

**UNIVERSITY OF TECHNOLOGY SYDNEY**

**SCHOOL OF LIFE SCIENCES**

**PLANTS AND ENVIRONMENTAL QUALITY RESEARCH GROUP**



Green wall technology for sustainably improving  
environmental quality:

*Investigations into green wall plant health  
and particulate deposition*

A thesis submitted by Naomi Paull to the School of Life Sciences,  
University of Technology Sydney, in partial fulfilment of the requirements of  
PhD

December 2020

## **Statement of Original Authorship**

I certify that this PhD thesis has not already been submitted for any other degree and is not being submitted as part of the candidature for any other degree.

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## **Certification by Supervisor**

Student name: Naomi Paull

Thesis title: Green wall technology for sustainably improving environmental quality:  
*Investigations into green wall plant health and particulate deposition*

The undersigned hereby states that the above student's PhD thesis meets the requirements for submission and is hence ready for examination.

Principal supervisor name: Fraser Torpy

Principal supervisor's signature: Production Note: Signature removed prior to publication.

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## Abstract

Air pollution is of significant concern, affecting millions of people globally. Plants are effective air pollution remediators; certain species, however, may exhibit higher removal capacities. Additionally, due to the continual pollution exposure, some species may exhibit sensitivity to pollution and will thus be ineffective for use in *in situ* applications.

This thesis assessed the particulate matter removal capacity of common green wall species used in *in situ* applications over a 6 month duration. High accumulating species were then identified, and leaf traits associated with enhanced particulate matter accumulation assessed. Leaf traits were not found to be exclusively related to enhanced particulate matter deposition; with small linear leaved species exhibiting the lowest particulate accumulation. The health of the green wall species from pollution exposure was then assessed. Most species did not encounter any significant differences among their health variables between polluted test sites and control glass house conditions, indicating their suitability for use *in situ*. The particulate matter removal capacity of *in situ* Sydney green walls was then examined. To do this, air quality tests were conducted in front of green walls and matched reference walls across the test sites. There were no significant differences observed for ambient particulate matter concentrations between green wall and reference wall sites, perhaps due to the ‘passive’ nature of the green wall systems tested. There was also no significant difference observed between the wall types for proximal temperature conditions, but there was a significant difference for ambient noise reduction, with green walls having significantly lower noise conditions. Lastly, the pollutant removal capacity of Australian native species used in active green walls was assessed. Active native green walls were effective at reducing benzene, with similar removal efficiencies to previously tested ornamental species. They were also capable of removing particulate matter,

however at lower efficiencies than ornamental species. Native plant active green walls were inefficient for carbon dioxide removal.

The results of this thesis highlight the importance of species selection for maximum pollutant removal efficiency and the capacity for vegetation to have positive impacts on ambient conditions. The results also indicate improvements that can be made to green wall systems for a higher efficiency for *in situ* applications, including the conversion of passive systems to active systems and the inclusion of select species for increased removal efficiency and tolerance to pollution exposure.

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## List of Abbreviations

Analysis of variance	ANOVA
Carbon dioxide	CO <sub>2</sub>
Carbon monoxide	CO
Crassulacean acid metabolism	CAM
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>
International agency for research on cancer	IARC
Linear mixed models	LMM
Methane	CH <sub>4</sub>
Nitrogen dioxide	NO <sub>2</sub>
Organisation for economic cooperation and development	OECD
Oxides of nitrogen	NO <sub>x</sub>
Oxides of sulphur	SO <sub>x</sub>
Ozone	O <sub>3</sub>
Particulate matter	PM
Particulates less than 10 micrometres in size	PM <sub>10</sub>
Particulates less than 2.5 micrometres	PM <sub>2.5</sub>
Particulates less than 0.1 micrometres	PM <sub>0.1</sub>
Photosystem one	PSI
Photosystem two	PSII
Polychlorinated biphenyl	PCB
Polychlorinated dibenzodioxins	PCDD
Polycyclic aromatic hydrocarbons	PAH
Principal components analysis	PCA
Reactive oxygen species	ROS
Relative water content	RWC
Ribulose biphosphate	RuBP
Scanning electron microscope	SEM
Single pass removal efficiency	SPRE
Standard error of the mean	± SE or ± SEM
Statistical package for social sciences	SPSS
Sulphur dioxide	SO <sub>2</sub>
Total suspended particulates	TSP
United States environmental protection agency	USEPA
Volatile organic compounds	VOCs
World health organization	WHO