Horticulture Innovation Australia

Final Report

202020 Vision: Goods Line Monitoring and Evaluation Research Proposal

Brent Jacobs
Institute for Sustainable Futures
University of Technology Sydney

Project Number: NY13024

NY13024

Contents

Summary

Greening the Goods Line is a research project aimed at evaluating the social, economic, and environmental changes emerging from the redevelopment of public open space in inner Sydney referred to as 'the Goods Line'. The research explores the social and biophysical changes that have resulted from the redevelopment, and the extent to which any identified changes are related to increases in green space. The research also tests the utility of an evaluation framework for green space development, collaboratively developed between the research team and industry stakeholders. The research is aimed at informing industry stakeholders, public and private sector urban planners, and the general public with an interest in understanding the benefits of green space.

The research focused on changes attributable to the redevelopment of the northern half of the Goods Line (the Goods Line North), completed in 2015. Participant questionnaires, direct observation (including time-lapse photography analysis), and interviews were used to assess social and economic attributes. An air quality study, stormwater runoff modeling, and a bird survey were used to assess biophysical attributes. Because the Goods Line North was not accessible to the general public before the redevelopment, an evaluation of the social, economic, and biophysical attributes of the southern half of the Goods Line (the Goods Line South) was undertaken using the above research methods to provide a surrogate evaluation of baseline conditions.

The research found that the redevelopment of the Goods Line has delivered a high quality public open space that is well used by the local community and others from further afield. The site serves as an important pedestrian corridor connecting local attractions and as a welcome space for local workers and students to take a break, enjoy lunch, or otherwise relax. The site enables both social interaction and solitude, which is a flexibility of the site that was not necessarily implied by a strict reading of the project's evaluation framework. Participants felt the site could be improved with more amenities as well as programming such as events or markets.

The research determined that visitors to the Goods Line North have a strong affinity for green space, with green space being the most commonly mentioned attribute of the site that they liked. Visitors had a greater affinity for the Goods Line North when compared with the Goods Line South, and felt the Goods Line North had better amenities, green space, and brought more people to the area. The site demonstrated the importance of not only providing green space but also the amenities necessary to support public enjoyment of the space, such as a range of seating, tables, and other facilities.

The stormwater runoff modeling showed that the redevelopment contributed to an almost ten per cent decrease in runoff rates. While the air quality study found no significant impact on air quality attributable to the redevelopment, it may have contributed to mitigation of some pollutant concentrations on hot days.

While this research project was able to suggest how the redevelopment has affected the social and biophysical fabric of the area, the Goods Line and its surrounds continue to change as adjacent areas such as Darling Harbour are redeveloped. This research may thus serve as the starting point of a longitudinal study that establishes how the contribution of the Goods Line to the local area matures over time and as its surroundings change.

Keywords

1. Introduction

Greening the Goods Line is a research project aimed at evaluating the social, economic, and environmental changes emerging from the redevelopment of 'the Goods Line', a public space in inner Sydney. The study was commissioned by Horticulture Innovation Australia (Hort Innovation) and contributes to the *202020 Vision*, a campaign that aims to promote a twenty per cent increase in green space by 2020. *Greening the Goods Line* delivers an independent evaluation of the type and scale of changes that emerge from urban renewal projects that increase the amount of green space in an area. This research contributes to a growing evidence base of positive outcomes associated with increases in green space, and thus hopes to promote inclusion of green space as a vital component of urban planning and renewal.

1.1. Background

As the built environment expands and population densities grow, urban vegetation is becoming increasingly important for social and environmental health outcomes (Brown et al, 2013; Kahn & Kellert, 2002; Rodhe & Kendle, 1994). Improvements in human health from living green infrastructure have been linked to the protection against the urban heat island effect (Akbari et al, 1992; Rosenfeld et al, 1996; Norton et al, 2013; Jacobs & Delaney, 2015; Norton et al, 2015) reduction in cardiovascular health and chronic diseases (Astell-Burt et al, 2014), improvements in community safety and reduction in crime (Kuo & Sullivan 2001) improved physiological wellbeing (Kaplan & Kaplan 1989) greater storm water retention and improved water quality (Wong 2006), and improved biodiversity (Alvey 2006), pollution and ecosystem services (Bolund & Hunhammar 1999). While these studies employ a range of methodologies, and focus on different demographics and geographies, they support the positive contribution of vegetation for each social and environmental outcome. A comprehensive literature review is outside the scope of this study, however there are a number of research papers that detail the breadth of findings on the effect of vegetation on social and environmental health, including Ely & Pitman (2013). *Greening the Goods Line* contributes to the growing body of work in the green infrastructure research space through the evaluation of an urban site at the local scale.

1.2. Industry relevance

The Nursery & Garden Industry Australia (NGIA) Strategic Plan 2010-2015 (NGIA 2010) emphasizes the importance of profitability and productivity.

Greening the Goods Line is aligned with Strategic Plan Objective 1; 'Increase the sales value of green-life products and services through marketing and promotion'. The first initiative outlined in support of this objective is 'the implementation of a national marketing promotion encouraging people to have more plants in their lives and educating them on the benefits of plants'. The *202020 Vision* is this national campaign, launched in November 2013. One of the primary ways in which this marketing campaign will work towards promoting the value of green life is through the publicity and circulation of independent empirical research such as *Greening the Goods Line*. *Greening the Goods Line* results may be used by the *202020 Vision* marketing campaign to promote increases to green space in urban areas.

1.3. Aims of study

Greening the Goods Line evaluates the social, cultural and environmental changes that can emerge from the redevelopment of a public space that includes green space. While the assessment of changes related to green space is an integral part of the project, the research will also consider how other components of the Goods Line redevelopment (e.g. public amenities), contribute to a visitor's broader experience. The following research questions guided the study:

a) What are the social and biophysical changes that have resulted from the redevelopment of the Goods Line into public open space?
b) To what extent are any social and biophysical changes related to increases in green space?
c) Which are the key evaluation criteria that should be applied to open space redevelopments that include green space to determine an accurate measurement of change?

The study provides a high-level overview of the social and environmental changes that have occurred at the Goods Line. The study does not attempt to isolate the strength and weight of specific contributions from environmental or social 'variables' to the visitor experience on the site. Any analysis of public place is highly site-specific as each site has a number of distinctive attributes and characteristics that determine how and why a local community engages with the space. Therefore, the conclusions of this study are not intended to apply universally or be generalized to other sites. Rather, the study contributes to the growing library of site-specific studies that present the breadth of possible changes from urban developments that include green space.

1.4. The Goods Line site

The Goods Line site refers to a disused railway corridor that passes through the inner Sydney suburbs of Ultimo and Haymarket. The site is situated among key attractions such as the Australian Broadcasting Corporation (ABC), the University of Technology Sydney (UTS), Sydney TAFE, the Powerhouse Museum, Darling Harbour (including the forthcoming Darling Square development), Railway Square bus interchange, and Sydney Central Station (Figure 1). The Goods Line is public land, owned and managed by the Sydney Harbour Foreshore Authority (SHFA).

Figure 1 Location of the Goods Line among surrounding attractions. Aerial photography courtesy of nearmap ltd (au.nearmap.com).

The redevelopment of the Goods Line from a disused railway into a public open space occurred in two phases over the past twenty years. The first phase of redevelopment of the Goods Line into a pedestrian corridor occurred in the 1990s and focused primarily on what is referred to in this report as the Goods Line South, or the section of the Goods Line bounded by Ultimo Road to the north and an access tunnel to Railway Square/Central Station to the south (Figure 2). The Goods Line North, being that section of the Goods Line bounded by Ultimo Road to the south and the Powerhouse Museum to the north, was generally inaccessible to the public until the second phase of the redevelopment in 2015. The redevelopment of the Goods Line North had the aim of transforming the area from an

'industrial relic on the city's western fringe into a linear and connected, elevated city park'[1]. The Goods Line North and Goods Line South are connected by a pedestrian bridge across Ultimo Road.

Figure 2 Aerial photograph of the Goods Line delineating its northern and southern halves. Aerial photography courtesy of nearmap ltd (au.nearmap.com).
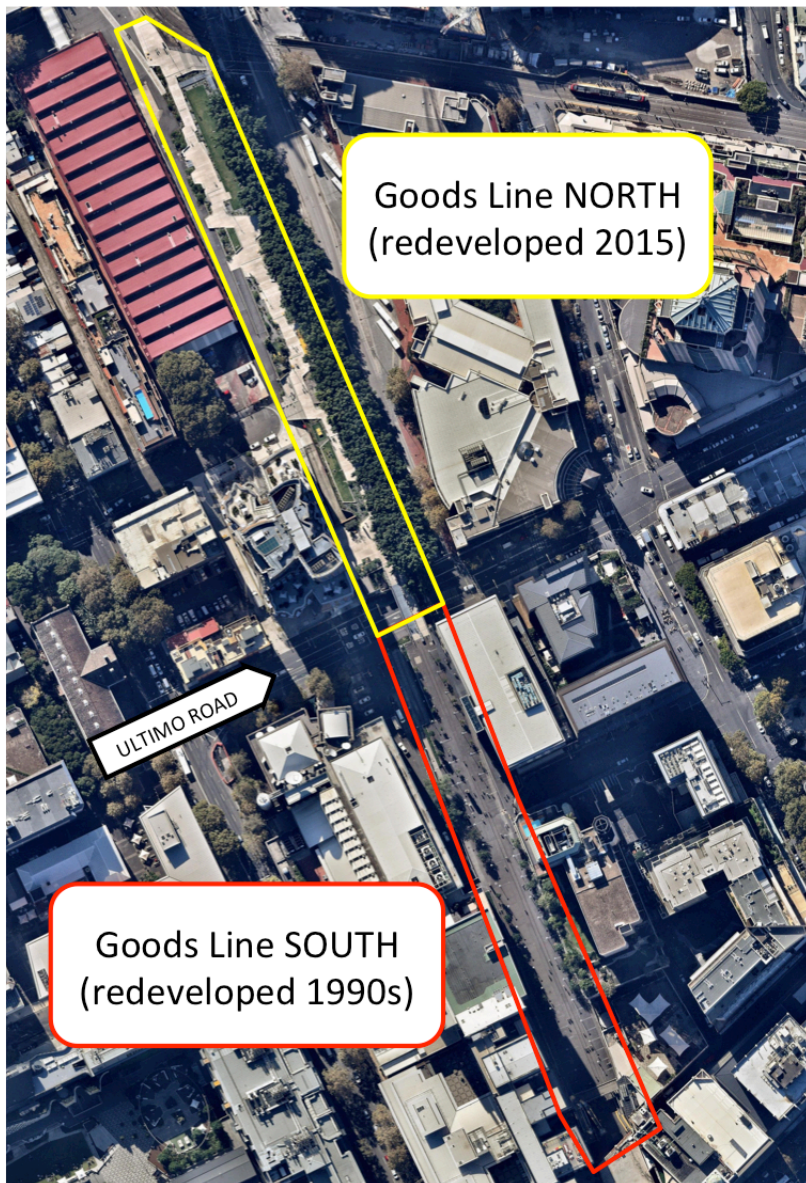
While the entirety of the Goods Line functions as public open space, the Goods Line South and Goods Line North differ in character. The Goods Line South consists almost entirely of paved areas. There is neither grass nor ground vegetation, except for two rows of street trees planted along most of the length of the section that provide limited canopy. Buildings of six or more storeys bound nearly all of the Goods Line South. A number of park benches are available for use, however the Goods Line South contains no other amenities intended for public recreation or rest.

---

[1] As stated on the *202020 Vision* website. http://202020vision.com.au/project/?id=152

Redevelopment of the Goods Line North resulted in the transformation of an uninviting area with no ground vegetation into a diverse urban park with a range of ground vegetation and other open space infrastructure (Figure 3). Between the Goods Line North and Darling Drive (to the northeast) is a line of large fig trees that provide a dense canopy that extends over the eastern half of the Goods Line North. These trees existed before the redevelopment as can be seen in Figure 3. The only buildings adjacent to the Goods Line North are the UTS Business School Dr Chau Chak Wing Building (approximately 12 storeys) to the southwest, and a low-rise warehouse-style building along its western boundary.

Figure 3 Aerial photographs of the Goods Line North before and after its redevelopment. The May 2016 image also shows the completed Dr Chau Chak Wing building along the site's southwestern boundary. Aerial photography courtesy of nearmap ltd (au.nearmap.com).
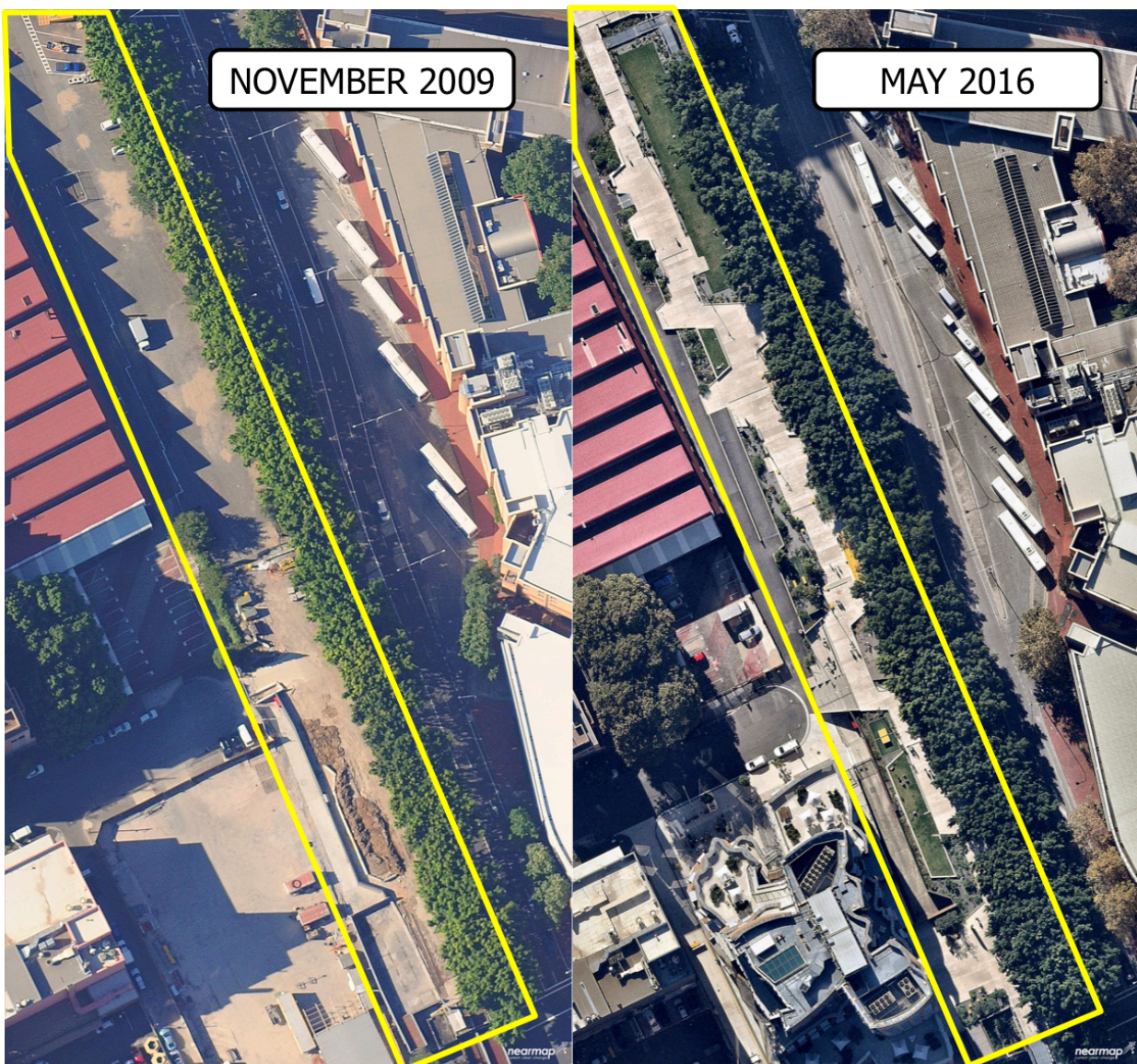
While an increase to the green space on the site is a notable feature of the redevelopment, Table 1 outlines additional public amenities provided in the Goods Line North.

Table 1: Public amenities and other features included in the redevelopment of the Goods Line North.[2]

Seating	• 125m of custom designed seating
Study pods	• Study pods including bench seating. • A communal table with integrated power outlets for laptop and device charging.
Electricity	• 3-phase power is provided at intervals throughout – for larger events (including a 50amp outlet for even bigger events
Internet	• Public WIFI has been provided throughout the entire Goods Line
Drinking water	• Bubblers and water bottle fill stations throughout
Fitness	• A fitness station • Table tennis tables
Playground	• A children's water play playground is included and includes a remnant sandstone culvert discovered on the site
Waste collection	• Custom bins provide for both rubbish and recycling
Bike racks	• Bike racks are positioned at key entry points
Green space	• 2398m2 increase in green space including open turf, tree and garden beds

As the design of the Goods Line North redevelopment includes increased urban green space, the site was selected by Hort Innovation to act as a case study to evaluate the social and environmental changes that can emerge from urban development projects. As the Goods Line is a public space in a densely populated professional and educational precinct, the addition of green space to the Goods Line may contribute to the health, well-being and productivity of professional, student and residential populations.

As part of the *202020 Vision*, this study has a particular interest in the role of green space in promoting social, environmental and economic change. The size of the Goods Line redevelopment site spans 7130 square metres, with 2398 square metres (33%) of the surface cover comprising green space as defined in Table 1. This is an increase from a complete absence of green space within the Goods Line North site boundary prior to the redevelopment. The tree canopy between Darling Drive and the Goods Line North was unchanged by the redevelopment. As the redevelopment of the Goods Line North included provision of public amenities additional to green space (Table 1) the study will not conclusively attribute any change to green space alone, but rather will evaluate the range of factors that contribute to an enhanced user experience, including the role of green space.

---

[2] Provided by ASPECT Studios, 2015

2. Methodology

Greening the Goods Line commenced in November 2013 and concluded in July 2016. The research adopted a collaborative design, involving both Hort Innovation and NGIA in the design iterations to ensure the project met the stakeholder expectations and adequately responded to the research brief.

The research was designed with regard to the overarching aim of the project – to evaluate social and biophysical changes resulting from the redevelopment of the Goods Line. A transdisciplinary approach guided the design and analysis phases to ensure the findings capture the complexity and nuance of public space engagements. Evaluation design involved moving away from looking at the world through a single disciplinary lens, but to 'transit from one [discipline] to the other, attaining glimpses from different levels of reality generating reciprocal enrichment that may facilitate the understanding of complexity' (Max-Neef 2005, p.15).

2.1.   Evaluation Framework and Indicators

At the commencement of the project an evaluation framework was drafted in partnership with the Project Steering Committee. The evaluation framework (Table 2) summarises the aims and objectives of the research and presents an overview of the variables, data collection methods, and expected outcomes for each component of the research. As the research has progressed, the evaluation framework has been modified to reflect the shifts in research design (such as amending methods used because of data availability or other limitations).

Developing an evaluation framework ensures that:

- the research design, methods, data collection and analysis respond to the research aims and objectives
- each of the varied stakeholders contribute to the research design, ensure their specific research needs are met, and feel confident and familiar with the direction of the research.

The evaluation framework and its indicators presented here serve as a guide to assist in measuring and interpreting a wide range of social, cultural and environmental changes rather than an inflexible way of containing the analysis. The research not only reports on the indicators in the evaluation framework but also considers their meaning and relevance for studies of this nature. The analysis will consider performance of the Goods Line North against each indicator while also analysing broader phenomena evident from considering the site as a whole.

Table 2: The evaluation framework developed to guide the research design and interpretation of results.

valuation of;	Expected outcome	Indicators	Data sources
igh level outcomes	An urban green infrastructure development with improved social, environmental and economic attributes.	Improvements in; • Frequency and duration of use • Breadth of activities • Health and wellbeing • Stimulating local economic activities • Air quality • Peak flow storm water runoff • Biodiversity – birds	Questionnaires Interviews Direct observation Photography analysis Air quality sampling Modeling of peak flow flooding events
ocial attributes			
sitation of space			
uantities	An increase in the number of people using the site	1. Number of people using the site	Questionnaires Direct Observation
uration	People stay in the space for longer	2. Time spent in the space	Questionnaires Direct Observation
iversity	A diversity of people using the space	3. Uses of the space by age and gender	Questionnaires Direct Observation
ses and activities			
readth	A broad range of activities undertaken in the space	4. An increasing number of activities taking place in the space	Questionnaires Direct Observation
ealth and wellbeing			
nysicality	The site is used for physical activity	5. An increase/evidence of physical activity	Questionnaires Direct Observation
edentary activity	The site encourages sedentary activity and relaxation	6. An increase/evidence of sedentary activity and/or relaxation	Questionnaires Direct Observation
nteraction	The space encourages increased social interactions	7. The number of social interactions in the space	Questionnaires Direct observation
ace attachment			
ommunity	There is an increased sense of community attachment in the space	8. Self reported sense of community 9. Reported vandalism	Questionnaires Interviews

hysical	There is an increased affinity towards the physical space	10. Self reported affinity towards the built environment 11. Self reported affinity towards the natural environment	Questionnaires
ature	There is an increased affinity towards the natural environment space		
afety	An increased perception of safety within the space	12. Self reported perception of safety within the space	Questionnaires
nvironmental Attributes			
r quality	Improved air quality on the site	13. Air quality sampling assessments	Weekly site and reference sampling
eak storm water runoff	A reduction in the storm water runoff from the site	14. Storm water peak flow assessment	Stormwater runoff modeling
odiversity	An increase in the biodiversity on the site	15. Assessment of bird life	Bird surveys
conomic Attributes			
ew businesses	Increased activity with new businesses	16. Count of new business start ups	Direct observation Interviews
xisting businesses	Increased business activity with existing businesses	17. Self reported assessment of small businesses operating on the site and immediate surrounds	Interviews

2.2. Social Research

The research design for social attributes drew upon a triangulation of data to verify the results, highlight limitations and/or errors, and provide a more robust representation of the human experience. These methods included semi structured interviews, direct observation (including time-lapse photography analysis), and on-site participant questionnaires. This multi-method design aimed to provide insights into usage patterns, as well as the reasons and influences underpinning engagement with the public space.

2.2.1. Surrogate baseline evaluation of Goods Line South

As discussed earlier, *Greening the Goods Line* focuses on the redevelopment of the Goods Line North. Evaluating changes resulting from the redevelopment would normally require assessing the baseline conditions prior to redevelopment, and comparing with an end-state, post-redevelopment, assessment. However, a baseline assessment of the Goods Line North was not possible because the site was not accessible to the general public prior to the redevelopment. Because a true baseline assessment of the Goods Line North could not be undertaken, the social and economic attributes of the Goods Line South were assessed as a comparator site for post-development research results from Goods Line North.

The evaluation of the Goods Line South was undertaken in March-May 2014, prior to the redevelopment of the Goods Line North. This evaluation captured a snapshot of usage patterns and conducted a brief assessment of the user experience. The results of the Goods Line South evaluation and Goods Line North evaluation (described in greater detail shortly) were compared to understand how differences in user experience exist between the two areas, and whether any differences may be related to the different characters of the areas. Section 1.4 described how The Goods Line South and Goods Line North differ with respect to green space and other open space infrastructure.

