HAMRIYAH POWER PLANT PROJECT

TECNICAS REUNIDAS

PROJECT No.: 70150

ENVIRONMENTAL CONTAMINATION SURVEY

FINAL REPORT

REVISION	DATE	PURPOSE OF ISSUE	PREPARED	REVIEWED	APPROVED
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1. INTRODUCTION

This document presents the final report of the Environmental Contamination Survey that has been carried out by Tecnicas Reunidas beside the already existing Hamriyah Power and Water Plants. In these grounds, a new Green field power generation plant – Hamriyah IPP shall be implemented within the Hamriyah Complex, situated adjacent to Hamriyah port in the emirate of Sharjah, United Arab Emirates.

The purpose of the Environmental Contamination Survey is to identify and assess the potentially contaminated soil and groundwater in the area covered by the Project that may have occurred through previous activities.

The survey consists of site investigations works, laboratory analysis and reporting.

The strategy of Environmental Contamination Survey is based on the conclusions and recommendations of the Desk Study "Soil and Groundwater Sampling Plan" executed by Mr. Mott MacDonald, 09 April 2018.

The present document includes the conclusions based on laboratory analysis results.

2. CODES AND STANDARDS

There are no published soil and groundwater quality standards in the United Arab Emirates (UAE).

Therefore, Dutch Standards have been considered for of soil and groundwater contamination levels/quality assessment. Where these standards do not provide limits for certain parameters, other appropriate international standards (e.g. USEPA) have been applied for comparison.

In addition, the survey has been executed based on the following relevant Standards and Codes of Practice:

BS 5930: 1999+A2:2015, "Code of Practice for Site Investigations".
BS 10175: "Code of Practice for Investigation of potentially contaminated sites"
BS 1377:1990 "Methods of Test for Soils for Engineering Purposes".
BS EN 1997-2:2007, BS EN ISO 22476-2:2005+A1:2011, BS EN ISO, 22476-3:2005+A1:2011, BS EN ISO 22476-1:2012.

3. SITE INVESTIGATIONS

The environmental site investigations have been developed according to the following sampling plan:

Note: The trial-pits and boreholes positions are approximate. The coordinates are presented below.

Groundwater investigations works

During the period from 03rd to 06th June, five (05) boreholes were drilled. The boring was advanced by using rotary drilling method with polymer circulation. The following table summarizes the boreholes data:

Borehole No	Drilled Depth	Ground Elevation (SHMD)	Easting	Northing	Drilling Start Date	Drilling Finish Date
BH-01	10.0	4.124	346967.64	2817009.765	06/06/18	06/06/18
BH-02	10.0	4.191	346750.828	2816883.039	03/06/18	03/06/18
BH-03	10.0	4.532	347121.221	2816929.515	03/06/18	03/06/18
BH-04	10.0	4.312	346878.005	2816754.554	04/06/18	04/06/18
BH-05	10.0	4.632	347034.111	2816667.854	04/06/18	04/06/18

The logs of the boreholes are presented in Appendix B of the document Attached, “SD18000031- Environmental Testing - Final report”.

The standpipe piezometers were installed in boreholes BH-01, BH-02, BH- 03, BH-04 & BH-05. The piezometers were installed as per BS 5930: Cl.23. Each monitoring well was composed of slotted pipes (continuous slots), 50mm diameter PVC screen followed with PVC solid pipe, gravel filter extends from bottom of the borehole up to the water table, followed by bentonite seal of 1.0m, which is further followed by a filter gravel pack up to the surface.

A week after the wells have been installed, the groundwater samples were collected. The wells were purged of three times their volume of water to sample collection in order to ensure a representative sample is collected.

The groundwater measurements were taken in situ: total dissolved solids (TDS), pH, temperature, salinity/ electrical conductivity (EC). The results are presented in below table:

Test	Unit	BH-01	BH-02	BH-03	BH-04	BH-05
pH*		7.06	7.48	7.45	7.67	7.55
Conductivity	ms/cm	30.72	64.59	63.67	62.10	48.31
TDS	ppt	15.37	32.32	31.85	31.05	24.15
Salinity	pSu	18.95	43.58	42.87	41.60	31.35

Five (5) groundwater samples were taken from piezometer and sent to the laboratory for further testing.

In addition, five (5) additional groundwater samples have been collected the first week of July in order to obtain representative results at different periods for evaluating the groundwater fluctuations and changes in groundwater quality.

The details are presented in the Appendix C “Field Tests” of document Attached “SD18000031- Environmental Testing - Final report”

Soil investigations works

Eighteen (18) trial pits were excavated up to a depths of 0.5 to 3.00 m below existing ground level at the specified locations within the site (6 TP located at laydown area and 12 TP located at the main Plant area). The trial pits were excavated mechanically.

In addition, 5 soil samples were collected from the existing sand stockpile at laydown area, at least 0.3m below the stockpile surface (0.5-1m depending on the depth of the stockpile).

The following table summarizes the trial pits:

Test pit No.	Ground Elevation (m SHMD)	Coordinates		Trial Pit Size	Excavation Depth (m)	Excavation date
		Easting	Northing			
TP-01E	4.532	347016.165	2816742.736	1.50 x 1.50	3.00	05/06/18
TP-02E	4.712	347112.770	2816904.114	1.50 x 1.50	3.00	05/06/18
TP-03E	4.100	346953.307	2816818.540	1.50 x 1.50	3.00	05/06/18
TP-04E	4.201	347001.591	2816898.691	1.50 x 1.50	3.00	04/06/18
TP-05E	4.325	346861.189	2816815.445	1.50 x 1.50	3.00	04/06/16
TP-06E	4.151	346932.378	2816939.980	1.50 x 1.50	3.00	04/06/18
TP-07E	3.432	346826.237	2816876.663	1.50 x 1.50	3.00	04/06/18
TP-08E	3.480	346851.863	2816920.132	1.50 x 1.50	3.00	04/06/18
TP-09E	4.241	346760.146	2816918.904	1.50 x 1.50	3.00	04/06/18
TP-10E	3.352	346785.313	2816960.056	1.50 x 1.50	3.00	04/06/18
TP-11E	4.311	346721.623	2816942.494	1.50 x 1.50	3.00	04/06/18
TP-12E	4.435	347199.135	2816956.492	1.50 x 1.50	3.00	05/06/18
TP-13E	4.481	347334.596	2816906.337	1.50 x 1.50	3.00	05/06/18
TP-14E	5.040	347261.034	2817097.951	1.50 x 1.50	3.00	05/06/18
TP-15E	44.778	347312.733	2817184.160	1.50 x 1.50	3.00	05/06/18
TP-16E	4.725	347384.893	2817304.147	1.50 x 1.50	3.00	05/06/18
TP-20E	4.225	347340.610	2817048.539	1.50 x 1.50	3.00	05/06/18
TP-21E	44.581	347392.309	2817135.435	1.50 x 1.50	3.00	05/06/18
TP-22E	16.302	347458.833	2817243.148	1.50 x 1.50	3.00	05/06/18
TP-15 Stock Pile	-	-	-	1.50 x 1.50	0.50	06/06/18
TP-16 Stock Pile	-	-	-	1.50 x 1.50	0.50	06/06/18
TP-17 Stock Pile	-	-	-	1.50 x 1.50	0.50	06/06/18
TP-18 Stock Pile	-	-	-	1.50 x 1.50	0.50	06/06/18
TP-19 Stock Pile	-	-	-	1.50 x 1.50	0.50	06/06/18

The sampling was carried out in accordance with BS 5930:2015.

Eighteen (18) soil samples were collected from trial pits executed in the main Plant area and laydown area and 5 soil samples were taken from the existing sand stockpile.

During the first week of July, five (5) soil samples were collected within boreholes influence areas to complete the soil investigations strategy.

The following table summarizes the trial pits:

Test pit No.	Ground Elevation (m SHMD)	Coordinates		Trial Pit Size	Excavation Depth (m)	Excavation date
		Easting	Northing			
BH-1E	4.054	346968.979	2817008.734	1.50 x 1.50	2.00	04/07/18
BH-2E	4.137	346750.682	2816883.126	1.50 x 1.50	2.00	04/07/18
BH-3E	4.526	347119.840	2816930.409	1.50 x 1.50	2.00	04/07/18
BH-4E	4.422	346877.994	2816754.626	1.50 x 1.50	2.00	04/07/18
BH-5E	4.573	347022.161	2816670.929	1.50 x 1.50	2.00	04/07/18

The logs of the test pit are presented in Appendix B of document attached.

Also asbestos were analysed in specific locations (TP-03E, TP-04E, TP-05E, TP-06E, TP-07E and TP-15E).

The following table summarizes the trial pits:

TP No.	Test	Method	Unit	Result
TP-03E	Asbestos Content	USEPA 600/R-93/116	-	Absent
TP-04E	Asbestos Content	USEPA 600/R-93/116	-	Absent
TP-05E	Asbestos Content	USEPA 600/R-93/116	-	Absent
TP-06E	Asbestos Content	USEPA 600/R-93/116	-	Absent
TP-07E	Asbestos Content	USEPA 600/R-93/116	-	Absent
TP-15E	Asbestos Content	USEPA 600/R-93/116	-	Absent

No asbestos content were found.

The results of laboratory tests are detailed in the Appendix D of document attached “SD18000031- Environmental Testing - Final report”.

4. LABORATORY TESTING

The groundwater samples have been analysed based on the following analytical programme:

Water	
pH	APHA4500
BTEX	USEPA8260
Total Petroleum Hydrocarbon (TPHCWG)	USEPA8015D
Poly Aromatic Hydrocarbon (PAHs)	USEPA8270 D
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	APHA 3120B ASTMD1067 B
Alkalinity	APHA 3120B
calcium	
Magnesium	
Sodium	
Potassium	APHA 4500
Total Ammonical nitrogen	APHA2340B
Hardness	BS1377P.3 CL.7
Chloride	APHA 4500
Fluoride	BS1377P.3CL.5
Sulphate	APHA 4500
Nitrate	APHA 4500
Nitrite	APHA 4500
Phosphate	
Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123) M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs	USEPA8270 D
Volatile Organic Compounds +TIC's	USEPA8260C
Semi volatile Organic Compounds+TIC's	USEPA8270 D

For soil sampling, the following tests have been completed:

Test	Test Method
Soil	
pH	BS1377 P.3 CL 9
Total Organic carbon	APHA 5310
BTEX	USEPA8260
Total Petroleum Hydrocarbon (TPHCWG)	USEPA8015D
Poly Aromatic Hydrocarbon (PAHs)	USEPA8270D
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	APHA 3120B
Asbestos	

Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs	USEPA8270 D
Volatile Organic Compounds +TIC's	USEPA8260C
Semi volatile Organic Compounds+TIC's	USEPA8270D

For asbestos sampling test method used was USEPA 600/R-93/116.

The results of laboratory tests are detailed in the Appendix D of document attached "SD18000031- Environmental Testing - Final report".

5. CONSIDERATIONS

Based on the information gathered on site and in laboratory, in the present section are shown the results of the environmental contamination survey.

For further detail, laboratory analysis are presented in the Appendix D and Appendix E of document attached “SD18000031- Environmental Testing - Final report” and also in item 6.0. “Results of the contamination assessment” within the mentioned attachment.

In absence of soil and groundwater quality standards in the United Arab Emirates (UAE), Dutch Standard “Soil Remediation Circular 2013, version of 1 July 2013” has been considered for of soil and groundwater contamination levels/quality assessment. Where these standards do not provide limits for certain parameters, Regional Screening Level (RSL) from USEPA Standards have been applied for comparison.

Soil sampling results

As can be observed in the soil results, the parameters analysed of Heavy metals, BTEX, TPH, PAH, VOC and SVOC are below the intervention values of Dutch Standard and also, the regional screening values of US EPA Standards.

Groundwater sampling results

According to the groundwater results, the parameters analysed of Heavy Metals, BTEX, TPH, PAH, VOC and SVOC are below the intervention values of Dutch Standard and regional screening values of US EPA Standards.

