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Final Report

The economic benefits of open space in metropolitan Melbourne: an ecosystem services framework applied in the City of Moreland

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EXECUTIVE SUMMARY

Urbanisation has generally led to increased degradation of environmental assets in our cities. There is growing recognition of the benefits that accrue to human beings and the environment from preserving existing open spaces, environmental assets and re-naturalising degraded ones. Across Australia, governments and land managers are seeking to better understand the benefits of green open spaces to inform planning, development and investment.

In this study we focus on the benefits of open spaces in the City of Moreland, a local government within Metropolitan Melbourne. The Department of Environment, Land, Water and Planning (DELWP) is seeking to further understand the economic value of investing in natural capital in urban open spaces, particularly through improvements in accessibility, re-naturalisation and aesthetic values. We used an ecosystem services framework to identify, scope and then value benefits of open spaces.

The primary objective of this study was to estimate the economic benefits of open spaces to local communities. Moreland City Council was used as the study area for this valuation. Approximately 20% of this 5,000 ha study area is open space.

Open spaces provide a multitude of benefits ranging from local amenity to carbon sequestration. The following benefits for open spaces in Moreland were quantified:

- Property price premiums reflecting access to the amenity benefits afforded by urban parks
- Recreation values attributable to the use of parks
- Avoided health costs of physical inactivity attributable to use of parks
- Traffic decongestion from bicycle commuting through the parks network.

There is insufficient quantitative data to value many of the benefits within a desktop research study and our estimates should be considered conservative. Despite this, when the quantitative estimates undertaken are combined, open spaces in Moreland deliver benefits estimated at $94 million per annum (estimates range from $79 million to $129 million per annum).

Many of the benefits are ultimately reflected in property prices. This provides policy opportunities for councils, where developer contributions can better reflect the open space values captured by new developments, and through incremental increases in rates revenues reflecting property prices that are higher than they otherwise would be.

The study for Moreland is effectively a case study to test the key methodologies and data available that could be used across greater Metropolitan Melbourne. While several limitations and areas for improvement in valuation were identified in this case study, these limitations could be overcome with astute primary research. Importantly, this framework could be used at the broader Metropolitan Melbourne scale to inform future policy, planning and investment in urban parks and open space.

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1 CONTEXT

1.1 Background

Urbanisation has generally led to increased degradation of environmental assets in our cities. There is growing recognition of the benefits that accrue to human beings and the environment from preserving existing environmental assets and re-naturalising degraded ones. Across Australia, governments and land managers are seeking to better capture benefits of green open spaces.

In this study we focus on the benefits of open spaces in Moreland, a local government within Metropolitan Melbourne. While the natural capital such as parks, waterways and wetlands are valued and provide aesthetic and recreational values, there is limited understanding on the economic value of investments in open spaces. The Department of Environment, Land, Water and Planning (DELWP) is seeking to further understand the economic value of investing in natural capital in open space, particularly through improvements in accessibility, re-naturalisation and aesthetic values. Given that the services offered by parks and reserves are not directly traded in a market, non-market valuation techniques are used to estimate the economic values of the relevant assets and their services to the community. The valuation approach utilises an ecosystem services framework to scope and value benefits of open spaces.

1.2 Purpose

The primary objective of this desktop study is to develop (where possible) estimates of the economic benefits of open spaces to local communities, using Moreland as a case study. The economic value of benefits was investigated based on the different ecosystem services offered by different open spaces. Using the approaches adopted in this report, the information developed can be used for a number of decision-making and investment purposes such as:

- Improving town and land use planning, including open space requirements for new developments and city renewal developments.
- Informing cost-sharing of open space establishment across stakeholder groups (broader community, local government, developers).
- Informing policy decisions (e.g. could school playing fields be incorporated into the broader portfolio of accessible open space where land availability is constrained?).
- Informing investments (e.g. do the benefits of enhancing the attributes of open space exceed the costs?).

1.3 Case study local government area

The study area for the current project is Moreland local government area (LGA), located in the inner north of Greater Melbourne. The LGA has an estimated 1,005 ha of open space, which is approximately 20% of the total LGA area. Over half of this area is public open spaces (576 ha), and 344 ha is restricted public land. Only 85 ha is private open spaces. Table 1 shows the different types and size of open spaces located in the study area.

Table 1. Moreland City Council open space categories

Open space	Area (ha)
Public open space	
Civic squares and promenades	0.1
Natural and semi-natural open space	235
Parks and gardens	150
Recreation corridor	22
Sports fields and organised recreation	169
Transport reservations	1.2
Private open space	
Natural and semi-natural open space	4.9
Non-government schools	24
Sports fields and organised recreation	56
Restricted public land	
Cemeteries	202.6
Government schools	71.1
Natural and semi-natural open space	12.9
Parks and gardens	3.5
Services and utilities reserves	20.1
Sports fields and organised recreation	11.5
Tertiary institutions	8.6
Transport reservations	14.3

Key points

A fifth of the LGA area in Moreland is open spaces.

Over half of the open spaces are categorised as public open space.

2 VALUATION FRAMEWORK

This section briefly outlines the valuation framework used in this study.

2.1 Human well-being and natural capital

An ecosystem services valuation approach was adopted for estimating the economic value of open spaces in Moreland LGA. This valuation approach recognises the critical role played by natural capital to enhance human well-being. The broad relationship between urban open spaces is illustrated in Figure 1. In summary, natural capital supports ecosystem processes that sustain ecosystem services. It is these ecosystem services that provide direct and indirect benefits to people.