The data gathered from the Goods Line South and Goods Line North evaluations are derived from different sample groups, sample sizes and at different locations (along the Goods Line development). As a site-specific analysis, only members of the general public who are on the Goods Line site at the time of data collection are requested to participate in the research. For these reasons, this is a non-random sample and not statically valid for a comparative analysis (i.e. Goods Line South group compared with Goods Line North group). To partially overcome some of the challenges presented from these differences and to strengthen the reliability of the comparative analysis, the Goods Line North questionnaire (to be discussed shortly) has retrospective elements to capture the opinions and activities of respondents who had previously spent time at the Goods Line South. These retrospective questions in the social research for the Goods Line North support the social research undertaken on the Goods Line South when comparing visitor experiences and perceptions of the two sites.

A full report detailing the method and results of the Goods Line South evaluation is provided at Appendix A. The rest of this section focuses on explaining the social research methods used in the evaluation of the Goods Line North. Participant questionnaires, direct observation, and interviews focusing on the Goods Line North were undertaken during April-May 2016. As for the evaluation of the Goods Line South, the approach to the Goods Line North assessment was undertaken during University session times to capture a representative snapshot of the site.

2.2.2. Participant Questionnaire

The participant questionnaire enabled the collection of a core data set for the social research focused on

the Goods Line North. The questionnaire comprised five sections (the questionnaire itself is provided at Appendix B):

- Section A: General attitudes – contained five open questions to assess why participants visited the Goods Line North and what they liked or did not like about the site.

- Section B: Previous use – contained one closed question assessing whether participants had previously visited the Goods Line South, and if so, asked three additional questions eliciting comparisons between Goods Line South and Goods Line North.

- Section C: Sentiments – contained closed questions asking participants to indicate frequency of conducting certain activities on the Goods Line North (and comparing this frequency to their visits to their Goods Line South, if applicable), whether they work or study on the Goods Line North alone or with others, whether they agree with specific statements on the Goods Line North's appeal (and comparing this to the appeal of Goods Line South), and their opinion as to the quality, quantity, and importance of both public facilities and green space.

- Section D: Visiting habits – contains questions assessing frequency and duration of visits to the Goods Line North (and how this compares to visits to the Goods Line South, if applicable).

- Section E: About you – contains five demographic questions.

The questionnaire was distributed by researchers to consenting participants at the Goods Line North, and was self-administered by participants to ensure responses were not influenced by the researcher's presence. A total of 201 surveys were completed by participants and analysed by researchers.

Responses to qualitative questions were coded in accordance with a coding scheme developed by the research team following an initial assessment of participant responses. The research team used SPSS Statistics software to assist with analysis.

2.2.3. Direct Observation

Direct observation of the Goods Line North involved taking time-lapse photos of the site from a set location at prescribed intervals over the course of two full days. In order to obtain an hourly count of visitors to the site, photos were taken every hour from 0800 to 1700, and the numbers of individuals sighted in the photos were counted.

In order to estimate duration of visits to the site, photos were taken every fifteen minutes during 'even' hours (e.g. photo at 0800 (even), 0815, 0830, 0845, 0900 (odd), 1000 (even), 1015, 1030, 1045, 1100, and so on). Consecutive photographs taken at fifteen-minute intervals were compared, and the duration of visits was estimated according the number of photographs in which the same individual appeared (Table 3).

Table 3 Method of estimating duration of visits from time-lapse photography analysis.

Number of consecutive photos containing the same individual	Estimated duration
One (e.g. 0830 only)	Less than 15 minutes[3]
Two (e.g. 0830 and 0845)	More than 15 minutes
Three (e.g. 0830, 0845, and 0900)	More than 30 minutes
Four (e.g. 0800, 0815, 0830, and 0845)	More than 45 minutes
Five (e.g. 0800, 0815, 0830, 0845, and 0900)	More than 60 minutes

All photos were also assessed as to the activities undertaken by visitors.

2.2.4. Interviews

Semi structured interviews with local businesses were conducted as part of the evaluation. The focus of the interviews was to assess whether the redevelopment of the Goods Line had any perceived impact on the business. These interviews contribute to the assessment of economic change indicators in the evaluation framework.

2.3.   Environmental Research

2.3.1. Air Quality Monitoring

Researchers from the UTS Science Faculty conducted air quality of monitoring of the Goods Line site to assess any in the change in air quality from increases in local green space.

Baseline sampling was conducted across four study sites for 16 months (Figure 4), from 4 October 2013 to 25 February 2015, to provide a dataset indicating the background air quality across the sample area. This involved a total of 59 sample events, with matched samples taken at sites likely to be influenced by increased green space and at reference sites. Initially site 1 and site 2 were to be compared to site 3 and 4 (Figure 4); however, additional vegetation expected to be planted at site 1 did not eventuate. Site 1 then became a third reference site, leaving only site 2 as a treatment site to which additional green space was established.

---

[3] A limitation of this method is that the number of individuals estimated to have visited for less than fifteen minutes may be slightly overstated. This is because an individual who arrives at 0820 and stays until 0840 would have stayed for twenty minutes, but would only be captured by one photograph and thus assumed to have stayed for less than fifteen minutes. This limitation would also mean that estimates of visitors staying more than fifteen minutes may be slightly understated.

Figure 4 Sampling locations along the Goods Line and at a reference control site for the air quality study.

Establishment of green space was completed and the Goods Line North opened on 30 August 2015. To detect any initial change, intensive air sampling was conducted on 1, 2, and 3 September. Further sampling followed in February 2016, where twice-daily samples were taken on 15, 17, 19, 22, 26, and 28 February. This regime allowed comparison with samples taken at the same time of year but prior to the establishment of new areas of green space to detect any changes attributable to additional vegetation. Air samples were collected between 1100 and 1400 h on weekdays. The time between samplings ranged from 3 to 14 days.

For quality assurance, comparisons were made of air quality at other locations in Sydney coincident with sampling times used at the Goods Line. These data were downloaded from the Randwick, Rozelle and Earlwood monitoring sites, operated by the NSW Office of Environment and Heritage (OEH).

More information on the air quality research method, including a description of the equipment used and approach to statistical analysis, is available in the Goods Line air quality report provided by UTS Science at Appendix C.

2.3.2. Stormwater runoff

A stormwater runoff assessment was included in this research to determine whether the redevelopment of the Goods Line North would affect levels of runoff from the site.

Stormwater runoff, expressed as a percentage of total precipitation that is not absorbed by the Earth's surface within the site boundary, was calculated for before and after redevelopment of the Goods Line North. With reference to site plans provided by ASPECT Studios (the Goods Line architects), GIS software was used to construct polygons for selected surface types (asphalt, concrete, grass and gravel) for the before and after sites. These polygons were overlaid on Google Earth satellite imagery relating before redevelopment (2009) and after redevelopment (2016). Proportions of each surface type to total site area were calculated from the constructed polygons.

To estimate total run-off, the Rational Method was used, which is accurate for estimation of runoff from small drainages with a high proportion of impervious area (ODOT 2011). Run-off coefficients for each surface type were obtained from the literature (ODOT 2011), and aggregated, weighted by surface area, to derive a total site runoff coefficient for before and after redevelopment. The total site runoff coefficients were converted to a percentage value and compared to assess any change in stormwater runoff resulting from the redevelopment.

2.3.3. Biodiversity

The inclusion of green space within the redevelopment of the Goods Line North may also increase the biodiversity of the area. Under the advice of Birds Australia, a 25-minute bird survey was undertaken to assess the diversity of bird life at the Goods Line, as a potential indicator of biodiversity more generally. The bird survey of the Goods Line North was undertaken in April 2016.

3. Outputs

This section describes the outputs of the social and biophysical research focusing on the Goods Line North, categorised according to the research methods used. Discussion of the outputs in relation to the project's evaluation framework, with comparisons to the evaluation of the Goods Line South, is provided in the Outcomes section that follows.

3.1. Goods Line North social research – participant questionnaire

3.1.1. Section A: General attitudes

Table 4 provides the most frequent themes[4] raised by participants when asked why they came to the Goods Line North. Participants were most likely to respond that they came for relaxation (30%), to eat lunch (26%), or to get outdoors (23%). Many responses also suggested participants came to the Goods Line North simply because it was convenient (22%). Only 13% of responses specifically mentioned that they came to the Goods Line North for green space.

Table 4 Summary of most frequent responses to Question A1.

Why do you come to this new end of the Goods Line?		
Coded response	**Frequency**	**Percentage**
Relax/break	59	30%
Eat	51	26%
Get outdoors	46	23%
Convenience	44	22%
Sitting	36	18%
To get somewhere else	31	16%
Aesthetics	29	15%
Green space	25	13%

Table 5 shows the most frequent themes raised by participants when asked what they like most about the Goods Line North. Green space was the most common theme (39%), followed by the available seating (37%), and the general aesthetics (36%).

---

[4] To simplify the reporting of results in Section 3.1.1, responses with a frequency greater than twenty are considered the 'most frequent' responses and are provided in the tables. A full breakdown of responses for Section A of the questionnaire, and the coding scheme used to group responses, is given in Appendix D.

Table 5 Summary of most frequent responses to Question A2.

What do you like most about this new end of the Goods Line (if anything?)		
Coded response	**Frequency**	**Percentage**
Green space	77	39%
Seating	73	37%
Aesthetics	71	36%
Urban escape	51	26%
Outdoor space (other than green space)	45	23%
Social	39	20%
Convenience	27	14%

Table 6 details the most frequent responses as to what site visitors disliked about the Goods Line North. It was most common for participants not to provide a response (38%), which likely indicates a general satisfaction with the site. When participants did identify something they disliked, it usually related to (a lack of) amenities (21%) or that it felt too sunny or lacked shade (11%).

Table 6 Summary of most frequent responses to Question A3.

What do you dislike about this new end of the Goods Line (if anything)?		
Coded response	**Frequency**	**Percentage**
Blank (no response)	76	38%
Amenities	42	21%
Too much sun/heat	22	11%

Table 7 shows the most frequent themes raised by participants when asked why they choose to come to the Goods Line North instead of other outdoor places. The majority of participants say they chose the site because it was convenient for them (54%). Over a quarter of participants suggested the site provided an escape from the urban environment (28%), and another quarter of participants said they chose the site for its aesthetics (25%). Only 6% of responses mentioned something related to green space when describing why they chose the site.

Table 7 Summary of most frequent responses to Question A4.

Why do/would you choose to come here to the Goods Line instead of other outdoor places?		
Coded response	**Frequency**	**Percentage**
Accessible/convenient	106	54%
Urban escape	55	28%
Aesthetics	48	25%
Outdoors (other than green space)	23	12%

Table 8 provides the most frequent suggestions from participants as to how the Goods Line North could be improved. The most common response was to express satisfaction or leave the question blank (42%), which likely indicates an unexpressed satisfaction with the site. Some participants felt there could be more shade or shelter either in the form of additional trees or a physical structure (14%). Others wished for additional amenities (13%), while others wished for the site to contain attractions or diversions such as buskers, market stalls, or other programming (11%).

Table 8 Summary of most frequent responses to Question A5.

Are there any changes that could be made to the Goods Line that would improve your experience or make you visit more often?		
Coded response	Frequency	Percentage
Satisfied (or blank)	93	42%
Shelter/shade	30	14%
Amenities (other than shade provision)	28	13%
More attractions	24	11%

3.1.2. Section B: Previous use

Figure 5 describes the percentage of participants who had (or had not) visited the Goods Line South. Nearly half of all participants responded that they had never visited the Goods Line South (45%). Around a quarter of participants responded that they only used the Goods Line South as a thoroughfare (26%).

Figure 5 Frequency of participant visits to the Goods Line South.
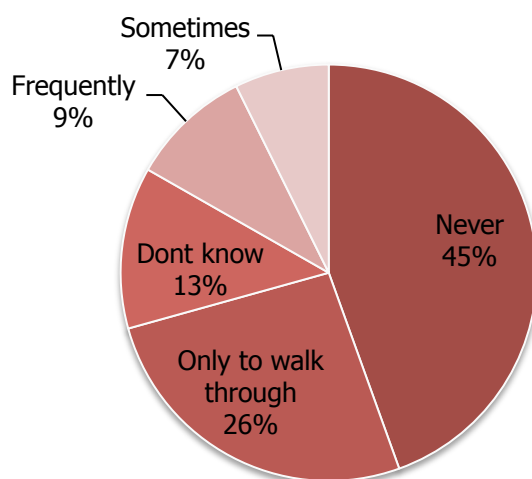
Those who had visited the Goods Line South were asked to answer some questions seeking a comparison of the Goods Line North with the Goods Line South. Table 9 shows themes raised by participants in consideration of the changes in the Goods Line since the opening of the Goods Line North. The most common sentiment was that there were more people (37%). Improved amenities or activity options (19%), aesthetics (19%), and green space (12%), were also common responses.

Table 9 Summary of responses to Question B2.

What have you noticed about how the Goods Line has changed since the opening of this new end?		
Coded response	Frequency	Per cent
More people	37	38%
Improved amenities/activity options	19	19%
Positive aesthetics or feel	19	19%
Green space	12	12%
All others	11	11%

Table 10 gives a breakdown of whether participants considered their experience on the Goods Line has improved or worsened since the opening of the Goods Line North. The vast majority of participants responded that their experience had improved (89%).

Table 10 Summary of responses to Question B3.

Has your experience in the Goods Line changed since the opening of this new end?		
Option	Frequency	Per cent
Yes – improved	79	89%
No – unchanged	10	11%
Yes – worsened	0	0%

Table 11 details the most common themes raised by participants when considering why their experience has improved since the opening of the Goods Line North. The improvement was most often attributed to the amenities and associated opportunities for activity/interaction (25%). Other common responses related to improved aesthetics (22%) and the additional green space (17%).

Table 11 Summary of responses to Question B4.

If you answered 'Improved' at B3 above, what is/are the main reason(s) for this improvement in your experience?		
Coded response	Frequency	Per cent
Amenities/activities	31	25%
Aesthetics/feel	27	22%
Green space	21	17%
Access/walkability/convenience	15	12%
Outdoors/openness	14	11%
All others combined	14	11%

3.1.3. Section C: Sentiments

Figure 6 shows the frequency of specified activities on the Goods Line North in which participants engaged. Participants responded that they most often use the Goods Line North for passive recreation such as taking a break, relaxing, socializing, to sit in the grass, or to find solitude. Many participants also responded that they used the Goods Line North as a thoroughfare. More active or professional uses of the Goods Line North such as exercising or working/studying were less common.[5]

---

[5] It is noted that the method of questionnaire dissemination may lead to a bias in responses toward those who were using the Goods Line North for passive recreation (i.e. those who were using the site as a place to run were less likely to stop and participate in the research by completing a questionnaire).

Figure 6 Frequencies of undertaking specified activities in the Goods Line North (Question C1A).
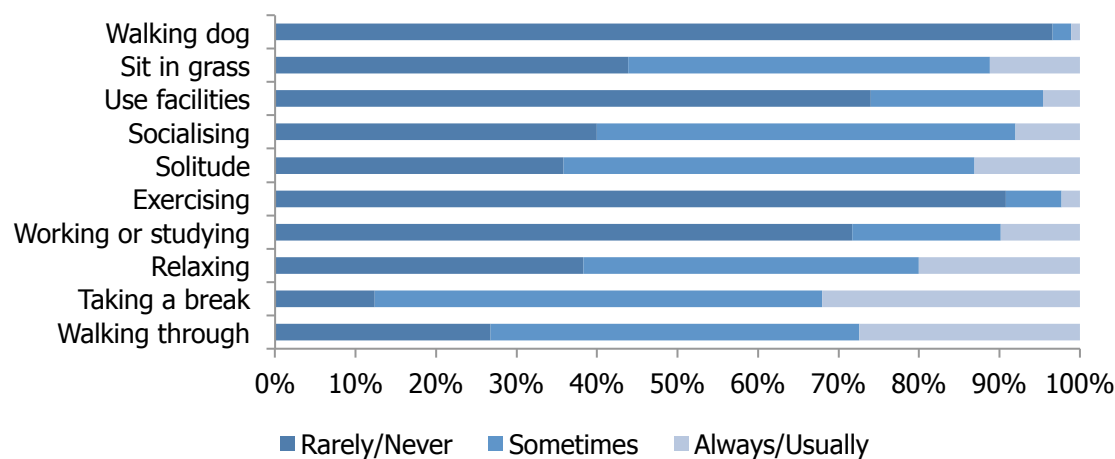
Figure 7 details whether participants engaged in specified activities more, or less, in the Goods Line North, when compared with their experience in the Goods Line South. Over half of participants suggested they use the Goods Line North more than the Goods Line South for passive recreation such as taking a break, relaxing, solitude, and socialising. Less than ten per cent of participants suggested they used the Goods Line North less than the Goods Line South for any of the specified activities.

Figure 7 Frequency of engaging in specified activities in Goods Line North, compared with Goods Line South (Question C1B).
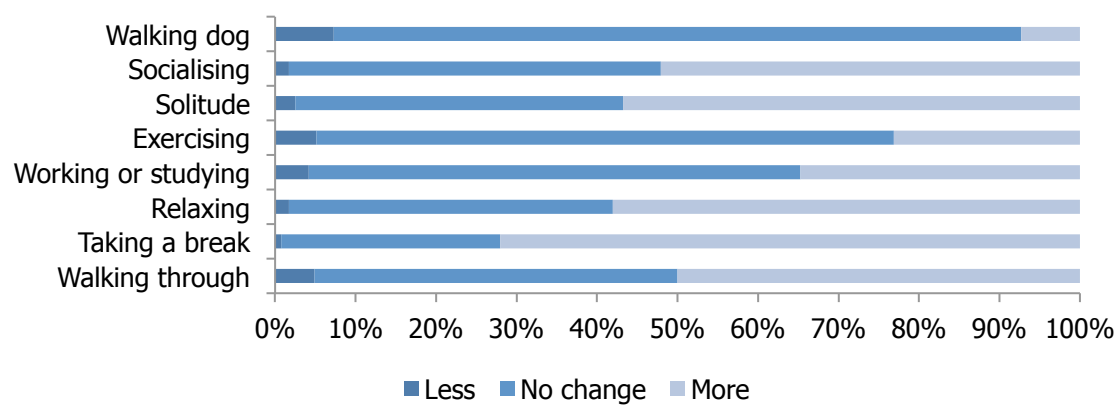
Table 12 summarises whether participants work or study on the Goods Line North alone or with others. Participants who responded to this question tended to prefer working or studying alone (47% more often or always alone). Slightly more than one quarter of participants (27%) indicated that they always or more often work or study with others.

Table 12 Summary of responses to Question C2.

Do you usually [work or study] alone or with others?		
Option	**Frequency[6]**	**Per cent**
Always alone	20	19%
More often alone	30	28%
Equally alone and with others	28	26%
More often with others	22	20%
Always with others	8	7%

Figure 8 details the extent of participant agreement with certain statements about the Goods Line North's appeal. Over ninety percent of participants agreed that the Goods Line North was visually appealing, that they liked its green space and built environment, that they felt safe, and that they enjoyed the space overall. A majority of participants also agreed that there was a sense of community in the Goods Line North, although this was lower than the proportion that agreed with the other statements.

Figure 8 Extent of participant agreement with specified statements about the Goods Line North (Question C3A).
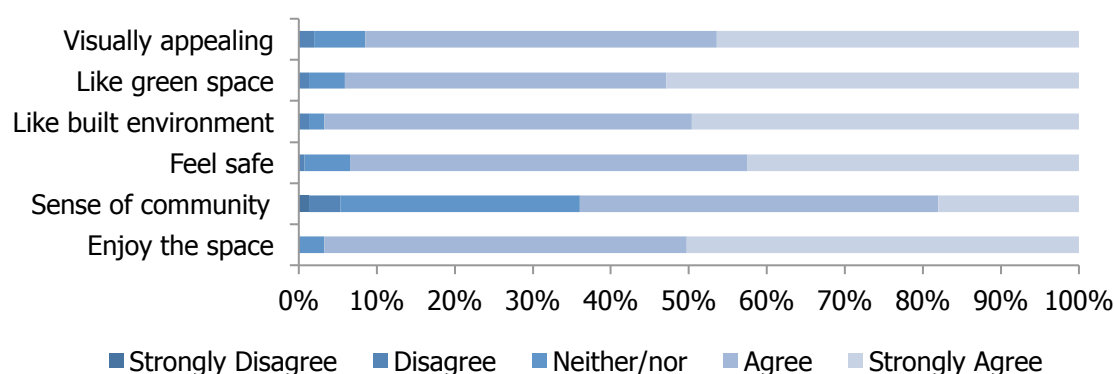
Figure 9 describes whether participants felt the Goods Line North outperformed the Goods Line South with regard to the aforementioned statements about the site's appeal. Nearly three-quarters of participants familiar with the Goods Line South felt that the Goods Line North was more visually appealing, felt safer, had stronger sense of community, was an improved green space and built environment, and was a more enjoyable space. Participants almost never felt that the Goods Line North performed worse than the Goods Line South on any of these sentiments.

---

[6] Question C2 was meant to be answered only by those participants who indicated that they 'Always/Usually' or 'Sometimes' worked or studied in the Goods Line North (Question C1A; Figure 6). Forty-nine participants indicated that they 'Always/Usually' or 'Sometimes' work or study in the Goods Line North, however 108 participants went on to indicate whether they work or study alone or with others on the Goods Line North (Question C2). Given that Question C2 was answered by a broader cohort than intended (i.e. over half of the responses may have come from participants who previously indicated they rarely or never work or study at the Goods Line North), the results are presented here but not interpreted further in this report.

Figure 9 Participant sentiment as to whether the Goods Line North was better or worse than the Goods Line South with regard to specified qualities (Question C3B).
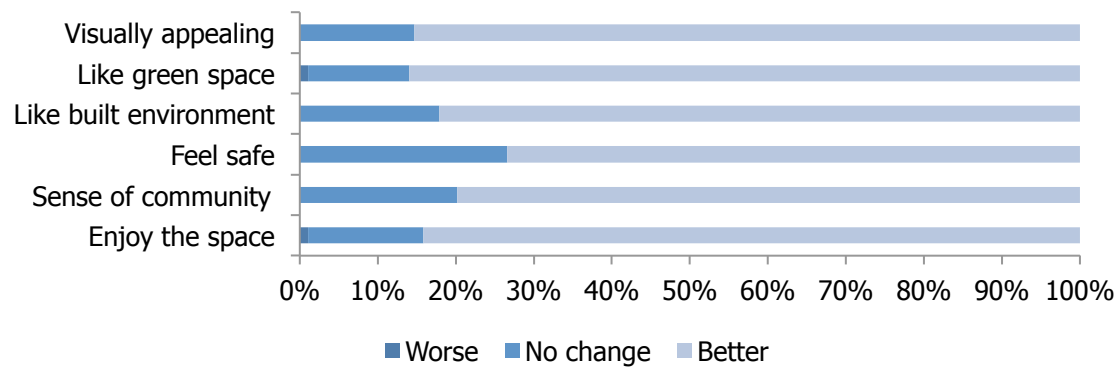
Questionnaire participants were asked to rate the quality, quantity, and importance of the public facilities and the green space in the Goods Line North on a scale of 0 (low) to 10 (high). Figure 10 shows the frequency of participant ratings for quality, quantity, and importance.

