GEOTechnologies FZCO

FOR GEOPHYSICAL AND GEOLOGICAL STUDIES AND SERVICES

Client: AL BATEEN ENGINEERING CONSULTANCY

GEOPHYSICAL STUDY FOR THE PROPOSED RESIDENTIAL VILLA AT PLOT 51, SECTOR MZ1 MADINAT ZAYED, ABU DHABI - U.A.E.

Job No.: 001-21_MZ1 51

Date of Submission: 15th march, 2021.

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EXECUTIVE SUMMARY

The undersigned Company was commissioned to carry out a Geophysical Survey on behalf of the Client **Al Bateen Engineering Consultancy** for the project **"Construction of Villa for Mr. Tousif Abdel Khaliq Mohammed Noor Al Khouri"** at Plot no. **51**, Sector **MZ1** in Madinat Zayed, Abu Dhabi - U.A.E."

Since all this work has to be finalized according to the prescribed rules and regulations of Abu Dhabi Municipality, so all the pre-project and post project planning was done considering these regulations provided by the Municipality.

For soil characterization and delineation of prevailing subsurface geological conditions, both geotechnical and geophysical studies were performed as per Municipality and consultant's guidelines.

Topographic survey was carried out to establish on ground location of project boundaries and geographic reference of the investigations, specially Boreholes for geotechnical studies and seismic lines starting ending for geophysical survey.

The Field Engineers along with the technical staff acquired data at site on 24th February 2021 and seismic data was processed using SurfSeis 6.6 software.

The geophysical survey MASW containing site visit plans, methodology for site acquisition, processing of geophysical results. Proposal of Calibration Borehole after identified seismic anomalies was submitted to the Client.

The Technical Report showing the final results obtained after the correlation of geophysical results with Borehole with redactions leading to the conclusions and recommendations.

1.0 INTRODUCTION

The Surveyed Plot was held on 24th February 2021 and the details of acquisition method, survey design, processing, interpretation and post interpretations finding will be presented in the following paragraphs.

Appendix A presents the site map and the geophysical survey location, Appendix B show the results obtained from the investigation presented in graphical and numerical form, calibrated with Borehole logs.

Appendix C Photographs during work at site.

1.1 Objectives of the Analysis

The main objectives of the study are to determine: the geological sensitivity of the investigation area, by increasing the knowledge of the known geological.

- Determine soil stiffness properties;
- Shear wave velocities for site classification (based on subsurface conditions and determine the seismic Site Classification (VS_{30});
- Detecting and define the subsurface geological hazards (cavities, weak zone and soft loose soil formation);
- Understand the nature and composition of the soil as the features of geotechnical concern;
- Assessment of site as acceptable for construction.
- Locating / mapping of adverse strata and give recommendations.

1.2 Site location

The proposed project is located in Madinat Zayed at Plot No. **51** sector **MZ1**, Abu Dhabi - U.A.E. and the total area covers about 1.315 sq.m.

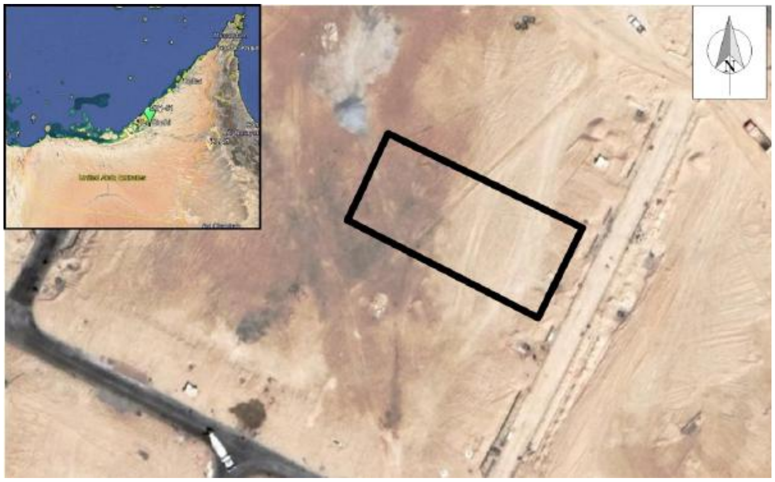

Figure 1: Site Location Map (Not in scale)

The general information regarding project site is tabulated in the following table.

Project Name	"Camp for West Trust General Maintenance"
Location	Plot No. 51, Sector MZ1, Madinat Zayed, Abu Dhabi - U.A.E.
Reference	Abu Dhabi Coordinates System
Project Type	Residential Building
Site Condition	Sand on surface and Flat area,

Tab. 1: General Information

The geographical reference of the location of the plot border is as below;

Point	Easting	Northing
1	256331.593	2696866.644
2	256380.248	2696842.977
3	256369.136	2696820.442
4	256321.482	2696844.985

Tab. 2: Coordinates of Corner Points of the Plot

The site plot is unbounded and is composed of sand at the surface with no obstacle for acquisition, as site conditions were favorable for the execution of MASW survey.

Six seismic lines running from NW to SE direction have been planned at 5 meters spacing and the length is 45 m for each line shown in following paragraph. All the area has been surveyed keeping in view the construction position for better and detailed subsurface information.

1.3 Acquisition Methods

A land streamer string with 24 geophones, connected by 24 takeout cable at 1-meter spacing was used to acquire seismic data at site. The offset chosen was 5 meters from the geophone chain to contain the near field effects.

The energization was made using a sledgehammer dropped on an iron. The signal to start recording, was sent to the instrument by a switch (Hammer switch) placed on the striking mass.

After the first position, the entire configuration of shot and 24 receiver spread were shifted 5 meters forward as roll-along movement acquisition mode, moving one receiver spread ahead of the other. The acquisition was carried out with a sample interval of 1.0 m/sec with 1000 samples for a record length of 1.0 sec.

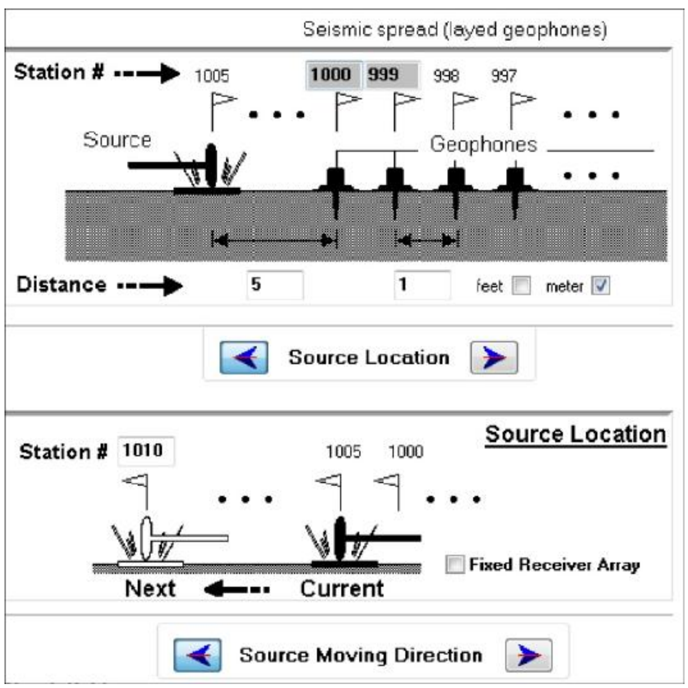

Figure 2: Array Diagram - Acquisition mode

No evidence/anomaly regarding the presence of lines of gas, water, electricity, telephone and drainage has been encountered inside the plot.

1.4 Calibration Boreholes

The geophysical data acquired for this plot was calibrated with three Boreholes drilled for Geotechnical Studies. The calibrated sections are represented in Appendix B. The location reference for these Boreholes is as under;

Borehole No.	Easting(m)	Northing(m)	Depth (m)
BH01	256368.01	2696827.87	20
BH02	256350.09	2696850.11	20
BH03	256328.29	2696847.06	20

Tab. 3: Calibration Boreholes Coordinates

The location of Calibration Boreholes are shown in the next Figure.

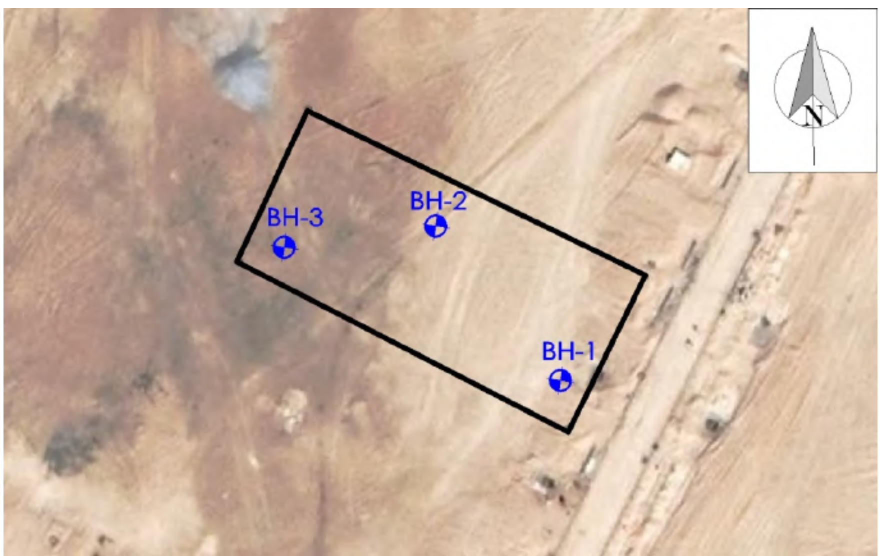

Figure 3: Calibration Boreholes location

2.0 DATA ACQUISITION AND TECHNICAL APPROACH

2.1 General

The site was visited for reconnaissance and arrangements. After initial planning, the site Engineers made first acquisition on 24th February 2021.

2.2 Geology of the Site

As far as the geology of the site at plot 51, Sector MZ1 Madinat ZayedAbu Dhabi - UAE is concerned, subsurface geology according to the geotechnical investigations is mainly composed of Silty Sand, Calcarenite, Mudstone and Gypsum.