6. ATTACHMENTS

Attachment 1: ACES Report “SD18000031- Environmental Testing - Final report”

GEOTECHNICAL SITE INVESTIGATION FOR PROPOSED SEWA HAMRIYAH POWER PLANT HAMRIYAH AREA, SHARJAH – U.A.E.

Report No.	SD18000031
Revision No.	Rev.00
Status	Final Report
Date	15th July 2018

PREPARED FOR
M/S. TECNICAS REUNIDAS
ABU DHABI - U.A.E.

Revision History						
Rev.00	15th July 2018	**Final Report for Approval**				
Rev.00	23rd June 2018	**Draft Report For Review**	SAV	KUR	ABO	MJA
Revision No.	**Date**	**Description**	**Prepared**	**Checked**	**QA Check**	**Approved**

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Ref.: SD18000031-Rev.00
Date: 15th July 2018

SUBJECT: GEOTECHNICAL INVESTIGATION FOR
Proposed SEWA Hamriyah Power Plant,
Hamriyah Area, Sharjah – U.A.E.

Dear Sirs,

Arab Center for Engineering Studies (ACES) is pleased to submit this report on the Environmental Investigation carried out for the **Proposed SEWA Hamriyah Power Plant** at Hamriyah Area in Sharjah, UAE. The investigation was carried out according to our proposal ref. no. PS180000323- Rev-01**,** dated 26th April 2017 and in accordance with the Client's Purchase order reference no. 7015023700, suppl.01 dated 09th June 2018.

This final report includes the results and findings of the field and laboratory investigations.

In the event that additional information or clarifications are required, please contact our office at your convenience. We would like to take this opportunity to thank you for your confidence and look forward to be of service to you in the near future.

Sincerely yours,
ARAB CENTER FOR ENGINEERING STUDIES
(ACES - DUBAI)

Eng. Mohammed J. Ahmed
Manager, Geotechnical Department
ACES - Dubai

ACES Confidentiality & Proprietary Rights

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1.0 INTRODUCTION

This final report presents the results of the environmental study carried out for the **Proposed SEWA Hamriyah Power Plant** at Hamriyah Area, in Sharjah, U.A.E.

1.1 Purpose of Study

The purpose of the study is to identify and assess the potentially contaminated soil and groundwater in the area covered by the Project, and is based on the results of environmental investigation works.

1. Determination of soil and groundwater contamination is performed on soil samples obtained after excavation and on groundwater samples from piezometers at positions defined on desk study and site visit.

1.2 Scope of Works

The scope of work for the environmental study consists of field studies and laboratory analysis. The field portion of the investigation employed test boring and excavation of trial pits, as primary investigative techniques; additionally piezometers were also installed for sampling of ground waters to determine the specified parameters. Laboratory studies included performing testing for the prescribed chemical suites on selected samples.

The project scope of works consists of the following:

1. Collecting information and maps particular to the project site.
2. Making inspection visits to the site to collect information about the present land use, surface topography, and geological features.
3. Drilling of five (05) boreholes up to a depth of 10.0 m each.
4. Excavation of five (05) trial pits near the boreholes locations upto 2.0mbelow the existing ground level.
5. Excavation of thirteen (13) trial pits at the plant and six (6) trial pits at the laydown area upto the specified depths within the site.
6. Collection of five (5) stockpile soil samples at the existing laydown area.
7. Installation of five (05) Standpipe Piezometers for GW sampling at specified locations (BH-01 to BH-05).
8. Conducting laboratory testing on selected soil and water samples as per agreed testing requirements of the Contract (RFQ. 70150-00-YC-CIO-TRE-150)
9. Preparing final report as per the project requirements.

1.3 Standards and Codes of Practice

Unless otherwise specified in this document, all equipment's, materials and procedures associated with this work comply with current editions of following relevant Standards and Codes of Practice.

1. BS 5930: 2015, "Code of Practice for Site Investigations".
2. BS 10175: "Code of Practice for Investigation of potentially contaminated sites"

3. BS EN 1997-2:2007. BS EN ISO 22476-2:2005+A1:2011, BS EN ISO 22476-3:2005+A1:2011, BS EN ISO 22478-1:2012.
4. Dutch Standards, USEPA or UK Soil or Groundwater Screening Values

2.0 PROJECT & SITE DESCRIPTION

The project is Hamriyah Power Plant Project. The project consists of construction of Green Field Power generation plant. This Hamriyah IPP shall be implemented as an Independent power producer (IPP) within the Hamriyah Complex, situated adjacent to Hamriyah port in the emirate of Sharjah, United Arab Emirates.

The site is located at Hamriyah Port in Sharjah – U.A. E. The Google map showing the location of the site is shown below.

Figure 1: Google Image of SEWA Hamriyah Power Plant - Project Location

At the time of investigation the site was uneven and was easily accessible. Ground levels are related to Sharjah Halcrow Municipality Datum (SHMD) & co-ordinates to WGS-84. General site layout plan is presented below:

Figure 2: Typical Site Photographs

A general site plan showing the project layout and all the test locations is presented in **Appendix A**, A Google Image showing the environmental test locations is presented in the figure below.

Figure 3: Google Image showing field test locations

3.0 FIELD WORKS

The field works in the investigation campaign consisted of drilling of boreholes and collection of soil from the trial pits & water samples from the piezometers for prescribed environmental samples. The details of test methods employed for each above stated field testing are provided in table below **Table 1**.

Table 1: Details of Field Testing and test methods

Type of Test	Test Name
Soil Sampling	Field investigation sampling in the ground BS 5930 Clause 22
Soil description	Soil description BS 5930 Clause 41 & Clark and Walker
Ground water Level measurement	Field Investigation Method of determining ground water pressure BS 5930 Clause 23.2 Cl. 27.5 & Cl. 47.2.7
Piezometer Installation	Field Investigation Ground Water ACES - MS-016 (BS 5930: Cl. 23)

The details of each component of field testing are briefly discussed in the following sections of the report.

3.1 Drilling of Boreholes

During the period from 03rd to 06th June, five (05) environmental boreholes will be drilled to maximum depth of 10.0m below existing ground with depths and at locations agreed with the Client. The boring was advanced by using rotary drilling method with polymer circulation. The following **Table 2** summarizes the borehole information:

Table 2: Summary of Boreholes

Borehole No	Drilled Depth	Ground Elevation (SHMD)	Easting	Northing	Drilling Start Date	Drilling Finish Date
BH-01	10.0	4.124	346967.64	2817009.765	06/06/18	06/06/18
BH-02	10.0	4.191	346750.828	2816883.039	03/06/18	03/06/18
BH-03	10.0	4.532	347121.221	2816929.515	03/06/18	03/06/18
BH-04	10.0	4.312	346878.005	2816754.554	04/06/18	04/06/18
BH-05	10.0	4.632	347034.111	2816667.854	04/06/18	04/06/18

The locations of the boreholes were set-out based on site conditions taking into account any site constraints and hazards including the presence of buried services. The borehole location is shown on the site plan attached in **Appendix A**. The borehole logs are presented in **Appendix B1.**

General photograph during drilling of boreholes were taken as presented below:

Figure 4: General photograph during drilling of boreholes

3.2 Installation of Standpipe Piezometers

In order to monitor ground water levels and to take representative samples of five (5 Nos) of standpipe piezometers were installed in boreholes BH-01, BH-02, BH- 03, BH-04 & BH-05. The piezometers were installed as per BS 5930: 2015, Cl.23. Each monitoring well was composed of slotted pipes (continuous slots), 50mm diameter PVC screen followed with PVC solid pipe, gravel filter extends from bottom of the borehole up to the water table, followed by bentonite seal of 1.0m, which is further followed by a filter gravel pack up to the surface .

The procedure adopted for installing the piezometer is given below.

3.2.1 Procedure for Installation of Piezometers

Piezometers are installed at each drilled borehole for monitoring of water level and sampling of groundwater samples to monitor the ground water levels.

Typical drawing of piezometer installation details is presented in Figure 5.0 below. Piezometer pipes with diameter 50mm are provided in threaded sections and assembled on site. PVC pipes of required lengths are joined together at their ends and with a filter screen at the lower end.

The bottom end of the PVC pipe is plugged to prevent entry of soil into the pipe.
The PVC pipes are installed into the hole vertically to the required depth with the filter screen at the lower end. The length of PVC is 50cm above the ground level.

The annular space between the PVC pipe and the borehole are filled with clean gravel.

The monitoring wells are made of 1.0m sections of HDPE tubing with slotted piping intersecting the groundwater table. A filter pack comprising clean, washed, well-rounded, siliceous gravel was installed around the slotted sections.

The grading of the gravel pack material was determined by the SUBCONTRACTOR depending on the strata encountered. Bentonite pellets are placed on top of the filter to form an upper seal not less than 0.5 m thick.

The remainder of the exploratory hole was filled with cement/bentonite grout or bentonite pellets to within 1.0m of ground level.

The wells are then extend approximately 0.5m above ground level and are protected with a metal casing.

Monitoring of ground water table was commenced after 24 hours after the installation of piezometer using water level meter for few days.

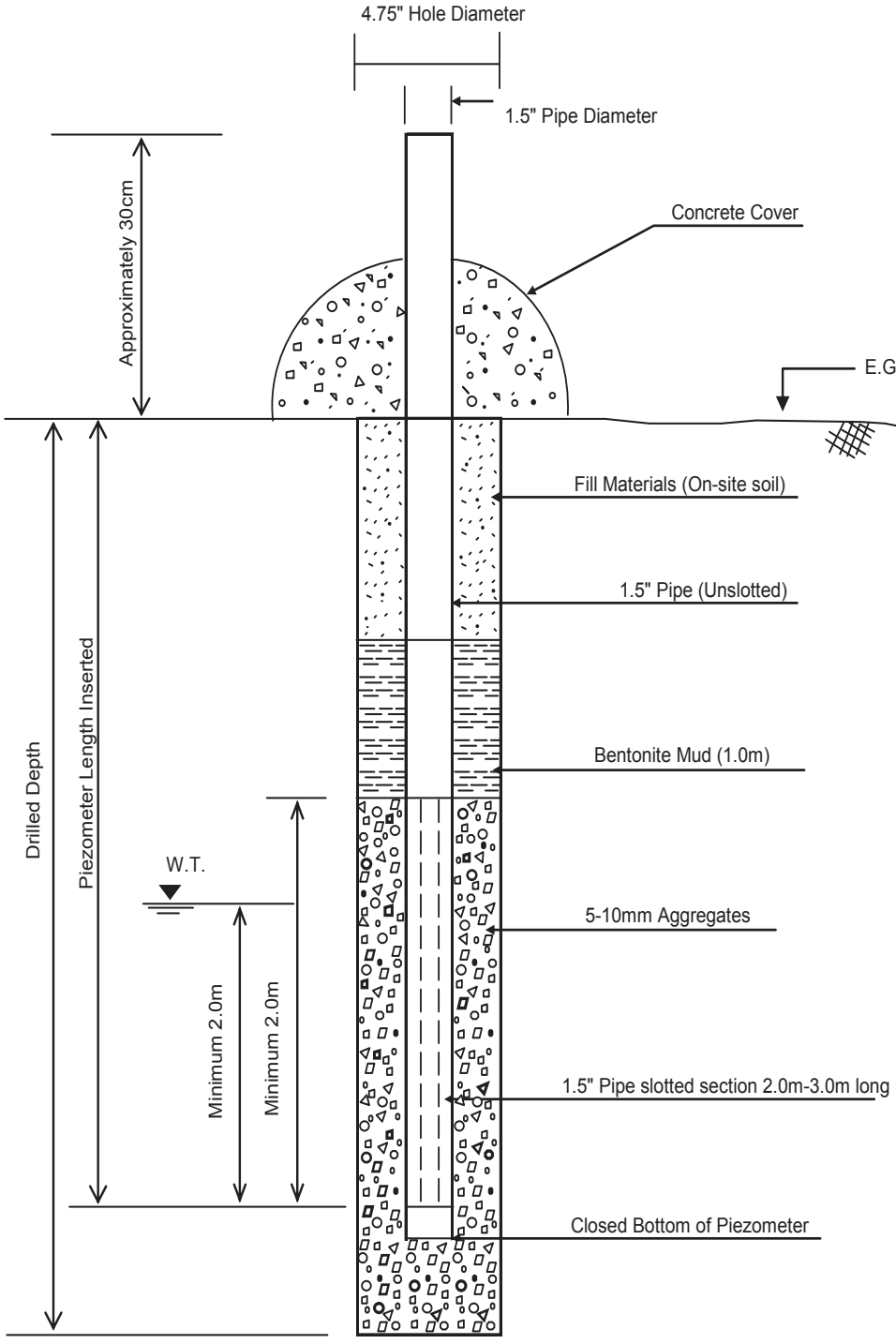

Figure 5: Typical Sketch of Piezometer Installation

Table 3: Standpipe Location and Installation data

BH No.	Total Depth (m)	Length of Screen Section (m)	Remarks
BH-01	9.00	3.00	Groundwater table was not encountered in all the installed piezometers.
BH-02	9.00	3.00	
BH-03	9.00	3.00	
BH-04	9.00	3.00	
BH-05	9.00	3.00	

Groundwater levels were measured from the installed piezometers using dip meter after the installation. The piezometer readings are presented in **Appendix C1**.