Figure 10 Frequency of ratings given to (a) quality, (b) quantity, and (c) importance of public facilities and green space at the Goods Line North from questionnaire participants.
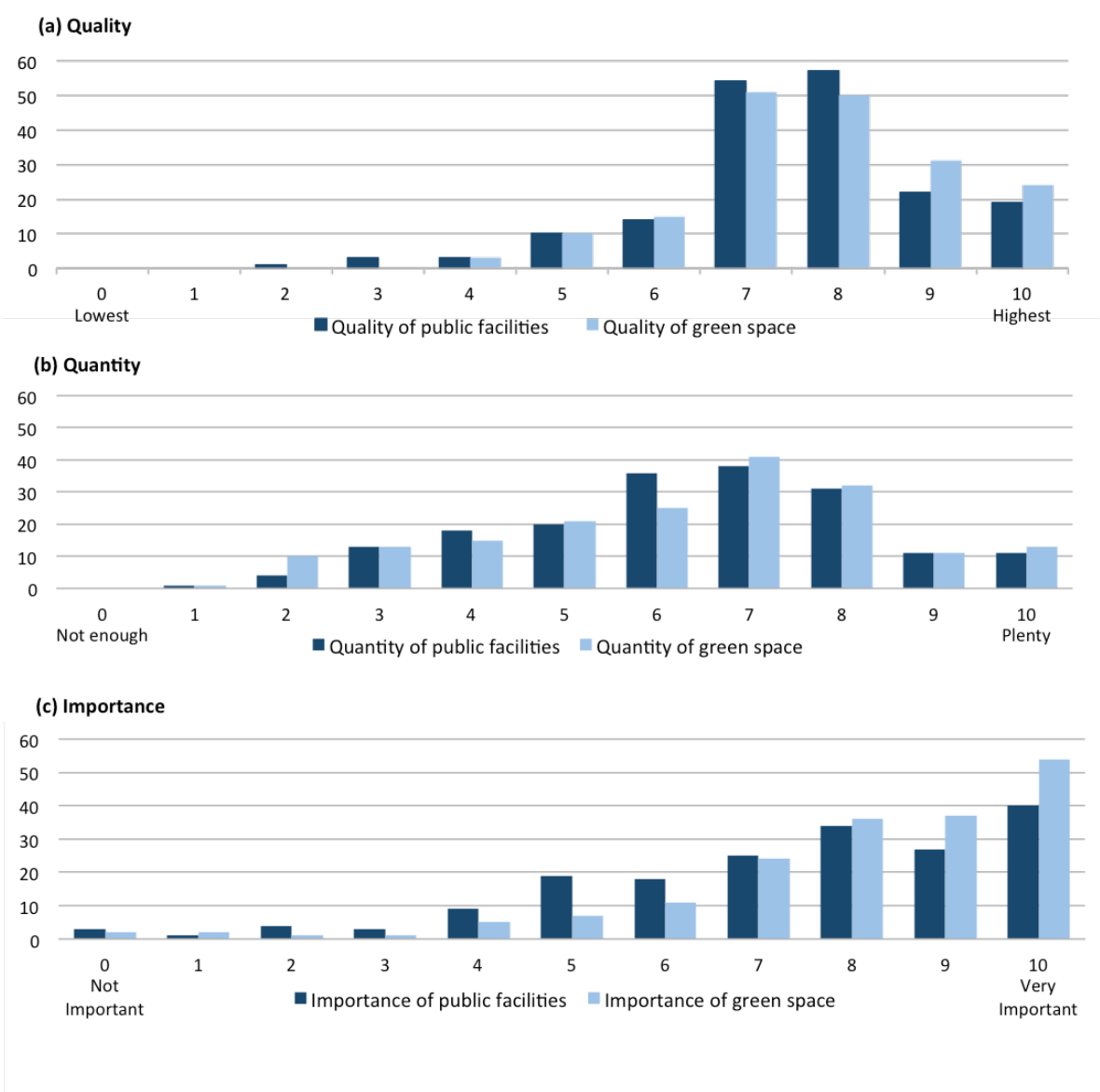
Participant attitudes about the quality of public facilities and green space were generally favourable, with the majority of ratings being 7 or higher. Participants also felt that public facilities and green space were important, with green space considered to be slightly more important than public facilities.

Participant attitudes about the quantity of public facilities and green space were more variable, which suggests a greater range of opinions as to the sufficiency of green space and public facilities at the Goods Line North.

3.1.4. Section D: Visiting habits

Figure 11 details how regularly participants indicated they visited the Goods Line North, and the duration of their visits. Nearly one-third of participants indicated that they visited the Goods Line North weekly, and nearly one-third indicated that they visited the site multiple times per week. Fourteen per cent of participants said it was their first time at the Goods Line North.

Just over half of participants indicated that their visits to the Goods Line North usually last between fifteen and thirty minutes. Just over a quarter of participants indicated that they usually stay anywhere between thirty and sixty minutes.

Figure 11 Participant regularity and duration of visits to the Goods Line North.
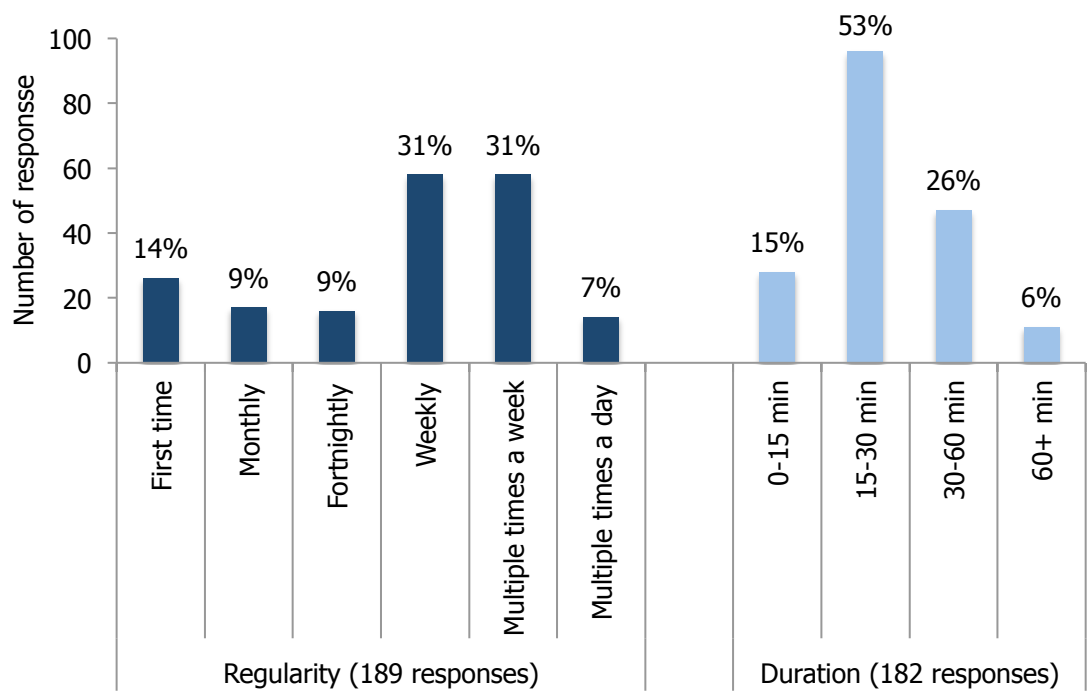
Figure 12 shows how participants have compared the regularity and duration of their visits to the Goods Line North with their visits to the Goods Line South. Over half of participants said they visited the Goods Line South less regularly (55% much less and somewhat less combined). Nearly three-quarters of participants said they spent less time in the Goods Line South (72% much less and somewhat less combined) when compared with their experience in Goods Line North.

Figure 12 Regularity and duration of participant visits to the Goods Line South, compared with the Goods Line North.
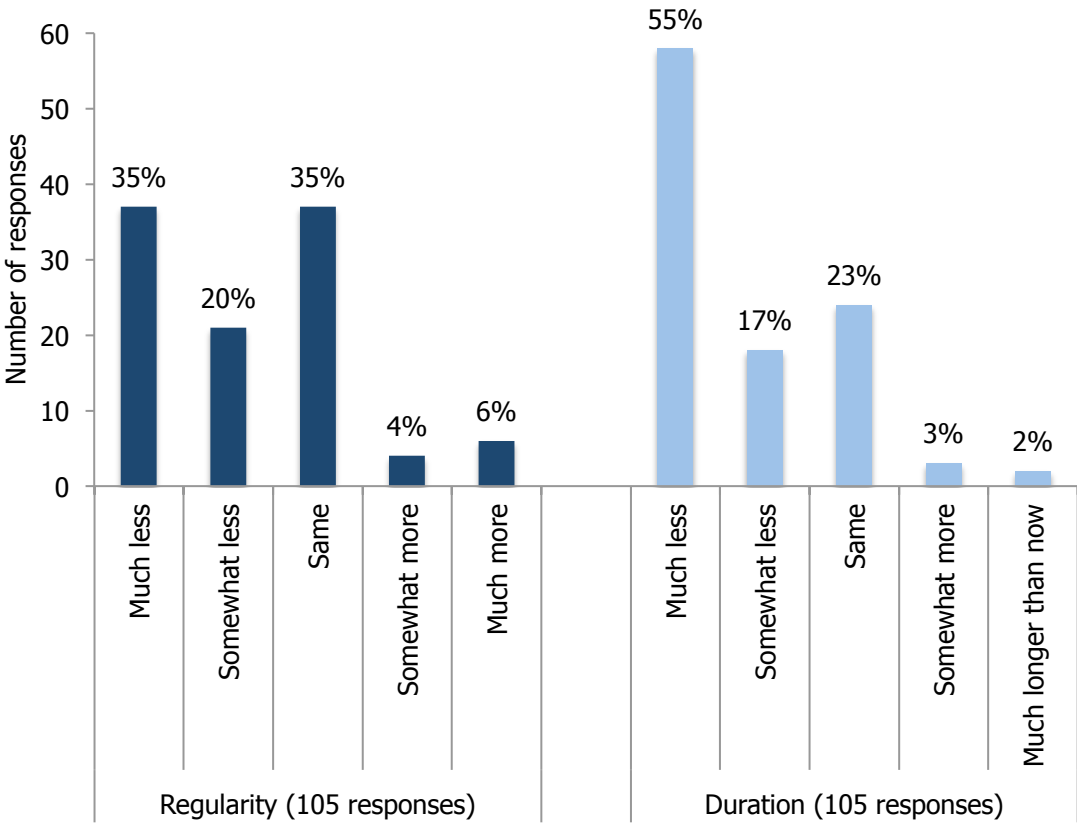
3.1.5. Section E: About you

Figure 13 indicates that the vast majority of participants lived, worked, and/or studied in the local area (defined as a fifteen-minute walk from the site).

Figure 13 Breakdown as to whether participants lived, worked, or studied locally, or were visiting for the day.
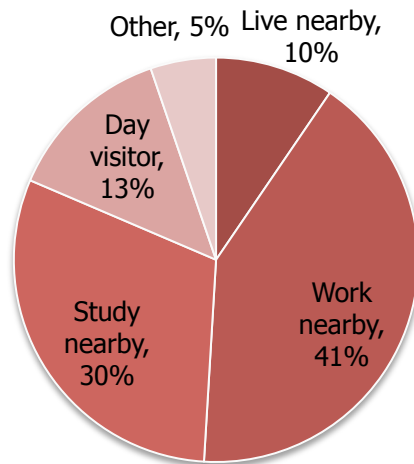
When asked whether they worked or studied in the UTS Dr Chau Chak Wing Building adjacent to the site (Question E2), 82% of respondents said they did not work or study there. This question was used to assess whether the proximity of the building would bias the participant sample in favour of building occupants. Given that over four out of five participants did not work or study in the building, the proximity of the building to the Goods Line North is not thought to have any particular bias on the questionnaire results.

Nearly all participants were under the age of 65, with 39% of participants being under 25 (Figure 14). This reflects the fact that the majority of visitors to the Goods Line North work or study nearby.

Figure 14 Age breakdown of participants.
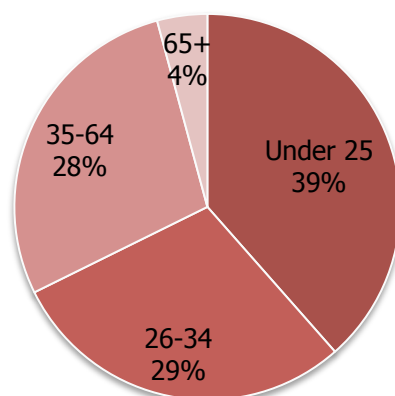
Slightly more males (97) than females (91) participated in the research, while one participant reported an 'Other' gender identity (twelve participants did not indicate any gender identity).

When asked what language they speak at home, a large majority of participants (87%) indicated English, while thirteen per cent indicated 'Other'.

3.1.6. Direct observation

Direct observation was conducted on the Goods Line North over two days – Thursday 21 April 2016 and Tuesday 3 May 2016. Figure 15 shows the hourly counts of visitors to the site on both days, and an average of the two sampling days. Usage of the Goods Line North was highest from 1100 to 1500, with average visitation peaking around 1300. Visitors were fewer in the morning and in the late afternoon. This pattern of visitation is consistent with the site's popularity as a location to have lunch outdoors or otherwise have a break from work or study obligations.

Figure 15 Hourly counts of visitors to the Goods Line North.
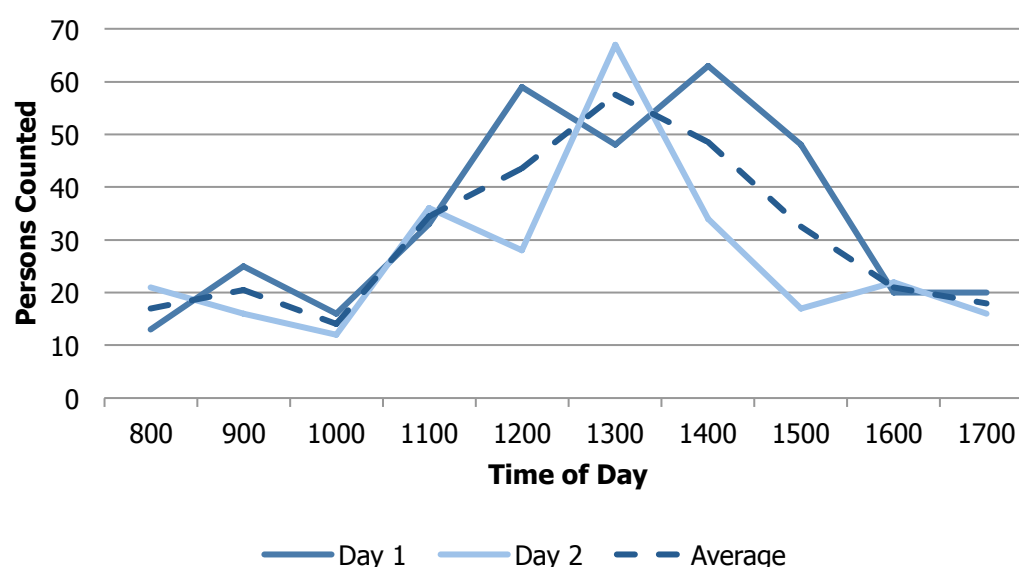
Table 13 describes the activities undertaken by visitors to the Goods Line North, as assessed using the time-lapse photographs. Nearly half of all individuals were at the Goods Line North because they were walking to a nearby attraction, such as UTS or the Powerhouse Museum, underscoring the important role of the site in enhancing the connectivity of the area. Other popular activities were sitting or laying on benches or the amphitheatre steps, which corroborates the site's utility for taking a break or eating lunch.

Table 13 Summary of activities undertaken on the Goods Line North by visitors.

Activity	Count		
	21 April	3 May	Total
Walking through	444	222	666
Standing, sitting, or laying on a bench or seat	96	123	219
Standing, sitting, or laying on the amphitheatre steps	37	64	101
Standing or sitting at the communal table	42	47	89
Interacting with the sand feature	50	21	71
Standing elsewhere on the Goods Line North	26	42	68

Standing, sitting, or laying in the grass	41	25	66
Interacting with the table tennis or outdoor gym infrastructure	24	10	34
Any other activity[7]	13	13	26

Analysis of the time-lapse photography revealed 108 children on 21 April, compared with 15 children observed on 3 May. The popularity of the site for children on 21 April is likely because 21 April fell within the NSW school holiday period in 2016. The Powerhouse Museum held a program of activities during the school holiday period, and many children were on the Goods Line North with parents or carers because they were walking to or from the museum. Many children stopped to interact with the sand feature while on site, which appears to be reflected in the popularity of that activity on 21 April as compared with 3 May. The school holiday period may also explain why more people overall were observed on 21 April when compared with 3 May.

An assessment of gender diversity of visitors to the site was not undertaken as part of the direct observation analysis because of uncertainty around identifying gender using the photographs. An assessment of gender diversity was included in the questionnaire described earlier.

Table 14 details the estimated duration of visits to the Goods Line North, excluding those who were only commuting through the site. Nearly two-thirds (63%) of visits were estimated to occupy the site for less than fifteen minutes, while nearly one-quarter (23%) of visits were estimated to be between fifteen and thirty minutes. Twelve visitors (2%) were estimated to have stayed longer than one hour.

Table 14 Estimated duration of visits to the Goods Line North, excluding those visitors who were walking through the site.

Estimated duration	Count (excluding commuters)	
Less than 15 minutes	355	63%
At least 15 minutes	130	23%
At least 30 minutes	48	8%
At least 45 minutes	21	4%
At least 60 minutes	12	2%

Table 15 displays the results of an assessment of the time-lapse photography as to whether visitors to the Goods Line North visited alone, in a pair, or as a group of three or more. This assessment revealed that the site was slightly more popular to visit with one or more companions than to visit alone. When excluding those who were only commuting through the site, two thirds of visitors came to the site with one or more companions.

---

[7] Other activities include cycling, setting up a film set, tai chi, skateboarding, or undertaking maintenance work.

Table 15 Numbers of visitors to the Goods Line North who visited alone, in a pair, or in a group of three or more.

	All visitors		**Excluding commuters**		**Commuters only**	
Alone	271	44%	118	33%	153	59%
In a Pair	197	32%	132	37%	65	25%
Group of 3+	147	24%	107	30%	40	16%

Figure 16 gives an hourly breakdown of visitation alone, as a pair, or in a group of three or more. Persons visiting alone exceed half of all visitors at 0800, 0900, 1600, and 1700 – consistent with both the site's utility for commuters and the relatively lower numbers of people visiting the site to take a break or eat lunch during those hours. Exclusion of commuters lowered the percentage of lone visitors at each hour, however the percentage of lone visitors remained above thirty per cent for most hourly snapshots. This mix of lone visitors as well as those visiting with others is consistent with questionnaire results suggesting the site was valued for both social interaction as well as for solitude.

Figure 16 Hourly breakdown of visitor numbers to the Goods Line North, based on whether they visited alone, in a pair, or in a group of three or more.
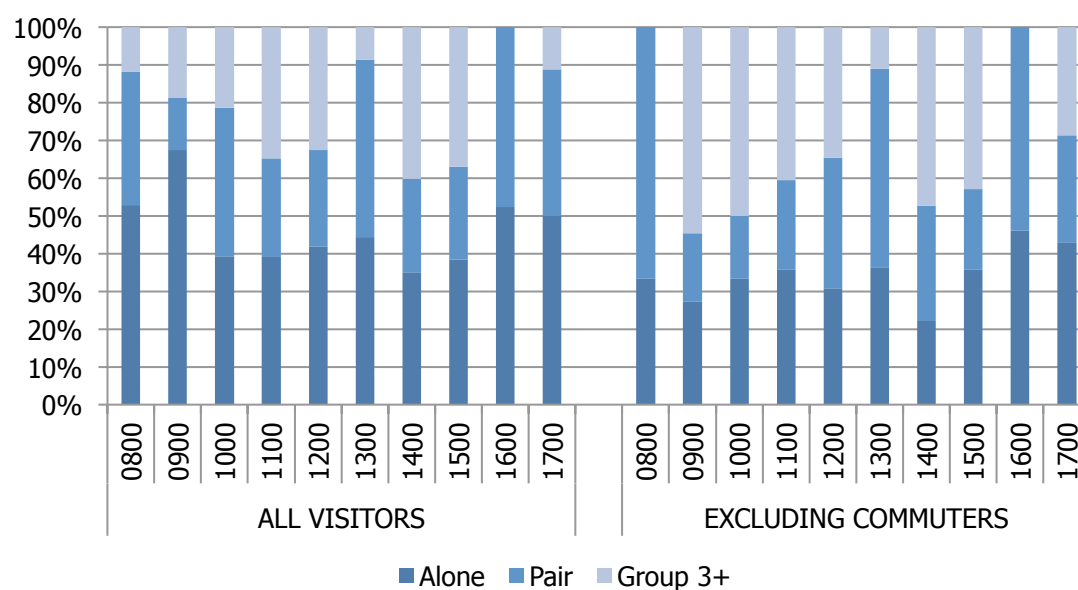
3.2. Interviews

In 2014, prior to the completion of the Goods Line North, a selection of five small businesses were asked to participate in an in-depth interview due to their close proximity to the site and high probability of being impacted by the redevelopment.

Common themes emerged for most of the interviewees who had primarily selected the location of their business due to cheaper rent, a strong student population and being close to a pedestrian thoroughfare.

Positive and negative attributes were associated with the local area, including the Goods Line.

Considering the local area as a whole, negative perceptions outweighed the positive with descriptions such as 'bleak', 'dilapidated', 'parking issues', 'dodgy' and 'unattractive' being common. Despite negative sentiments about the appeal of the local area, only the inability to park conveniently was perceived to have an impact on some businesses. While the lack of atmosphere and perceived unattractiveness of the area were conveyed by all interviewees, the current pedestrian thoroughfare was seen to be beneficial to the commercial success of the area.

Interviewees expressed skepticism as well as optimism about the benefits the Goods Line redevelopment will bring to their businesses. While one small business owner felt the Goods Line would not impact their sales in any way, the resounding hope was that 'more people will mean more business'. Although the potential success of the Goods Line created apprehension in some interviewees that rents would increase and impact their business negatively, on the whole the small business interviewees were hopeful that their sales and profits would increase.

Four of the five businesses were interviewed again in 2016, following the opening of the Goods Line North. Interviewees generally felt that the completion of the Goods Line North had neither a positive nor negative impact on their business. One business owner mentioned that the opening of the site had improved connectivity to Chinatown, but that this alone was unlikely to change the existing preferences of local workers and residents as to where they want to eat, drink, and socialise. Another interviewee suggested that the thoroughfare brings in pedestrian activity and that the Dr Chau Chak Wing Building is an attraction that brings people to the area, but that the Goods Line North itself did not have much of an impact on business.

One interviewee described a desire to hold events or markets on the Goods Line. Suggested ideas were drama performances, light installations, music festivals, afternoon teas, basketball or other sport. The interviewee felt that the amphitheatre at the Goods Line North that looks onto the Mary Ann Street cul de sac is well suited to performances or other events. This potential for activation is made difficult, however, because of confusion over who is allowed access or has control over the use of different areas of the Goods Line. It was also claimed that consent authorities are unwilling to partner with local businesses and grant permission to use the Goods Line for events, markets, and other activation opportunities.

