TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Mr Drew Wetherell
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The Wharf
Newenden
Cranbrook
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24th January 2022
Our Ref: TOHA/21/7247/1/SS
Your Ref: PO 79810

Dear Sirs

Urban Tree Soil Analysis Report – Structural Tree Sand, Sevenoaks

We have completed the analysis and testing of the sample recently submitted, referenced *Structural Tree Sand,* and have pleasure reporting our findings.

The purpose of the analysis was to determine the suitability of the rootzone sample for use as urban tree soil for tree planting in hard landscape situations.

This report presents the results of analysis for the sample submitted to our office, and it should be considered 'indicative' of the rootzone 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 rootzone has left the Bourne Amenity Ltd site.

SAMPLE EXAMINATION

The sample was described as a yellow brown (Munsell Colour 10YR 5/4), slightly moist, friable, non-calcareous SAND with a single grain structure*. The sample was virtually stone-free and contained a moderate proportion of organic fines and occasional woody fragments. No unusual odours, deleterious materials, 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.

ANALYTICAL SCHEDULE

The sample was submitted to the laboratory for a range of physical and chemical analyses in accordance with the following schedule:

Geotechnical Properties

- permeability;
- total, air-filled and capillary porosity;
- bulk density;
- California Bearing Ratio (CBR);

Horticultural Properties

- detailed particle size distribution;
- stone content;
- moisture content;
- pH value;
- calcium carbonate
- electrical conductivity value;
- exchangeable sodium percentage;
- major plant nutrients (N, P, K, Mg);
- organic matter content;
- C:N ratio;
- visible contaminants (>2.00mm).

Environmental Properties

- heavy metals (Sb, As, B, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn);
- total cyanide and total (mono) phenols;
- elemental sulphur, acid volatile sulphur and water soluble sulphate;
- 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 Distribution and Stone Content

The sample fell into the *sand* texture class. The grading of the sand indicates a sufficiently narrow particle size distribution and a predominance of *medium sand* (0.25-0.50mm), followed by *coarse sand* (0.50-1.0mm). This is ideal for 'structural soils' as sufficient porosity levels are maintained in a compacted state and the risk of particle interpacking is minimised.

The stone content of the sample was low and, as such, stones should not restrict the use of the rootzone for landscape purposes.

Permeability and Porosity

The permeability of the sample when in a compacted state (Standard Compaction) was high (87 mm/hr) and satisfactory for tree planting in hard landscape situations.

The total porosity result recorded was satisfactory for urban tree soil in a compacted state, but this comprised mainly capillary pores. This indicates that the sample should have a reasonable water-holding capacity, however, the low proportion of larger, air-filled pores suggests that, in its compacted state, there could be reduced aeration for root function.

California Bearing Ratio

A re-compacted California Bearing Ratio (CBR) was completed as part of the engineering testing undertaken on the sample. The sample was re-compacted using the 2.5kg rammer at the as received moisture content (13%) and the sample returned a minimum CBR of 9.0%. Assuming that the in-situ compaction method selected during installation provides similar levels of compaction to that of the laboratory test, the in-situ performance of the material should be able to achieve a similar result (provided it is compacted at the same moisture content).

As the performance of the rootzone will be linked to the moisture content at time of compaction, further work may be required in order to correlate the change in engineering performance of the material over the range of moisture contents at which the rootzone is likely to be placed and compacted.

We recommend a more conservative approach with the performance of the material, and as opposed to declaring a CBR value of 15%, we would quote "should achieve a CBR in excess of 5%..." The 5% CBR value is important as this is the lower limit for the sub-grade for the minimum construction thickness of pavements.

pH and Electrical Conductivity Values

The sample was extremely alkaline in reaction (pH 9.0), with a pH value that exceeded the maximum specified value (pH 8.5). However, further analysis of the calcium carbonate (lime) content of the soil found the level to be low. Therefore, the high pH recorded is likely to be due to the very low buffering capacity of the high sand content material.

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

The electrical conductivity value by $CaSO_4$ extract fell below our maximum recommended value (3300 µS/cm).

Organic Matter and Fertility Status

The sample was adequately supplied with organic matter and most major plant nutrients in relation to use as urban tree soil but was slightly deficient in total nitrogen. This can be remedied by an appropriate fertiliser application. Longer term nutrient retention could be improved with an appropriate soil conditioner

The C:N ratio was acceptable for landscape purposes.