3.3 Sampling

3.3.1 Soil Sampling (Near boreholes)

Additional five (05) soil samples were collected from the trial pits at the nearest borehole locations by excavating manually. Each soil sample was collected in clean unused laboratory supplied containers and stored in cool boxes containing ice packs for transportation to an accredited laboratory for further testing.

3.3.2 Ground Water Sampling

A week after the wells have been installed, the ground water samples were collected. The ground water depth and well depth below the surface was determined using oil/water interface probe and wells will be purged of three times their volume of the water sample to sample collection in order to ensure a representative sample is collected. The water samples were collected in clean unused laboratory supplied containers and stored in cool boxes containing ice packs for transportation to an accredited laboratory for further testing.

3.4 In-situ test of Ground Water Samples

After purging the piezometers, the in situ measurements of groundwater samples were carried out at the site for total dissolved solids (TDS), pH, temperature, salinity/ electrical conductivity (EC) for each of the boreholes. The results are presented in below table.

Table 4: Summary of Insitu Test Results of Water samples

Test	Unit	BH-01	BH-02	BH-03	BH-04	BH-05
pH*	-	7.06	7.48	7.45	7.67	7.55
Conductivity	ms/cm	30.72	64.59	63.67	62.10	48.31
TDS	ppt	15.37	32.32	31.85	31.05	24.15
Salinity	pSu	18.95	43.58	42.87	41.60	31.35
Temperature	°C	28	28	29	28.2	28.1

The results are presented in **Appendix C2**.

3.5 Excavation of Trial Pits

A total of nineteen (19) trials pits i.e. thirteen (13) trial pits in the plant area and six (6) trial pits at the laydown area were excavated up to a depth of 3.00 m below existing ground level. The trial pits were excavated mechanically. Five (05) small pits were carried out manually to collect the stockpile samples at the existing laydown area. Additionally five trial pits near the environment

boreholes were also excavated upto 2.0m mechanically. The following table summarizes the boreholes.

Table 5: Summary of Trial pit Information

Test pit No.	Ground Elevation (m SHMD)	Coordinates		Trial Pit Size	Excavation Depth (m)	Excavation date
		Easting	Northing			
TP-01E	4.532	347016.165	2816742.736	1.50 x 1.50	3.00	05/06/18
TP-02E	4.712	347112.770	2816904.114	1.50 x 1.50	3.00	05/06/18
TP-03E	4.100	346953.307	2816818.540	1.50 x 1.50	3.00	05/06/18
TP-04E	4.201	347001.591	2816898.691	1.50 x 1.50	3.00	04/06/18
TP-05E	4.325	346861.189	2816815.445	1.50 x 1.50	3.00	04/06/16
TP-06E	4.151	346932.378	2816939.980	1.50 x 1.50	3.00	04/06/18
TP-07E	3.432	346826.237	2816876.663	1.50 x 1.50	3.00	04/06/18
TP-08E	3.480	346851.863	2816920.132	1.50 x 1.50	3.00	04/06/18
TP-09E	4.241	346760.146	2816918.904	1.50 x 1.50	3.00	04/06/18
TP-10E	3.352	346785.313	2816960.056	1.50 x 1.50	3.00	04/06/18
TP-11E	4.311	346721.623	2816942.494	1.50 x 1.50	3.00	04/06/18
TP-12E	4.435	347199.135	2816956.492	1.50 x 1.50	3.00	05/06/18
TP-13E	4.481	347334.596	2816906.337	1.50 x 1.50	3.00	05/06/18
TP-14E	5.040	347261.034	2817097.951	1.50 x 1.50	3.00	05/06/18
TP-15E	44.778	347312.733	2817184.160	1.50 x 1.50	3.00	05/06/18
TP-16E	4.725	347384.893	2817304.147	1.50 x 1.50	3.00	05/06/18
TP-20E	4.225	347340.610	2817048.539	1.50 x 1.50	3.00	05/06/18
TP-21E	44.581	347392.309	2817135.435	1.50 x 1.50	3.00	05/06/18
TP-22E	16.302	347458.833	2817243.148	1.50 x 1.50	3.00	05/06/18
Stock Pile15	11.789	347313.475	2817183.490	1.50 x 1.50	0.50	06/06/18
Stock Pile16	6.430	347379.709	2817287.328	1.50 x 1.50	0.50	06/06/18
Stock Pile17	5.448	347290.165	2817079.467	1.50 x 1.50	0.50	06/06/18
Stock Pile18	11.503	347351.320	2817160.750	1.50 x 1.50	0.50	06/06/18
Stock Pile19	16.282	347438.080	2817252.608	1.50 x 1.50	0.50	06/06/18
BH-1E	4.054	346968.979	2817008.734	1.50 x 1.50	2.00	04/07/18
BH-2E	4.137	346750.682	2816883.126	1.50 x 1.50	2.00	04/07/18
BH-3E	4.526	347119.840	2816930.409	1.50 x 1.50	2.00	04/07/18
BH-4E	4.422	346877.994	2816754.626	1.50 x 1.50	2.00	04/07/18
BH-5E	4.573	347022.161	2816670.929	1.50 x 1.50	2.00	04/07/18

The locations of the trial pits were set-out by ACES at locations provided by the client. The strata's encountered were visually described and representative bulk samples were carefully collected from the sides and bottom of the pits. Sampling was carried out in accordance with BS 5930:2015 The logs of the test pit are presented in **Appendix B2.**

3.5.1 Trial-pit methodology

Trial pitting for the laydown area and proposed Plant area were carried out using the mechanical excavator with a bucket in 200mm layers to 3.0m depth.

As the trial pit is advanced, the spoil was segregated in such a way that it can be used to backfill the pit in the same order that it was removed (i.e. topsoil should be excavated and stockpiled separately from other soil layers).

Excavated materials are placed away from the side of the trial pit at a distance equivalent to the trial pit depth to reduce the risk of the trial pit collapsing.

General Photographs during trial pit excavation are also presented below:

Figure 6: Typical Photographs during Trial Pit Excavation

3.6 Soil Sampling

As specified soil samples & stock pile samples were collected from trial pits. The details and no of requested tests are presented below:

Table 6: Summary of Environmental Testing for Soil Samples

TP. No.	Depth (m)	TEST REQUIRED	No. OF TESTS
TP-01E	1.50	See Table 7 below	1
TP-02E	1.50		1
TP-03E	1.50		1
TP-04E	1.50		1
TP-05E	1.50		1
TP-06E	1.50		1
TP-07E	1.50		1
TP-08E	1.50		1
TP-09E	1.50		1
TP-10E	1.50		1
TP-11E	1.50		1

TP-12E	1.50		1
TP-13E	1.50		1
TP-14E	1.50		1
TP-15E	1.50		1
TP-16E	1.50		1
TP-20E	1.50		1
TP-21E	1.50		1
TP-22E	1.50		1
TP-15 Stock Pile	0.50		1
TP-16 Stock Pile	0.50		1
TP-17 Stock Pile	0.50		1
TP-18 Stock Pile	0.50		1
TP-19 Stock Pile	0.50		1
BH- 01E	1.00		1
BH- 02E	1.00		1
BH- 03E	1.00		1
BH- 04E	1.00		1
BH- 05E	1.00		1

To avoid cross contamination, sampling devices was properly decontaminated prior to every sampling as per the specifications and brushed to remove any loose material, rinsing in tap water, washing with phosphate free detergent, followed by rinse in distilled water and air drying.

Table 7: List of Tests and Test Methods for Soil Samples

Test	Test Method
Soil	**BS1377 P.3 CL 9**
pH	**APHA 5310**
Total Organic carbon	**USEPA8260**
BTEX	**USEPA8015D**
Total Petroleum Hydrocarbon (TPHCWG)	**USEPA8270D**
Poly Aromatic Hydrocarbon (PAHs)	**APHA 3120B**
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	
Asbestos	**USEPA8270 D**

Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs		**USEPA8260C** **USEPA8270D**
Volatile Organic Compounds +TIC's		
Semi volatile Organic Compounds+TIC's		

3.7 Ground Water Sampling Ground water samples from piezometer were collected and sent to our laboratory for further testing. The details and no of requested test are presented below:

Table 8: Summary of Environmental Testing for Water Samples

BH. No.	Depth (m)	TEST REQUIRED	No. OF TESTS
BH-01	2.53	See Table 9 below	2
BH-02	2.43		2
BH-03	2.56		2
BH-04	2.34		2
BH-05	2.51		2

Table 9: List of Tests and Test Methods for Water Samples

Water	
pH	APHA4500
BTEX	USEPA8260
Total Petroleum Hydrocarbon (TPHCWG)	USEPA8015D
Poly Aromatic Hydrocarbon (PAHs)	USEPA8270 D
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	APHA 3120B ASTMD1067 B
Alkalinity	APHA 3120B
calcium	
Magnesium	
Sodium	

Potassium		APHA 4500
Total Ammonical nitrogen		APHA2340B
Hardness		BS1377P.3 CL.7
Chloride		APHA 4500
Fluoride		BS1377P.3CL.5
Sulphate		APHA 4500
Nitrate		APHA 4500
Nitrite		APHA 4500
Phosphate		
Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123) M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs		USEPA8270 D
Volatile Organic Compounds +TIC's		USEPA8260C
Semi volatile Organic Compounds+TIC's		USEPA8270 D

3.8 Site safety

ACES staff was fully committed for implementing the Health and Safety measures for all personnel who were working at this project. Effective methods were adopted to ensure the policies and procedures are communicated to, and properly understood by all crew personnel and followed throughout the operations, controlled by inspection visits of the safety representative.

It is concluded that no accidents/ incidents occurred during the period of site investigation work for this project.

3.9 Site Clean Out

Following the completion of field works, the location of each borehole was cleaned-off bentonite remains, cuttings and the surface reinstated with surrounding sand.

