TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Mr Jonathan Bourne
Bourne Amenity Ltd
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22nd February 2023
Our Ref: TOHA/23/7818/2/SS
Your Ref: PO 114359

Dear Sirs

Soil Analysis Report: Intensive Lightweight Subsoil

We have completed the analysis of the soil sample recently submitted, referenced *Intensive Lightweight Subsoil*, and have pleasure reporting our findings.

The purpose of the analysis was to determine the suitability of the material for use as a lightweight subsoil in a rooftop or podium garden environment.

This report presents the results of analysis for the sample submitted to our office, and it should be considered 'indicative' of the soil source. The report and results should therefore not be used by third parties as a means of verification or validation testing, waste designation purposes, or for any project-specific applications especially after the soil has left the Bourne Amenity Ltd site.

SAMPLE EXAMINATION

The sample was described as a yellowish brown (Munsell Colour 10YR 5/6), slightly moist, friable, non-calcareous SAND with a single grain structure. The sample was free of stone-sized material, with the exception of frequent lightweight expanded clay aggregate particles (leca). No deleterious materials, unusual odours, roots or rhizomes of pernicious weeds were observed.

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Plate 1: Intensive Lightweight Subsoil Sample

ANALYTICAL SCHEDULE

The sample was submitted to a UKAS and MCERTS accredited laboratory for a range of physical and chemical tests to confirm the composition and fertility of the soil, and the concentration of selected potential contaminants. The following parameters were determined:

- detailed particle size analysis (5 sands, silt, clay);
- stone content (2-20mm, 20-50mm, >50mm);
- bulk density (oven dry, field capacity, saturated);
- saturated hydraulic conductivity;
- porosity;
- particle density;
- visible contaminants (>2mm);
- pH and electrical conductivity values;
- calcium carbonate;
- exchangeable sodium percentage;
- organic matter content;
- heavy metals (Sb, As, B, Ba, Be, Cd, Cr, Cr VI, Cu, Pb, Hg, Ni, Se, V, Zn);
- soluble sulphate, elemental sulphur, acid volatile sulphide;
- total cyanide and total (mono) phenols;
- aromatic and aliphatic TPH (C5-C35 banding);
- speciated PAHs (US EPA16 suite);
- benzene, toluene, ethylbenzene, xylene (BTEX);
- asbestos screen.

The results are presented on the attached Certificate of Analysis and an interpretation of the results is given below.

RESULTS OF ANALYSIS

Particle Size Analysis & Stone Content

The sample fell into the *sand* texture class and would be described as light in texture. Further detailed particle size analysis revealed the sample to have a narrow particle size distribution and a predominance of *medium sand* (0.25-0.50mm), followed by *coarse sand* (0.50-1.0mm). This is acceptable for subsoil for podium or roof garden environments as porosity levels are maintained under a degree of consolidation and the risk of particle interpacking is minimised.

With the exception of 'leca' particles, the sample was virtually free of 'stone' sized material (>2mm).

Bulk Density, Saturated Hydraulic Conductivity and Porosity

The sample displayed slightly lower bulk density values compared to those typically recorded for the base material without the addition of leca. The suitability of the bulk density results for the requirements of the recipient site should be confirmed by the project engineer.

The saturated hydraulic conductivity of the sample was very high (8.4 mm/minute or 504 mm/hour), and would be described as 'free-draining'. The appropriateness of this drainage rate will depend on the specifics of any particular roof garden design (e.g. overall soil depths, topsoil media performance, plant species selection, irrigation provision, environmental conditions).

The sample displayed a satisfactory total porosity value.

pH and Electrical Conductivity Values

The sample was strongly alkaline in reaction (pH 8.1) with a low calcium carbonate (lime) content. Therefore, the pH recorded is likely to be influenced by the very low buffering capacity of the material as a result of its very high sand and very low organic matter content. As such, this pH value should not significantly restrict species selection.

The electrical conductivity (salinity) values (water and $CaSO_4$ extracts) were low, which indicates that soluble salts should not be present at levels that would be harmful to plants.

Organic Matter

The organic matter content was low (<0.5%).

Potential Contaminants

In the absence of site-specific criteria, the concentrations that affect human health have been assessed for *residential with homegrown produce* end-use against the Suitable For Use Levels (S4ULs) presented in the LQM/CIEH S4ULs for Human Health Risk Assessment (2015) and the DEFRA SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document (2014).

Of the potential contaminants determined, none was found at levels that exceed their guideline values.

