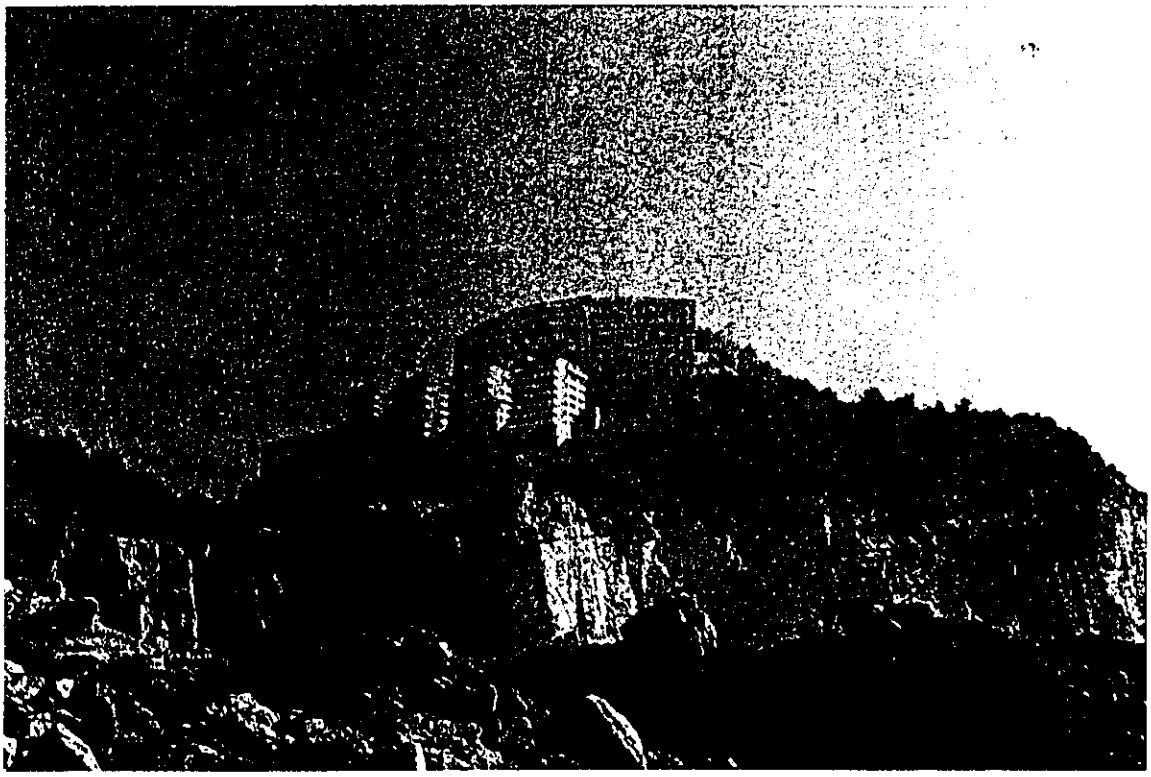


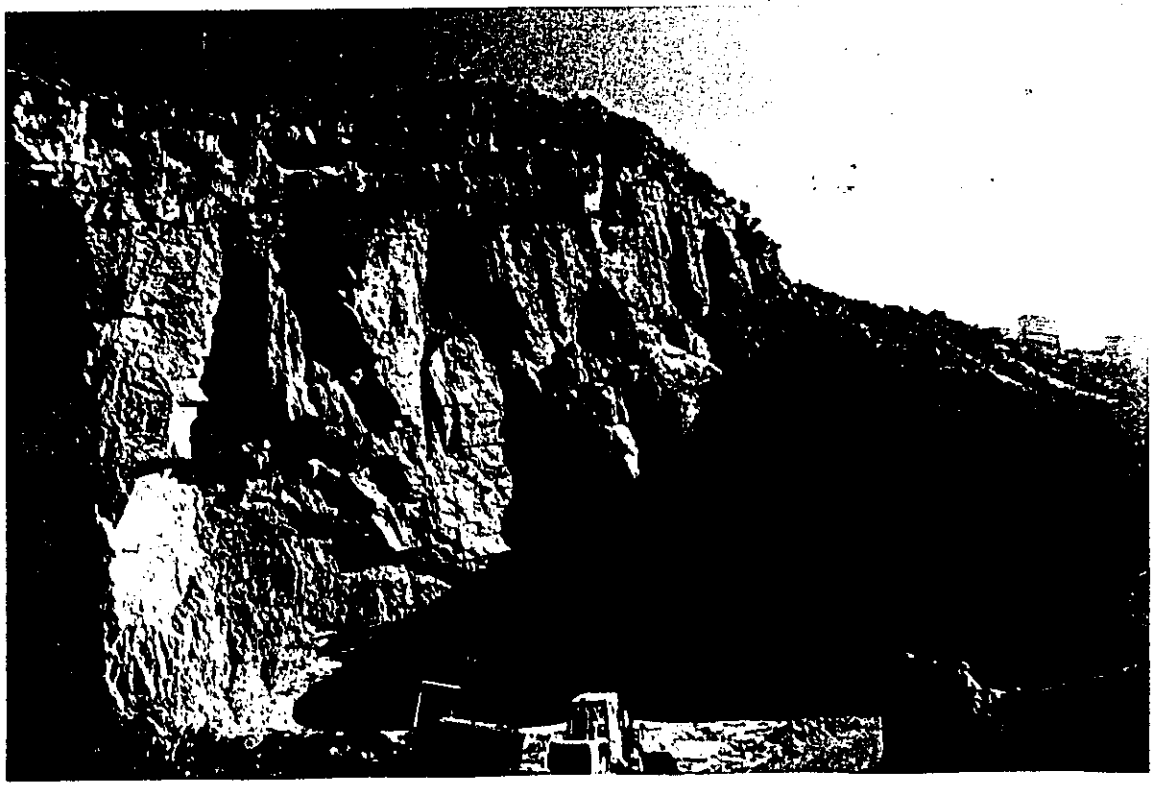
MOUNT LEBANON

ML001 **Farhat Abu Jawdeh** **Antelias**

This is another quarry in Antelias area in relatively close proximity to the village and close to the quarry of Raymond Kanaan and Bross. A high cliff of about 80 m has been excavated with no benches or berms to enhance stability. Nevertheless, the dip of the rock layers is favorable and except for loose rock blocks and overhangs no major stability problems are anticipated.

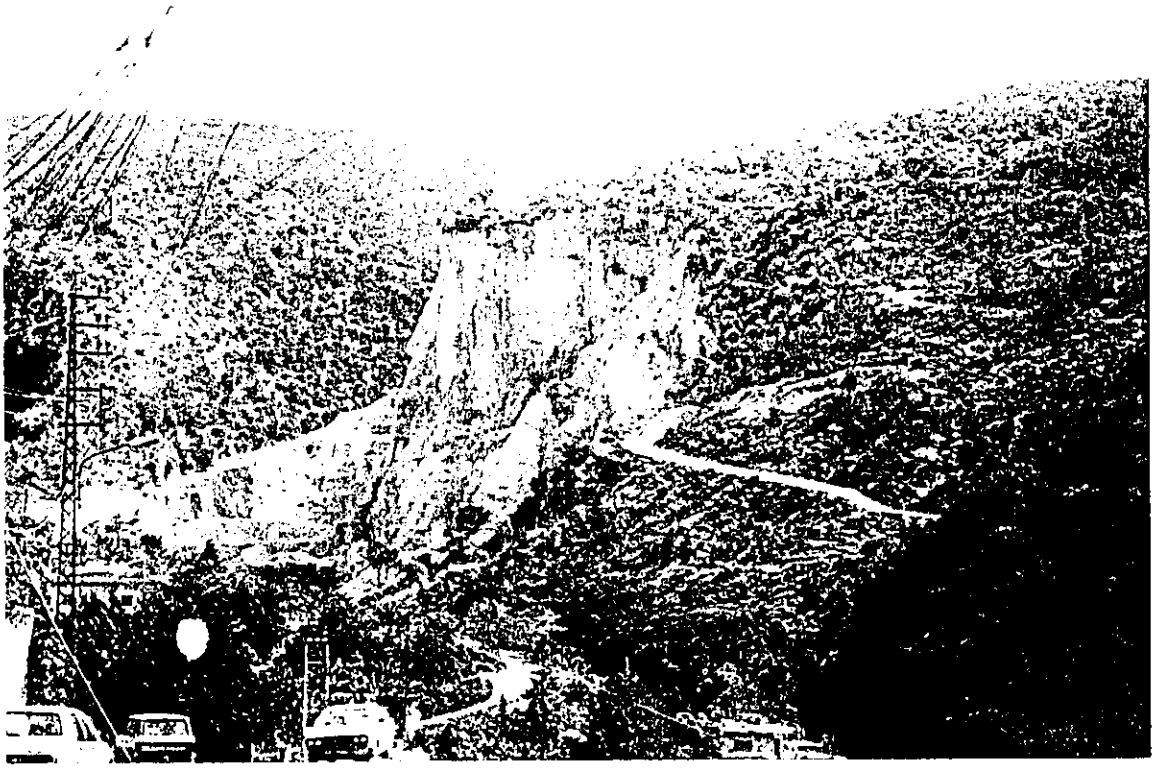
The Roman Catholic Patriarchate is directly on top of this quarry.





ML003 **Raymond Kanaan and Bross** **Antelias**

This is one of the quarries in Wadi Antelias, it is in close proximity to the village. It is one of the few quarries where berms are used for stability purposes. However, a high vertical cliff is excavated. Further advance of excavation may endanger the electricity pylon at the top.

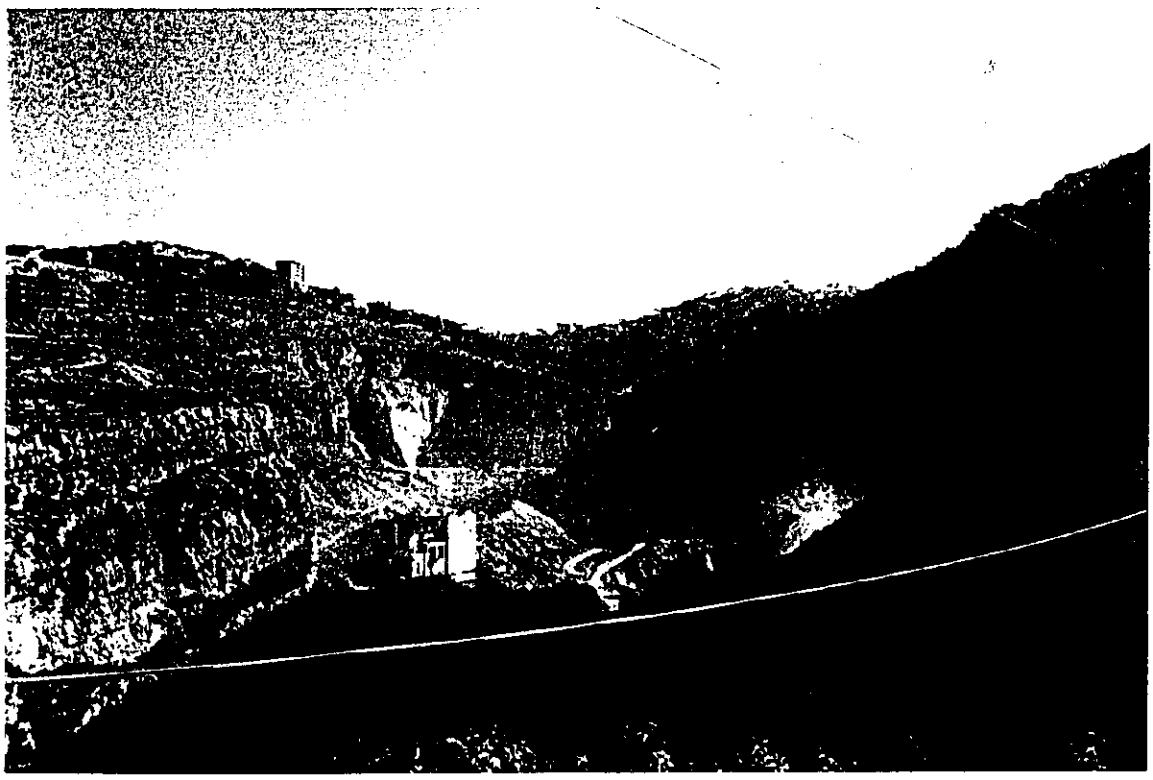


ML005 - 6	**Nimr Milan**	**Nahr Al Maout**
ML025	**Jean and George Zaynoun**	
	Joseph Khoury	

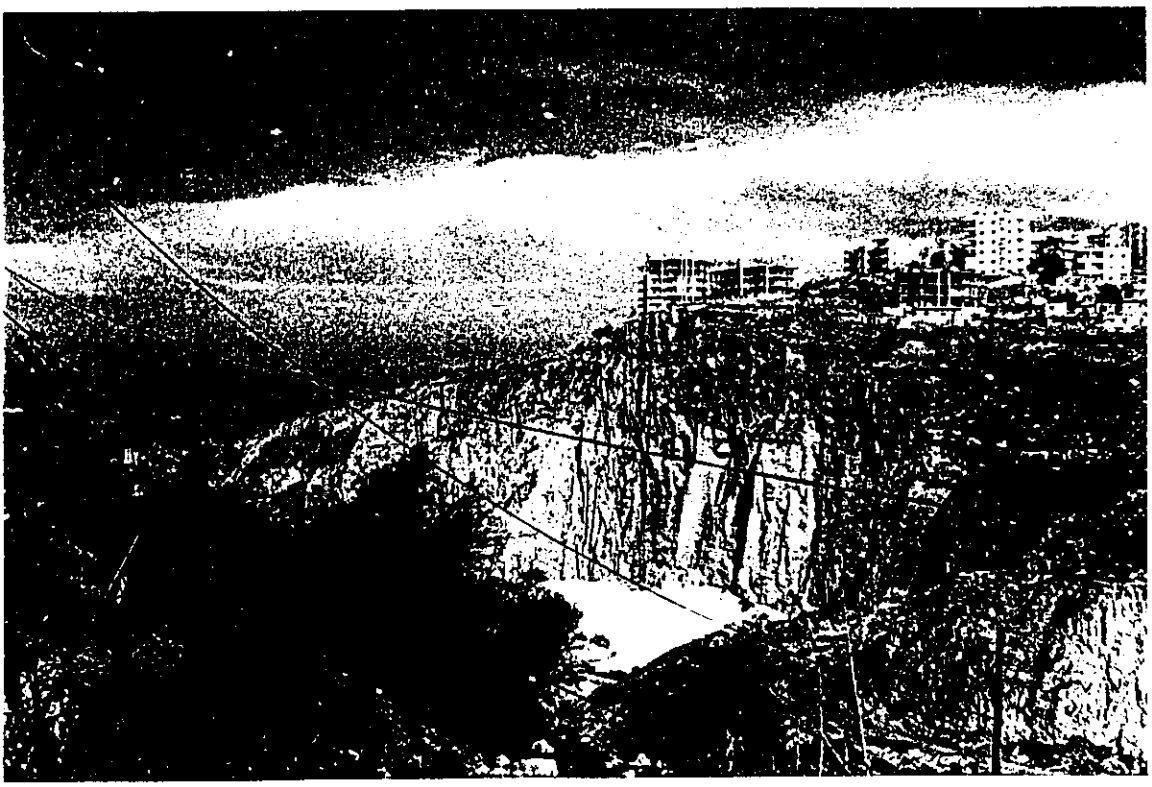
These are several quarries, operating and abandoned, at Wadi Nahr Al Maout. The area has been exploited for a long time and urbanism has become very close.
These quarries can be seen from both Roumieh and Biaqout - Bsalim hill sides.

Block and wedge type failures are apparent on site. One of the quarries is already too close to the boundary fence of Roumieh prison. Further excavation in this quarry may endanger the stability of the wall and eventually the prison.