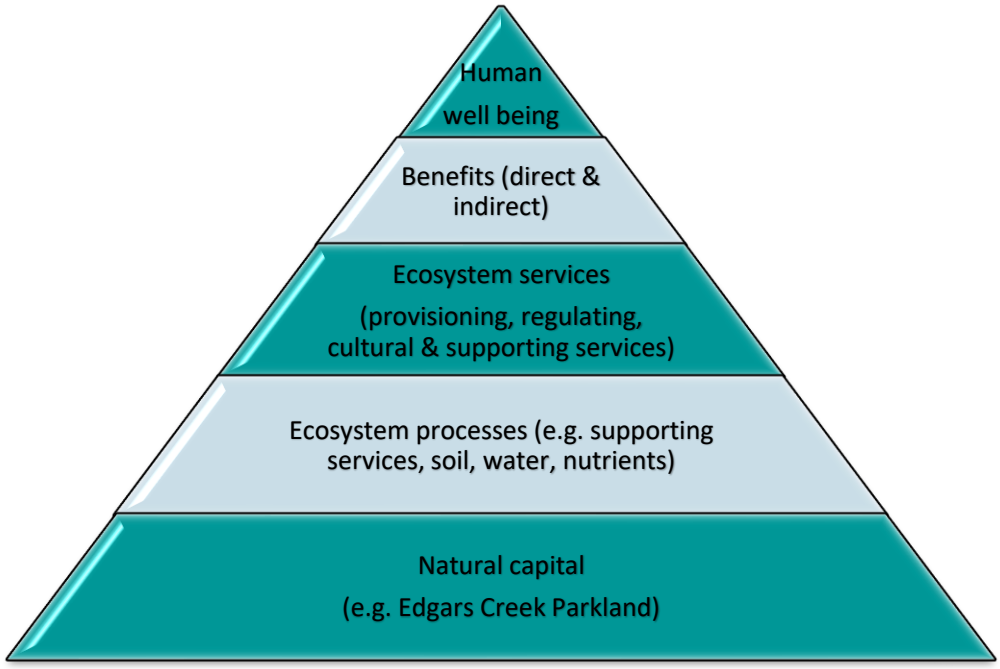

Figure 1. The relationship between natural capital and human well-being

2.2 Ecosystem services valuation approach

We identified the relevant ecosystem services generated from an urban open space based on the local socio-demographic and environmental conditions. Ecosystem services are the benefits people obtain from the natural environment. Our analysis considered the current condition or presence of open spaces and estimated the benefits of different ecosystem services. These ecosystem services are categorised into four broad types, specifically[1]:

- *Provisioning services:* all of the products obtained from ecosystems (e.g. raw water supplies for garden beds).
- *Regulating services:* the benefits obtained from the regulation of ecosystem processes such as pollination, flood mitigation, and regulation of water quality, air quality, climate and erosion.
- *Cultural services:* non-material benefits such as recreation, aesthetic experiences, and spiritual enrichment. These services are the primary focus of this study.

[1] These ecosystem services categories were used by the Millennium Ecosystem Assessment (MEA 2005)

- *Supporting services:* ecosystem services that underpin the other categories (provisioning, regulating and cultural). These include soil formation, photosynthesis, water cycling, seed dispersal, and nutrient cycling.

Figure 2 shows different ecosystem services emanating from public open spaces and the beneficiaries of the different ecosystem services. For example, a riparian park provides aesthetic benefits that are captured by nearby property owners and developers through higher property premiums. The local council also benefits from increased rates collection, while the state captures some of the benefits through higher land taxes.

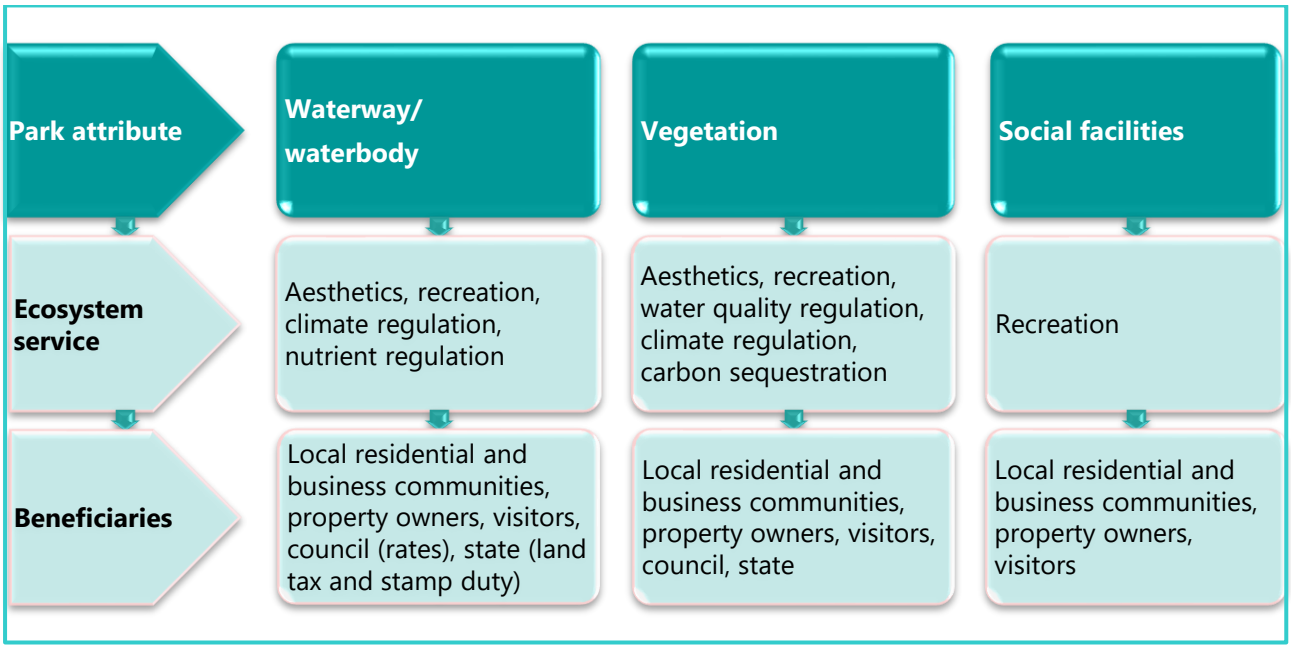

Figure 2. Identified key ecosystem services and beneficiaries

3 NON-MARKET VALUATION AND BENEFIT TRANSFER METHODOLOGY

This section briefly outlines the valuation methodologies used to implement the framework outlined in Section 2.