Phytotoxic Contaminants

Of the phytotoxic (toxic to plants) contaminants determined (copper, nickel, zinc), none was found at levels that exceeded their guideline values.

CONCLUSION

The purpose of the analysis was to determine the suitability of the material for use as a lightweight subsoil for landscaping purposes in a rooftop garden environment.

From the sample examination and laboratory analysis, the substrate was described as a strongly alkaline, non-saline, non-calcareous sand with a single grain structure and low stone content with frequent leca particles. The sample possessed a very high saturated hydraulic conductivity and satisfactory total porosity value. The organic matter content was low. Of the potential contaminants determined, none exceeded their respective guideline values.

Based on our findings, the substrate represented by this sample should be suitable for use as a lightweight subsoil in a roof garden environment where a free-draining subsoil is required. The suitability of the bulk density and saturated hydraulic conductivity results should be confirmed by the project engineer and landscape designer.

Soil Handling Recommendations

It is important to maintain the physical condition of the soil and avoid structural damage during all phases of soil handling (e.g. stockpiling, respreading, cultivating, planting, seeding or turfing). As a consequence, soil handling operations should be carried out when soil is reasonably dry and non-plastic (friable) in consistency.

It is important to ensure that the soil is not unnecessarily compacted by trampling or trafficking by site machinery, and soil handling should be stopped during and after heavy rainfall and not continued until the soil is friable in consistency. If the soil is structurally damaged and compacted at any stage during the course of soiling or landscaping works, it should be cultivated appropriately to relieve the compaction and to restore the soil's structure prior to any planting, turfing or seeding.

We hope this report meets with your approval and provides the necessary information. Please do not hesitate to contact the undersigned if we can be of further assistance.

Yours faithfully

Harriet MacRae
BSc MSc
Graduate Soil Scientist

Matthew Heins
BSc (Hons) MISoilSci
Senior Soil Scientist

For & on behalf of Tim O'Hare Associates LLP

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Bourne Amenity Ltd**
Project	**Lightweight Subsoil for Roof Gardens**
Job:	**Physical and Horticultural Properties**
Date:	**22/02/2023**
Job Ref No:	**TOHA/23/7818/2/SS**

Sample Reference			**Intensive Lightweight Subsoil**
		Accreditation	
Clay (<0.002mm)	%	UKAS	2
Silt (0.002-0.063mm)	%	UKAS	1
Very Fine Sand (0.05-0.15mm)	%	UKAS	3
Fine Sand (0.15-0.25mm)	%	UKAS	10
Medium Sand (0.25-0.50mm)	%	UKAS	48
Coarse Sand (0.50-1.0mm)	%	UKAS	30
Very Coarse Sand (1.0-2.0mm)	%	UKAS	6
Total Sand (0.05-2.0mm)		UKAS	97
Texture Class (UK Classification)	--	UKAS	S
Stones (2-20mm)	% DW	UKAS	1
Stones (20-50mm)	% DW	UKAS	0
Stones (>50mm)	% DW	UKAS	0
Bulk Density (at Field Capacity)	g/cm^3	A2LA	1.71
Bulk Density (at Saturation)	g/cm^3	A2LA	1.75
Bulk Density (when Oven Dried)	g/cm^3	A2LA	1.36
Field Capacity	% v/v	A2LA	35
Particle Density	g/cm^3	A2LA	2.25
Saturated Hydraulic Conductivity	mm/hr	A2LA	504
	mm/min		8.4
Total Porosity	%	A2LA	40
Porosity at Field Capacity		A2LA	4
pH Value (1:2.5 water extract)	units	UKAS	8.1
Calcium Carbonate	%	UKAS	< 1.0
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	220
Electrical Conductivity (1:2 $CaSO_4$ extract)	uS/cm	UKAS	2206
Exchangeable Sodium Percentage	%	UKAS	3.2
Organic Matter (LOI)	%	UKAS	<0.5
Visible Contaminants: Plastics >2.00mm	%	UKAS	0
Visible Contaminants: Sharps >2.00mm	%	UKAS	0

S = SAND

Visual Examination

The sample was described as a yellowish brown (Munsell Colour 10YR 5/6), slightly moist, friable, non-calcareous SAND with a single grain structure. The sample was free of stone-sized material, with the exception of frequent lightweight expanded clay aggregate particles (leca). No deleterious materials, unusual odours, roots or rhizomes of pernicious weeds were observed.

