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SOIL & LANDSCAPE CONSULTANCY

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21st March 2023
Our Ref: TOHA/23/7885/SS/Rev.1
Your Ref: see below

Dear Sirs

Soil Analysis Report: Green Roof Extensive Substrate (BH-EX1)

We have completed a review of the supplied data for sample referenced *Green Roof Extensive Substrate (BH-EX1)* (STRI Report - Sample No: A20090/1 – 08/03/23 and 09/03/23) 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 predominantly 'fine gravel' and 'coarse gravel' sized particles (2-8mm). The results are compliant with the requirements of *BS8616:2019 – Table 1*.

This grading should be acceptable for extensive roof garden vegetation, albeit the minimal 'fines' content (particles <2mm – result 18.3%) and prevalence of 'gravel' and 'stone sized' material (>2mm) may possibly result in patchy establishment of seeded swards in the short term (ref. Note A associated with *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 Annex A.3 of *BS8616:2019*).

The saturated hydraulic conductivity of the sample was moderately high (14.8 mm/minute or 888 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. However, given the coarse grading of this material and associated rapid drainage potential, drought tolerant plant species should be considered.

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

pH and Electrical Conductivity Values

The sample was slightly alkaline in reaction (pH 7.1) and compliant with *BS8616:2019 – Table 1*. This balanced pH value would be considered ideal for a range of plant species.

The electrical conductivity value by CaSO₄ extract (2.52 mS/cm or 2520 µS/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 (1:6.6) fell just outside the specified target range given in *BS8616:2019 – Table 1*. (1:10 – 1:32). However, this is unlikely to be considered a significant non-compliance in this instance.

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 a slightly alkaline, non-saline material containing predominantly gravel sized particles (2-8mm). The saturated hydraulic conductivity and porosity results were moderately high, with field capacity within target range. The organic matter and nutrient reserves were satisfactory. 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 C:N ratio.

With reference to Annex A.2 of *BS8616:2019*, (Substrate Categories), the organic matter result of this sample (9.2%) would categorise it between the 'Medium Organic Matter Substrate' (MOS) and 'High Organic Matter Substrate' (HOS). As stated in *BS8616:2019*, '*Most extensive green roofs, such as Sedum roofs, wild flower or biodiversity roofs and turf roofs, are constructed using a medium organic substrate or extensive substrate. MOS typically have an organic matter content of between 4% – 8% (% mass). These substrates may also be used for more intensive type applications, but with the knowledge that organic matter content is relatively low*'. As such, this material should be suitable for the majority of applications; however, may be limited for more intensive planting or those which require low organic matter contents (LOS).

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 (1.03 g/cm³ or 1030 kg/m³) it appears that the material is likely to fall into the category of 'Ultra-Lightweight 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 SUPPLIES	DATE:	09/03/23
		RESULTS TO :	MAB
DESCRIPTION:	EXTENSIVE SUBSTRATE (BH-EX1)	SAMPLE NO :	A20090/1

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

CATEGORY	DIAMETER mm	%
Stones	>8	11.3
Coarse gravel	8-4	38.9
Fine gravel	4-2	31.5
Very coarse sand	2-1	2.5
Coarse sand	1.0-0.5	3.5
Medium sand	0.50-0.25	2.5
Fine sand	0.250-0.125	1.9
Very fine sand	0.125-0.050	1.1
Silt	0.050-0.002	4.4
Clay	<0.002	2.4
Loss on ignition (%)		9.2
pH		7.1
Phosphate (P ₂ O ₅ mg/l)		77
Potassium (K ₂ O mg/l)		304
Copper (mg/l)		1.5
Zinc (mg/l)		3.3
Lead (mg/l)		1.2
Cadmium (mg/l)		0.1
Nickel (mg/l)		0.7
Salinity (mS/cm)		2.52
Total Nitrogen (%)		0.81
C:N Ratio		6.6

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:	A20090/1
DESCRIPTION:	EXTENSIVE SUBSTRATE (BH-EX1)	DATE:	08/03/23

Bulk density of substrate at oven dried (g/cc) 0.70

Bulk density of substrate at field capacity (g/cc) 1.03

Predicted density of saturated substrate total porosity 1.27

Field Capacity (%) 33.2

Saturated HC (mm/min) 14.8

Porosity at Field Capacity (%) 24.4

Particle Density (g/cc) 1.65

Total Porosity (%) 57.6

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