



TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

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20th April 2023
Our Ref: TOHA/23/7921/SS
Your Ref: see below

Dear Sirs

Soil Analysis Report: Green Roof Extensive Substrate

We have completed a review of the supplied data for sample referenced *Green Roof Extensive Substrate (BH-EX2)* (STRI Report - Sample No: A20130/1 - 31/03/23) and have pleasure providing the following comments.

The purpose of the analysis was to determine the suitability of the material for use as an extensive lightweight substrate in a rooftop garden environment. In addition, this sample has been assessed to determine its compliance with the requirements of the British Standard for Green Roofs (*BS8616:2019 – Specification for performance parameters and test methods for green roof substrates*).

This report presents the interpretation of laboratory results submitted to our office, and it should be considered 'indicative' of the substrate 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 application, especially after the substrate has left the Bury Hill Landscape Supplies Ltd site.

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LABORATORY ANALYSIS

The sample was submitted to STRI for a range of physical and chemical analyses. The following parameters were determined:

- detailed particle size analysis (5 sands & gravel, silt, clay);
- saturated hydraulic conductivity;
- bulk density;
- porosity;
- pH value;
- electrical conductivity values (water and CaSO₄ extracts);
- organic matter content;
- plant available phosphate;
- plant available potassium;
- total nitrogen;
- carbon:nitrogen ratio;
- heavy metals (Cu, Cd, Pb, Ni, Zn).

The results of analysis are attached in the form of STRI Ltd Test Certificates at the end of this document.

RESULTS OF ANALYSIS

Particle Size Analysis

The grading data indicates that the material comprises reasonably equal proportions of each of the particle size ranges from fines (<0.053 mm) to stones (>8mm). The results are compliant with the requirements of *BS8616:2019 – Table 1*.

Bulk Density, Saturated Hydraulic Conductivity and Porosity

The sample displayed low bulk density values, which would usually be acceptable for roof garden schemes where loading restrictions apply. The suitability of the bulk density results should be confirmed by the project engineer for the recipient site (see Annexe A.3 of *BS8616:2019*).

The saturated hydraulic conductivity of the sample was moderately high (17.4 mm/minute or 1044 mm/hour) and was compliant with the requirements of *BS8616:2019 – Table 1*. The high saturated hydraulic conductivity result should enable efficient conveyance of water through the substrate to the underlying drainage system.

The sample displayed field capacity and total porosity values that were compliant with the requirements of *BS8616:2019 – Table 1*.

The porosity at field capacity (7.8%) fell below the minimum level ($\geq 10\%$). This may be indicative of smaller, water-holding pores making up a greater proportion of the overall porosity rather than larger, air-filled pores. As such, aeration potential within the substrate profile may be slightly reduced when moisture content is at field capacity. The high saturated hydraulic conductivity result; however, indicates that the material is unlikely to remain at field capacity for extended periods, provided any underlying substrate and the drainage system are facilitating conveyance of moisture effectively.

pH and Electrical Conductivity Values

The sample was alkaline in reaction (pH 7.6) and compliant with *BS8616:2019 – Table 1*. This pH value would be considered suitable for a range of plant species provided they are tolerant of alkaline soil conditions.

The electrical conductivity value by CaSO₄ extract (2.63 mS/cm or 2630 μ S/cm) fell within the target range indicated in *BS8616:2019 – Table 1*.

Organic Matter and Fertility Status

The sample contained compliant reserves of organic matter and all major plant nutrients in accordance with the requirements of *BS8616:2019 – Table 1*.

The C:N ratio of the sample (1:24) fell within the specified target range given in *BS8616:2019 – Table 1*. (1:10 – 1:32).

Phytotoxic Contaminants

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

Foreign Matter

The supplied analytical report states that no undesirable foreign matter was identified within the sample by visual examination.

CONCLUSION

The purpose of the analysis was to determine the suitability of the material for use as an extensive lightweight substrate in a rooftop garden environment. In addition, this sample has been assessed to determine its compliance with the requirements of the British Standard for Green Roofs (*BS8616:2019 – Specification for performance parameters and test methods for green roof substrates*).

From the supplied laboratory analysis report, the substrate was described as an alkaline, non-saline material with reasonably equal proportions of each of the mineral particle sizes. The saturated hydraulic conductivity and porosity results were moderately high, with field capacity within target range. The organic matter and nutrient reserves were satisfactory. The porosity at field capacity was slightly low. Of the potentially phytotoxic (toxic to plants) elements determined (cadmium, copper, lead, nickel, zinc), none was found at levels that exceeded their guideline values.