3.3.   Air Quality

A full report by UTS Science detailing the results of the air quality investigations on the Goods Line is given at Appendix C.

In summary, the investigation found no significant differences in ambient air quality between the Goods Line North and adjacent reference control sites. However, sporadic, high concentrations of some air pollutants appear to have been mitigated after opening of the Goods Line North. Specifically, average concentrations of nitrogen dioxide were lower at the Goods Line North on days hotter than 27°C. This result indicates that the inclusion of urban green space may be producing a quantifiable reduction in local nitrogen dioxide, and that this mitigating effect may be enhanced with additional vegetation or with growth of existing vegetation.

3.4.   Stormwater runoff

Table 16 provides the details of the stormwater runoff analysis. The analysis revealed a near ten per cent decrease in runoff following the redevelopment, based on an assessment of site surface types prior to (2009) and after (2016) the redevelopment. Aerial imagery showing proportions of site

surface types before and after redevelopment is provided at Appendix E.

Table 16 Results of stormwater runoff analysis for the Goods Line North redevelopment.

Surface type	Before construction (2009)		After construction (2016)	
	Site area (%)	Runoff (%)	Surface area (%)	Runoff (%)
Asphalt	54.7	90	6.9	90
Concrete	8.4	85	51.8	85
Grass	0	25	11.8	25
Gravel	36.9	85	29.6	85
Whole site		88		78

4. Outcomes and Discussion

Implications of the research results are discussed here with reference to the evaluation framework described at Section 2.1. Results from the 2014 evaluation of the Goods Line South (presented in full at Appendix A) are referenced in this section when appropriate for making a comparison with the Goods Line North or when discussing the entirety of the Goods Line.

4.1.   Social attributes

4.1.1. Visitation of space

Expected outcomes in the evaluation framework relating to **visitation of space** include:

- An increase in the number of people using the site
- People stay in the space for longer
- A diversity of people are using the space.

Direct observation and questionnaires revealed that the entirety of the Goods Line is a well-used space. Visitors who were familiar with the entirety of the site felt that there were more people on the Goods Line since the opening of the Goods Line North.

Visitation levels for both the Goods Line North and the Goods Line South are at their highest between the hours of 1100 to 1500, when the site is popular for having lunch or taking a break from work or study. The Goods Line South is slightly more popular in the morning and late afternoon compared with the Goods Line North, likely a result of the Goods Line South's closer proximity to Central Station, the ABC, and other office buildings.

Visitors to the Goods Line North are likely to spend more time in the space, compared with visitors to the Goods Line South. Participant questionnaires revealed that 32% of visitors remain at the Goods Line North for thirty minutes or more, compared with only 11% of visitors to the Goods Line South. A majority of visitors to the Goods Line North also said they visit the Goods Line North much more regularly than the Goods Line South, and that they spend more time per visit in the Goods Line North compared with the Goods Line South. Therefore, it is likely that the green space and public amenities associated with the Goods Line North have resulted in people staying in the space for longer periods.

The Goods Line North was visited by roughly equal percentages of males and females. The site was also popular with children with visitation levels demonstrably higher during the school holiday period. Questionnaire results suggested that there were relatively few visitors over the age of 65. While this may be a result of the Goods Line North's popularity with students and people of working-age, further research may be warranted to understand whether the site could be made more attractive or accessible for the elderly.

4.1.2. Uses and activities

Expected outcomes in the evaluation framework relating to **uses and activities** include:

- A broad range of activities is undertaken in the space.

The Goods Line is heavily used as a pedestrian corridor, underscoring its importance for providing a

safe and attractive commute between destinations in the Ultimo/Haymarket area. At the same time, both direct observation and participant questionnaires revealed that the Goods Line North is used for a wide range of activities other than commuting. The most popular activities relate to passive recreation such as respite from work or study, eating lunch, relaxing, socializing, sitting in the grass, or finding solitude. Activities such as exercising were mentioned by participants, and observed by the research team, but were less popular.

Users of the site suggested that the varied amenities provided in the Goods Line North were a major attraction and enabled a wide range of activities. Participants most commonly used the many benches, the amphitheatre, the communal table, and the grassy areas to find some time alone or socialise with peers. The sand feature was popular with children, as many families or groups stopped here as they traveled from Central Station to the Powerhouse Museum. The table tennis and outdoor gym facilities were also used, but were less popular than the amenities designed for passive recreation or collaborative working/studying. An affinity for amenities in public places aligns with the research of Fried (2000), who found that physical features such as the presence of amenities facilitate social interactions which, in turn, contribute to place attachment.

While it may be said that the Goods Line North meets the outcome of supporting a broad range of activities, the evaluation has revealed the importance of harmonising green space and public amenities to deliver a positive and diverse visitor experience.

A selection of visitors surveyed wished for more activity on the Goods Line in the form of events, markets, performances, or even buskers. Interviews with local businesses confirmed the desire to hold events or markets on the Goods Line, particularly the Goods Line North and its amphitheatre area. However, there is confusion as to the process for, and likelihood of, having such programming approved by the relevant consent authority. Overcoming these barriers to enable programming to activate the Goods Line North would further broaden the range of activities undertaken in the space.

4.1.3. Health and wellbeing

Expected outcomes relating to **health and wellbeing** include:

- The site encourages physical activity
- The site encourages sedentary activity and relaxation
- The space encouraged increased social interactions

There is evidence to suggest that the Goods Line North encourages and enables an increase in sedentary activity and relaxation. On the other hand, while selected aspects of the site encourage physical activity, this was far less common. Although direct observation did reveal a small number of joggers, cyclists, tai chi practitioners, and individuals using the outdoor gym facilities, the Goods Line North is most popular as a site for passive recreation rather than active recreation. Relaxing, taking a break, sitting, and simply being outdoors were some of the most popular reasons for people to visit the Goods Line North. A majority of visitors familiar with the entirety of the Goods Line suggested they use the Goods Line North more than they used the Goods Line South for taking a break, relaxing, solitude, and socializing.

There is also evidence to suggest that the Goods Line North encourages social interactions, as two-thirds of 'non-commuters' visited the site in groups of two or more people. However, one-third of 'non-commuters' visited the site alone, which suggests that the site enables both social interaction and solitude. Evidence to corroborate this mix of uses is seen in the roughly equal amount of

questionnaire participants who said they used the site for 'Socialising' and for 'Solitude'. When considering all visitors, groups of two or more were more common in the middle of the day, while lone visitors were more common in the morning and late afternoon. However, the proportion of lone visitors was never less than 30%, suggesting that the Goods Line North is a versatile space that enables social interaction or solitude throughout the day.

Therefore, while the Goods Line North did encourage social interaction, it was sufficiently flexible to allow for a range of experiences catering to a diversity of user needs.

4.1.4. Place attachment

Expected outcomes relating to **place attachment** include:

- An increased sense of community attachment in the space
- An increased affinity towards the physical space
- An increased affinity towards the natural environment space
- An increased perception of safety within the space.

A majority of questionnaire participants agreed with the statement that there is a sense of community at the Goods Line North, and that the sense of community is stronger than in the Goods Line South. Community attachment may also be inferred by the high number of participants who said they visit the Goods Line North because it is near their work, their university, or is otherwise convenient. This high level of usage by local workers, students, and residents suggests that the Goods Line North has been a welcome contribution to the lives of those who regularly spend time in the area (i.e. the local community). The social ties between work or study colleagues, such as those in the Goods Line local community, are a form of social attachment (Riger & Lavrakas 1981). Combining this social attachment with an emerging attachment to the Goods Line North may be described as a combined physical-social place attachment (Mesch & Manor 1998; Uzzell et al. 2002).

The site is well used as both a meeting place and a respite space for the local community, while also serving as an attraction for a small number of 'tourists' visiting the Powerhouse Museum or the Dr Chau Chak Wing Building. Given the popularity of the space for locals and its tourist potential, the staging of events or markets (as suggested by local businesses and some questionnaire participants) may further expand the appeal of the Goods Line to a community broader than the immediate workers and students.

Visitors also reported a high level of affinity for the physical and natural space in the Goods Line North, and felt that the green space and built environment are an improvement to what exists at the Goods Line South. The quality and importance of the green space and public amenities were rated highly, and in many cases users felt there could have been more green space and public amenities at the site. These results suggest not only an affinity toward both the physical and natural environment, but also a recognition that the visitor experience is dependent on the availability of urban green space and physical facilities that support public enjoyment of the space (e.g. seating).

The green space and the available public amenities were also mentioned frequently when participants explained why the Goods Line North has delivered an improved experience when compared with Goods Line South. An affinity for amenities in public spaces was shown to contribute to place attachment (Fried 2000) and was discussed above. With regard to green space, participants valued the trees between the Goods Line North and Darling Drive, and the canopy provided by the trees. It is interesting to note that although participants showed an affinity for the tree canopy along

the Goods Line North, the trees themselves existed prior to the redevelopment. Therefore, while the Goods Line North did not provide additional trees as such, it did provide the benches, lawns, tables, and other amenities that unlocked the space below the trees and enabled visitors to experience benefits they provided in the form of shade, access to nature, and bird life. The Goods Line North was thus able to enhance the value of an existing green space asset – a dense tree canopy rare in inner city areas – by enabling access to the asset that had not existed previously. While participants desired more trees to provide further shade on sunny, warm days, further research is required to investigate whether this desire remains in the winter months when visitors may seek sun exposure on cooler days.

Participants overwhelmingly agreed that the Goods Line North felt safe and over three-quarters of participants were of the opinion that the Goods Line North performed better with regard to perceptions of safety when compared with the Goods Line South.

4.2. Environmental attributes

4.2.1. Air quality

The expected outcome relating to **air quality** is an improvement at the site.

While the air quality investigation undertaken as part of this research did not determine that the Goods Line North redevelopment contributed to any significant difference in ambient air quality, the study results pointed to potential mitigation of high concentrations of some air pollutants on hot days. Further sampling in the future would be required to enhance the confidence that the Goods Line North is contributing to improved air quality.

That the redevelopment did not lead to a strong improvement in air quality is likely to be related to the fact that only around one-third of the site was converted to green space, and that this green space is predominantly grass. Urban green spaces linked with improvements in air quality often have a more complex assemblage of vegetation types such as trees, shrubs, and grasses, and air quality improvements associated with vegetation generally increase with the amount of leaf area (Escobedo et al. 2011). Grass areas alone in urban environments may be inferior to large trees and shrubs when it comes to improvements in air quality (Currie & Bass 2008).

4.2.2. Stormwater runoff

The expected outcome is a reduction in **stormwater** runoff from the site.

The stormwater runoff analysis revealed a ten per cent decrease in runoff from the site after the redevelopment of the Goods Line North. The decrease in runoff is largely attributable to the nearly 12 per cent increase in grassed area because of the redevelopment. While the majority of the site remains impervious, the small increased in grassed area has resulted in a minor reduction (improvement) in volumes of storm water runoff when compared to the site conditions before the redevelopment.

Green space such as tree pits and ground vegetation have been shown to reduce stormwater runoff, which lessens stress on local stormwater systems and retains water in local areas that can support vegetation growth (Armson et al. 2013). Modelling suggests that the Goods Line North is reducing stormwater runoff which is likely to be benefiting local stormwater systems. It is likely that the inclusion of more green space either at the Goods Line or its immediate surroundings would provide

further benefits.

4.2.3. Biodiversity

The expected outcome is an increase in **biodiversity** on the site.

A bird survey on the Goods Line North was conducted on 13 May 2016. The survey located six different Noisy Miners in the trees at various intervals. Comparing this result with the lone Rock Dove (feral pigeon) found in the 2014 survey of the Goods Line South suggests that the redevelopment cannot be linked to change in biodiversity at this time or without more intensive biodiversity survey methods.

The redevelopment's lack of impact on biodiversity may be related to the relatively small amount and simple type of green space included in the redevelopment (i.e. predominantly grass), as discussed above when considering a lack of impact on air quality. Enhanced biodiversity at small urban scales requires increasing the coverage and complexity of vegetation (Ely & Pitman 2013) with the inclusion of trees the most important variable for enhancing bird species diversity (Goldstein et al. 1986; Sandström et al. 2006; Evans et al. 2009). No additional trees were provided by the redevelopment of the Goods Line North and it is unsurprising that only Noisy Miners were observed during the bird survey, and that they were found in the tree canopy that existed prior to the redevelopment.

4.3. Economic attributes

Expected outcomes relating to **new businesses** and **existing businesses** include:

- Increased activity with new businesses
- Increased activity with existing businesses.

Direct observation and interviews did not discover any new businesses on the Goods Line North, nor was there evidence to suggest that the redevelopment contributed to increased business activity with existing businesses in the area. However, business activity may lag site usage and it may take some time before business owners detect a measurable change. Similar sites at nearby locations have seen a marked upsurge in business activity through precinct scale renewal (e.g. at Chippendale). More intensive efforts at site activation, through local events, markets, or other programming on the Goods Line may be needed to enhance economic activity on the Goods Line itself, and may attract additional visitors to the site with flow on impacts to economic activity for businesses in the local area.

5. Evaluation

Greening the Goods Line was guided by research questions collaboratively developed by the research team and Hort Innovation. These research questions were:

   a) What are the social and biophysical changes that have resulted from the redevelopment of the Goods Line into public open space?
   b) To what extent are any social and biophysical changes related to increases in green space?
   c) Which are the key evaluation criteria that should be applied to open space redevelopments that include green space to determine an accurate measurement of change?

To investigate these questions, the researchers used participant questionnaires, direct observation, air quality studies, storm water runoff modeling, and bird surveys to generate data that was then interpreted within an evaluation framework developed by the research team in collaboration with Hort Innovation. The evaluation framework defined expected outcomes, indicators, and data sources designed to evaluate a number of social attributes, environmental attributes, and economic attributes. This section reflects on the effectiveness of the research methods and evaluation framework used.

5.1.   Social research methods and outcomes

The participant questionnaires and direct observation were effective for evaluating the social attributes contained within the evaluation framework, and thus for answering social aspects of the research questions. Direct observation using time-lapse photography analysis enabled a comprehensive assessment of the number of visitors to the site, the activities undertaken, amenities used, and estimated duration of stay. The participant questionnaires enabled a deeper assessment of why visitors came to the site, what they liked or disliked about the site, and whether they felt a sense of attachment to the place (Scannell & Gifford 2010).

Direct observation confirmed that the site is heavily used as a pedestrian thoroughfare, which confirms its important contribution to the connectivity of the local area. However, it was difficult to encourage commuters to participate in the questionnaire, which means that these results are not representative of all users of the site, but rather only those who were not walking through the site at the time of their participation. Some questionnaire participants contributed insights as to the value of the site as a pedestrian thoroughfare, with comments about how enjoyable the walk is or that it is safer to cross Ultimo Road since the Goods Line North opened up access to the pedestrian bridge. Trying to gain a more comprehensive insight as to the perspective of commuter users of the site would be an important avenue for further research.

While there was a low level of interest among business owners in participating in interviews, they were useful for providing a high-level perspective of business in the area and whether the Goods Line had any impact on economic activity. Further research of a similar nature in the future may be able to uncover whether the Goods Line and surrounding redevelopments have had a positive impact on business or whether the improvements result in a gentrification impact with negative effects on existing business operators through displacement (Wolch et al. 2014).

5.2.   Biophysical research methods and outcomes

The air quality study and bird surveys were useful for analysing air quality and biodiversity, however

did not find the site had any impact on these variables, save a potential mitigating impact for some pollutants on hot days. It is important to reiterate, however, that this result may be a consequence of the simplicity of the green space installed at the Goods Line North, being primarily grass areas. Improvements to air quality and biodiversity metrics resulting from urban green space developments are most commonly found where the green space includes complex vegetation, particularly trees (Escobedo et al. 2011; Goldstein et al. 1986; Currie & Bass 2008; Evans et al. 2009; Sandström et al. 2006). Future research into biophysical impacts on the Goods Line North may identify impacts on air quality and biodiversity as the site and its surroundings mature. At the same time, the results of this study underscore the importance of providing a sufficient quality of green space if an objective of the space is to improve biophysical variables such as air quality and biodiversity.

5.3. Evaluation framework and measuring change

One of the concerns evident when using an indicator-based evaluation framework is that it presents a simplified, structured way to analyse a complex social space that may lack an obvious structure. Indicators generally simplify in order to make complex phenomena quantifiable in such a manner that communication is either enabled or promoted (MacGillivray & Zadek 1995). The communication of research to a variety of audiences is a key component in the production and dissemination of knowledge, and for this project, the evaluation framework was useful for structuring the presentation and analysis of research results.

At the same time, the simplification and ease of communication using indicators can come at the cost of nuance and understanding complexity. For example, the evaluation framework suggests that an increased number of social interactions is the appropriate indicator for measuring the social attribute of 'Interaction'. While a high level of social interaction was observed at the Goods Line North, there was also a substantial presence of individuals seeking solitude and seemingly avoiding interaction (e.g. sitting alone in far reaches of the site, or sitting with their backs to the majority of the site). A strict reading of the evaluation framework would suggest that visiting the site alone is negative when it comes to encouraging interaction. Given that a majority of questionnaire respondents suggested that they visit the Goods Line to seek both social interaction and solitude, however, the fact that many visitors come alone should not be seen as something that detracts from the site's value. Rather, its capacity to accommodate both social interaction and solitude suggests that the Goods Line North is meeting the varied desires of visitors, rather than falling short when it comes to encouraging social interaction.

Arriving at conclusions as to the level of 'change' at the Goods Line North and attributing changes to the amount and quality of green space was difficult because the site was not open to the public prior to the redevelopment. As such, the Goods Line North should really be considered as a new development rather than as a redevelopment of an existing site. The research incorporated a comparison of the Goods Line North with the Goods Line South, in order to understand how visitors perceive a site with green space and varied amenities (Goods Line North) compared with an adjacent site without these features (Goods Line South). Questions comparing the two sites, as well as other questionnaire topics, enabled the research to answer questions about the role of green space in visitor's experiences and to examine how green space contributes to the attractiveness of a site.

Finally, it is important to consider that at the time of the evaluation, the site had only been open to the public for several months. While it may be the case that the further positive change associated with the Goods Line North will never eventuate, it may also be the case that enhancement will

develop over the course of several years. In fact, in the case of social and economic attributes, the contributions of the Goods Line North are likely to change as ongoing redevelopments in the immediate area (such as Darling Square and Darling Harbour) are completed. It is thus recommended to evaluate the Goods Line North again once these redevelopments are complete, to determine whether a more mature site has any further impact on social, environmental, and economic attributes.

6. Recommendations

Key recommendations from the project include:

- Green space is a highly valued and sought after component of public open space.
- If additional green space cannot be provided on a site because of space considerations, a site can provide amenities necessary for the visitors to enjoy green space that already exists (such as seats underneath existing trees), as a way of promoting access to green space and its benefits.
- Governance arrangements that promote activation of open spaces with green space is important for full benefits associated with green space to be realized.
- This evaluation should be repeated following the completion of surrounding redevelopments and in light of the wider urban renewal of the Ultimo precinct, in order to understand how the contributions of the Goods Line North mature over time and with changes to the surrounding urban fabric and its population.

>

7. Scientific Refereed Publications

None to report.

>

8. Intellectual Property/Commercialisation

No commercial IP generated.

9. References

Akbari, H. et al., 1992. *Cooling our communities: A guidebook on tree planting and light-coloured surfacing*, Washington D.C: US Environmental Protection Agency, Office of Policy Analysis, Climate Change Division.

Alvey, A. a., 2006. Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening*, 5(4), pp.195–201.

Armson, D., Stringer, P. & Ennos, A.R., 2013. The effect of street trees and amenity grass on urban surface water runoff in Manchester, UK. *Urban Forestry and Urban Greening*, 12(3), pp.282–286. Available at: http://dx.doi.org/10.1016/j.ufug.2013.04.001.

Astell-Burt, T., Xiaoqi, F. & Kolt, G., 2014. Is neighbourhood green space associated with a lower risk of Type 2 diabetes? Evidence from 267,072 Australians. *Diabetes Care*, 37(January), pp.197–201.

Bolund, P. & Hunhammar, S., 1999. Ecosystem services in urban areas. *Ecological Economics*, 29(2), pp.293–301.

Brown, H. et al., 2014. Cool communities: Urban trees, climate and health. Available at: http://ehia.curtin.edu.au/local/docs/CoolCommunities.pdf.

Currie, B.A. & Bass, B., 2008. Estimates of air pollution mitigation with green plants and green roofs using the UFORE model. *Urban Ecosystems*, 11(4), pp.409–422.

Ely, M. & Pitman, S., 2013. *Green Infrastructure: Life support for human habitats*, Adelaide.

Escobedo, F.J., Kroeger, T. & Wagner, J.E., 2011. Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. *Environmental Pollution*, 159(8-9), pp.2078–2087.

Evans, K.L., Newson, S.E. & Gaston, K.J., 2009. Habitat influences on urban avian assemblages. *Ibis*, 151(1), pp.19–39. Available at: http://10.1111/j.1474-919X.2008.00898.x.

Fried, M., 2000. Continuities and Discontinuities of Place. *Journal of Environmental Psychology*, pp.193–205.

Goldstein, E.L., Gross, M. & DeGraaf, R.M., 1986. Breeding birds and vegetation: A quantitative assessment. *Urban Ecology*, 9(3), pp.377–385. Available at: http://www.sciencedirect.com/science/article/pii/0304400986900100.

Jacobs, B. & Delaney, C., 2015. *Adapting to Urban Heat: Penrith City Council*, Sydney, Australia.

Kahn, P.H.J. & Kellert, S.R., 2002. *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, Cambridge, Mass., United States: MIT Press Ltd.

Kaplan, R. & Kaplan, S., 1989. *The Experience of Nature: A Pschchology Perspective*, Cambridge, New York: Cambridge University Press.

Kuo, F.E. & Sullivan, W.C., 2001. Environment and Crime in the Inner City: Does Vegetation Reduce Crime? *Environment and Behavior*, 33(3), pp.343–367.

MacGillivray, A. & Zadek, S., 1995. *Accounting for Change: Indicators for Sustainable Development*, New Economics Foundation. Available at: https://books.google.com.au/books?id=EzL1AQAACAAJ.

Max-Neef, M.A., 2005. Foundations of transdisciplinarity. *Ecological Economics*, 53(1), pp.5–16.

Available at: http://www.sciencedirect.com/science/article/B6VDY-4FNW4S2-3/2/651916c13354d7f43067072ebf277781.

Mesch, G.S. & Manor, O., 1998. Social Ties, Environmental Perception, and Local Attachment. *Environment and Behavior*, 30(4), pp.504–519.

NGIA, 2010. *Nursery & Garden Industry Strategic Plan 2010 - 2015*, Epping.

Norton, B. et al., 2013. *Decision principles for the selection and placement of Green Infrastructure*, Melbourne, Australia: Victorian Centre for Climate Change Adaptation Research.

Norton, B. et al., 2015. Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. *Landscape and Urban Planning*, 134, pp.127–138.

ODOT, 2011. *Hydraulics Manual: Oregon Department of Transportation, Geo-Environmental's Engineering and Asset Management Unit*, Oregon, USA.