The detail of lithological stratum according to borehole No. BH-01 (Easting 256368.01, Northing 2696827.87) as per their actual location is tabulated as below;

Depth b.g.l. (m)		Description of litho logy
From	To	
0.00	1.00	Top soil composed of silty SAND
1.00	7.50	Dense to loose silty SAND with traces of gypsum and sandstone fragments.
7.50	9.50	Very weak to week, highly fractured, moderately to highly weathered, MUDSTONE with inclusion of gypsum – SALT.
9.50	16.00	Weak, slightly weathered, MUDSTONE with inclusion of gypsum, interbedded with thin bands of weak CALCARENITE.
16.00	18.50	Weak, slightly weathered, MUDSTONE with inclusion of gypsum.
18.50	20.00	Weak, slightly weathered, MUDSTONE with inclusion of gypsum.

Tab. 4: Lithological Stratum

There is slight variation in layer identification, estimation of depth and thickness of each layer through geophysical because different lithologies having same velocities can overlap.

2.3 Scope of Geophysical Investigation

The location of the acquired Geophysical Lines is shown in the following figure;

Figure 4: Seismic Lines design:
(In Red the Final Sections location - Not in scale).

Seismic data was acquired as per drawing location. The geographic reference for the location of the sections is as followings;

Line	Starting		Ending		Length
	Easting	Northing	Easting	Northing	(m)
L1	256332.065	2696867.655	256372.101	2696847.035	45
L2	256329.962	2696863.114	256369.984	2696842.501	45
L3	256327.86	2696858.572	256367.868	2696837.967	45
L4	256325.715	2696854.053	256365.751	2696833.433	45
L5	256323.616	2696849.509	256363.634	2696828.899	45
L6	256321.482	2696844.985	256361.518	2696824.365	45

Tab. 5: Coordinates of Final Sections

2.4 Topography

In the Plot area a topographic Survey was executed and its defined limits have been identified and marked by using GPS. The starting and ending of the lines were marked and recorded for the presentation of the seismic sections.

2.5 Theory

The MASW methodology is based on the measurement and analysis of Rayleigh waves in a layered half-space.

The existence of Rayleigh waves in a layered half-space has been studied over the years through different methodologies.

When energized the site at a point on its free surface will generate different types of waves. If the source is perpendicular to the free surface waves, the following are generated belonging to the vertical plane: P waves, SV waves, Rayleigh waves, refracted waves.

If the source is parallel to the free surface waves, the following are generated belonging to the horizontal plane: SH waves, Love waves.

The **M**ultichannel **A**nalysis of **S**urface **W**ave method is using generally only the Rayleigh waves, and neglect the effects of P and SV waves.

Although a point source vertical engenders also the P waves and S waves in addition to Rayleigh waves, there are two aspects that make the contribution of the Rayleigh waves prevailing on the contribution of P and SV waves. The first aspect is that the Rayleigh waves carry about two-thirds of the energy generated by the source; the second aspect is that moving away from the source, the Rayleigh waves are attenuated geometrically lower than the P and SV waves, because Rayleigh waves propagate second cylindrical wave fronts, instead of P and SV waves propagating according to spherical wave fronts.

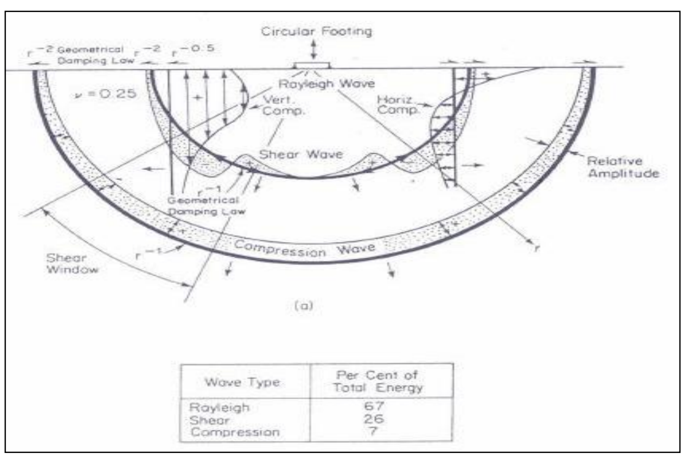

Figure 5: Waves generated by a harmonic vertical source on the free surface (Richard et al., 1970).

The MASW Survey provides the profile of one-dimensional velocity Vs, assuming an average value of velocity along the stringing of the receivers. The length of the stringing depends both on the number of receivers to be used and by the available space. Normally you have the receivers to constant distance between 0.5m and 3.0m. With the same number of receivers, a distance of 3.0m permits longer stringing of receivers and thus a higher resolution of the dispersion curve. Conversely, a small distance may be necessary in small spaces which allows a wider range of wave numbers, but results in a lower resolution of the dispersion curve.

Limitations of MASW Survey

The general limitations of the geophysical MASW method are as follows;

- Surface waves are best generated over a 'flat' ground at least within one receiver spread length (D) then; overall topographic variation within an entire survey line should not matter. However, any surface relief with dimension greater than 10% of 'D' will cause a significant hindrance to the surface waves generation.

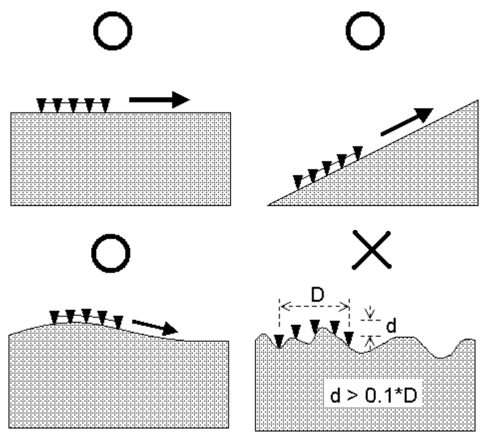

Figure 6: (taken from Kansas Geological Survey - KGS)

- Highly irregular surface topography adversely affects MASW as shown in the above figure and in these areas normally refraction or reflection seismic is recommended as S-waves are independent of morphological changes.
- The theoretical foundations of the MASW method refer to a half space laminated with parallel and horizontal, then a limitation to its applicability could be represented by the presence of significant slopes more than 20°, both of the topography and of the different elastic discontinuity.

- MASW method requires linear topographies and floor layers to be parallel but very easy to perform in localized or confined environment as compared to refraction seismics where large space is required for geophone installation.

In our case the project site is a flat plane, so the area is suitable for MASW Acquisition.

2.6 Reference Standards

For the purpose of conducting geophysical investigations, reference is made to following Standards:

- **ASTM D6429** (Standard Guide for Selecting Surface Geophysical Methods);
- Internal procedures as per following the procedures ISO 9001, Safety Instruction in the field and office as well as the many technical journals available in the bibliography.

2.7 Instrumentation

The seismograph used is GEODE Seismograph 24-channel box manufactured by Geometrics - USA in a solid casing connected with PC compatible.

Figure 7: Geode Seismograph

The sensors consist of a chain of 24 GEOV/ 4.5 Hz Vertical mounted in a land streamer.

Figure 8: Geophones 4.5 Hz Land streamer

2.8 Field Procedures and Quality Control

Seismic crew aligned the land streamer along the planned lines by using GPS. After setting data acquisition parameters on seismograph, the field Engineer recorded test shots to make adjustments for noise free data. Geophone positions and sledgehammer of 10 Kg was used to record good quality data. After finalization, the following acquisition parameters are used.

Parameter	Setting
Survey Type	Active MASW
Survey Purposes	2D Vs Profiling
Acquisition System	Geode
Source	Sledghammer
Receiver	4.5 Hz (Land Streamer = 24 take out)
Number of Receiver	24
Receiver Array	Roll Along
Receiver Spacing (dx)	1m
Array Lenght (L)	23m
Source Offset	5m
Source Receiver move	5m
Depth of investigation (Z)	≈30m
Profile spacing	5m
Sample Interval	1 ms
Record Lenght	1 s
Delay	Set to 0 ms
Filters	Out
Number of shots per Record	2 – 4
Record Format	SG2

Tab. 6: Field and Acquisition Parameters

After the assurance of quality control parameters and satisfaction of good field data at first position, the entire configuration of shot and 24 receiver spread were shifted forward as roll-along movement acquisition mode, moving one receiver spread ahead of the other. The acquisition was carried out with a sample interval of 1.0 msec with 1000 samples for a record length of 1.0 sec.

In the following figure is simplified the array for the field investigation.

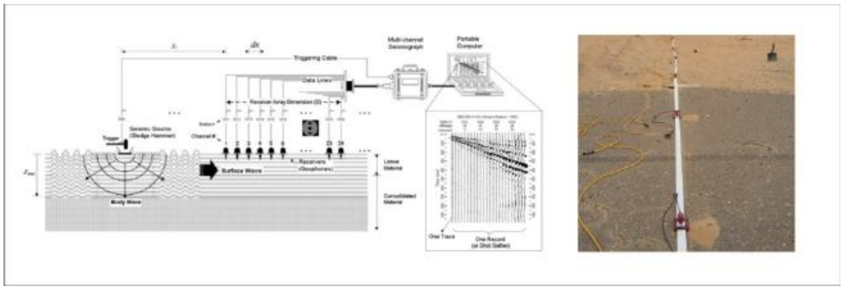

Figure 9: MASW Active Method; Field investigation

2.9 Data Processing & Interpretation (processing parameter)

After field acquisition the data was processed with SURFSEIS 6.6, advanced software for processing, manufactured by KGS (Kansas Geological Survey).

The following processing steps will be performed.

- Edit shot gather;
- Conversion data into processing format;
- Assign field geometry;
- Defines the surface waves travel (t) time and distance (d) on computer (T-D Domain).
- Transform data from T-D domain to Frequency (F) –Wave number (K) domain
- Pick Peak Frequency and Wave No. Values
- Calculate phase velocity (**c**) = **f** (frequency)/**λ** (wave length) to produce phase velocity dispersion curves.

In the following table is presented the parameters used in this processing.