Based on these results, the substrate represented by this analytical data would be considered suitable for use as an extensive green roof substrate provided the target planting types are suited to the substrates specific properties (e.g. organic matter and fertility levels). The suitability of the material for any project specific application should be confirmed prior to use.

The sample was largely compliant with the requirements of the British Standard for Green Roofs (*BS8616:2019 – Specification for performance parameters and test methods for green roof substrates*), with the exception of the slightly low porosity level at field capacity. This may reduce the aeration potential of the substrate when moisture content is at field capacity. As such, it will be important to ensure that the material is effectively drained so that it does not remain at field capacity for extended periods.

With reference to Annex A.2 of *BS8616:2019*, (Substrate Categories), the organic matter result of this sample (10.8%) would categorise it as a 'High Organic Matter Substrate' (HOS). As stated in *BS8616:2019*, 'High organic substrates are often used for intensive green roofs where greater amounts of nutrients are required to support larger plants, such as trees and shrubs or thick vegetation coverage as needed for lawn areas. At present, a typical intensive substrate or HOS would have an organic matter content of between 10% – 17.5% (% mass) but it could be much higher if specific plant species were required'. As such, this material should be suitable for more intensive planting applications; however, may be limited for applications which require lower organic matter contents.

As further advised in Note 2 of Annex A.2, 'Low, medium and high organic substrate is not to be confused with low, medium or high fertility soils.

In accordance with Annex A.3 of *BS8616:2019* (Substrate Bulk Density), substrates can be further classified according to their *loose bulk density*. Whilst bulk density results are recorded for the sample (oven dried, at field capacity and saturation), these are usually recorded in a *consolidated* state as opposed to 'loose'. However, based on the bulk density result recorded at field capacity (1.22 g/cm³ or 1220 kg/m³) it appears that the material is likely to fall into the category of 'Heavyweight Substrate'.

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



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Senior Soil Scientist



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Senior Associate

For & on behalf of Tim O'Hare Associates LLP

Bury Hill Landscape Supplies Ltd

SUBSTRATE ANALYSIS RESULTS

CLIENT:	BURY HILL LANDSCAPE	DATE:	06/04/23
	SUPPLIES	RESULTS TO :	MAB
DESCRIPTION:	EXTENSIVE SUBSTRATE (4W-EX2)	SAMPLE NO :	A20130/1

Note: There was not any undesirable foreign matter discernible by the naked eye

CATEGORY	DIAMETER mm	%
Stones	>8	13.3
Coarse gravel	8-4	18.0
Fine gravel	4-2	18.8
Very coarse sand	2-1	10.5
Coarse sand	1.0-0.5	9.2
Medium sand	0.50-0.25	9.4
Fine sand	0.250-0.125	5.8
Very fine sand	0.125-0.050	3.2
Silt	0.050-0.002	7.0
Clay	<0.002	4.8
Loss on ignition (%)		10.8
pH		7.6
Phosphate (P ₂ O ₅ mg/l)		127
Potassium (K ₂ O mg/l)		630
Copper (mg/l)		4.5
Zinc (mg/l)		9.8
Lead (mg/l)		2.6
Cadmium (mg/l)		0.2
Nickel (mg/l)		0.7
Salinity (mS/cm)		2.63
Total Nitrogen (%)		0.26
C:N Ratio		24.0

THESE RESULTS PERTAIN ONLY TO THE SAMPLE(S) SUBMITTED AND TESTED



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PHYSICAL CHARACTERISTICS OF GREENROOF SUBSTRATE

CLIENT:	BURY HILL LANDSCAPE SUPPLIES	RESULTS TO:	MAB
		SAMPLE NO:	A20130/1
DESCRIPTION:	EXTENSIVE SUBSTRATE (4W-EX2)	DATE:	31/03/23

Bulk density of substrate at oven dried (g/cc) 0.72

Bulk density of substrate at field capacity (g/cc) 1.22

Predicted density of saturated substrate total porosity 1.30

Field Capacity (%) 50.1

Saturated HC (mm/min) 17.4

Porosity at Field Capacity (%) 7.8

Particle Density (g/cc) 1.72

Total Porosity (%) 57.9

THESE RESULTS PERTAIN ONLY TO THE SAMPLE(S) SUBMITTED AND TESTED