Riger, S. & Lavrakas, P.J., 1981. Community ties: Patterns of attachment and social interaction in urban neighborhoods. *American Journal of Community Psychology*, 9(1), pp.55–66.

Rodhe, C. & Kendle, A., 1997. *Human Well-Being, Natural Landscapes and Wildlife in Urban Areas*, English Nature.

Rosenfeld, A.H. et al., 1996. Policies to reduce heat islands: Magnitudes of benefits and incentives to achieve them. In *1996 ACEEE Summer Study on Energy Efficiency in Buildings*. pp. 177–186.

Sandström, U.G., Angelstam, P. & Mikusiński, G., 2006. Ecological diversity of birds in relation to the structure of urban green space. *Landscape and Urban Planning*, 77(1–2), pp.39–53. Available at: http://www.sciencedirect.com/science/article/pii/S0169204605000277.

Scannell, L. & Gifford, R., 2010. Defining place attachment: A tripartite organizing framework. *Journal of Environmental Psychology*, 30(1), pp.1–10. Available at: http://dx.doi.org/10.1016/j.jenvp.2009.09.006.

Uzzell, D., Pol, E. & Badenas, D., 2002. Place Identification, Social Cohesion, and Environmental Sustainability. *Environment and Behavior*, 34(1), pp.26–53.

Wolch, J.R., Byrne, J. & Newell, J.P., 2014. Urban green space, public health, and environmental justice: The challenge of making cities "just green enough." *Landscape and Urban Planning*, 125, pp.234–244.

Wong, T.H.., 2006. Water Sensitive Urban Design: the journey thus far. *Australian Journal of Water Resources*, 10(3), pp.213–222.

10. Appendices

APPENDIX A. 2014 Evaluation of Goods Line South

NY13024

M102

BASELINE SUMMARY REPORT

The Baseline Summary Report for MS102 is in accordance with the NY13024 contract between Horticulture Australia Limited and the Institute for Sustainable Futures, University of Technology, Sydney.

This report presents the Evaluation Framework and an overview of the findings from the baseline data collection of the Goods Line that took place in October – May 2014.

The aim of Stage 1 - Baseline data Collection and Analysis was to capture a detailed assessment of the current social and biophysical conditions of the Goods Line site, providing a foundational dataset from which change will be evaluated in Stage 3 of the project.

The overarching aim of the research is to respond to the following three research questions.

1.   What are the social and biophysical changes as a result of redeveloping an urban site into green infrastructure?

2.   What are the local social and biophysical benefits of redeveloping the Goods Line site into green infrastructure?

3.   Which are the key evaluation criteria that should be applied to green infrastructure redevelopments to determine an accurate measurement of change?

BACKGROUND

The Goods Line Site

The Goods Line is an old railway line in Ultimo, Sydney, which was redeveloped into a public corridor the 1990s to connect Central Station to Darling Harbour. This strip of public land is situated between the ABC building, the University of Technology, TAFE, local businesses and the Central Station tunnel (see Figure 1). The central location of this site makes it a highly utilized thoroughfare for the local population. In its current state, the northern end of the Goods Line is closed to the public. The northern end has been approved for development and is currently in the construction phase. The southern end of the Goods Line is awaiting approval for development.

The current redevelopment of the Goods Line aims to transform the area from an 'industrial relic on the city's western fringe into a linear and connected, elevated city park'[1].

As the development of the Goods Line has urban green-space components, it has been selected to act as case study to evaluate the social and environmental changes that can emerge from such an urban transformations. This case study will feed into the 202020 Vision to promote green space targets in Local Government Areas.

---

[1] 202020 Vision website. http://202020vision.com.au/project/?id=152

Figure 1: Aerial view of the Goods Line

EVALUATION FRAMEWORK

At the commencement of the project an Evaluation Framework was drafted and finalised in partnership with the Project Steering Committee. The Evaluation Framework summarises the aims and objectives of the research and presents an overview of the variables, data collection methods, and expected outcomes for each component of the research (Table 1). Developing an evaluation framework at the commencement of the research project fulfills multiple objectives. Primarily, the framework provides clear guidance as the research progresses, ensuring the research design, data collection and analysis continues to respond to the research aims and objectives. For trans-disciplinary, mixed methods research design with a large number of variables for analysis, the Evaluation Framework encourages a structured approach in carrying out the research.

Secondly, the development of framework summaries the research activities and lines of analysis thereby aligning stakeholder expectations of research process and probable outcomes. With multiple stakeholders representing a wide and varied range of organizations, each with vested interests in the research outcomes, providing input into the development of the Evaluation Framework allows for each group to be part of the research design, ensuring their specific research needs are met, and feel confident and familiar with

the direction of the research. The framework can trigger collaboration and active participation in the design phase of the work.

Lastly, for this project, the development of the Evaluation Framework had the long-term aim of creating a tool to be publically available for local governments, NGOs, industry and decision makers to use in evaluating the quality and impact of green infrastructure initiatives. While not all of the variables detailed in the framework will always be able to be included in a future evaluation, as is this case for this research, the Evaluation Framework aims to present a wide range of triple bottom line variables that not only present a best practice approach, but outline the range of important elements that can emerge from quality green infrastructure that may otherwise be undervalued.

Once Stage 3 (Evaluation) of the research has been completed, the Evaluation Framework will be revised to ensure the structure and details reflect the outcomes of the research and best practice in assessing the quality and impact of urban green space.

Table 1: Evaluation Framework

Evaluation of;	Expected outcome	Indicators	Data sources
High level outcomes	An urban green infrastructure development with improved social, environmental and economic attributes.	Improvements in; • Frequency and duration of use • Breadth of activities • Health and wellbeing • Stimulating local economic activities • Air quality • Peak flow storm water runoff • Surface temperatures • Biodiversity – birds and insects	Air quality sampling Surveys Interviews Direct observation Air quality sampling Modeling of peak flow flooding events Comparative surface readings Comparative insect samplings
Social attributes			
Use of space			
Quantities	An increase in the number of people using the site	1. Number of people using the site	Surveys Direct Observation
Duration	People are using the space for longer	2. Time spent in the space	Surveys Direct Observation
Diversity	A diversity of people using the space	3. Uses of the space by age and gender	Surveys Direct Observation
Uses and activities			
Breadth	A broad range of activities undertaken in the space	4. An increasing number of activities taking place in the space	Surveys Direct Observation Interviews
Health and wellbeing			
Physicality	The site is used for physical activity	5. An increase/evidence of physical activity	Surveys Direct Observation Interviews
Sedentary activity	The site encourages sedentary activity	6. An increase/evidence of sedentary activity	Surveys Direct Observation Interviews

Interaction	The space encourages increased social interactions	7. The number of social interactions in the space	Direct observation Surveys Interviews
Place attachment			
Community	There is an increased sense of community attachment in the space	8. Self reported sense of community 9. Reported vandalism	Surveys Interviews
Physical Nature	There is an increased affinity towards the physical space There is an increased affinity towards the natural environment space	10. Self reported affinity towards the built environment 11. Self reported affinity towards the natural environment	Surveys Interviews
Safety	An increased perception of safety within the space	12. Self reported perception of safety within the space	Surveys Interviews
Environmental Attributes			
Air quality	Improved air quality on the site	13. Air quality sampling assessments	Weekly site and reference sampling
Peak storm water runoff	A reduction in the peak flow of storm water runoff	14. Storm water peak flow assessment	Modeling
Biodiversity	An increase in the biodiversity on the site	15. Assessment of bird life and insects	Bird surveys Insect samples
Surface temperature	A reduction in surface temperature	16. A change in surface temperatures on the site	Surface temperature software
Economic Attributes			
New businesses	Increased activity with new businesses	17. Count of new business start ups	Direct observation Interviews
Existing businesses	Increased business activity with existing businesses	18. Self reported assessment of small businesses operating on the site and immediate surrounds	Interviews
Land value and livability	An increase in the value of real-estate in and around the surrounding areas	19. Land value and rental rates 20. Vacancy rates	Land valuation data Interviews

BASELINE ANALYSIS

This research design has employed a trans-disciplinary methodology to promote knowledge production that attempts to understand and respond to real-world problems. Evaluating the range of changes that may occur as a result of redeveloping the Goods Line involves examining a suite of possibilities that transcends a single disciplinary framework. Working trans-disciplinarily aims to capture the complexity of changes that may occur across a range of social, environmental and economic spheres. The intended outcome is to gain a holistic understanding of the ways and culture, environment and local economies may respond to urban greening projects.

SOCIAL

SOCIAL RESEARCH

The social research was conducted in April and May 2014. Due to the close proximity of a number of educational institutions to the Goods Line, the baseline data was collected during session times to capture a representative snapshot of the site.

On-site social research was conducted on the southern end of the Goods Line only (yellow box in Figure 1) as the northern side was closed to the public.

The data collection methods drew upon on-site participant surveys, direct observation and time-lapse photography analysis. The survey comprised of closed questions to allow for quantitative information regarding visitation frequencies and durations, as well as open questions to gather qualitative insights on the participants' thoughts and perspectives. A total of 58 surveys were collected.

The time-lapse photography analysis supplemented the quantitative information gathered from the survey to compare the reported use and visitation patterns of the site. Two full days of direct observation and time-lapse photography was undertaken to monitor the site qualitatively, and to derive quantitative data around durations of visits of overall quantities of people utilizing the Goods Line. This multi-source social research design provides a robust evidence base of the current social engagements and usage pattern of the Goods Line.

The Baseline Survey captured relevant demographic information (Table 2) as a snapshot of those who are currently utilizing the Goods Line.

Table 2: Demographic results

Gender (N= 58)	%	Number
Female	34.5%	20
Male	65.5%	38
Age (N=59)		
Under 25	33.9%	20
26-34	25.4%	15
35-64	37.3%	22

65+	3.4%	2
Reason for being in the area (N = 58)		
Live locally	8.6%	5
Work locally	56.9%	33
Study locally	31%	18
Visiting for the day	10.3%	6

The survey results indicate a higher representation of men using the Goods Line than women, which is consistent with the direct observation findings. The gender balance was not quantified due a lack of certainty in identifying gender from the time-lapse photography, but generally a higher representation of men was noted qualitatively.

Quantities

The local working community was the most highly represented group reporting to use the Goods Line (56.9%), followed by the local student community (31%). Amount of people visiting for the day was relatively low, which may be an indication of the low number of tourists accessing the area compared to the surrounding tourist hotspots such as Central Station and Darling Harbour.

Observation at intervals throughout the day produced a snapshot of the total numbers of site users. Figure 2 presents these snapshot totals over the two-day observation period.

Figure 2: Snapshot number of people in the Goods Line
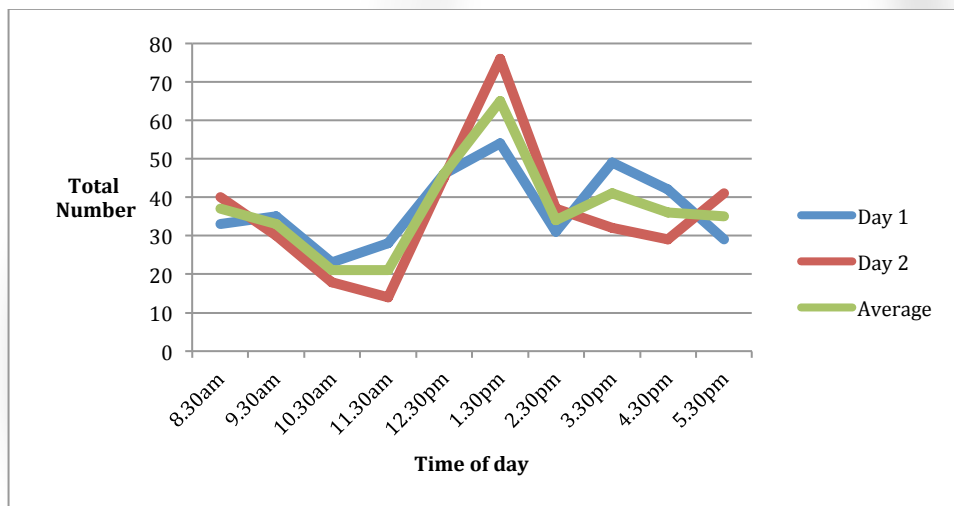
The results show a consistent level of use throughout the day with higher usage at the beginning and end of the working day. The total usage of the site peaks between 12.30pm-1.30pm. These fluctuations are in keeping with the movements of the local professional and student who predominantly use the site (see Table 2).

The frequency of visitation to the site was collected through the baseline survey. The results are presented in Figure 3.
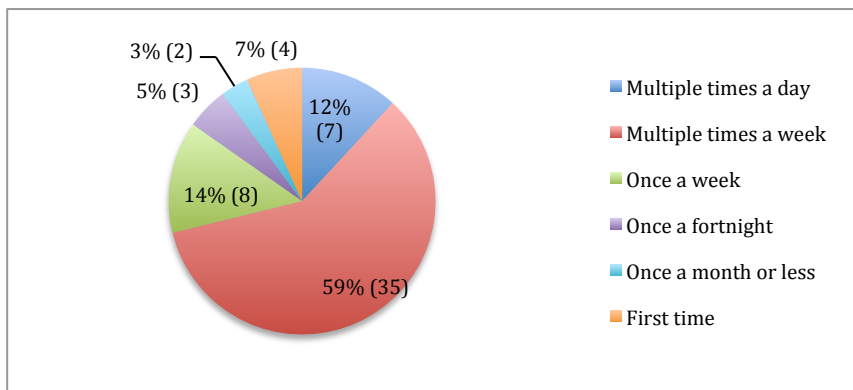
The results show a high frequency of visitation to the site with most participants visiting multiple times a week, with an additional 12% visiting multiple times a day.

Duration

The duration of time spent in the site was derived from both the survey and direct observation data. The time-lapse photography focused on a sample of 22 benches at intervals throughout the day to monitor how long people were spending on the seating provided in the site. The direct observation results captured 5 minute intervals up to a maximum of 15 minutes. The observation of 193 people over 2 days showed that close to 50% of people use the benches for 10 minutes or less, while a substantial portion (36%) appeared to use the site for a minimum of 15 minutes and could extend anywhere up to an hour. The survey responses indicated longer durations on the whole with 58% of respondents reporting to use the site for 15-30mins, and 11% for 30-60mins. Approximately 25% reported to use the site for less than 15minutes. These mixed results show that the Goods Line is currently used for both brief and extended period.

Activities

In addition to providing pedestrian access between Central Station to Ultimo, the baseline analysis sought to understand the range of additional activities carried out on the Goods Line.

Survey respondents where asked to respond to three closed questions regarding the intention and motivation of the activities undertaken at the Goods Line (Table 3).

Table 3: Intention of activities

	Yes	No
Do you come to this space to relax and unwind?	81% (44)	17% (9)
Do you use the space physical activity?	9% (5)	91% (52)
Do you ever work or study in the space?	22% (12)	78% (42)

This was supplemented by an open survey question asking respondents to list the activities they usually undertook at Goods Line. For the 59 respondents, 98 activities were reported, the breadth of which is presented in Figure 4.
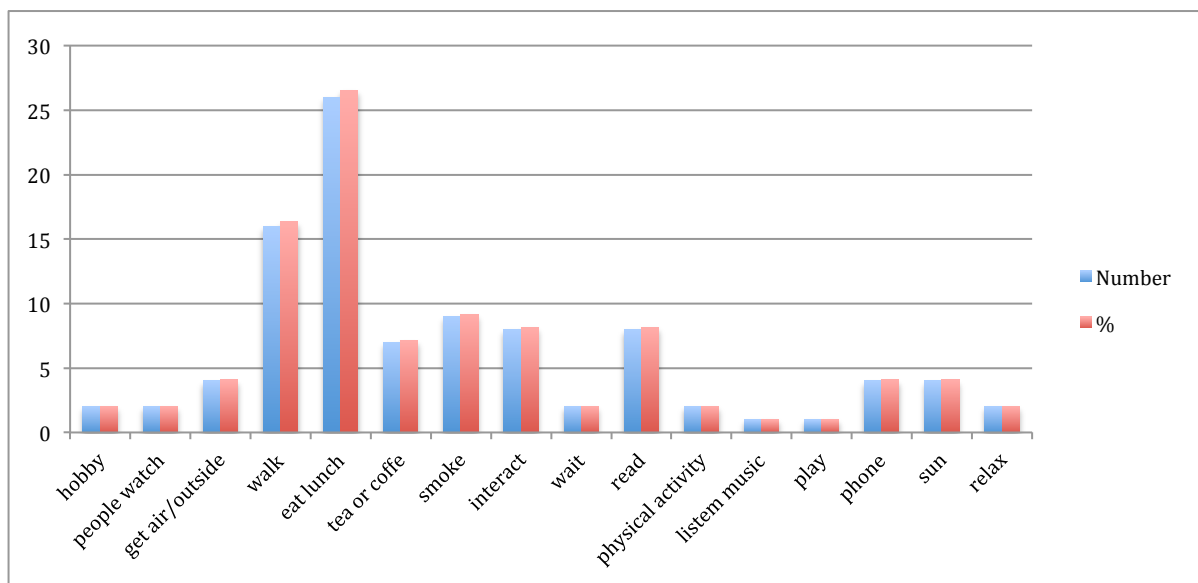
The majority of activities reportedly undertaken in the Goods Line could be classified as a form of relaxation and/or unwinding, which is consistent with 81% who reported using the space for this purpose (Table 3). Similarly, aside from walking, which in this case is a form of commuting rather than exercise, respondents show very low levels of physical activity in the space. This is consistent with the results presented in Table 3 for physical activity. The high proportion of respondents who reportedly 'eat lunch' at the Goods Line is supported by total snapshot quantities, which peaks during the lunchtime period (see Figure 2).

The direct observation and time-lapse photography revealed a relatively small range of activities in comparison to the survey results. For this variable, this difference in results is a limitation of the direct observation method, which is unable to capture the detail or intention of a given activity, but must rely on what is observable. The direct observation was nonetheless able to report on the nature of activities, for example, phone use, eating, and sedentary activities in general. Using the phone, talking to another person and eating and/or drinking were the primary activities observed at the Goods Line. Due to the vantage point of the observation and photography, approximately 30% of those observed were not facing the camera which meant their exact activity could not specified, however it its highly likely that the activities undertaken were one of the aforementioned.

Interaction

Social connectivity and interaction on the Goods Line is another important social variable examined in this research. The time-lapse photography revealed that 73% of the people observed over two days who were using the park benches were alone. This may be a result of the limited seating and infrastructure available on the Goods Line to facilitate groups and/or group activities. This low level of observed social interaction differed significantly from the survey results with 56% reporting to socially interact on the site. While this is a larger proportion than those observed, it indicates that close to half of the respondents do not interact with others at the Goods Line.

Perceptions of the Goods Line

The survey also sought to understand the variety of ways in which respondents perceived the Goods Line. Table 4 presents the results of four key themes.

	Strongly agree	Agree	Neither /nor	Disagree	Strongly disagree
I enjoy being in the Goods Line	15%	70%	12%	3%	0%
I feel a sense of community in the Goods Line	2%	40%	29%	29%	0%
I feel safe in the Goods Line	27%	64%	3%	5%	0%
I like the building and built environment in the Goods Line	3%	46%	19%	32%	0%

A strong majority of survey respondents enjoy being in the Goods Line, with 85% reporting to 'agree' or 'strongly agree' with this statement.

Respondents were divided on whether the Goods Line offered a sense of community, with the majority (58%) not sure or disagreeing with this statement.

A clear majority of respondents also felt safe at the Goods Line. This is likely to be reflective of the patterns of use by the local working community who use the site when it is populated and during working hours.

An affiliation with the surrounding buildings and built environment presents divided responses. Approximately half of the respondents are impartial or do not like the built environment, while the other half agree with the statement.

Green infrastructure

The primary objective of the research is to gain insights into the impact of green infrastructure at the Goods Line. To do this a baseline understanding of the current perception of green space is needed. The evaluation will seek to assess the change in perceptions and subsequent impact the change in green infrastructure has on the health and wellbeing of the local community who utilize the space. Figure 5 presents the responses to the question, "I like the green space and natural environment of this space?"

Figure 5: Perception of green space in the Goods Line (N=57)
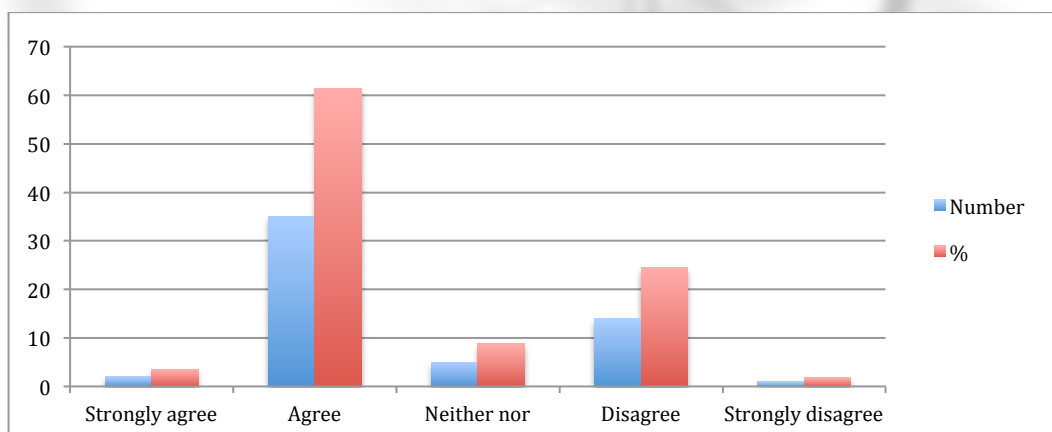
The results show that the majority of respondents (64%) like the green space and natural environment of the Goods Line, while 25% dislike the green space. Importantly, the qualitative responses reveal that 26 of the 35 (74%) who liked the green space added that there wasn't enough and/or the green space needed improvement.

What would improve the space?

Lastly, survey respondents were asked what changes to the Goods Line would make them visit the space more often. This was an open question to elicit the range of personal changes that would make the site more appealing to each respondent. The responses were thematically coded and are presented in Figure 6.

Figure 6: Suggested changes to the Goods Line (N=140)
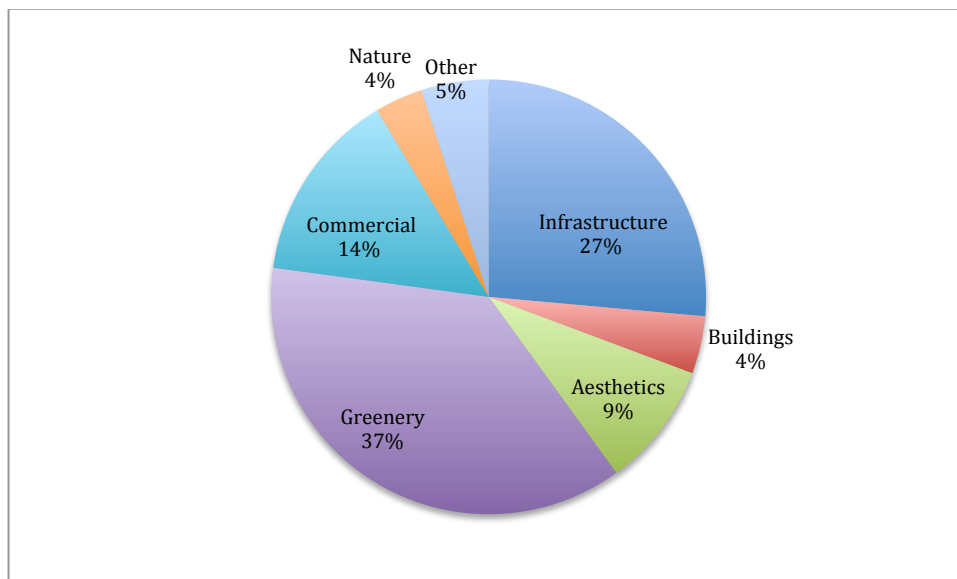
Figure 6 shows that 'greenery'[2] was the theme most highly represented for desire change. 'Infrastructure'[3] was the second largest desired change with 27% of responses suggesting a wide range of additional facilities in the space. Importantly, these findings reinforce the interconnectedness of nature and the built environment in improving urban places and promoting quality place creation.

