

GEOTECHNICAL SITE INVESTIGATION REPORT

RAMALLAH SPORT HALL

(Ein Sama'an Street - Ramallah)



Prepared for:

First Option for Construction Management Co.

Prepared by:

Hijjawi Construction Labs

May - 2009



**M-s/ 1st Option for Construction Management Co.
Ramallah**

Ref : SI/361

Date : 6/5/2009

**Project – Ramallah Sport Hall – Ein Sama’an Street
Subject - Site Investigation Report**

Dear Sirs,

With reference to your request (SI/361 on 29/4/2009, **Hijjawi Construction Labs (HCL)** is pleased to submit this report of the site investigation carried out for the proposed construction site of the above mentioned project.

The investigation ended up with conclusions and recommendations relevant to the findings. Those, in addition to the laboratory test results and engineering recommendations are herewith attached.

We look forward for further cooperation and would like to take this opportunity to highly considerate your confidence in our laboratories. For any clarification concerning this report, please contact us at your convenience.

Yours sincerely,

**Dr. Sami A. Hijjawi
General Manager**

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1. INTRODUCTION

1.1 GENERAL

This report presents the outcome of the site investigation carried out for the proposed construction site of Ramallah Sport Hall building in Ramallah (Ein Sama'an Street).

1.2 PROJECT DESCRIPTION

The project consists of the construction of about 1000 m² steel structure building (sport hall).

1.3 PURPOSE AND SCOPE

Investigation of the underground conditions at a site is prerequisite to the economical design of the substructure elements. It is also necessary to obtain sufficient information for feasibility and economic studies for any project.

In general, **the purpose of this site investigation** was to provide the following:

- 1- Information to determine the type of foundation required (shallow or deep).
- 2- Information to allow the geotechnical consultant to make a recommendation on the allowable bearing capacity of the soil.
- 3- Sufficient data/ laboratory tests to make settlement and swelling predictions.
- 4- Location of the groundwater level.
- 5- Information so that the identification and solution of excavation problems can be made.
- 6- Information regarding permeability and compaction properties of the encountered materials.

7- Information regarding cavitations and other kinds of geological weaknesses within the construction site.

This was accomplished through the close cooperation of **HCL**'s geotechnical engineer and the technical staff of its Geotechnical Department.

2. SITE CONDITIONS

2.1 DESCRIPTION

The site is located in Ramallah (Ein Sama'an street) at the location of the recently demolished slaughterhouse. It is bordered by roads from north, south and east as shown on the attached Figure.1

No high voltage, electrical or telephone poles, sewer or water pipes were observed within the depth of the drilled boreholes.

2.2 SUBSURFACE CONDITIONS

The study area on the date of field investigation consisted of different elevations with approximate difference between the higher and lower elevations of about 7-8m. However, the formation within the depths of the drilled boreholes consists mostly of creamy, hard to medium hard formation of marlstone to the full depth of exploration covered by different depth fills.

The drilled boreholes for this study reflect the described above general conditions. They are discussed in more detail in the subsequent sections of this report. Borehole logs with description of soil and rock formations are attached in the Appendix.

2.3 GROUNDWATER AND CAVITIES

Ground water was not encountered within the depths of the drilled boreholes and no ground water table was observed. No cavities or other kind of weaknesses were noticed within the drilled depths of boreholes.

3. FIELD EXPLORATION AND TESTING

3.1 DRILLING

Upon the Client's request, the site investigation program included the exploration of site subsurface conditions at the construction area through the drilling of four boreholes: two to a depth of 8.0 m each and two to a depth of 5.0 m each below the existing ground level.

Drilling has been carried out utilizing a truck-mounted drilling rig (Mobile Drill B-31) with the possibility of continuous sampling at different depths and at each lithological change of the strata.

3.2 SAMPLING

Two types of samples were collected:

- a- disturbed samples suitable for identification and index property testing purposes at various depths.
- b- undisturbed rock samples for strength tests.

Representative samples were placed in sealed plastic bags and transported to the laboratory for further testing.

In our opinion the obtained samples were of good quality.

4. LABORATORY TESTING

Representative soil and rock samples were collected from the drilled boreholes, tightly sealed and transported to **HCL's** Laboratories in Nablus.