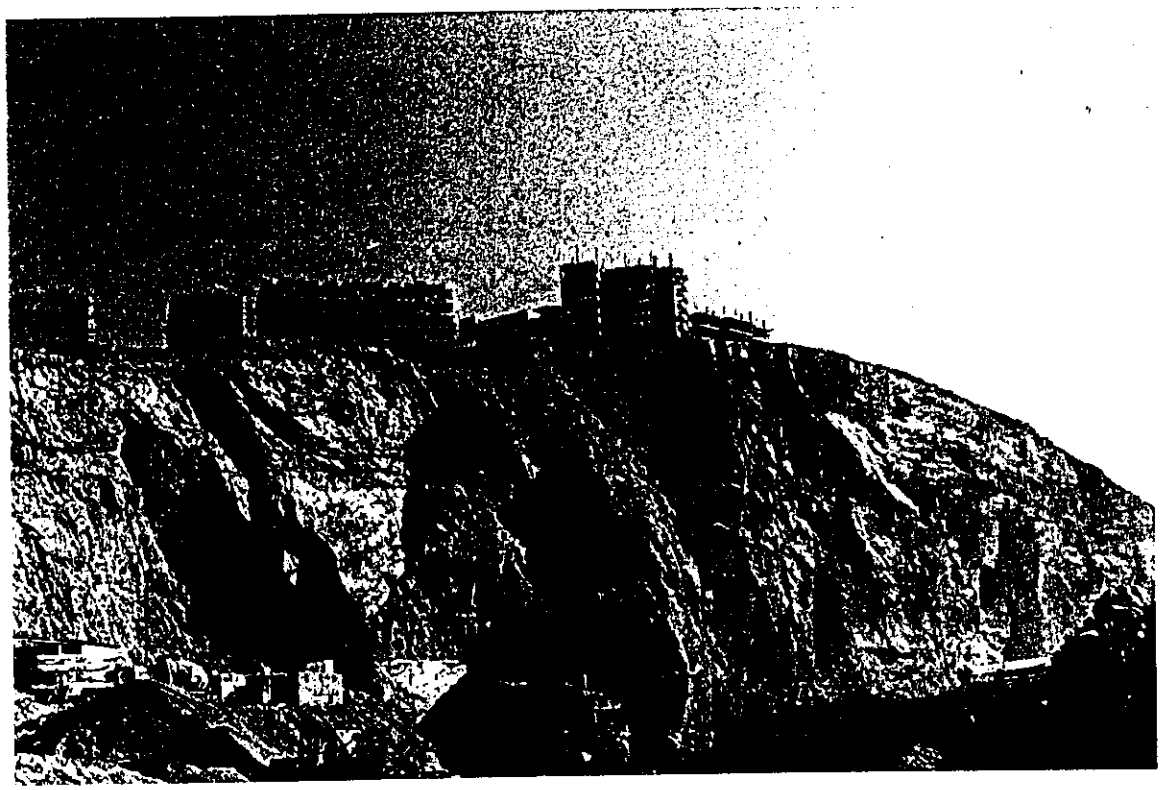
For this site of quarries, a general assessment is required both environmental and urban, and consequently future land use.

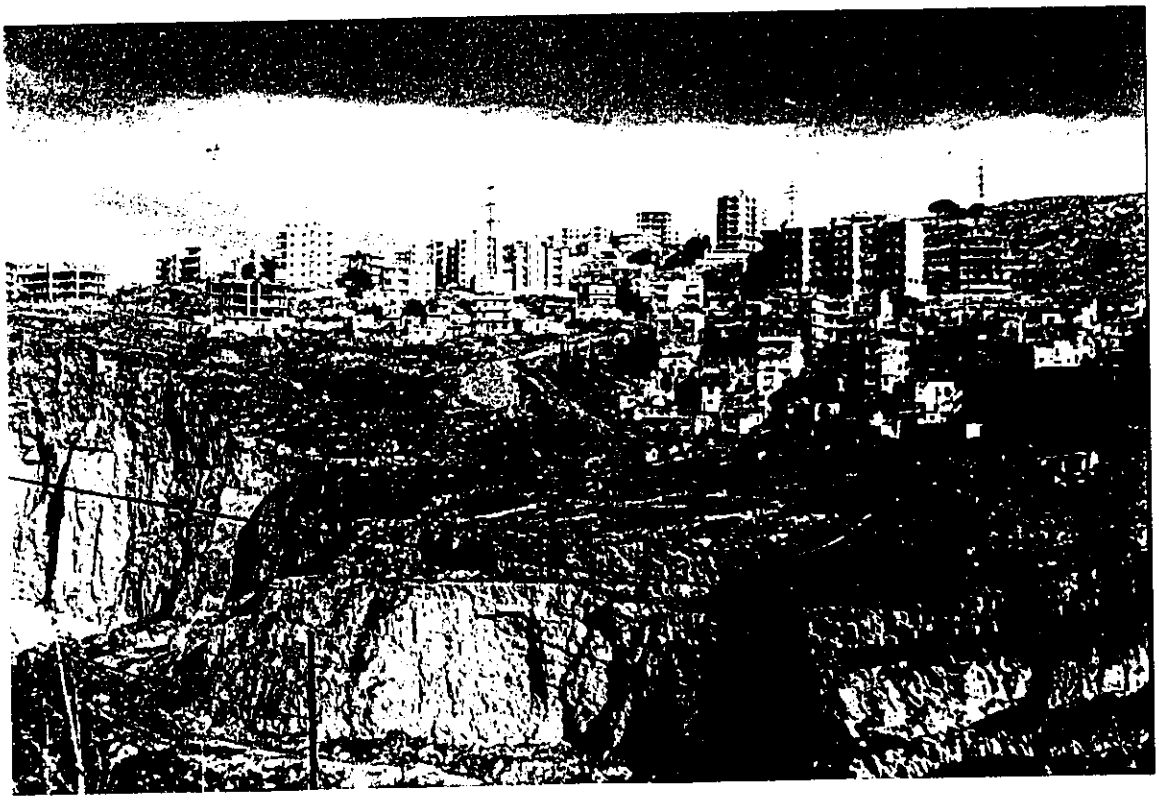


Nahr Al Maout



Nahr Al Maout

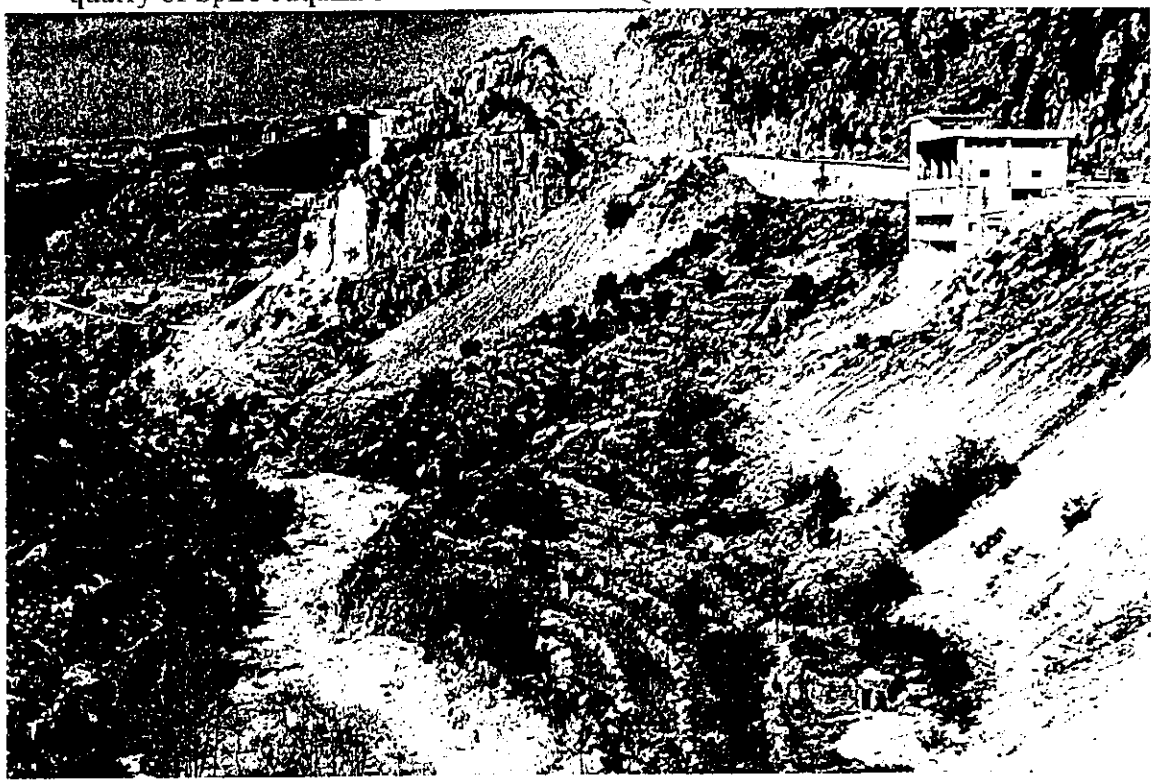




Nahr Al Maout

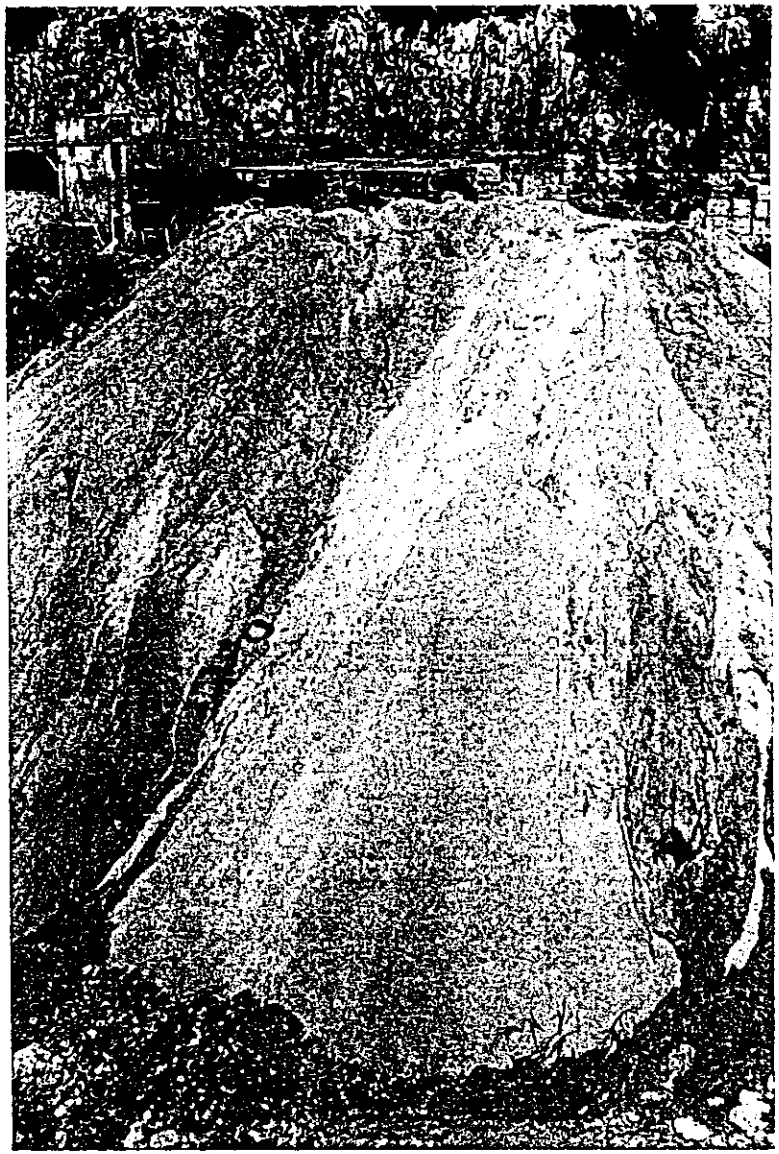
ML009	**John Al Qaii**	**Abu Mizan**
ML008	**Jamil Al Qaii**	
ML010	**Haikal Al Khazen**	
ML012	**Spiro Jupaim**	

This is a cluster of quarries in the proximity of the Hardoun River. The quarry of John Al Qaii is directly at the river and is heavily polluting the water with quarry waste. The quarry of Jamil Al Quii, however, is away from the water course. The other quarries are also contributory to the pollution of the water in the river. The Wadi course is also blocked by the waste material from a block factory facing the quarry of Spiro Juqaim on the main road to Quleiaat.



Abu Mizan - Mount Lebanon

Abu Mizan - Mount Lebanon

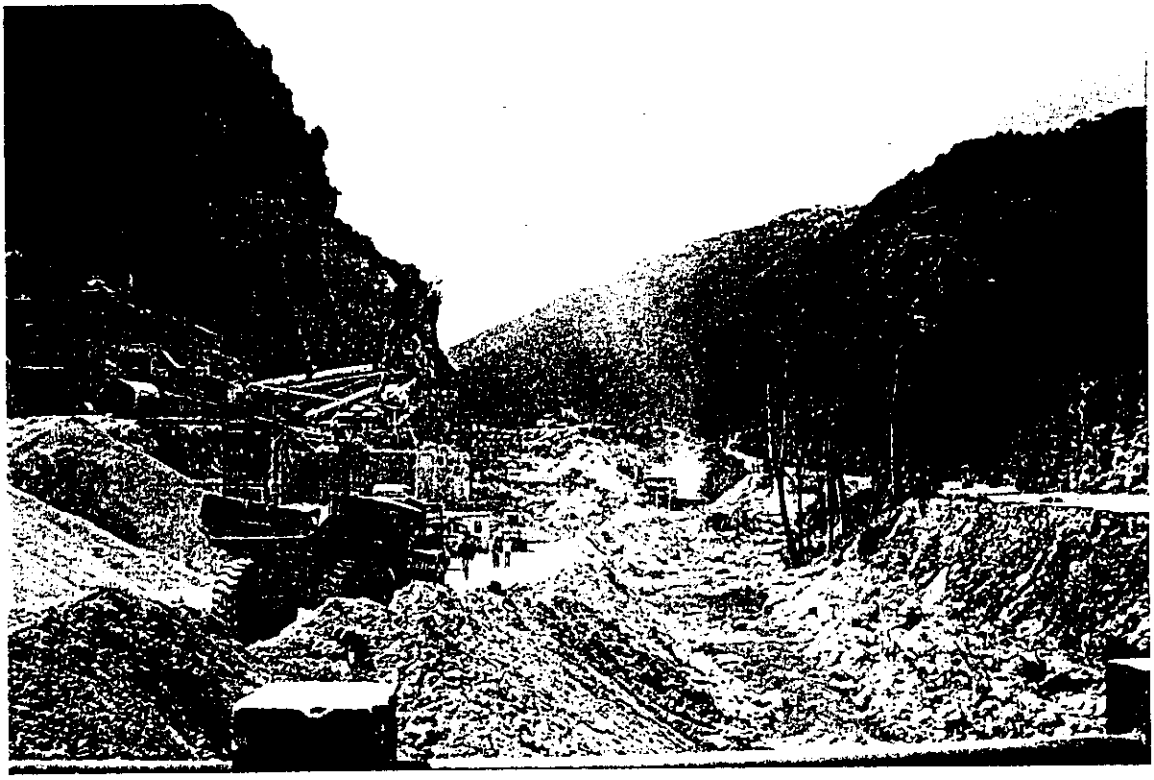


L9467/ML9-12/#11/11/03/96

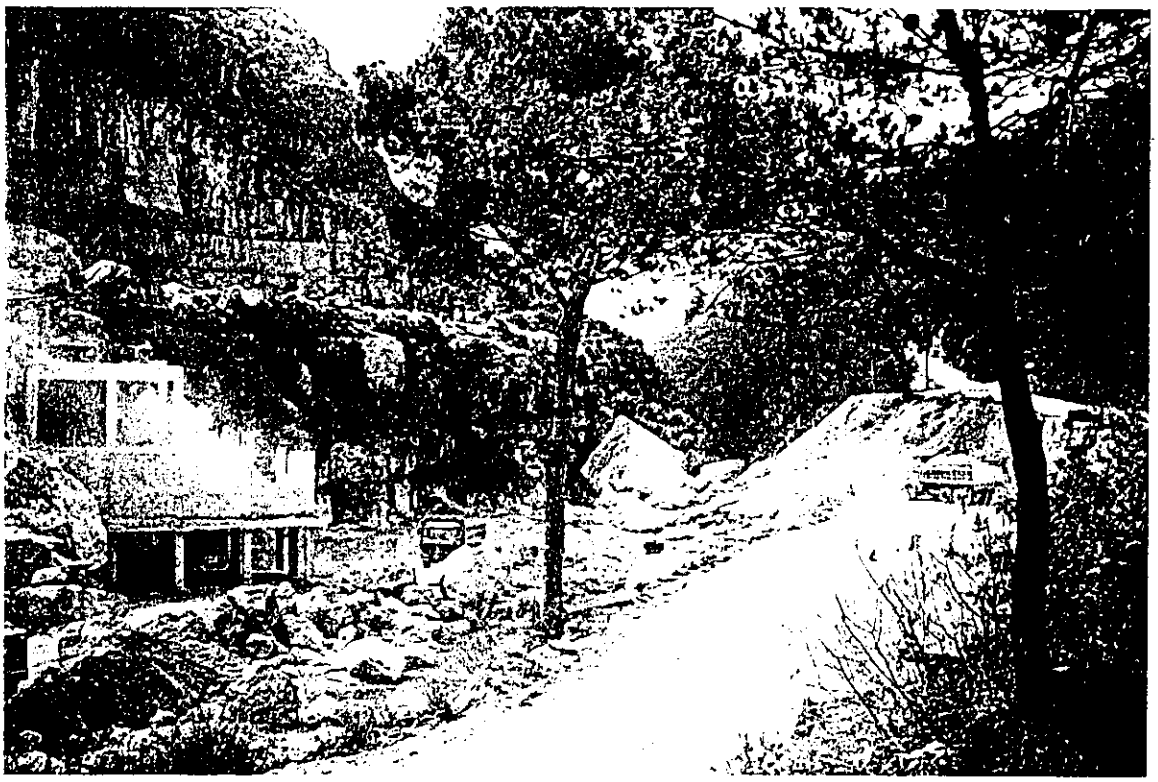
ML013	**John Salem & Habib Hakim**	**Qurtada**
ML014	**Simon Zaynoun**	

These two quarries are in close proximity to a normal road and to a river. They are just below the road leading to Qurtada and can be seen clearly from the touristic area of Beit Meri.
Those quarries have resulted in the blockage of the river course and have encroached on the road on top of the quarries.