---

[2] The range of responses categorized under 'greenery' includes: plants, flowers, shrubs, trees, garden, green wall, grass, green.

[3] The range of responses categorized under 'infrastructure' includes: more seating. Improved seating, wifi, tables, skate area, signage, parking, play equipment, bubblers, covered area, bicycle facilities.

ENVIRONMENTAL

The environmental baseline analysis for the Goods Line drew upon three variables from the Evaluation Framework; air quality, peak storm water runoff and biodiversity assessments.

AIR QUALITY

Air quality testing commenced in October 2013, with regular samples taken at the site and two reference sites[4](Figure 7).

The overall goal of this component of the project is to test the positive effect of the increase in green space, in the Goods Line pedestrian corridor, on the improvement in urban air quality.

---

[4] Site 1: Southern Goods Line
Site 2: Northern Goods Line (Samples are taken as proximal to this site as possible. Samples are taken along Darling Drive)
Site 3. Northern Goods Line Reference control sample (North Quay Street)
Site 4. Southern Goods Line Reference Control sample (South Quay Street).

The experimental aims of the project are to conduct air quality investigations, both at the sites that experience increases in green space and at proximal control (reference) sites, to see whether the greening of the Goods Line causes an improvement in a range of air quality variables relative to the reference sites.

Analysis of the data produced from the samples will reveal any relationships between increasing the area of city green space and air quality. In doing so, the project aims to quantify the urban air pollution abatement services provided by urban forestry and the proximal green space.

Sampling will continue until the greening process has been completed, then for several months afterwards. To date 10 months of samples have been conducted at two sampling sites in the Goods Line corridor, with matched samples from two local reference control sites.

Method

Samples are collected once weekly, between 1100 and 1400 on weekdays.

We are using hand-held instruments for all measurements.

A DustTrack II Aerosol Monitor 8532 laser densitometer is used for measuring total suspended particles (TSP), 10 µm and greater particulate matter (PM10) and 2–10 µm particulate matter (PM2.5). A Yessair 8-channel IAQ Monitor (Critical Environment Technologies) is used to measure temperature, humidity, CO_2, CO, nitrogen oxides, sulphur dioxide and volatile organic compounds. A Turbometer Davis anemometer is used to measure wind speed, and a Digitech multifunction Environment meter is used to record noise and light levels.

Data is downloaded from the Randwick, Rozelle and Earlwood air quality monitoring sites operated by The Office of Environment and Heritage (OEH); for comparison on the days that samples are collected.

Traffic Density

To sample traffic density at the locations, twenty-one traffic sampling sites were located at each location, 2 within each 100 m area, 4 within the 250 m areas (but outside the 100 m area) and a further 7 within the 500 m areas outside of the 250 m radius areas. Traffic sampling sites were selected based on a stratified random sampling process amongst high low and medium traffic density road ways. Traffic was sampled manually by counting vehicles passing sample roadways for 15 minute periods per site. Samples were taken mid-week, between 1100 and 1400 (the same time interval in which the air quality samples are taken). These traffic density estimates will be validated against another surrogate traffic density estimate (ambient noise) at the conclusion of the data collection phase of the project.

Preliminary Results

To date, preliminary data indicates that treatments sites have no significant differences in air quality variables than proximal reference sites. Reference areas were selected to be indicators of what would have occurred at the treatment sites (the Goods Line) had the development not occurred. We are greatly encouraged by the strength of this pattern with the limited number of samples taken so far, as this will mean that when the development does take place, there is a greater probability of detecting changes in air quality.

Patterns in all forms of particulate matter (PM10, PM2.5, Total Suspended Particles) were similar. We predict that plants may reduce particulate matter, as they both accumulate particulates, and alter airflow that may cause particle deposition.

Noise in decibels is currently being measured, and we are hoping to record reductions in traffic noise, as the plants may form sound barriers.

Similarly, the formation of windbreaks due to the increase in plant matter is an exciting prospect of this research.

Nitrogen oxides were rarely recorded, however a newer NO_2 meter has recently been acquired for more sensitive detection.

All sites have little to no carbon monoxide, sulfur oxides, or volatile organic compounds, indicating that the general air quality in Sydney is very good for these particular pollutants. These chemicals, when detected, were mostly prevalent on very hot days i.e. over 35°C. It is thought that these chemicals were leaching from the bitumen, indicating that with increased green space, they would be even less frequently detected, due to the urban heat island effect. This is a promising angle of the research, as the increase in green space may have an amelioration effect on in-frequent but high concentrations of certain dangerous chemicals.

Further data analysis will require a larger data set before any worthwhile conclusions can be drawn between air quality and other characteristics of the environment

The fungal spore density and species distribution data is highly variable, but within the range of what would be expected for an urban area. Pathogenic fungi are very rare in the data set, and are well below the levels that would cause a concern for human health. We will require more samples to be collected before this data set can be analysed.

Few problems have arisen with sampling. However, abnormalities encountered with Sydney's air quality have made some sampling trips difficult. Bushfires north of Sydney caused some samples to be non-representative of Sydney's normal air quality at that time. Similarly, January 2014 was Sydney's driest month for that period in 70 years, leading to higher dust that might normally be expected. These problems will be dealt with during the data analysis.

STORM WATER MODELING

The following calculations where used to determine the runoff coefficient (%) for the Goods Line prior to construction. Figure 8 presents an aerial view of the Northern end of the Goods Line separated into different land use types. The various land types in the area have been estimated using Google Earth. From this analysis we estimated the following land types had the following proportions (Figure 9).

The methodology for assessing the storm water runoff followed the standard Rational Method calculation, namely:

$$Q = c.I.A$$

Where Q is the discharge rate, c is the runoff coefficient, I is the rainfall intensity and A is the area of the site. Since the location and area are static the only variable that will change in the Rational Method calculation is the runoff

17

coefficient. As a result the following calculations are only concerned with the runoff coefficient. The coefficients for various land types are obtained from (ODOT 2005 and LMNO 2013) and are:

Table 5: Coefficients for land use runoffs

Land Type	Coefficient
Green areas (large Trees area)	10%
Green beds	25%
Gravel area	85%
Sloping gravel area	60%
Tarred pavement	90%
Construction site (roof)	90%

Table 6: Land type estimates

Land Type	Area (m^2)	Color on image
Green areas (overgrown Trees area)	1186	Dark Green
Green beds	84	Light Green
Gravel area	3146	Dark Grey
Sloping gravel area	168	Light Grey
Tarred pavement	843	Black
Construction site (roof)	790	White
Total area (rounded)	**6216**	

The overall runoff coefficient for the site can be determined by multiplying the percentage of the area devoted to land type X by the run off coefficient for X. This can be expressed mathematically as:

$$c = \sum_i c_i \frac{A_i}{A}$$

Where c_i is the runoff coefficient for land type i, A_i is the area of land type i and A is the size of the total area.

From this analysis it is estimated that the overall runoff coefficient is ~71%. Note this value represents the percentage of rainfall that is converted to runoff. It is important to note that this percentage is highly sensitive to the assumption of the runoff coefficient of the gravel area. As the area currently is predominately a compacted gravel and tar car park the runoff coefficient is reasonably high.

Biodiversity

Under the advice of Birds Australia, a 25-minute bird survey was undertaken to assess the level and diversity of bird life at the Goods Line. Based on the outcome of the bird survey, the level and diversity of bird life was very low, with a single siting of a Rock Dove (feral pigeon) during the survey time frames.

ECONOMIC

The economic analysis comprises of a qualitative assessment of local business owners and relevant local stakeholders to gain their perspectives on;

- How the Goods Line currently impacts sales and profitability?
- How the redevelopment of the Goods Line will impact upon their sale and profitability?

As one half of the Goods Line is closed to the public, and a great deal of construction is underway in the local area, there is a relatively low level of commercial activity compared to other sections of Ultimo and Haymarket.

A selection of 5 small businesses were asked participate in an in-depth interview due to their close proximity to the site and high probability of being impacted by the Goods Line redevelopment.

Common themes emerged for most of the interviewees who had primarily selected the location of their business due to cheaper rent, a strong student population and being close to a pedestrian thoroughfare.

Positive and negative attributes were associated to the current Goods Line and local area. On the whole, negative descriptions outweighed the positive reflections with the descriptions such as 'bleak', 'dilapidated', 'parking issues', 'dodgy' and 'unattractive', however only the inability to park conveniently was perceived to have an impact on some businesses. One local business owner felt the 'yuck factor' worked in his favour as "if you do something attractive [in an unattractive area] it attracts people".

While the lack of atmosphere and perceived unattractiveness of the area was conveyed by all interviewees, the current pedestrian thoroughfare was seen to be beneficial to the commercial success of the area.

Interviewees where relatively unaware of the changes being made to the Goods Line, knowing only what they had read in the newspapers.

Interviewees expressed skepticism as well as optimism in the benefits that the Goods Line redevelopment will bring to their businesses. While one small business owner felt the Goods Line would not impact their sales in any way, the resounding hope was that 'more people will mean more business'. Although the potential success of the Goods Line created fear in some interviewees that rents would increase and impact their business negatively, on the whole the selected small business were hopeful that their sales and profits would increase.

CONCLUSIONS

The result show the Goods Line to be a highly utilized area for the local student and working community, but does not appear to be adequately serving the local population. There is very limited infrastructure to sustain long periods in the space, which significantly limits the opportunity for work or study related activities. This lack of infrastructure and communal design is likely to contribute to the high amount of individual utilizing the space rather than groups. During the lunchtime period, the available sitting is fully occupied, with groups and individuals hugging the perimeter, and eating lunch on the walls of surrounding buildings. As there is no grass or turf ground cover at the Goods Line, which makes it difficult for the local community to utilize the majority of the space.

Usage patterns of the Goods Line change significantly throughout the day. The morning and afternoon periods present a dense pedestrian thoroughfare with little to no other activities. The breadth of activities evident at the Goods Line appears to be low. Walking, as a means of commuting, is the primary activity, which is supplemented by a small range of sedentary activities. There are very few signs of additional physical activities in the site. The changes to the Goods Line offer an opportunity to extend the activities undertaken which may benefit the health and well being of the local community.

In terms of social and cultural diversity, the Goods Line exhibits an adequate gender balance, despite a slight over representation of men, and consistent levels of ethnic diversity. People over 65 and those under 18 years old are underrepresented, as too are mothers and children, families, and the physically impaired.

Air quality at the Goods Line is consistent with other areas of Ultimo, which has been established through the sample reference sites. Storm water run-off is quite high, with estimates concluding that the northern end of the site currently experiences rainfall runoff of 71%. Bird life is extremely low on the southern end of the Goods Line, which is likely to be reflective of the lack habitat, plant life and water bodies to sustain local biodiversity.

Once the changes to the Goods Line has been completed, evaluating the social and environmental changes will be undertaken, with a focus on the attribution of these changes to the increases in green space and vegetation.

REFERNCES

ODOT 2005, Oregon Department of Transportation Highway Division, Hydraulics Manual, 2005, ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Hydraulics/Hydraulics%20Manual/Chapter_07/Chapter_07_appendix_F/CHAPTER_07_appendix_F.pdf

LMNO 2013, LMNO Engineering, Research, and Software, Ltd website, http://www.lmnoeng.com/Hydrology/rational.php

APPENDIX B. Participant questionnaire

Thanks for agreeing to take our survey on attitudes and experiences relating to this newly opened end of the Goods Line!

Section A: General attitudes

To begin, we'd like to understand your general perspective on this new end of the Goods Line.

A1.   **Why do you come to this new end of the Goods Line?**

A2.   **What do you like most about this new end of the Goods Line (if anything)?**

A3.   **What do you <u>dislike</u> about this new end of the Goods Line (if anything)?**

A4.   **Why do/would you choose to come here to the Goods Line instead of other outdoor places?**

A5.   **Are there any changes that could be made to the Goods Line that would improve your experience / make you visit more often?**

Section B: Previous use

This NEW end of the Goods Line (Powerhouse Museum end) was newly opened in August 2015. Before this, the OLD Goods Line was only accessible from Central Station tunnel to Ultimo Road (the bridge overpass).

B1. **Before the opening of this NEW end (near Powerhouse Museum), did you visit the OLD end of the Goods Line (near the Central Station tunnel)?**

(Please tick one)

Yes, I frequently came to spend time in the old Goods Line ☐

Yes, I came a few times to spend time in the old Goods Line ☐

Yes, but only to walk through the old Goods Line to other places ☐

▼
Continue to B2 below

No, I never came to the old Goods Line, before this new end opened ☐

I'm not sure/ I don't remember ☐

▼
Skip to C1 over the page

Only answer the rest of this section if you answered YES to Question B1 above. Otherwise skip to Section C over the page.

This section compares your past experience of the OLD end of the Goods Line (Central Station tunnel end) with your current experiences in this NEW end of the Goods Line (Powerhouse Museum end).

B2. **What have you noticed about how the Goods Line has changed since the opening of this new end?**

B3. **Has your experience in the Goods Line changed since the opening of this new end?**

(Please tick one)

Yes - improved ☐ **Continue to B4 below**

Yes - worsened ☐ **Skip to C1**

No - unchanged ☐ **Skip to C1**

B4. **If you answered 'Improved' at B3 above, what is/are the main reason(s) for this improvement in your experience?**

1:

2:

3:

Section C: Sentiments

C1. **A. How often do you come to this NEW end of the Goods Line for the following activities?**

If you answered 'Yes' to B1 on p.2, please also answer the following:
B. How does this compare to the frequency of your visits to the OLD Goods Line before the opening of this NEW section? Is it more or less than before?

	A. Frequency *(Please tick one of the three options for each activity)*			B. Comparison to before *(Please tick one of the three options for each activity)*		
	Always/ Usually	Some times	Rarely/ Never	More than before	No change	Less than before
Walking through here without stopping on my way to other places	☐	☐	☐	☐	☐	☐
To take a break (eg. eat lunch, have a coffee, get some air)	☐	☐	☐	☐	☐	☐
To relax (eg. read, listen to music, use my phone)	☐	☐	☐	☐	☐	☐
To work or study	☐	☐	☐	☐	☐	☐
To do some exercise (eg. Use the outdoor gym, go for a run)	☐	☐	☐	☐	☐	☐
To spend some time on my own	☐	☐	☐	☐	☐	☐
To socialize with my peers	☐	☐	☐	☐	☐	☐
To use the facilities (wifi, tables, table tennis)	☐	☐	☐			
To sit on the grass	☐	☐	☐			
To walk my dog	☐	☐	☐	☐	☐	☐

C2. *If you answered 'Always/Usually' or 'Sometimes' to work or study above:*
Do you usually do this alone or with others?

(Please tick one)

Always alone ☐

More often alone ☐

Equally alone and with others ☐

More often with others ☐

Always with others ☐

C3. **A. How do you feel about this NEW end of the Goods Line?**

If you answered 'Yes' to B1 on p.2, please also answer the following:

B. How does this compare to how you felt about the OLD Goods Line before the opening of this new section? Is it better or worse than before?

A. Perceptions
(Please tick one of the five options for each activity)

B. Comparison to before
(Please tick one of the three options for each activity)

	Strongly Agree	Agree	Neither /nor	Disagree	Strongly Disagree		Better than before	No change	Worse than before
I enjoy being in this space	☐	☐	☐	☐	☐		☐	☐	☐
I feel a sense of community in this space	☐	☐	☐	☐	☐		☐	☐	☐
I feel safe in this space	☐	☐	☐	☐	☐		☐	☐	☐
I like the buildings and built environment of this space	☐	☐	☐	☐	☐		☐	☐	☐
I like the green space and natural environment of this space	☐	☐	☐	☐	☐		☐	☐	☐
I find the Goods Line visually appealing	☐	☐	☐	☐	☐		☐	☐	☐

*Thinking about both the **public facilities** (eg. wifi, tables, outdoor gym) and the **green space** (eg. trees, plants and grass) in this new end of the Goods Line, please answer the following questions.*

C4. **How would you rate the <u>quality</u> of these public facilities/green space at this new end of the Goods Line?**

(Please select a number between 0 and 10, whether 0 is Lowest quality and 10 is Highest quality.)

	Lowest quality										**Highest quality**
	0	1	2	3	4	5	6	7	8	9	10
Public facilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green space	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

C5. **Do you think there <u>are enough</u> of these public facilities/green space at this new end of the Goods Line?**

(Please select a number between 0 and 10, whether 0 is Definitely not enough and 10 is Plenty.)

	Not enough										**More than enough**
	0	1	2	3	4	5	6	7	8	9	10
Public facilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green space	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

C6. **How <u>important to you</u> are these public facilities/green space at this end of the Goods Line?**

(Please select a number between 0 and 10, whether 0 is Not all important and 10 is Very important.)

	Not at all important										**Very important**
	0	1	2	3	4	5	6	7	8	9	10
Public facilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green space	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Section D: Visiting habits

The following two questions relate to your visiting habits in the Goods Line since the opening of this new end.

D1. How regularly do you visit this new end of the Goods Line?

(Please tick one)

Multiple times a day ☐

Multiple times a week ☐

About once a week ☐

About once a fortnight ☐

Once a month or less ☐

First time here ☐

D2.   How long do you usually stay when you visit this new end of the Goods Line?

(Please tick one)

Less than 15 minutes ☐

About 15-30 minutes ☐

About 30-60 minutes ☐

An hour or more ☐

If you had previously visited the old end of the Goods Line (ie. you answered YES to B1 on p.2) please answer the following two questions. Otherwise skip to Section E.

D3.   How often did you visit the original end?

(Please tick one)

Much less often than now ☐

Somewhat less often than now ☐

About the same as now ☐

Somewhat more often than now ☐

Much more often than now ☐

D4.   How long did you used to stay in the old end of the Goods Line, before the opening of this new end?

(Please tick one)

Much shorter than now ☐

Somewhat shorter than now ☐

About the same as now ☐

Somewhat longer than now ☐

Much longer than now ☐

Section E: About you

E1. **Are you from the local area (within a 15 minute walk)?**

(Please tick all that apply)

Yes, I live locally ☐

Yes, I work locally ☐

Yes, I study locally ☐

No, I am visiting for the day ☐

Other ▼

Other

_____

E2. **Do you work or study in the new Business School building (Dr Chau Chak Wing/Frank Gehry building)?**

(Please tick one)

Yes ☐

No ☐

E3. **How old are you?**

(Please tick one)

Under 25 ☐

26-34 ☐

35-64 ☐

65 and over ☐

E4. **What is your gender identity?**

(Please tick one)

Female ☐

Male ☐

Other ☐

E5. **What language do you mainly speak at home?**

English ☐

Other ☐

Thanks again for taking our survey. Once you have finished, please return you completed survey to the ISF collection box (near the ISF banner).

APPENDIX C. Air quality evaluation report

Does an increase in urban greening and urban forestry have a positive influence the air quality of Sydney: A BACI (Before – After – Control – Impact) design.

PJ Irga, ANJ Douglas, M Burchett, FR Torpy

Plants and Environmental Quality Research Group

School of life sciences

University of Technology, Sydney

1. INTRODUCTION

Air pollution in urban areas remains an important and unresolved problem of global scale. Air pollution kills an estimated 8 million people across the world annually (WHO, 2014), with a global cost of 90 trillion dollars (Hutton, 2014). Exposure to air pollutants can have significant health effects; including increased risk of premature death, acute and chronic morbidity and increased cardiopulmonary mortality (Currie & Bass 2008, Escobedo et al. 2012). In Australia it is estimated that urban air pollution causes over 1,400 deaths per annum in Sydney alone (Department of Health, 2009), with national health care and associated costs estimated to be as high as 1% of gross domestic product (Brindle et al, 1999). Calculations conducted by Broome et al (2015) determined that even a meagre 10% reduction in $PM_{2.5}$ exposure in Sydney would result in 650 fewer premature deaths, a gain of 3500 life-years and about 700 fewer respiratory and cardiovascular hospital visits per year.

A considerable amount of air pollution can be biological in nature (pollen, spores, etc), however most other pollutants come from fossil fuel emissions, which comprise a mixture of particulate matter (PM), oxides of sulfur (SO_x), oxides of nitrogen (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOCs) and ozone (Table 1). Particulate matter is the most frequently studied air pollutant due to the associated health risks. The main characteristics of the airborne particles are their size, chemical composition and morphology. The source of particulate matter tends to determine the size of particulate generated, with combustion leading to smaller particles from mechanical generation methods, as opposed to biological sources forming larger particles (Lazaridis, 2011). Epidemiological studies mainly focus on particulate matter (PM) of 10μm is size (PM_{10}) and smaller as these particles are able to penetrate beyond the nasal passages and into respiratory system, and the smaller the particle the further it can penetrate (Raaschou-Nielsen et al, 2016). Once there, these particles have the potential to cause adverse pulmonary and extra-pulmonary health effects (Millar et al, 2010), potentially resulting in acute exacerbations of chronic obstructive pulmonary

disease and asthma. Similarly, the presence and concentrations of nitrogen oxides (NO_x) and sulfur oxides (SO_x) are of equal concern, as these chemicals, whilst less concentrated in urban air, are considered the most harmful components of air pollution (Pugh et al, 2012). High concentrations of NO_x and SO_x exist in areas where traffic is present as the majority of it is formed during the incomplete combustion of fossil fuels, usually from vehicular exhaust (Currie & Bass 2008, Grundström & Pleijel, 2014).

'Urban forestry and urban greening' has been proposed as a means to reduce airborne pollutant levels, with increasing research identifying and quantifying the various ecosystem services it provides, including the reduction and mitigation of air pollution. The capacity of urban forestry, in particular trees, to reduce air pollutants is through a number of mechanisms. The first is dry deposition, a process whereby a particle is deposited on to the surface of the plants utilised in urban forestry either by settling, impact, diffusion, or interception (McDonald et al, 2007). The larger the surface area of the vegetation and the waxier it is, the greater chance of deposition occurring – thus plants with large leaves or pubescent leaves tend to accumulate more particulate matter (Janhäll, 2015). In regards to gaseous pollutants, pollutant removal is through stomatal uptake (Beckett et al, 1998). Vegetation is able to sequester air pollutants through their open stomata and either store it or process it through a series of chemical reactions (Currie & Bass 2008). Subsequently, the ability to sequester air pollutants, both on the plant, and in the plant through the stomata, potentially makes vegetation a viable option in maintaining and improving air quality in urban areas. These benefits notwithstanding, urban forestry does create some limited air pollutant disservices, including the emissions of biologically derived volatile organic compounds (BVOCs) and the source of allergenic pollen and fungal spores (bioaerosols).