4.1 TESTS CARRIED OUT

The following tests were performed to evaluate the engineering properties of the soils and rocks influencing the performance of the proposed structure:

- 1- **Natural moisture contents** were determined in accordance with **ASTM D-2216**.
- 2- **Atterberg limits (Liquid and Plastic)** in accordance with **ASTM D-4318**. Liquid and plastic limit tests were conducted on the powder of the obtained samples and the plasticity index (PI) was determined.
- 3- **Specific gravity and absorption** in accordance with **ASTM C-127**.
- 4- **Test for Unconfined Compressive Strength** of Intact Rock Core Specimens in accordance with **ASTM D-2938**.
- 5- **Direct shear test** in accordance with ASTM D-3080, where three identical specimens were sheared under three vertical load conditions and the maximum shear stress in each case was measured. The strength parameters, namely cohesion (c) and angle of internal friction (ϕ) were determined from the maximum shear-vs- normal stress plot.

The results of the mentioned above tests are summarized in tables below.

Borehole No.	Depth (m)	Moisture content (%)	Liquid limit (%)	Plasticity Index (PI)
1	793.0-792.0	7.8	32.5	13.2
	792.0-790.0	10.9	Non plastic (NP)	
	790.0-785.0	7.5	NP	NP
2	792.0-791.0	-	-	-
	791.0-790.0	8.0	NP	NP
	790.0-789.0	8.5	NP	NP
	789.0-787.0	7.8	NP	NP
3	789.0-787.5	7.4	42.0	14.9
	787.5-786.0	7.7	NP	NP
	786.0-781.0	7.1	NP	NP
4	787.0-786.0	5.5	-	-
	786.0-784.5	9.9	NP	NP
	784.5-782.0	7.3	NP	NP

Note : tests were carried out on cuttings resulted from the DTH drilling.

Table (1) Summary of Test Results

Borehole No.	Depth (m)	Specific gravity	Water absorption (%)	Compressive strength (Kg/cm²)
1	791.5	2.333	11.5	76
2	791.0	2.344	10.5	85
3	787.5	2.338	10.8	82
4	784.5	2.353	9.7	105

Table (2) – Summary of rock properties

Borehole No.	Elevation (m)	Cohesion (Kg/cm²)	Angle of internal friction ϕ (°)
1	792.0-790.0	10	23
2	791.0-790.0	11	24
3	787.5-786.0	11	23
4	784.5-782.0	8	27

*Samples were collected from the cuttings resulted from drilling.

Table (3) Summary of Shear Test Result

5. BEARING CAPACITY ANALYSIS

Two approaches were utilized to calculate the bearing capacity of the shallow bedrocks:

5.1 Utilizing the bearing capacity Equations:

The bearing capacity was calculated using the shear test parameters of cohesion and angle of internal friction and the soil density of the specimens extracted from the boreholes. The following well known Terzaghi equation with correction terms suggested by Schultze can be used to calculate the bearing capacity of rectangular foundation of any sides ratio B:L

$$q_{ult} = (1 + 0.3 B/L) CN_c + \gamma_o DN_q + (1 - 0.2 B/L) (\gamma_1 B/2) N_\gamma$$

where:

γ_o - Unit weight of soil above foundation level in KN/m³.

γ_1 - Unit weight of soil below foundation level in KN/m³.

C, ϕ - Strength parameters of the soil below foundation level in KN/m² and degrees respectively.

B - Width of foundation in (m).

L - Length of foundation in (m).

N_c, N_q, N_γ - Bearing capacity coefficients dependent on the angle of internal friction

of the soil below foundation level (dimensionless).

D - Depth of foundation (m).

Calculations for an assumed isolated footing :

Considering:

$$B = 2.5\text{m}$$

$$L = 2.5\text{m}$$

$$D = 2.0\text{m}$$

$$\gamma_o = 22 \text{ KN/m}^3$$

$$\gamma_1 = 22 \text{ KN/m}^3$$

$$C = 10 \text{ KN/m}^2$$

$$\phi = 23^\circ$$

The bearing capacity was computed using a special computer program following Terzaghi method. The sheet with computations is attached. Based on the calculations, a bearing capacity of **363 KPa** is given at a depth of not less than 2.0m from the original ground assuming **isolated footings** will be utilized.

5.2 Utilizing the Code Instructions:

According to the known codes of engineering practice, the bearing capacity of rocks is taken as a percentage of the unconfined compressive strength of rock core samples tested in accordance with ASTM D-2938.