The future of these two quarries should be considered in the light of the strategic and operational criteria set out by this study.



Qurtada



ML063 **Joseph Khoury** **Aamsheet**

This is a typical quarry in an intermittent Wadi course. Such quarries are frequent in the country and widespread in the various Muhafazat. It is essential that if such quarries are to continue they abide by the strategic requirements.

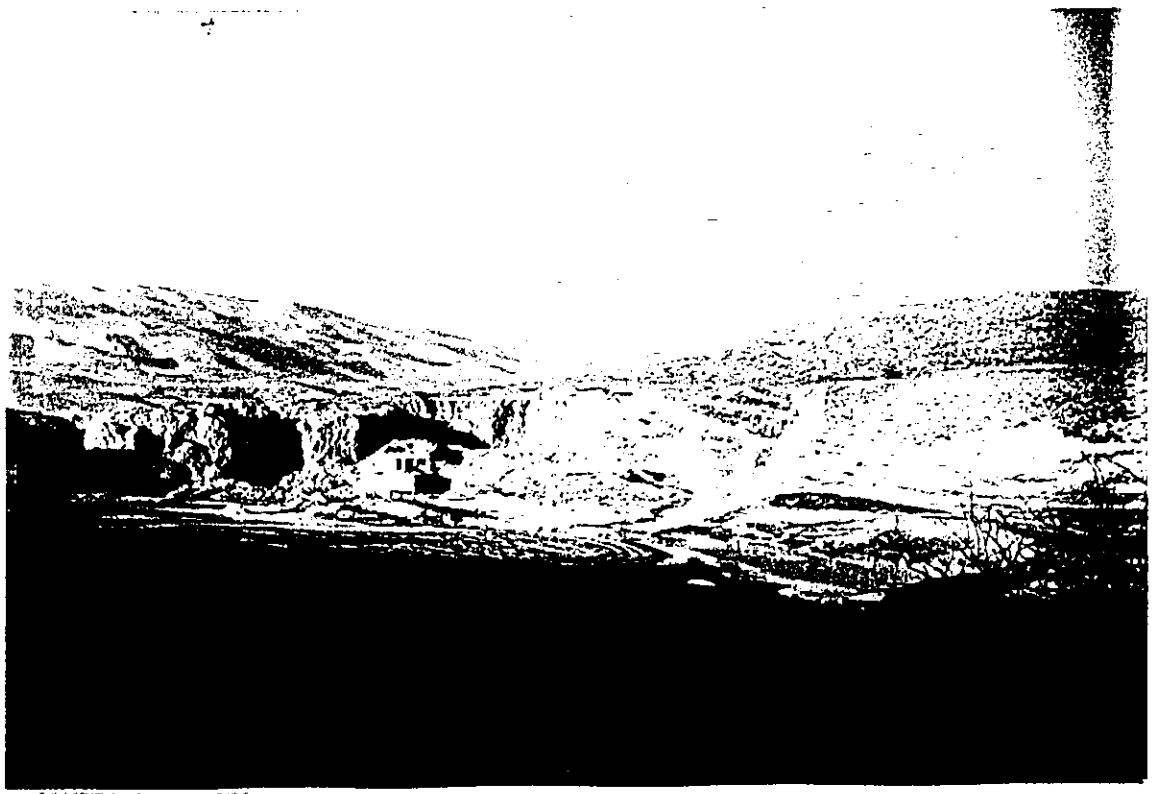
ML080 **Joseph Sfair** **Frat**

This quarry is below the road leading to Quleiaat. In general, the quarry is away from roads and cannot be seen from a distance as it is hidden within the valley walls. However, the embankment slope created from the quarry waste appears to be unstable and is directly at the back of houses. The quarry if not cautiously used may endanger the inhabitants and/or their properties.

BEKAA

B006	**Tourki Youssef Al Mikdad & Tamer Al Mikdad**	**Maqneh - Baalbeck**
B007	**Abu Jaafar Al Mikdad**	
B017	**Maksoud Al Mikdad**	

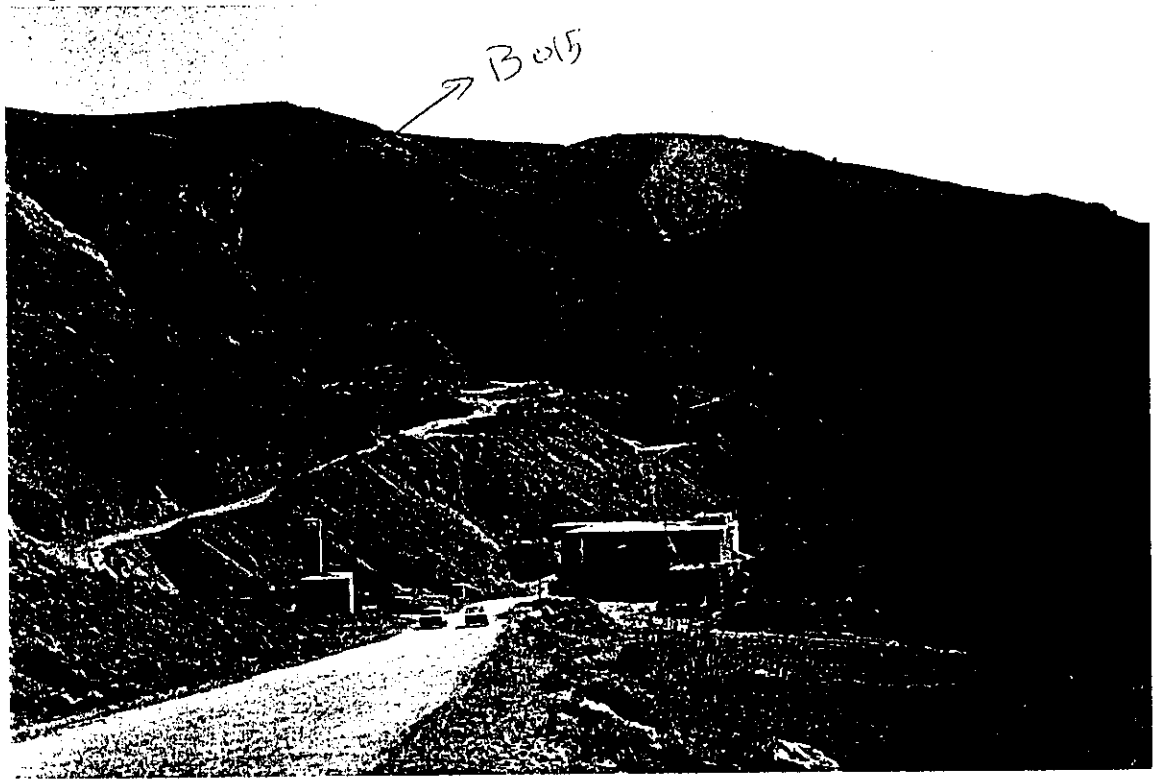
These quarries are located in within Wadi Nahleh. The land is governmental land. They extract conglomerate from the rive banks to be used as aggregates. Quarrying operations have resulted in blocking the river course and subsequently several small - scale floods in the area. It is understood that the government intends to construct a small dam neat quarry B006 and create an artificial lake.

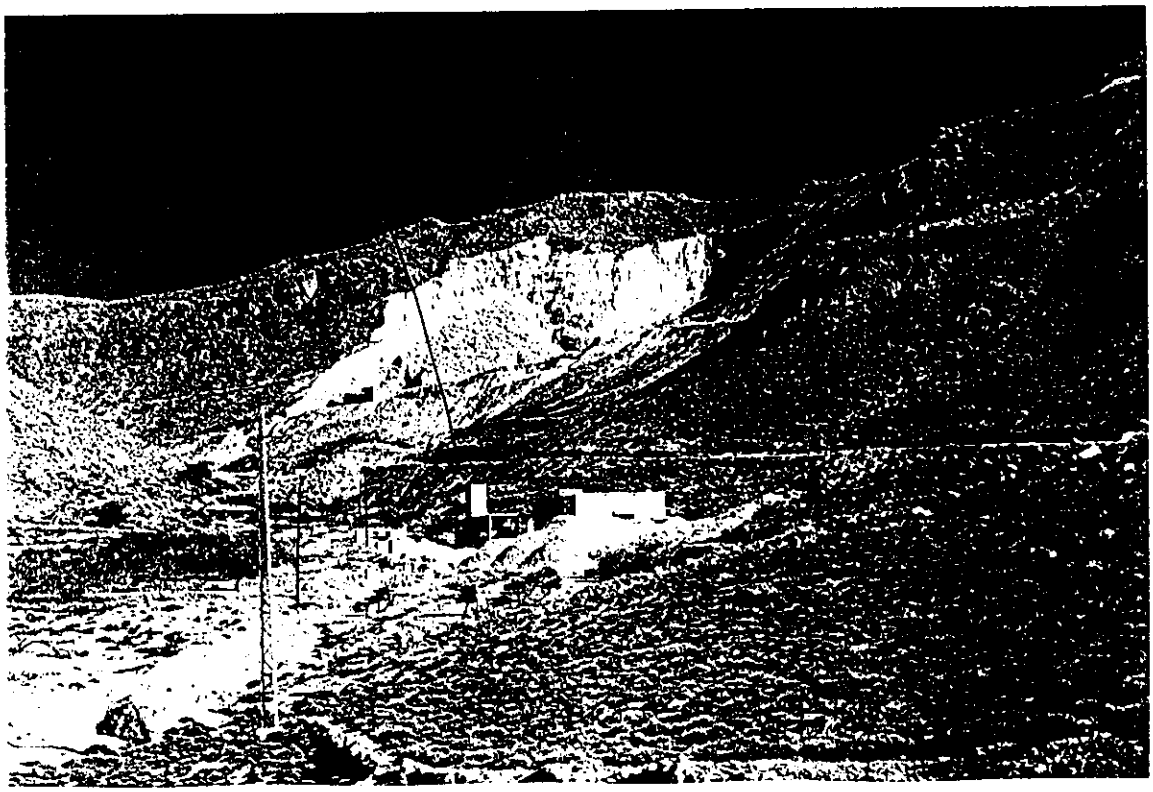


L9467/B6-17/#11/09/03/96

B013	**Muhamad Abdul Karim Al Hujairy**	**Arsal**
B014	**Mahmoud Muhammad Al Hujairy**	
B015	**Abandoned**	
B016	**Ali Al Hujairy**	

These quarries are located in Ain Al Sha'ab at the entrance to the village of Arsal. They are used for the production of aggregates.
The four quarries are located directly above the main and only road leading to Arsal. Due to blasting and quarrying operations they have frequently resulted in closure of the road. The waste material is dumped in Wadi Ain Al Sha'ab. Those quarries are hazardous to passengers on the road.

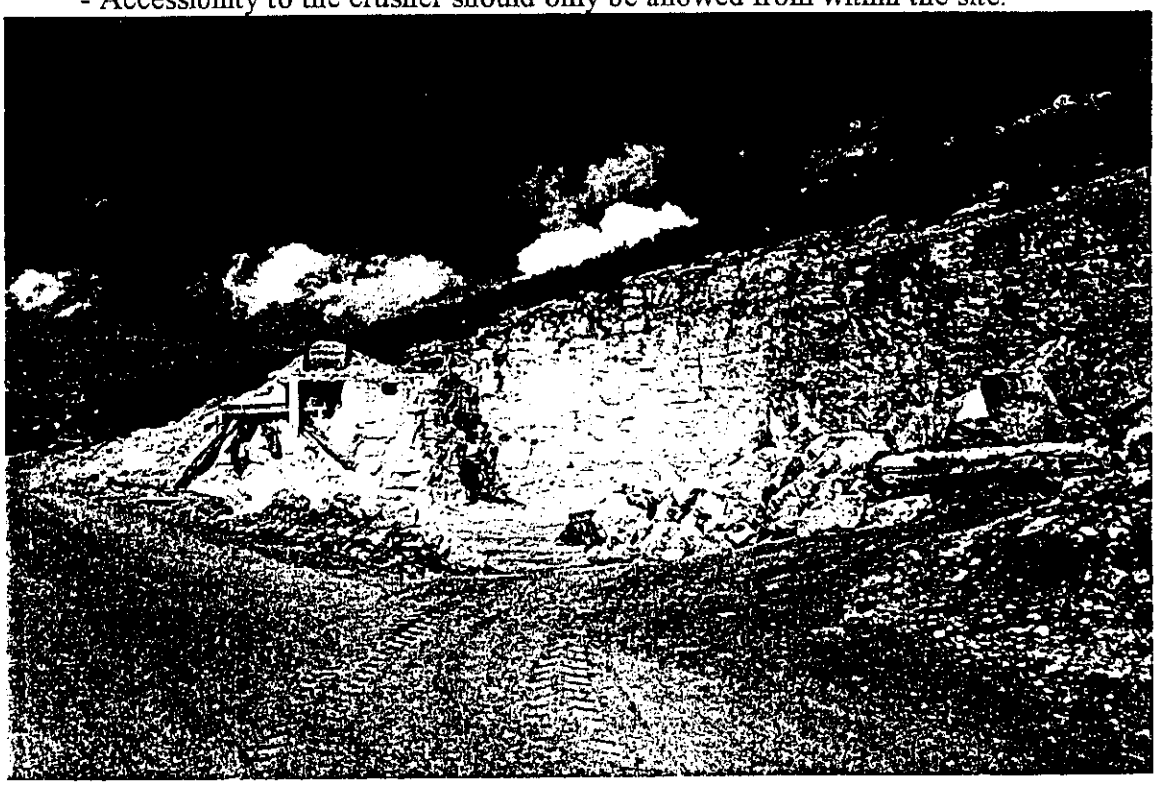


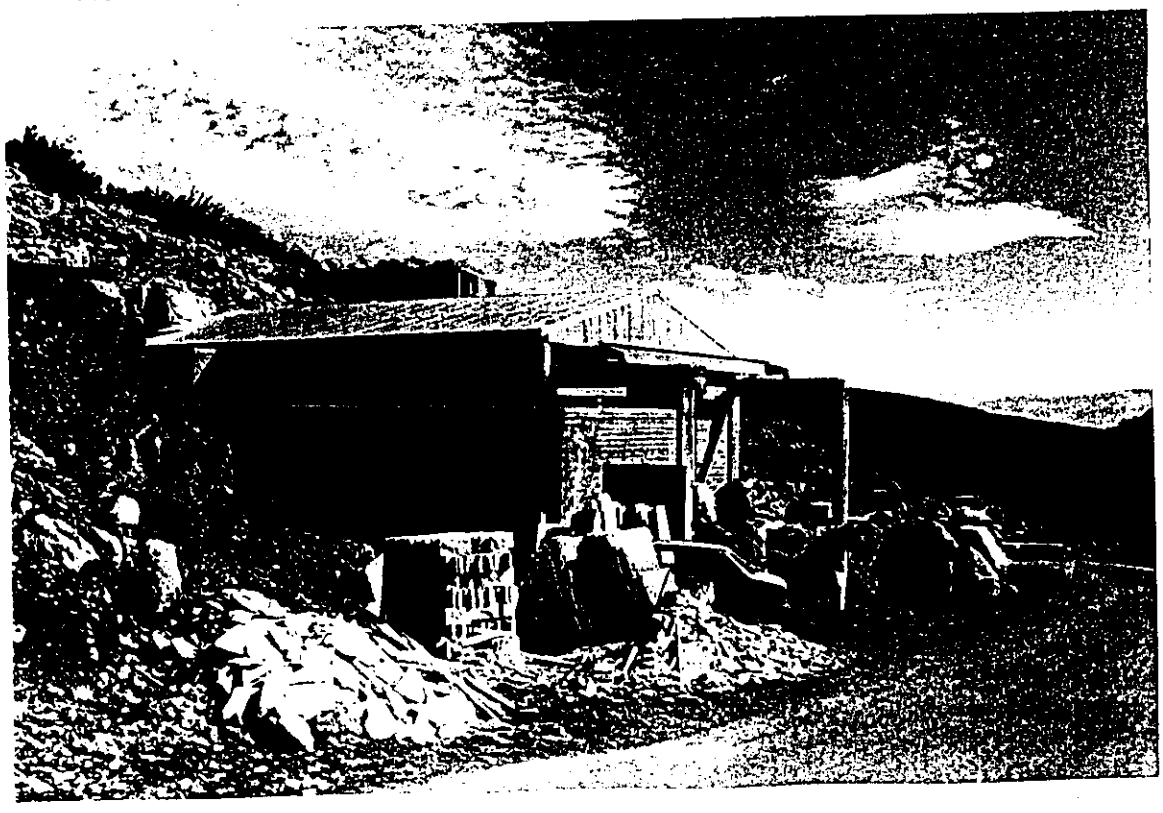


B023 Abdullah Habshi Deir Al Ahmar - Bekaa

This quarry is in a public area, it produces both aggregates and dimension stones. It is considered one of the largest quarries in the area. It is only 2 m away from the road linking Deir Al Ahmar to the picnic area of Yammouneh village. The location of the quarry is hazardous to the by passing cars. If quarrying is to continue warning signs should be erected,

- A fence at the Row of the highway should be constructed limiting the access to one gate opening.
- Trees at 7 m spacing and shrubs in between are to be planted.
- Accessibility to the crusher should only be allowed from within the site.

