APPENDIX III

SOIL AND MATERIAL SURVEY AND DATA

Appendices III SOIL AND MATERIAL SURVEYS

III. 1 Purpose of Surveys

III. 1.1 Purpose of Surveys

One of the most important works in the detailed design is that the geological condition of the study area will be fully understood in order to plan and design highways and structures such as bridges and retaining walls sinsce the structures and road pavement will be designed to be suitable to soil conditions.

Public facilities should be constructed using high quality materials, therefore the quality of materials to be used for the construction in relation to this project will be thoroughly investigated.

Being based on the same policy as the topographic survey, soil and material surveys are carried out obtaining cooperation from Swiss Boring Overseas Co. (hereinafter called "local surveyor"), which has much experience of geological investigation in Oman.

III. 1.2 Scope of Work

The surveys to be conducted for this detailed design study will be comprised of the following:

(1) Field Investigation

(a) Flyover

-Machine boring regardless of type of soils
-Standard penetration test
-Pressio metric test
-Thin-walled tube sampling, if any soft layer was found
-Measurement of ground water level
-Ground water sampling
-Test pit

(b) Approach bank of flyover

-Machine boring regardless of type of soils
-Standard penetration test

(c) Pedestrian underpass

-Machine boring regardless of type of soils
-Standard penetration test
-Thin-walled tube sampling, if any soft layer was found
-Measurement of ground water level

(2) Laboratory Test

(a) Flyover

1) Sample of SPT
- Natural water content test
- Specific gravity test
- Grain size analysis
- pH test of soil
- Water-soluble component of chloride test including chloride content test
- Water-soluble component of sulfate test including sulfate content test

2) Sample of thin-walled tube, if any undisturbed soft soil sampled
- Natural water content test
- Specific gravity test
- Grain size analysis with sedimentation
- Liquid and plastic limit test & index
- Wet density test
- Unconsolidated-undrained triaxial compression test
- Consolidation

3) Sample of groundwater
- PH Test of Ground Water

(b) Pedestrian underpass

a) Sample of thin-walled tube
- Natural water content test
- Specific gravity test
- Grain size analysis with sedimentation
- Liquid and plastic limit test & index
- Wet density test
- Unconsolideted-undrained triaxial compression trst
- Swelling test by consolidation test

(3) Material

(a) Banking material

- Compaction test
- California bearing ratio test
- Grain size analysis
- pH test of soil
- Water-soluble component of chloride test including chloride content test

(b) Aggregate

- Alkali-aggregate reaction test

(c) Water for making concrete

- pH test of ground water
- Chloride content test
- Sulfate content test

III. 2 Soil and Material Surveys Method

III. 2.1 Soil Investigation Method

Soil investigation survey works implemented in this study consisted of both field investigations and laboratory tests. Field investigation commenced on 20th of January, 1996, while soil laboratory test was started from 27th of January, 1996.

(1) Field Investigation Method

Field investigation carried out includes the standard boring, standard penetration test, a sampling of soil layers, pressure meter test, ground water level measurement, ground water sampling and test pit excavation.

a) Boring

Field boring investigation was performed in accordance with BS 5930. Boring was done by means of rotary machine drilling with casing and slurry to secure the stability of the bore hole. Each bore hole had to be drilled to a minimum 10 meters and the diameter of the bore hole had be keep more than 86 mm at every location. Core sample was taken when the soil became hard enough. Bit pressure and revolutions per minute of the drilling machine were carefully controlled during the core sampling process.

b) Standard Penetration Test (SPT)

Standard Penetration Test was carried out at the bottom of the bore hole after it was sufficiently clean and any slime removed.
SPT in each bore hole was carried out at one meter depth intervals in accordance with ASTM D 1586. The characteristics of the soil sample, such as soil layer, color, hardness, admixture, organic component were carefully observed and recorded.

c) Sampling of soil layer

Samples of soil layer were collected from a standard penetration test sampler and a double walled tube sampler.
These collected samples were transferred to polyethylene bag to preserve their water content for the physical and chemical laboratory tests. After the physical laboratory tests, these samples were keep in the core boxes and carefully labeled with the project name and bore hole numbers. They are stored at the soil investigation consultant's office up to the end of this year (1996).

d) Pressio metric test

Pressio metric tests were carried out at three specified depths of 3 m, 5 m and 7 m. These tests were conducted in 3 bore holes at each study roundabout in accordance with the requirements of British Standard 5930.

e) Ground water level measurement

Ground water level measurement was performed in each bore hole.

f) Ground water sampling

Ground water samples were collected from bore holes where ground water was found. Samples were obtained from two roundabouts (R/A-12: Sohar, R/A-18: Al Aqr), and 3 pedestrian underpass locations (P/U-5: A' Tharmad, P/U-7: Al Khadra and P/U-9; Majaz A' Sughra).

g) Test pit excavation

Test pit excavations were performed by hand for 3 trial pits at the study roundabouts to depth of 3 meters.

(2) Laboratory Test Method

Physical and a chemical laboratory tests were performed on the soil samples gathered from the standard penetration test sampler in accordance with British Standard 1377. The following tests were carried out:

- Natural water content
- Specific gravity
- Grain size analysis
- Liquid and plastic limit test
- pH test of soil
- Water-soluble component of chloride of soil test
- Water-soluble component of sulfate of soil test
- pH test of ground water
- Water-soluble component of chloride of ground water test
- Water-soluble component of sulfate of ground water test

III. 2.2 Material Survey Method

Samples of materials such as aggregates, banking materials and water for making concrete mix were gathered from local contractors.

Stability and chemical laboratory tests on these material samples were carried out in accordance with British Standard 1377 with the following tests:

- Compaction test for banking materials
- California bearing ratio test for banking materials
- Alkali-aggregate reaction test for aggregate
- pH test of ground water for making concrete mix
- Chloride content test of ground water for making concrete mix
- Sulfate content test of ground water for making concrete mix

III. 3 Soil Investigation and Material Survey Performed

III. 3.1 Soil Investigation Performed

(1) Field Investigation Performed

The field investigations were implemented at the eight study roundabouts and the twelve study pedestrian underpass locations.

a) Periods of field investigation at the roundabout and pedestrian underpass locations

Period of field investigation performed at the roundabouts are shown in Table III. 1 and that of the proposed pedestrian underpass locations are shown in Table III. 2.

Table III. 1 Period of Field Investigation Performed at the study roundabouts are

Name of Roundabout	Date of Commencement	Date of Completion
R/A- 2 : A' Naseem Garden	24-Jan-96	28-Jan-96
R/A- 3 : Barka	20-Jan-96	24-Jan-96
Junc- 5 : Al Muladdah	30-Jan-96	3-Feb-96
R/A- 8 : Al Khaburah	5-Feb-96	8-Feb-96
R/A- 10 : Saham	8-Feb-96	15-Feb-96
R/A- 12 : Sohar	16-Feb-96	28-Feb-96
R/A- 14 : Falaj Al Qabail	27-Feb-96	1-Mar-96
R/A- 18 : Al Aqr	3-Mar-96	6-Mar-96

Table III. 2 Period of Field Investigation Performed at the Study Pedestrian Underpasses Location

Name of Pedestrian Underpasses Location	Date of Commencement	Date of Completion
P/U- 1 : Barka	24-Jan-96	24-Jan-96
P/U- 2 : Al Billah	28-Jan-96	29-Jan-96
P/U- 3 : A' Tarcef	29-Jan-96	30-Jan-96
P/U- 4 : Al Qarat	1-Feb-96	3-Feb-96
P/U- 5 : A' Thamad	3-Feb-96	4-Feb-96
P/U- 6 : A' Suweiq	4-Feb-96	4-Feb-96
P/U- 7 : Al Khadra	5-Feb-96	5-Feb-96
P/U- 8 : Qarih	5-Feb-96	5-Feb-96
P/U- 9 : Majaz A' Sughra	15-Feb-96	16-Feb-96
P/U- 10 : Khor A' Siyabi	17-Feb-96	18-Feb-96
P/U- 11 : Liwa	1-Mar-96	2-Mar-96
P/U- 12 : Asrar Bani Sa'd	2-Mar-96	2-Mar-96

b) Quantity of field investigation at the eight roundabouts

A total of 88 bore holes with a combined total length 955 meters were bored at the study roundabouts. A total of 955 standard penetration tests were conducted, 75 tests in excess than the original proposed number. This is because the number of SPT required increases with increase in total length of boring due to the soil conditions.

Sampling of thin-walled tube was not carried out at every study roundabout because soft layers were not found at some locations. Ground water samples were taken from four boreholes at two locations.

Summary of these quantities on soil investigations at the study roundabout are shown in Table III. 3.

Table III. 3 Summary of Field Investigation Quantities at the Proposed Roundabouts

Name of Roundabout	Numb-er of Boring Hole (hole)	Boring Total Length (m)	Numbers of SPT (test)	Numbers of Pressure Meter Test (test)	Laboratory Test of SPT Sample (test/set)	Th.-walled Tube Sampling (set)
R/A- 2 : A' Naseem Garden	11	110	110	9	9	0
R/A- 3 : Barka	11	110	110	9	9	0
Junc- 5 : Al Muladdah	11	110	110	9	9	0
R/A- 8 : Al Khaburah	11	110	110	9	9	0
R/A- 10 : Saham	11	110	110	9	9	0
R/A- 12 : Sohar	11	182	182	9	9	0
R/A- 14 : Falaj Al Qabail	11	113	113	9	9	0
R/A- 18 : Al Aqr	11	110	110	9	9	0
Performed total	88	955	955	72	72	0

Name of Roundabout	Laboratory Test of Th.-walled Tube Sample (test/set)	Ground Water Leveling Measurement (hole)	Ground Water Sampling (hole)	Laboratory Test of Ground Water Sample (test/set)	Numbers of Test Pitting (test)
R/A- 2 : A' Naseem Garden	0	2	0	0	3
R/A- 3 : Barka	0	2	0	0	3
Junc- 5 : Al Muladdah	0	2	0	0	3
R/A- 8 : Al Khaburah	0	2	0	0	3
R/A- 10 : Saham	0	2	0	0	3
R/A- 12 : Sohar	0	2	2	2	3
R/A- 14 : Falaj Al Qabail	0	2	0	0	3
R/A- 18 : Al Aqr	0	2	2	2	3
Performed total	0	16	4	4	24

SPT: Standard Penetration Test

c) Quantity of field investigation at the twelve pedestrian underpass locations

Compared to the roundabout locations, a total of only 24 bore holes, having a combined total length 240 meters were bored at the study pedestrian underpass locations. This boring length was similar to the proposed length. 240 SPT were conducted.

Sampling of thin-walled tube was not carried out at every location here, either. Ground water samples were gathered from three locations which are not proposed the pedestrian underpass locations.

Summary of these quantities on soil investigations at the study pedestrian underpass locations are shown in Table III. 4.

Table III. 4 Summary of Field Investigation Quantities at the Proposed Pedestrian Underpass Locations

Name of Roundabout	Number of Boring Hole (hole)	Boring Total Length (m)	Numbers of SPT (test)	Thin-walled Tube Sampling (set)	Ground Water Leveling Measurement (hole)	Ground Water Sampling (hole)
P/U- 1 : Barka	2	20	20	0	1	
P/U- 2 : Al Billah	2	20	20	0	1	
P/U- 3 : A' Tareef	2	20	20	0	1	
P/U- 4 : Al Qarat	2	20	20	0	1	
P/U- 5 : A' Thamad	2	20	20	0	1	1
P/U- 6 : A' Suweiq	2	20	20	0	1	
P/U- 7 : Al Khadra	2	20	20	0	1	1
P/U- 8 : Qarih	2	20	20	0	1	
P/U- 9 : Majaz A' Sughra	2	20	20	0	1	1
P/U- 10 : Khor A' Siyabi	2	20	20	0	1	
P/U- 11 : Liwa	2	20	20	0	1	
P/U- 12 : Asrar Bani Sa'd	2	20	20	0	1	
Performed total	24	240	240	0	12	3

SPT: Standard Penetration Test

(2) Laboratory Test Performed

Laboratory tests were implemented on the soil samples and ground water samples.

a) Quantity of laboratory test at the eight roundabouts

Physical and chemical tests were carried out on soil samples gathered by the standard penetration test sampler and undisturbed sampler at the study roundabouts. Chemical tests were performed on the ground water samples.

Quantity of laboratory tests on soil and ground water smples from the study roundabouts are given in Table III. 5.

b) Quantity of laboratory test at the twelve pedestrian underpass locations

Chemical tests were performed on the ground water samples.
Quantity of laboratory tests on ground water samples from the study pedestrian underpass locations are given in Table III. 6.