Following the Jordanian Code for Foundations and Retaining Walls (Amman- 1992) [§3/7/1-2], the mentioned percentage is 5% for rocks with RQD \leq 25 % and the bearing capacity should not exceed 10 Kg/cm².

Taking the lowest compressive strength value of rock core specimens from the table (2) with test results above and applying the percentage of 5%, the strength will be:

$$Q_{\text{all}} = 5 \% \times 76 = 3.8 \text{ Kg/cm}^2$$

BEARING CAPACITY OF SHALLOW FOUNDATIONS

Terzaghi Method

Date May 6, 2009
 Identification Ramallah Sport Hall

BEARING CAPACITY OF SHALLOW FOUNDATIONS

Terzaghi and Vesic Methods

Date May 6, 2009
 Identification Ramallah Sport Hall

Input

Units of Measurement	SI	SI or E
Foundation Information		SQ, CI, CO, or
Shape	SQ	RE
B =	2.5	m
L =	2.5	m
D =	2	m
Soil Information		
c =	10	kPa
phi =	25	deg
gamma =	22	kN/m ³
Dw =	20	m
Factor of Safety		
F =	3	

Results

	Terzaghi
Bearing Capacity	
q a =	363 kPa
Allowable Column Load	
P =	2,268 kN

6. SELECTION OF FOUNDATION TYPE

According to the nature and characteristics of the materials encountered in the drilled boreholes as described in § 2.2 (hard to medium hard marlstone), we recommend to consider **isolated footings with tie beams** at any depth after cleaning all debris and loose fill materials.

7. SETTLEMENT ANALYSIS

With footings designed and constructed on the described above rocky formation, the settlement is negligible.

8. ENGINEERING RECOMMENDATIONS

As a result of field and laboratory activities carried out and the analysis of the available data and test results, the following engineering recommendations can be made:

8.1 ALLOWABLE BEARING CAPACITY

According to the analysis of the materials encountered (hard to medium hard marlstone) and the laboratory test results, the recommended allowable bearing capacity is **3.5 Kg/cm²** for shallow foundations assuming that foundations will rest on the described marlstone formation after cleaning of all loose inclusions.

8.2 DRAINAGE OF THE SITE

It is recommended to design an effective rainwater drainage system to get rid of the consequences of the rainwater percolation into the layers. The site should be graded so as to direct rainwater and water away from all planned structures.

8.3 MATERIALS FOR BACKFILL – COMPACTION CRITERIA

Materials encountered in the drilled boreholes are satisfactory for using for backfilling purposes. In general, materials for the backfilling should be granular, not containing rocks or lumps over 15 cm in greatest dimension, free from organic matter, with plasticity index (PI) not more than 10. The backfill material should be laid in lifts not exceeding 25 cm in loose thickness and compacted to at least 95 percent of the maximum dry density at optimum moisture content as determined by modified compaction test (Proctor) (ASTM D-1557).

8.4 SEISMIC CONSIDERATIONS

As far as the seismic activity in the region has not witnessed any serious earthquakes in the last 70 years, the last earthquake in February 2004 in Palestine and

neighboring Middle East countries and their serious consequences made it necessary to consider a seismic precautionary factor in the design of the project structures.

Referring to the Unified Building Code Research in Jordan, the area can be considered within Zone B, which corresponds to an intensity of VI to VIII according to the Mercalli Scale (4-6 Richter Scale respectively).

According to the seismic zoning chart prepared by An-Najah National University for Palestine (see appendix), the seismic gravity acceleration factor for area (Zone II) $z = 0.12-0.15 g$, where g – gravity acceleration.

Finally , it should be noted that the results and recommendations of this report are solely based on the collected samples from the drilled boreholes on **May 2nd, 2009** and assuming that the subsurface conditions do not significantly deviate from those encountered.

