



TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Mr Drew Wetherell
Bourne Amenity Ltd
The Wharf
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26th March 2018
Our Ref: TOHA/18/7517/2/SS
Your Ref: PO32907

Dear Sirs

Soil Analysis Report: Lightweight Subsoil

We have completed the analysis of the soil sample recently submitted, referenced *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 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 or waste designation purposes, especially after the soil has left the Bourne Amenity Ltd site.

SAMPLE EXAMINATION

The sample was described as a strong brown (Munsell Colour 7.5YR 5/6), moist, friable, very slightly calcareous SAND with a single grain structure*. The sample was slightly stony and contained frequent lightweight expanded clay aggregate particles (leca). No deleterious materials, unusual odours, roots or rhizomes of pernicious weeds were observed.

* This appraisal of soil structure was made from examination of a disturbed sample(s). Structure is a key soil characteristic that may only be accurately assessed by examination in an in-situ state.

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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 (dry and saturated);
- permeability and porosity;
- water holding capacity;
- 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-C44 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

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 sufficiently narrow particle size distribution and a predominance of *medium sand* (0.25-0.50mm) and *coarse sand* (0.50-1.0mm). This is acceptable for subsoil for roof garden environments as porosity levels are maintained under a degree of consolidation and the risk of particle interpacking is minimised.

The 'stone' sized fraction (>2mm) of the sample was low (by mass), comprising leca particles. The proportion of stone sized particles recorded would be considered acceptable for a roof garden subsoil.

Bulk Density, Permeability and Porosity

The sample displayed a reasonably low bulk density value (1.70 Mg/m³) compared to that typically recorded for this type of material without the addition of leca.

The permeability and porosity tests were designed to test the substrate's drainage, aeration and water-storage capacities.

The permeability rate of the sample was moderately high (234 mm/hour), and indicates a suitable drainage rate for a lightweight subsoil.

The sample displayed a satisfactory total porosity value, with a predominance of capillary pores.

pH and Electrical Conductivity Values

The sample was alkaline in reaction (pH 7.5). This pH value would be considered suitable as subsoil for landscape purposes, providing species with a wide pH tolerance or those known to prefer alkaline soils are selected for planting, turfing and seeding.

The electrical conductivity (salinity) value (water extract) was low, which indicates that soluble salts should not be present at levels that would be harmful to plants.

The electrical conductivity value by CaSO₄ extract fell below our maximum recommended value (3300 µS/cm).

Organic Matter

The organic matter content was low (<2%) and consistent with that of subsoil.

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 an alkaline, non-saline, very slightly calcareous sand with a low stone content, including frequent leca particles. The sample possessed a moderately high permeability rate and satisfactory porosity values. The organic matter content was low. Of the potential contaminants determined, none exceeded their respective guideline values.

Based on our findings so far, the substrate represented by this sample should be suitable for use as a lightweight growing medium in roof garden environments, provided the bulk density is appropriate for the weight allowance for the proposed scheme. The soil would be suited to species with a wide pH tolerance or those known to prefer alkaline soils.

RECOMMENDATIONS

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, resspreading, 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. If the soil is compacted at any stage during the course of soiling or landscaping works, it should be cultivated appropriately to relieve the compaction.

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



Rebecca Hollands
BSc MSc AMIAgrE
Soil Scientist



Ceri Spears
BSc MSc MISoilSci
Senior Associate

For & on behalf of Tim O'Hare Associates LLP



Client:	Bourne Amenity Ltd
Project	Lightweight Subsoil for Roof Gardens
Job:	Physical and Horticultural Properties
Date:	26/03/2018
Job Ref No:	TOHA/18/7517/2/SS

Sample Reference		
		Accreditation
Clay (<0.002mm)	%	UKAS
Silt (0.002-0.063mm)	%	UKAS
Very Fine Sand (0.05-0.15mm)	%	UKAS
Fine Sand (0.15-0.25mm)	%	UKAS
Medium Sand (0.25-0.50mm)	%	UKAS
Coarse Sand (0.50-1.0mm)	%	UKAS
Very Coarse Sand (1.0-2.0mm)	%	UKAS
Texture Class (UK Classification)	--	UKAS
Stones (2-20mm)	% DW	UKAS
Stones (20-50mm)	% DW	UKAS
Stones (>50mm)	% DW	UKAS

Lightweight Subsoil

3
1
1
7
50
35
3
S
7
0
0

Bulk Density (at 'as received' Moisture Content)	Mg/m ³	UKAS
Bulk Density (at Field Capacity)	Mg/m ³	UKAS
Moisture Content (as received)	%	UKAS
Moisture Content (at Field Capacity)	%	UKAS
Water Holding Capacity (at 0.33 Bar)	%	GLP

1.57
1.70
10
19
3.4

Falling Head Permeability (standard compaction)	mm/hr	UKAS
Total Porosity	%	UKAS
Air-Filled Porosity	%	UKAS
Capillary Porosity	%	UKAS

234
38
11
28

pH Value (1:2.5 water extract)	units	UKAS
Calcium Carbonate	%	UKAS
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS
Electrical Conductivity (1:2 CaSO ₄ extract)	uS/cm	UKAS
Exchangeable Sodium Percentage	%	UKAS

7.5
0.2
164
2029
2.0

Organic Matter (LOI)	%	UKAS
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<0.5

Visible Contaminants: Plastics >2.00mm	%	UKAS
Visible Contaminants: Sharps >2.00mm	%	UKAS

0
0

S = SAND

Visual Examination

The sample was described as a strong brown (Munsell Colour 7.5YR 5/6), moist, friable, very slightly calcareous SAND with a single grain structure. The sample was slightly stony and contained frequent lightweight expanded clay aggregate particles (leca). No deleterious materials, unusual odours, roots or rhizomes of pernicious weeds were observed.

