Site Investigations
♣
Geologists
♣
Environmental &
Geotechnical
Engineers

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Date: 1st August 2018

GROUND GAS RISK ASSESSMENT

Plots 3 to 5, Ashroyd Business Park
S180236/GAS

Dear Sirs

INTRODUCTION

Authorisation

Solmek were instructed by William Saunders to undertake a site investigation on a parcel of land at Ashroyd Business Park, Hoyland near Barnsley, South Yorkshire, S74 9SB. A drawing showing the position of the site is included in Appendix A (Figure 1).

Sources of information, including previous work undertaken at the site, are detailed below:

- *Plot 5, Ashroyd Business Park, Hoyland, Barnsley, Wm Saunders Phase 1 Geo-Environmental Report (11717-WMS-ZZ-XX-RP-C-30901-S2-P1-PHASE_1_REPORT, March 2018)*
- *Solmek Phase 2 Site Investigation Report (S180236, April 2018)*

Reference should be made to the above reports for details of the site's history, environmental/contamination setting and expected underlying geological conditions.

Scope of Works

The proposed development comprises a series of industrial units, hardstanding parking areas and service yards. It is assumed that areas of soft landscape are proposed along the peripheries of each plot.

The information provided in this Ground Gas Assessment is based on the investigation fieldwork and is subject to the comments and approval of the various Regulatory Authorities.

There may be other conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report. Solmek reserve the right to alter conclusions and recommendations should further information be available or provided. Any schematic representation or opinion of the possible configuration of ground conditions between exploratory holes is conjectural and given for guidance only and confirmation of intermediate ground conditions should be considered if deemed necessary.

GROUND GAS ASSESSMENT

Ground gases such as carbon dioxide (CO_2) and methane (CH_4) can be classed as a form of contamination where there is a potential risk to human health. As a result, gas monitoring has been undertaken. Six visits have been carried out between May and July 2018 to assess the potential risks posed by ground gases.

The gas was monitored by measuring emissions from monitoring points installed into BH1, BH4, BH6, BH9, BH10 and BH12 during the fieldwork. Although during the monitoring visits BH1 and BH4 were either vandalised or not found. The results are attached to this letter report. The monitoring was generally carried out in accordance with current guidance provided within CIRIA C665:2007.

Ground Gas Results

The atmospheric pressure has an impact on the concentrations of gas released. The atmospheric pressure ranged between 999 and 1030 millibars during the surveys. Times of falling and rising atmospheric pressure regional trends were noted during the survey.

This is considered to be a good range of conditions for the time of year. In addition, a reading during low atmospheric conditions (<1000mb) was also undertaken.

- Methane was detected in BH9 during the first three visits ranging between 1.4 and 3.8%.
- Methane was not detected in the remaining boreholes monitored.
- Carbon dioxide concentrations were recorded between 0.0 and 9.7%. (Highest readings in BH9)
- Oxygen levels were between 0.0 and 20.6% with oxygen depletion (<19.0%) in BH9 only.
- No significant flow rates were recorded.

Ground Gas Analysis

The results obtained have been compared with relevant guidance that includes the following:

- BRE/Environment Agency BR414 (2001) - Protective Measures for housing on gas-contaminated land
- Wilson & Card (1999) - Reliability and Risk in Gas Protection Design
- CIRIA 149 (1995) - Protecting Development from Methane
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings.

The Building Regulations set action levels for both methane and carbon dioxide from which an initial assessment can be made. The action threshold for methane is 1% while for carbon dioxide an initial consideration should be undertaken if gas concentrations exceed 1.5%.

Action might be required if carbon dioxide concentrations exceed 5%. If these thresholds are exceeded, reference should be made to specific documentation to determine the nature and extent of the gas control measures required.

A Characteristic Situation ranking of between 1 and 6 is given based on the ground gas monitoring results coupled with the gas flow rate. These combined produces a Gas Screening Value (GSV). Where no flow is recorded a flow rate of 0.1l/hr is assumed.

The GSV and risk classification define the characteristic situation, which are comparable to the table below, taken from CIRIA C665, and derived from CIRIA R149. Given that the site will be covered by hardstanding and the buildings will be for commercial land use, the protection measures required are based on CIRIA R149, shown in Table 1 below.

CIRIA R149 GAS REGIMES

Characteristic Situation (CS)	Risk Classification	Gas Screening Value CH4 or CO2 (l/hr)	Additional Factors
1	Very Low Risk	<0.07	*CS1 where CH_4 is <1% and/or CO_2 is <5%, Otherwise increase to CS2*
2	Low Risk	<0.7	
3	Moderate Risk	<3.5	
4	Moderate to High Risk	<15	
5	High Risk	<70	
6	Very High Risk	>70	

The worst case GSV can be taken from the highest flow rate recorded over the visits (0.3l/hr) along with the greatest volume of CO_2 (9.7%). Based on these figures the worst GSV has been calculated as 0.0291(l/hr).