4.0 LABORATORY TESTING

In order to determine the chemical properties of the ground materials (soil and water samples) laboratory testing's were carried out water samples collected from boreholes and soil samples

collected from trial pits, stockpile and boreholes “unsaturated soils located above the groundwater level as per testing suite provided by the client. Laboratory tests were performed on selected samples according to following Standards:

Table 10: List of Tests and Standard Test Methods

Test	Test Method
Soil	
pH	**BS1377 P.3 CL 9**
Total Organic carbon	**APHA 5310**
BTEX	**USEPA8260**
Total Petroleum Hydrocarbon (TPHCWG)	**USEPA8015D**
Poly Aromatic Hydrocarbon (PAHs)	**USEPA8270D**
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	**APHA 3120B**
Asbestos	
Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs	**USEPA8270 D**
Volatile Organic Compounds +TIC's	**USEPA8260C**
Semi volatile Organic Compounds+TIC's	**USEPA8270D**
Water	
pH	**APHA4500**
BTEX	**USEPA8260**
Total Petroleum Hydrocarbon (TPHCWG)	**USEPA8015D**
Poly Aromatic Hydrocarbon (PAHs)	**USEPA8270 D**
Heavy Metals (suits of 17 Metals: arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc)	**APHA 3120B**
Alkalinity	**ASTMD1067 B** **APHA 3120B**

Cacium		
Magnessium		
Sodium		
Potassium		**APHA 4500**
Total Ammonical nitrogen		**APHA2340B**
Hardness		**BS1377P.3 CL.7**
Chloride		**APHA 4500**
Fluoride		**BS1377P.3CL.5**
Sulphate		**APHA 4500**
Nitrate		**APHA 4500**
Nitrite		**APHA 4500**
Phosphate		
Poly Chlorinated Biphenyls 2,3,3',4,4',5,5'- (PCB 189), Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167), ~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157), Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156), ~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169), Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123) M, Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118), Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105), Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114), Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126), Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77), Tetrachlorobiphenyl, 3,4,4',5- (PCB 81), Total PCBs		**USEPA8270 D**
Volatile Organic Compounds +TIC's		**USEPA8260C**
Semi volatile Organic Compounds+TIC's		**USEPA8270 D**
Reporting (Factual without optional scope)		

5.0 RESULTS

The results obtained from the laboratory analysis for Soil & Water tests are presented in **Appendix D.** Summary of the soil and water results are presented in the table below.

ANALYSIS OF SOIL			
Test Parameter	**Test Method**	**Test Results**	
		Min Value	**Max Value**
TOTAL ORGANIC CARBON			
Total Organic Carbon	Walkey-black Method	0.01	0.07

ANALYSIS OF SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
BTEX			
Benzene	USEPA 8260C	<0.52	<0.52
Toluene		<0.54	<0.54
Ethylbenzene		<0.44	<0.44
m & p- Xylene		<1.14	<1.14
o-Xylene		<0.55	<0.55
BTEX		<3.19	<3.19
TOTAL PETROLEUM HYDROCARBONS			
TPH C8-C38 ALIPHATIC	USEPA 8015D	<0.1	<0.1
TPH C6-C8 AROMATIC	USEPA 8260C	<0.1	<0.1
TPH C10-C22 AROMATIC	USEPA 8270D	<0.1	<0.1
POLYNUCLEAR AROMATIC HYDROCARBONS			
Naphthalene	USEPA 8270D	<0.05	<0.05
Acenaphthylene		<0.05	<0.05
Acenaphthene		<0.05	<0.05
Fluorene		<0.05	<0.05
Phenanthrene		<0.05	<0.05
Anthracene		<0.05	<0.05
Fluoranthene		<0.05	<0.05
Pyrene		<0.05	<0.05
Benz(a)anthracene		<0.05	<0.05
Chrysene		<0.05	<0.05
Benzo(b)fluoranthene		<0.05	<0.05
Benzo(k)fluoranthene		<0.05	<0.05
Benzo(a)pyrene		<0.05	<0.05
Indeno(1,2,3-cd)pyrene		<0.05	<0.05
Dibenz(a,h)anthracene		<0.05	<0.05
Benzo(g,h,i)perylene		<0.05	<0.05
Polynuclear Aromatid Hydrocarbons (PAHs)		<0.05	<0.05
POLYCHLORINATED BIPHENYLS			
3,3',4,4'-Tetrachlorobiphenyl	USEPA 8270D	<0.01	<0.01
3,4,4',5-Tetrachlorobiphenyl		<0.01	<0.01
2,3,3',4,4'-Pentachlorobiphenyl		<0.01	<0.01
2,3,4,4',5-Pentachlorobiphenyl		<0.01	<0.01
2,3',4,4',5-Pentachlorobiphenyl		<0.01	<0.01
2',3,4,4',5-Pentachlorobiphenyl		<0.01	<0.01
3,3',4,4',5-Pentachlorobiphenyl		<0.01	<0.01
2,3,3',4,4',5-Hexachlorobiphenyl		<0.01	<0.01
2,3,3',4,4',5'-Hexachlorobiphenyl		<0.01	<0.01
2,3',4,4',5,5'-Hexachlorobiphenyl		<0.01	<0.01
3,3',4,4',5,5'-Hexachlorobiphenyl		<0.01	<0.01
2,3,3',4,4',5,5'-Heptachlorobiphenyl		<0.01	<0.01
Total PCBs		<0.01	<0.01
VOLATILE ORGANIC COMPOUNDS (VOCs) + TIC's			
Dichlorodifluoromethane[1]	USEPA 8260C	<0.60	<0.60
Chloromethane[1]		<0.81	<0.81
Vinyl chloride[1]		<0.88	<0.88

ANALYSIS OF SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Bromomethane[1]		<0.67	<0.67
Chloroethane[1]		<0.28	<0.28
Trichlorofluoromethane[1]		<0.63	<0.63
Acetonitrile[1]		<1.81	<1.81
Acetone[1]		<2.75	<2.75
Diethyl ether[1]		<1.03	<1.03
1,1-Dichloroethene[1]		<0.91	<0.91
Iodomethane[1]		<0.87	<0.87
Propionitrile[1]		<0.77	<0.77
Acrylonitrile[1]		<0.85	<0.85
Methylene chloride[1]		<1.21	<1.21
1,1,2-Trichlorotrifluoroethane (CFC-113)[1]		<0.98	<0.98
Allyl chloride[1]		<0.57	<0.57
Carbon disulfide[1]		<0.35	<0.35
trans-1,2-Dichloroethene[1]		<0.96	<0.96
MTBE[1]		<0.81	<0.81
1,1-Dichloroethane[1]		<0.55	<0.55
Chloroprene[1]		<3.11	<3.11
2-Butanone (MEK)[1]		<6.81	<6.81
Methacrylonitrile[1]		<0.79	<0.79
cis-1,2-Dichloroethene[1]		<0.50	<0.50
Bromochloromethane[1]		<0.90	<0.90
Chloroform[1]		<0.60	<0.60
Methyl acrylate[1]		<0.90	<0.90
2,2-Dichloropropane[1]		<0.79	<0.79
Tetrahydrofuran[1]		<1.64	<1.64
1,2-Dichlorethane[1]		<0.86	<0.86
1,1,1-Trichloroethane[1]		<0.55	<0.55
1,1-Dichloropropene[1]		<0.64	<0.64
Carbon Tetrachloride[1]		<0.61	<0.61
Benzene[1]		<0.52	<0.52
Dibromomethane[1]		<0.90	<0.90
1,2-Dichloropropane[1]		<0.51	<0.51
Trichloroethene[1]		<0.76	<0.76
Bromodichloromethane[1]		<0.74	<0.74
Methyl methacrylate[1]		<0.90	<0.90
cis-1,3-Dichloropropene[1]		<0.39	<0.39
4-Methyl-2-pentanone (MIBK)[1]		<2.57	<2.57
trans-1,3-Dichloropropene[1]		<0.61	<0.61
1,1,2-Trichloroethane[1]		<0.59	<0.59
Toluene[1]		<0.54	<0.54
1,3-Dichloropropane[1]		<0.89	<0.89
Ethyl methacrylate[1]		<0.78	<0.78
2-Hexanone[1]		<3.40	<3.40
Dibromochloromethane[1]		<0.35	<0.35
1,2-Dibromoethane-EDB[1]		<0.88	<0.88
Tetrachloroethene[1]		<0.78	<0.78
1,1,1,2-Tetrachloroethane[1]		<0.34	<0.34
Chlorobenzene[1]		<0.59	<0.59
Ethylbenzene[1]		<0.44	<0.44
m & p- Xylene[1]		<1.14	<1.14

ANALYSIS OF SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Bromoform[1]		<0.63	<0.63
cis-1,4-Dichloro-2-butene[1]		<0.63	<0.63
Styrene[1]		<0.64	<0.64
1,1,2,2-Tetrachloroethane[1]		<0.95	<0.95
o-Xylene[1]		<0.55	<0.55
1,2,3-Trichloropropane[1]		<0.92	<0.92
trans-1,4-Dichloro-2-butene[1]		<1.43	<1.43
Isopropylbenzene[1]		<0.38	<0.38
Bromobenzene[1]		<0.69	<0.69
n-Propylbenzene[1]		<0.60	<0.60
2-Chlorotoluene[1]		<0.86	<0.86
4-Chlorotoluene[1]		<0.72	<0.72
1,3,5-Trimethylbenzene[1]		<0.43	<0.43
Pentachloroethane[1]		<0.89	<0.89
tert-Butylbenzene[1]		<0.50	<0.50
1,2,4-Trimethylbenzene[1]		<0.40	<0.40
sec-Butylbenzene[1]		<0.55	<0.55
1,3-Dichlorobenzene[1]		<0.52	<0.52
1,4-Dichlorobenzene[1]		<0.59	<0.59
p-Isopropyltoluene (p-Cymene)[1]		<0.52	<0.52
1,2-Dichlorbenzene[1]		<0.73	<0.73
n-Butylbenzene[1]		<0.65	<0.65
1,2-Dibromo-3-Chloropropane[1]		<1.25	<1.25
1,2,4-Trichlorobenzene[1]		<0.69	<0.69
Naphthalene[1]		<1.29	<1.29
Hexachlorobutadiene[1]		<0.76	<0.76
1,2,3-Trichlorobenzene[1]		<0.86	<0.86
TIC's	NIST Library Search	ND	ND
SEMI-VOLATILE ORGANIC COMPOUNDS + TIC's			
N-Nitrosodimethylamine	USEPA 8270D	<0.02	<0.02
Pyridine		<0.02	<0.02
Phenol		<0.02	<0.02
Aniline		<0.02	<0.02
Bis(2-chhloroethyl) ether		<0.02	<0.02
2-Chlorophenol		<0.02	<0.02
1,3-Dichlorobenzene		<0.02	<0.02
1,4-Dichlorobenzene		<0.02	<0.02
Benzyl alcohol		<0.02	<0.02
2-Methylphenol		<0.02	<0.02
1,2-Dichlorobenzene		<0.02	<0.02
Bis(2-chloroisopropyl) ether		<0.02	<0.02
4-Methylphenol/3-Methylphenol		<0.02	<0.02
N-Nitrosodi-n-propylamine		<0.02	<0.02
Hexachloroethane		<0.02	<0.02
Nitrobenzene		<0.02	<0.02
Isophorone		<0.02	<0.02
2,4-Dimethylphenol		<0.02	<0.02
2-Nitrophenol		<0.02	<0.02
Bis(2-chloroethoxy)methane		<0.02	<0.02
2,4-Dichlorophenol		<0.02	<0.02
1,2,4-Trichlorobenzene		<0.02	<0.02