Geometry Parameter	
Closet Receiver	1000
Seismic Souce Station	105
Moving	5 station drag configuration
Generation of OverTone	
Frequency min	2 Hz
Frequency max	100 Hz
Filter used	Trapezoidal
Phase Velocity min	10
Phase velocity max	2000
Contrast	min
Nos. Of extracted Point	30
Curve smoothing	5%
Inversion 2D profile	
Iteration	10
RMS max	5%
Initial Vs layer	Created from each dispersion curve
Signal to Noise ratio	1
Nos. Of layers	10
Thichness Model	Variable
Poison ratio	0.4
Inizial S-Velocity	Auto
Inizial P-Velocity	Auto
Model Display	
Smoothing	2%
Normalization	Non
Display gain	0
Color scale	200-1400 m/sec
Type of color	rainbow

Tab. 7: Processing Parameters

DISPERSION CURVE

When measuring the surface waves along one stringing of receivers on the surface of a site energized at one point, you have the range of motion, displacement or velocity or acceleration, in the space-time domain. The perturbation generated by energizing contains all the different modes or Rayleigh waves (P-waves and SV are reduced to a few meters from the source), which form a single wave train and have not yet separated or missing. So that the dispersion phenomenon of different modes of Rayleigh waves is recorded on the seismogram and for this we need to have a sufficient distance from the source (above about 100m in practice).

When transforming from the space-time domain to the frequency domain a wave train or in an equivalent manner to the domain phase velocity - frequency to represent the dispersion relation, then it detects that it is not generally possible to measure separately the modal curves predicted by theory. Instead of getting the modal curves separated you get a single curve called curve apparent or actual.

The actual or apparent curve which is obtained from the traces measured on site is the result of interaction between all modes of Rayleigh and the same measurement system from the receivers. The configuration of the receivers in the stringing can influence the value that the dispersion curve becomes apparent at certain frequencies.

Independently of the disorder contributed by the measuring system, the apparent curve is still given by the interaction of different modes of Rayleigh. In function of the geometrical characteristics (thickness) and mechanical (Vs, Vp, bulk density) of the layers of soil certain modes of Rayleigh may be predominant with respect to the other modes in certain frequency ranges. Generally, when the rigidity of the layers gradually increases with the depth, the fundamental Rayleigh mode is predominant at all frequencies.

However, there are several stratigraphy, with rigid layers between soft layers or soft layers between rigid layers, or with abrupt variation in stiffness with depth, in which the modes of Rayleigh higher than the first become predominant in certain range of frequencies. It may happen that there are some frequencies of transition in which there is a clear predominance of a way than the other, but that there are two or more modes neighbors carrying approximately the same amount of energy. In these situations, the apparent curve may not coincide with any way, but it would be the combination of two or more ways.

The Multichannel Analysis of Surface Wave methodology in 2D, represent a technical innovation with respect to the acquisition of 1D. The difference consists in the execution of shots in external position to the geophone chain, so to obtain on the shot point, the vertical profile and the variations of Vs, and proceeding to the interpolation, using dedicated software of data in order to obtain a seismic profile of Vs in 2D.

In practice, the acquisition mode in 2D is similar to the acquisition of a profile of seismic reflection but with recording times and different type of sampling.

This methodology allows you to highlight within the profile investigated reversals seismic velocity.

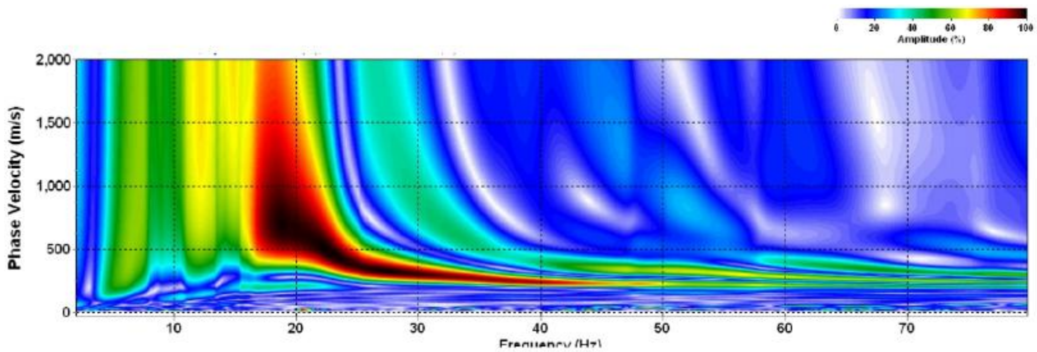

Figure 10: Example of Dispersion Curve obtained

2D Vs SECTIONS

Construct 2D Vs section from the inversion using an appropriate 2D shot gather; the remaining gathers are converted and combined into a single file with sequentially increasing field records. Station numbers for source and receivers are assigned to each record in the combined file, and then all the geometry encoded records are recompiled into the equivalent roll-along mode data set. Records are selected from different locations along the surveyed line and their dispersion characteristics; application of a band pass filter on the original 24 trace common shot gather and calculate the F-K transform, velocity spectra.

Each record is analyzed to generate a dispersion image with the fundamental mode dispersion trend identified and a signal dispersion curve extracted based on the image identified. After the dispersion curves have been extracted, they are inverted to generate one 1D Vs profile from each dispersion curve. The Vs profile so calculated is assigned the station location in the middle of the receiver spread. When all the profiles 1D are obtained, a 2D interpolation is used to have the final 2D Vs section.

After the processing, the interpretation was done putting the significant subsurface geological hazards (i.e. cavities, weak zone and soft loose soil formation).

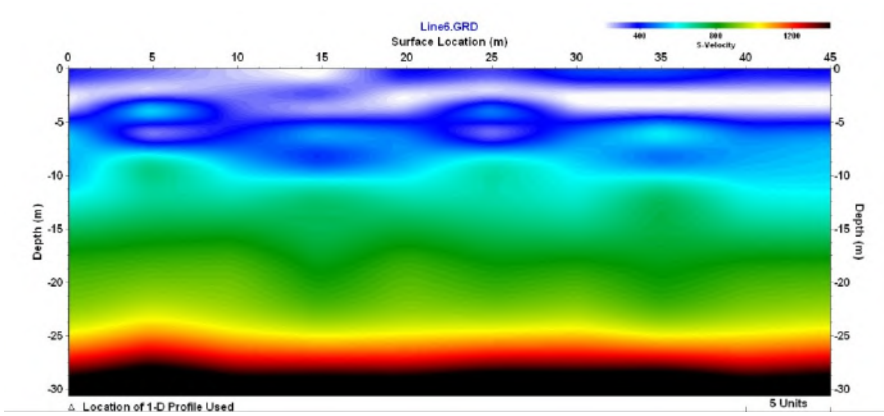

Figure 11: Example of MASW 2D processed Section

2.10 V_S^{30} Coefficient for Site Classification

The elastic properties of the near-surface materials and their effects on the seismic wave propagation are very important in earthquake geotechnical engineering, civil engineering and environmental earth science studies. The seismic site characterization for calculating the seismic hazard is usually carried out based on the near-surface shear wave velocity values. The average shear wave velocity for the depth ''d'' of the soil is referred as VH. The average shear wave velocity down to a depth of VH is computed as follow (cumulative depth in m. for the 30m average):

$$V_S^{30} = 30/\sum (d/V_S)$$

Where ∑ represent the sum of seismic layers.

Therefore, shear waves velocity is an essential parameter to evaluate the dynamic properties of soils. The parameter known as V_S^{30} in accordance with Abu Dhabi International Building Code (ADIBC) which contributes to the determination of categories of stratigraphic profile of the soil foundation. The site classes are categorized as below;

SITE CLASS	SOILPROFILE NAME	AVERAGE PROPERTIES (TOP 30.5 M)		
		Soil shear wave Velocity(Vs) m/s	Standard penetration resistance, N	Soil undrained shear strength, Su, (kPa)
A	Hard rock	Vs >1,500	N/A	N/A
B	Rock	760 < Vs ≤ 1,500	N/A	N/A
C	Very dense soil and soft rock	365 < Vs ≤ 760	N>50	Sμ ≥96
D	Stiff soil profile	185 ≤ Vs ≤ 365	15 ≤ N≤ 50	48 ≤ Sμ ≤ 96
E	Soft soil profile	Vs ≤ 185	N < 15	Sμ < 48
E	-	Any profile with more than 3.05 m of soil having following characteristics: 1. Plasticity Index PI>20 2. Moisture content w ≥40% 3. Undrained shear strength Su<24kPa		
F	-	Any profile containing soils having one or more of the following characteristics: 1. Soil vulnerable to potential failure or collapse under seismic loading such as liquefiable soil, quick and high sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays(H>3.05 m of peat and/or highly organic clay where H=thickness of soil) 3. Very high plastic clays(H>7.6 m with Plasticity Index PI>75) 4. Very thick soft/medium stiff clays(H>36.5 m)		

Tab. 8: Soil Classification ADIBC 2013

3.0 DISCUSSION

This section of the report is mainly concerned with the analysis of the interpreted seismic sections with MASW methodology executed at this site. The acquired seismic lines are 45 m in length (see Appendix A).

The seismic sections obtained from MASW data interpretation show generally values of shear wave velocity between 200 to 1300 m/sec

A correlation has been developed between velocities and lithology on the basis of boreholes drilled at the site and the seismic sections interpreted through MASW data. (Ref. Appendix B).

The following results shows the *Site Classification Based on the Average* Vs^{30} and *Discussion Based on Interpreted Seismic Sections* will be discuss in the following paragraphs.

3.1. Site Classification based on Average of V_S^{30}.

The parameters for calculation of Vs^{30} for geotechnical studies is different from geophysical as they are unidirectional stress at 1 or 1.5 meter spacing while shear waves are continuous roll along in the rock mass having different physio–mechanical properties and sometimes discrepancy occurs among both studies. However for better design always consider what is safer.

The average Vs^{30} with ADIBC 2013 class is tabulated as under:

Line ID.	Average V_S^{30} *(m/sec)*	IBC Site Class
Line 1	607	C
Line 2	601	C
Line 3	616	C
Line 4	608	C
Line 5	609	C
Line 6	624	C

Tab. 9: Average VS30 calculated along MASW profiles.

According to the interpretation of MASW data, the average shear wave's velocity (***V_S^{30}***) for the project area understudy is **≈ 610 m/sec**, so area lies in the safe range i.e. **Class C** (Very dense soil and soft Rock) according with Abu Dhabi International Building Code (ADIBC).