3.1 Why non-market valuation?

While there is general agreement on the utility of open spaces and their benefits to human beings, these benefits typically do not have a market to reflect their monetary value. Historically, this has often resulted in an under-provision of quality and accessible open space in urban areas. Environmental economics studies have shown that ecosystem services have impacts on people's lives and, if environmental resources are not managed well, real costs can be incurred. While people do not buy and sell these ecosystem services in a market, they pay extra for other goods to access good quality open spaces with recreation facilities, aesthetic value and other benefits.[2] Thus, stated and revealed preference methods have been applied to investigate people's willingness to pay for ecosystem services. The economic values are usually estimated for the following four main reasons:[3]

1) Inform policy.
2) Resource allocation and priority setting.
3) Estimate compensation for losses.
4) Design environmental markets (e.g. carbon market).

The current study is primarily targeted at contributing to 1 and 2.

3.2 Benefit transfer

Our approach to value the benefits of ecosystem services is a benefit transfer method. Benefit transfer is a non-market valuation method that is widely used to measure benefits of environmental resources for which there is a missing market or a market failure. It involves the use of results from previous studies at other sites or in other policy contexts to predict impacts in a different study area or policy context. In this case, the benefit transfer process involves transfer of ecosystem unit values from similar Australian studies to the open spaces in Moreland. This approach is increasingly being used to meet demand for valuation of ecosystem services of natural resources (Richardson et al., 2015). The increased usage is driven by limited opportunities to undertake intensive primary studies and the growing need to account for use and non-use values of environmental assets in making investment decisions. There are five broad steps in undertaking a point or central tendency estimate benefit transfer method, which are summarized in Table 2.

The unit values established through this process, in conjunction with the key attributes of open space in Moreland (e.g. area of parks, location, amenities), can be used to establish aggregate values for open space.

Key point

Given resource and data constraints, primary research was not possible. However, using a benefit transfer approach reasonably robust estimates have been established.

[2] For example people will pay extra to be located near natural amenities such as parks and urban wetlands (Tapsuwan et al. (2009), Crompton (2005)).

[3] See Sergeson (2017)

Table 2. Steps in undertaking a unit value transfer

Step	Description
1	Define the current context in terms of quantity/quality (including changes due to policy)
2	Undertake a review of the literature to gather value estimates (V) from past studies
3	Assess the previous studies for relevancy to the current study. That is, how well does the original research context match the current study context?
4	Select a unit value or a range of unit values from relevant past studies. The selected values are those that best match the current study context.
5	Transfer the unit value or range of values and aggregate the value/s by multiplying it by the total number of units to get the total value estimate for the benefit of interest

Source: Adapted from Rosenberger and Loomis (2017)

As a first step to the valuation process, a list of potential ecosystem services and their benefits was developed. The following benefits were identified as outcomes from open spaces in the study area:

- Carbon sequestration (regulating service).
- Contribution to property price premiums (aesthetics – cultural services).
- Mitigation of climate extremes including urban heat islands (climate regulating service).
- Noise pollution reduction (regulating service).
- Air quality improvements (regulating service).
- Support for human well-being through improved physical activity, stress reduction and general relaxation (cultural services).
- Visual amenity to local and visiting population (cultural services).
- Casual or commute trip connection passages/paths (cultural services).
- Public recreation and exercise areas for cycling, running and walking (cultural services).

Unit values can be derived using surveys and historical local data for a specific project. However, such an approach is costly and generic estimates tend to be used. Unit values for identified ecosystem services were sourced from the literature and then assessed for their suitability for use in the current study. Where there was no single study that provided a satisfactory match to the current study context, further unit values were considered, and a range of estimates were used in our modelling. All monetary values were converted to 2018 Australian dollars. Based on an analysis of different ecosystems services, the current valuation context and available relevant studies, the following key benefits for open spaces in Moreland were identified for evaluation:

- Property price premiums from aesthetic values.
- Recreation activity induced by more natural and enhanced social facilities located in urban green space.
- Avoided physical inactivity related health costs.
- Benefits associated with traffic decongestion as active transport options improve.

Key points

There is sufficient information available to develop economic estimates for a number of key benefits attributable to the presence and quality of open spaces. These include aesthetic benefits/property price premiums, recreation values, avoided health costs, and decongestion benefits.

Nonetheless in some cases there is no relevant data to properly estimate the economic value of identified key benefits (e.g. climate regulation, carbon sequestration, noise and air pollution control).

3.3 GIS data analysis

Evaluation of the key benefits was grounded in GIS analysis. A range of relevant spatial data was assessed, focused on:

- The type, area (hectares) and attributes of every open space (using Victorian Planning Authority and City of Moreland data)
- Detached houses and units within 200 m and 500 m of every open space (using Vicmap Property and City of Moreland data)
- The total adult population of each Moreland suburb, calculated in relation to every open space (using Australian Bureau of Statistics 2016 Census data)
- The length (metres) of foot- and shared paths in every open space (using City of Moreland data)
- The area of major waterbodies and their distance (metres) to residential properties (using Melbourne Water and City of Moreland data)

  The presence of waterways and drainage channels, which were categorised according to their degree of modification (using Melbourne Water data). Following geoprocessing and analysis in QGIS and ArcGIS, this data was exported to spreadsheets as a base for the economic analysis.