9 . REFERENCES

- ١- **كودة استطلاع الموقع.** وزارة الأشغال العامة والاسكان، عمان، الطبعة الأولى، ١٩٩٠.
- ٢- **كودة القواعد والأساسات والجدران الساندة.** وزارة الأشغال العامة والاسكان، عمان، الطبعة الأولى، ١٩٩٢.
- 3- **Code of practice for Site Investigations.** BS 5930: 1981. British Standards Institution.
- 4- **Methods of Test for Soils for Civil Engineering Purposes.** BS 1377: 1975. British Standards Institution.
- 5- K.H. Head. **Manual of Soil Laboratory Testing.** Vol. 1 & 2. ELE International Ltd. London, 1984.
- 6- J.E. Bowles. **Foundation Analysis and Design.** Third edition. McGraw - Hill International, 1982.
- 7- M.J. Tomlinson. **Foundation Design and Construction.** Fourth edition, ELBS, London, 1983.
- 8- R.Peck, W.Hanson, T.Thornburn. **Foundation Engineering.** 2nd edition, Willey, 1980.
- 9- N. Tsytoich. **Soil Mechanics.** Mir Publishers. Moscow, 1987.
- 10- N. Maslov. **Basic Engineering Geology and Soil Mechanics.** Mir Publishers. Moscow, 1987.

10. APPENDICES

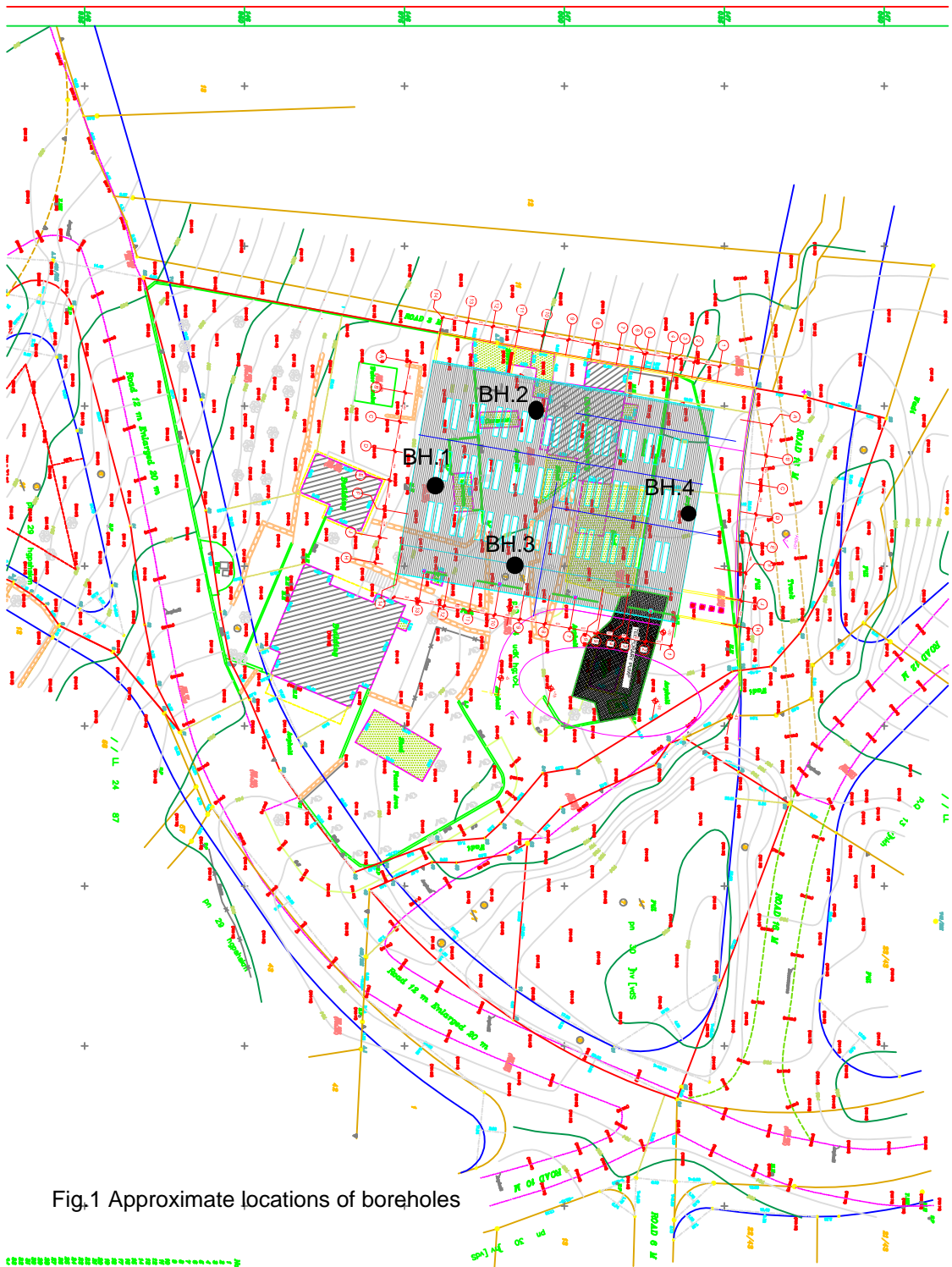
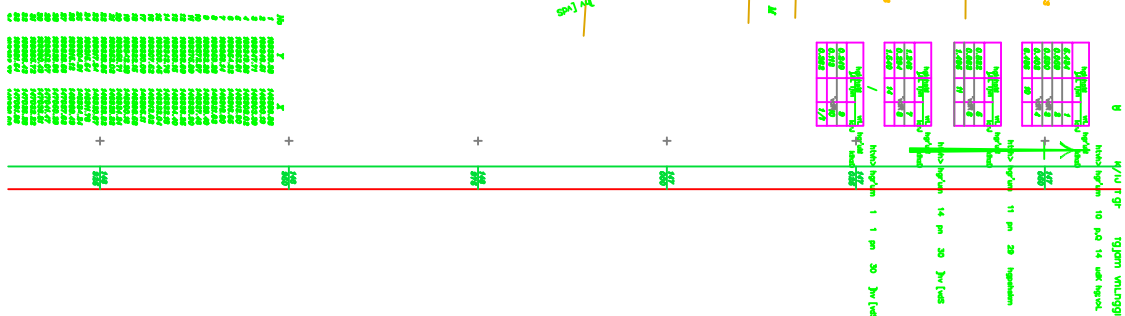