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Client:	Bourne Amenity Ltd
Project	Lightweight Subsoil for Roof Gardens
Job:	Chemical Properties
Date:	26/03/2018
Job Ref No:	TOHA/18/7517/2/SS

Sample Reference		Accreditation
Total Antimony (Sb)	mg/kg	MCERTS
Total Arsenic (As)	mg/kg	MCERTS
Total Barium (Ba)	mg/kg	MCERTS
Total Beryllium (Be)	mg/kg	MCERTS
Total Cadmium (Cd)	mg/kg	MCERTS
Total Chromium (Cr)	mg/kg	MCERTS
Hexavalent Chromium (Cr VI)	mg/kg	MCERTS
Total Copper (Cu)	mg/kg	MCERTS
Total Lead (Pb)	mg/kg	MCERTS
Total Mercury (Hg)	mg/kg	MCERTS
Total Nickel (Ni)	mg/kg	MCERTS
Total Selenium (Se)	mg/kg	MCERTS
Total Vanadium (V)	mg/kg	MCERTS
Total Zinc (Zn)	mg/kg	MCERTS
Water Soluble Boron (B)	mg/kg	MCERTS
Total Cyanide (CN)	mg/kg	MCERTS
Total (mono) Phenols	mg/kg	MCERTS
Elemental Sulphur (S)	mg/kg	MCERTS
Acid Volatile Sulphide (S)	mg/kg	MCERTS
Water Soluble Sulphate (SO ₄)	g/l	MCERTS

Lightweight Subsoil

<1.0
7
8
0.49
<0.2
12
<4.0
3
4
<0.3
11
<1.0
28
12
0.6
<1.0
<1.0
<5.0
2.7
0.06

Naphthalene	mg/kg	MCERTS
Acenaphthylene	mg/kg	MCERTS
Acenaphthene	mg/kg	MCERTS
Fluorene	mg/kg	MCERTS
Phenanthrene	mg/kg	MCERTS
Anthracene	mg/kg	MCERTS
Fluoranthene	mg/kg	MCERTS
Pyrene	mg/kg	MCERTS
Benzo(a)anthracene	mg/kg	MCERTS
Chrysene	mg/kg	MCERTS
Benzo(b)fluoranthene	mg/kg	MCERTS
Benzo(k)fluoranthene	mg/kg	MCERTS
Benzo(a)pyrene	mg/kg	MCERTS
Indeno(1,2,3-cd)pyrene	mg/kg	MCERTS
Dibenzo(a,h)anthracene	mg/kg	MCERTS
Benzo(g,h,i)perylene	mg/kg	MCERTS
Total PAHs (sum USEPA16)	mg/kg	MCERTS

< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.05
< 0.8

Aliphatic TPH >C5 - C6	mg/kg	MCERTS
Aliphatic TPH >C6 - C8	mg/kg	MCERTS
Aliphatic TPH >C8 - C10	mg/kg	MCERTS
Aliphatic TPH >C10 - C12	mg/kg	MCERTS
Aliphatic TPH >C12 - C16	mg/kg	MCERTS
Aliphatic TPH >C16 - C21	mg/kg	MCERTS
Aliphatic TPH >C21 - C35	mg/kg	MCERTS
Aliphatic TPH >C35 - C44	mg/kg	MCERTS
Aliphatic TPH (C5 - C35)	mg/kg	MCERTS
Aromatic TPH >C5 - C7	mg/kg	MCERTS
Aromatic TPH >C7 - C8	mg/kg	MCERTS
Aromatic TPH >C8 - C10	mg/kg	MCERTS
Aromatic TPH >C10 - C12	mg/kg	MCERTS
Aromatic TPH >C12 - C16	mg/kg	MCERTS
Aromatic TPH >C16 - C21	mg/kg	MCERTS
Aromatic TPH >C21 - C35	mg/kg	MCERTS
Aromatic TPH >C35 - C44	mg/kg	MCERTS
Aromatic TPH (C5 - C35)	mg/kg	MCERTS

< 0.001
< 0.001
< 0.001
< 1.0
< 2.0
< 8.0
< 8.0
<8.4
<10.0
< 0.001
< 0.001
< 0.001
< 1.0
< 2.0
< 10.0
< 10.0
< 10.0
<8.4
<10.0

Benzene	mg/kg	MCERTS
Toluene	mg/kg	MCERTS
Ethylbenzene	mg/kg	MCERTS
p & m-xylene	mg/kg	MCERTS
o-xylene	mg/kg	MCERTS
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	MCERTS

< 0.001
< 0.001
< 0.001
< 0.001
< 0.001
< 0.001

Asbestos Screen	ND/D	ISO 17025
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Not-detected

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