3.2. Discussion based on interpreted Seismic Sections.

Interpreted seismic sections have been developed on the basis of shear wave velocity variation along the seismic lines executed in the area. Overall comparison of shear waves velocity suggests that velocity distribution is uneven. Color scheme of the sections is in fact associated with velocity change due to subsurface lithological stratum variations and their physical strength. White color corresponding to very low velocities of S waves, Sky blue to blue color is related to loose formations while Cyan represents Compact materials. Green is associated with medium velocity and Yellow is related to even denser formations.

In certain specific color layer is evident of superseding velocities indicating present physical state of subsurface material after mechanical reworking. In some cases, two different stratum yields same velocity due to their physical state so same color layer mask both and can be differentiated by correlation boreholes only.

Overall analysis of all 2-D shear-velocity (Vs) cross section describe subsurface conditions which indicates different layers model with shear wave velocity with depth. The sections show generally a low velocity of propagation of shear waves. A velocity (Vs) scale of 200 - 1400 m/sec was used for the color scheme shown on top of the section.

A top surface layer shows low shear wave velocity values ranging from 200 – 450 m/sec and attributed by different grades of dense silty (see appendix B). Thickness of this layer varies due to different degree of density of the material. In some lines this layer goes deeper up to 6 to 8 meters.

Below this depth there is intermediate layer with medium shear wave velocity ranging from 500 – 700 m/sec and thickness of this layer is estimated up to 9 to 10 meters. The change of colour from greenish to yellowish red shows a change in physio mechanic property and/or in lithology as well as velocity amalgamation with depth.

Borehole logs calibration shows how this horizon is characterized by the presence of very weak and fractured Mudstone.

Underlying this medium velocity layer there is third layer with high shear waves velocity ranging more than 700 m/sec and is attributed as moderately weak Gypsum and Mudstone till the maximum depth of Boreholes explored. This bottom layer seems to be uniform with increase of consistency as convolution of velocities is almost settled and linearity is becoming more prominent as the low frequencies proceeds to greater depths.

The findings of geophysical section in general are in accordance with Calibration Boreholes but some localised variations with borehole logs have been noticed due to localized fractures and degree of weathering within the rock formations.

The interpreted anomalous zones are of varying size and their location may vary 5-10% within the identified zone due to topographic and geophysical adjustments in measured data.

No evidence of cavities has been observed under the surveyed lines within investigated depth of 30 meters and accordingly with soil Report.

4.0 CONCLUSIONS

No evidence of cavities / hazardous zones has been observed under the surveyed lines within investigated depth, therefore **the site area is suitable for construction**.

For site classification V_S^{30} value **610 m/sec** lies in the **class C** (Very dense soil and soft Rock) according with Abu Dhabi International Building Code (ADIBC) 2013.

Velocity values related to rock shows that velocity anomalies related to localized vertical and lateral variations are product of changing in lithology and/or weak materials enfolded in relatively sound rock.

5.0 RECOMMENDATIONS

Keeping in view the findings of the geophysical studies, the following recommendations have been made:

- Presence of strata with poor physio-mechanical properties composed of silty sand at varying depths and top of rock layer (Mudstone) can become a probable hazard in future up to 7 to 8 m depth, as indicated by velocity anomalies in Appendix B.
- The inversion of velocities according with Borehole logs, that show anomalies from 6 to 8 m up to 9 to 10 m, it is related to “high fractured zone”.

- No evidence of high-risk cavities/anomalous zones of a significant size have been observed under the surveyed lines within investigated depth, therefore the site area is in the safe range and it is suitable for construction.
- V_S^{30} is **610 m/sec**, Class C (very dense soil and soft rock) according with Abu Dhabi International Building Code (ADIBC).

Dubai, 15th February 2021

Federico Pellegrini

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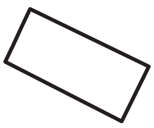
GeoTechnologies FZCO.

APPENDIX

CLIENT:	**Al Bateen Engineering Consultancy**	GEOTechnologies FZCO FOR GEOPHYSICAL AND GEOLOGICAL STUDIES AND SERVICES GeoTech DUBAI
JOB:	GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.	

Job No.: **001-21**	SITE MAP AND GEOPHYSICAL SURVEY LOCATION	Appendix	C

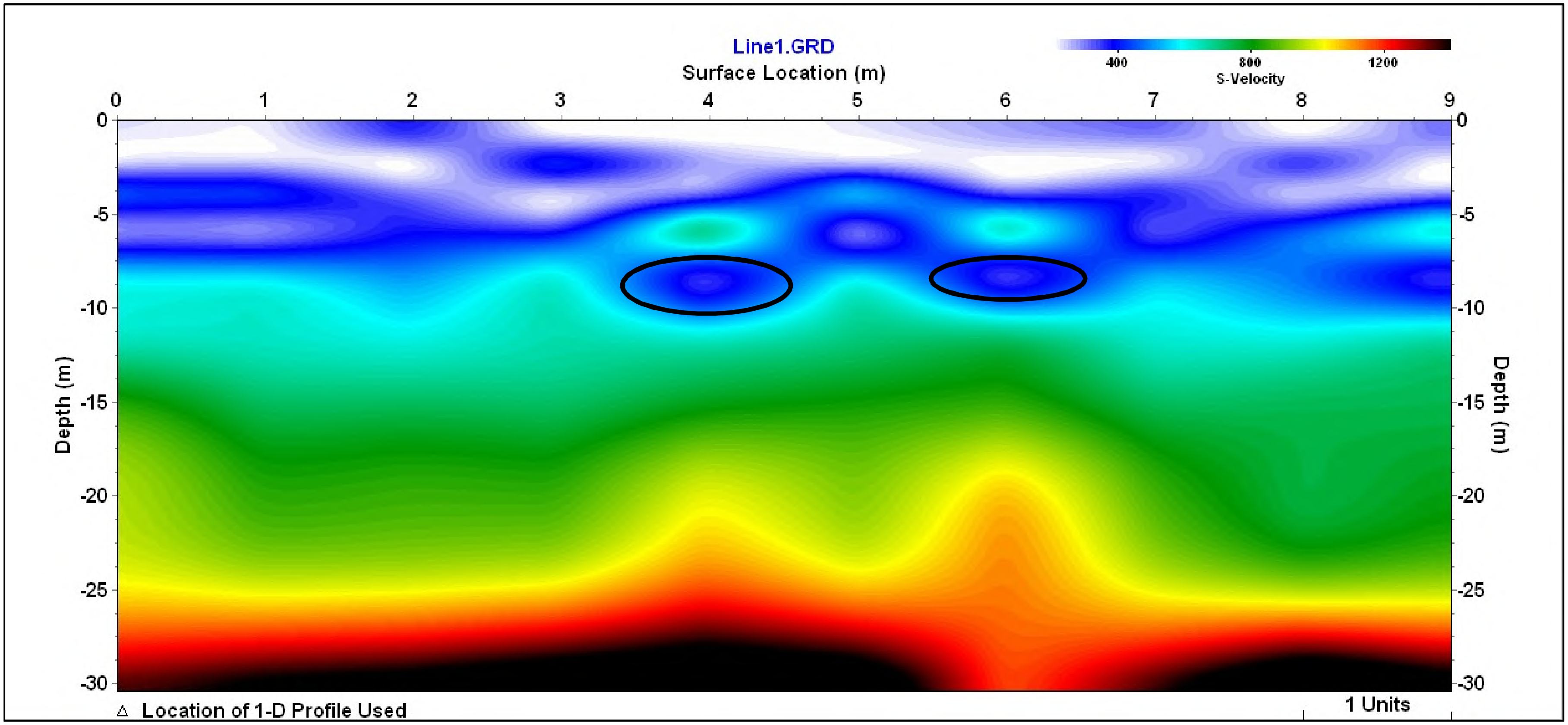
LEGEND:

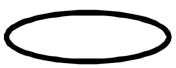
 Plot Boundary

Final Section location

L1 → Line No.