Fig.1 Approximate locations of boreholes



BOREHOLE LOG

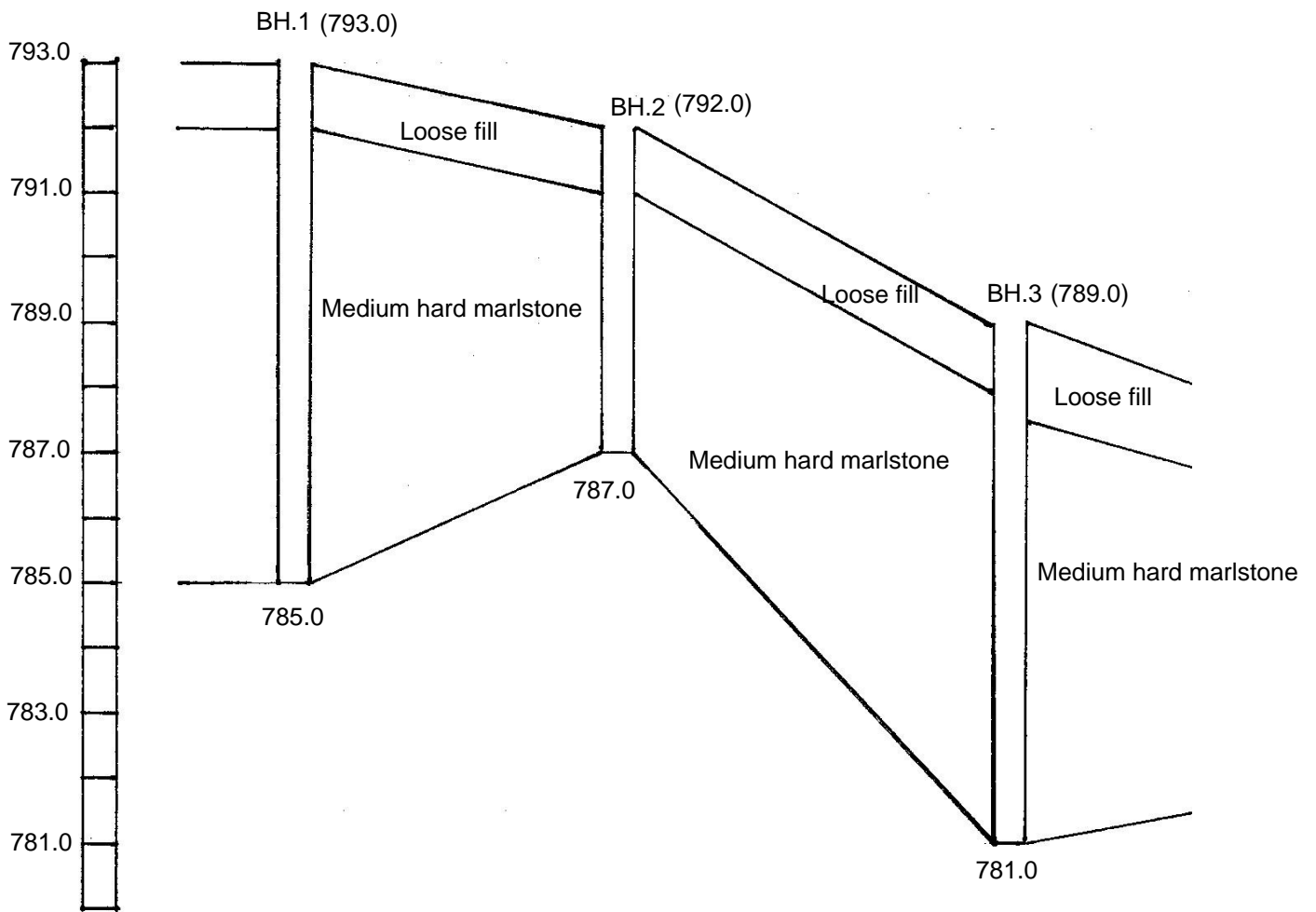
Project		Ramallah Sport Hall		Location		Ramallah			
Borehole No.		1	Page No.		1/1	Drilling Date		2/5/2009	
Ground level		793.0		Weather		Sunny			
Drill Rig		Mobile B-31		Operator		Adnan			
Scale (m)	Sampler Type	Symbol	Description of soil strata	USCS	SPT (No. of blows)				
					15	15	15	N	
793.0			Fill material of brown silty clay and boulders	CL					
792.0			Soft to medium hard formation of creamy and slightly damp marlstone with occasional boulders	-				R	
791.0									
790.0			Hard formation of creamy marlstone	-				R	
789.0									
788.0									
787.0									
786.0									
785.0									
			End of boring @ 785.00						
Water Record									
Level, at which water was encountered				None	Color of water		-		
Water level 24hrs. after completion					None				
Remarks :									
USCS- Unified Soil Classification System R- Refusal (more than 50 blows)									
Approved :		Dr. Sami A. Hijjawi							