Table III. 5 Summary of Laboratory Test Quantities at the Proposed Roundabouts

Name of the Roundabout	Samples	Soil Laboratory Test					
	Number of SPT/UDS Sampler (sample)	Natural Water Content (test)	Specific Gravity (test)	Grain Size Analysis (test)	Plastic & Liquid Limit Test (test)	pH Test of Soil (test)	SO_3&Cl Test of Soil (test)
R/A- 2 : A' Naseem Garden	8 / 1	9	9	9	2	3	3
R/A- 3 : Barka	9 / -	9	9	9	2	4	4
Junc- 5 : Al Muladdah	7 / 5	12	12	12	3	-	-
R/A- 8 : Al Khaburah	9 / 5	14	14	14	5	3	3
R/A- 10 : Saham	8 / 1	9	9	9	1	2	2
R/A- 12 : Sohar	9 / 1	10	10	10	1	3	3
R/A- 14 : Falaj Al Qabail	9 / 1	10	10	10	1	3	3
R/A- 18 : Al Aqr	8 / 1	9	9	9	-	3	3
Performed total	67 / 15	82	82	82	15	21	21

Name of the Roundabout	Samples	Water Laboratory Test		
	Number of Ground Water (sample)	pH Test of Gr. Water (test)	SO_3 Test of Gr. W. (test)	Cl Test of Gr. W. (test)
R/A- 2 : A' Naseem Garden	-	-	-	-
R/A- 3 : Barka	-	-	-	-
Junc- 5 : Al Muladdah	-	-	-	-
R/A- 8 : Al Khaburah	-	-	-	-
R/A- 10 : Saham	-	-	-	-
R/A- 12 : Sohar	2	2	2	2
R/A- 14 : Falaj Al Qabail	-	-	-	-
R/A- 18 : Al Aqr	2	2	2	2
Performed total	4	4	4	4

UDS: Un-disturbed Sampler
SO_3: Water-soluble Component of Chloride Test
Cl: Water-soluble Component of Sulfate Test

Table III. 6 Summary of Laboratory Test Quantities at the Proposed Pedestrian Underpass Locations

Name of the Pedestrian Underpasses Location	Samples Number of Ground Water (sample)	Water Laboratory Test pH Test of Gr. Water (test)	SO_3 Test of Gr. W. (test)	Cl Test of Gr. W. (test)
P/U- 1 : Barka	-	-	-	-
P/U- 2 : Al Billah	-	-	-	-
P/U- 3 : A' Tarcef	-	-	-	-
P/U- 4 : Al Qarat	-	-	-	-
P/U- 5 : A' Thamad	1	1	1	1
P/U- 6 : A' Suweiq	-	-	-	-
P/U- 7 : Al Khadra	1	1	1	1
P/U- 8 : Qarih	-	-	-	-
P/U- 9 : Majaz A' Sughra	1	1	1	1
P/U- 10 : Khor A' Siyabi	-	-	-	-
P/U- 11 : Liwa	-	-	-	-
P/U- 12 : Asrar Bani Sa'd	3	3	3	3

SO_3: Water-soluble Component of Chloride Test
Cl: Water-soluble Component of Sulfate Test

III. 3.2 Material Survey Performed

(1) Location of Material Samples

Table III. 7 shows the type of material samples taken at six locations with varying distance from Batinah Highway. Aggregate, banking material and water samples were taken. Location map of material samples are given in Figure III. 1.

Table III. 7 List of Material Samples from Six Locations

Classification	Location	Distance from Batinah Highway	Type of Sample
A	A' Tarcef	10 km to inland	Aggregate
			Water
			Bank material
B	Wadam As Sahil	10 km to inland	Aggregate
			Water
			Bank material
C	Al Hijari	10 km to inland	Aggregate
			Water
			Bank material
D	Wadi Salah	10 km to inland	Aggregate
			Bank material
E	Ohi	2 km to inland	Aggregate
			Water
			Bank material
F	Al Aqr	100 m to inland	Water

(2) Quantity of Laboratory Test on Material Samples

The type of laboratory tests on the material samples are given in Table III. 8.

Table III. 8 Quantity of Laboratory Tests on Material Samples

Sample	Laboratory Test	Quantity of Test
Aggregate	Alkali-aggregate reaction test	5
Water	pH test	5
	Chloride content test	5
	Sulfate content test	5
Bank material	Compaction test	6
	California bearing ratio test	6

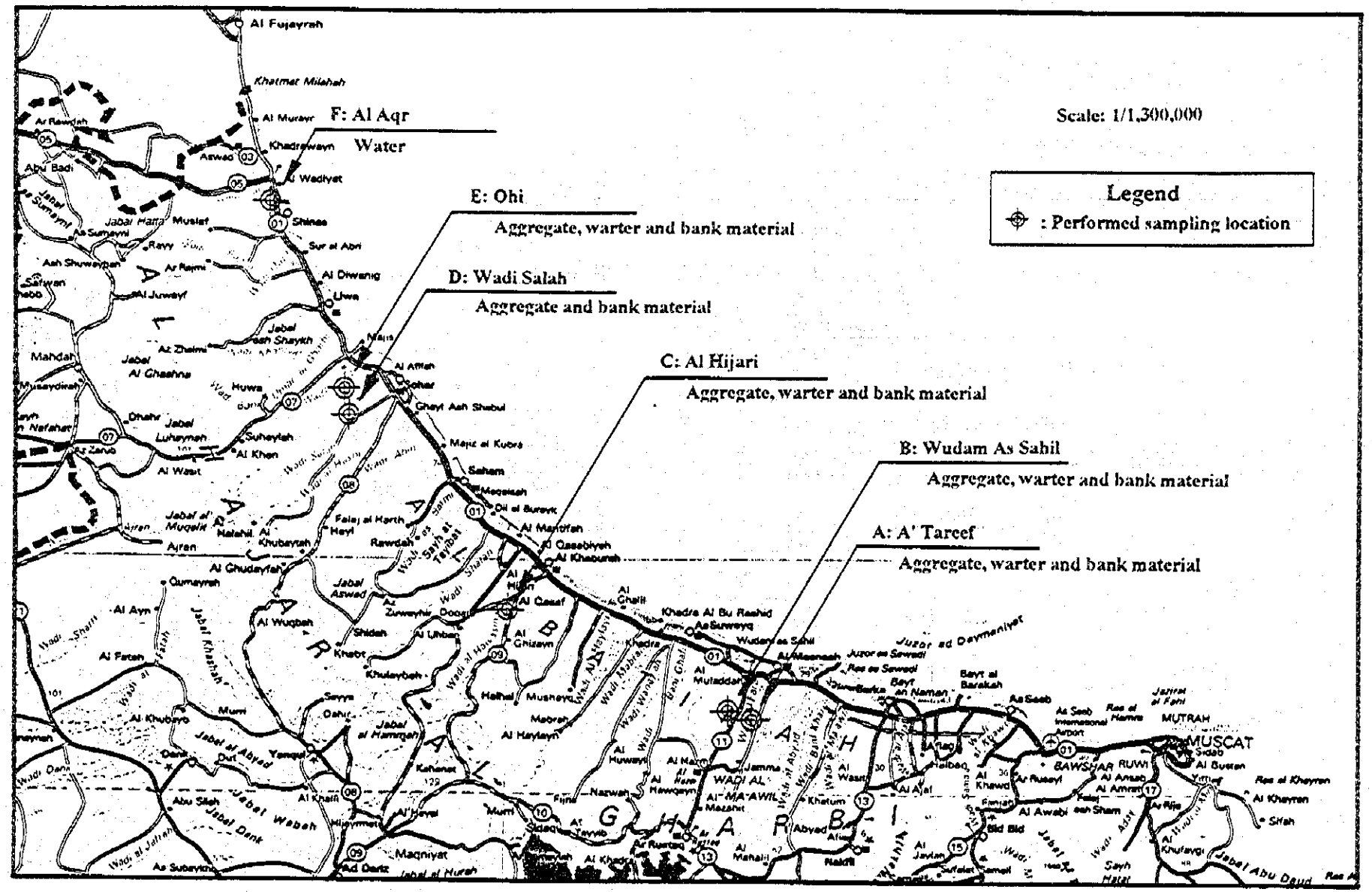


Figure III. 1 Location Map of Material Samples

III.4 Result of Soil Investigation

III.4.1 Result of Field Investigation

(1) Stratigraphy in Batinah Coastal Plain

The stratigraphy of Batinah coastal plain consists of sedimentary formation of tertiary and quaternary age as following Table III.9. The detailed was described in Clause 2.3.2 of CHAPTER 2 of Main Report.

Table III. 9 Explanation of Sedimentary Rocks

Geological Time		Formation	Description
Quaternary	Holocene	Alluvium	Fluviatile deposit recent fans coastal deposit
	Pleistocene	Diluvium	Fluviatile deposit old fans terrace deposit
Tertiary	Neocene	Mudstone	Mudstone, Gravity mudstone and marlymudstone, marlystone
	Paleocene	Limestone	Limestone, marlystone

(2) Soil Conditions at the Study Roundabouts

a) A' Naseem Garden R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a layer of made ground extending from the E.G.L. down to a maximum depth of 0.6 m, overlying medium dense, silty, fine to medium SAND with gravel down to a depth of approximately 2.7 m. Dense to very dense, cemented, fine to the medium SAND and GRAVEL was intersected thereafter down to the maximum investigated depth of 10.0 m.

In-situ dry densities measured in the trial pits show values of 1,820 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

b) Barka R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a layer of made ground extending from the E.G.L. down to a maximum depth of 0.9 m, overlying medium dense, silty, fine to medium SAND with gravel down to a depth of approximately 4.0 m. Dense to very dense fine to medium SAND and GRAVEL with a layer of cemented clayey SILT was intersected thereafter down to the maximum investigated depth of 10.0 m.

In-situ dry densities measured in the trial pits show values of 1,710 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

c) Al Muladdah Junction

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a thin layer of made ground extending from the E.G.L. down to maximum depth of 0.9 m, overlying loose to medium dense, sandy, clayey SILT with thin layers of silty sand down to a depth of 3.8 m. Dense to very dense, slightly silty, fine to coarse sand with gravel was intersected thereafter down to 7.2 m followed by dense to very dense, weakly cemented, sandy clayey SILT, with some fine gravel down to the maximum investigated depth 10.0 m.

In-situ dry densities measured in the trial pits show values of 1,700 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

d) Al Khaburah R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a thin layer of made ground extending from the E.G.L. down to maximum depth of 1.75 m, overlying loose to medium dense, very silty, fine SAND down to a depth of approximately 5.3 m Dense to very dense fine to medium SAND and GRAVEL with cobbles was intersected thereafter down to the maximum investigated depth of 10.0 m.

In-situ dry densities measured in the trial pits show values of 1,670 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

e) Saham R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a thin layer of made ground extending from the E.G.L. down to maximum depth of 0.8 m, overlying loose to medium dense SAND and clayey SILT down to a depth of approximately 5.9 m. Dense to very dense fine to medium SAND and GRAVEL with clayey SILT was intersected thereafter down to the maximum investigated depth of 10.0 m.

In-situ dry densities measured in the trial pits show values of 1,700 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

f) Sohar R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a thin layer of made ground extending from the E.G.L. down to maximum depth of 1.5 m. The natural material consisting of medium dense SAND and SILT distributed in district horizons was thereafter intersected down to the maximum investigated depth of 19.0 m.

In-situ dry densities measured in the trial pits show values of 1,690 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was established at an approximately depth of 9.2 m below working level. However, this level may be subjected to seasonal / tidal variation or charge if dewatering takes place in the vicinity. Reconfirmation is recommended prior to any works relating to the ground regime.

g) Falaji Al Qabail R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of a thin layer of made ground extending from the E.G.L. down to maximum depth of 0.9 m, overlying medium dense silty fine to medium SAND with gravel and layers of silty SAND down to the maximum depth of 4.1 m. Dense to very dense fine to medium SAND and GRAVEL with cobbles were intersected thereafter down to 7.3 m followed by very dense cemented sand with gravel down to the maximum investigated depth of 13.0 m.

In-situ dry densities measured in the trial pits show values of 1,930 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

h) Al Aqr R/A

In general terms, similar ground conditions were intersected at all boreholes and trial pits, consisting of brown / gray medium dense to dense, sand and gravel with occasional cobbles extending from the E.G.L. down to maximum depth of 2.5 m, overlying dense to very dense, SAND GRAVEL and COBBLES with occasional boulders down to the maximum investigated depth of 10.0 m.

In-situ dry densities measured in the trial pits show values of 2,020 kg/m^3 approximately, consistent with the dense state of the formation.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled and trial pits excavated by the soil survey consultant.

(3) Soil Condition at the Study Pedestrian Underpass Locations

a) Barka P/U

Similar ground conditions were encountered consisting of a thin layer of made ground approximately 0.2 m to 0.6 m thick, overlying brown, silty, fine to medium SAND with gravel, loose to medium dense at first but becoming dense from 2.0 m below E.G.L. Very dense, cemented, sandy, creyey, SILT with fine gravel and thin layers of sandy gravel were intersected thereafter down to the depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

b) Al Billah P/U

Similar ground conditions were encountered consisting of a thin layer of made ground approximately 0.2 m to 0.5 m thick, overlying brown, silty, fine to medium SAND with gravel, loose at first but becoming medium dense from 3.0 m below E.G.L. Dense, weakly cemented, silty SAND and GRAVEL were intersected thereafter down to the depth of 7.75 m and then gray, medium dense, weakly cemented, sandy, clayey, SILT with fine gravel down to the maximum investigation depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

c) A' Tareef P/U

Similar ground conditions were encountered consisting of a thin layer of made ground approximately 0.2 m thick, overlying brown, loose SILT and fine SAND extending to a depth of 6.8 m followed by brown, very dense, cemented sandy SILT down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

d) Al Qarat P/U

Similar ground conditions were intersected comprising, under a thin layer of made ground, medium dense, silty, fine SAND extending to a depth of 2.8 m thereafter grading to fine to coarse dense or very dense, SAND to a depth of 4.8 m and 5.3 m at BH-1 and BH-2 respectively. Very dense SAND and GRAVEL with cobbles wee intersected thereafter down to 6.75 m followed by very dense cemented sandy SILT with some fine gravel down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

e) A' Thamad P/U

A similar succession of soil layers was intersected consisting of brown, medium dense, silty fine SAND with some fine gravel extending from surface down to a maximum depth of 2.75 m, overlying sense, slightly silty, fine to medium SAND and GRAVEL with some cobbles down to a depth of 4.9 m. Very dense, cemented sandy, clayey SILT with fine gravel was intersected thereafter down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was established at an approximately depth of 9.1 m below working platform. However, this level may be subject to seasonal / tidal variation or change if dewatering takes place in the vicinity. Reconfirmation is recommended prior to any work relating to the groundwater regime.

f) A' Suweiq P/U

Similar ground conditions were encountered consisting of a thin layer of medium dense, silty fine SAND and GRAVEL with cobbles extending from E.G.L. down to maximum depth of 0.7 m, overlying brown, silty, fine SAND, loose at first but becoming medium dense below 3.0 m down to 4.8 m. Dense, silty, fine to coarse SAND with gravel was intersected thereafter grading with depth into very dense down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

g) Al Khadra P/U

Similar ground conditions were encountered consisting of a thin layer of brown, loose silty SAND with gravel, approximately 0.3 m thick, overlying brown, medium dense, SILT and SAND down to 5.9 m E.G.L. Dense to very dense weakly cemented SAND and SILT were intersected thereafter down to the Maximum investigated depth of 10.0 m.