Potential Contaminants

With reference to *BS3882:2015 - Table 1*: Notes 3 and 4, there is a recommendation to confirm levels of potential contaminants in relation to the topsoil's proposed end use. This includes human health, environmental protection and metals considered toxic to plants. In the absence of site-specific assessment criteria, the concentrations that affect human health have been compared with the *residential without home grown produce* land use in 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* (C4SLs) *for Assessment of Land Affected by Contamination – Policy Companion Document* (2014).

Of the potential contaminants determined, none exceeded their respective guideline values.

Phytotoxic Contaminants

Of the phytotoxic (toxic to plants) contaminants determined (copper, nickel, zinc), none was found at levels that exceeded the maximum permissible levels specified in *BS3882:2015 – Table 1*.

CONCLUSION

The purpose of the analysis was to determine the suitability of the rootzone sample for use as urban tree soil for tree planting in hard landscape situations.

From the visual examination and laboratory analysis undertaken, the sample can be described as a strongly alkaline, non-calcareous, non-saline, medium to coarse SAND with low stone content. The material contained sufficient levels of organic matter and most major plant nutrients, but was slightly deficient in total nitrogen. Of the potential contaminants determined, none exceeded their respective guideline values.

Based on our findings, the horticultural and geotechnical properties of the rootzone represented by this sample would be considered suitable for an urban tree soil for tree planting in hard landscape, However, its reduced air-filled porosity indicates that when the soil is in a compacted state, aeration levels may be a little low. As such, measures may need to be included within the tree pit design to mitigate this (e.g. additional aeration points).

In order to minimise the risk of anaerobic (oxygen depleted) soil conditions developing within the tree pit, this rootzone should not be placed deeper than 600mm. A suitable washed sand, preferably with the same particle size distribution as this sample, should be used beneath the tree soil.

In addition, the nutrient deficiencies should be addressed by a routine fertiliser application, with nutrient retention improved with an appropriate soil conditioner.

RECOMMENDATIONS

Fertiliser Application

To address the nutrient deficiencies and to help promote effective tree establishment, we recommend applying and incorporating the compound, slow release fertiliser *ICL Enmag CRF* (11%N:22%P_2O_5:9%K_2O:6%MgO) at a rate of 70 g/m^2 into the upper 200 mm layer of rootzone prior to consolidation of this layer.

Soil Conditioner

To improve the water and nutrient retention capacities of this soil, we recommend application and incorporation of a suitable soil conditioner, e.g. *TerraCottem "Complement"*, at the manufacturers recommended rate into each layer of the rootzone prior to consolidation.

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We hope this report meets with your approval. Please call us if you wish to talk through the findings and recommendations.

Yours faithfully

Ceri Spears
BSc MSc MISoilSci
Senior Associate

For and on behalf of Tim O'Hare Associates LLP

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Bourne Amenity Ltd**
Project	**Structural Tree Sand Analysis**
Testing:	**Geotechnical Properties**
Date:	**January 2022**
Job Ref No:	**TOHA/21/7247/1/SS**

Sample Reference			**Structural Tree Sand**
		Accreditation	
Clay (<0.002mm)	%	UKAS	3
Silt (0.002-0.05mm)	%	UKAS	1
Very Fine Sand (0.05-0.15mm)	%	UKAS	3
Fine Sand (0.15-0.25mm)	%	UKAS	11
Medium Sand (0.25-0.50mm)	%	UKAS	58
Coarse Sand (0.50-1.0mm)	%	UKAS	21
Very Coarse Sand (1.0-2.0mm)	%	UKAS	3
Total Sand (0.05-2.0mm)	%	UKAS	96
Texture Class (UK Classification)	--	UKAS	S
Stones (2-20mm)	% DW	GLP	1
Stones (20-50mm)	% DW	GLP	0
Stones (>50mm)	% DW	GLP	0

Visible Contaminants: Plastics >2.00mm	%	UKAS	0
Visible Contaminants: Sharps >2.00mm	%	UKAS	0

Determination of Permeability and Porosity - K H Volume 10.7 method			
Initial Height	mm	UKAS	130.0
Initial Diameter	mm	UKAS	100.0
Particle Density	Mg/m^3	UKAS	2.53
Initial Bulk Density	Mg/m^3	UKAS	1.68
Final Bulk Density	Mg/m^3	UKAS	1.85
Initial Moisture Content	%	UKAS	14
Final Moisture Content	%	UKAS	26
Initial Dry Density	Mg/m^3	UKAS	1.47
Final Dry Density	Mg/m^3	UKAS	1.47
Total Porosity (Initial)	%	UKAS	42
Total Porosity (Final)	%	UKAS	42
Air Filled Porosity (Initial)	%	UKAS	21
Air Filled Porosity (Final)	%	UKAS	4
Capillary Porosity (Initial)	%	UKAS	21
Capillary Porosity (Final)	%	UKAS	38
Permeability	mm/hr	UKAS	87