Despite the numerous known benefits urban forestry has on ameliorating and mitigating air pollutants, there is a scarcity of quantitative data available for its ability to do so, with many regions' vegetation-atmosphere interactions relatively unstudied. This knowledge gap may be a consequence of the complexity of the physical and chemical processes involved in the vegetation-atmosphere interactions within urban areas, as well as over reliance on numerical estimate models that are not designed for Australian conditions. Sydney's urban forestry is poorly studied with respect to its ability to reduce urban air pollution. Further, few studies from any location are available that provide quantitative experimental data on the air pollutant removal capacity of urban forestry/greenspace.

1.2. Research Synopsis and experimental aims

The goal of this research was to examine the effect of a planted increase in greenspace on local air quality in an area on the southern edge of the CBD of Sydney. The location examined was the corridor of a previous railway 'Goods Line', now a pedestrian by-way in the Haymarket area, running from the end of the Devonshire St pedestrian tunnel to the Powerhouse Museum (Figure 1), (coordinates: -33.883246, 151.202849 to -33.877625, 151.199670).

Air quality investigations were made, both at the sites which were expected to receive increases in greenspace and at proximal control (reference) sites (Figure 1). The project followed a Before – After – Control – Impact (BACI) design, aimed at revealing relationships between increasing city greenspace and air quality. In doing so, the project aimed to detect any ambient urban air pollution abatement services provided by urban forestry and greenspace.

2. METHODS

Baseline sampling was conducted across 4 study sites for 16 months (Figure 1), from 4th October 2013 to 25th February 2015, to provide a strong dataset indicating the background air quality across the sample area. This involved a total of 59 sample events, with matched samples taken at sites to be impacted by increased greenspace and at reference sites. Initially site 1 and site 2 were going to be compared to site 3 and 4, however site 1 never received additional plants, and thus was added as a third reference site, leaving only site 2 as a treatment site to which additional greenspace had been installed. Greenspace installation and subsequent opening of the 'Goods Line' was completed on the 30th August 2015. Intensive air sampling was conducted on the September 1st, 2nd and 3rd, to detect any initial impact followed by further sampling in February 2016, where twice daily samples were conducted on February 15th, 17th, 19th, 22nd, 26th, and 28th, to allow comparison to samples taken at the same time of year prior to the implementation of the greenspace impact installation.

Air samples were collected between 1100 and 1400 h on weekdays. The time between samplings ranged from 3 to 14 days. Hand-held instruments were utilised for all measurements: A DustTrack II Aerosol Monitor 8532 laser densitometer was used for measuring total suspended particles (TSP), 10 µm and smaller particulate matter (PM_{10}) and 2.5 µm and smaller particulate matter ($PM_{2.5}$). A Yessair 8-channel IAQ Monitor (Critical Environment Technologies) was used to measure temperature, humidity, CO_2, CO, nitrogen oxides, sulphur dioxide and volatile organic compounds. A Turbometer Davis anemometer was used to measure wind speed, and a Digitech multifunction Environment meter was used to record noise and light levels.

For quality assurance, we made comparisons of air quality elsewhere in Sydney on the days that samples were collected. For this purpose, data were downloaded from the Randwick, Rozelle and Earlwood monitoring sites operated by The Office of Environment and Heritage (OEH).

All data is expressed as a time weighted average (TWA) for the sampling duration (3 hours). Data was checked for normality and homogeneity of variance, then analysed utilising a two factor repeated measures ANOVA.

Table 1: Air quality variables to be measured to determine their relationship with environmental characteristics

Variable	Source if relevant
CO_2	Fossil fuel combustion
CO	Fossil fuel combustion
Volatile organic compounds (total)	Vehicle emissions
Total suspended particulate matter	Diesel engines, dust, industry, atmospheric reactions involving other air pollutants
PM_{10} (particles with equivalent aerodynamic diameter of 10 µm or less)	Diesel engines, industry, abrasion of tyres on road surfaces, natural dust
$PM_{2.5}$ (with equivalent aerodynamic diameter of 2.5 µm or less)	Diesel engines, industry, abrasion of tyres on road surfaces, natural dust
NOx	Combustion
SOx	Coal fired power generation
Noise (Db)	Roads with active populations, road traffic, industry, and construction

Figure 1. Goods Line sample sites. Site 1: Southern Goods Line (Ultimo pedestrian Network), Site 2: Northern Goods Line Darling Drive), Site 3. Northern Goods Line Reference control sample (North Quay Street), Site 4. Southern Goods Line Reference Control sample (South Quay Street)

3. RESULTS

Our findings indicated that whilst there were no significant differences in ambient air quality between treatment sites and adjacent reference control sites, sporadic high concentrations of some air pollutants appear to have be mitigated after installation of the greenspace. Patterns in all forms of particulate matter (total Suspended Particles, PM_{10}, $PM_{2.5}$) were similar (Figure 2–4). There was no significant difference in total suspended particles and the fraction of particulate matter less than 10 microns (PM_{10}) between sites. This is an indicator that the inclusion of plants present in the sample sites may need to be increased for quantitative air quality benefits to be observed. Concentrations of $PM_{2.5}$ were relatively high compared to documented particulate concentrations in other parts of Sydney. The device used in this project: the DustTrack II Aerosol Monitor 8532 has been known to overestimate the smaller fractions of PM, thus a correction factor derived from OEH air quality monitoring sites that utilise a tapered element oscillating microbalance (TEOM) to measure PM was applied. This did not alter the high $PM_{2.5}$ levels detected, which therefore were most likely derived from the associated traffic on the nearby arterial roadways.

There was no variation in CO_2 concentrations amongst sites, nor were seasonal trends observed, with mean concentrations ranging from 370 ppm to 987 ppm (GLM ANOVA, $P > 0.05$). Once again, this is possibly due to the small extent of the greenspace installed, and also possibly affected by the influx of polluted air from the surrounding heavily trafficked areas.

Noise in decibels was measured in an attempt to detect any reductions in traffic noise, as the plants may form sound barriers (Figure 5). Site 1, had lower noise levels than the other three sites ($p < 0.05$), possibly due to the nearby buildings acting as a sound barrier in the street canyon. These same barrier formations similarly have a positive effect on wind flow. Although not assessed formally, observations of the Goods Line effect on wind was interesting, as wind strength was mitigated from most directions, except for strong north easterlies (mainly over late spring to mid-summer), which may assist in the dispersal of air pollutants subsuming the effect of proximal greenspace ability to improve the air quality. The formation of wind breaks due to the increase in plant matter is an exciting prospect of this research, as these barriers prevent the penetration of vehicular derived pollutants into these areas of increased pedestrian activity.

Nitrogen dioxide levels were low throughout sampling; however a large peak across all sites was recorded on a single extreme heat day ($+40^{\circ}C$). Additionally, although not statistically significant, average concentrations of NO_2 were lower at the greened site by 0.2 ppm on days that were hotter than $27^{\circ}C$. Whilst this phenomenon was only observed on a single sampling event, it does indicate that the inclusion of urban forestry may be producing a quantifiable reduction in local NO_2, and this mitigation phenomenon is likely to increase in efficiency with increased quantities and growth of vegetation.

All sites had little to no detectable carbon monoxide, sulfur oxides, nitrogen oxides or volatile organic compounds, indicating that the general air quality in Sydney was very good for these particular pollutants. When detectable, these chemicals were mostly

prevalent on very hot days above 35°c. It is thought that these chemicals were leaching from the bitumen. With greater concentrations of greenspace than were installed in this project, these pollutants could be expected to be even less frequently detected, due to reductions in the urban heat island effect. This is a promising angle of the research, as the increase in greenspace may have an ameliorating effect on infrequent but high concentrations of a range of air contaminants.

4. IMPLICATIONS OF RESEARCH AND FUTURE DIRECTIONS

At the conclusion of sampling, whilst the effect of the new greenspace installed on air quality was not significant, some encouraging conclusions can be derived from the data collected.

As reported by Irga et al (2015), in order to produce quantitative differences in ambient air pollutants, a minimum of 25% canopy coverage within a 100 m radius of a site is required, which in this study would require a substantial increase from the current 11%. Nevertheless, the removal of impervious surfaces which may have contributed to some of the gaseous pollutants detected prior to the installation of the greenspace may have made a contribution to the abatement of those pollutants on the hot days. By taking into account the particular characteristics of street canyons, the potential for air quality improvements could be greatly enhanced. However, urban greening initiatives whose focus is purely to increase grass coverage will fail to achieve their maximum air quality potential and may even worsen air quality in street canyons, as greenspace that is comprised solely of grass has been associated with bioaerosols that would contribute to particulate matter. This is because grass cover harbours greater quantities of decaying organic material, which facilitates the proliferation of fungal saprophytes, which produce aerosolized spores. Additionally, turf grass in urban areas is regularly mown: potentially mechanically aerosolizing trichomes, plant detritus, endophytic and epiphytic fungi along with any other precipitated particulate matter.

As limited reductions in ambient particulate matter concentrations were recorded, and most particulates are of vehicular exhaust origin, further greening projects should consider creating strategic configurations of plants as a preventative barrier or buffer zone to prevent the penetration of particles from the source as opposed to haphazard style plantings which can potentially channel air through the area intended for remediation. Further, as the mechanism of particulate matter removal includes the deposition or particles on to the large waxy surface that urban forestry can provide, sampling of the particulate matter deposition rate per tree may be able to elucidate the interception and accumulation efficiency of each individual planting, to provide evidence on the selection of the most appropriate planting for optimising the enhancement of air abatement services of individual greening projects.

High greenspace densities have been proposed to have lower NO_2 concentrations (Janhäll 2015), although empirical data to demonstrate this is lacking, and efforts to demonstrate this trend have failed to find effects of the magnitude detected by theoretical models. This may be due to greenspace concentrations never exceeding a

threshold in which the full potential of urban forestry is realised, as was probably the case in the current work.

A commonly used measure of urban forest ecosystem services is the Urban Forest Effects (UFORE) model developed U.S Forest Service (Nowak et al, 2006). However, the model has limitations in its potential application in Australia, specifically concerning the deposition rates for plant species native to that region not being in the system, the uncertainty related to particle re-suspension rates and the fine scale spatial variability often observed in concentrations of air pollutants within urban areas such as Sydney (Baró et al 2014). Thus surveying of air pollutant draw down for Sydney needs to be verified with empirical evidence first and foremost and if the model is to be used it should be used with restraint. Further work that details the deposition velocity of pollutants may allow the UFORE estimates to be applied to Sydney.

Use of computational fluid dynamic models taking into consideration of street-canyon chemistry and deposition could also be utilised to explore deposition surfaces in conjunction with the urban infrastructure, which is then evaluated against available empirical measurements.

In conclusion, the current study did not find significant air quality improvements associated with the greenspace installed as part of the Goods Line redevelopment, due to the constrained area of the greenspace, and the small quantity of plants used. Whilst there is strong evidence that urban greenspace can have powerful effects in remediating poor urban air quality, if future developments are to have functions beyond improving the utility and attractiveness of an area, they must contain sufficient density and extent of planted area of appropriate species to ensure measurable effects occur.

5. REFERENCES

Baró, F., Chaparro, L., Gómez-Baggethun, E., Langemeyer, J., Nowak, D. J., & Terradas, J. 2014. Contribution of Ecosystem Services to Air Quality and Climate Change Mitigation Policies: The Case of Urban Forests in Barcelona, Spain. Ambio 43, 466–479.

Brindle, R., N. Houghton, and G. Sheridan. Transport Generated Air Pollution and its Health Impacts. A Source Document for Local Government. In: R. R. A. 336. (ed.). ARRB Tranport Research, Vermont South, Victoria. 1999.

Broome RA, Fann N, Cristina TJN, Fulcher C, Duc H, Morgan GG. The health benefits of reducing air pollution in Sydney, Australia. Environmental Research. 2015;143, Part A:19-25.

Currie BA, Bass B. Estimates of air pollution mitigation with green plants and green roofs using the UFORE model. Urban Ecosystems. 2008;11(4):409-22.

Department of Health NSW, 2009. Air Pollution Health Risks, New South Wales. Available at: http://www.health.nsw.gov.au/PublicHealth/environment/air/air_pollution.asp (accessed 21st of November 2011).

Grundström M, Pleijel H. Limited effect of urban tree vegetation on NO2 and O3 concentrations near a traffic route. Environmental Pollution. 2014;189:73-6.

Hutton G. Air Pollution: Global Damage Costs. In: Lomborg B., editor. How Much have Global Problems Cost the World? New York, USA: Cambridge University Press; 2013.

Irga PJ, Burchett MD, Torpy FR. Does urban forestry have a quantitative effect on ambient air quality in an urban environment? Atmospheric Environment. 2015;120:173-81.

Janhäll S. Review on urban vegetation and particle air pollution – Deposition and dispersion. Atmospheric Environment. 2015;105:130-7.

Lazaridis M,. Atmospheric Aerosols First Principles of Meteorology and Air Pollution. Environmental Pollution, Springer Netherlands. 2011. 19. p 169-199.

McDonald AG, Bealey WJ, Fowler D, Dragosits U, Skiba U, Smith RI, et al. Quantifying the effect of urban tree planting on concentrations and depositions of PM10 in two UK conurbations. Atmospheric Environment. 2007;41(38):8455-67.

Millar G, Abel T, Allen J, Barn P, Noullett M, Spagnol J, et al. Evaluating Human Exposure to Fine Particulate Matter Part I: Measurements. Geography Compass. 2010;4(4):281-302.

Nowak DJ, Crane DE, & Stevens JC. Air pollution removal by urban trees and shrubs in the United States. Urban Forestry & Urban Greening. 2006;4(3–4):115-23.

Pugh TAM, MacKenzie AR, Whyatt JD, Hewitt CN. Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons. Environmental Science & Technology. 2012;46(14):7692-9.

Raaschou-Nielsen O, Beelen R, Wang M, Hoek G, Andersen ZJ, Hoffmann B, et al. Particulate matter air pollution components and risk for lung cancer. Environment International. 2016;87:66-73.

World Health Organisation (WHO). Burden of disease from Ambient Air Pollution for 2012. The World Health Organisation, Geneva Switzerland; 2014.

Table 2. Descriptive statistics for reference and impact sites, matched by month of sampling.

		Mean	SEM	Min	Max
TSP	Before Reference	21.86	0.79	12.00	43.00
	Before Impact	24.81	1.00	10.00	47.00
	After reference	22.59	0.79	11.67	41.33
	After Impact	24.78	0.99	10.00	47.00
PM_{10}	Before Reference	20.63	0.78	12.00	42.00
	Before Impact	22.49	0.89	11.00	45.00
	After reference	22.59	0.79	11.67	41.33
	After Impact	22.31	0.85	11.00	45.00
$PM_{2.5}$	Before Reference	14.12	0.72	5.00	34.00
	Before Impact	15.07	0.87	6.00	44.00
	After reference	14.51	0.71	5.33	33.00
	After Impact	15.02	0.83	6.00	44.00
NO_2	Before Reference	0.39	0.05	0.00	3.10
	Before Impact	0.37	0.05	0.00	2.80
	After reference	0.40	0.06	0.00	3.57
	After Impact	0.37	0.04	0.00	2.80
Noise (db)	Before Reference	78.50	0.24	74.30	82.00
	Before Impact	78.84	0.28	72.10	83.00
	After reference	78.80	0.30	67.67	82.67
	After Impact	78.66	0.35	65.00	83.00
Temperature (°C)	Before Reference	22.76	0.39	16.00	31.00
	Before Impact	23.12	0.39	17.00	32.00
	After reference	23.50	0.44	16.00	34.30
	After Impact	23.60	0.43	17.00	33.50
Relative humidity (%)	Before Reference	54.09	1.59	28.00	90.00
	Before Impact	54.58	1.61	29.00	95.00
	After reference	55.07	1.62	28.67	91.67
	After Impact	55.59	1.62	29.00	95.00
CO_2	Before Reference	392	2.56	390	907
	Before Impact	413	10.33	370	927
	After reference	401	3.22	382	903
	After Impact	415	9.78	372	987

Table 2. Cont'd. Descriptive statistics for reference and impact sites, matched by month of sampling.

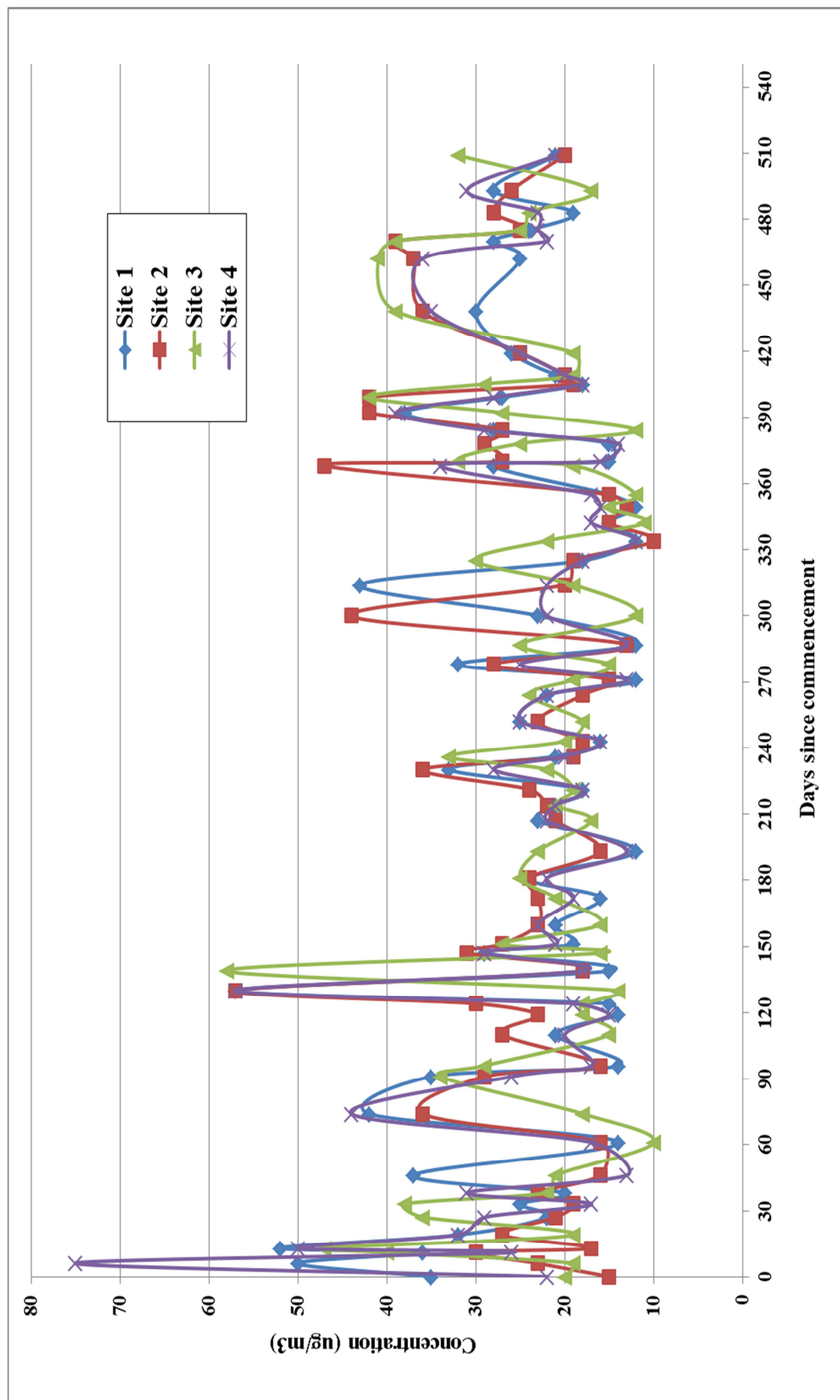|		Mean	Median	SEM	Min	Max
CO	Before Reference	0.03	0.00	0.01	0.00	0.50
	Before Impact	0.01	0.00	0.00	0.00	0.20
	After reference	0.01	0.00	0.01	0.00	0.40
	After Impact	0.01	0.00	0.00	0.00	0.20
NO	Before Reference	0.01	0.00	0.01	0.00	0.30
	Before Impact	0.01	0.00	0.01	0.00	0.30
	After reference	0.02	0.00	0.01	0.00	0.37
	After Impact	0.01	0.00	0.00	0.00	0.30

Figure 2. Ambient total suspended particles across sites. Site 1: Southern Goods Line (Ultimo pedestrian Network), Site 2: Northern Goods Line Darling Drive), Site 3. Northern Goods Line Reference control sample (North Quay Street), Site 4. Southern Goods Line Reference Control sample (South Quay Street)