At the time of investigation, the ground water level was established at an approximately depth of 7.9 m below working platform. However, this level may be subject to seasonal / tidal variation or changes if dewatering takes place the vicinity. Reconfirmation is recommended prior to any work relating to the groundwater regime.

h) Qarih P/U

Similar ground conditions were encountered consisting of a thin layer of loose, silty SAND approximately 0.2 m to 0.4 m thick, overlying brown fine SAND and SILT, loose at first but becoming medium dense between 3.0 m and 8.0 m below E.G.L. Very dense, weakly cemented sandy SILT were intersected thereafter down to the maximum investigated depth of 10.0 m

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

i) Majaz A' Sughra P/U

Similar ground conditions were encountered consisting of a thin layer of made ground approximately 0.4 m thick, overlying loose to medium dense, silty SAND down to 3.8 m below E.G.L. Dense to very dense SAND with gravel were intersected thereafter down to 7.5 m followed by loose to medium dense, very silty SAND down to maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was established at an approximately depth of 7.7 m below working platform. However, this level may be subject to seasonal / tidal variation or changes if dewatering take place in the vicinity. Reconfirmation is recommended prior to any work relating to the ground water regime.

j) Khor A' Siyabi P/U

Similar ground conditions were encountered consisting of a thin layer of made ground approximately 0.25 m thick overlying loose to medium dense, very silty SAND down to 3.9 m below E.G.L. Medium dense, silty, fine to medium SAND with gravel was intersected thereafter down to 5.6 m, followed by dense to very dense SAND and GRAVEL down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

k) Liwa P/U

Similar succession of soil layers were intersected consisting of medium dense to dense, silty SAND and GRAVEL extending from surface down to a maximum depth of 1.5 m, overlying dense to very dense SAND and GRAVEL with cobbles down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

l) Asrar Bani Sa'd P/U

Similar succession of soil layers were intersected consisting of medium dense to dense, silty SAND and GRAVEL extending from surface down to a maximum depth of 1.6 m, over lying dense to very dense SAND and GRAVEL with cobble down to the maximum investigated depth of 10.0 m.

At the time of investigation, the groundwater level was not established at any of the boreholes drilled by the soil survey consultant.

(4) Result of Pressure Meter Test at the Study Roundabouts

Modules of deformation is shown as following formula:

$$E = 2(1+\mu)(V0+Vm)\ \triangle P / \triangle V$$

where	E:	Modulus of deformation	(kN/m^2)
	V0:	Volume of main cell at non pressure	(m^3)
	Vm:	Average to be supplied water	(m^3)
	$\triangle P / \triangle V$:	Gradient of P-V straight line	(kN/m^5)
	μ:	Poisson's ratio of the soil	(0.33 or 0.5)

Summary of result for pressure meter test at the Study Roundabouts is shown in Table III. 10.

Table III. 10 Summary of Result for Pressure Meter test

Name of the Roundabout	Value	Depth (m)	N Values	Modulus of Deformation		
				E1 (kN/m2)	E2 (kN/m2)	EN (kN/m2)
R/A- 2 : A' Naseem Garden	Average	3.75	39	61	1,902	26,950
		5.75	50	66	7,177	35,000
		7.75	50	115	12,982	35,000
R/A- 3 : Barka	Average	3.75	44	65	2,451	30,917
		5.75	50	75	6,373	35,000
		7.75	50	77	19,569	35,000
Junc- 5 : Al Muladdah	Average	3.75	46	57	5,305	32,083
		5.75	49	250	8,605	34,183
		7.75	50	705	11,084	35,000
R/A- 8 : Al Khaburah	Average	3.75	14	90	3,051	9,450
		5.75	38	69	10,160	26,250
		7.75	50	71	10,204	35,000
R/A- 10 : Saham	Average	3.75	24	363	7,765	16,450
		5.75	27	309	12,434	18,900
		7.75	43	288	15,037	29,983
R/A- 12 : Sohar	Average	3.75	17	318	6,809	11,550
		5.75	31	196	9,677	21,350
		7.75	48	96	13,617	33,367
R/A- 14 : Falaj Al Qabail	Average	3.75	41	108	10,976	28,933
		5.75	50	861	15,246	35,000
		7.75	50	57	17,269	35,000
R/A- 18 : Al Aqr	Average	3.75	50	517	18,670	35,000
		5.75	50	581	23,967	35,000
		7.75	50	442	23,630	35,000

EN: Estimate from N value

(5) Boring Log at the Roundabouts and Proposed Pedestrian Underpass Locations

Boring log at the roundabouts and proposed pedestrian underpass locations are shown in record of borehole (boring log) on the soil investigation report fom local consultant.

(6) N Value at the Roundabouts and Proposed Pedestrian Underpass Locations

N value with boring log at the roundabouts and proposed pedestrian underpass locations are shown in each record of borehole on the soil report fom local consultant.

(7) Soil Profile at the Roundabouts

N value at the roundabouts is shown in the soil report fom local consultant.

III. 4.2 Result of Laboratory Test

(1) At the Study Roundabouts

a) Particle Size Gradation

The gradation of three categories at the roundabouts is shown in Table 14.11.

Table III. 11 Result of Particle Size Gradation

Name of the Roundabout / Type of Soil	Value	Moisture Content (%)	Grain Size Analysis (%) (mm) Cray <0.002	Silt <0.06	Sand <2.0	Gravel <60.0
R/A- 2 : A' Naseem Garden						
Gravelly Soil	Average	11.9	3.51	17.39	45.30	33.80
Sandy Soil	Average	9.7	0.00	17.00	56.10	27.10
R/A- 3 : Barka						
Cohesive Soil	Individual	27.2	30.50	55.70	9.50	4.30
Gravelly Soil	Average	10.2	2.73	12.82	47.42	37.03
Sandy Soil	Average	6.3	0.00	0.15	89.10	10.75
Junc- 5 : Al Muladdah						
Cohesive Soil	Average	21.4	10.51	65.29	23.81	0.23
Sandy Soil	Average	9.6	3.20	18.40	77.14	1.26
R/A- 8 : Al Khaburah						
Cohesive Soil	Average	20.0	7.74	67.90	23.37	1.26
Sandy Soil	Average	6.6	0.00	35.73	57.97	6.30
R/A- 10: Saham						
Cohesive Soil	Average	18.8	0.92	61.30	34.12	3.67
Gravelly Soil	Individual	5.8	0.00	7.30	37.20	44.30
Sandy Soil	Average	11.5	0.00	29.20	68.35	2.45
R/A- 12: Sohar						
Cohesive Soil	Average	19.9	2.54	59.49	35.81	2.16
Sandy Soil	Individual	22.8	0.00	52.20	45.60	2.20
R/A- 14: Falaj Al Qabail						
Cohesive Soil	Average	22.8	3.83	46.53	31.93	17.70
Gravelly Soil	Average	5.8	0.00	7.08	39.23	53.72
Sandy Soil	Individual	21.3	0.00	36.10	55.80	8.10
R/A- 18: Al Aqr						
Gravelly Soil	Average	7.0	0.00	12.80	34.37	52.83

b) Character of Consistency

The character of consistency is summarized in Table III. 12.

c) Character of Chemical Test

The character of chemical test is summarized in Table III. 13.

Table III. 12 Result of Consistency Test

Name of the Roundabout	Type of Soil	Value	Moisture Content (%)	Consistency		
				Plastic Index	Plastic Limit	Liquid Limit
R/A- 2 : A' Naseem Garden						
	Gravelly Soil	Average	11.9	12.00	38.80	47.20
R/A- 3 : Barka						
	Cohesive Soil	Individual	27.2	26.80	28.20	55.00
	Gravelly Soil	Average	10.2	16.20	34.80	51.00
Junc- 5 : Al Muladdah						
	Cohesive Soil	Average	21.4	8.38	134.67	0.14
R/A- 8 : Al Khaburah						
	Cohesive Soil	Average	20	6.80	22.78	29.58
R/A- 10: Saham						
	Cohesive Soil	Average	18.8	7.30	21.20	28.50
R/A- 12: Sohar						
	Cohesive Soil	Average	19.9	11.50	20.50	32.00
R/A- 14: Falaj Al Qabail						
	Cohesive Soil	Average	22.8	12.00	32.70	44.70
R/A- 18: Al Aqr						
	Cohesive Soil	was not found				

Table III. 13 Result of Chemical Test

Name of the Roundabout	Type of Soil	Value	Chemical Analysis		
			pH	SO3 (mg/l)	Cl (%)
R/A- 2 : A' Naseem Garden					
	Gravelly Soil	Average	8.09	152	0.04
	Sandy Soil	Average	8.12	168	0.04
R/A- 3 : Barka					
	Gravelly Soil	Average	8.18	55	0.03
	Sandy Soil	Average	8.21	137	0.00
Junc- 5 : Al Muladdah					
	Cohensive Soil	Average	8.38	135	0.16
R/A- 8 : Al Khaburah					
	Cohesive Soil	Average	8.58	130	0.02
	Sandy Soil	Average	7.81	198	0.25
R/A- 10: Saham					
	Cohesive Soil	Average	8.82	276	0.13
R/A- 12: Sohar					
	Cohesive Soil	Average	8.50	55	0.02
R/A- 14: Falaj Al Qabail					
	Gravelly Soil	Average	9.07	106	0.01
R/A- 18: Al Aqr					
	Gravelly Soil	Average	9.11	118	0.00

d) Specific Gravity, Density, Void Ratio and Degree of Saturation

The result of specific gravity, density, void ratio and degree of saturation is summarized in Table III. 14.

Table III. 14 Specific Gravity, Density, Void Ratio and Degree of Saturation

Name of the Roundabout	Type of Soil	Value	Dry Density (tf/m3)	Wet Density (tf/m3)	Specific Gravity (g/cm3)	Void Racio	Degree of Saturation (%)
R/A- 2 : A' Naseem Garden							
	Gravelly Soil	Average	1.847	1.925	2.655	0.38	29.5
	Sandy Soil	Average	1.793	1.893	2.626	0.39	37.7
R/A- 3 : Barka							
	Gravelly Soil	Average	1.713	1.805	2.598	0.50	29.2
	Sandy Soil	Average	1.705	1.804	2.724	0.51	31.1
Junc- 5 : Al Muladdah							
	Cohesive Soil	Average	1.700	1.849	2.680	0.45	55.2
	Sandy Soil	Individual	1.696	1.823	2.715	0.49	41.6
Junc- 8 : Al Khaburah							
	Cohesive Soil	Average	1.679	1.771	2.659	0.50	29.2
	Sandy Soil	Average	1.661	1.805	2.717	0.51	50.3
R/A- 10: Saham							
	Cohesive Soil	Average	1.699	1.847	2.682	0.45	53.8
R/A- 12: Sohar							
	Cohesive Soil	Average	1.692	1.819	2.596	0.43	48.0
R/A- 14: Falaj Al Qabail							
	Cohesive Soil	Average	1.895	1.989	2.553	0.28	47.8
	Gravelly Soil	Average	1.974	2.073	2.760	0.33	42.6
R/A- 18: Al Aqr							
	Gravelly Soil	Average	2.018	2.099	2.674	0.28	42.8

III. 4.3 Foundation Layer for Structural Design

(1) Bearing Layer Condition at the Study Roundabouts

Bearing layer at the roundabouts which have N value of more than equal 30 is summarized in Table III. 15.

Table III. 15 Bearing Layer (N≧30) Condition at the Study Roundabout

Name of the Roundabout	Bearing layer (N value ≧30)			
	Depth (m)	Wet Density (t/m3)	Cohesion of the First Stage (t/m2)	Internal Friction Angle (Degree)
R/A- 2 : A' Naseem Garden	2.0 m - 4.0 m	1.925	0.625*N	15+√(15*N)
R/A- 3 : Barka	2.0 m - 5.0 m	1.805	0.625*N	15+√(15*N)
Junc- 5 : Al Muladdah	2.0 m - 4.0 m	1.849	0.625*N	15+√(15*N)
R/A- 8 : Al Khaburah	4.0 m - 6.0 m	1.771	0.625*N	15+√(15*N)
R/A- 10 : Saham	6.0 m - 8.0 m	1.847	0.625*N	15+√(15*N)
R/A- 12 : Sohar	5.0 m - 14.0 m	1.819	0.625*N	15+√(15*N)
R/A- 14 : Falaj Al Qabail	1.0 m - 7.0 m	1.989	0.625*N	15+√(15*N)
R/A- 18 : Al Aqr	1.0 m - 4.0 m	2.099	0.625*N	15+√(15*N)

Bearing layer at the roundabouts which have N value of more than equal to 50 are summarized in Table III. 16.

