

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER

**GEOLOGICAL AND HYDROGEOLOGICAL STUDY
WITHIN KFAR HAOURA REGION**

Final Report

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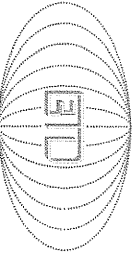


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1 GEOLOGY AND HYDROGEOLOGY OF KFAR HAOURA AREA

The geological study of the project area is based on the previous geological and hydrogeological investigations done by BTD in north Lebanon and more precisely in the cazas of Batroun and Koura. In addition, the bulk of information mentioned in this report is the result of works done by L. Dubertret, B. Hakim, B.T.D. and on the geological and hydrogeological extensive survey made by the FAO and more precisely by Mr. A. Guerre in 1971 in the Koura-Zgharta area. Moreover, several investigations were utilized to update the geological data and, hence, better understand the geology and hydrogeology of the project area. These are particularly the remote sensing interpretation of MAPS photo satellite and the photo interpretation of the aerial stereographic photographs at a scale 1/25000 (1963). Fieldwork also took an important share of the investigation. The final result is an up to date regional geological map at a scale of 1/10,000 (**fig. 1**). The following report therefore gives a description of the geomorphological, stratigraphical structural and hydrogeological aspects of the project area and give construction details of the well to be drilled.

1.1 GEOMORPHOLOGY

The study area is characterized by an almost flat topography which constitution is made of the Quaternary deposits and the Vindobonian marly limestones and limestones. The altitude of the studied area varies between 150 and 200m above the sea level.

1.2 STRATIGRAPHY

The outcropping formations in the study area extend from the Lower Eocene (e2) at the bottom to the Plaisancian (P) at the surface. In between are found, above the bottom Eocene, the Vindobonian (m2 – Middle Miocene deposits) which are overlain by the Pontian (ml) and of Miocene age and which are overlain finally by the Plaisancian (P) the Quaternary.

1.2.1 Plaisancian (P)

Kfar Haoura area lies on the Plaisancian (P) deposits. They are made of successive layers of sandy limestones, sandy marls and shales. Their overall thickness is of about 60 meters.

1.2.2 Pontian (ml)

The Pontian deposits are made of lacustrine marls embedded with limestone gravels. These gravel layers change sometimes in facies and become fluvial conglomerates more or less thick, depending on the paleogeographic history and depending on the successive levels of the sea during the Pontian age.

These Pontian deposits are very thick and can exceed 300 m. It is very hard to cross them by drilling due to the presence of the gravels and also due to caving in problems that could be encountered while drilling.

1.2.3 Vindobonian (m2)

The Vindobonian deposits are of middle Miocene age and are mainly made of marls and marly limestones in their upper part (m2b – 50 m) and of sandy and marly limestones in their lower part (m2a – 250 m).

1.2.4 Lower Eocene (e2)

The rocks of the formation consist of gray marls, chalky marls and marly limestones. The stratigraphic thickness of (e2) is more than 200 m in the study area.

1.2.5 Quaternary (Q)

These deposits are recent in age and consist of gravels and red clays, red brown marls and clays (q_{ar}-q_j) as well as conglomerates (q_{eg}). They have a wide extent in the study area.

1.3 STRUCTURAL GEOLOGY

The general structure configuration describing the study area is related to the western flexure of Mount-Lebanon and the presence of Kfar Zeina syncline.

The axis of Kfar Zeina syncline is oriented SW-NE and it is located at the middle of Kfar Zeina village.

The beds of the eastern flank of this syncline which consist of the Middle Miocene formation are dipping by 38° toward the west, while those of the western flank of this syncline are dipping by 20° toward the east.

This synclinal structure has formed a kind of tectonic basin in which have been deposited all the stratigraphic formations that extend from the Miocene at the bottom to the Plaisancian and Quaternary deposits at the top.

The Vindobonian Miocene limestones, due to their thickness and to their extensive karstification, constitute the best aquifer. But they are very deep under Kfar Haoura village (almost at a depth varying between 400 and 650 meters depending on the fold angle of that syncline). Therefore, emphasis should be put on the Pontian and Plaisancian (p) deposits (m1) and on their possibility of having aquifers being formed in them.