ANALYSIS OF SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Naphthalene		<0.02	<0.02
4-Chloroaniline		<0.02	<0.02
Hexachlorobutadiene		<0.02	<0.02
4-Chloro-3-methylphenol		<0.02	<0.02
2-Methylnaphthalene		<0.02	<0.02
1-Methylnaphthalene		<0.02	<0.02
Hexachlorocyclopentadiene		<0.02	<0.02
2,4,6-Trichlorophenol		<0.02	<0.02
2,4,5-Trichlorophenol		<0.02	<0.02
2-Chloronaphthalene		<0.02	<0.02
2-Nitroaniline		<0.02	<0.02
1,4-Dinitrobenzene		<0.02	<0.02
Dimethyl phthalate		<0.02	<0.02
1,3-Dinitrobenzene		<0.02	<0.02
2,6-Dinitrotoluene		<0.02	<0.02
1,2-Dinitrobenzene		<0.02	<0.02
Acenaphthylene		<0.02	<0.02
3-Nitroaniline		<0.02	<0.02
Acenaphthene		<0.02	<0.02
2,4-Dinitrophenol		<0.02	<0.02
4-Nitrophenol		<0.02	<0.02
2,4-Dinitrotoluene		<0.02	<0.02
Dibenzofuran		<0.02	<0.02
2,3,5,6-Tetrachlorophenol		<0.02	<0.02
2,3,4,6-Tetrachlorophenol		<0.02	<0.02
Diethyl phthalate		<0.02	<0.02
4-Chlrophenyl phenyl ether		<0.02	<0.02
4-Nitroaniline		<0.02	<0.02
4,6-Dinitro-2-methylphenol		<0.02	<0.02
Fluorene		<0.02	<0.02
N-nitrosodiphenylamine (diphenylamine)		<0.02	<0.02
1,2-Diphenylhydrazine (as azobenzene)		<0.02	<0.02
4-Bromophenyl phenyl ether		<0.02	<0.02
Hexachlorobenzene		<0.02	<0.02
Pentachlorophenol		<0.02	<0.02
Phenanthrene		<0.02	<0.02
Anthracene		<0.02	<0.02
Carbazole		<0.02	<0.02
Di-n-butyl phthalate		<0.02	<0.02
Fluoranthene		<0.02	<0.02
Benzidine		<0.02	<0.02
3,3'-Dimethylbenzidine		<0.02	<0.02
Pyrene		<0.02	<0.02
Butyl benzyl phthalate		<0.02	<0.02
Bis(2-ethylhexyl) adipate		<0.02	<0.02
Bis(2-ethylhexyl) phthalate		<0.02	<0.02
3,3'-Dichlorobenzidine		<0.02	<0.02
Benz(a)anthracene		<0.02	<0.02
Chrysene		<0.02	<0.02
Di-n-octyl phthalate		<0.02	<0.02

ANALYSIS OF SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Benzo(b)fluoranthene		<0.02	<0.02
Benzo(k)fluoranthene		<0.02	<0.02
Benzo(a)pyrene		<0.02	<0.02
Indeno(1,2,3-cd)pyrene		<0.02	<0.02
Dibenz(a,h)anthracene		<0.02	<0.02
Benzo(g,hi)perylene		<0.02	<0.02
TIC's	NIST Library Search	ND	ND

ANALYSIS OF WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
CHEMICAL ANALYSIS			
Ammoniacal Nitrogen	APHA 4500 NH3 (F)	0.03	2.25
Flouride[1]	APHA 4500 F- (D)	0.70	1.90
Nitrate	APHA 450 NO3 (E)	<0.02	0.40
Nitrite	APHA 450 NO2 (B)	<0.02	0.26
Phosphate as PO4	APHA 4500 P (C)	<0.6	1.30
ORAGANIC BTEX			
Benzene	USEPA 8260C	<0.57	<0.57
Toluene		<0.88	587
Ethylbenzene		<0.88	<0.88
Xylene		<2.69	<2.69
BTEX		<5.02	587
TOTAL PETROLEUM HYDROCARBONS (TPHCWG)			
TPH C8-C38 ALIPHATIC	USEPA 8015D	<0.01	<0.01
TPH C6-C8 AROMATIC	USEPA 8260C	<0.01	<0.1
TPH C10-C22 AROMATIC	USEPA 8270D	<0.01	<0.1
POLYNUCLEAR AROMATIC HYDROCARBONS			
Naphthalene	USEPA 8270D	<0.05	<0.05
Acenaphthylene		<0.05	<0.05
Acenaphthene		<0.05	<0.05
Fluorene		<0.05	<0.05
Phenanthrene		<0.05	<0.05
Anthracene		<0.05	<0.05
Fluoranthene		<0.05	<0.05
Pyrene		<0.05	<0.05
Benz(a)anthracene		<0.05	<0.05
Chrysene		<0.05	<0.05
Benzo(b)fluoranthene		<0.05	<0.05
Benzo(k)fluoranthene		<0.05	<0.05
Benzo(a)pyrene		<0.05	<0.05
Indeno(1,2,3-cd)pyrene		<0.05	<0.05
Dibenz(a,h)anthracene		<0.05	<0.05
Benzo(g,h,i)perylene		<0.05	<0.05
Polynuclear Aromatid Hydrocarbons (PAHs)		<0.05	<0.05
POLYCHLORINATED BIPHENYLS			
3,3',4,4'-Tetrachlorobiphenyl	USEPA 8270D	<0.02	<0.02
3,4,4',5-Tetrachlorobiphenyl		<0.02	<0.02
2,3,3',4,4'-Pentachlorobiphenyl		<0.02	<0.02

ANALYSIS OF WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
2,3,4,4',5-Pentachlorobiphenyl		<0.02	<0.02
2,3',4,4',5-Pentachlorobiphenyl		<0.02	<0.02
2',3,4,4',5-Pentachlorobiphenyl		<0.02	<0.02
3,3',4,4',5-Pentachlorobiphenyl		<0.02	<0.02
2,3,3',4,4',5-Hexachlorobiphenyl		<0.02	<0.02
2,3,3',4,4',5'-Hexachlorobiphenyl		<0.02	<0.02
2,3',4,4',5,5'-Hexachlorobiphenyl		<0.02	<0.02
3,3',4,4',5,5'-Hexachlorobiphenyl		<0.02	<0.02
2,3,3',4,4',5,5'-Heptachlorobiphenyl		<0.02	<0.02
Total PCBs		<0.02	<0.02
SEMI-VOLATILE ORGANIC COMPOUNDS + TIC's			
N-Nitrosodimethylamine	USEPA 8270D	<0.01	<0.01
Pyridine		<0.01	<0.01
Phenol		<0.01	<0.01
Aniline		<0.01	<0.01
Bis(2-chhloroethyl) ether		<0.01	<0.01
2-Chlorophenol		<0.01	<0.01
1,3-Dichlorobenzene		<0.01	<0.01
1,4-Dichlorobenzene		<0.01	<0.01
Benzyl alcohol		<0.01	<0.01
2-Methylphenol		<0.01	<0.01
1,2-Dichlorobenzene		<0.01	<0.01
Bis(2-chloroisopropyl) ether		<0.01	<0.01
4-Methylphenol/3-Methylphenol		<0.01	<0.01
N-Nitrosodi-n-propylamine		<0.01	<0.01
Hexachloroethane		<0.01	<0.01
Nitrobenzene		<0.01	<0.01
Isophorone		<0.01	<0.01
2,4-Dimethylphenol		<0.01	<0.01
2-Nitrophenol		<0.01	<0.01
Bis(2-chloroethoxy)methane		<0.01	<0.01
2,4-Dichlorophenol		<0.01	<0.01
1,2,4-Trichlorobenzene		<0.01	<0.01
Naphthalene		<0.01	<0.01
4-Chloroaniline		<0.01	<0.01
Hexachlorobutadiene		<0.01	<0.01
4-Chloro-3-methylphenol		<0.01	<0.01
2-Methylnaphthalene		<0.01	<0.01
1-Methylnaphthalene		<0.01	<0.01
Hexachlorocyclopentadiene		<0.01	<0.01
2,4,6-Trichlorophenol		<0.01	<0.01
2,4,5-Trichlorophenol		<0.01	<0.01
2-Chloronaphthalene		<0.01	<0.01
2-Nitroaniline		<0.01	<0.01
1,4-Dinitrobenzene		<0.01	<0.01
Dimethyl phthalate		<0.01	<0.01
1,3-Dinitrobenzene		<0.01	<0.01
2,6-Dinitrotoluene		<0.01	<0.01
1,2-Dinitrobenzene		<0.01	<0.01
Acenaphthylene		<0.01	<0.01

ANALYSIS OF WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
3-Nitroaniline		<0.01	<0.01
Acenaphthene		<0.01	<0.01
2,4-Dinitrophenol		<0.01	<0.01
4-Nitrophenol		<0.01	<0.01
2,4-Dinitrotoluene		<0.01	<0.01
Dibenzofuran		<0.01	<0.01
2,3,5,6-Tetrachlorophenol		<0.01	<0.01
2,3,4,6-Tetrachlorophenol		<0.01	<0.01
Diethyl phthalate		<0.01	<0.01
4-Chlrophenyl phenyl ether		<0.01	<0.01
4-Nitroaniline		<0.01	<0.01
4,6-Dinitro-2-methylphenol		<0.01	<0.01
Fluorene		<0.01	<0.01
N-nitrosodiphenylamine (diphenylamine)		<0.01	<0.01
1,2-Diphenylhydrazine (as azobenzene)		<0.01	<0.01
4-Bromophenyl phenyl ether		<0.01	<0.01
Hexachlorobenzene		<0.01	<0.01
Pentachlorophenol		<0.01	<0.01
Phenanthrene		<0.01	<0.01
Anthracene		<0.01	<0.01
Carbazole		<0.01	<0.01
Di-n-butyl phthalate		<0.01	<0.01
Fluoranthene		<0.01	<0.01
Benzidine		<0.01	<0.01
3,3'-Dimethylbenzidine		<0.01	<0.01
Pyrene		<0.01	<0.01
Butyl benzyl phthalate		<0.01	<0.01
Bis(2-ethylhexyl) adipate		<0.01	<0.01
Bis(2-ethylhexyl) phthalate		<0.01	<0.01
3,3'-Dichlorobenzidine		<0.01	<0.01
Benz(a)anthracene		<0.01	<0.01
Chrysene		<0.01	<0.01
Di-n-octyl phthalate		<0.01	<0.01
Benzo(b)fluoranthene		<0.01	<0.01
Benzo(k)fluoranthene		<0.01	<0.01
Benzo(a)pyrene		<0.01	<0.01
Indeno(1,2,3-cd)pyrene		<0.01	<0.01
Dibenz(a,h)anthracene		<0.01	<0.01
Benzo(g,hi)perylene		<0.01	<0.01
TIC's	NIST Library Search	ND	ND
VOLATILE ORGANIC COMPOUNDS (VOCs) + TIC's			
Dichlorodifluoromethane[1]	USEPA 8260C	<0.92	<0.92
Chloromethane[1]		<0.84	<0.84
Vinyl chloride[1]		<3.13	<3.13
Bromomethane[1]		<2.08	<2.08
Chloroethane[1]		<0.63	<0.63
Trichlorofluoromethane[1]		<0.58	<0.58
Acetonitrile[1]		<1.52	<1.52
Acetone[1]		<3.23	<3.23

ANALYSIS OF WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Diethyl ether[1]		<0.92	<0.92
1,1-Dichloroethene[1]		<0.96	<0.96
Iodomethane[1]		<0.71	<0.71
Propionitrile[1]		<0.35	<0.35
Acrylonitrile[1]		<1.27	<1.27
Methylene chloride[1]		<1.90	<1.90
1,1,2-Trichlorotrifluoroethane (CFC-113)[1]		<1.01	<1.01
Allyl chloride[1]		<0.93	<0.93
Carbon disulfide[1]		<1.79	<1.79
trans-1,2-Dichloroethene[1]		<0.88	<0.88
MTBE[1]		<1.44	<1.44
1,1-Dichloroethane[1]		<0.69	<0.69
Chloroprene[1]		<1.21	<1.21
2-Butanone (MEK)[1]		<3.84	<3.84
Methacrylonitrile[1]		<1.09	<1.09
cis-1,2-Dichloroethene[1]		<0.56	<0.56
Bromochloromethane[1]		<1.02	<1.02
Chloroform[1]		<1.18	<1.18
Methyl acrylate[1]		<0.66	<0.66
2,2-Dichloropropane[1]		<1.41	<1.41
Tetrahydrofuran[1]		<1.70	<1.70
1,2-Dichlorethane[1]		<0.46	<0.46
1,1,1-Trichloroethane[1]		<0.95	<0.95
1,1-Dichloropropene[1]		<1.24	<1.24
Carbon Tetrachloride[1]		<0.52	<0.52
Benzene[1]		<0.57	<0.57
Dibromomethane[1]		<0.51	<0.51
1,2-Dichloropropane[1]		<0.64	<0.64
Trichloroethene[1]		<0.89	<0.89
Bromodichloromethane[1]		<1.06	<1.06
Methyl methacrylate[1]		<1.31	<1.31
cis-1,3-Dichloropropene[1]		<1.17	<1.17
4-Methyl-2-pentanone (MIBK)[1]		<3.30	<3.30
trans-1,3-Dichloropropene[1]		<1.17	<1.17
1,1,2-Trichloroethane[1]		<0.92	<0.92
Toluene[1]		<0.88	587
1,3-Dichloropropane[1]		<0.77	<0.77
Ethyl methacrylate[1]		<1.07	<1.07
2-Hexanone[1]		<2.19	<2.19
Dibromochloromethane[1]		<0.82	<0.82
1,2-Dibromoethane-EDB[1]		<0.63	<0.63
Tetrachloroethene[1]		<0.63	<0.63
1,1,1,2-Tetrachloroethane[1]		<1.04	<1.04
Chlorobenzene[1]		<0.60	<0.60
Ethylbenzene[1]		<0.88	<0.88
m & p- Xylene[1]		<1.90	<1.90
Bromoform[1]		<0.75	<0.75
cis-1,4-Dichloro-2-butene[1]		<1.11	<1.11
Styrene[1]		<0.83	<0.83
1,1,2,2-Tetrachloroethane[1]		<0.91	<0.91
o-Xylene[1]		<0.79	<0.79