Table III. 16 Bearing Layer (N≧50) Condition at the Roundabouts

Name of the Roundabout	Bearing layer (N value ≧50)			
	Depth (m)	Wet Density (t/m3)	Cohesion of the First Stage (t/m2)	Internal Friction Angle (Degree)
R/A- 2 : A' Naseem Garden	3.0 m - 5.0 m	1.925	0.625*N	15+√(15*N)
R/A- 3 : Barka	3.0 m - 5.0 m	1.805	0.625*N	15+√(15*N)
Junc- 5 : Al Muladdah	4.0 m - 7.0 m	1.823	0.625*N	15+√(15*N)
R/A- 8 : Al Khaburah	5.0 m - 7.0 m	1.771	0.625*N	15+√(15*N)
R/A- 10 : Saham	7.0 m - 9.0 m	1.847	0.625*N	15+√(15*N)
R/A- 12 : Sohar	6.0 m - 15.0 m	1.819	0.625*N	15+√(15*N)
R/A- 14 : Falaj Al Qabail	3.0 m - 9.0 m	2.073	0.625*N	15+√(15*N)
R/A- 18 : Al Aqr	1.0 m - 5.0 m	2.099	0.625*N	15+√(15*N)

(2) Bearing Layer Condition at the Study Pedestrian Underpass Locations

Bearing layer at the proposed pedestrian underpass locations which have N value of more than equal to 30 are summarized in Table III. 17.

Table III. 17 Bearing Layer (N≧30) Condition at the Proposed Pedestrian Underpass Locations

Name of the Roundabout	Bearing layer (N value ≧ 30)			
	Depth (m)	Wet Density (t/m3)	Cohesion of the First Stage (t/m2)	Internal Friction Angle (Degree)
P/U- 1 : Barka	2.0 m	1.805	0.625*N	15+√(15*N)
P/U- 2 : Al Billah	5.0 m - 6.0 m	1.805	0.625*N	15+√(15*N)
P/U- 3 : A' Tareef	4.0 m - 5.0 m	1.849	0.625*N	15+√(15*N)
P/U- 4 : Al Qarat	2.0 m - 3.0 m	1.823	0.625*N	15+√(15*N)
P/U- 5 : A' Thamiad	2.0 m - 3.0 m	1.823	0.625*N	15+√(15*N)
P/U- 6 : A' Suweiq	5.0 m	1.823	0.625*N	15+√(15*N)
P/U- 7 : Al Khadra	2.0 m - 3.0 m	1.805	0.625*N	15+√(15*N)
P/U- 8 : Qarih	8.0 m	1.771	0.625*N	15+√(15*N)
P/U- 9 : Majaz A' Sughra	4.0 m - 5.0 m	1.847	0.625*N	15+√(15*N)
P/U- 10 : Khor A' Siyabi	6.0 m - 7.0 m	1.819	0.625*N	15+√(15*N)
P/U- 11 : Liwa	2.0 m	2.073	0.625*N	15+√(15*N)
P/U- 12 : Asrar Bani Sa'd	2.0 m	2.073	0.625*N	15+√(15*N)

Wet Density: Value of the nearest R/A

Bearing layer at the proposed pedestrian underpass locations which have N value of more than equal to 50 are summarized in Table III.18.

Table III. 18 Bearing Layer (N≧50) Condition at the Proposed Pedestrian Underpass Locations

Name of the Roundabout	Bearing layer (N value ≧ 50)			
	Depth (m)	Wet Density (t/m3)	Cohesion of the First Stage (t/m2)	Internal Friction Angle (Degree)
P/U- 1 : Barka	5.0 m - 7.0 m	1.805	0.625*N	15+√(15*N)
P/U- 2 : Al Billah	not found	-	-	-
P/U- 3 : A' Tareef	6.0 m	1.849	0.625*N	15+√(15*N)
P/U- 4 : Al Qarat	3.0 m	1.823	0.625*N	15+√(15*N)
P/U- 5 : A' Thamiad	3.0 m - 7.0 m	1.823	0.625*N	15+√(15*N)
P/U- 6 : A' Suweiq	6.0 m - 7.0 m	1.823	0.625*N	15+√(15*N)
P/U- 7 : Al Khadra	8.0 m	1.805	0.625*N	15+√(15*N)
P/U- 8 : Qarih	9.0 m	1.771	0.625*N	15+√(15*N)
P/U- 9 : Majaz A' Sughra	not found	1.847	0.625*N	15+√(15*N)
P/U- 10 : Khor A' Siyabi	8.0 m	1.819	0.625*N	15+√(15*N)
P/U- 11 : Liwa	3.0 m - 4.0 m	2.073	0.625*N	15+√(15*N)
P/U- 12 : Asrar Bani Sa'd	2.0 m - 4.0 m	2.073	0.625*N	15+√(15*N)

Wet Density: Value of the nearest R/A

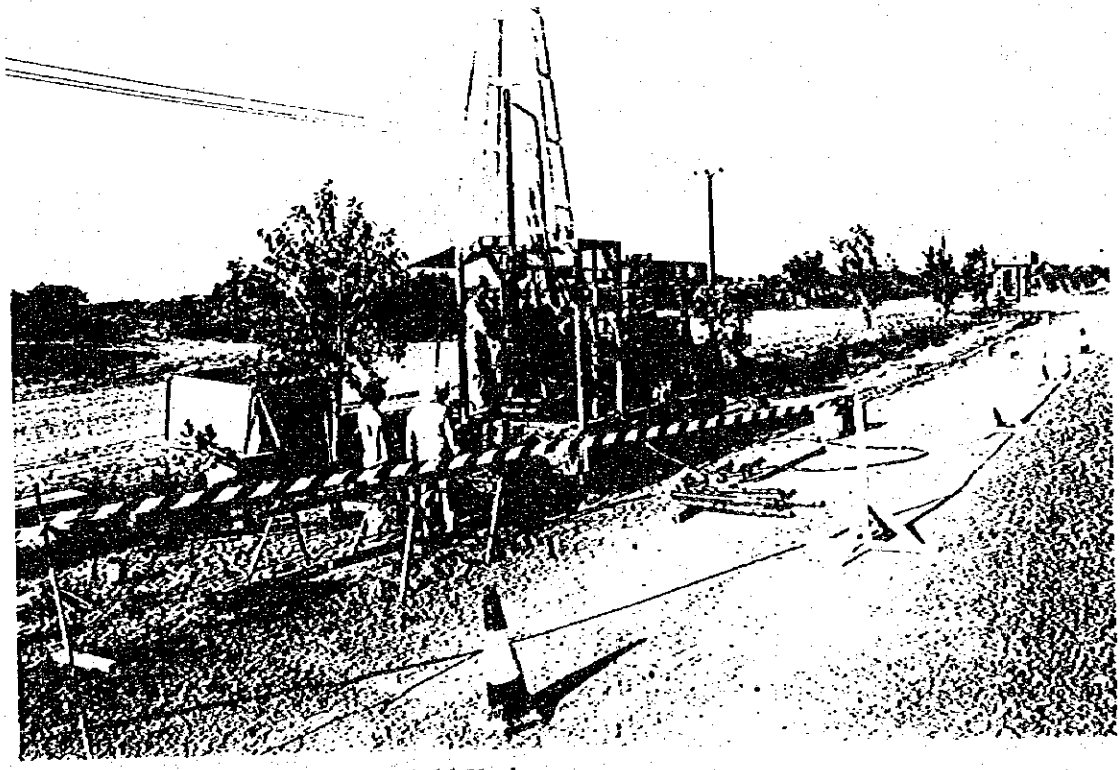
III. 5 Result of Material Survey

The result of chemical test on aggregate and water samples are summarized in Table III. 19.

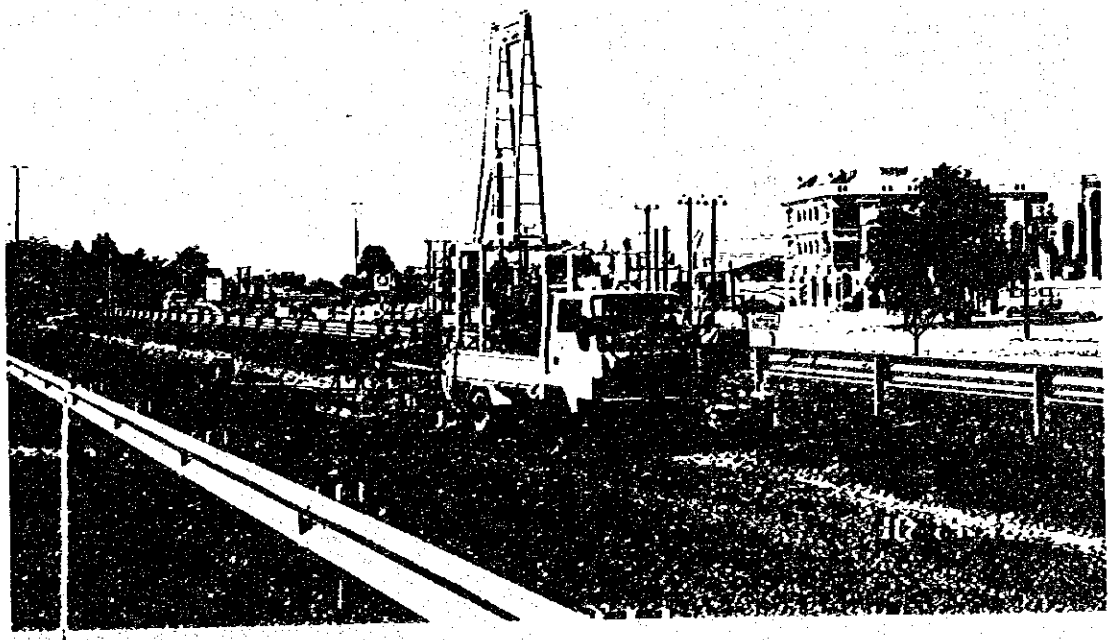
Table III. 19 Result of Chemical Test on Aggregate and Water Samples

Name of Sample		Chemical Analysis				
	Location	pH	SO_3 (g/l)	Cl (mg/l)	Reduction in Alkalinity (millimoles/l)	Dissolved Silica (millimoles/l)
Aggregate						
	A' Tareef	-	-	-	117.970	11.390
	Wudam As Sahil	-	-	-	90.000	5.220
	Al Hijari	-	-	-	105.000	9.210
	Wadi Salah	-	-	-	101.670	55.500
	Ohi	-	-	-	73.330	17.200
Water						
	A' Tareef -1	7.14	-	238.6	-	-
	Wudam As Sahil	7.78	0.050	65.2	-	-
	Al Hijari	8.25	0.151	53.9	-	-
	Ohi	8.22	0.096	70.9	-	-
	Al Aqr	8.09	0.109	119.1	-	-

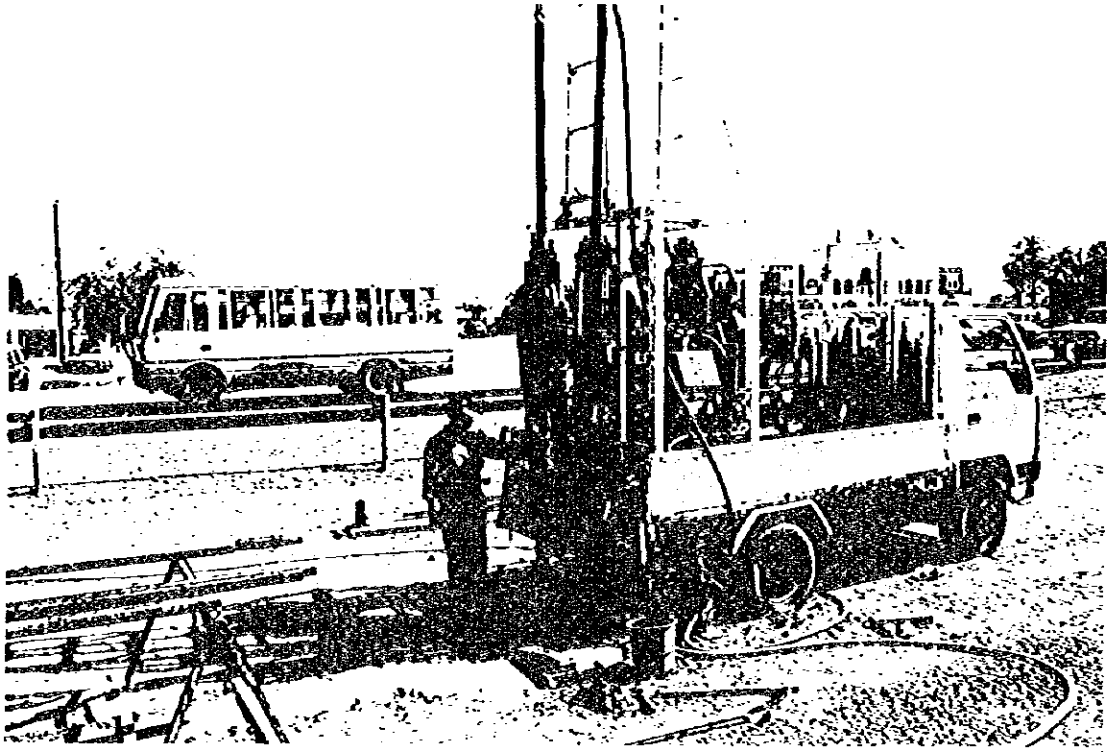
1 Photographs of Field Soil Investigation Works