3.4 Sensitivity analysis

Several assumptions were made in estimating the economic value of open spaces. Given the uncertainty of some on the key input parameters, ranges of these inputs were included in the modelling process to create lower, middle and upper bounds. Consequently, a range of values for the benefits are provided for each quantified ecosystem service in the results section. The range of values was estimated using Monte-Carlo simulations with 20,000 iterations to identify the 90 per cent confidence interval for each estimated ecosystem service benefit. A summary of assumptions for the key input parameters is provided in Table A1.

Additionally, a simple 'traffic light' approach was used to reflect the confidence rating of our assumptions (see Figure 3). The rating was based on the quality of available data and the valuation approach used for each ecosystem service valued. The traffic light system is also useful for identifying areas that may need further investigation to improve uncertainty levels.

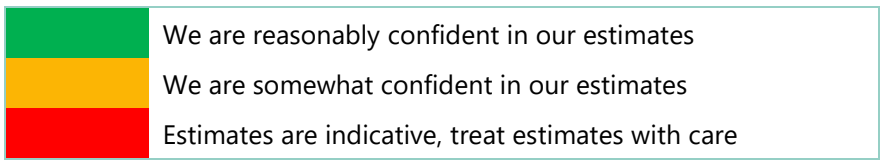

Figure 3. Illustration of the traffic light approach for confidence rating for our estimates

3.5 Property price premiums

Urban open spaces provide a variety of benefits to nearby residents. One of the key benefits associated with urban open spaces is the aesthetic value. The aesthetic value is captured through property price premiums. Open spaces such as sports fields, golf courses and other green open spaces have been found to have a positive impact on property values (see Breunig et al. (2018), Mahmoudi et al. (2013), Thomy et al. (2016)).

In order to estimate the impact of urban open spaces on property values, one needs to establish a counterfactual. The counterfactual is often driven by the project/study objectives. For example, in a project involving preserving an existing open space, a hedonic study may be undertaken to quantify

the cost of not having a park within a specified distance to a house against preserving the park. Similarly, the hedonic property valuation method can be used to capture the variation in the quality of open spaces (e.g. tree density, natural waterway). The counterfactual informs the unit values that are then used to estimate the aesthetic value of an open space.

The following general formula was used to estimate the annual property price premiums accruing from open spaces located in Moreland City Council.

Annual property premium = *Unit value (%) × Average median price ($) × net annualisation rate (%)*

The unit values were sourced from prior work on (1) riparian open spaces located along urban waterways with specific Vegetation and Riparian Conditions (VRC), (2) non-riparian urban open spaces[4], and (3) proximity to a golf course[5]. For parks located along waterways, a benefit transfer was undertaken based on VRC associated with open spaces. Table 3 provides a description of the VRC categories and their marginal impact on property prices. The unit values were then transferred based on the assessment of each open space grouping in Moreland City Council area. The counterfactual was a scenario where the open spaces are degraded with highly modified channels and little to no vegetation (VRC1).

Table 3. Vegetation and Riparian Condition Index for riparian urban parks

VRC	Channel Condition	Vegetation Condition	Marginal Impact (%)[a]
VRC1	Highly modified channel	• Little to no buffer; • Little to no canopy; and • The number and frequency of road crossings is undefined.	-
VRC2	Modified channel	• Little to no buffer; • Discontinuous canopy; and • The number and frequency of road crossings is undefined.	4.8
VRC3	Un-modified channel	• Buffer greater than 10m for 30% of length; • Discontinuous canopy; and • Road crossings occur at intervals of >500m.	5.84
VRC4	Modified channel	• Buffer greater than 10m for 30% of length; • Discontinuous canopy; and • Road crossings >100m apart.	1.13
VRC5	Un-modified channel	• Buffer greater than 20m for 70% of length; • Semi-continuous canopy; and • Road crossings no less than 500m apart.	6.76
VRC6	Un-modified channel	• Buffer greater than 50m for 70% of length; • Continuous canopy; and • Road crossings that are no less than 2km apart.	9.31

[a]Estimated impact compared to VRC1, source: Thomy et al. (2016)

[4] Based on Mekala et al. (2015)

[5] Based on the golf course function by CRC Water Sensitive Cities' (Iftekhar et al., 2018))

Where open spaces did not have a waterway, the unit values were sourced from another Melbourne study by Mekala et al. (2015) which was based on by findings from Adelaide by Mahmoudi et al. (2013). Mekala et al. (2015) estimated the impact on properties from having an open space nearby and estimated the benefits to range from 0.9% to 4.5% within the 500m distance radius from an open space. Lastly, the CRC for Water Sensitive Cities developed a golf course function for assessing the impact of a golf course on nearby properties (Iftekhar et al., 2018). The function requires input on the size of golf course area and average house distance to provide an estimated marginal impact (%). The Northern Golf course (53 ha) is the only golf course in Moreland. For all properties within a 500 m buffer, the average distance of properties from the course was 263 m. Based on the golf course function, the estimated property value impact is estimated to be 3.37%.

Moreland has 53,600 detached dwellings and 25,190 non-detached dwellings. Given the high open space coverage across the LGA, only 5,664 and 1,760 detached houses and units, respectively, were not included in the assessment of property value impacts.[6] To avoid counting the same house more than once, each house was associated with its closest park grouping. Median property prices by suburb area for the last 12 months were sourced from CoreLogic (2018). The average median price for all suburbs in the LGA was $893,670 for detached dwellings and $535,180 for non-detached dwellings.[7] A net annualisation rate of 5% was used to estimate the annual value of property premiums.[8] This effectively allows a capital value to be converted to an annual benefit stream to enable easier aggregation and comparison with the value of other benefit streams attributable to open spaces.