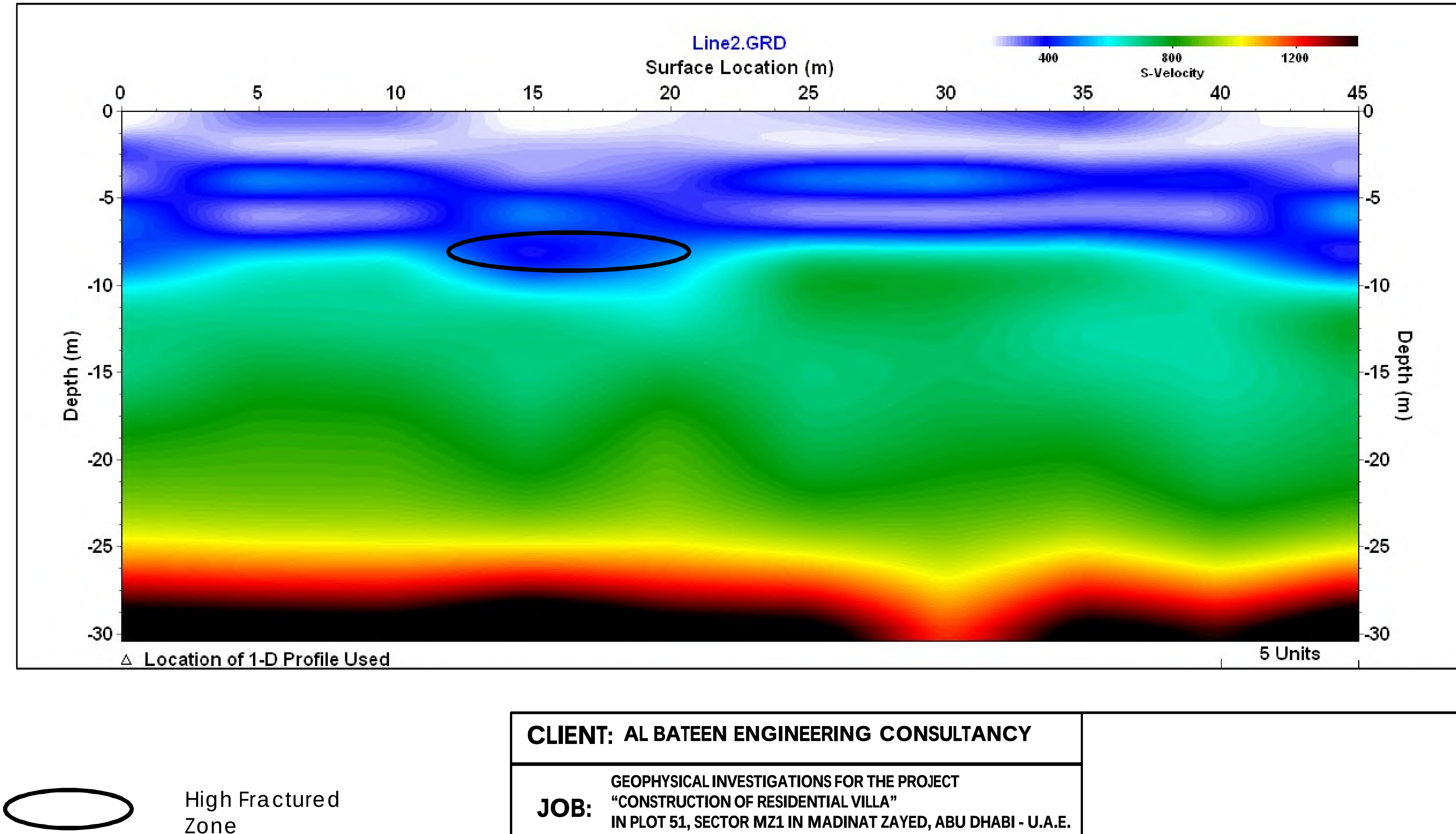
Scale: 1:1.000



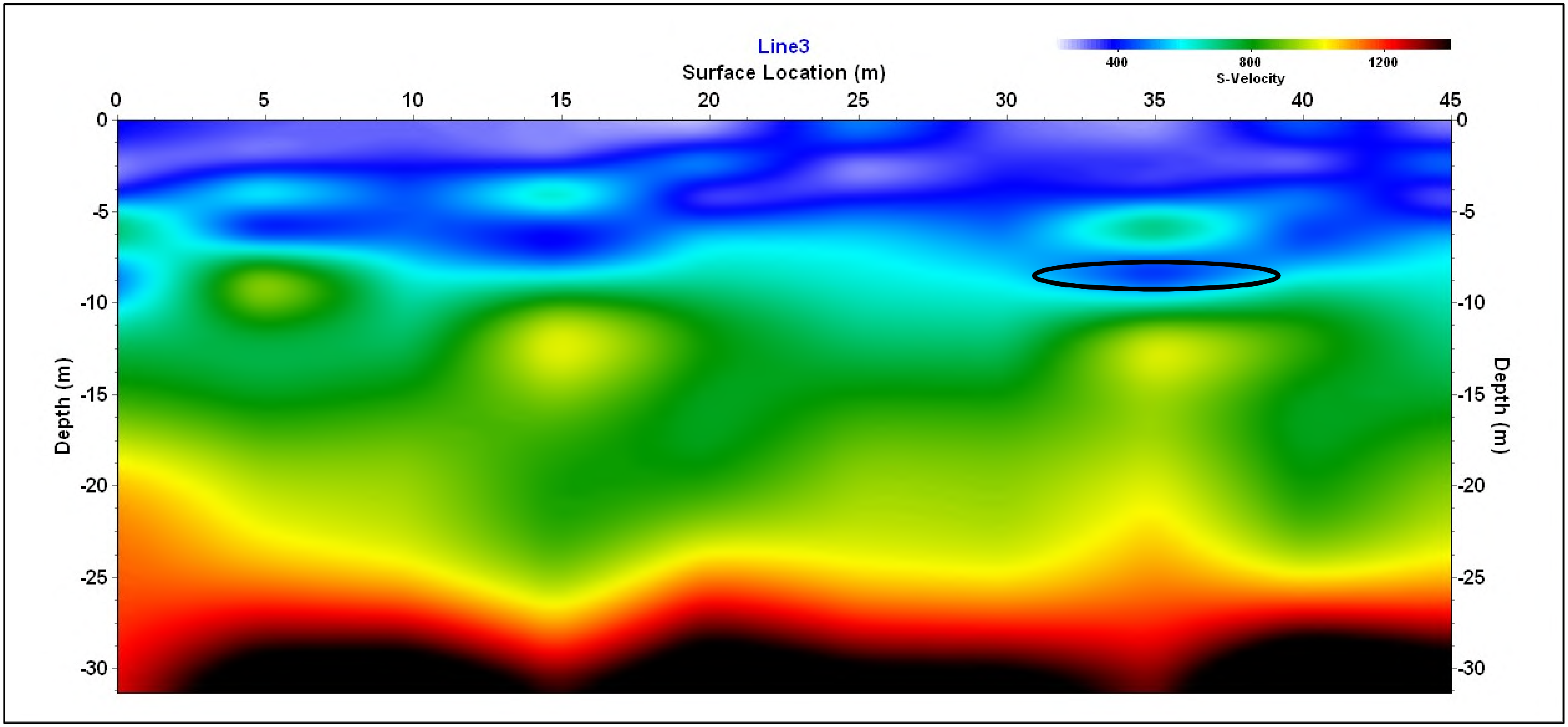


High Fractured Zone

CLIENT: AL BATEEN ENGINEERING CONSULTANCY	
JOB: GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.	
JOB 001-21	**Drawing:** **SECTION Line1**
Scale: Graphic	**Appendix B**

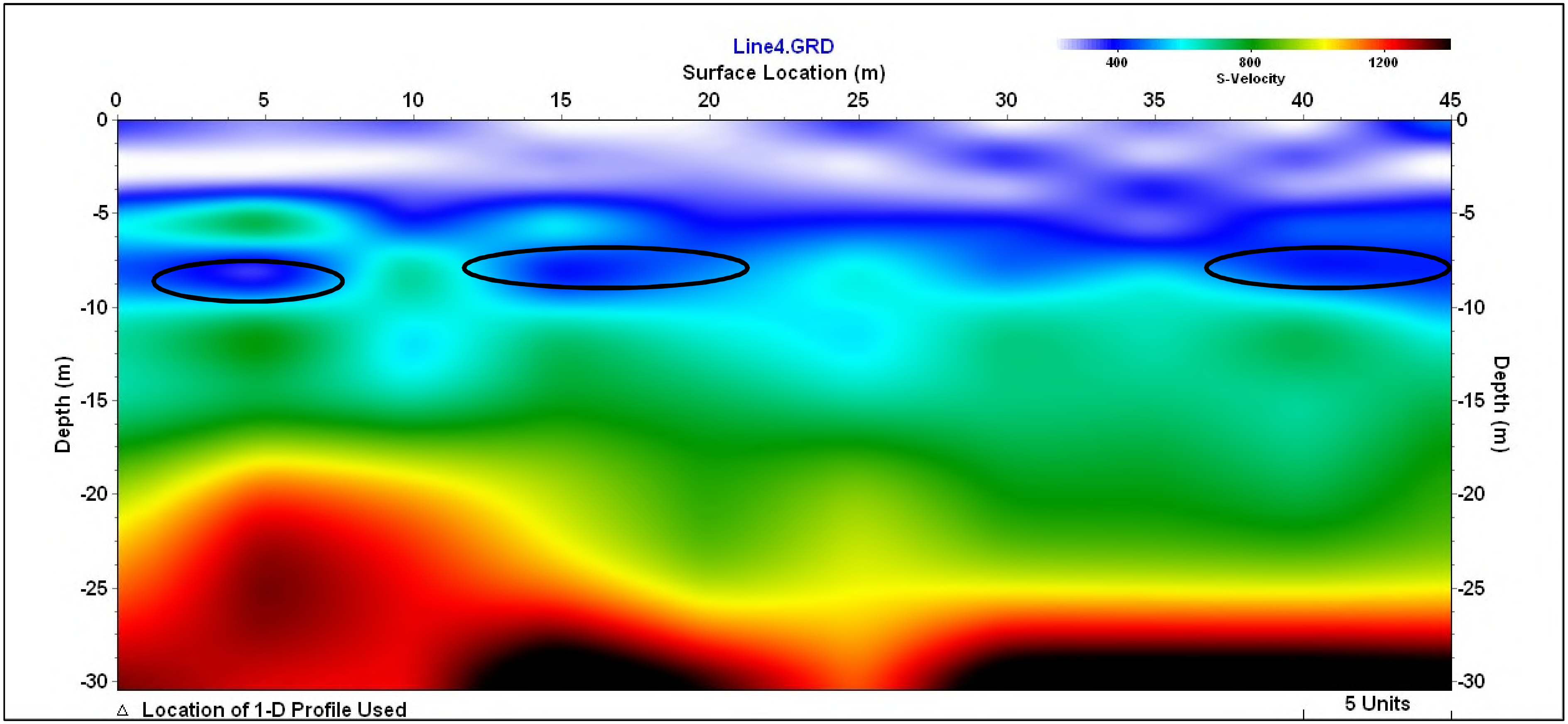


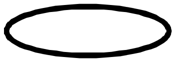
CLIENT: AL BATEEN ENGINEERING CONSULTANCY	
JOB: GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.	
JOB 001-21	**Drawing:** **SECTION Line2**
Scale: Graphic	**Appendix B**



High Fractured Zone

CLIENT:	**AL BATEEN ENGINEERING CONSULTANCY**
JOB:	**GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.**
JOB 001-21	**Drawing:** **SECTION Line3**
Scale: Graphic	**Appendix B**