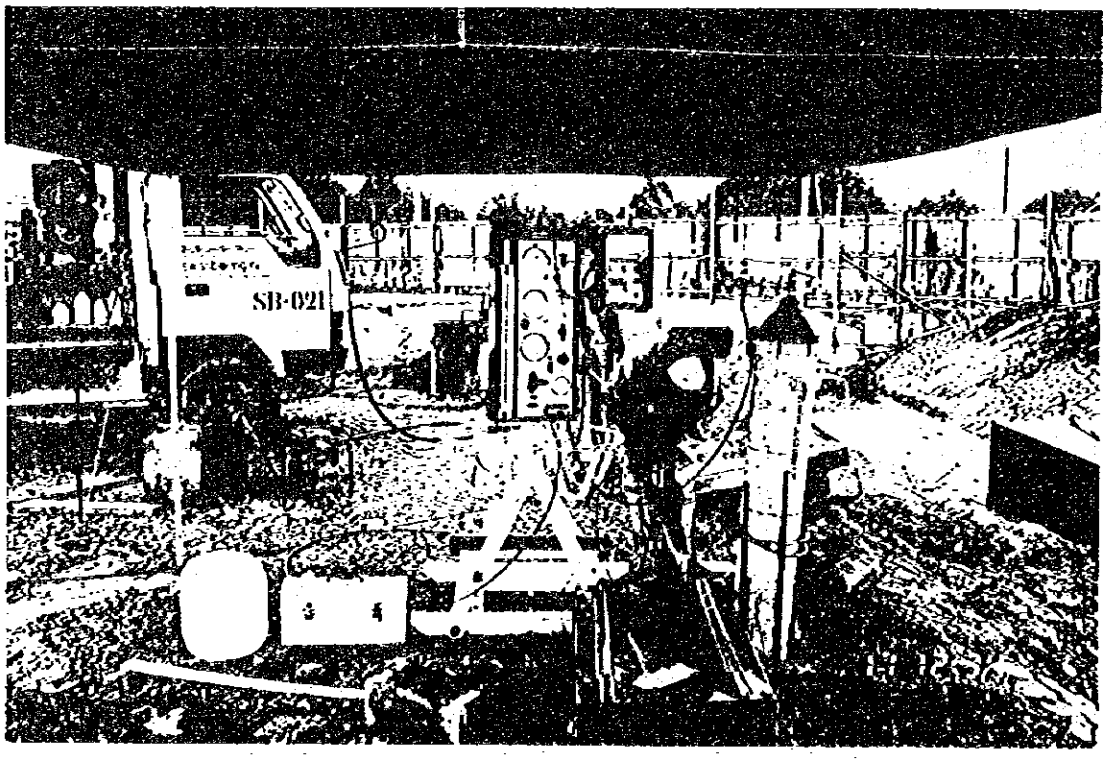
Field Boring Work at P/U-7-2, Al Kadra



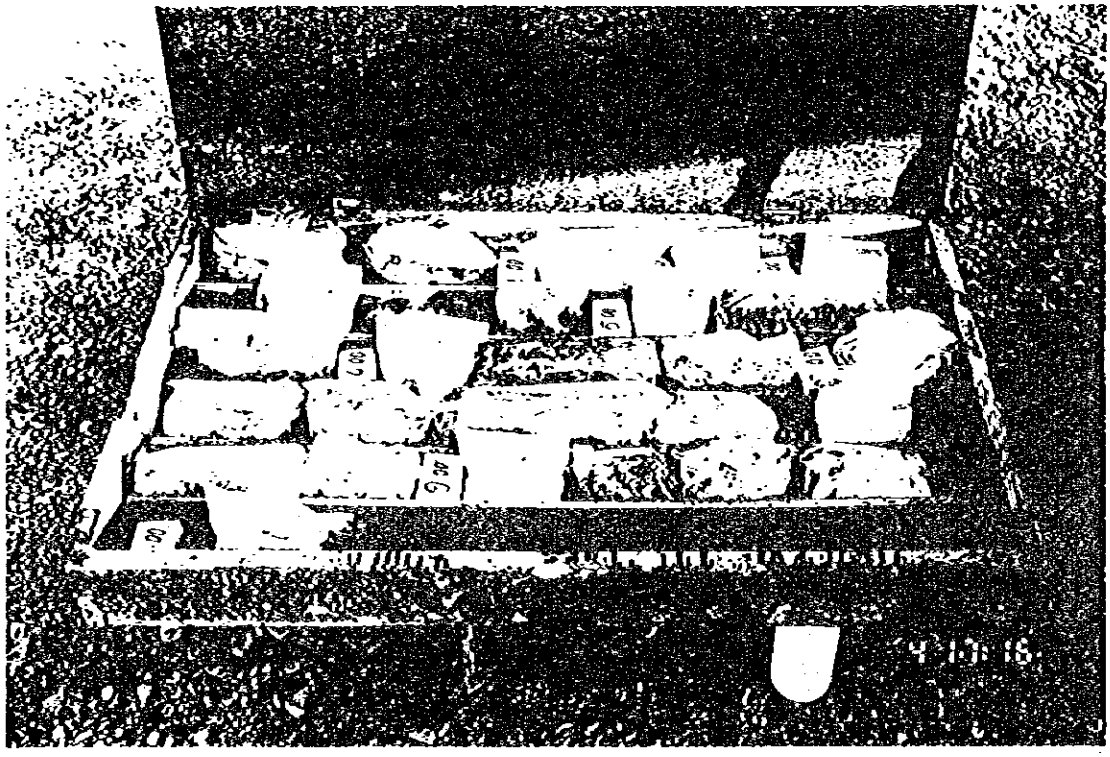
Field Boring Work at R/A-10-2, Sahan



Standard Penetration Test Work at R/A-10-10, Saham



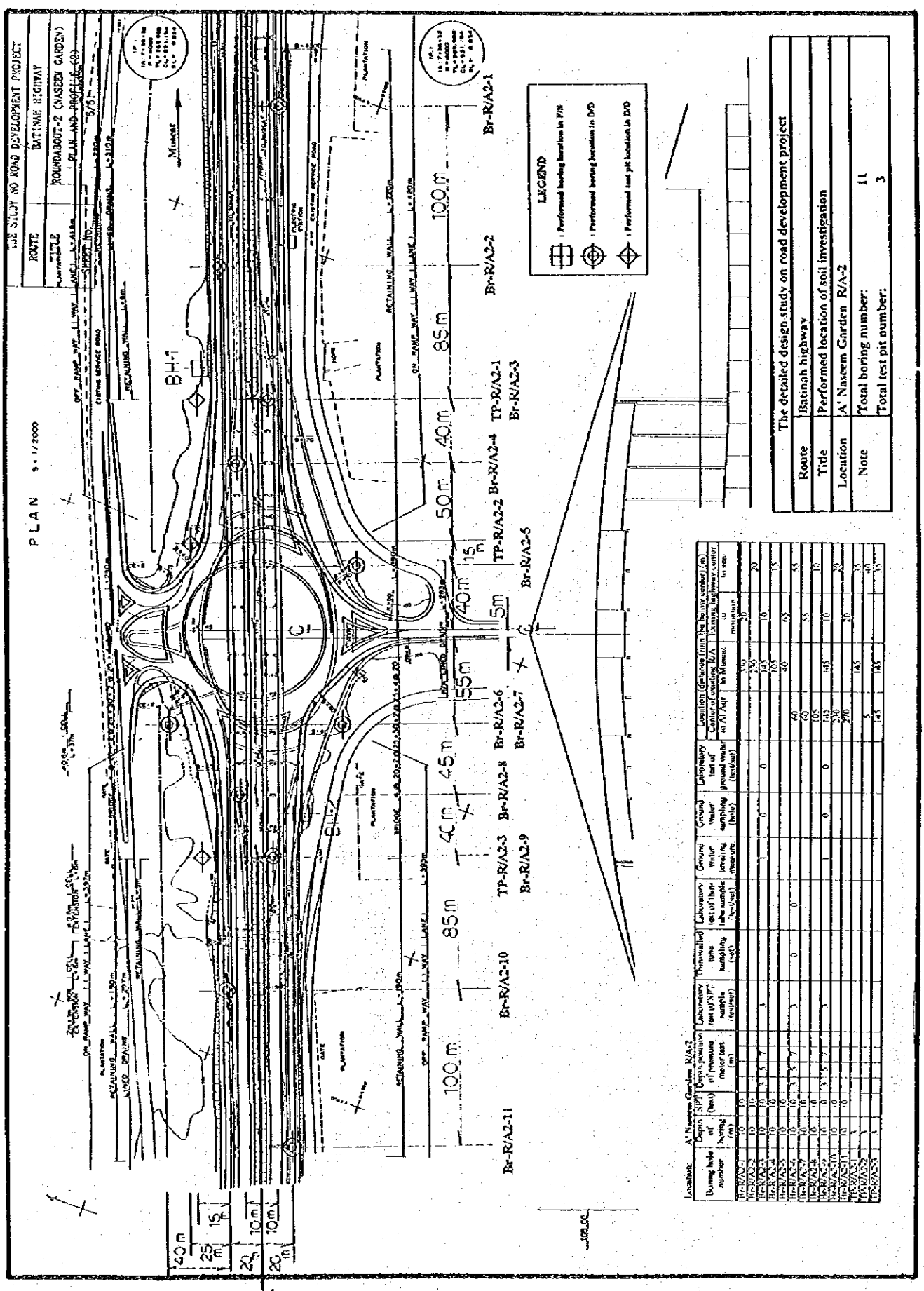
Pressure Meter Test Work at R/A-12-6, Sohar



Sample of Boring Core at P/U-S-1, Al Tharmad

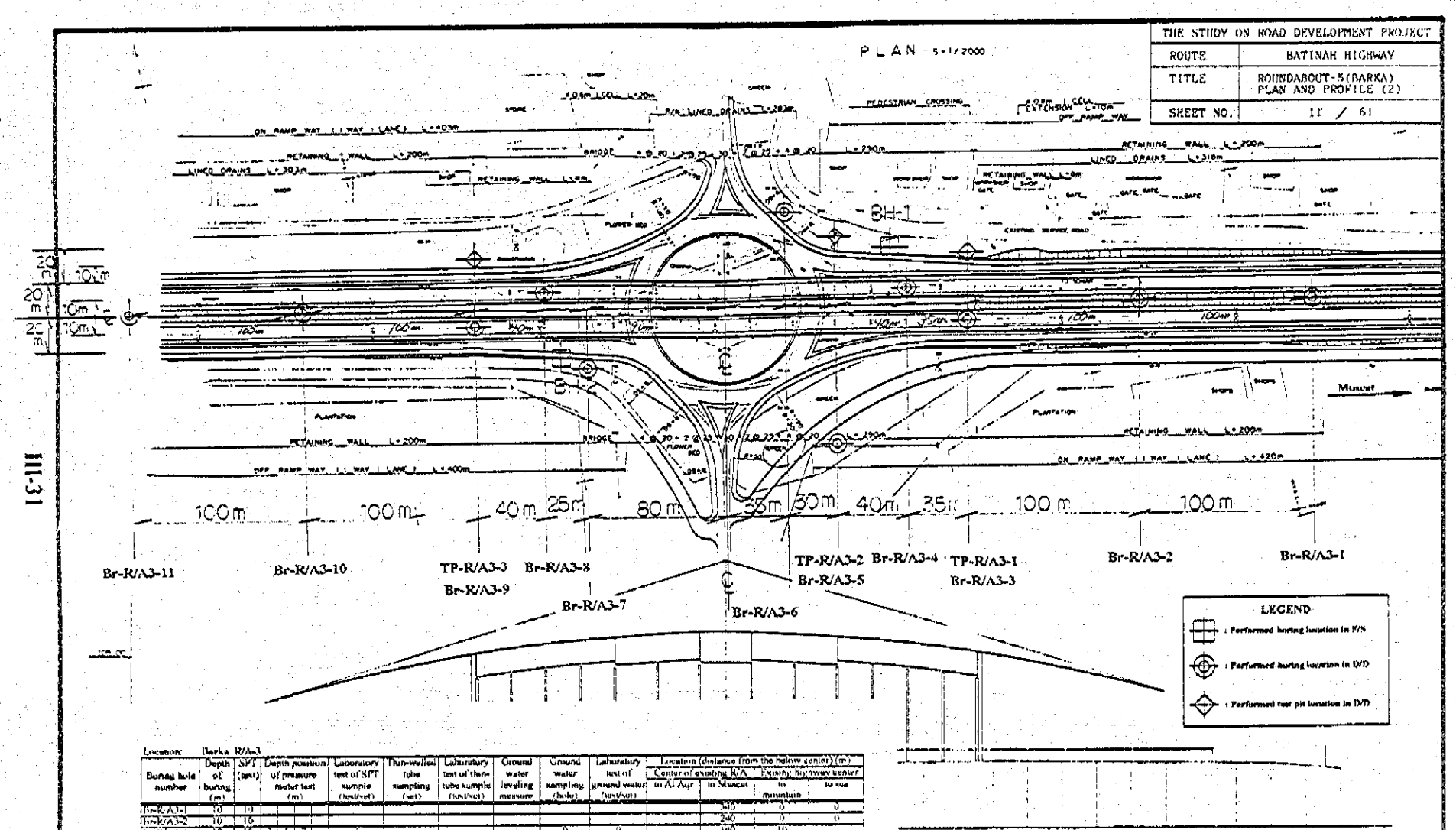
Test Pit Excavation Work at R/A-10-1, Saham