1.4 HYDROGEOLOGY

As it has been already stated previously the only possibility of encountering underground water with a big yield is by reaching the Miocene Vindobonian limestones (m2a & m2b). The latter, however, are deep and cannot be reached easily due to the extensive thickness of the overlying Pontian deposits and to the presence within them of deposits of successive layers of gravels. Therefore, emphasis should be put on finding underground water in these Pontian deposits.

The Plaisancian (P) deposits can also form a kind of small aquifer in them but because of their relative small thickness and their vulnerability of getting polluted by the surface water. Evidences for the above-mentioned facts are the:

- Presence of a water well in Kfar Haoura that yields around 1 l/sec and which depth is about 175 m and which tapped the quaternary and Plaisancian deposits.
- Presence of a water well in Kfar Chakna that yields a flow of about 10 l/sec, and which depth is about 300 m.

It is therefore recommended to drill a water well of 650 meters depth to cross all the Plaisancian and Pontian deposits and reach the Vindobonian limestones in order to get a productive well sufficiently. The details of that well are here after mentioned.

1.5 DESIGN OF THE WATER WELL

1.5.1 Kfar Haoura well

1.5.1.1 Borehole location

The well is located near the existing water tower reservoir at the entrance of Kfar Haoura village, at the following coordinates (Fig. 1):

X = -301647 km
 Y = +24070 km
 Z = 175 m
 (Zgharta map, 1/20.000)

1.5.1.2 Access to Borehole

Access to the site is easy on main road. Some clearing and excavation for the well site is necessary.

1.5.1.3 Depth

650 m

1.5.1.4 Expected discharge

432-605 m³/day (or 5-7 l/s).

1.5.1.5 Static water level

150 m below ground level.

1.5.1.6 Geology

The well is located on the axis of Kfar Zeina syncline. The beds that will be penetrated by the drilling rig are:

- (a) The Quaternary deposits (q).
- (b) The sandy limestones, marls, and clays of the Plaisancian (P) formation.

- (c) The lacustrine, fluvial conglomerates and gravel layers.
- (d) The marls and marly limestones of the Upper Vindobonian (m2b) formation.

1.5.1.7 Schedule of drilling, casing and grouting

The Contractor shall present the schedule for drilling in order to have a final casing and screen diameter of 10". The well is to be drilled with a rotary rig and provide for all additional equipment such as water and fuel, as well as treating collapsing rocks at his own expense. Attention should be made while crossing the gravel layers of the Quaternary which might necessitate the use of mud white drilling.

Nevertheless, the schedule of the proposed works could be as follows (Fig. 3):

- Drilling by rotary methods with a 22" bit from 0 to 20m, with samples collection as described in the general specifications from this depth and onwards.
- Installing 18" I.D. casing (black steel, thickness 5mm)
- Grouting the annular space as described in the general specifications from the bottom to the surface, then waiting between 36 to 48 hours for the cement to set, and then continue the works.
- Drilling with a 17½" bit from 20 to the depth of 200 m.
- Installing 15½" ID casing (black steel, thickness 5mm).
- Drilling with a 14¾" bit from 200 to 500 m.
- Installing 12½" ID casing (black steel, thickness 6 mm).
- Drilling with 12¼" bit from 500 to the total depth of 650 m.
- Installing 10" casing and screens as shown below:
 - a) Casing:
 - Diameter: 10" ID
 - Type: Carbon steel
 - Thickness: 6 mm
 - Total length: 600 m
 - b) Screens:
 - Diameter: 10" OD
 - Type: Carbon steel, bridge slotted 12.2% void, 1.5-2mm slots.
 - Thickness: 6 mm
 - Total length: 50 m.

The installation of the casing and screens will be in accordance with the general specifications, and in particular, the welding and closure of all openings such that the water only enters the well through the screen openings, in order to minimize the pollution from zones above the SWL.

