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The Influence of Plant Type, Substrate and Irrigation Regime on Living Wall Performance in a Semi-Arid Climate

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Abstract: Living walls are fast becoming a ubiquitous feature of modern living and are widely implemented in commercial buildings in both internal and external environments. However, there are several challenges associated with maintaining healthy plant growth on these water sensitive urban design systems. This experimental study of an instrumented prototype-scale living wall has found that there is a close relationship between the plants, substrates and adopted irrigation regimes. In this study, plant selection was found to be more critical than either substrate or irrigation regime selection. This research also found that both the location of the plants on the wall and irrigation volume significantly affected the plants' ultimate total dry weight. In particular, plants were found to grow taller on the upper section of the living wall compared to the middle and lower sections. It is recommended that particular attention should be given to plant location and the amount of irrigation water supplied at different positions on the living wall.

Keywords: water sensitive urban design; vertical garden; green wall; green infrastructure; low impact development; sustainable drainage systems; nature-based solutions

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1. Introduction

Plants grown on vertical landscaping can be termed vertical greenery, vertical gardens, green vertical systems, green walls, vertical greens, bio-shaders and vertical landscaping. It is commonly agreed that these can be divided into two major groups, namely green façades (GFs) and living walls (LWs) [1]. In GFs, the plants are rooted at ground level and only the foliage extends upwards onto a vertical surface, which is usually a wall. LWs on the other hand are rooted in containers placed in a vertical arrangement on a wall. In terms of plant selection, façades often use a smaller number of climbers (see Figure 1), while LWs employ potting mechanisms that enable the use of a larger number of individual, typically non-climbing plants (see Figure 2). This study focuses on exterior LWs, although indoor living walls are also common. LWs were selected because more variables can be explored compared to GFs [2].

The GF is a centuries-old technology [3] and has been adopted as a template for more modern LW systems. While LWs offer flexibility with attractive designs, they are generally more complicated and costly in terms of both set-up and maintenance. They are still an expanding and evolving area of study and are therefore probably yet to be optimised to their full potential [4].

Living wall studies have examined both experimental and simulated models to evaluate their thermal performances, including energy and energy-saving potential [5–7], and to determine their thermal potential [8–10]. More recent research has investigated other benefits of these systems, including optimisation of various LW design and operational factors [11], as well as the role of lightweight substrates [12] and plants [13] in treating greywater (relatively clean wastewater from baths, showers, sinks, washing machines, and