California Bearing Ratio - BS 1377-4:1990:Method 7.4			
Moisture Content (Initial)	%	UKAS	13
Moisture Content (Top)	%	UKAS	13
Moisture Content (Base)	%	UKAS	13
Moisture Content (Mean)	%	UKAS	13
Initial Bulk Density	Mg/m^3	UKAS	1.71
Initial Dry Density	Mg/m^3	UKAS	1.51
CBR Top	%	UKAS	9.0
CBR Base	%	UKAS	9.3

Determination of Permeability and Porosity - K H Volume 10.7 method

Notes
Material recompacted at the 'as-received' moisture with a 2.5kg rammer
Sample is assumed to be fully saturated when a rate of steady flow is achieved
Permeability is determined when sample achieved a state of steady flow

Determination of California Bearing Ratio - BS 1377-4:1990:Method 7.4

Notes
Material recompacted at the 'as-received' moisture with a 2.5kg rammer
Sample tested in an unsoaked condition
Applied Seating Load (top) : 48N
Applied Seating Load (base) : 48N
Applied Surcharge : 12.5kg

S = SAND

Visual Examination

The sample was described as a yellow brown (Munsell Colour 10YR 5/4), slightly moist, friable, non-calcareous SAND with a single grain structure. The sample was virtually stone-free and contained a moderate proportion of organic fines and occasional woody fragments. No unusual odours, deleterious materials, roots or rhizomes of pernicious weeds were observed.

Ceri Spears
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Senior Associate

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

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Client:	**Bourne Amenity Ltd**
Project	**Structural Tree Sand Analysis**
Testing:	**Horticultural and Environmental Properties**
Date:	**January 2022**
Job Ref No:	**TOHA/21/7247/1/SS**

Sample Reference			**Structural Tree Sand**
		Acreditation	
pH Value (1:2.5 water extract)	units	UKAS	8.0
Calcium Carbonate	%	UKAS	< 1.0
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	692
Electrical Conductivity (1:2 $CaSO_4$ extract)	uS/cm	UKAS	2990
Exchangeable Sodium Percentage	%	UKAS	4.9
Organic Matter (LOI)	%	UKAS	1.9
Total Nitrogen (Dumas)	%	UKAS	0.09
C : N Ratio	ratio	UKAS	12
Extractable Phosphorus	mg/l	UKAS	31
Extractable Potassium	mg/l	UKAS	695
Extractable Magnesium	mg/l	UKAS	62
Total Antimony (Sb)	mg/kg	MCERTS	<1.0
Total Arsenic (As)	mg/kg	MCERTS	6
Total Barium (Ba)	mg/kg	MCERTS	7.5
Total Beryllium (Be)	mg/kg	MCERTS	0.2
Total Cadmium (Cd)	mg/kg	MCERTS	< 0.2
Total Chromium (Cr)	mg/kg	MCERTS	10
Hexavalent Chromium (Cr VI)	mg/kg	MCERTS	< 4.0
Total Copper (Cu)	mg/kg	MCERTS	9
Total Lead (Pb)	mg/kg	MCERTS	7
Total Mercury (Hg)	mg/kg	MCERTS	< 0.3
Total Nickel (Ni)	mg/kg	MCERTS	8
Total Selenium (Se)	mg/kg	MCERTS	< 1.0
Total Vanadium (V)	mg/kg	MCERTS	20
Total Zinc (Zn)	mg/kg	MCERTS	27
Water Soluble Boron (B)	mg/kg	MCERTS	0.7
Total Cyanide (CN)	mg/kg	MCERTS	< 1.0
Total (mono) Phenols	mg/kg	MCERTS	< 1.0
Elemental Sulphur	mg/kg	MCERTS	< 5.0
Acid Volatile Sulphide	mg/kg	MCERTS	< 1.0
Water Soluble Sulphate (SO_4)	g/l	MCERTS	0.25
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	< 0.001
Toluene	mg/kg	MCERTS	< 0.001
Ethylbenzene	mg/kg	MCERTS	< 0.001
p & m-xylene	mg/kg	MCERTS	< 0.001
o-xylene	mg/kg	MCERTS	< 0.001
MTBE (Methyl Tertiary Butyl Ether)	mg/kg	MCERTS	< 0.001
Asbestos	ND/D	ISO 17025	Not-Detected

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