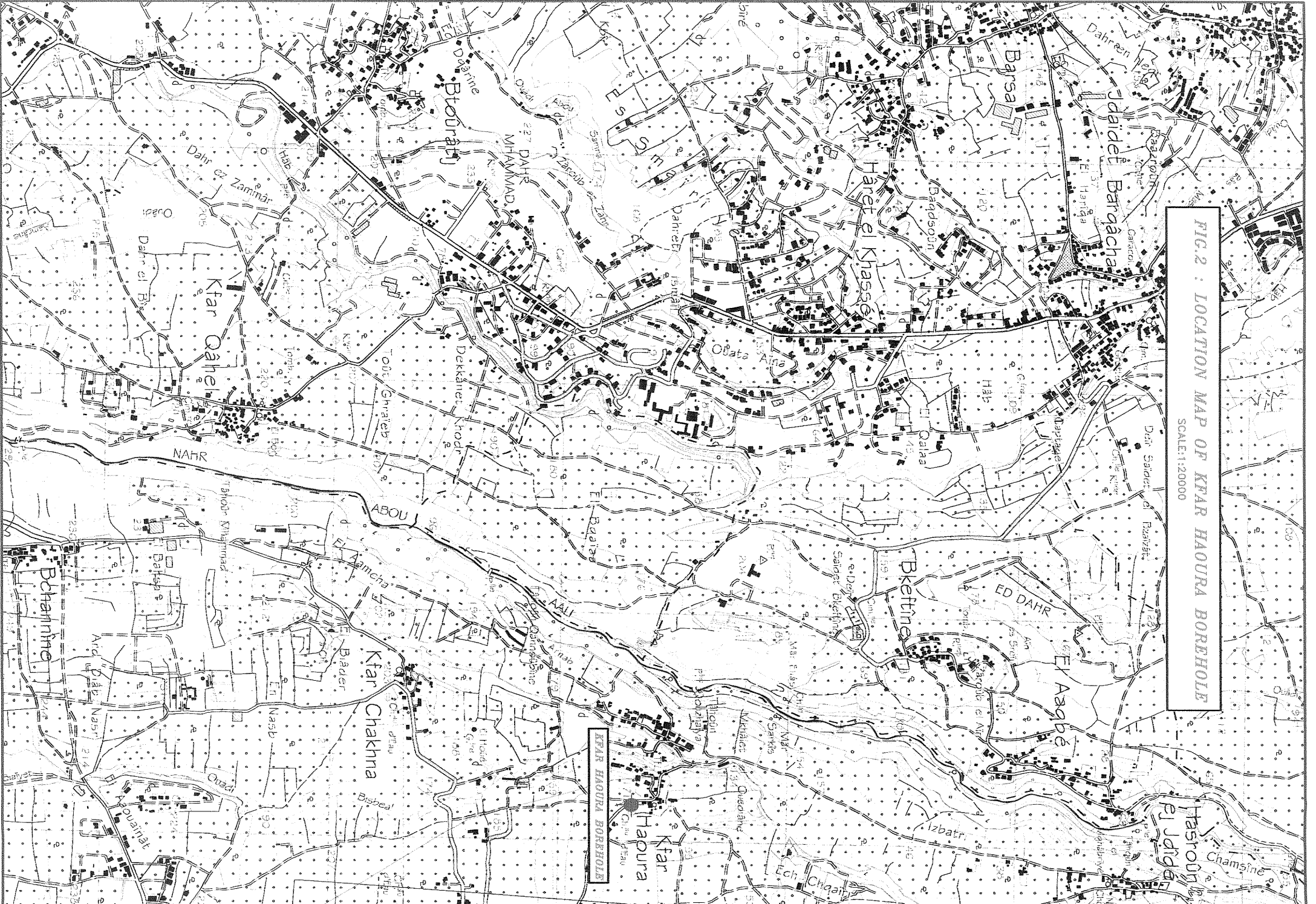


FIG. 2 : LOCATION MAP OF KFAR HAOURA BOREHOLE
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FIG. 3 : VERTICAL CROSS SECTION OF KFAR HOURA BOREHOLE