The gas screening values from the monitoring visits would place the site in **Characteristic Situation (CS) 2.** A list of recommended gas protection measures for a commercial development is attached to the rear of this letter.

No radon protection measures are required in accordance with the procedure described in BRE Publication BR211 *Radon: Guidance on Protective Measures for New Dwellings.*

Yours sincerely,



Adrian Cutts
On behalf of Solmek Ltd.



SOLMEK

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Figure Title

Site Location Plan

Project Number

S180236

Project Name

Plots 3-5, Ashroyd Business Park

Client

William Saunders

Date

August 2018

DRG Number

Figure 1

Scale

1:6500 @ A4 [DO NOT SCALE]

Legend Key

Project Bounds - Project Bounds



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Figure Title

BH/TP Location Plan

Project Number

S180236

Project Name

Plots 3-5, Ashroyd Business Park

Client

William Saunders

Date

August 2018

DRG Number

Figure 2

Scale

1:3000 @ A4 [DO NOT SCALE]

Legend Key

- Locations By Type - CP
- Locations By Type - TP
- Project Bounds - Project Bounds

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	1
Date	02/05/2018
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	Cloudy
Ground Conditions	Damp
Ambient Atmospheric Pressure	999
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	999	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	999	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	999	0.0	0.0000	0.9	0.0009	19.2	-	-	3.06	4.00	
BH9	0.3	999	3.8	0.0114	8.8	0.0264	0.0	-	-	3.08	3.50	
BH10	0.1	999	0.0	0.0000	0.0	0.0000	20.3	-	-	0.27	4.00	
BH12	0.1	999	0.0	0.0000	0.1	0.0001	20.2	-	-	0.37	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	2
Date	17/05/2018
Equipment	GFM 435 Gas Analyser
Operator	PF

Weather Conditions	Cloudy
Ground Conditions	Damp
Ambient Atmospheric Pressure	1030
Regional Pressure Trend	Falling

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	1030	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	1030	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	1030	0.0	0.0000	0.6	0.0006	20.1	-	-	3.18	4.00	
BH9	0.1	1030	3.2	0.0032	9.7	0.0097	0.0	-	-	3.15	3.50	
BH10	0.1	1030	0.0	0.0000	0.1	0.0001	19.9	-	-	2.66	4.00	
BH12	0.1	1030	0.0	0.0000	0.0	0.0000	20.4	-	-	1.00	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	3
Date	14/06/2018
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	Cloudy
Ground Conditions	Dry
Ambient Atmospheric Pressure	1002
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	1002	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	1002	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	1002	0.0	0.0000	0.3	0.0003	19.9	-	-	3.21	4.00	
BH9	0.1	1002	1.4	0.0014	4.7	0.0047	11.8	-	-	2.79	3.50	
BH10	0.1	1002	0.0	0.0000	0.5	0.0005	19.8	-	-	3.24	4.00	
BH12	0.1	1002	0.0	0.0000	0.0	0.0000	20.4	-	-	1.00	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	4
Date	02/07/2018
Equipment	GFM 435 Gas Analyser
Operator	MA

Weather Conditions	Sunny
Ground Conditions	Dry
Ambient Atmospheric Pressure	1020
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	1020	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	1020	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	1020	0.0	0.0000	0.7	0.0007	20.1	-	-	3.12	4.00	
BH9	0.1	1020	0.0	0.0000	1.5	0.0015	19.4	-	-	2.99	3.50	
BH10	0.1	1020	0.0	0.0000	0.5	0.0005	20.1	-	-	3.56	4.00	
BH12	0.1	1020	0.0	0.0000	0.0	0.0000	20.6	-	-	1.53	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	5
Date	16/07/2018
Equipment	GFM 435 Gas Analyser
Operator	IN

Weather Conditions	Rain
Ground Conditions	Wet
Ambient Atmospheric Pressure	1016
Regional Pressure Trend	Falling

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	1016	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	1016	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	1016	0.0	0.0000	0.2	0.0002	20.5	-	-	2.50	4.00	
BH9	0.1	1016	0.0	0.0000	0.4	0.0004	19.9	-	-	2.95	3.50	
BH10	0.1	1016	0.0	0.0000	0.0	0.0000	20.5	-	-	2.79	4.00	
BH12	0.1	1016	0.0	0.0000	0.0	0.0000	20.5	-	-	1.60	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