Hedonic property valuation studies have focused on detached single homes, and thus no relevant marginal impact values were found for non-detached homes. However, evidence from the United Kingdom suggests that the price premium impact of a local park on apartments is about 20 per cent less than that of a single detached home (Green Infrastructure Valuation Network, 2011). This factor was used to modify the impact of open spaces on the non-detached properties.

Key point

Previous hedonic valuation studies enable a reasonably robust basis for estimating the impact of open space in Moreland on local property prices.

3.6 Recreation values

Urban open spaces serve as outdoor recreation sites for the local and visiting communities. In our case study area, the larger and more connected public open spaces are located along waterways and many of them have pathways that are used for outdoor recreational activities such walking and cycling. In order to estimate the economic value of recreation on urban open spaces one needs to establish the average value of a visit and the visitation frequency to a given site. This information is then combined as per the equation below to estimate the annual economic value of recreation.

Annual economic value of recreation = *Unit value ($/visit) × Number of visits to a site per year*

In primary studies, recreation unit values are commonly quantified using travel cost methods. These methods account for the cost and time it takes for a visit to a given site. In the current study we relied

[6] A conservative 500m exclusion zone around open spaces was used to identify houses affected (prior studies indicate that there is a strong significant impact on property prices from small parks within the 500m distant (e.g. Espey and Owusu-Edusei, 2001).

[7] Median price for the last 12 months to October 2018

[8] Net annualization value for Moreland City Council is 5% of the capital improved value (Moreland City Council, 2018)

on unit values reported by Parks Victoria and DELWP (2015). This study reported that the value of a visit to an urban park in Victoria is $9 (2014 AUD).[9] The indicative value was updated from an earlier travel cost study by Read et al. (1999). The number of visits to Moreland LGA open spaces was estimated using data on number of households and average park visitation rates in Australian urban areas. According to the ABS (2017) census, Moreland has 40,000 families, and it was assumed that a conservative 50% of this population will visit parks within their council area. The proportion of the population visiting the park is based on Lin et al. (2014) and Veal (2006). Lin et al. (2016) found that in Brisbane, an estimated 60% of those surveyed indicated that they had visited a park in the past week. The proximity to parks was found to be one of the key drivers for reported visitation rates. Veal et al. (2006) reports that 45% of those surveyed in Sydney reported having visited a park in the last week. In this analysis we have adopted these values as the range and their average as the middle value.

It is worth noting that this is a conservative approach as higher proportions are expected if longer reporting periods are accommodated. For example, Veal (2006) found that over a year-long reporting period, 97% of the Sydney population would have visited a park at least once. Veal (2006) also found that park visitors visited their local council park 2.8 days per week on average. More recent data from Melbourne indicate that people will visit a nearby riparian zone for recreation purposes 4.4 times a month. These two values were used as the range for visitation rates. We have assumed that half of the benefits are already captured by property price premiums to account for potential double counting of benefits.[10] The counterfactual for this estimation is a scenario where people have no access to local open spaces for recreation purposes.

Key point

Unit values transferred from Australians urban studies were used to establish indicative unit values and annual number of visits to parks in Moreland.

3.7 Avoided health costs

Attractive and accessible urban open spaces are used by communities to engage in active recreation, as explained Section 3.4. While people are willing to pay to access these open spaces for recreation purposes, there is an added benefit in terms of increased physical activity. Limited physical activity is associated with increased healthcare costs, productivity losses, and reduced life expectancy. Physically inactive people are at a higher risk of mental illness, obesity, cardiovascular diseases, type 2 diabetes and cancer (WHO 2016). A study by Medibank Private (2008) estimated that the total cost of physical inactivity in Australia was $13.8 billion per annum. This estimate included the health care costs ($719 million), productivity losses ($9,299 million) and mortality costs/costs of reduced life expectancy ($3,812 million). These estimates demonstrate the significant cost of physical inactivity to the Australian economy.

The Department of Health (2017) recommends that individual adults (18 years and older) should engage in at least 150 minutes of moderate intensity physical activity or 75 minutes of vigorous intensity physical activity per week. An estimated 52% of Australian adults aged between 18 and 64 are not sufficiently active (AIHW, 2017). Another report by the Public Health Information Development Unit estimates that 64% of the adult population (18 years +) in Moreland LGA undertook no or low

[9] While there are some more recent travel cost studies in Australia, the focus tends to be on assets such as national parks, dams and lakes which are dissimilar to the urban open spaces

[10] This attribution factor is conservative. Cohen et al. (2007) found that people living more than 3.2 km (2miles) away from a park, visited the park more than nearby residents (those living within 3.2km from the park). Further sensitive analysis was undertaken for this assumption. See Appendix.

exercise in the week prior to a Social Health Atlas of Australia survey (PHIDU 2018). These figures demonstrate the prevalence of physical inactivity in Moreland and across Australia.

Annual avoided health cost *= Unit value ($/physically inactive adult person) × number of physically active adults × attribution of physical activity to open space (%)*

The average annual cost of a physically inactive adult person has been reported at $757 per person (Mekala et al., 2015).[11] Another Australian study, Bauman et al., (2008), estimated that 54,112 cyclists saved the Australian economy an estimated $72.1 million in 2006, this is equivalent to $1,750 per cyclist (2018 AUD). SKM and PWC (2011) provides a more disaggregated estimates of avoided health costs. They estimated that the avoided health cost from walking was $1.68 per km (and ranged from $1.30 to $2.50). Cycling benefits were estimated at $1.12 per km (and ranged from $0.82 per km to $1.67 per km).[12] Given the various activities that could be undertaken in an open space and the limited data on distance covered, we have chosen to use the average annual values from Mekala et al. (2015) and Bauman et al. (2008) as the unit value range for avoided health costs per physically inactive person.