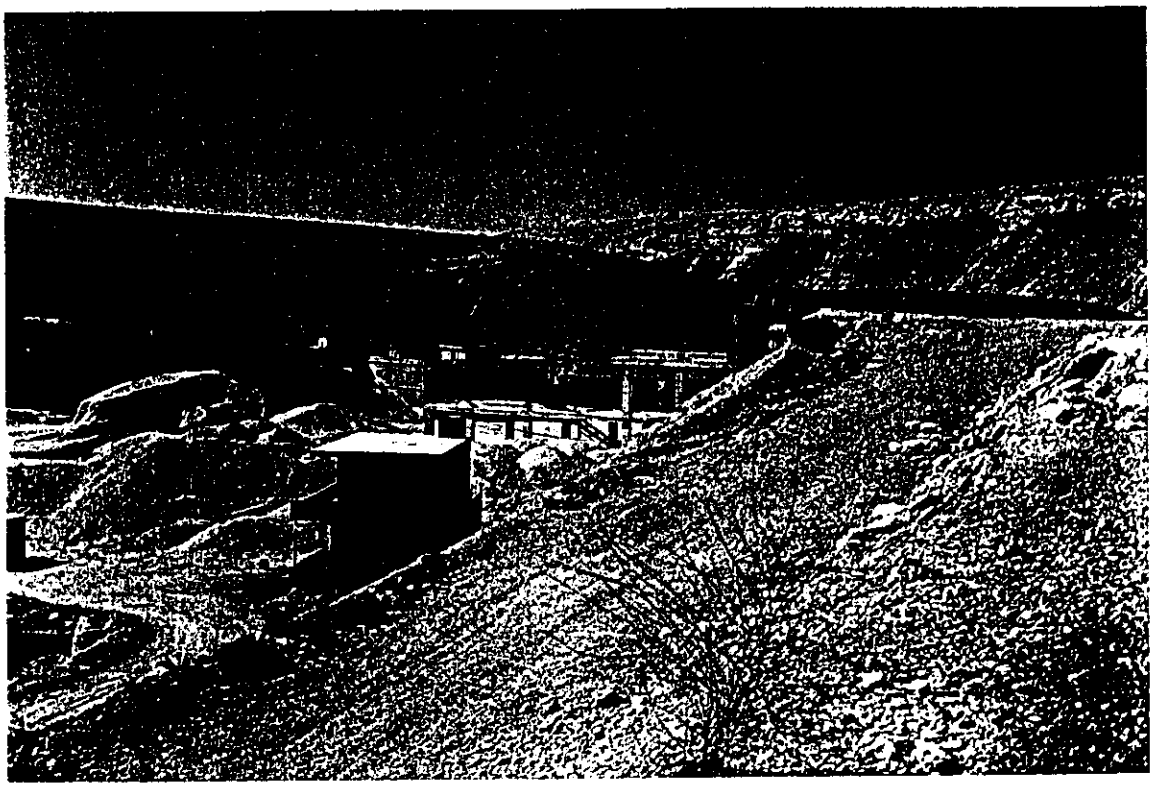




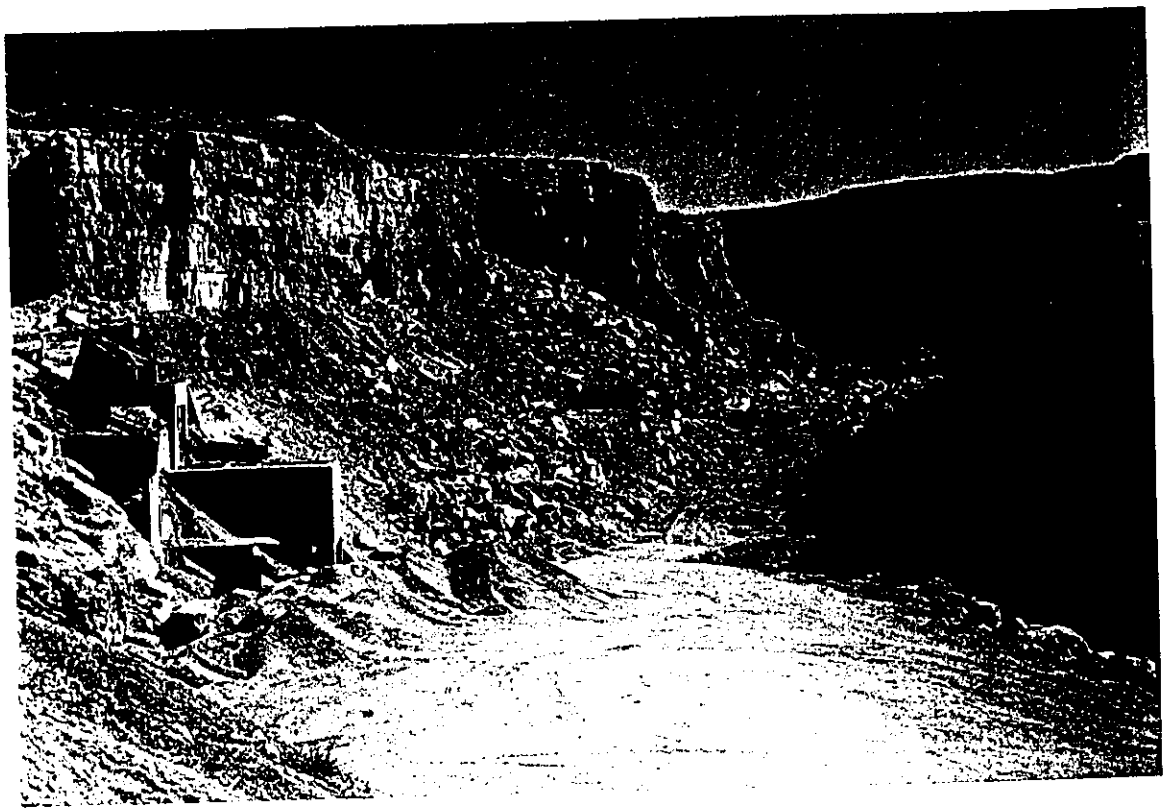
B037 Ali Abbas Younis Taibah - Bekaa

This quarry is an example of the use of wadi courses as storage area and for the construction of crushers. This quarry is about 800 m in length along Wadi Hrayban. The rocks on both sides of the wadi are extracted by blasting in galleries. The wadi plain is being used as a large storage yard. It was reported that water used to flow in this wadi but was diverted same fine years ago.

An environmental impact assessment should be requested from the operator with a clear description of the pre-quarrying condition. The crusher is to be relocated away from the right of way of the wadi. If this quarry is to continue operation, it should conform to the requirements set out in this study. The old stream bed, however, should be cleared of all debris and restored to its original state.



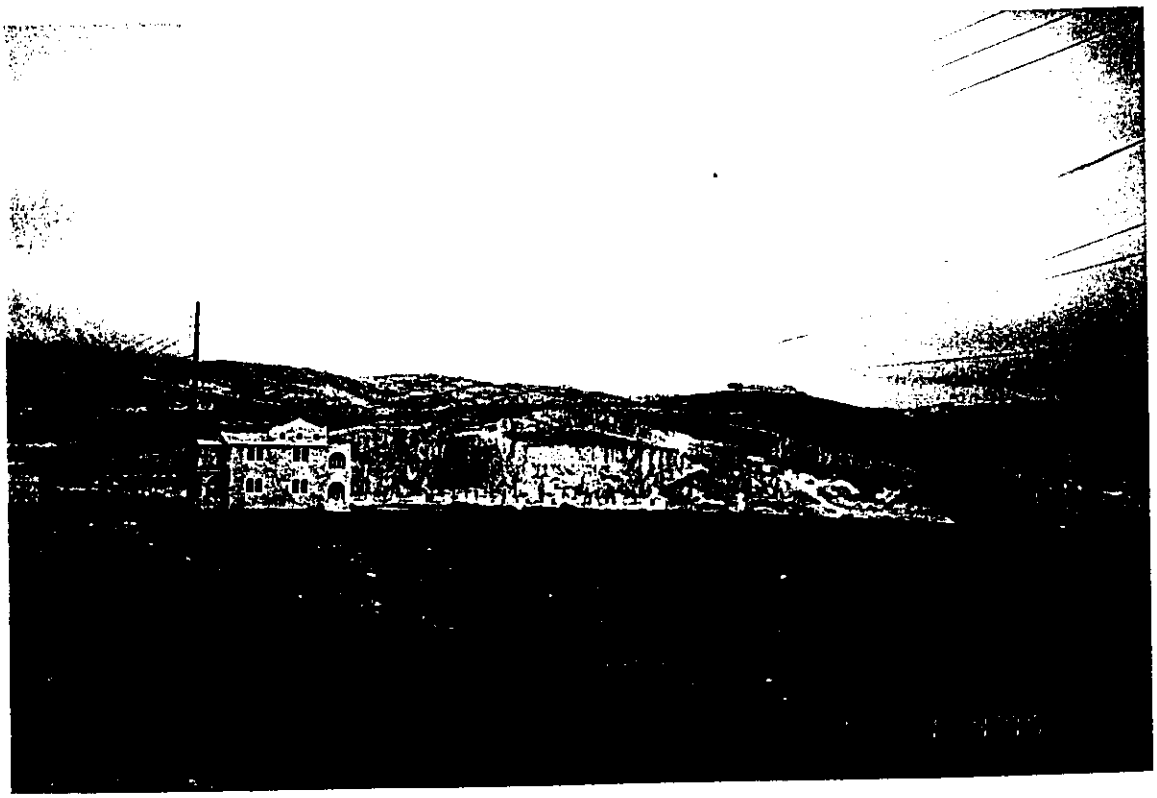
Taibah - Bekaa



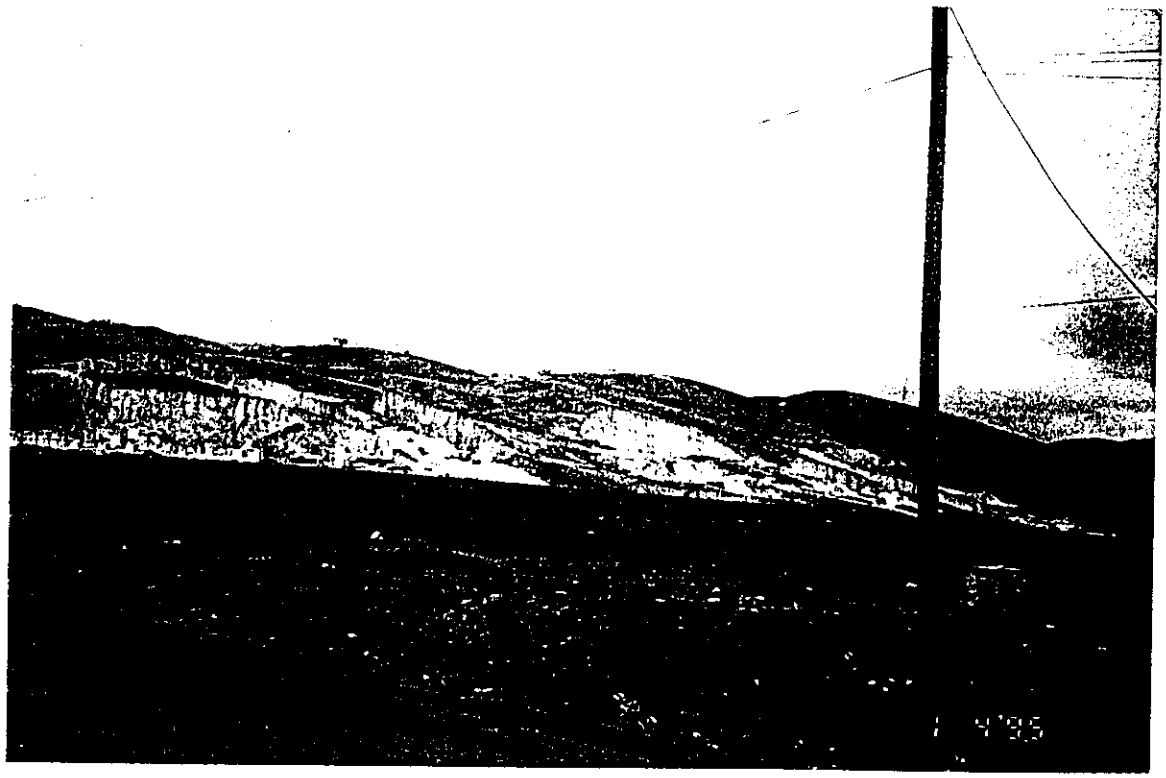
B056	**Joseph Trad**	**B062**	**Serhal Abu Trad**	**Deir Al Ghazal - Bekaa**
B057	**Saad Kazan**	**B063**	**Salibi Abu Haydar**	
B058	**Ajjaj Freiji**	**B064**	**Assaf Abdo**	
B059	**Daha Kazzan**	**B065**	**Jihad Deeb Kazan**	
B060	**Amin Kazan**			

These quarries lie on the western slopes of the Anti - Lebanon mountain range, and stretch over a distance of 1.5 Km between Raait and Deir Al Ghazzal. They can be seen from large distances in Bekaa and from the eastern slopes of Mount Lebanon. In general, these quarries are clustered to the extent that limits between adjacent quarries are sometimes difficult to delineate. Moreover, they are close to the fertile land and to main roads.

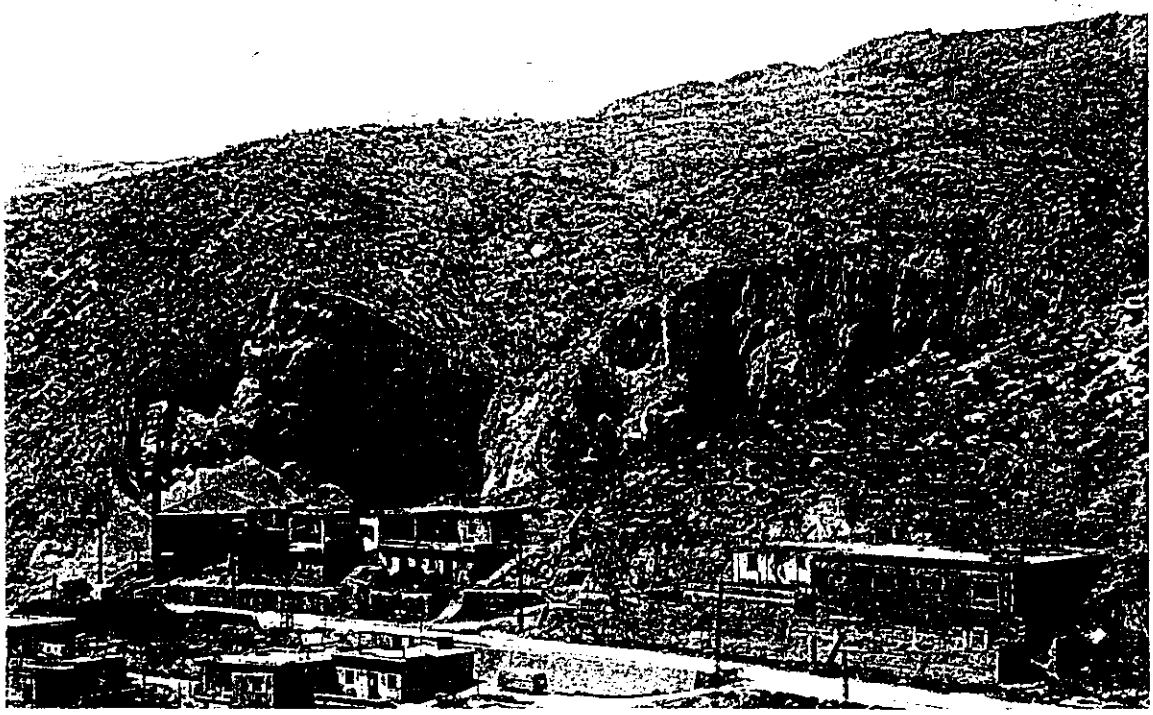
The strategic criteria together with enforcement of environmental measures are required to upgrade these quarry sites. the land on which these quarries are established is all governmental land.