2 Location Maps of Soil Investigations at the Proposed Study Roundabouts



The detailed design study on road development project	
Route	Batinah highway
Title	Performed location of soil investigation
Location	A' Naseem Garden R/A-2
Note	Total boring number: 11 Total test pit number: 3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	ROUNDABOUT-5(BARKA) PLAN AND PROFILE (2)
SHEET NO.	11 / 61



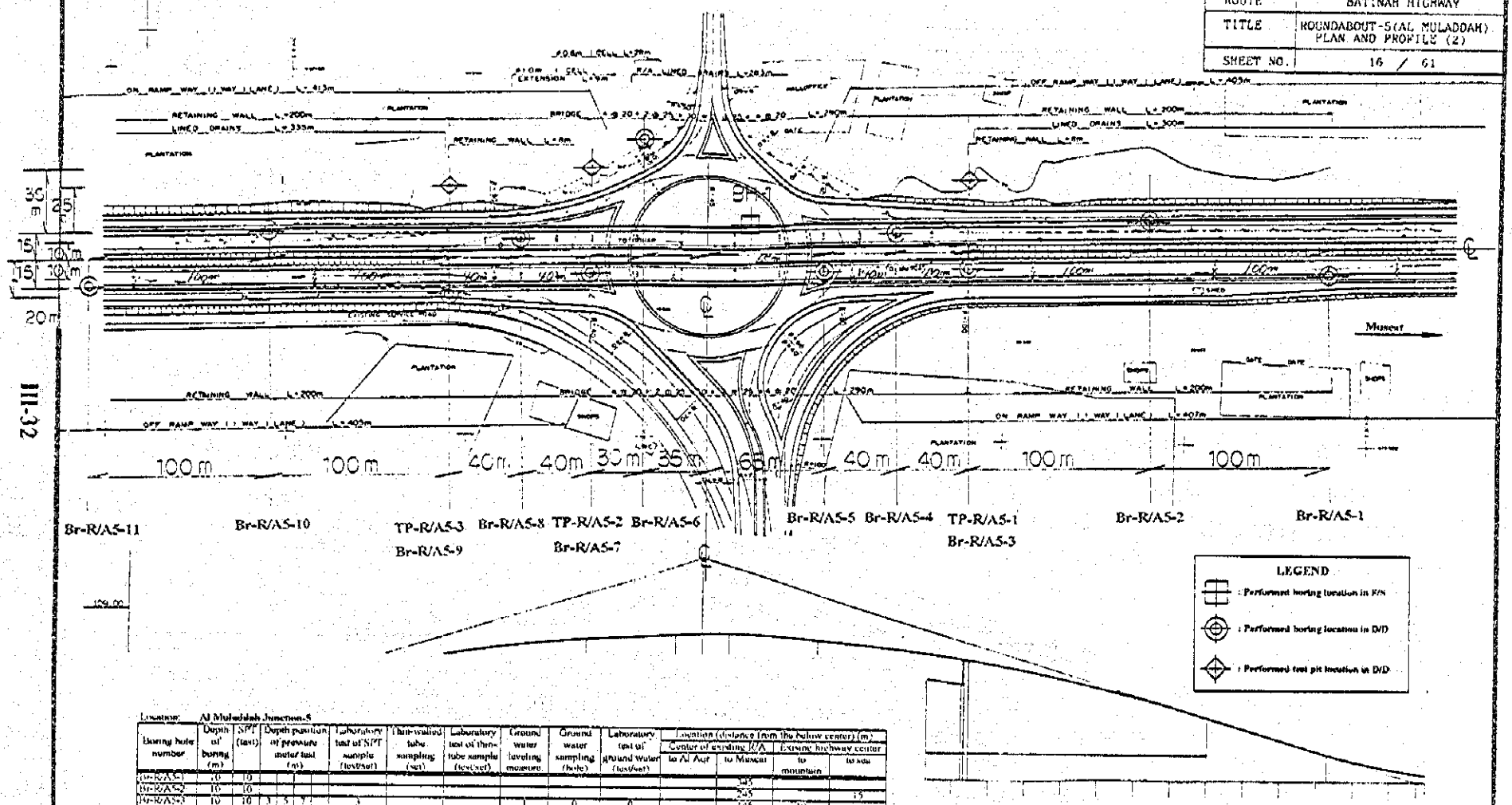
Location: Barka R/A-3

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thin-walled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
												Center of existing R/A in Al Aqr	Existing highway center in Muscat	to mountain	to sea
Br-R/A3-1	10	10											300	0	0
Br-R/A3-2	10	10											260	0	0
Br-R/A3-4	10	10	3	5	7	3				0	0		160	10	0
Br-R/A3-5	10	10											105		10
Br-R/A3-6	10	10											65	30	
Br-R/A3-7	10	10	3	5	7	3	0	0					15		55
Br-R/A3-8	10	10										80		35	
Br-R/A3-9	10	10										105			10
Br-R/A3-10	10	10	3	5	7	3				0	0	145		10	0
Br-R/A3-11	10	10										245		0	0
TP-R/A3-1	3											305		0	0
TP-R/A3-2	3												160		30
TP-R/A3-3	3												65		40
												145			30

The detailed design study on road development project		
Route	Batinah highway	
Title	Performed location of soil investigation	
Location	Barka R/A-3	
Note	Total boring number:	11
	Total test pit number:	3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	ROUNDABOUT-5(AL MULADDAH) PLAN AND PROFILE (2)
SHEET NO.	16 / 61

PLAN 1:2000



LEGEND

: Performed boring location in F/S

: Performed boring location in D/D

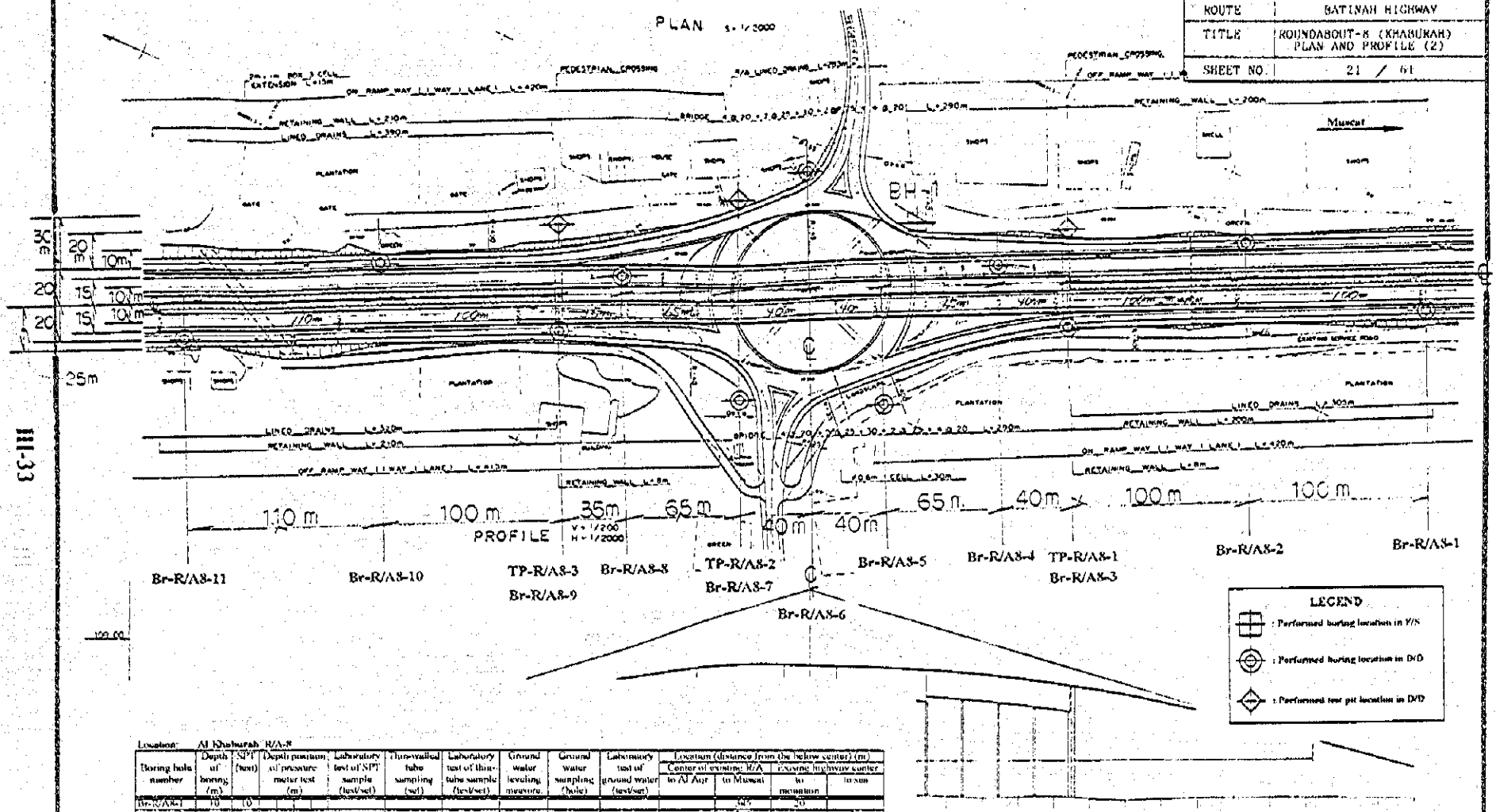
: Performed test pit location in D/D

Location: Al Muladdah Junction-5

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thin-walled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
												Center of existing R/A		Existing highway center	
												to Al Aqir	to Muscat	to mountain	to sea
Br-R/A5-1	10	10											305		
Br-R/A5-2	10	10											245		15
Br-R/A5-3	10	10	3	5	7	3			1	0	0		145	10	
Br-R/A5-4	10	10											105		10
Br-R/A5-5	10	10											65	10	
Br-R/A5-6	10	10	3	5	7	3	0	0				35			65
Br-R/A5-7	10	10	3	5	7	3						65		10	
Br-R/A5-8	10	10										105			10
Br-R/A5-9	10	10				0				0	0	145		20	
Br-R/A5-10	10	10										245			15
Br-R/A5-11	10	10										305		15	
TP-R/A5-1	3											305	145		40
TP-R/A5-2	3											65			50
TP-R/A5-3	3											145			40

The detailed design study on road development project		
Route	Batinah highway	
Title	Performed location of soil investigation	
Location	Al Muladdah Junction-5	
Note	Total boring number:	11
	Total test pit number:	3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	ROUNDABOUT-8 (KHABURAH) PLAN AND PROFILE (2)
SHEET NO.	21 / 61

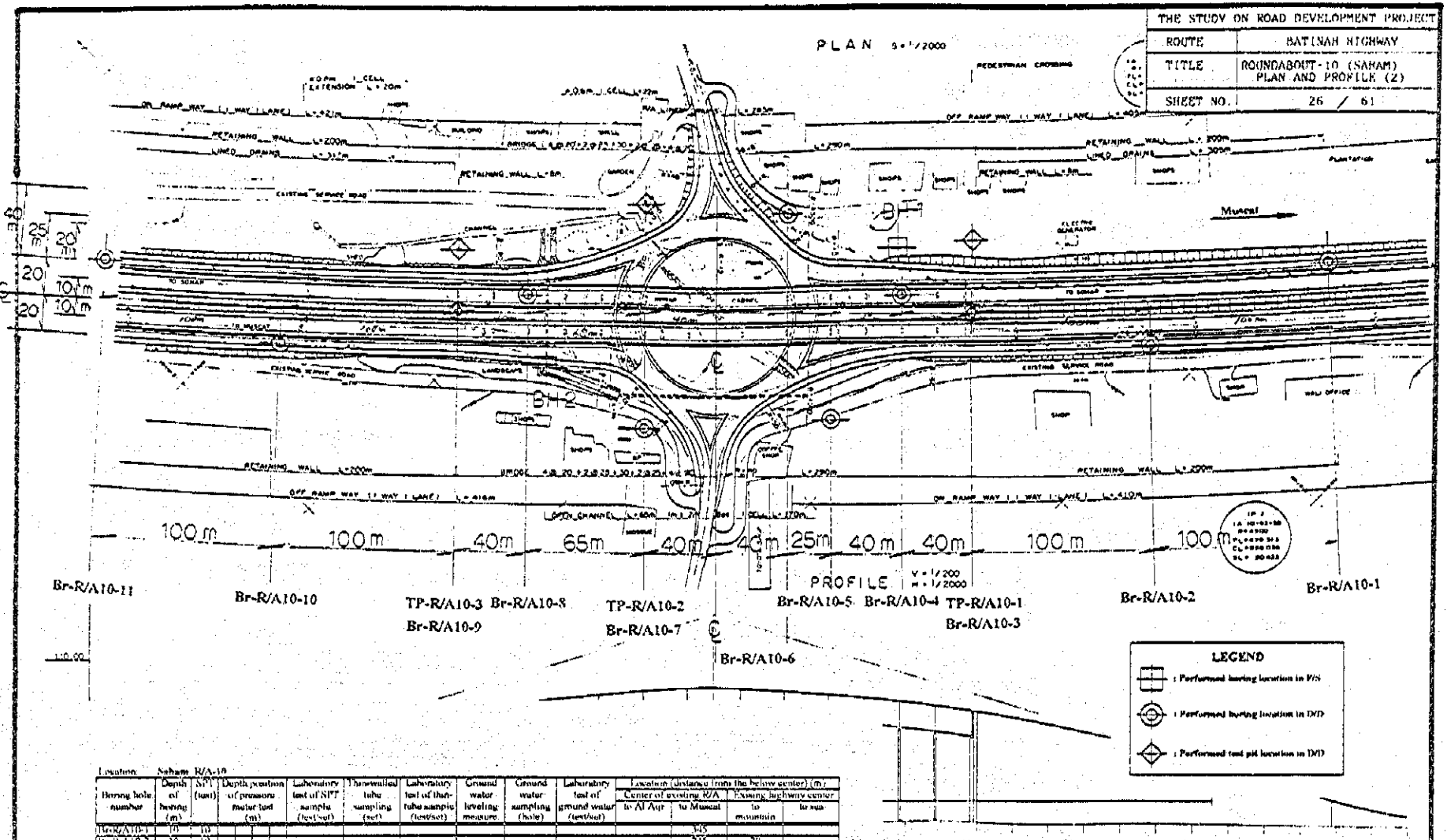


Location: Al Khaburah R/A-8

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thin-walled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure.	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
												Center of existing R/A		Existing highway center	
												to Al Aqr	to Muscat	to median	to sea
Br-R/A8-1	10	10											305	20	
Br-R/A8-2	10	10											245		20
Br-R/A8-3	10	10	5	5	7	3			1	0	0		145	30	
Br-R/A8-4	10	10											105		10
Br-R/A8-5	10	10											40	65	
Br-R/A8-6	10	10	5	5	7	3	0	0				0	0		65
Br-R/A8-7	10	10										40		60	
Br-R/A8-8	10	10										105			10
Br-R/A8-9	10	10	5	5	7	3			1	0	0	140		20	
Br-R/A8-10	10	10										240			26
Br-R/A8-11	10	10										450		20	
TP-R/A8-1	3												195		30
TP-R/A8-2	3											40			50
TP-R/A8-3	3											140			40