BOREHOLE LOG

Project		Ramallah Sport Hall			Location		Ramallah		
Borehole No.		2	Page No.		1/1	Drilling Date			2/5/2009
Ground level		792.0			Weather		Sunny		
Drill Rig		Mobile B-31			Operator		Adnan		
Scale (m)	Sam- pler Type	Sym- bol	Description of soil strata	USCS	SPT (No. of blows)				
					15	15	15	N	
792.0			Asphalt and base course	-					
791.0			Hard creamy formation of marlstone	-				R	
790.0			Medium hard formation of creamy marlstone	-				R	
789.0			Hard formation of creamy marlstone	-				R	
788.0									
787.0			End of boring @ 787.0						
Water Record									
Level, at which water was encountered					None	Color of water		-	
Water level 24hrs. after completion					None				
Remarks :									
USCS- Unified Soil Classification System R- Refusal (more than 50 blows)									
Approved :		Dr. Sami A. Hijjawi							

BOREHOLE LOG

Project		Ramallah Sport Hall			Location		Ramallah		
Borehole No.		3	Page No.		1/1	Drilling Date			2/5/2009
Ground level		789.0			Weather		Sunny		
Drill Rig		Mobile B-31			Operator		Adnan		
Scale (m)	Sampler Type	Symbol	Description of soil strata	USCS	SPT (No. of blows)				
					15	15	15	N	
789.0	X		Fill materials of silty clay and boulders	CL					
788.0									
787.0	X		Medium hard formation of creamy marlstone	-				R	
786.0									
785.0	X		Hard to very hard formation of creamy marlstone	-				R	
784.0									
783.0									
782.0									
781.0									
			End of boring @ 781.00						
Water Record									
Level, at which water was encountered					None		Color of water		-
Water level 24hrs. after completion					None				
Remarks :									
USCS- Unified Soil Classification System R- Refusal (more than 50 blows)									
Approved :		Dr. Sami A. Hijjawi							



Cross section through boreholes 1,2,3