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Graduate Soil Scientist

Results of analysis should be read in conjunction with the report they were issued with

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Client:	**Bourne Amenity Ltd**
Project	**Lightweight Subsoil for Roof Gardens**
Job:	**Chemical Properties**
Date:	**22/02/2023**
Job Ref No:	**TOHA/23/7818/2/SS**

Sample Reference			**Intensive Lightweight Subsoil**
		Accreditation	
Total Antimony (Sb)	mg/kg	MCERTS	<1.0
Total Arsenic (As)	mg/kg	MCERTS	12
Total Barium (Ba)	mg/kg	MCERTS	12
Total Beryllium (Be)	mg/kg	MCERTS	0.25
Total Cadmium (Cd)	mg/kg	MCERTS	0.2
Total Chromium (Cr)	mg/kg	MCERTS	5
Hexavalent Chromium (Cr VI)	mg/kg	MCERTS	< 1.8
Total Copper (Cu)	mg/kg	MCERTS	5
Total Lead (Pb)	mg/kg	MCERTS	4
Total Mercury (Hg)	mg/kg	MCERTS	< 0.3
Total Nickel (Ni)	mg/kg	MCERTS	13
Total Selenium (Se)	mg/kg	MCERTS	< 1.0
Total Vanadium (V)	mg/kg	MCERTS	16
Total Zinc (Zn)	mg/kg	MCERTS	25
Water Soluble Boron (B)	mg/kg	MCERTS	0.3
Total Cyanide (CN)	mg/kg	MCERTS	< 1.0
Total (mono) Phenols	mg/kg	MCERTS	< 1.0
Elemental Sulphur (S)	mg/kg	MCERTS	< 5.0
Water Soluble Sulphate (SO_4)	g/l	MCERTS	12
Naphthalene	mg/kg	MCERTS	< 0.05
Acenaphthylene	mg/kg	MCERTS	< 0.05
Acenaphthene	mg/kg	MCERTS	< 0.05
Fluorene	mg/kg	MCERTS	< 0.05
Phenanthrene	mg/kg	MCERTS	< 0.05
Anthracene	mg/kg	MCERTS	< 0.05
Fluoranthene	mg/kg	MCERTS	< 0.05
Pyrene	mg/kg	MCERTS	< 0.05
Benzo(a)anthracene	mg/kg	MCERTS	< 0.05
Chrysene	mg/kg	MCERTS	< 0.05
Benzo(b)fluoranthene	mg/kg	MCERTS	< 0.05
Benzo(k)fluoranthene	mg/kg	MCERTS	< 0.05
Benzo(a)pyrene	mg/kg	MCERTS	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	MCERTS	< 0.05
Dibenzo(a,h)anthracene	mg/kg	MCERTS	< 0.05
Benzo(g,h,i)perylene	mg/kg	MCERTS	< 0.05
Total PAHs (sum USEPA16)	mg/kg	MCERTS	< 0.80
Aliphatic TPH >C5 - C6	mg/kg	MCERTS	< 0.001
Aliphatic TPH >C6 - C8	mg/kg	MCERTS	< 0.001
Aliphatic TPH >C8 - C10	mg/kg	MCERTS	< 0.001
Aliphatic TPH >C10 - C12	mg/kg	MCERTS	< 1.0
Aliphatic TPH >C12 - C16	mg/kg	MCERTS	< 2.0
Aliphatic TPH >C16 - C21	mg/kg	MCERTS	< 8.0
Aliphatic TPH >C21 - C35	mg/kg	MCERTS	< 8.0
Aliphatic TPH (C5 - C35)	mg/kg	MCERTS	< 10
Aromatic TPH >C5 - C7	mg/kg	MCERTS	< 0.001
Aromatic TPH >C7 - C8	mg/kg	MCERTS	< 0.001
Aromatic TPH >C8 - C10	mg/kg	MCERTS	< 0.001
Aromatic TPH >C10 - C12	mg/kg	MCERTS	< 1.0
Aromatic TPH >C12 - C16	mg/kg	MCERTS	< 2.0
Aromatic TPH >C16 - C21	mg/kg	MCERTS	< 10
Aromatic TPH >C21 - C35	mg/kg	MCERTS	< 10
Aromatic TPH (C5 - C35)	mg/kg	MCERTS	< 10
Benzene	mg/kg	MCERTS	< 0.005
Toluene	mg/kg	MCERTS	< 0.005
Ethylbenzene	mg/kg	MCERTS	< 0.005
p & m-xylene	mg/kg	MCERTS	< 0.005
o-xylene	mg/kg	MCERTS	< 0.005
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	MCERTS	< 0.005
Asbestos Screen	ND/D	ISO 17025	Not-detected

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