Deir Al Ghazal - Bekaa



Kfar Selwan - Toueitah - Jdeita

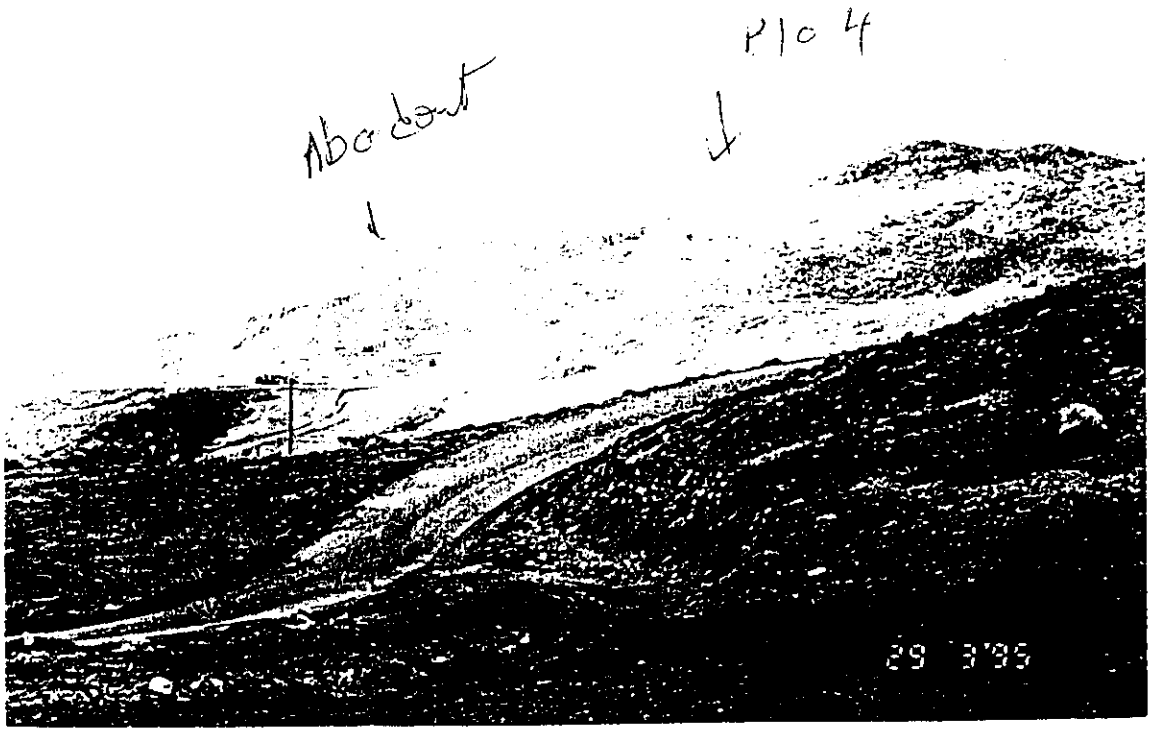


Kfar Selwan - Toueitah - Jdeita

B100 and B101	**Esmat Murad**	**Bekaa - Qub Elias**
B102	**Joseph Sawaya**	
B103	**Harati & Baset**	
B104	**Akram Saiid**	
B105	**Omar Jaber**	

There are 10 quarries in this area, five of which are abandoned. The quarries are located in Ain Dara belonging to the Caza of Aaley in Mount Lebanon. Most of the quarries are in relatively close proximity to the village.

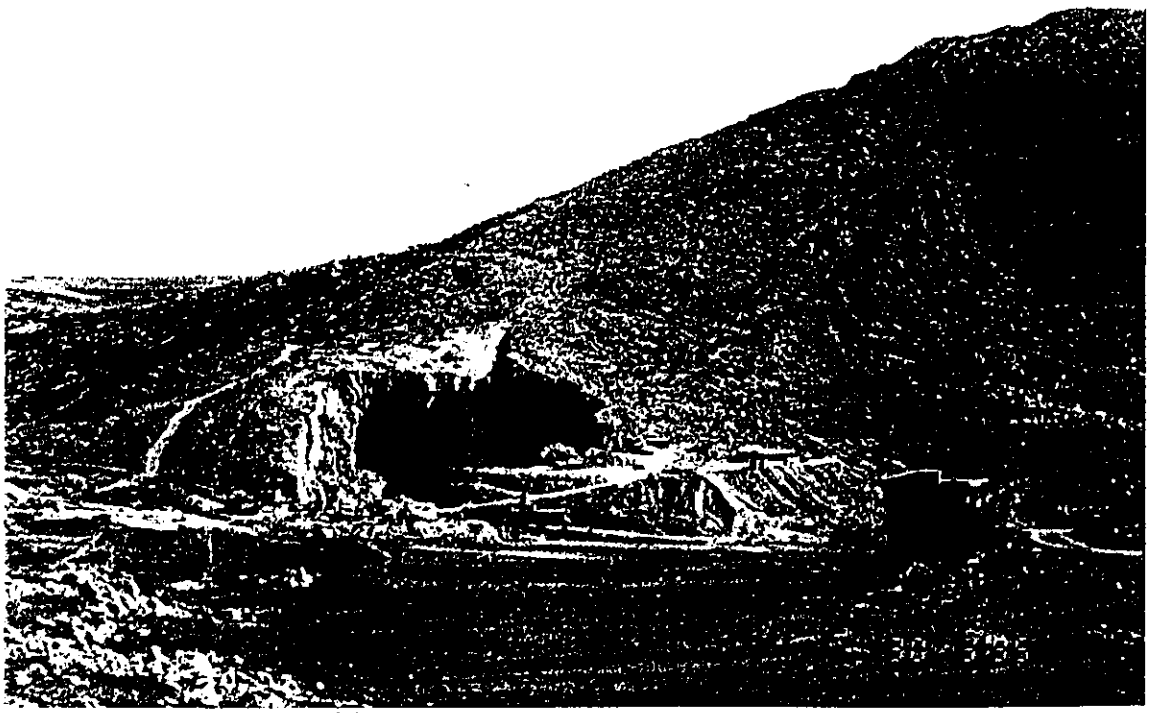
Quarry B104 and an abandoned quarry can be seen from Beirut-Damascus International Road. The other quarries overlook Qub-Elias. They can be seen from Bekaa Valley. The area of the quarries is generally barren with no vegetation.



Bekaa - Qub Elias

B107 Youssef Issa West Bekaa

This quarry is in close proximity (≅ 50 m) to the primary road (Machghara-Claraou-Rashaya) and lies behind the Qaraoun Dam lake. This quarry should be monitored to assess if excavation from the hill, especially if blasting is used, has any adverse affect on the water reservoir.



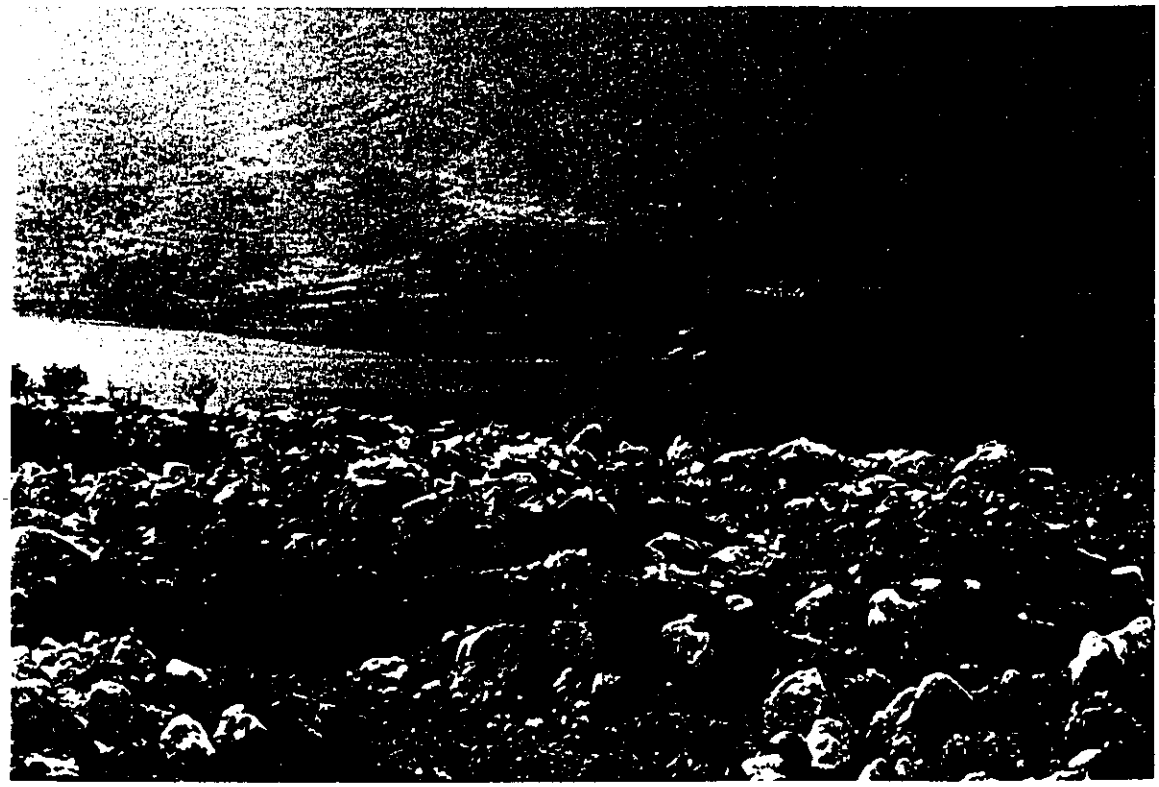
SCATTERED QUARRY SITES

Baaloul and Qaraoun Quarries

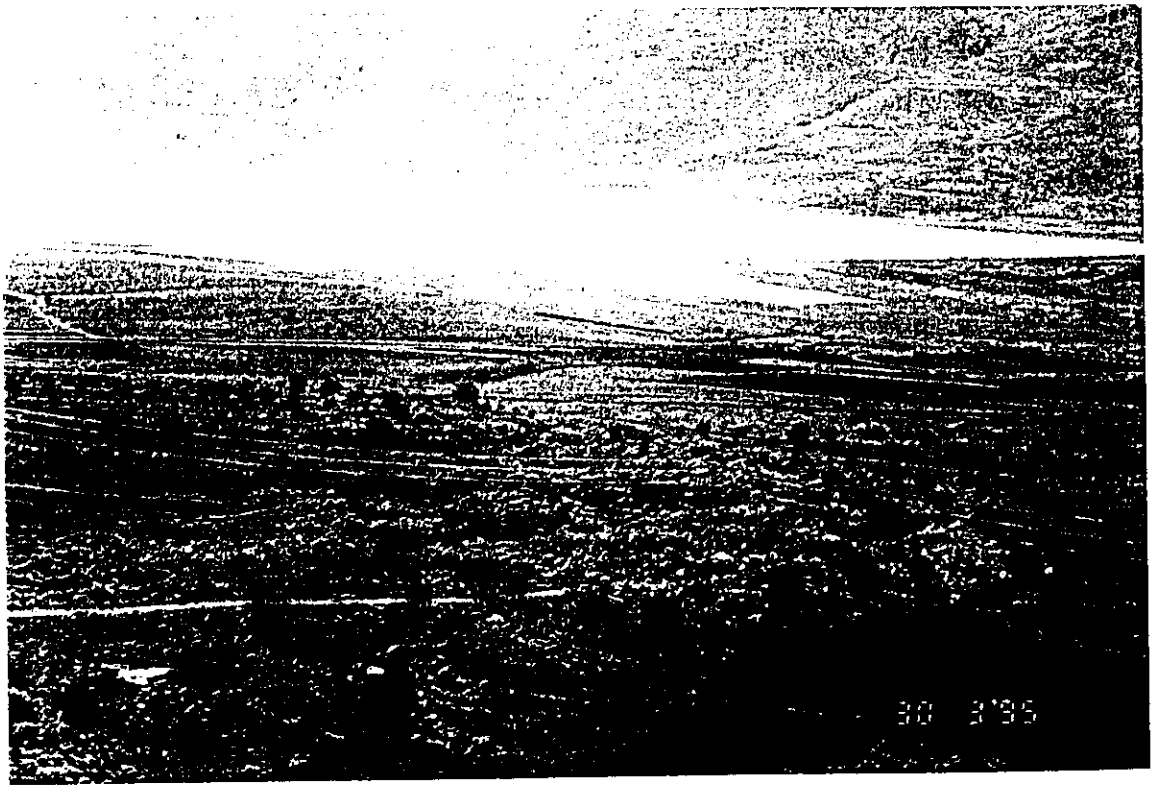
Many quarries are present in this area. The extracted rock is mainly used for face stone. Stones are extracted in no orderly fashion which frequently resulted in destroying vegetation and sometimes endangering public properties. Consequently, this has led at many times to conflict with farmers and land owners.
Much of the extracted rock is saved in waterslops close Qaraoun dam and have caused pollution to the reservoir and nearby canal especially the workshop of Mr. Yehia Jamil Mahmoud B114. some of the names are:

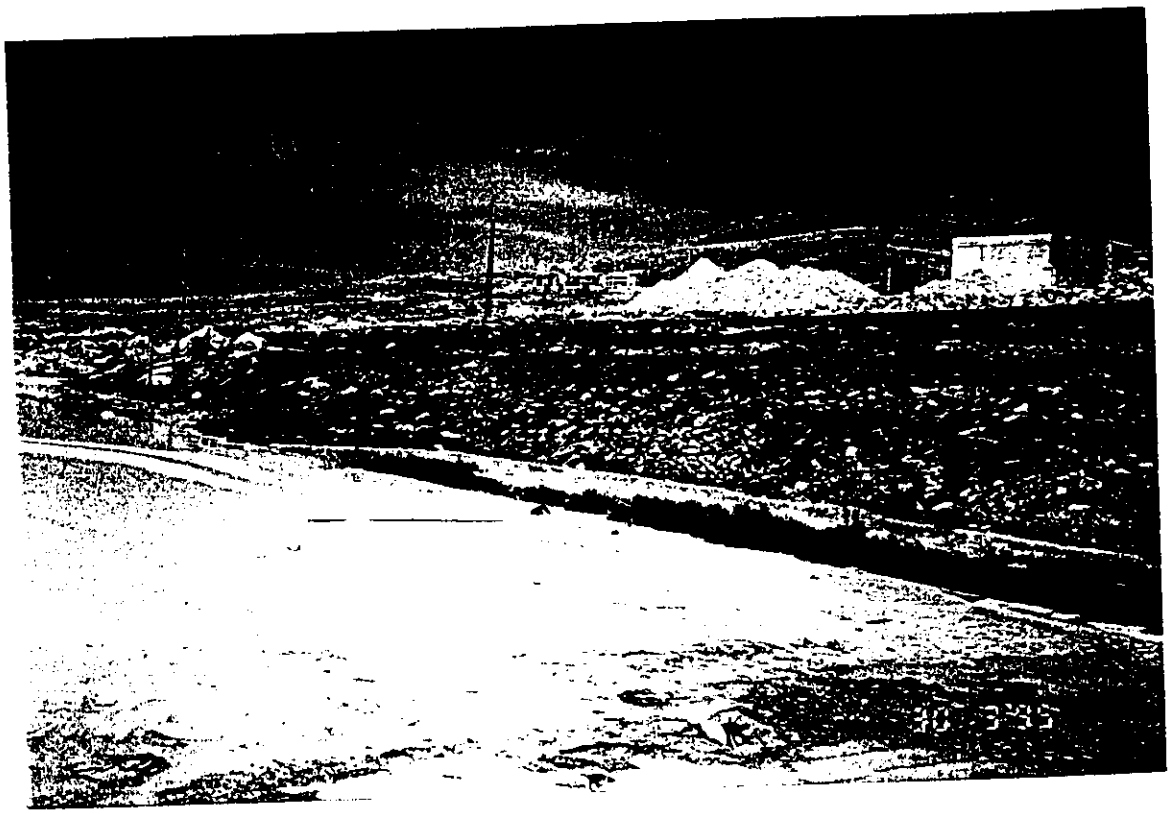
Ahmad Juma'a
Ali Ahmad Issa
Ezzuddine Ezzudine
Hamad Mahmoud
Jamal Bazzi
Jamil Hussein Mahmoud
Maroun Aduar Tarif
Nour Eddine Birany
Omar Al Birany
Safwan Yassin
Saiid Dahrouj
Shawki Mahmoud
Walid Al Birany
Yehia Mahmoud

Quarrying in this area should either be stooped or organized specially Due to the touristic and agricultural nature of the land.