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GAS MONITORING RESULTS

Project number	S180236
Project name	Plots 3-5 Ashroyd Business Park
Client	Wm Saunders
Visit no	6
Date	30/07/2018
Equipment	GFM 435 Gas Analyser
Operator	KM

Weather Conditions	Cloudy
Ground Conditions	Damp
Ambient Atmospheric Pressure	1007
Regional Pressure Trend	Rising

Position	Flow	Pressure	CH4		CO2		O2 (% v/v)	CO (ppm)	H2S (ppm)	Groundwater Level (mbgl)	Depth to Base (mbgl)	Notes
			(% v/v)	GSV (l/hr)	(% v/v)	GSV (l/hr)						
BH1	-	1007	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH4	-	1007	-	-	-	-	-	-	-	-	4.00	Pipe not found/vandalised
BH6	0.1	1007	0.0	0.0000	0.6	0.0006	20.2	-	-	2.50	4.00	
BH9	0.1	1007	0.0	0.0000	1.2	0.0012	19.7	-	-	2.72	3.50	
BH10	0.1	1007	0.0	0.0000	0.5	0.0005	20.2	-	-	2.64	4.00	
BH12	0.1	1007	0.0	0.0000	0.3	0.0003	20.1	-	-	1.45	2.20	

KEY

CH_4 = Methane, **CO_2** = Carbon Dioxide, **O_2** = Oxygen, **CO** = Carbon Monoxide, **H_2S** = Hydrogen Sulphide, **GSV** = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed), ND = Not Detected, * = not measured, N/A = Not applicable, % = % by volume, mbgl = m below ground level, ppm = parts per million.

Gas Protection Measures – Commercial Development

<table>
<tr><th>Characteristic Situation</th><th>Membrane</th><th>Floor Slab</th><th>Sub-floor ventilation</th><th>External ventilation</th><th>Additional measures to reduce gas concentrations in the ground</th></tr>
<tr><td>1</td><td colspan="5">No special precautions</td></tr>
<tr><td rowspan="2">2
(equivalent to basic radon)</td><td rowspan="2">Waterproofing membrane</td><td rowspan="3">Well constructed suspended floor or raft foundation</td><td>Beam & block floors: open void min. 150mm depth (uneconomical for large structures)

Suspended in-situ concrete floors:
20mm single size gravel blanket (min. 300mm thick)
or proprietary void former:
either expanded polystyrene shuttering with equivalent clear void depth of 22mm or geocomposite drainage blanket

Rafts: granular blanket min. 300mm thick (not suitable on sites with high water table)</td><td rowspan="6">Passive venting to atmosphere via bricks / gravel filled trenches / risers as DETR report</td><td></td></tr>
<tr><td rowspan="2">Beam & block floors: open void min. 150mm depth (uneconomical for large structures)

Suspended in-situ concrete floors:
20mm single size gravel blanket with interleaved pipes at 3m centres or proprietary void former:
either expanded polystyrene shuttering with equivalent clear void depth of 22mm or geocomposite drainage blanket

Rafts: granular blanket min. 300mm thick (not suitable on sites with high water table) with drainage pipe network</td><td></td></tr>
<tr><td>3
(Equivalent to full radon)</td><td>Gas resistant membrane (basic)</td></tr>
<tr><td>4</td><td rowspan="3">Gas resistant membrane (with aluminium foil)</td><td rowspan="3">Reinforced concrete cast in situ ground slab or suspended floor</td><td>Beam & block floors: open void min. 150mm depth (uneconomical for large structures)

Suspended in-situ concrete floors: proprietary void former:
geocomposite drainage blanket (structures <7.5m only)
expanded polystyrene shuttering with equivalent clear void depth of 22mm (structures <7.5m only)
expanded polystyrene shuttering with equivalent clear void depth of 100mm (structures >7.5m)</td><td></td></tr>
<tr><td>5</td><td>Beam & block floors; open void min. 150mm depth (uneconomical for large structures)

Suspended in-situ concrete floor (structures <7.5m wide only): proprietary void former – expanded polystyrene shuttering with equivalent clear void depth of 22mm or geocomposite drainage blanket</td><td rowspan="2">Actively ventilated under floor sub-space with monitoring / clean air blanket / in-ground barrier / in-ground venting layer / trenches / wells.</td></tr>
<tr><td>6</td><td>Actively ventilated under floor sub-space with monitoring</td></tr>
</table>

♠Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2018)

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party invoiced) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek. Solmek was a trading name of Hymas Geoenvironmental Ltd.

Solmek cannot be held liable and do not warrant, or otherwise guarantee the validity of information provided by third parties and subsequently used in our reports. Solmek are not responsible for the action negligent of otherwise of subcontractors or third parties.

Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2001 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional indemnity Insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.