ANALYSIS OF WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
1,2,3-Trichloropropane[1]		<1.20	<1.20
trans-1,4-Dichloro-2-butene[1]		<1.52	<1.52
Isopropylbenzene[1]		<0.96	<0.96
Bromobenzene[1]		<1.19	<1.19
n-Propylbenzene[1]		<1.26	<1.26
2-Chlorotoluene[1]		<1.29	<1.29
4-Chlorotoluene[1]		<1.22	<1.22
1,3,5-Trimethylbenzene[1]		<1.08	<1.08
Pentachloroethane[1]		<1.18	<1.18
tert-Butylbenzene[1]		<1.06	<1.06
1,2,4-Trimethylbenzene[1]		<1.05	<1.05
sec-Butylbenzene[1]		<0.97	<0.97
1,3-Dichlorobenzene[1]		<0.94	<0.94
1,4-Dichlorobenzene[1]		<1.25	<1.25
p-Isopropyltoluene (p-Cymene)[1]		<1.50	<1.50
1,2-Dichlorbenzene[1]		<0.93	<0.93
n-Butylbenzene[1]		<1.88	<1.88
1,2-Dibromo-3-Chloropropane[1]		<2.50	<2.50
1,2,4-Trichlorobenzene[1]		<1.78	<1.78
Naphthalene[1]		<3.92	<3.92
Hexachlorobutadiene[1]		<1.40	<1.40
1,2,3-Trichlorobenzene[1]		<0.93	<0.93
TIC's	NIST Library Search	ND	ND

METALS IN SOIL			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Arsenic As	APHA3120B	0.555	1.171
Barium Ba		25.79	73.59
Beryllium Be		<0.01	<0.01
Boron B		11.11	43.97
Cadmium Cd		0.326	0.468
Chromium (Total) Cr		21.16	27.30
Copper Cu		3.297	5.018
Iron (Total) Fe		4671	5632
Lead Pb		1.457	3.326
Manganese Mn		140.0	221.0
Molybdenum Mo		0.177	0.406
Nickel Ni		14.34	36.98
Selenium Se		<0.10	0.10
Vanadium V		11.02	15.86
Zinc Zn		10.84	14.76
Mercury Hg		<0.003	0.096
pH*	BS1377 P.3 CL9	8.4	9.7

METALS IN WATER			
Test Parameter	Test Method	Test Results	
		Min Value	Max Value
Arsenic* As	APHA3120B	<0.12	<0.12
Barium* Ba		<0.12	<0.12

METALS IN WATER				
Test Parameter		Test Method	Test Results	
			Min Value	Max Value
Beryllium*	Be		<0.01	<0.01
Boron*	B		2.432	3.394
Cadmium*	Cd		<0.02	<0.02
Calcium*	Ca		235.8	496.2
Chromium (Total)*	Cr		<0.01	<0.01
Copper*	Cu		<0.01	<0.01
Iron (Total)*	Fe		0.006	0.346
Lead*	Pb		<0.01	<0.01
Magnesium	Mg		493.5	1566
Manganese*	Mn		<0.02	0.622
Molybdenum	Mo		<0.01	0.015
Nickel *	Ni		<0.02	0.02
Potassium	K		234.9	481.0
Selenium*	Se		<0.10	<0.10
Sodium	Na		594.8	13700
Vanadium	V		<0.01	<0.01
Zinc*	Zn		0.006	0.02
Mercury	Hg		<0.003	0.003
Sulphate*	SO_4	BS1377 P.3 CL 5	1853	3147
Chloride*	Cl	BS1377 P.3 CL 7	8799	23349
pH*		BS1377 P.3 CL9	7.2	7.8
Carbonates		ASTM D 1067-11	Nil	Nil
Bicarbonates		ASTM D 1067-11	507	1776
Total Alkalinity as $CaCO_3$		APHA	416	1455
Total Hardness as $CaCO_3$			2563	7685
ON SITE TEST				
Test Parameter		Test Method	Test Results	
			Min Value	Max Value
pH*		BS1377 P.3:1990	7.06	7.67
Conductivity			30.72	64.59
TDS			15.37	32.32
Salinity			18.95	43.58

6.0 RESULTS OF THE CONTAMINATION ASSESSMENT

Hamiriyah Power Plant Project is being developed in an already demarcated area in which various industrial activities are going on. The area is also already exposed to pumping and storage of the gas and petroleum products. **Hamiriyah** being a free port the area is previously exposed to the various materials which pass through this area. The analysis of the samples both soil and ground water will therefore have a component of the various elements and compounds which pass through this area. This is particularly true for hydrocarbon products and as well as for the volatiles as gas, which is transported through this area from oil field nearby.

Geologically, the area is a flat terrain very near to the sea. It does not have any drainage lines which cancel the possibility of any elements being carried in to the area from the surroundings by drainage.

Being a sea shore, the area is covered by sand. Regionally the area is covered by recent marine and wind born superficial deposits. The constant winnowing of the superficial sediment increases the possibility of concentration of the heavy metals in the soil. This may diminish as the surrounding area is built up

In the light of the above setting, both geological and manmade, the results of both the ground water and the soil are evaluated. These results are also compared against the natural abundance of elements on the surface of the earth. This gives a view whether presence of these elements is abnormal.

6.1 Analysis of the metals in soil

The sample analysis was analyzed and comparison made with the crustal abundance of the various metals analyzed. It has been found that values of all the metals analyzed were found in lesser than the crustal abundance limits for the geological setting. Therefore, it implies that there is nothing abnormal in the natural setting which needs immediate attention.

The analysis of the metals was also compared with the regional survey limits set by various organization for health point of view. In this the limits set for carcinogenic studies were taken. The values are compared with the regional survey level standards of Dutch and USA for industrial soil.

It has been found that

- All the analysis fall far below the limits set for raising concerns of health.
- All the levels are far below the remediation values.
- It may also be noted that all the levels are below the Residential soil levels also.
- The analysis also reveals that there has been no heavy mineral concentration in the area due to the winnowing action of winds and sea waves.
- The analysis decipher that the matals in the soil is well below the limits of safety and therefore environmentally safe therefore no intervention is needed.

The results and corresponding values against which they are compared are presented in **Appendix -E.**

6.2 Analysis of the metals in Ground water

In the light of the physiography and general geology of the area and the human activity, the results of the ground water are evaluated. World over, the norms for ground water are different and are mostly determined by local geology. The concentration of the various elements is depended in their availability in the aquifer from where the ground water is extracted. As such there are no universal parameters for ground water. That is why absolute safe parameters, for all the elements and compounds quoted in the analysis, are not available. The area being very near to sea, it is assumed that there will be incursion of sea water.

The parameters, fixed by various agencies, are dependent on the usage of the water. Most of the parameters quoted in this study are the parameters fixed for the usage of ground water for drinking purpose. It is also to be noted that the safe limits of metals quoted in the literature for the intake of various metals is as part of diet (which includes water also) and as per kg of the body weight.

To get a general view, on the elements analyzed, these elements are compared with data on the crustal abundance of such elements. From the comparison it is seen that the metals present in the ground water is far less than the crustal abundance. This indicates that the aquifer is not enriched in any of these elements**. Therefore, it implies that there is nothing abnormal in the natural setting which needs immediate attention**.

Comparisons with standards of various countries and organizations.

The analyses of the metals are also compared with the regional survey limits set by various organizations from human health point of view.

In this study two values of Dutch studies are quoted these values are target values that is the safe values another value is remediation values that is the values at which it is necessary to take a corrective measure to bring the values to target level.

The USA values quoted are the values safe for carcinogenic point of view.

The analysis of the bore holes data are compared with the available data from Indian, Canada and WHO studies also, to ascertain if the data from analysis deviates from any well-known International Norm.

The studies of the analysis following inferences are made;

- It has been found that majority of analysis fall far below the limits set for raising concerns of health.
- All the levels are far below the remediation values therefore no intervention is needed.
- The elements analyzed are also below the target level (that is the optimal levels where no health hazard is indicated) as per Dutch and USA standards.
- The values for non-metals and compounds are not universally prescribed. This is because these are more local and highly dependent on local geological, physiographic and climatic condition.
- The limits of chloride, sulphate, bicarbonates total alkalinity, hardness, carbonates, bi-carbonates are not defined universally.
- It is seen that Na, Chloride, sulphate, total alkalinity, total hardness and bi-carbonates are on higher side. This is attributed to the nature of the aquifer being located within recent marine sediments and in close proximity of the sea.
- All these elements are treatable if the water is to be used for drinking purposes therefore do not pose any problem.
- The water can be treated after post extraction.
- However, if the water is to be used for construction purposes the presence of chlorine, sulphate will have a bearing. For safe construction activity Sulphate upto 4000ppm is used but safe limit is around 1500ppm. The safe limit for chlorite is 2000ppm.

The safe limits for metals as per different standards are presented in **Appendix -E**

6.3 Analysis of the organic compounds in soil

Hydrocarbons are not naturally occurring substances in the soil except in the area where there are petroleum shows, therefore there is no natural level with which these analysis can be compared. Most of the organic Hydrocarbon compounds are produced from hydrocarbons or

synthesized in laboratories or factories therefore in whatever percentage they are present they indicates a polluted environment. Constant research takes place to find the safe limits of these compounds.

There are huge number of organic compounds which have been synthesized and mostly used for industries and medicine. There are no universal norms/ survey limits set about these compounds. Most of the limits set by various countries group large number of compound into a group and prescribe a safe limit for a group of compounds.

In the analysis provided it has been found that the only standards available for most of the compounds analyzed are from the USA. Therefore, all these analysis have been compared with the survey levels and safety limits prescribed by various organizations of USA and adopted by the country.

There are large number of compounds for which no limit has been prescribed. Where no limits are prescribed it is found the limits have been set for direct intake by humans or fish etc. As soil is not taken as direct intake by humans etc , therefore these parameter do not apply in the present studies. It is also found that many of these chemicals are found to be non carcinogenic therefore no safe levels have been prescribed.

It is also found that many of these compounds are not stable for long time.

The analysis of the data reveals that the analyzed results are far below the known safe limits, thus area is not polluted **and there is no cause for further action.**

The analytic result of soil and the safe limits are presented in **Appendix E**.

6.4 Analysis of the organic compounds in ground water

Hydrocarbons are not naturally occurring substances in Ground water except in the area where there are petroleum shows surface, therefore there is no natural level with which these analysis can be compared, Most of the organic Hydrocarbon compounds are produced from hydrocarbons or synthesized in laboratories or factories therefore in whatever percentage they are present they indicate a polluted environment. Constant research takes place to find the safe limits of these compounds.

It is found that no country or study has set standards for the hydrocarbons in ground water. This itself clearly indicates that these compounds are not expected in the nature therefore their presence in whatever amount in groundwater amounts to be a pollutant. Secondly most of these compounds are manufactured therefore their presence in nature hence in ground water is not expected. However safety limits are set for Tap water as human beings may come in contact while workings in the environment were these compounds are manufactured.