High Fractured Zone

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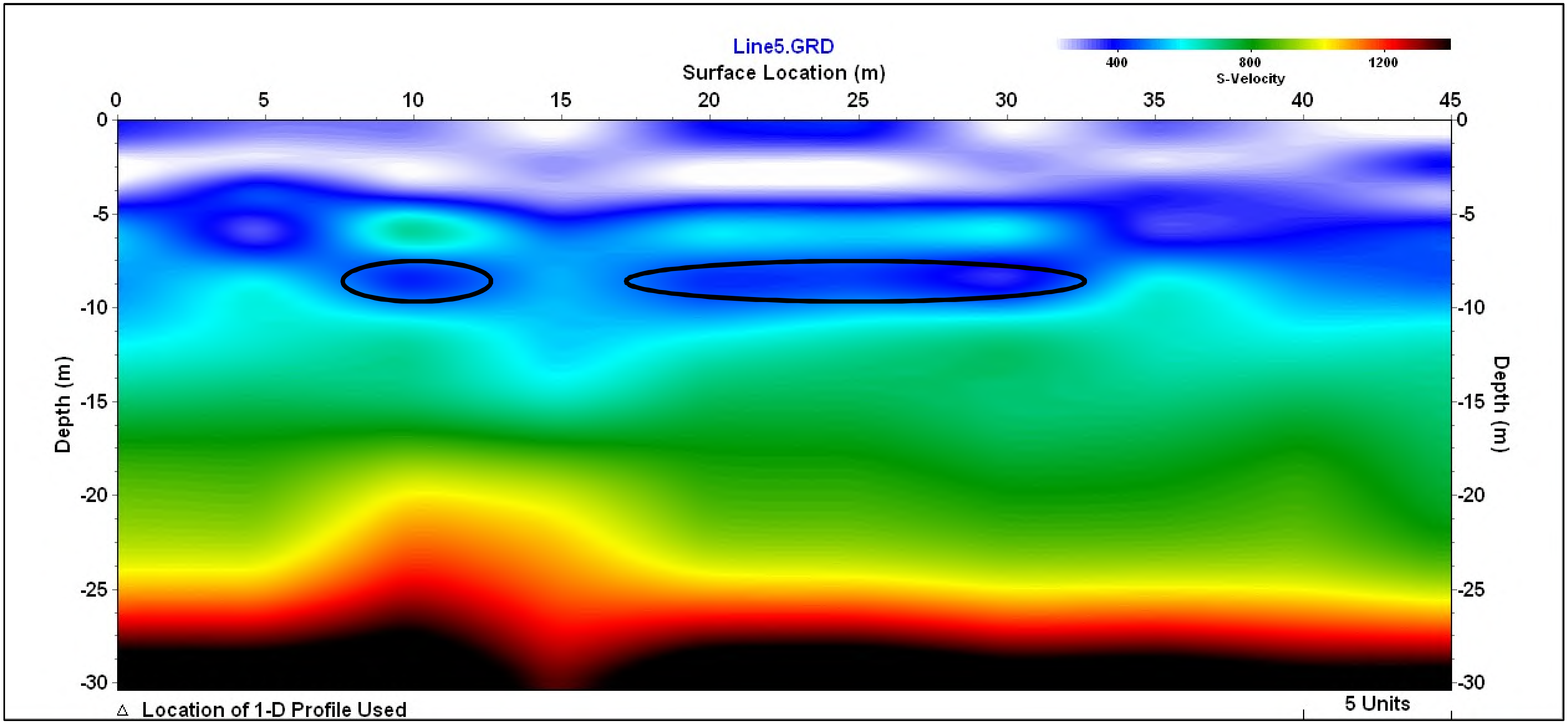
JOB 001-21

Drawing:

SECTION Line4

Scale: Graphic

Appendix B



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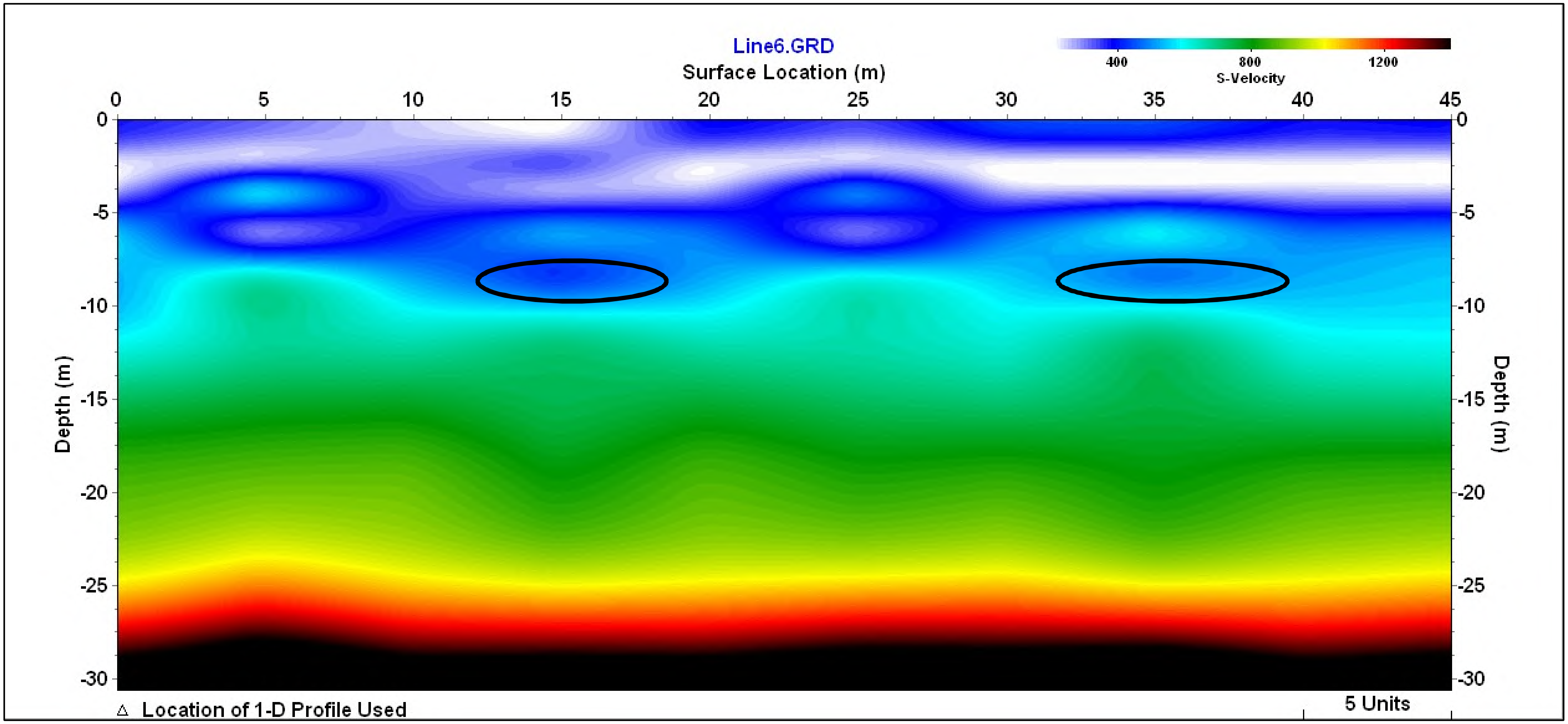
JOB 001-21	**Drawing:** **SECTION Line5**
Scale: Graphic	**Appendix B**



High Fractured Zone

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JOB: GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT
"CONSTRUCTION OF RESIDENTIAL VILLA"
IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.

JOB
001-21

Drawing:

SECTION Line6

Scale: Graphic

Appendix B

CLIENT: **Al Bateen Engineering Consultancy** JOB: GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.	GEOTechnologies FZCO FOR GEOPHYSICAL AND GEOLOGICAL STUDIES AND SERVICES GeoTech DUBAI

Job No.: **001-21**	PHOTOS FROM THE SITE	Appendix	C

Photo- 1

Photo- 2

CLIENT: **Al Bateen Engineering Consultancy**

JOB: GEOPHYSICAL INVESTIGATIONS FOR THE PROJECT "CONSTRUCTION OF RESIDENTIAL VILLA" IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.

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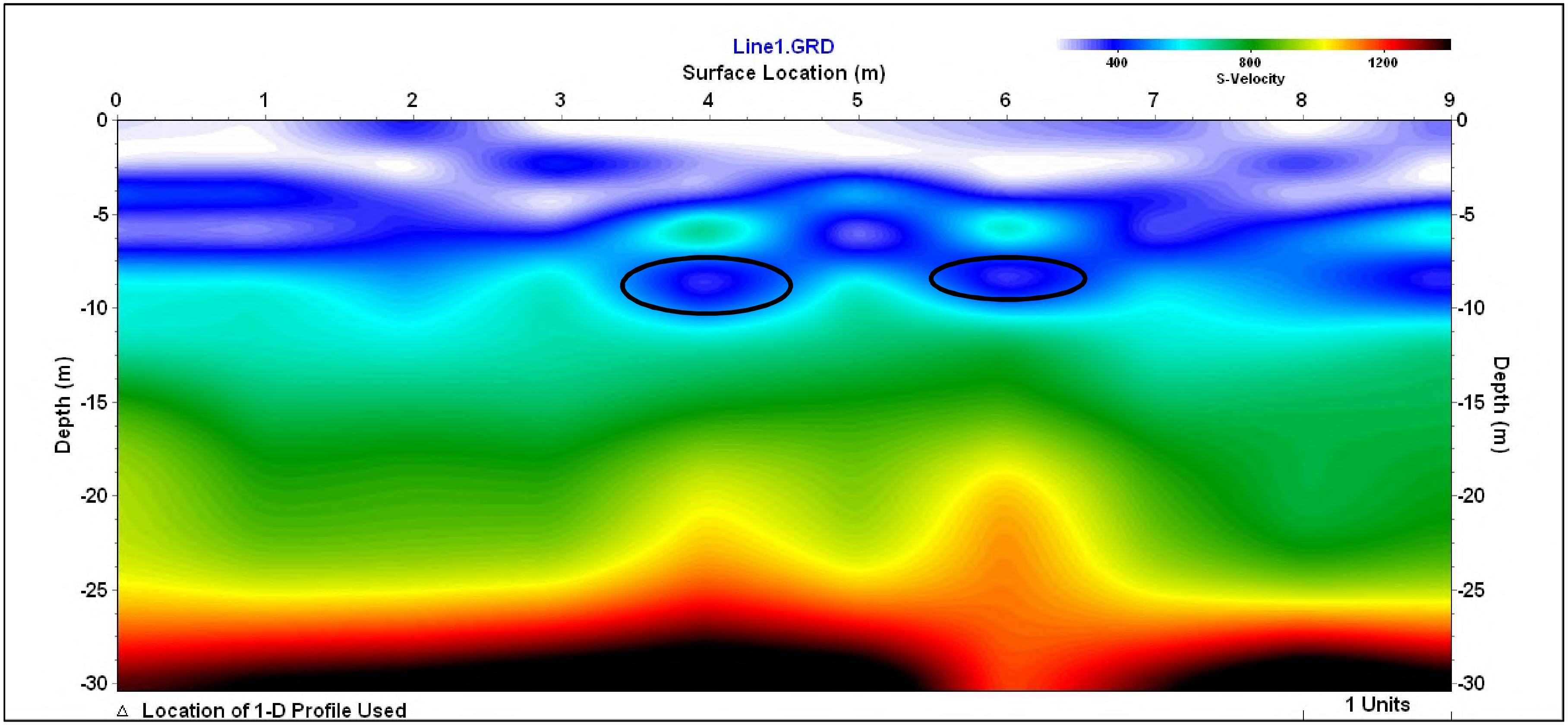
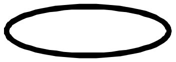
Job No.: **001-21**	SITE MAP AND GEOPHYSICAL SURVEY LOCATION	Appendix	C