Urban open spaces provide a place for the community to connect and engage in physically active activities as well as to relax. Both physical activity and relaxation have been promoted as positive contributors to well-being. Cohen et al., (2007) undertook a study in the City of Los Angeles, US to investigate physical activity by park visitors, they found that 35% of park visitors engaged in walking and vigorous exercise across all parks. Parks with playgrounds and sports facilities had relatively more people walking and/or undertaking vigorous activities. Survey respondents indicated that parks were the most common place they undertook their exercise (Cohen et al., 2007). The counterfactual for the health benefits estimation is that without access to nearby open spaces, a proportion of the population will not attain the "physically active" status as recommended by the Department of Health (2017). It is assumed that the proximity of open spaces stimulates both visitation rates and overall intensity of activities.

Key points

A significant proportion of the adult population in Moreland and Australia are not physically active. Physical inactivity costs the Australian economy $13.8 billion per year (Medibank, 2008).

Urban open spaces play a key role in stimulating frequency and intensity of physical activity.

3.8 Avoided traffic congestion

It is well understood that active transport, particularly for commuting, reduces the level of congestion in roads and the broader public transport system. Urban parks provide convenient, safe and connected pathways. These pathways are used for commuting, recreational cycling and walking. There is limited data on people who choose to use their local parks to walk and cycle to their destinations (e.g. to work, shops, and visit friends). Thus, only the benefits associated with bicycle commuters are captured in this study. Commuters are more likely to contribute to decongestions benefits as they travel during peak periods. Moreland LGA has a high proportion of bicycle commuters (5.6%) relative to the Greater Melbourne region (1.4%).[13] Figure 4 indicates that suburbs located in the south of the

[11] 2011 AUD

[12] SKM and PwC (2011) values are in 2010 AUD

[13] Estimates based on reported mode of travel to work (ABS 2017)

LGA closer to the Melbourne central business district have relatively more bicycle commuters (e.g. over 12% of commuters in Brunswick use bicycle compared to 0% for Gowanbrae).

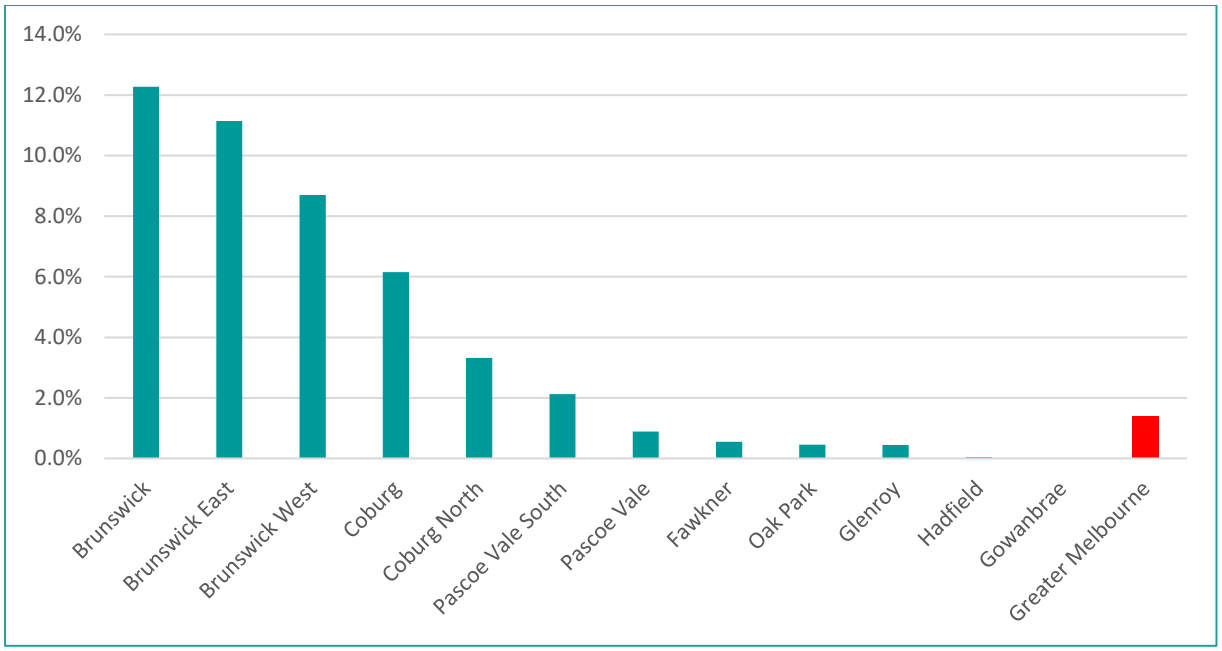

Figure 4. Proportion (%) of bicycle commuters to employed population by suburb

Source: Calculations based on ABS (2017)

The high bicycle commute rate in Moreland is driven by: (1) Moreland LGA is relatively close to the central business district and other employment centres, so there are reasonable cycling distances to and from work, and (2) there is a significant network of bike trails in and around Moreland. The main biking pathways are the Merri Creek Trail, Moonee Ponds Creek Trail and the Upfield Shared Path. The first two of these traverses along waterways through open spaces. Merri Creek Trail starts from the north east of the LGA at Fawkner and runs along Merri Creek to Clifton Hill where it links to more pathways. Monee Ponds Creek Trail runs the length of the LGA from Gowanbrae (north west) through to Parkville in the south of the LGA. Figure 5 shows some key cycling routes across the LGA.