Figure 3. Ambient PM$_{10}$ concentrations across sites. Site 1: Southern Goods Line (Ultimo pedestrian Network), Site 2: Northern Goods Line Darling Drive), Site 3. Northern Goods Line Reference control sample (North Quay Street), Site 4. Southern Goods Line Reference Control sample (South Quay Street)
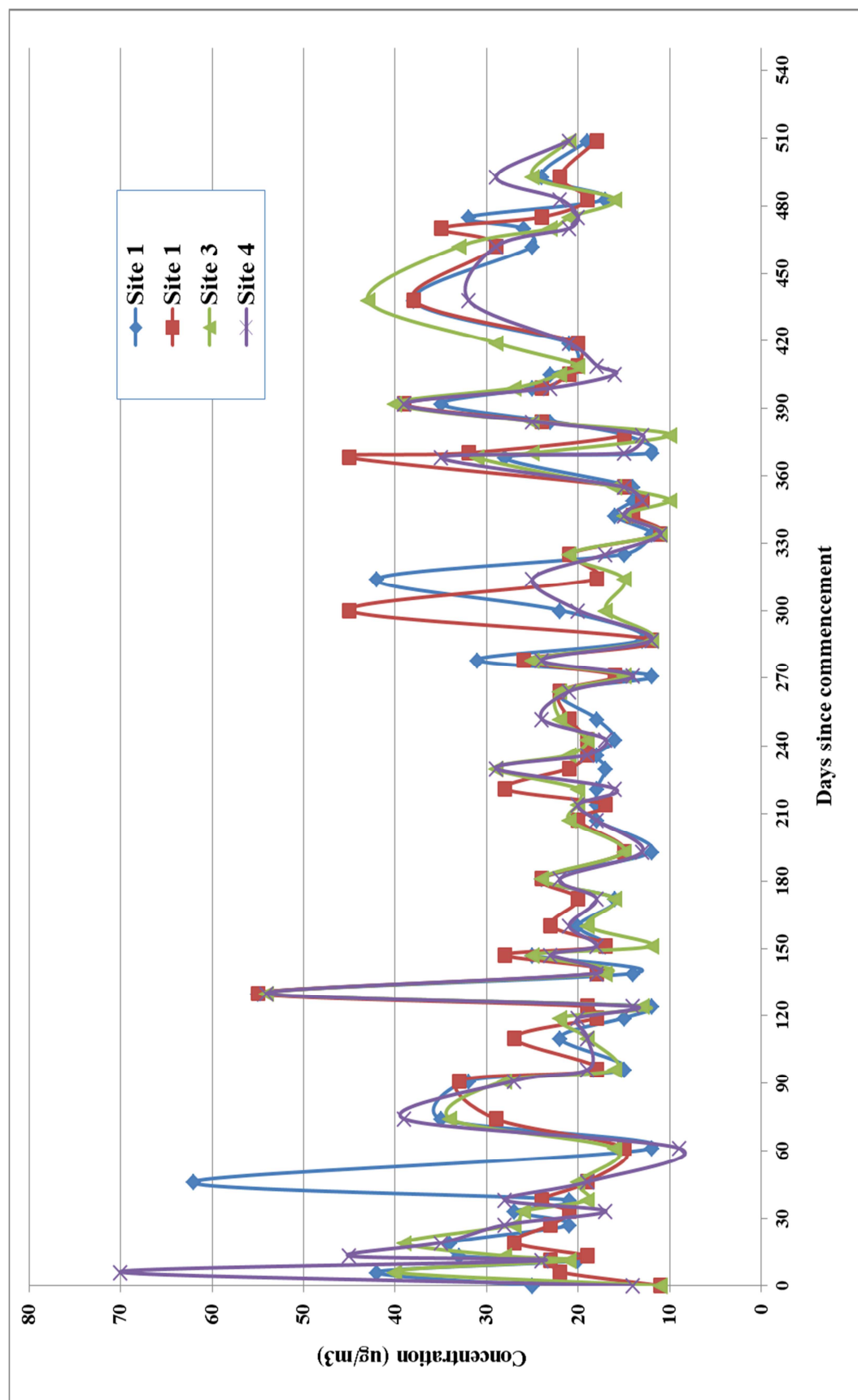
Figure 4. Ambient PM$_{2.5}$ concentrations across sites. Site 1: Southern Goods Line (Ultimo pedestrian Network), Site 2: Northern Goods Line Darling Drive), Site 3. Northern Goods Line Reference control sample (North Quay Street), Site 4. Southern Goods Line Reference Control sample (South Quay Street)
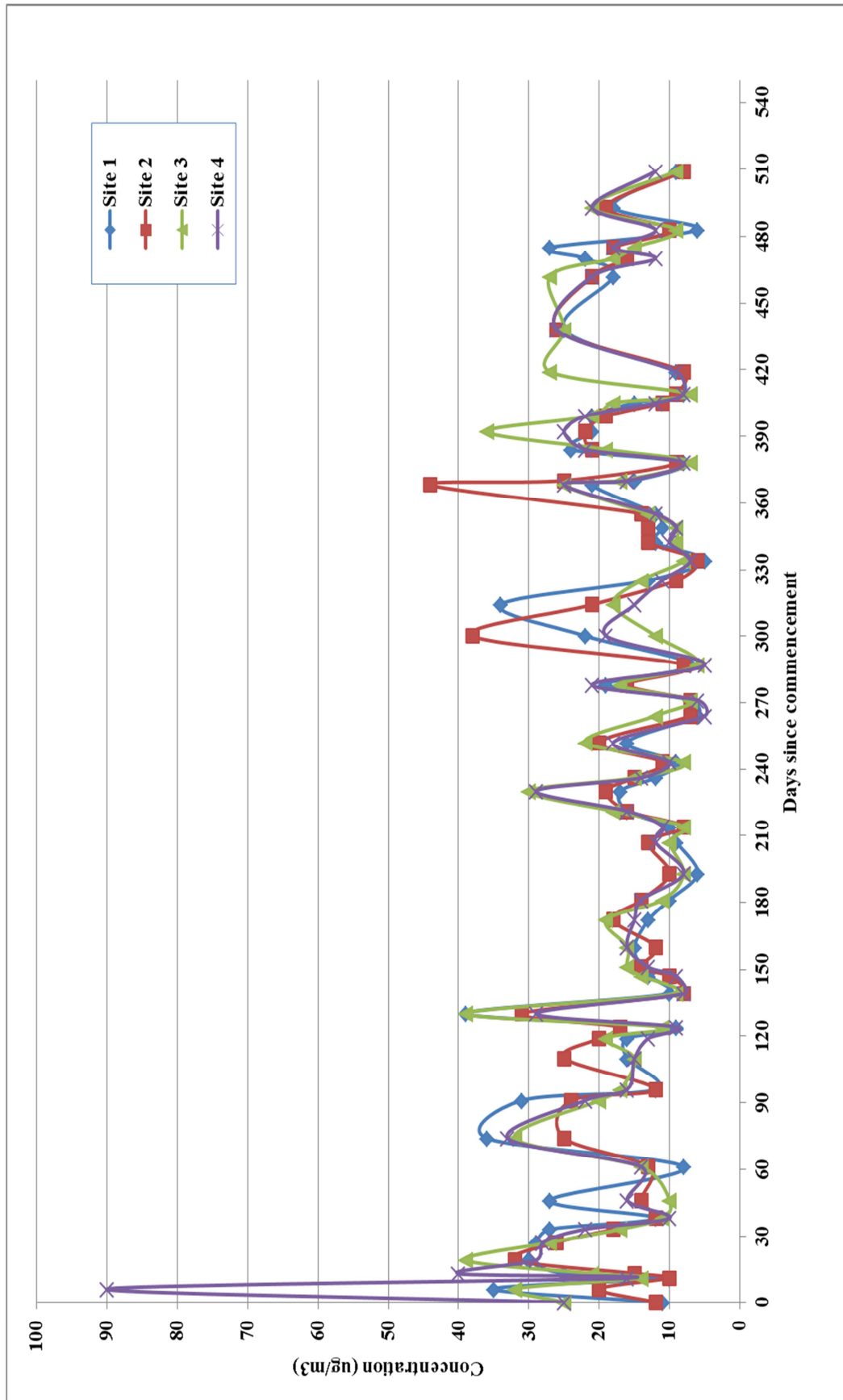
Figure 5. Noise levels across sites. Site 1: Southern Goods Line (Ultimo pedestrian Network), Site 2: Northern Goods Line Darling Drive), Site 3. Northern Goods Line Reference control sample (North Quay Street), Site 4. Southern Goods Line Reference Control sample (South Quay Street)
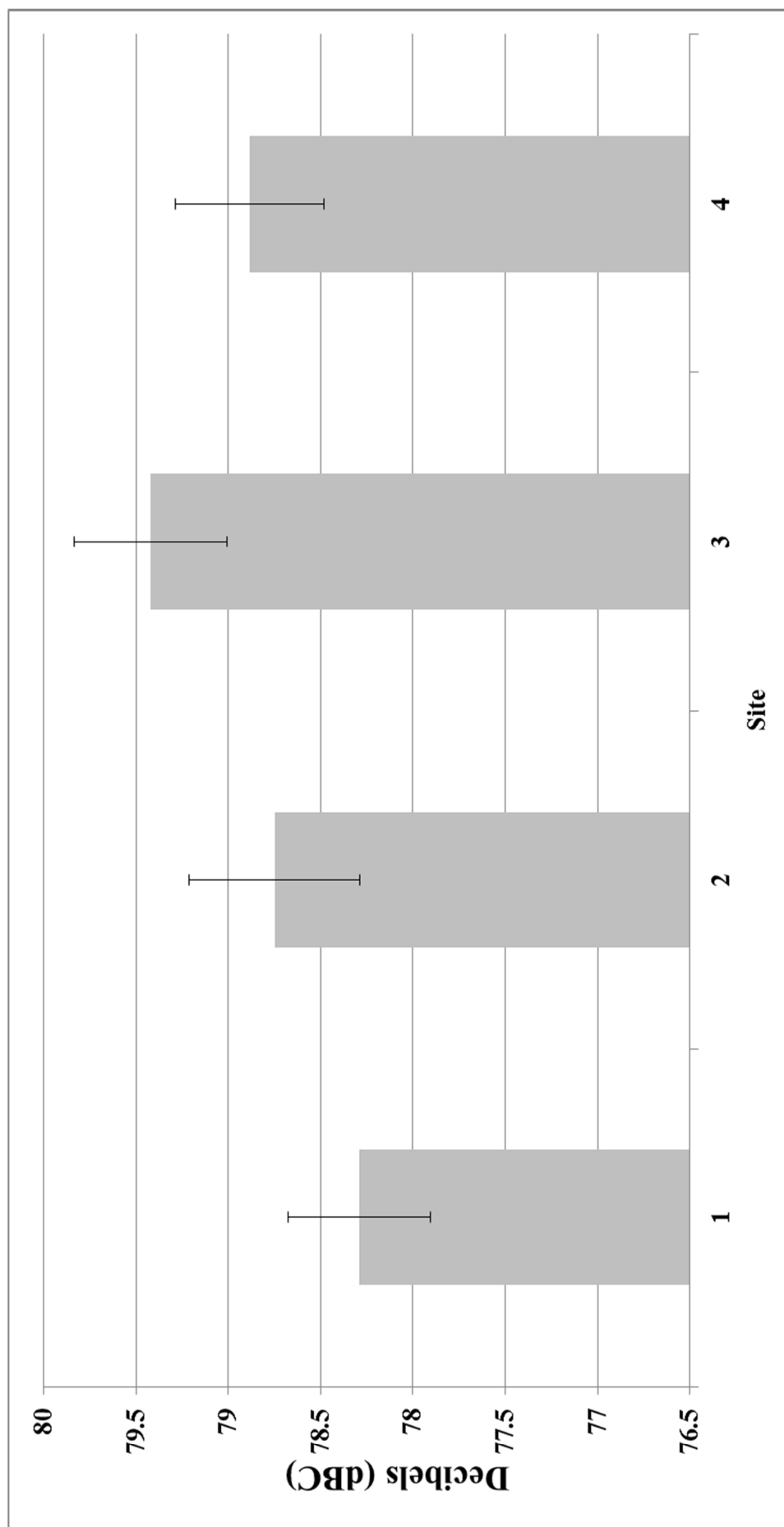
APPENDIX D. Responses and coding scheme for questionnaire questions A1 - A5

Complete list of coded responses to questionnaire questions A1 through A5

A1 Why do you come to this new end of the Goods Line?		
Coded response	**Frequency**	**Percentage**
Relax/break	59	30%
Eat	51	26%
Get outdoors	46	23%
Convenience	44	22%
Sitting	36	18%
To get somewhere else	31	16%
Aesthetics	29	15%
Green space	25	13%
Destination	17	9%
Social activity	12	6%
Other	8	4%
Blank	1	1%

A2 What do you like most about this new end of the Goods Line (if anything?)		
Coded response	**Frequency**	**Percentage**
Green space	77	39%
Seating	73	37%
Aesthetics	71	36%
Urban escape	51	26%
Outdoors	45	23%
Social	39	20%
Convenience	27	14%
Other	8	4%
Blank	5	3%

A3 What do you dislike about this new end of the Goods Line (if anything)?		
Coded response	**Frequency**	**Percentage**
Blank	76	39%
Infrastructure/facilities (any other)	42	21%
Too much sun/heat	22	11%
Noise	15	8%
No rain shelter	10	5%
People	10	5%
Access	9	5%
Lack of green space (other than trees for shade)	6	3%
Other	4	2%
Lack of programming	3	2%

A4 Why do/would you choose to come here to the Goods Line instead of other outdoor places?

Coded response	Frequency	Percentage
Accessible/convenient	106	54%
Escape	55	28%
Aesthetics	48	25%
Outdoors (other than green space)	23	12%
Social	14	7%
Green space	12	6%
Seating	12	6%
Other	11	6%
Facilities	8	4%
Blank	6	3%

A5 Are there any changes that could be made to the Goods Line that would improve your experience or make you visit more often?

Coded response	Frequency	Percentage
Blank	65	33%
Shelter/shade	30	15%
Satisfied	28	14%
Other infrastructure	28	14%
More attractions	24	12%
Seating	19	10%
Green space	12	6%
Maintenance	7	4%
Other	4	2%
Noise	2	1%
Activities	2	1%

Coding scheme used to group questionnaire responses to questions A1 through A5

A1 Why do you come to this new end of the Goods Line?	
CODE	EXAMPLES
Close to something (convenience)	Close to work Close to study/UTS Close to home
To get somewhere else	Powerhouse To get to work To get to UTS Darling Harbour Aquatic Centre
Relax/break	Relaxing Chill out Take a break Take time out Escape Quiet Peaceful
Sitting	Sit Sitting Seating
Eat	Have lunch Eat
Social activities (other than eating)	Friends Chat Ping pong Workout areas
Green space	Trees Green Grass Parkland Plants
Outdoors (other than green space related)	Outdoors Sun Shaded Nature Fresh air
Aesthetics	Nice area to walk Nice design Clean Interesting
Destination	Gehry To see the development Curiosity One time visit
Other	(if not classified above)

A1 Why do you come to this new end of the Goods Line?	
CODE	EXAMPLES

A2 What do you like most about this new end of the Goods Line (if anything)?	
CODE	EXAMPLES
Green space	Green space Plants Trees
Outdoor space (other than green space)	Open space Shade Sunny Cool breeze
Aesthetics	Creative Interesting design Modern Clean Fresh Integration of rail line Authentic
Urban escape	Lack of noise Quiet Escape the office Relaxed atmosphere Open space amidst buildings Not overly busy
Convenience	Close to Powerhouse, UTS, etc Accessibility to UTS etc Thoroughfare Continuation of pedestrian route
Seating	Sitting Seating Variety of places to sit
Social	Ping pong Workout spot Facilities Communal table/areas People watching
Other	(if not classified above)

97

| A3 What do you dislike about this new end of the Goods Line (if anything)?	
CODE	EXAMPLES
Too much sun/heat	Too much sun Sunlight More shade More shelter Too exposed Not enough trees for shade
Lack of green space (other than trees for shade)	Needs more green space Not enough grass Too much concrete
Noise	Too much noise Street noise Close to building/construction operations
Lack of programming	No events No stalls No shops Feels empty
No rain shelter	No cover for rain Shelter for rain
Access	Hard to access Inconvenient access
People	Too many people Skateboarders do damage Workers disrespecting the site, leaving rubbish
Infrastructure/facilities (any other)	Not enough tables Not enough bins Needs cycling path No toilets Floor grids are slippery
Other	(if not classified above)

A4 Why do/would you choose to come here to the Goods Line instead of other outdoor places?	
CODE	EXAMPLES
Accessible/convenient	Close to work/UTS/etc Convenient On the way to work/station/UTS/etc
Aesthetics	Nice space Varied Funky Design Clean
Green space	Green Grass Plants Trees
Outdoors (other than green space)	Outside Shade Sun Air feels fresher
Seating	Lots of options to sit Seating
Facilities	Facilities Can workout Park-like amenities
Escape	Quiet No traffic No stress Casual Not too many people Private Have my own space
Social	Good for people watching Broad range of people Nice vibe Atmosphere of people walking past
Other	(if not classified above)

| A5 Are there any changes that could be made to the Goods Line that would improve your experience or make you visit more often?	
CODE	EXAMPLE
Satisfied	Nothing
	N/A
	I like it as is
	(no answer)
Seating	More seating
	More seats that aren't concrete
	Chairs on the grass
	Daybed
Noise	Block/Drown out noise
More attractions	More coffee/food options
	Events
	Stalls
	Market place
	More bars/cafes
	More public art
	Sculpture
	Buskers/entertainment/music
Activities	More activities for (older) children
Shelter/shade	More shaded seating
	Trees for shade
	More shelter
Green space	More grass
	More Australian native plants
	More wildlife/birds
	Colour in the gardens
Other infrastructure	Bins
	More tables
	Water feature
	Recycling
	No holes in the concrete
	Fix drainage
	Ashtrays
	Light rail
	More access points
	Wifi
Maintenance	Trim grass more
	Bolts to stop skateboarders
	Make no smoking
Other	(if not classified above)

APPENDIX E. Aerial imagery supporting stormwater assessment
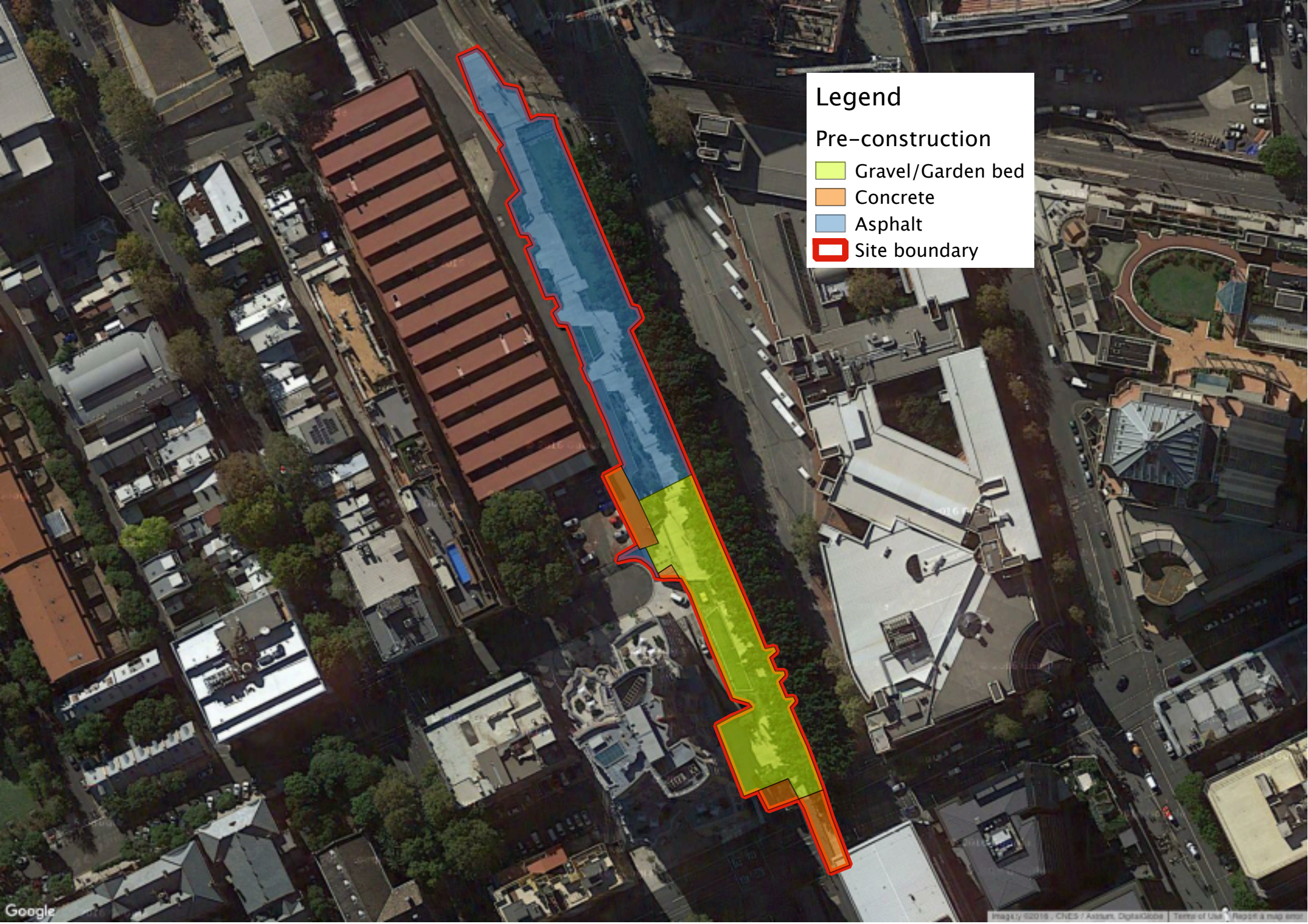
Legend

Pre-construction

- Gravel/Garden bed
- Concrete
- Asphalt
- Site boundary
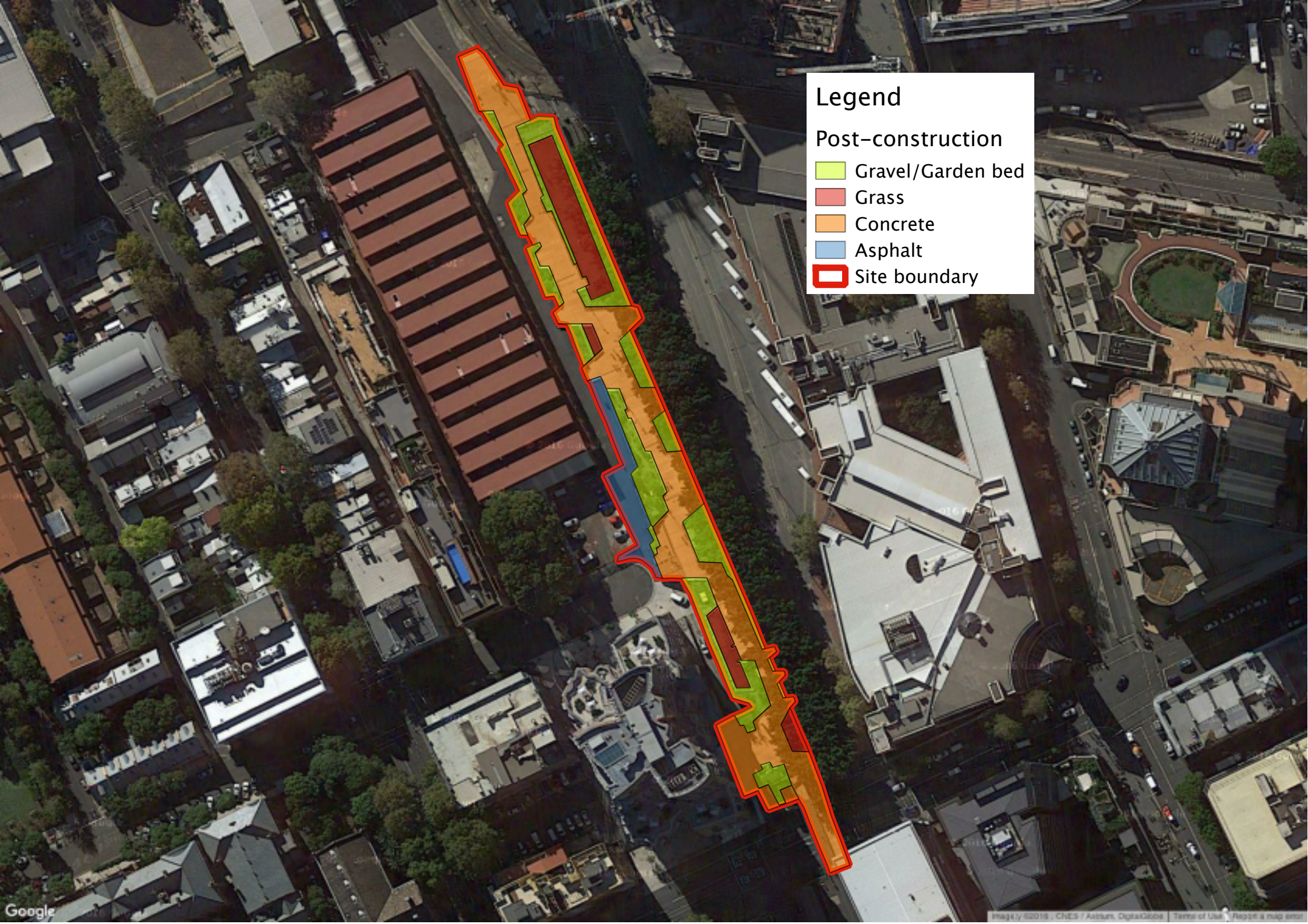
Legend

Post-construction

■ Gravel/Garden bed	
■ Grass	
■ Concrete	
■ Asphalt	
▭ Site boundary	