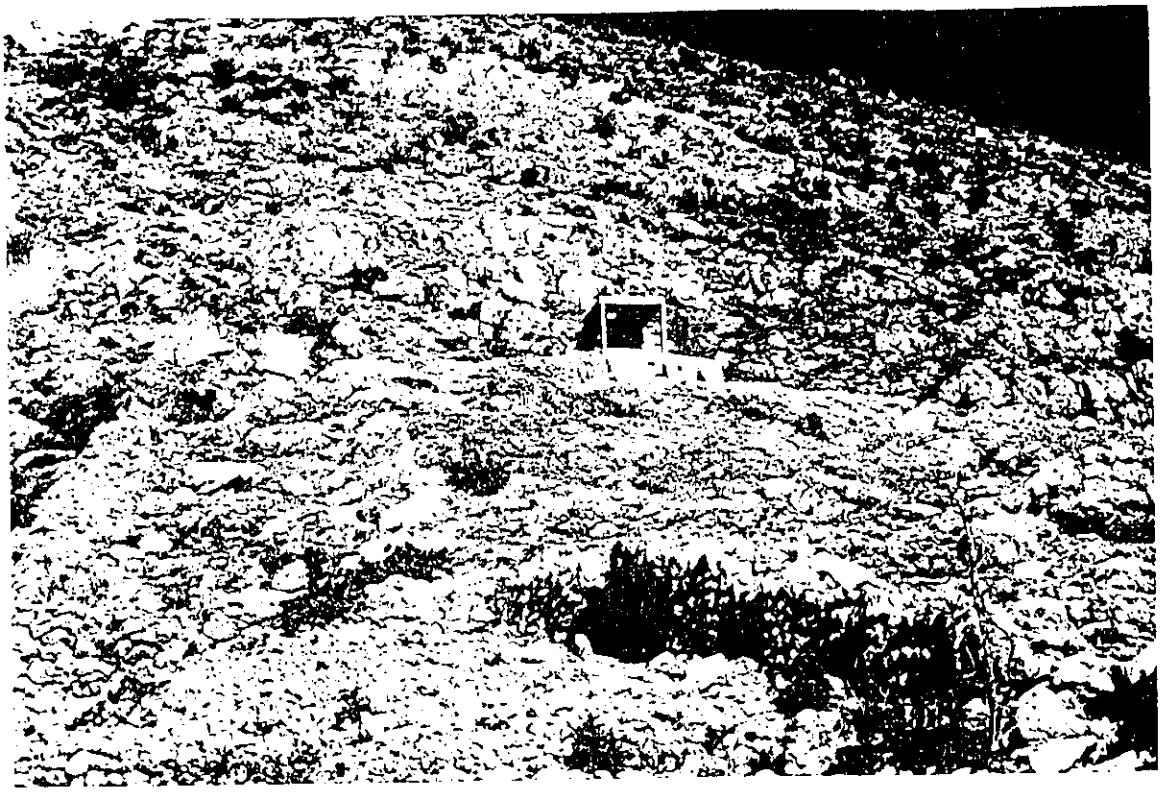
Baaloul and Qaraoun Quarries





L9467/baaloul/#11a/09/03/96

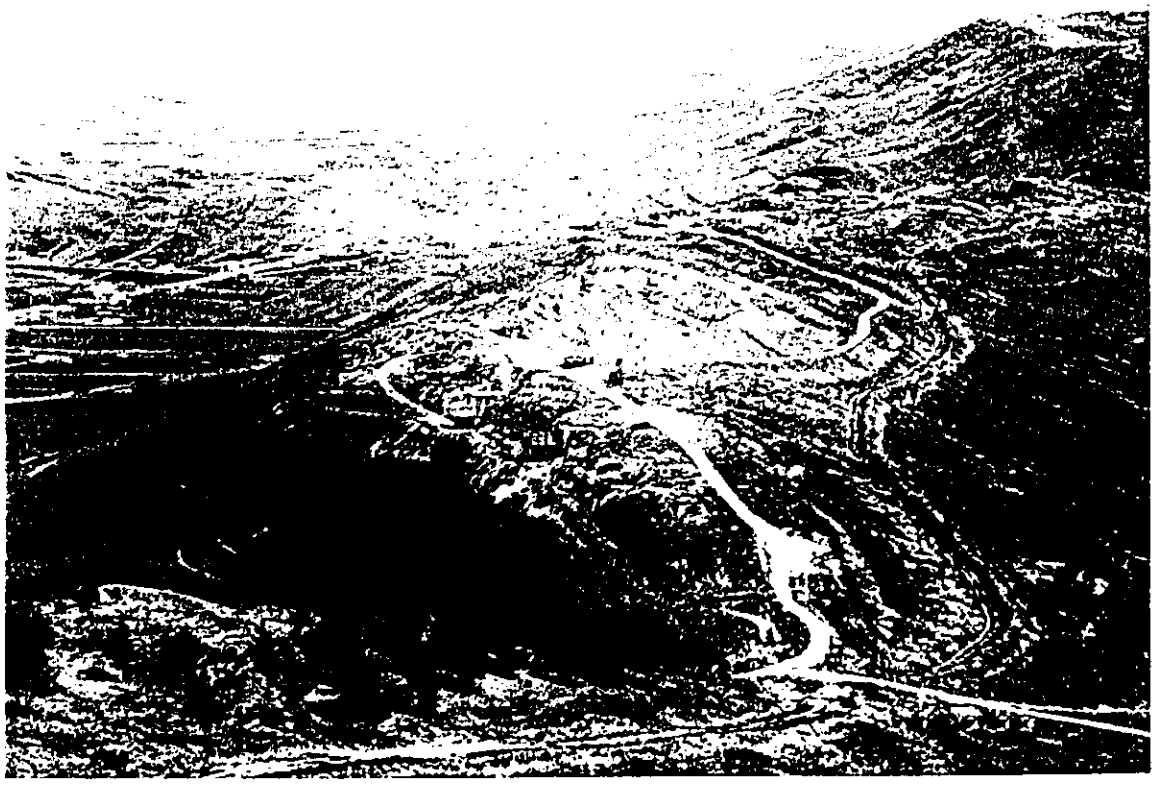
Baaloul and Qaraoun Quarries



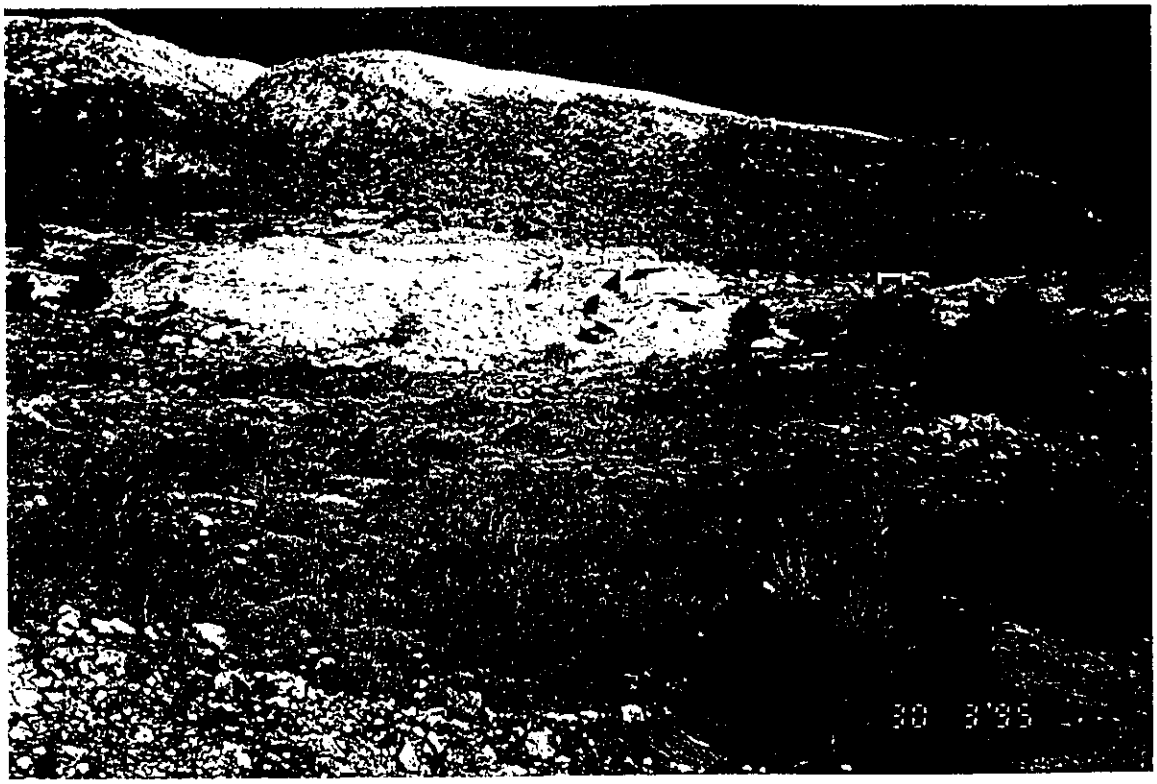
Abandoned quarry of Edmond Ghazal at Mechghara.

Abandoned quarry overlooking Qaraoun reservoire. It was used to build the Dam. It is benched and requires planting as it is seen from the touristic area.

Plain of Kamed Al Louz and Jib Jinnin. Quarry of Hussein Al Hajj. Refused to provide information. Dust from this quarry effect the nearby agriculture.



Village of Sultan Yacoub Al Fawqa. Abandoned quarry since 1980, when the owner, Andreh Dahrouj died.



Abandoned quarry since 1982, in Kifraya. Leased by Taysir Al Qadir from Chtoura. The land belongs to the municipality.

Abandoned quarry in Soghbine - Western Bekka.

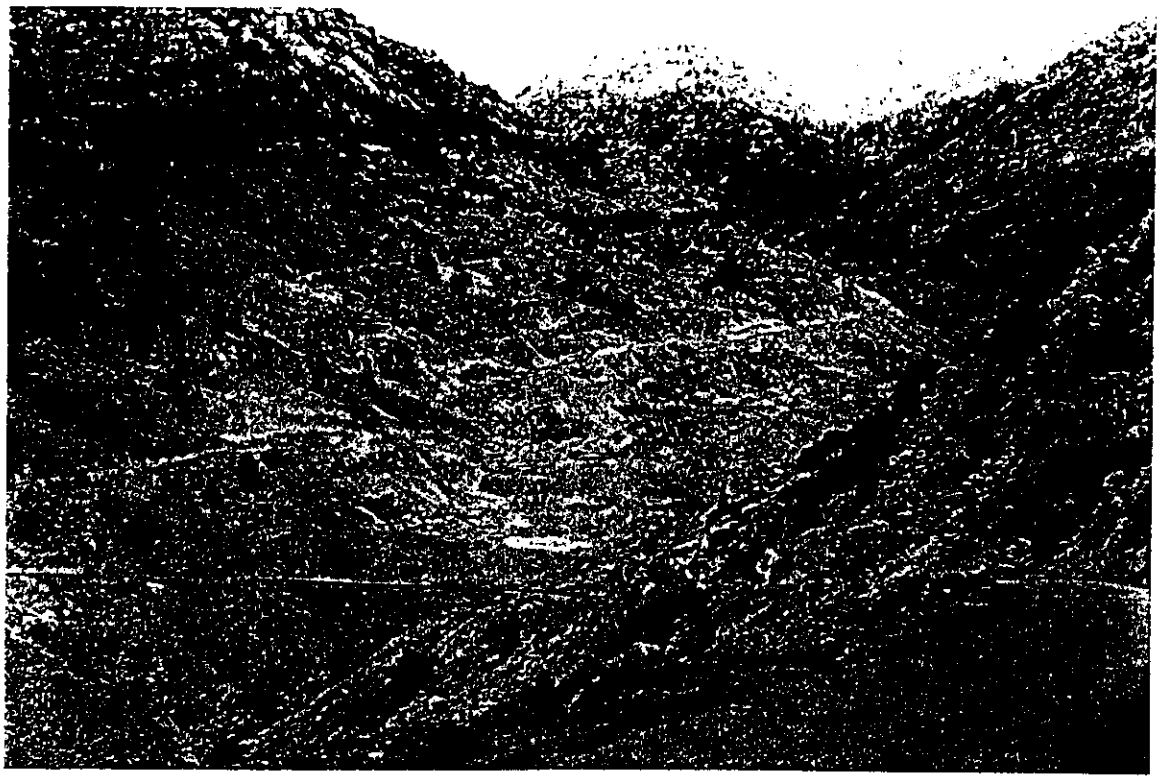
Abandoned quarry at Beit Lahia. Operators were Youssif Al Saifi and Elias Abu Assleh. Note damage to electricity pole.

Abandoned quarry in Tannoura - Rachaya operated by Hassan Serhal.

Quarries at Wata Al Jouz - General view.

Quarries at Wata Al Jouz - general view.

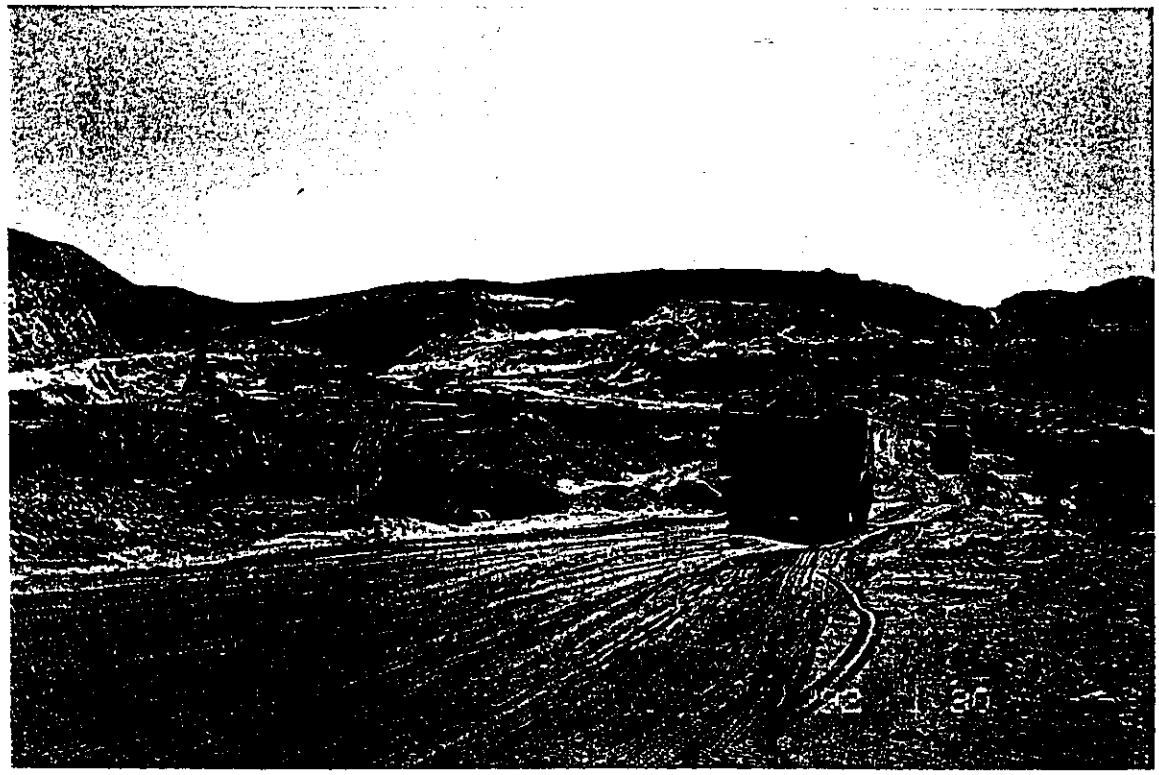
SELECTED SAND SOURCES



An abandoned sand source on the road to Qulayayat operated by Saadeh family.

General view of Tony Mehana sand source at Faraya - Meyrouba.

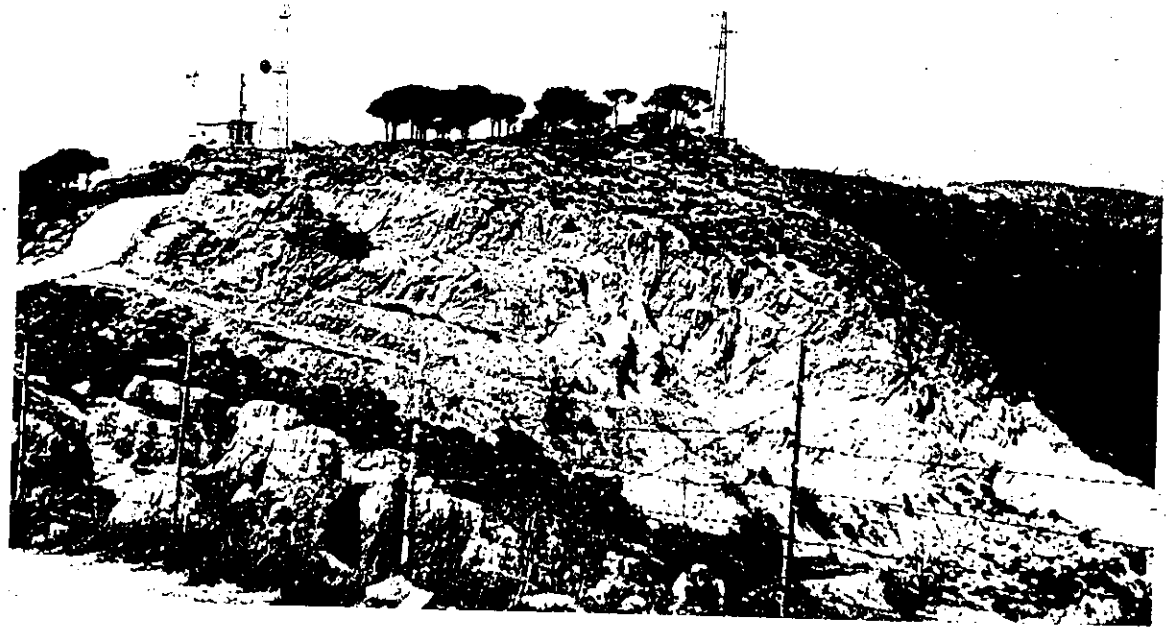
Same sand source of Tony Mehana.