The detailed design study on road development project	
Route	Batinah highway
Title	Performed location of soil investigation
Location	Al KhaburR/Ah R/A-8
Note	Total boring number: 11
	Total test pit number: 3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	ROUNDABOUT-10 (SAHAM) PLAN AND PROFILE (2)
SHEET NO.	26 / 61

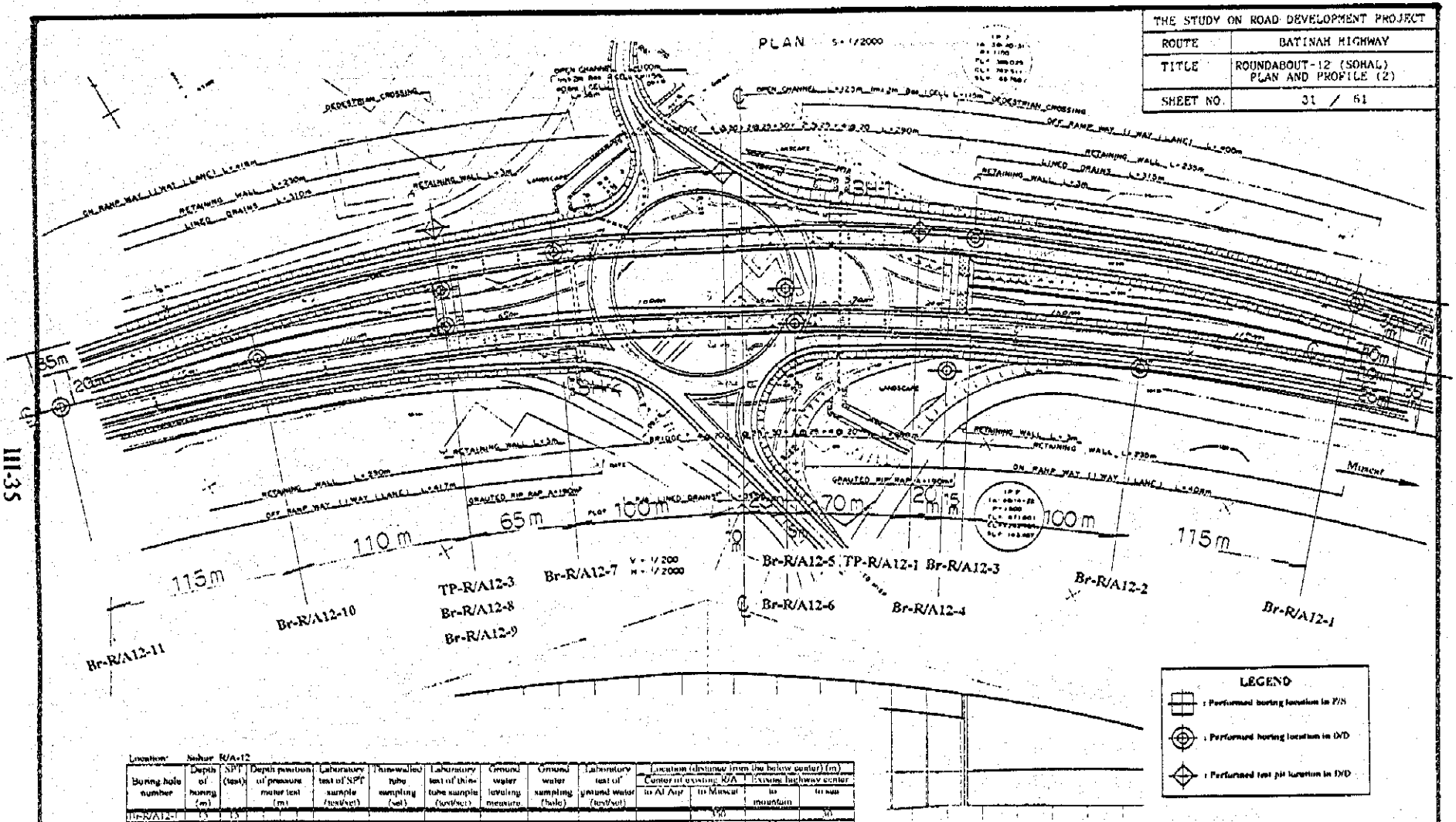


Location: Saham R/A-10

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thinwalled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
												Center of existing R/A		Existing highway center	
												to Al Aqr	to Muscat	to mountain	to sea
Br-R/A10-1	10	10											345		
Br-R/A10-2	10	10											245	20	
Br-R/A10-3	10	10	3	5	7	3			1	0	0		145	0	0
Br-R/A10-4	10	10											105		10
Br-R/A10-5	10	10											65	60	
Br-R/A10-6	10	10	3	5	7	3	0	0					40		55
Br-R/A10-7	10	10										40		65	
Br-R/A10-8	10	10										105			10
Br-R/A10-9	10	10	3	5	7	3			1	0	0	145		0	0
Br-R/A10-10	10	10										245		20	
Br-R/A10-11	10	10										345			20
TP-R/A10-1	3												145		40
TP-R/A10-2	3											45			60
TP-R/A10-3	3											145			35

The detailed design study on road development project		
Route	Batinah highway	
Title	Performed location of soil investigation	
Location	Saham R/A-10	
Note	Total boring number:	11
	Total test pit number:	3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	ROUNDABOUT-12 (SOHAR) PLAN AND PROFILE (2)
SHEET NO.	31 / 61



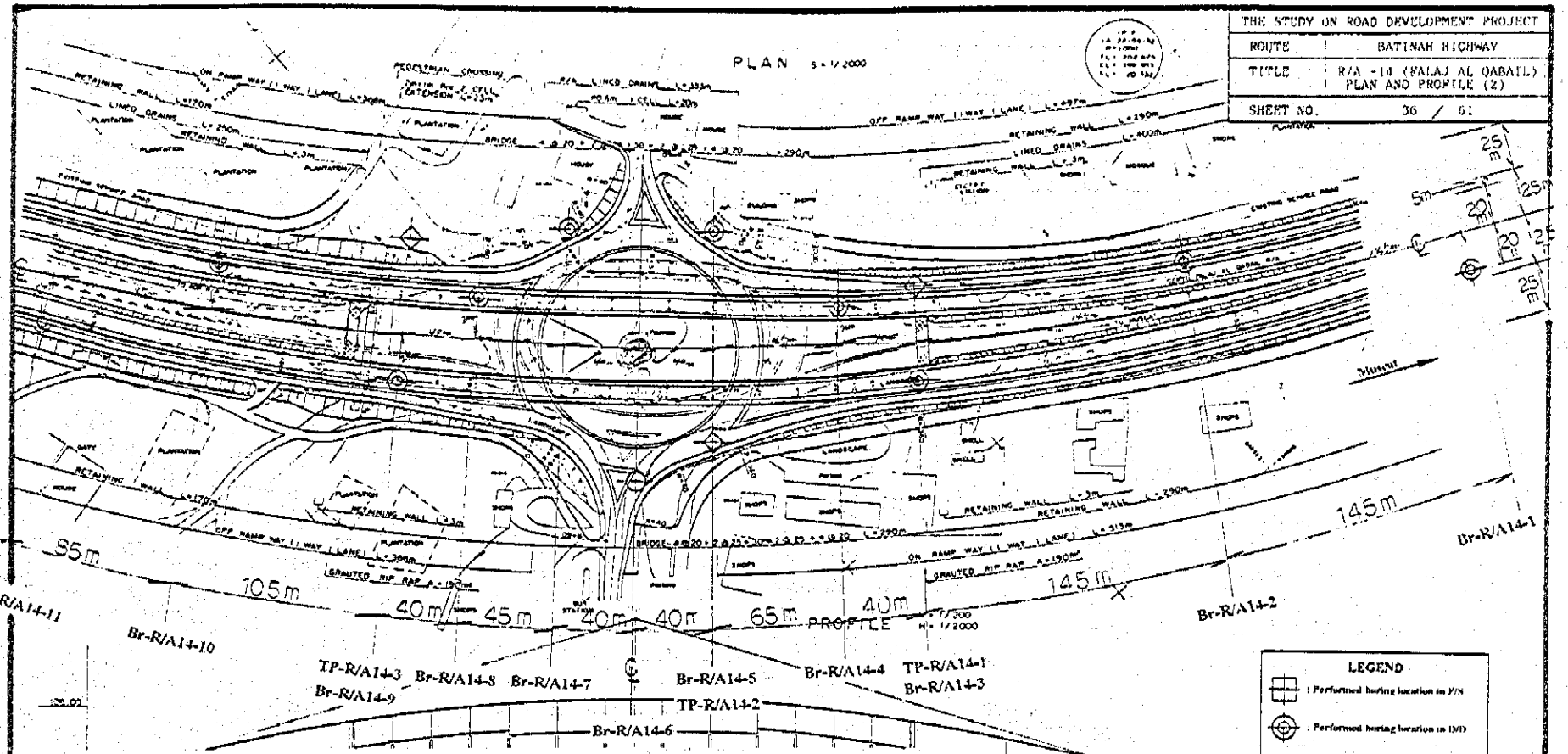
LEGEND
- : Performed boring location in P/S
- : Performed boring location in D/D
- : Performed test pit location in D/D

Location: Sohar R/A-12

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thin-walled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
												Center of existing R/A		Existing highway center	
												to Al Ain	to Muscat	to mountain	to sea
Br-R/A12-1	15	15											190		30
Br-R/A12-2	18	18											245	25	
Br-R/A12-3	18	18	5	5	5	1			0	0	0		135		40
Br-R/A12-4	18	18											120	35	
Br-R/A12-5	19	19											30	10	
Br-R/A12-6	19	19	5	5	5	1	0	0	1	1	1		25		10
Br-R/A12-7	16	16										100			35
Br-R/A12-8	19	19	5	5	5	1						165			20
Br-R/A12-9	16	16							1		1	165		0	0
Br-R/A12-10	16	16										275		0	0
Br-R/A12-11	16	16										190		0	0
TP-R/A12-1	3												100		30
TP-R/A12-2	3											10			75
TP-R/A12-3	3											175			45

The detailed design study on road development project		
Route	Batinah highway	
Title	Performed location of soil investigation	
Location	Sohar R/A-12	(under construction monument)
Note	Total boring number:	11
	Total test pit number:	3

THE STUDY ON ROAD DEVELOPMENT PROJECT	
ROUTE	BATINAH HIGHWAY
TITLE	R/A -14 (FALAJ AL QABAIL) PLAN AND PROFILE (2)
SHEET NO.	36 / 61