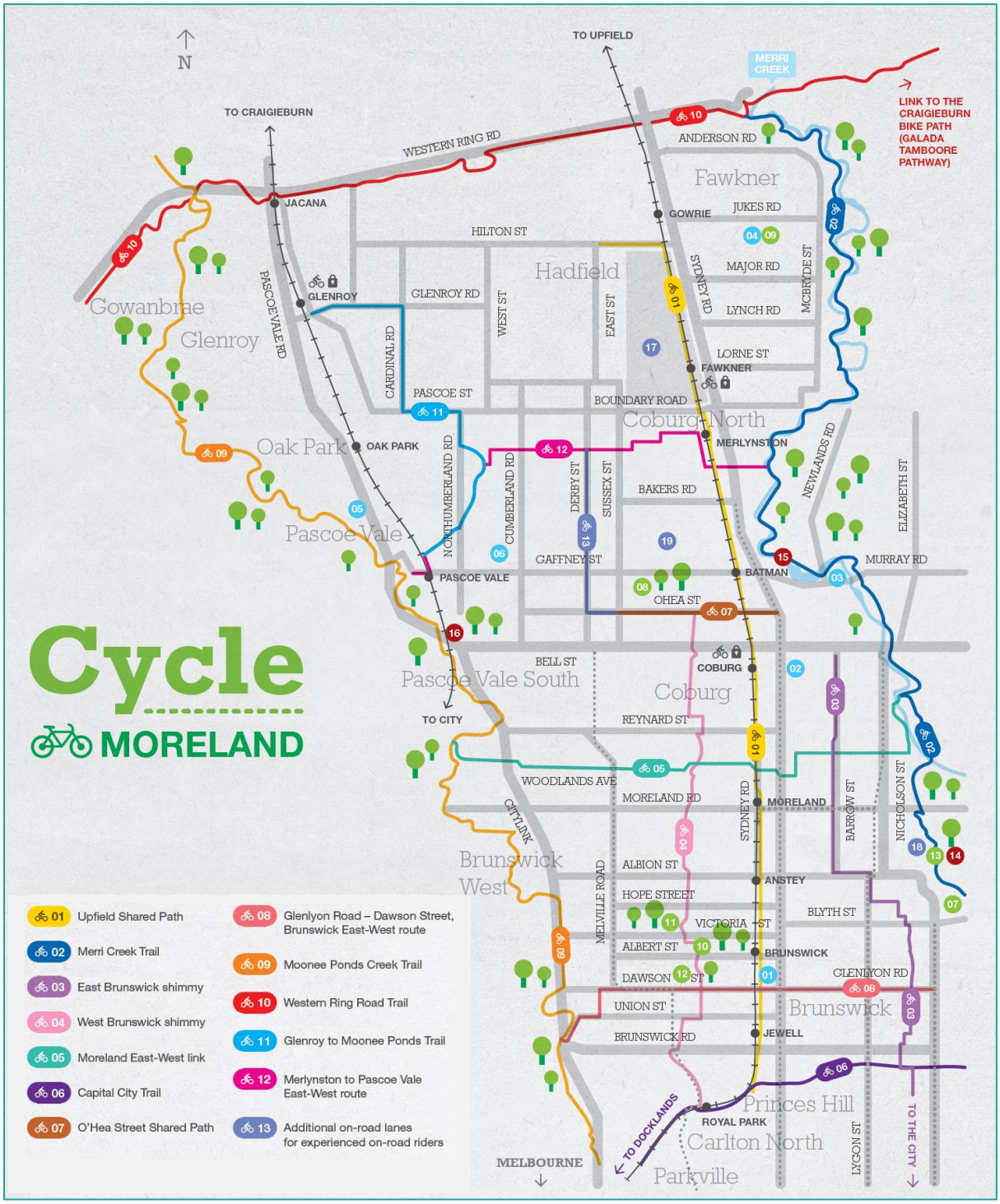

Figure 5. Cycling trails in Moreland LGA

Source: Moreland City Council (2018a)

The following formula illustrates how the decongestion benefit is estimated.

Annual value of traffic decongestion = *Unit value ($/km) × number of bicycle trips × bicycle commute distance × diversion rate*

Several studies have estimated the value of decongestion from active transport. The Australian Transport Council (2006) reports that the benefit of decongestion is estimated at $0.17, $0.64, and

$0.90 per km for light, moderate and heavy traffic congestion periods (2004 AUD). Similar results have been reported by CDM Research (2013) and are being used in the unit values for Brisbane's Active Transport Economic Appraisal Tool. The decongestion benefit per km used by CDM Research is $0.26, $0.99 and $1.39 for light, moderate and heavy traffic, respectively. The more recent figures by CDM Research were adopted for use in the current study after adjusting them for inflation.

Most commute trips occur during a week day and peak traffic is also more common during the week days. Therefore, only week day trips were used to estimate the number of commute trips in a year. As there was no survey data on routes utilisation rates and distance travelled, we adopted a zonal approach to estimate the distances travelled. Each suburb was treated as a single zone, from which commute trips began on the way to work and the return trips terminated. All bicycle commutes were assumed to commence from each suburb and up to Park Street in Parkville. The distance between the starting point for each suburb and Park Street in Parkville was adopted as the average commute distance through the LGA's open spaces. A conservative attribution rate of 20% was applied to the estimated benefits to account for trips and/or distance travelled outside of open spaces.14

It is important to note that the decongestion benefit accrues to the remaining road users as they are now able to travel in less congested roads. Accordingly, the reduction in congestion relates to the length and timing (peak or off-peak) of the replaced trip. For example, if a commuter who usually drives 5km to work shifts to a 7km bicycle ride to work, the relevant distance is the 5km drive to work. SKM and PwC (2010) reported that each active travel trip replaces 0.616 car kilometers. Given the absence of data on actual bicycle trips and the replaced road trips, this figure was adopted as the diversion rate. Some indicative estimates were made using available data. The counterfactual for this estimation is a scenario where traffic congestion occurs as current bicycle commuters choose car trips.