LEGEND:

	Plot Boundary		Final Section location
L1 →	Line No.		Scale: 1:1.000

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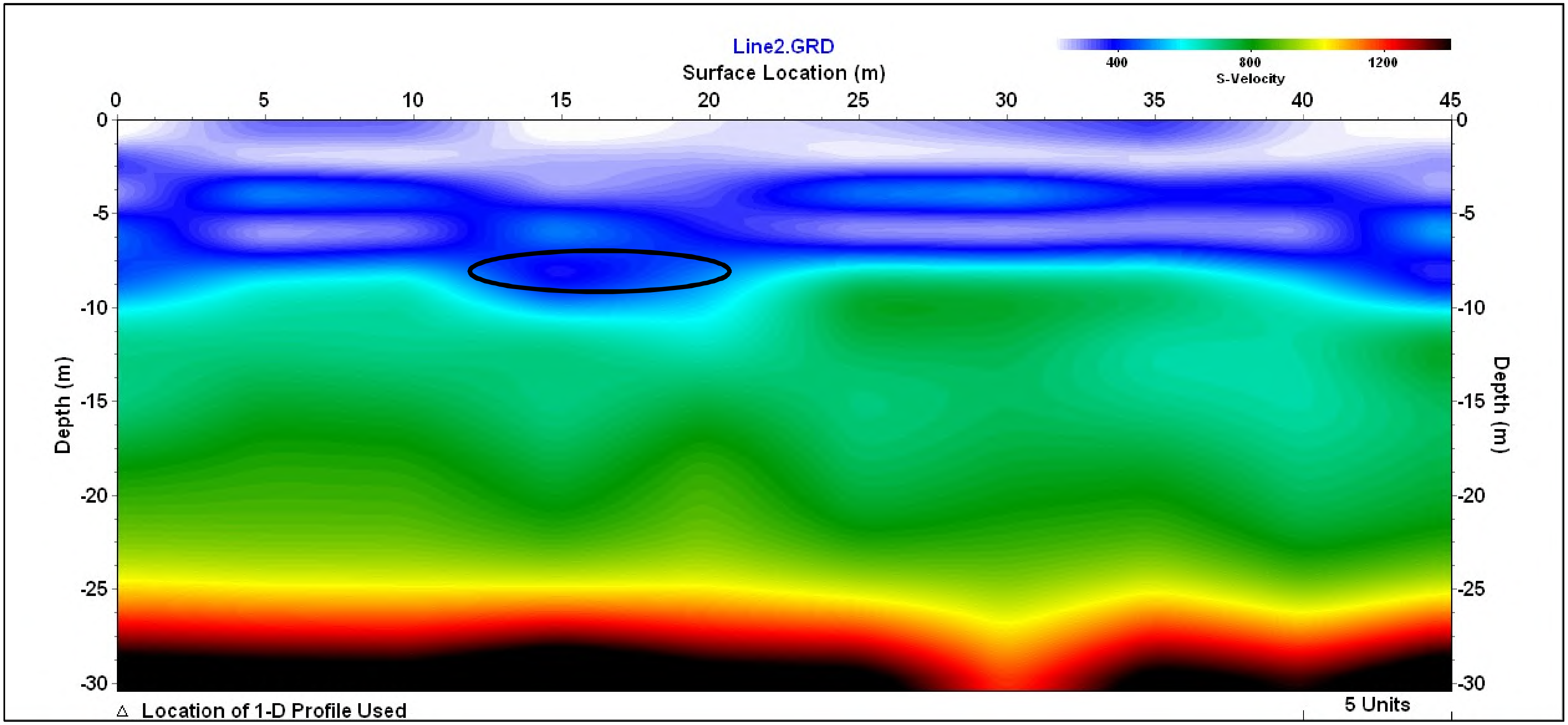
JOB 001-21	**Drawing:** **SECTION Line1**
Scale: Graphic	**Appendix B**



High Fractured Zone

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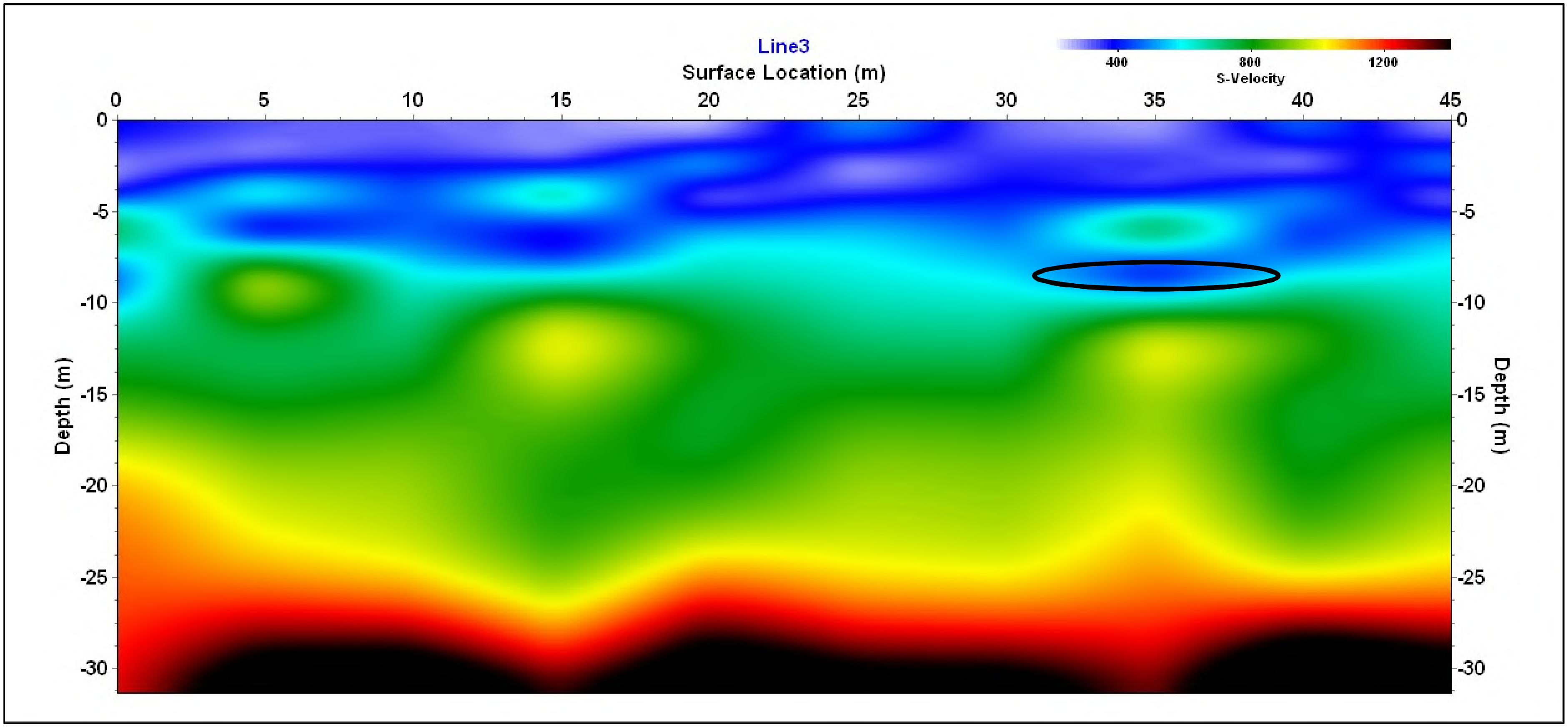
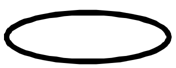
JOB 001-21	**Drawing:** **SECTION Line2**
Scale: Graphic	**Appendix B**





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IN PLOT 51, SECTOR MZ1 IN MADINAT ZAYED, ABU DHABI - U.A.E.