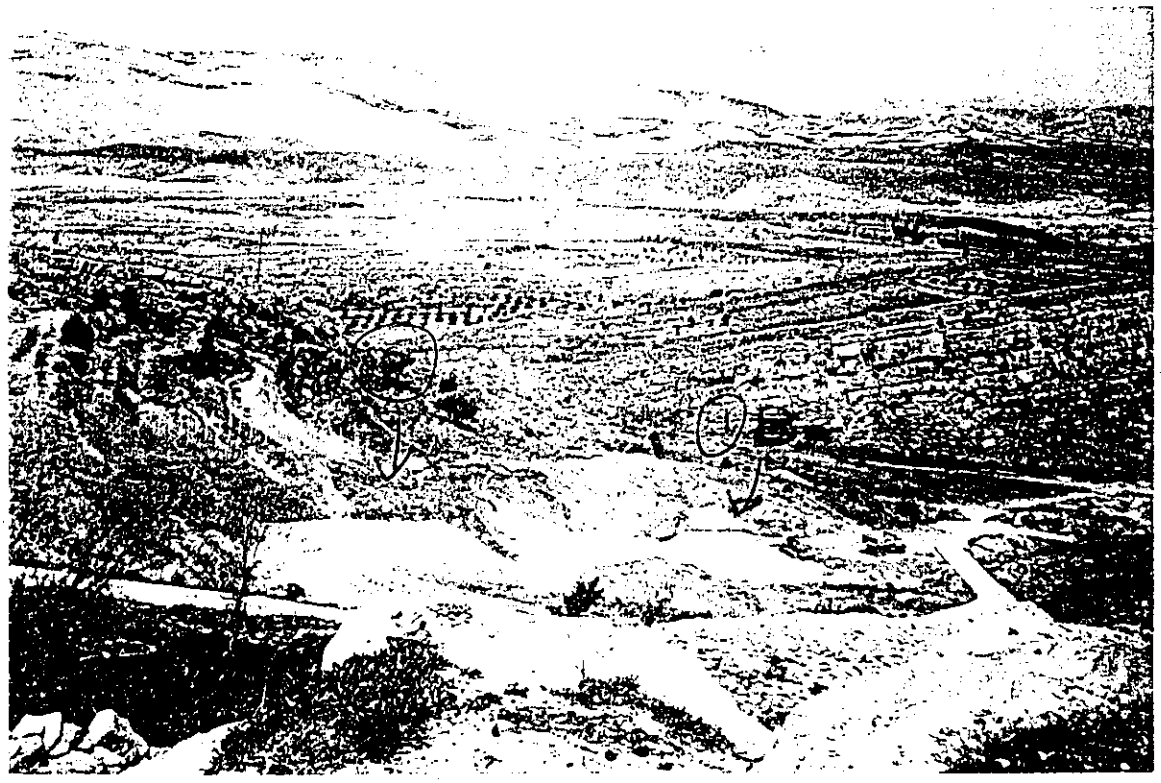
A sand source at Al Mtain owned and operated by Labaki family.

General view from Labaki sand source. It is claimed that water from this quarry site is contaminating this artificial reservoir.

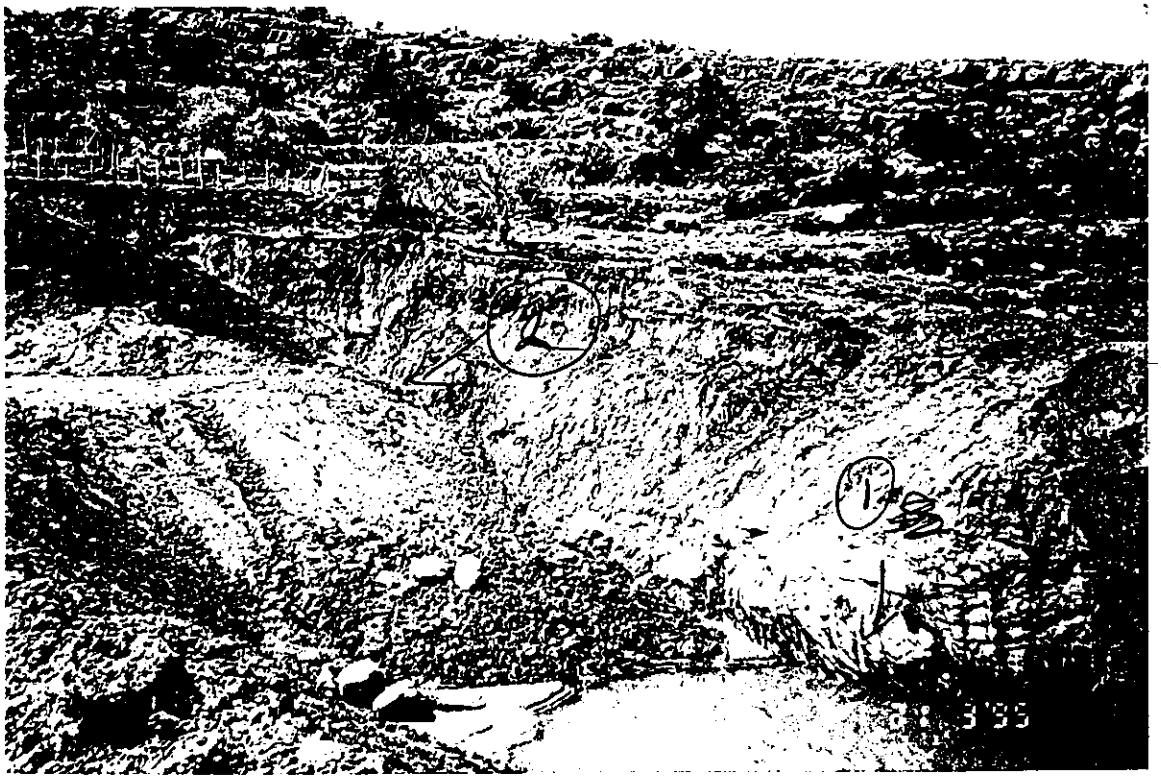
A sand source in Ain Ata - Rashaya. Land is owned by Assad Haddad and operated by Hamed Ghazi.



A close up view of the Ain Ata sand source.



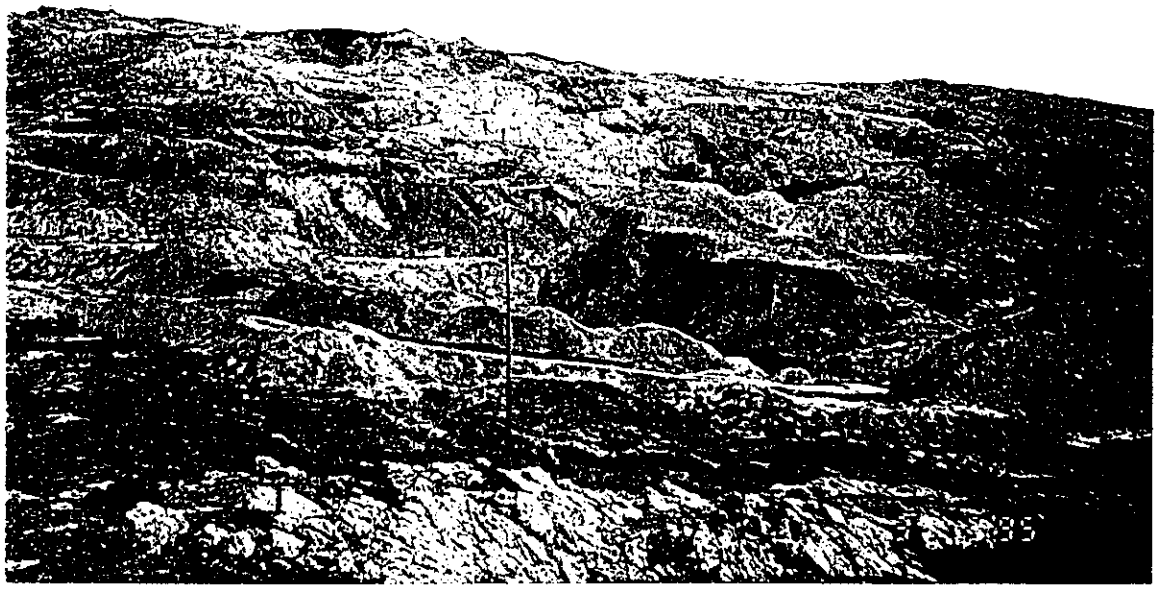
A sand source in Tannoura - Rashaya. Note proximity to main road.



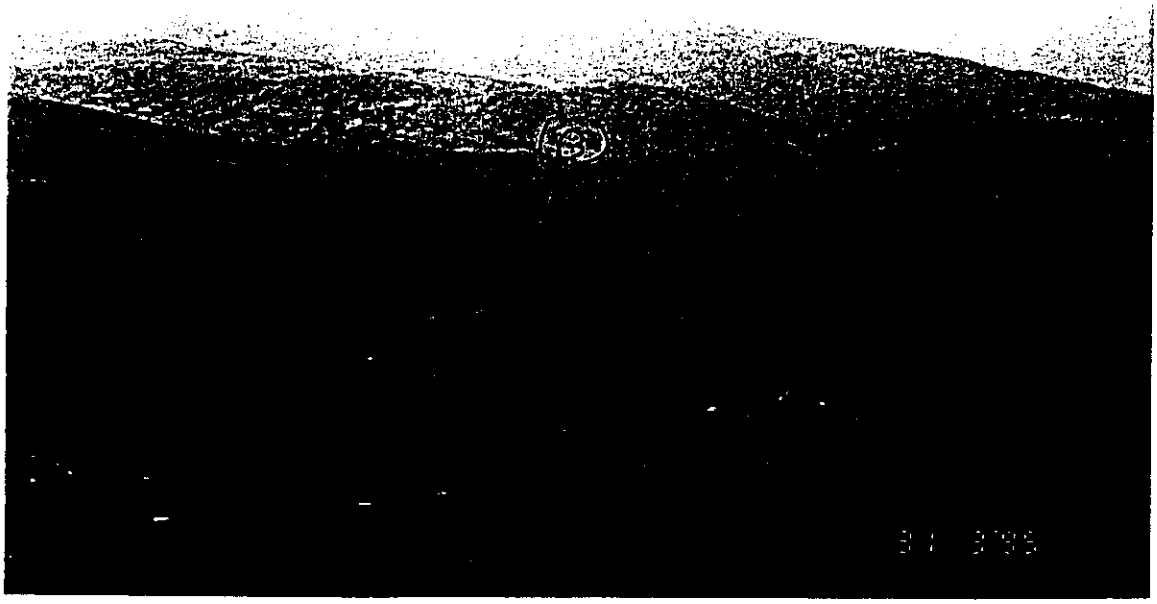
A close up view of the above source. Note water accumulation.

A sand source on the road to Kfar Miski established by the Israelis - now abandoned.

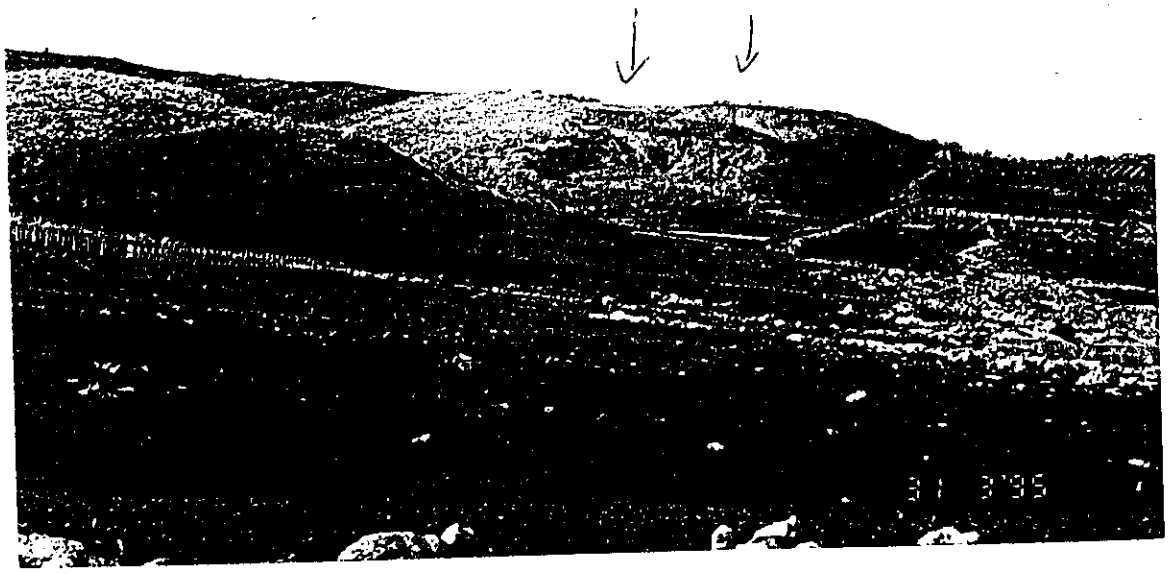
A sand source at Tannoura - Rashaya. About 60 m from houses and in close proximity to agricultural land.



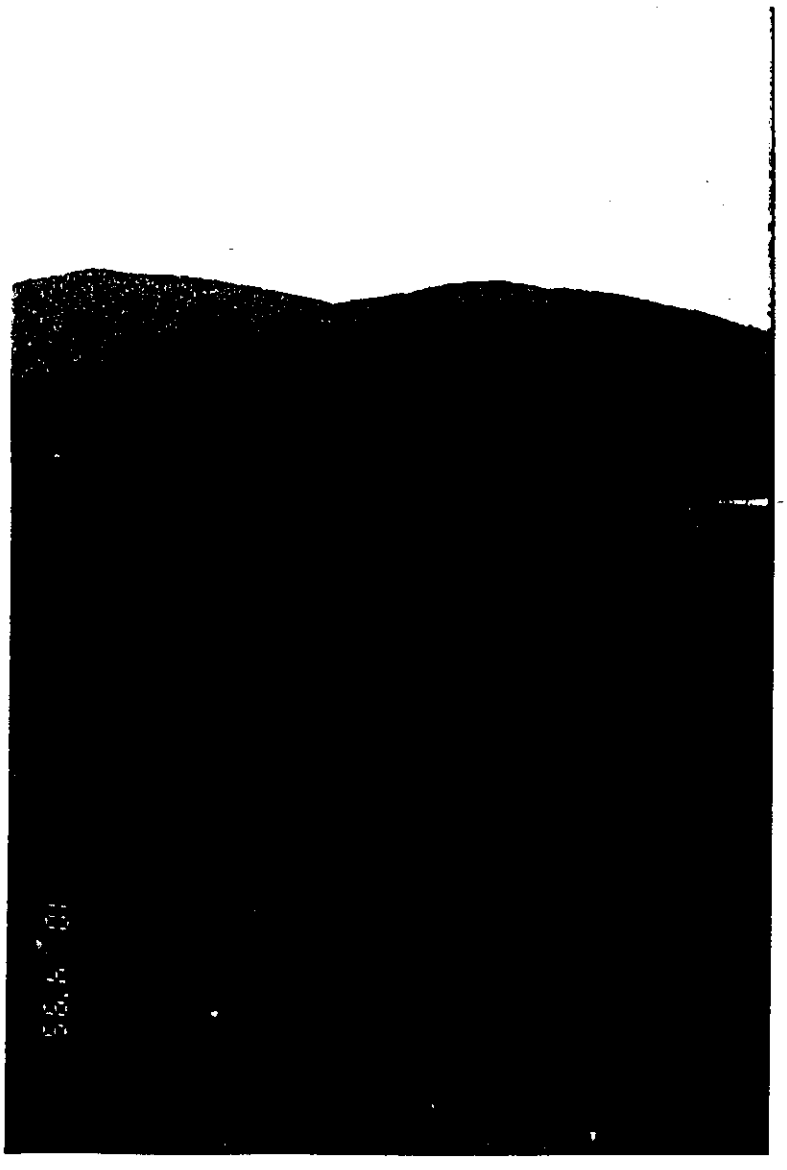
A sand source in Aita Al Fakhaar operated by Andrawos Dahrouj.