In present case we have compared the analytic results with the **standards of tap wate**r as ground water may be used for drinking purposes and also as this area is near the port were petroleum and its products are produced or transported.

In the analysis provided it has been found that the only standards for tape water are available from the USA. All other countries have mostly grouped these compounds and provided standards for the group. In such case it has been found that the standards recommended by USA are more useful for comparisons.

There are large number of compounds for which no limit has been prescribed, where no limits are prescribed it is found the limit of intake directly has been prescribed per kg of human or animal weight. Therefore those values have no relevance where in present care.. It is also found that many of these chemicals are found to be non carcinogenic therefore no safe levels have been prescribed.

It is also found that many of these compounds are not stable for long time therefore cannot exist in soil therefore no limits can have been set.

The analysis of the data reveals that the analyzed results are far below the known safe limits for tap water therefore there is no cause for further action.

The analysis reveals that the area has not been polluted by hydrocarbon

The analyses of the results and the safe limits are presented in **Appendix- E.**

7.0 IMPORTANT NOTES

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8.0 SOFT COPY

Electronic copy of the contents of this report & appendices is attached to this report.

APPENDIX A

SITE PLAN


TP-16E
TP-22E
TP16E-Stock Pile
TP19E-Stock Pile
TP-15E
TP-21E
TP15E-Stock Pile
TP18E-Stock Pile
TP17E-Stock Pile
TP-20E
TP-14E
TP-13E
TP-12E
BH-03
BH-3E
BH-1E
TP-02E
BH-01
TP-04E
TP-06E
TP-08E
TP-10E
TP-03E
TP-07E
TP-09E
TP-01E
TP-05E
BH-02
BH-2E
BH-4E
BH-04
BH-05
BH-5E
© 2018 Google
Image © 2018 DigitalGlobe
Google earth
2005
Imagery Date: 5/4/2018 40 R 347149.43 m E 2816982.27 m N elev 6 m eye alt 1.33 km


TP-11E
TP-09E
TP-10E
BH-02
TP-08E
TP-07E
TP-05E
BH-1E
TP-06E
BH-01
BH-04
BH-4E
TP-03E
TP-04E
TP-01E
BH-03
BH-3E
TP-02E
TP-16E
TP16E-Stock Pile
TP-12E
TP-14E
TP-15E
BH-05
BH-5E
TP17E-Stock Pile
TP18E-Stock Pile
TP19E-Stock Pile
TP-20E
TP-21E
TP-22E
TP-13E
© 2018 Google
Image © 2018 DigitalGlobe
Google earth
2005
Imagery Date: 5/4/2018 40 R 347150.22 m E 2817132.32 m N elev 4 m eye alt 1.18 km

APPENDIX B

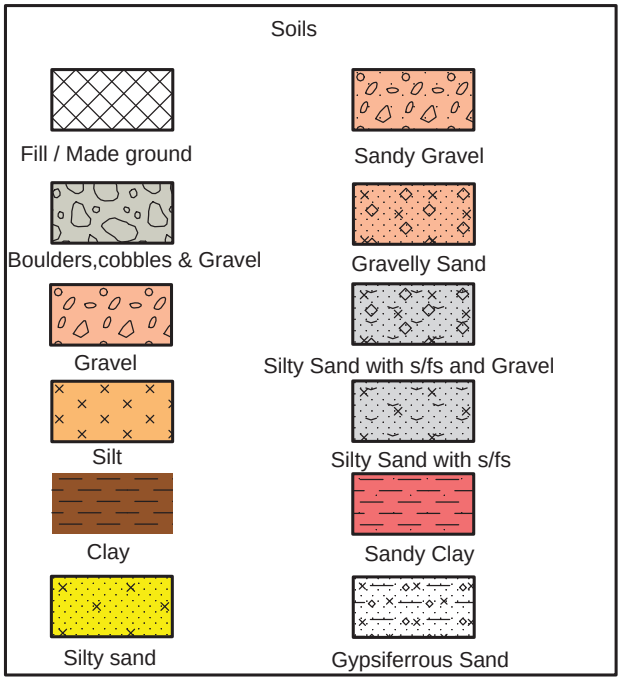
LOGS OF BORING & LOGS OF TRIAL PIT

APPENDIX B1

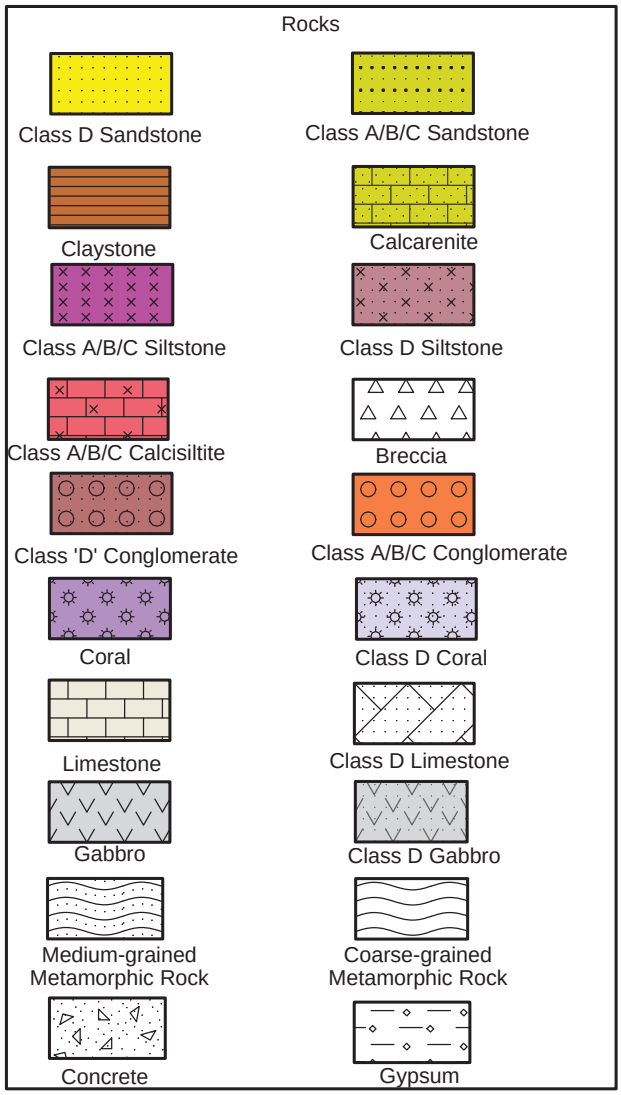
LOGS OF BORING

LEGEND TO BOREHOLE LOGS

Soils



Rocks



RELATIVE DENSITY OF GRANULAR SOILS

(BS 5930 : 1999-A2:2010)

SPT N Value (Blows/300mm)	Relative Density	Angle of Internal Friction *
0 - 4	Very loose	< 30°
4 - 10	Loose	30° - 35°
10 - 30	Medium dense	35° - 40°
30 - 50	Dense	40° - 45°
> 50	Very dense	> 45°

* After Meyerhof

CONSISTENCY OF COHESIVE SOILS

(BS 5930 : 1999-A2:2010)

Consistency	Undrained Shear Strength (kN/m²)
Very Soft	< 20
Soft	20 - 40
Firm	40 - 75
Stiff	75 - 150
Very Stiff	150 - 300
Hard	> 300

ROCK STRENGTH CLASSIFICATION

(BS 5930 : 1999-A2:2010)

Unconfined Compressive Strength (MN/m²)	Description
0.6 - 1.0	Extremely Weak
1 - 5	Very Weak
5 - 25	Weak
25 - 50	Medium Strong
50 - 100	Strong
100 - 200	Very Strong
> 200	Extremely Strong

APPROACH 4 CLASSIFICATION INCORPORATING MATERIAL AND MASS FEATURES (BS 5930 : 1999-A2:2010)		
Class	Classifier	Typical characteristics
A	Unweathered	Original strength, colour, fracture spacing
B	Partially weathered	Slightly reduced strength, slightly closer fracture spacing, weathering penetrating in from fractures, brown oxidation
C	Distinctly weathered	Further weakened, much closer fracture spacing grey reduction
D	Destructured	Greatly weakened, mottled, ordered lithorelics in matrix becoming weakened and disordered, bedding disturbed
E	Residual or reworked	Matrix with occasional altered random or 'apparent' lithorelics, beddding destroyed. Classed as reworked when foreign inclusions are present as a result of transportation.

Borehole Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Borehole No. BH-01** Sheet 1 of 1	ACES

Total Depth (m): 10 Ground Level (m): 4.124 Coordinates: N= 2,817,009.77 E= 346,967.64	Drilling Method: ROTARY DRILLING Boring Started: 06/06/18 Boring Completed: 06/06/18 Rig: RD-14 Driller: Adem	Drilling Medium: Polymer Boring Dia. (mm): 140/125 Core Dia. (mm): 85 Casing Dia. (mm): 136 Casing Depth (m): 10.00 Water Depth (m): 2.53

Scale (m)	Samples: Type and Number	Samples: Depth (m)	SPT Records: Field Records 0-15 (cm)	15-30 (cm)	30-45 (cm)	N Blows	Core Recovery: TCR (%)	SCR (%)	RQD (%)	UCS (MPa)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 0.5	-	-	-	-					**Dense**. brown, silty, fine to medium SAND.	(0.50) 0.5	3.62	
	SPT1	0.5 - 0.95	5	6	6	12					**Medium dense to loose**. brown, silty, fine to medium SAND.	(1.45)		
2	SPT2	1.5 - 1.95	2	2	2	4						1.95	2.17	
											ROLLING. [Brown silty, fine to medium SAND]			
3														
4														
5														
6	R1	2 - 10	-	-	-	-						(8.05)		
7														
8														
9														
											END OF BORING.	10	-5.88	

Undisturbed Sample Key:	Disturbed Sample Key:	Abbreviations:	Remarks:
CS: Core Sample	P:Percussion	Ground Water Table	• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)
DB: Drive Barrel	SPT:Standard Penetration Test	TCR: Total Core Recovery	• Ground water table was encountered at 2.53m depth, i.e. R.L: +1.594m SHMD.
SH: Shelby Tube	AU:Auger	SCR: Solid Core Recovery	• Strength assessment of rock is based on UCS results.
		RQD: Rock Quality Designation	• Rock core description is based on BS 5930 : 2015.
		UCS:Unconfined Comp. Strength	
		NI: Non Intact Core	

Logged By: Jameel

Checked By: Engr. Savithri

Borehole Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Borehole No. BH-02** Sheet 1 of 1	ACES

Total Depth (m): 10 Ground Level (m): 4.191 Coordinates: N= 2,816,883.04 E= 346,750.83	Drilling Method: ROTARY DRILLING Boring Started: 03/06/18 Boring Completed: 03/06/18 Rig: RD-14 Driller: Adem	Drilling Medium: Polymer Boring Dia. (mm): 140/125 Core Dia. (mm): 85 Casing Dia. (mm): 136 Casing Depth (m): 10.00 Water Depth (m): 2.43

Scale (m)	Samples: Type and Number	Samples: Depth (m)	SPT Records: Field Records 0-15 (cm)	15-30 (cm)	30-45 (cm)	N Blows	Core Recovery: TCR (%)	SCR (%)	RQD (%)	UCS (MPa)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	-	-	-	-					Brown, silty, slightly gravelly, fine to medium SAND. Gravel sized fragments of basic rock.	(0.50) 0.5	3.69	
1	SPT1	0.5 - 0.95	15	19	22	41					**Dense**. brown, silty, slightly gravelly, fine to medium SAND. Gravel sized fragments of basic rock.	(1.00) 1.5	2.69	
2	SPT2	1.5 - 1.95	13	24	24	48					**Dense**, brown, silty, fine to medium SAND.	(0.45) 1.95	2.24	
											ROLLING. [Brown silty, fine to medium SAND]			
3														
4														
5														
6	R1	2 - 10	-	-	-	-						(8.05)		
7														
8														
9														
											END OF BORING.	10	-5.81	