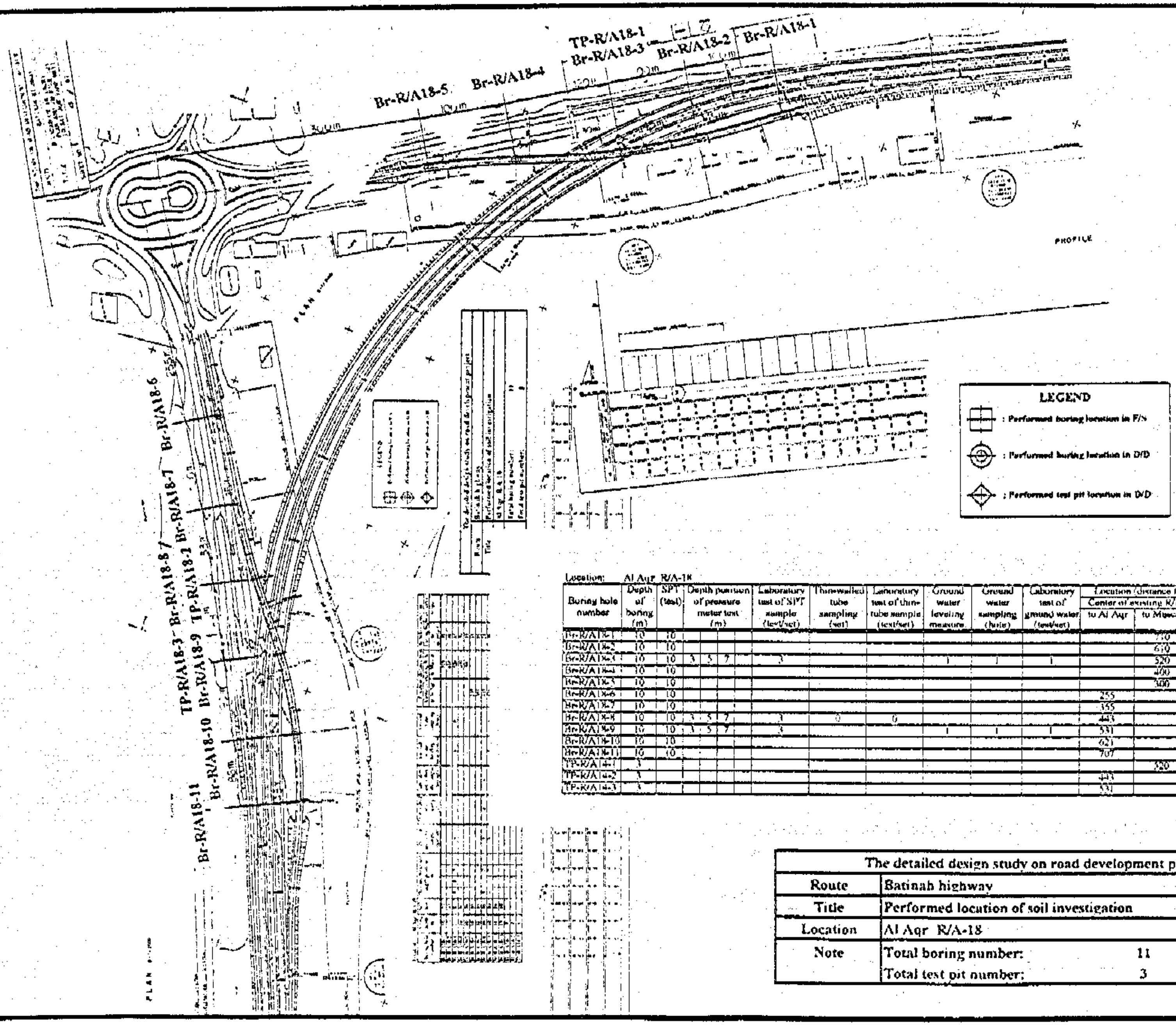


LEGEND
: Performed boring location on P/S
: Performed boring location in D/D
: Performed test pit location in D/D

Location: Falaj Al Qabail R/A-14

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)			Laboratory test of SPT sample (test/set)	Thinwalled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (Distance from the below center) (m)			
												Center of existing R/A		Planing highway center	
												to Al Aqr	to Muscat	to mountain	to sea
Br-R/A14-1	10	10											435		
Br-R/A14-2	10	10											290		20
Br-R/A14-3	10	10	3	5	7	3				0	0		145	20	
Br-R/A14-4	13	13											105		20
Br-R/A14-5	10	10											40		10
Br-R/A14-6	10	10	3	5	7	3	0	0				0	0	70	
Br-R/A14-7	10	10										40			60
Br-R/A14-8	10	10										85			20
Br-R/A14-9	10	10	3	5	7	3				0	0	125		25	
Br-R/A14-10	10	10										230			25
Br-R/A14-11	10	10										315		25	
TP-R/A14-1	3												145		30
TP-R/A14-2	3												40	30	
TP-R/A14-3	3											125			30

The detailed design study on road development project		
Route	Batinah highway	
Title	Performed location of soil investigation	
Location	Falaj Al Qabail R/A-14	
Note	Total boring number:	11
	Total test pit number:	3



Location: Al Aqr R/A-18

Boring hole number	Depth of boring (m)	SPT (test)	Depth position of pressure meter test (m)				Laboratory test of SPT sample (test/set)	Thin-walled tube sampling (set)	Laboratory test of thin-tube sample (test/set)	Ground water leveling measure	Ground water sampling (hole)	Laboratory test of ground water (test/set)	Location (distance from the below center) (m)			
													Center of existing R/A		Existing highway center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A18-1	10	10												710	35	
Br-R/A18-2	10	10												610	45	
Br-R/A18-3	10	10	3	5	7		3			1	1	1		520	45	
Br-R/A18-4	10	10												400	30	
Br-R/A18-5	10	10												300	15	
Br-R/A18-6	10	10											255		15	
Br-R/A18-7	10	10											355		15	
Br-R/A18-8	10	10	3	5	7		3	0	0				443		25	
Br-R/A18-9	10	10	3	5	7		3			1	1	1	531		40	
Br-R/A18-10	10	10											621		50	
Br-R/A18-11	10	10											707		48	
TP-R/A18-1	3													520	30	
TP-R/A18-2	3												443		35	
TP-R/A18-3	3												531		25	

The detailed design study on road development project	
Route	Batinah highway
Title	Performed location of soil investigation
Location	Al Aqr R/A-18
Note	Total boring number: 11
	Total test pit number: 3

3 Details of Soil Investigation Quantities at the Proposed Study Roundabouts

Summary of Details for Soil Investigation Quantities at the Proposed Study Roundabouts

Name of Roundabout	Number of Boring Hole (hole)	Boring Total Length (m)	Numbers of SPT (test)	Numbers of Pressure Meter Test (test)	Laboratory Test of SPT Sample (test/set)	Th.-walled Tube Sampling (set)	Laboratory Test of T.-walled Tube Sample (test/set)	Ground Water Leveling Measurement (hole)	Ground Water Sampling (hole)	Laboratory Test of G. Water Sample (test/set)	Numbers of Test Pit (test)
R/A- 2: A' Naseem Garden	11	110	110	9	9	0	0	2	0	0	3
R/A- 3: Barka	11	110	110	9	9	0	0	2	0	0	3
June- 5: Al Muladdah	11	110	110	9	9	0	0	2	0	0	3
R/A- 8: Al Khaburah	11	110	110	9	9	0	0	2	0	0	3
R/A-10: Saham	11	110	110	9	9	0	0	2	0	0	3
R/A-12: Sohar	11	182	182	9	9	0	0	2	2	2	3
R/A-14: Falaj Al Qabail	11	113	113	9	9	0	0	2	0	0	3
R/A-18: Al Aqr	11	110	110	9	9	0	0	2	2	2	3
Performed total	88	955	955	72	72	0	0	16	4	4	24
Proposed total	88	880	880	72	72	8	8	16	16	16	24
Balance	-	+75	+75	-	-	- 8	- 8	-	- 12	- 12	-

SPT: Standard Penetration Test

Details of Soil Investigation Quantities at the Proposed Study Roundabouts (1/4)

Location: **R/A-2: A' Naseem Garden**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A2-1	10	10												330	20	
Br-R/A2-2	10	10												230		20
Br-R/A2-3	10	10	3	5	7		3			1	0	0		145	10	
Br-R/A2-4	10	10												105		15
Br-R/A2-5	10	10												40	65	
Br-R/A2-6	10	10	3	5	7		3	0	0				60			55
Br-R/A2-7	10	10											60		55	
Br-R/A2-8	10	10											105			10
Br-R/A2-9	10	10	3	5	7		3			1	0	0	145	145	10	
Br-R/A2-10	10	10											230			20
Br-R/A2-11	10	10											270		20	
TP-R/A2-1	3													145		35
TP-R/A2-2	3												5			40
TP-R/A2-3	3												145	145		35

Location: **R/A-3: Barka**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A3-1	10	10												340	0	0
Br-R/A3-2	10	10												240	0	0
Br-R/A3-3	10	10	3	5	7		3			1	0	0		140	10	
Br-R/A3-4	10	10												105		10
Br-R/A3-5	10	10												65	80	
Br-R/A3-6	10	10	3	5	7		3	0	0					15		55
Br-R/A3-7	10	10											80		35	
Br-R/A3-8	10	10											105			10
Br-R/A3-9	10	10	3	5	7		3			1	0	0	145		10	
Br-R/A3-10	10	10											245		0	0
Br-R/A3-11	10	10											345		0	0
TP-R/A3-1	3													140		30
TP-R/A3-2	3													65		40
TP-R/A3-3	3												145			30

Details of Soil Investigation Quantifies at the Proposed Study Roundabouts (2/4)

Location: **Junc-5: Al Muladdah**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A5-1	10	10												345		
Br-R/A5-2	10	10												245		15
Br-R/A5-3	10	10	3	5	7		3			1	0	0		145	10	
Br-R/A5-4	10	10												105		10
Br-R/A5-5	10	10												65	10	
Br-R/A5-6	10	10	3	5	7		3	0	0				35			65
Br-R/A5-7	10	10											65		10	
Br-R/A5-8	10	10											105			10
Br-R/A5-9	10	10	3	5	7		3			1	0	0	145		20	
Br-R/A5-10	10	10											245			15
Br-R/A5-11	10	10											345		15	
TP-R/A5-1	3													145		40
TP-R/A5-2	3												65			50
TP-R/A5-3	3												145			40

Location: **R/A-8: Al Khaburah**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A8-1	10	10												345	20	
Br-R/A8-2	10	10												245		20
Br-R/A8-3	10	10	3	5	7		3			1	0	0		145	30	
Br-R/A8-4	10	10												105		10
Br-R/A8-5	10	10												40	65	
Br-R/A8-6	10	10	3	5	7		3	0	0				0	0		65
Br-R/A8-7	10	10	3	5	7		3						40		60	
Br-R/A8-8	10	10											105			10
Br-R/A8-9	10	10					0			1	0	0	140		20	
Br-R/A8-10	10	10											240			20
Br-R/A8-11	10	10											350		20	
TP-R/A8-1	3													145		30
TP-R/A8-2	3												40			50
TP-R/A8-3	3												140			40

Details of Soil Investigation Quantities at the Proposed Study Roundabouts (3/4)

Location: **R/A-10: Saham**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A10-1	10	10												345		
Br-R/A10-2	10	10												245	20	
Br-R/A10-3	10	10	3	5	7		3			1	0	0		145	0	0
Br-R/A10-4	10	10												105		10
Br-R/A10-5	10	10												65	60	
Br-R/A10-6	10	10	3	5	7		3	0	0					40		55
Br-R/A10-7	10	10											40		65	
Br-R/A10-8	10	10											105			10
Br-R/A10-9	10	10	3	5	7		3			1	0	0	145		0	0
Br-R/A10-10	10	10											245		20	
Br-R/A10-11	10	10											345			20
TP-R/A10-1	3													145		40
TP-R/A10-2	3												45			60
TP-R/A10-3	3												145			35

Location: **R/A-12: Sohar**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A12-1	15	15												350		30
Br-R/A12-2	18	18												235	25	
Br-R/A12-3	18	18	3	5	7		3			0	0	0		135		40
Br-R/A12-4	18	18												120	35	
Br-R/A12-5	19	19												30	10	
Br-R/A12-6	17	17	3	5	7		3	0	0	1	1	1		25		10
Br-R/A12-7	16	16											100			35
Br-R/A12-8	19	19	3	5	7		3						165			20
Br-R/A12-9	16	16								1	1	1	165		0	0
Br-R/A12-10	10	10											275		0	0
Br-R/A12-11	16	16											390		0	0
TP-R/A12-1	3													100		30
TP-R/A12-2	3												10			75
TP-R/A12-3	3												175			45

Details of Soil Investigation Quantities at the Proposed Study Roundabouts (4/4)

Location: **R/A-14: Falaj Al Qabail**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A14-1	10	10												435		
Br-R/A14-2	10	10												290		20
Br-R/A14-3	10	10	3	5	7		3			1	0	0		145	20	
Br-R/A14-4	13	13												105		20
Br-R/A14-5	10	10												40		60
Br-R/A14-6	10	10	3	5	7		3	0	0				0	0	70	
Br-R/A14-7	10	10											40			60
Br-R/A14-8	10	10											85			20
Br-R/A14-9	10	10	3	5	7		3			1	0	0	125		25	
Br-R/A14-10	10	10											230			25
Br-R/A14-11	10	10											315		25	
TP-R/A14-1	3													145		30
TP-R/A14-2	3													40	50	
TP-R/A14-3	3												125			50

Location: **R/A-18Al Aqr**

Bore Hole or Test Pit	Depth of Boring (m)	SPT (test)	Depth Position of Pressure Meter Test (m)				Laboratory Test of SPT Sample (test/set)	Thin-walled Tube Sampling (set)	Laboratory Test of Th.-tube Sample (test/set)	Ground Water Level Measure.	Ground Water Sampling (hole)	Laboratory Test of G. Water (test/set)	Location (distance from the below center) (m)			
													Center of Existing R/A		Existing Highway Center	
													to Al Aqr	to Muscat	to mountain	to sea
Br-R/A18-1	10	10												710	35	
Br-R/A18-2	10	10												610	45	
Br-R/A18-3	10	10	3	5	7		3			1	1	1		520	45	
Br-R/A18-4	10	10												400	30	
Br-R/A18-5	10	10												300	15	
Br-R/A18-6	10	10											255		15	
Br-R/A18-7	10	10											355		15	
Br-R/A18-8	10	10	3	5	7		3	0	0				443		25	
Br-R/A18-9	10	10	3	5	7		3			1	1	1	531		40	
Br-R/A18-10	10	10											621		50	
Br-R/A18-11	10	10											707		48	
TP-R/A14-1	3													520	30	
TP-R/A14-2	3												443		35	
TP-R/A14-3	3												531		25	

4 Location Maps of Soil Investigations at the Proposed Study Pedestrian underpasses