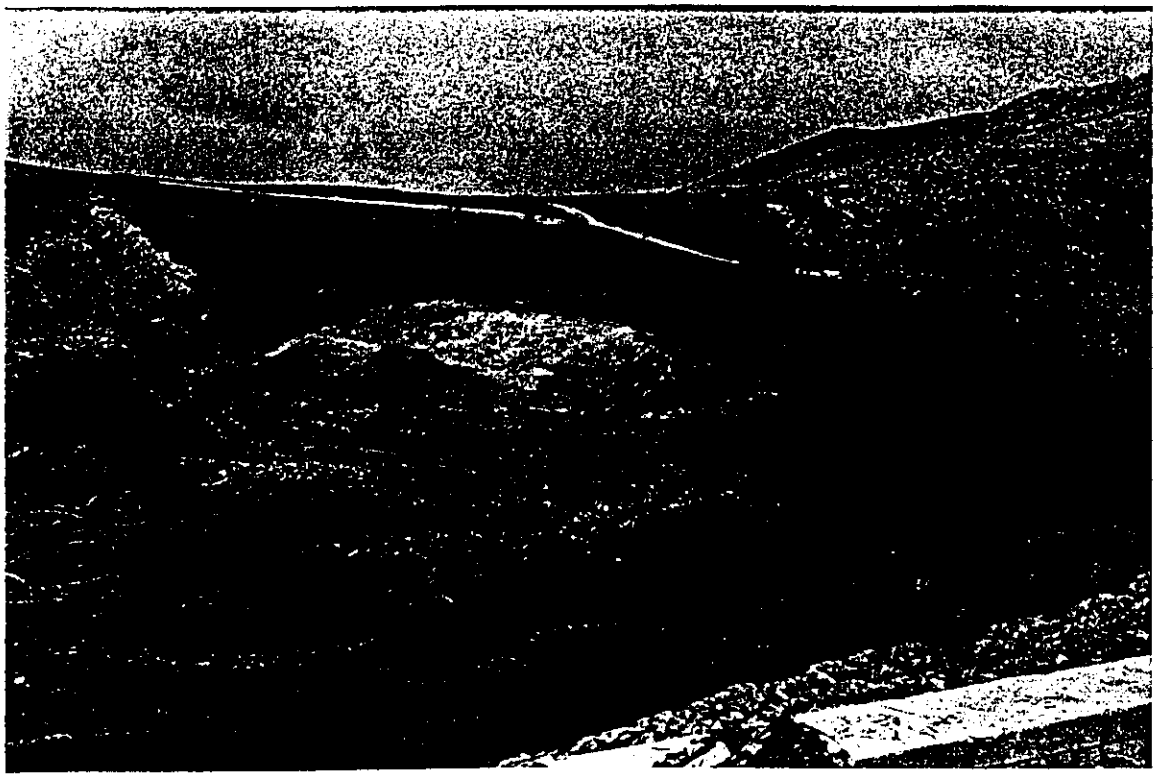
Another sand source in Aita Al Fakhar operated by Andreh Maalouf Dahrouj.



A sand source in Dahr Al Ahmar.



A sand source at Bikfaya - Bekka, operated by Najib Merei Dargham.



A sand source at Ain Arab - Operator: Elias Mansour Al Qaissi.

A sand source at Dahr Al Ahmar.

Republic of Lebanon

Office of the Minister of State for Administrative Reform

Center for Public Sector Projects and Studies

(C.P.S.P.S.)

A sand source in Beit Lahia - Ain Hersha (Rashaya)
previously used in the ceramic industry, now abandoned.

APPENDICES

APPENDIX A.

REQUIREMENTS FOR CORRECT SITE OPERATION

Appendix A - Requirements for Correct Site Operation

Feature	Criteria
1. Site Area for Facing stone	Not less than 2500 m^2
for aggregates	Not less than 10,000 m^2
2. Access	
- Visibility splays	100 m in each direction from a point 3 m back from edge of carriageway
Junction details -	- Incorporating kerb line defining junction. - Surfaced in the macadam or other dust free material.
- Site controls	- Weigh bridges should be installed to ensure quarry trucks do not exceed maximum axle load of 12 tonnes.
3. Site Layout and Structures	
- Crushers associated with the quarry	- Shall not be built within 10 m of the plot boundary. - Shall be screened.
4. Landscaping	
- Embankments	- Shall be 1.5 to 2.0 m high and delineate the quarry site. The slopes shall be planted to prevent erosion.
- Quarry faces	- Redundant quarry faces must be planted with vegetation. Practical measures may include wire mesh, geotextile, hollow mesh matting, compost etc. No redundant face should be without vegetation for more than 6 months.
- Tree planting	- Trees of a minimum height of 1.5 m shall be planted at a maximum of 7.0 m centers.
- Maintenance	- Dead or dying trees shall be removed and replaced.

Feature	Criteria
5. Quarrying Operations	
- Size of quarry face	- Shall not be higher than 25 m.
- Benches	- Shall be a minimum of 3 m width.
- Covering of lorries	- Lorries shall be adequately covered to prevent stone and dust falling on the road. The cover shall extent for at least 50 cms down the vertical sides of the lorry and be tightly roped.
6. Blasting and the Use of Explosives	
- Time limits	- Blasting shall only be allowed between 11.00 and 13.00 hours on any normal working day. Drilling or blasting shall not take place on Sundays or National Holidays.
- Warnings	- Audible and visual warnings shall be given prior to blasting operations.
- Ground vibration	Shall not exceed the following peak particle velocities ppv/(mm/s) - Historical building monuments buildings of special value 2 - Houses and low rise residential buildings 10 - Commercial and industrial properties 25
- Extra Precautions	- Areas being blasted, particularly in populated areas and those within 200 m of roads, must be covered to reduce dust and flyrock.

Appendix A - (Cont'd)

Feature	Criteria
7. Dust Suppression	- Dust creating equipment shall be fitting with effective dust suppression systems. Such as those using filtration or sprays. - Unsurfaced quarry roads, stock piles or processing areas shall be treated to reduce dust emission. - All access roads shall be surfaced.
8. Safety Measures	
- Boundary security	- A boundary fence at least 2 m in height shall be constructed around the site.
- Signs	- The presence of the quarry shall be shown on signs located 200 m from the entrance
- Equipment	- Safety helmets and shoes must be used in the quarry.
- Fire protection	- Fire extinguishers which comply with the appropriate fire regulations shall be kept on the site at all times.
- First aid kits	- Fully stocked first aid kits approved by the Ministry of the Interior shall be available at all times in each building, truck, crusher plant and explosives store. At least one stretcher shall be available on the site at all times. - Records shall be kept of all accidents and injuries.
- Storage of explosives	- Explosives must only be stored in secured buildings isolated from other quarrying activities such that stores are 100 m away from public footpath etc. and 50 m away from the nearest building.

APPENDIX B.

TENTATIVE CODE OF GOOD PRACTICE

Appendix B - Code of Practice for Quarrying Works (Draft)

Each quarry site has its unique environment. It is characterized by its:

i. physical features.
ii. flora and fauma.
iii. human aspects.

1- Physical Features

Physical features include, among others landform, soils, surface water, groundwater and location.

Accepting the fact land and other natural resources are community assets needed by the future generation as much as the present imply that quarry sites should be exploited with one of the following end targets:

i. The site is restored to conform with prior use.

ii. The site is worked out with a definite land use in mind such as agriculture, sanitary landfill, storage reservoirs, industrial city, or any other economic activity.

iii. The sites is left in an acceptable condition to be adopted to future use.

2- Fauna and Flora

Some of the Lebanese mountains are rich in fauna and flora. Others are eroded and covered with low density crops. They have a green look over a short seasonal period. Whatever is the case, quarrying has a negative impact on ecology

Quarrying may also have a positive impact, such as spreading the soil extracted and considered as waste on lands subject to afforestation. Solid waste compost material could be mixed with this soil to improe its physical and fertility conditions.

Such activities should be planned and coordinated with municiplaities, solid waste planning authorities, the ministry of finance for public lands and the ministry of agriculture.

The advantage of this management plan is that:

- Discharge sites are identified for quarry waste.
- A practical solution for the discharged of quarry waste is adopted.
- Discharge on wadi banks can be strictly forbidden.
- Solid waste compost material are usefully used to improve the soil and the flora conditions.
- Erosion is reduced.
- Afforestation could be initiated.

3- Socio-Cultural Aspects

These aspects are human related and hence tend to be mostly subjective. They include noise, dust, landscape, cultural heritage, transportation and economic activities.

a- Noise

Noise is generated from crushers, dozing, hammering, loading, trucks and various other operations or quarry sites. Reversing warning signals, if trucks or other equipments are equipped with, can be intrusive. Noise doesn't have to be loud to be instrusive. Adaptation to the noise could be possible in certain conditions, but if people are annoyed with the originators of the noise, it will be difficult for them to accept and adpat to it.

The ambient noise climate vary significantly from one site to another depending on topography, natural landscape and economic activities of the area. Climate can also affect noise propagation particularly in cloudy days.

Good practie would to take into acccount.

- Ambient level with and without quarrying.
- Duration of the noise.
- Time of the day, which would require to limit the hours of operation and avoid working at night.
- Provision of noise control measures.

b. Dust

Dust soils vegetation, buildings, cars, houses, etc.... premises are said to be vulnerable within about 500 m, but distance varies with local topography and prevailing wind. Dust can be emitted from stacks, crushers or picked up by the wind from the ground:

The potential dust problems are:

- Corrosion caused by chemical activities, such as limestone.
- Health effects due to inhalation or irritation of the eyes.
- Obstruction of road signs.
- Effects on vegetation such as reduced photosynthesis, inhibition of growth, destroying leaf tissues, premature leaf fall and degradation to tree bark due to alkaline dust.

Good practie would require, among others:

- Planting wind breaks.
- Covering crushers, screens, heaps of stored material, etc..
- Misting access roads and any other place where dust is likely to deposit and accumulate.

- Adequately covering trucks; the cover should fold on the vertical sides at least 50 cm and be tightly roped to prohibit dusting or dropping of gravel.

c. Landscape

Visual intrusion is one of the major negative impacts of mineral mining. The steep topography of the Lebanese mountains, the narrow plains, the narrow serpentine wadis and canayons and the scattered communities make it even worse. A quarry site could be seen across the wadi from various spots and villages and from restaurants whose locations are usually selected overlooking a beautiful sceenary of the Lebanese mountains if not the sea.

In most cases, visual intrusion is more intense looking at a quarry site from across a wadi, particularly in Spring. A dull gray or brownish spot in a green background could not pass unnoticed.

Visual intrusion is subjective. Residents in an area may adapt to an alien spot in the middle of a nice looking landscape. Others may not. People on a leisure trip are most affected.

Mitigation measures of visual intrusion could include:

- Tree planting at a maximum spacing of 7 meters with a minimum hight of 1.5 meters at planting date. These would only give a local treatment and could act as windbreaks. Adequate tree species should be selected to meet the objectives.

- Construction of crusher structures on the road should be prohibited.

- A straight uninterrupted vision from the road to the working site should be avoided.

- The construction of an embankment of 1.5 to 2 high delignating the quarry site and constructed 0.5 to 1 m off the right of way of rivers, wadi and roads would protect them and provide local landscape treatment. The embankment shall be protected from erosion and planted with shrubs or creepers.

- Concrete structures in abandoned quarry sites should be demolished, and depressions filled with soil to promote vegetative growth.

- Vegetative growth on most quarry faces, except the vertical hard rock ones, should be promoted. Various practical measurs can be adopted using wiremesh, geotextile, hollow mesh mats, compost material, etc... As a matter of fact this should be applied not only to quarries but aslo to building and road constructions that disturb, demolish or cover the natural landscape. These could have as bad an impact as quarries.

d. Traffic

The road capacity and noise generated by trucks traveling in residential areas may be the only reasons for the refusal of a quarry license.

Entrance and exist from a quarry site from or to international, national or local roads are site related. All other problems are off-site. These latter are:

- Damages from large vehicles limiting visibility.
- Congestion and accident risks caused by the added number of vehicles in a traffic.
- Intimidation to pedestrians and small cars.
- Suitability of roads to the load and size of vehicles.
- Damage to verge.
- Dust and spillage.
- Mud from wheels and body.
- Noise and vibration from early starts or passing through residential areas.

Mitigation of such problems could be achieved through:

- Strict repsect of permissible load capacity of trucks.
- Regular maintenance of trucks, possibly linked to milage.
- Adequate site entrance.
- Sign posts at and ahead of quarry sites for at least 200m.
- Limiting hours of work, (already in application).
- Proper truck sheeting.
- Provision of vehicle washing facilities at site, where mud is a potential problem.
- Release of information and instruction leaflets to drivers.

e. Blasting

Blasting is a mean to achieve safely and economically a desired degree of fragmentation in the rock. It gives rise to a number of effects such as:

- Vibration transmitted through the ground causing shake to buildings, damage and nuisance.

  The ground vibration effects on buildings and other structure depends of wave magnitude, duration of motion, nature of the ground, frequency of vibration of the structure, distance from the blast, charge, blasting pattern and the interaction between ground and structures.

  Cosmetic damages to sensitive structures, such as ruins, is in the range of 12 mm/s at peak partile velocity of the vibration (PPV), whereas damge to residential structure can occur, according to the Australian Standard, at PPV greater than 50 mm/s.

  On the otherhand people can feel ground vibration at a level of 0.2 - 0.5 mm/s PPV which is considerably less than those which can cause damage

to buildings. Complaints from blasting are likely to be received at 1.5 to 2 mm/s vibration. This concludes that the main reason for complaints from vibration is fear of damage and nuisance rather than actual structural damage.

Slamming doors, producing a vibration of about17 mm/s or driving a nail in concrete can induce strains in a structure or a crack in the mortar greater than those caused by vibrations from reasonable quarry blasting.

In the UK ground vibration limits are in the range of 4 to 12 mm/s. The Australian standard adopts criteria in function of the type of structure or human comfort.

Type of Structure/Human Comfort	PPV (mm/s)
• Historical buildings or monuments and buildings of special value	2
• Houses and low-rise residential buildings	10
• Commercial and industrial buildings or structures	25
• Human comfort	5

- Overpressure transmitted through the air causing damage and nuisance.

  It covers a wide range of frequencies some of which are audible known as sound waves. They arrive after ground vibration by up to 2 seconds over a distance of 1 km.

  The magnitude of air overpressure depends on many factors such as type of explosives, distance from blast, amount of explosive per delay, initiation system, topography, atmospheric conditions, rock type and jointing.

  Damage in the form of broken windows is likely to occur at 168 dB. Rattling is possible at 120 - 140 dB.

- Potential risks to people and property caused by flyrocks, dust, fumes, unstable slopes and quarry faces and unsafe handling and storage.

  Flyrocks are a significant problem. They may reach over 200 meters beyond the blasting site. They can be a high risk to workers on site if preventive measures are not adopted. Similarly, a significant amount of dust particles and poisonous gas fumes are emitted from blasting.

  Blasting skills and use of adequate equipment, material and techniques are important for reducing human risks as well as damage. Use of ammonium nitrate fertilizer is common in Lebanon. It is cheap and less controllable by the government. But to achieve the required degree of rock fragmentation, an excessive amount is used.

It was also reported that a low blasting frequency is applied which implies the use of excessive amounts of explosives per delay causing unacceptable levels of ground vibration, overpressure, damage and nuisance to the nearby communities.

The survey shows that about 70% of the quarries have inadequate overall quarry stability, more than 60% have unstable to dangerous quarry face conditions, about 90% have 70 to 90° face slope inclination and 71% do not use the terrassing technique.

To mitigate the negative impacts of blasting, one or several of the following measures could be adopted:

- Locate residential, commercial, archeological and sensitive buildings such as hospitals, etc... within a horizental redius of 500 meters. This could be a request for a license application.

- Test suitable blasting techniques adaptable to each specific site. The services of a geologist and a blasting expert are required to prepare a sound technical report.

- Measure ground vibration and air overpressure transmission as a function of distance and charge of a delay. Monitor and re-optimize throughout operation and whenever required by the authority.

- Use nuisance criteria (human comfort) rather than physical damage criteria as the level of the former is lower.

- Adopt adequate blasting design, accurate setting out and drilling, and correct charging and explosives.

- Use more frequent blasting, reduce surface area subject to heave and reduce degree of surface heave.

- Use delay (successive) detonation. It has many advantages over instantaneous firing. It gives better fragmentation, higher efficiency of explosive used, reduced vibration and has better control of the rock.

- Avoid gas venting by accurate drilling and complete filling of borehole. In Karstic rocks, the higher density and plasticity of gelatin dynamite provide it an added power over powder explosives.

- Blast under the supervision of a blasting expert.

- Provide a suitable shelter to be used by workers during blasting and adequate explosive storage facitilty approved by the concerned authorities.

- Keep an updated inventory of explosives showing dated amounts used and acquired.

- Blast a limited heave depth not exceeding 6 meters and adopt terracing method. It reduces flyrock risks, vibration, overpressure and the probability of unstable quarry faces and improves work efficiency.

- Cover blasted surface, particularly in populated areas and when distance to roads is less than 200 m. Covers could consist of industrial felt, mesh nets or heavy mats that could be made out of used tires. It reduces dust and flyrock impacts.

- Avoid blasting early in the morning, in the evening, on week ends and in public holidays.

- Avoid blasting in adverse weather conditions:

  - moderate to strong winds towards sensitive areas.
  - still cloudy days with a low cloud ceiling, foggy or hazy days. Heavy cloud cover a warm air temperatur at high altitudes reflects noise back to the ground.