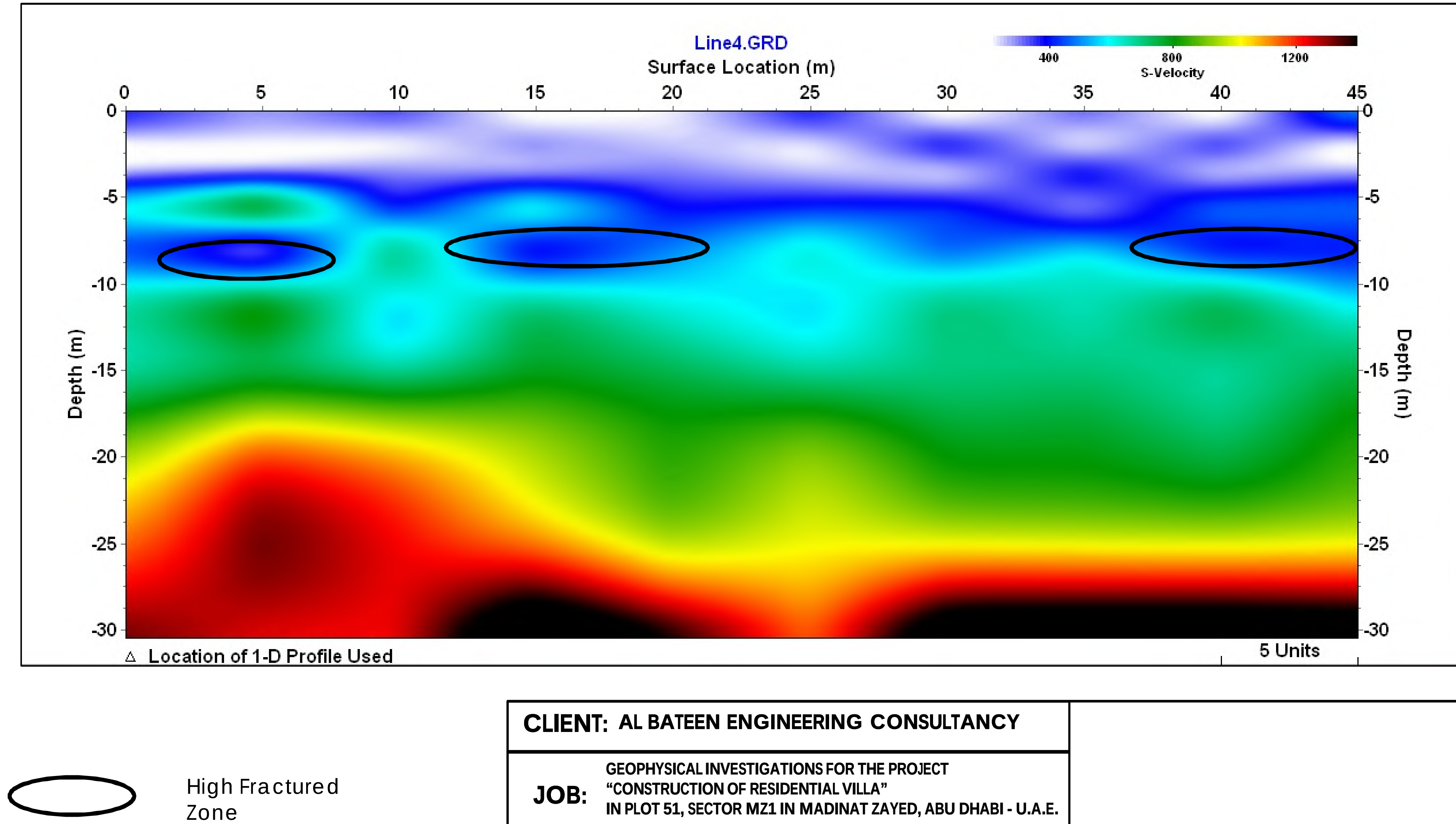
JOB
001-21

Drawing:

SECTION Line3

Scale: Graphic

Appendix B



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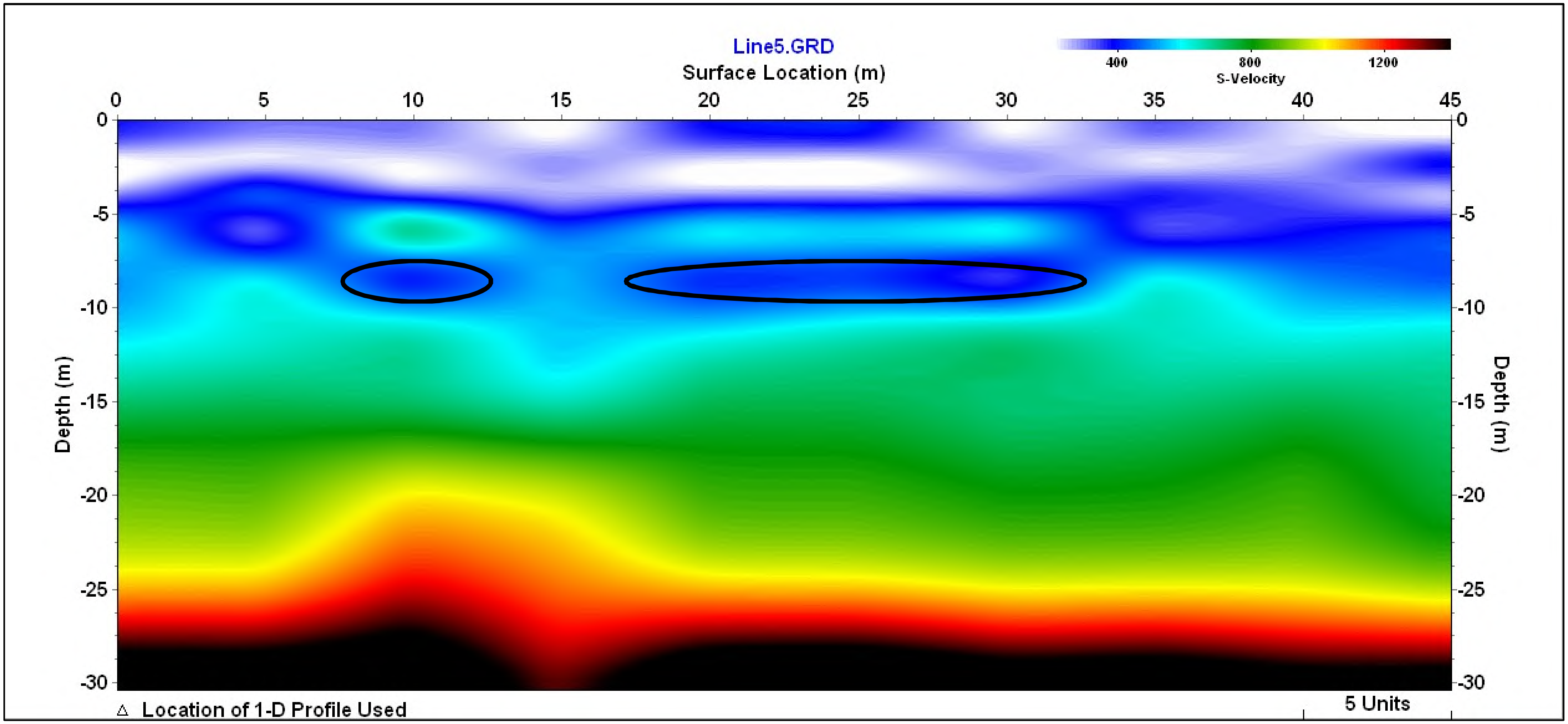
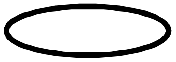
JOB 001-21	**Drawing:** **SECTION Line4**
Scale: Graphic	**Appendix B**





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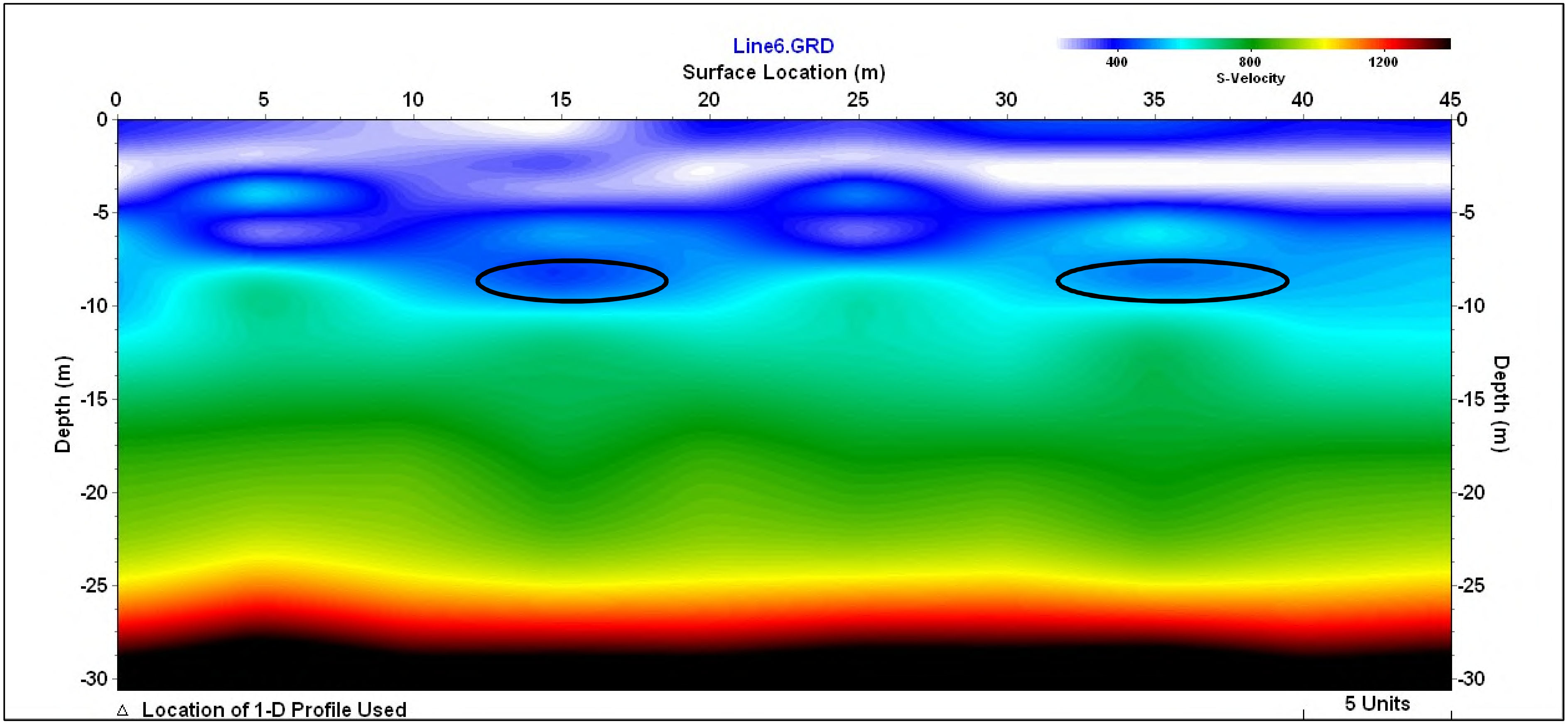
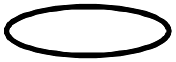
JOB 001-21	**Drawing:** **SECTION Line5**
Scale: Graphic	**Appendix B**





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JOB 001-21	**Drawing:** **SECTION Line6**
Scale: Graphic	**Appendix B**

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Job No.: **001-21**	PHOTOS FROM THE SITE	Appendix	C

Photo- 1

Photo- 2