Undisturbed Sample Key:	Disturbed Sample Key:	Abbreviations:	Remarks:
CS: Core Sample	P:Percussion	Ground Water Table	• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)
DB: Drive Barrel	SPT:Standard Penetration Test	TCR: Total Core Recovery	• Ground water table was encountered at 2.43m depth, i.e. R.L: +1.761m SHMD.
SH: Shelby Tube	AU:Auger	SCR: Solid Core Recovery	• Strength assessment of rock is based on UCS results.
		RQD: Rock Quality Designation	• Rock core description is based on BS 5930 : 2015.
		UCS:Unconfined Comp. Strength	
		NI: Non Intact Core	

Logged By: Jameel

Checked By: Engr. Savithri

Borehole Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Borehole No. BH-03** Sheet 1 of 1	ACES

Total Depth (m): 10 Ground Level (m): 4.532 Coordinates: N= 2,816,929.52 E= 347,121.22	Drilling Method: ROTARY DRILLING Boring Started: 03/06/18 Boring Completed: 03/06/18 Rig: RD-14 Driller: Adem	Drilling Medium: Polymer Boring Dia. (mm): 140/125 Core Dia. (mm): 85 Casing Dia. (mm): 136 Casing Depth (m): 10.00 Water Depth (m): 2.56

Scale (m)	Samples: Type and Number	Samples: Depth (m)	SPT Records: Field Records 0-15 (cm)	15-30 (cm)	30-45 (cm)	N Blows	Core Recovery: TCR (%)	SCR (%)	RQD (%)	UCS (MPa)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	-	-	-	-					Brown, silty, fine to medium SAND.	(0.50) 0.5	4.03	
1	SPT1	0.5 - 0.95	12	17	20	37					**Dense**, brown, silty, fine to medium SAND.	(1.45)		
2	SPT2	1.5 - 1.95	20	30	20	50						1.95	2.58	
											ROLLING. [Brown silty, fine to medium SAND]			
3														
4														
5														
6	R1	2 - 10	-	-	-	-						(8.05)		
7														
8														
9														
											END OF BORING.	10	-5.47	

Undisturbed Sample Key:	Disturbed Sample Key:	Abbreviations:	Remarks:
CS: Core Sample	P:Percussion	Ground Water Table	• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)
DB: Drive Barrel	SPT:Standard Penetration Test	TCR: Total Core Recovery	• Ground water table was encountered at 2.56m depth, i.e. R.L: +1.972m SHMD.
SH: Shelby Tube	AU:Auger	SCR: Solid Core Recovery	• Strength assessment of rock is based on UCS results.
		RQD: Rock Quality Designation	• Rock core description is based on BS 5930 : 2015.
		UCS:Unconfined Comp. Strength	
		NI: Non Intact Core	

Logged By: Jameel

Checked By: Engr. Savithri

Borehole Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Borehole No.** **BH-04** Sheet 1 of 1	ACES

Total Depth (m): 10 Ground Level (m): 4.312 Coordinates: N= 2,816,754.55 E= 346,878.01	Drilling Method: ROTARY DRILLING Boring Started: 04/06/18 Boring Completed: 04/06/18 Rig: RD-14 Driller: Adem	Drilling Medium: Polymer Boring Dia. (mm): 140/125 Core Dia. (mm): 85 Casing Dia. (mm): 136 Casing Depth (m): 10.00 Water Depth (m): 2.34

Scale (m)	Samples: Type and Number	Samples: Depth (m)	SPT Records: Field Records 0-15 (cm)	15-30 (cm)	30-45 (cm)	N Blows	Core Recovery: TCR (%)	SCR (%)	RQD (%)	UCS (MPa)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
0	DB1	0 - 0.5	-	-	-	-					Brown, silty, fine to medium SAND.	(0.50) 0.5	3.81	
1	SPT1	0.5 - 0.95	14	19	21	40					**Dense**, brown, silty, fine to medium SAND.	(1.00) 1.5	2.81	
2	SPT2	1.5 - 1.92	21	31	19/12.5	>50					**Very dense**, brown, silty, fine to medium SAND.	(0.45) 1.95	2.36	
3											ROLLING. [Brown silty, fine to medium SAND]			
4														
5														
6	R1	2 - 10	-	-	-	-						(8.05)		
7														
8														
9														
											END OF BORING.	10	-5.69	

Undisturbed Sample Key:	Disturbed Sample Key:	Abbreviations:	Remarks:
CS: Core Sample	P:Percussion	Ground Water Table	• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)
DB: Drive Barrel	SPT:Standard Penetration Test	TCR: Total Core Recovery	• Ground water table was encountered at 2.34m depth, i.e. R.L: +1.972m SHMD.
SH: Shelby Tube	AU:Auger	SCR: Solid Core Recovery	• Strength assessment of rock is based on UCS results.
		RQD: Rock Quality Designation	• Rock core description is based on BS 5930 : 2015.
		UCS:Unconfined Comp. Strength	
		NI: Non Intact Core	

Logged By: Jameel

Checked By: Engr. Savithri

Borehole Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Borehole No. BH-05** Sheet 1 of 1	ACES

Total Depth (m): 10 Ground Level (m): 4.632 Coordinates: N= 2,816,667.85 E= 347,034.11	Drilling Method: ROTARY DRILLING Boring Started: 04/06/18 Boring Completed: 04/06/18 Rig: RD-14 Driller: Adem	Drilling Medium: Polymer Boring Dia. (mm): 140/125 Core Dia. (mm): 85 Casing Dia. (mm): 136 Casing Depth (m): 10.00 Water Depth (m): 2.51

Scale (m)	Samples: Type and Number	Samples: Depth (m)	SPT Records: Field Records 0-15 (cm)	15-30 (cm)	30-45 (cm)	N Blows	Core Recovery: TCR (%)	SCR (%)	RQD (%)	UCS (MPa)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 0.5	-	-	-	-					Brown, silty, slightly gravelly, slightly shelly, fine to medium SAND.	(0.50) 0.5	4.13	
	SPT1	0.5 - 0.95	13	18	17	35					**Dense to Medium dense**, brown, silty, fine to medium SAND.	(1.45)		
2	SPT2	1.5 - 1.95	2	5	12	17						1.95	2.68	
3											ROLLING. [Brown silty, fine to medium SAND]			
4														
5														
6	R1	2 - 10	-	-	-	-						(8.05)		
7														
8														
9											END OF BORING.	10	-5.37	

Undisturbed Sample Key:	Disturbed Sample Key:	Abbreviations:	Remarks:
CS: Core Sample	P:Percussion	Ground Water Table	• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)
DB: Drive Barrel	SPT:Standard Penetration Test	TCR: Total Core Recovery	• Ground water table was encountered at 2.51m depth, i.e. R.L: +2.122m SHMD.
SH: Shelby Tube	AU:Auger	SCR: Solid Core Recovery	• Strength assessment of rock is based on UCS results.
		RQD: Rock Quality Designation	• Rock core description is based on BS 5930 : 2015.
		UCS:Unconfined Comp. Strength	
		NI: Non Intact Core	

Logged By: Jameel

Checked By: Engr. Savithri

APPENDIX B2

LOGS OF TRIAL PIT

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-01E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 4.532 Coordinates: N= 2,816,742.74 E= 347,016.17	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.53	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.53	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-02E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.712 Coordinates: N= 2,816,904.11 E= 347,112.77	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.71	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.71	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-03E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.100 Coordinates: N= 2,816,818.54 E= 346,953.31	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.10	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.10	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-04E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 4.201 Coordinates: N= 2,816,898.69 E= 347,001.59	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.20	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.20	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-05E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.325 Coordinates: N= 2,816,815.45 E= 346,861.19	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.33	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.33	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-06E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 4.151 Coordinates: N= 2,816,939.98 E= 346,932.38	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.15	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.15	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-07E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 3.432 Coordinates: N= 2,816,876.66 E= 346,826.24	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	2.43	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	0.43	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-08E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 3.480 Coordinates: N= 2,816,920.13 E= 346,851.86	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown,silty, fine to medium SAND.	(1) 1	2.48	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	0.48	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-09E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.241 Coordinates: N= 2,816,918.90 E= 346,760.15	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.24	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.24	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-10E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 3.352 Coordinates: N= 2,816,960.06 E= 346,785.31	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	2.35	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	0.35	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-11E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.311 Coordinates: N= 2,816,942.49 E= 346,721.62	Excavation Method: MECHANICAL Excavation Date: 04/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.31	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.31	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-12E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.435 Coordinates: N= 2,816,956.49 E= 347,199.14	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.44	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.44	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-13E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 4.481 Coordinates: N= 2,816,906.34 E= 347,334.60	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.48	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.48	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-14E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 5.040 Coordinates: N= 2,817,097.95 E= 347,261.03	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	4.04	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	2.04	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-15 Stock Pile** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 11.789 Coordinates: N= 2,817,183.49 E= 347,313.48	Excavation Method: MECHANICAL Excavation Date: 06/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		0.5	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	Brown, silty, fine to medium SAND.	(0.5)		
				0.5	11.29	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-15E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 44.778 Coordinates: N= 2,817,184.16 E= 347,312.73	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	43.78	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	41.78	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-16 Stock Pile** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 6.430 Coordinates: N= 2,817,287.33 E= 347,379.71	Excavation Method: MECHANICAL Excavation Date: 06/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		0.5	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	Brown, silty, fine to medium SAND.	(0.5)		
				0.5	5.93	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-16E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 4.725 Coordinates: N= 2,817,304.15 E= 347,384.89	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1)		
1				1	3.73	
	DB2	1 - 2	Brown, silty, fine SAND.			
2				(2)		
	DB3	2 - 3				
3				3	1.73	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-17 Stock Pile** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 5.448 Coordinates: N= 2,817,079.47 E= 347,290.17	Excavation Method: MECHANICAL Excavation Date: 06/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		0.5	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	Brown, silty, fine to medium SAND.	(0.5)		
				0.5	4.95	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-18 Stock Pile** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 11.503 Coordinates: N= 2,817,160.75 E= 347,351.32	Excavation Method: MECHANICAL Excavation Date: 06/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		0.5	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	Brown, silty, fine to medium SAND.	(0.5)		
				0.5	11.00	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-19 Stock Pile** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 16.282 Coordinates: N= 2,817,252.61 E= 347,438.08	Excavation Method: MECHANICAL Excavation Date: 06/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		0.5	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
	DB1	0 - 0.5	Brown, silty, fine to medium SAND.	(0.5)		
				0.5	15.78	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-20E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 4.225 Coordinates: N= 2,817,048.54 E= 347,340.61	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	3.23	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	1.23	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-21E** Sheet 1 of 1	ACES

		Size of Test Pit		
Ground Level (m): 44.581 Coordinates: N= 2,817,135.44 E= 347,392.31	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	43.58	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	41.58	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri

Test Pit Log

Project: Proposed SEWA Hamriyah Power Plant Project Ref. No.: SD18000031 Location: Sharjah Client: M/S. TECNICAS REUNIDAS	**Test Pit No.** **TP-22E** Sheet 1 of 1	

		Size of Test Pit		
Ground Level (m): 16.302 Coordinates: N= 2,817,243.15 E= 347,458.83	Excavation Method: MECHANICAL Excavation Date: 05/06/18 Water Depth (m): NE	Depth (m)	Length (m)	Width (m)
		3	1.50	1.50

Scale (m)	Samples: Type and Number	Samples: Depth (m)	Description of Strata	Depth (Thickness) (m)	Reduced Level (m)	Legend
1	DB1	0 - 1	Brown, silty, fine to medium SAND.	(1) 1	15.30	
2	DB2	1 - 2	Brown, silty, fine SAND.	(2)		
3	DB3	2 - 3		3	13.30	

END OF TRIAL PIT.

Remarks:

* The samples were described in accordance with BS 5930 : 2015.
• Ground level are related to Sharjah Halcrow Municipality Datum. (SHMD)

Sample Key:

DB: (Bulk Sample)

Abbreviations:

Ground Water Table NE : Not Encountered

Logged By: Jameel

Checked By: Engr. Savithri