Key point

Active commuter transport through the open space network will reduce the cost of congestion to the community.

[14] This conservative estimate considers that even without pathways, some people may ride on roads, there are limited or costly parking spaces in the central business district, some people may catch trains or trams to work.

4 RESULTS

This section uses the unit value for key benefits outlined in Section 3 in conjunction with key data on the physical attributes of open space to develop aggregate estimates of the economic value of open space. Given the variability in input data and the need to make assumptions, a range of values is provided for each type of benefit.

4.1 Property price premiums

The property price premium impact from proximity to urban open spaces with and without waterways and the Northern golf course was estimated at $71 million per annum across the whole LGA. This value is based on a 5% annualization rate, average median price of houses ($894,000) and units ($535,000), and the number of houses and units within a 500m distance from open spaces. There were 47,950 detached houses and 25,190 units included in this assessment. At the current median prices, the value of houses in Moreland located within 500m from an open space is estimated at $55 billion. The estimated annual property price premium from open spaces across the council area for all housing stock is 2.56%.

The estimated benefits primarily accrue to local homeowners and developers undertaking projects near open spaces. Higher property values contribute to local council rates. Based on the 2018 Moreland council rates, the marginal contribution to council rates is $3.1 million per annum. Given that benefits accrue to the community and property developers, the findings can be used to inform business cases for investing in open spaces. Findings can also be used guide cost-sharing arrangements.

Figure 6 illustrates the distribution of estimated impact that open spaces have on nearby residential properties across the study areas. Open spaces on located in the easten side of the Moreland were found to have generally have the highest positive on property selling prices. The assumed values were based on an assessment of both vegetation and channel conditions for riparian parks. The impact of cemeteries located in Hadfield and Glenroy suburbs were not used in the estimation of property benefits due to limited data on how these open space affected nearby property prices.

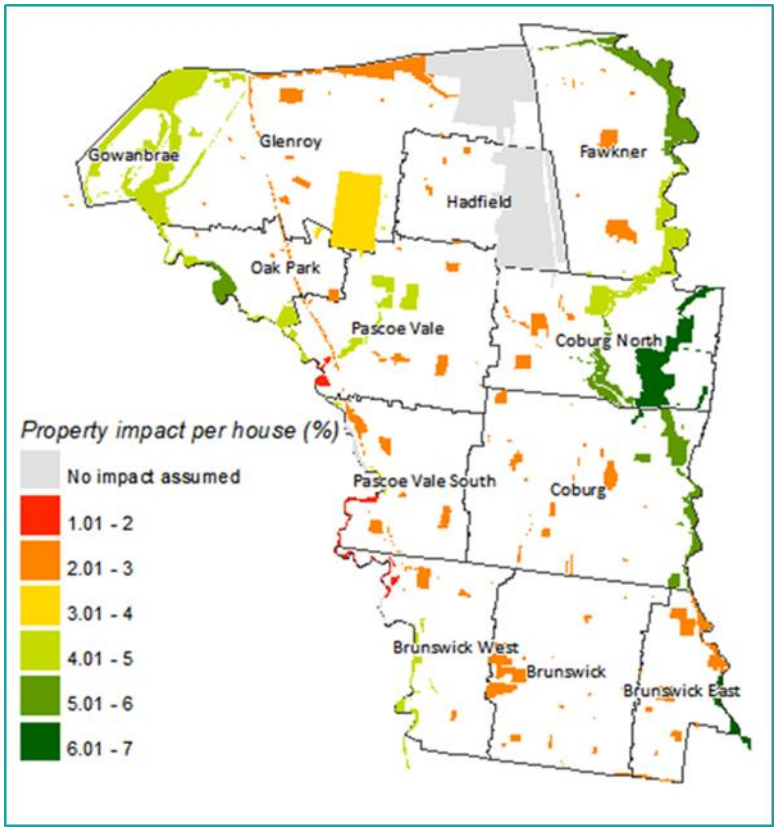

Figure 6. Distribution of property price impact (%) by open spaces

Sensitivity analysis and confidence rating

A Monte-Carlo sensitivity analysis was undertaken on all input and output parameters. The fifth (p5) and 95th percentile (p95) estimates and reliability of the estimated recreation benefits are given in Table 4. We are somewhat confident on our estimated impact on detached dwellings as these we based on recent Australian studies, however the estimated impact on non-detached dwellings is indicative. Non-detached dwelling price impacts were based on Australian studies but modified using UK study. Overall, the impact on property prices is deemed indicative. The confidence rating could be improved by accounting for individual open space size, quantity and quality of park attributes.

Table 4. Estimated annual property price premium

Benefit	Average	p5 value	p95 value	Reliability of estimates
Detached dwelling ($ per dwelling pa)	1,200	960	1,760	
Non-detached / Apartment dwelling ($ per dwelling pa)	580	460	850	
All Moreland properties ($, million pa)	70.8	56.7	104.6	

Sensitivity analysis suggests that the most significant driver of the estimated property price premium is non-riparian open space. That is, changes in the assumptions about non-riparian open space has the largest impact on aggregated benefits. This is because most houses are close to these types of open spaces and that property values dominate the estimated aggregate benefit. For example, 70% of

detached dwellings were found to be located closest to a non-riparian open space.[15] There is also high variability in the sizes, attributes and consequently impacts of these open spaces on property prices. Overall, the variability is driven by both the number of houses located in proximity to these open spaces and the uncertainty around the impact on property prices.

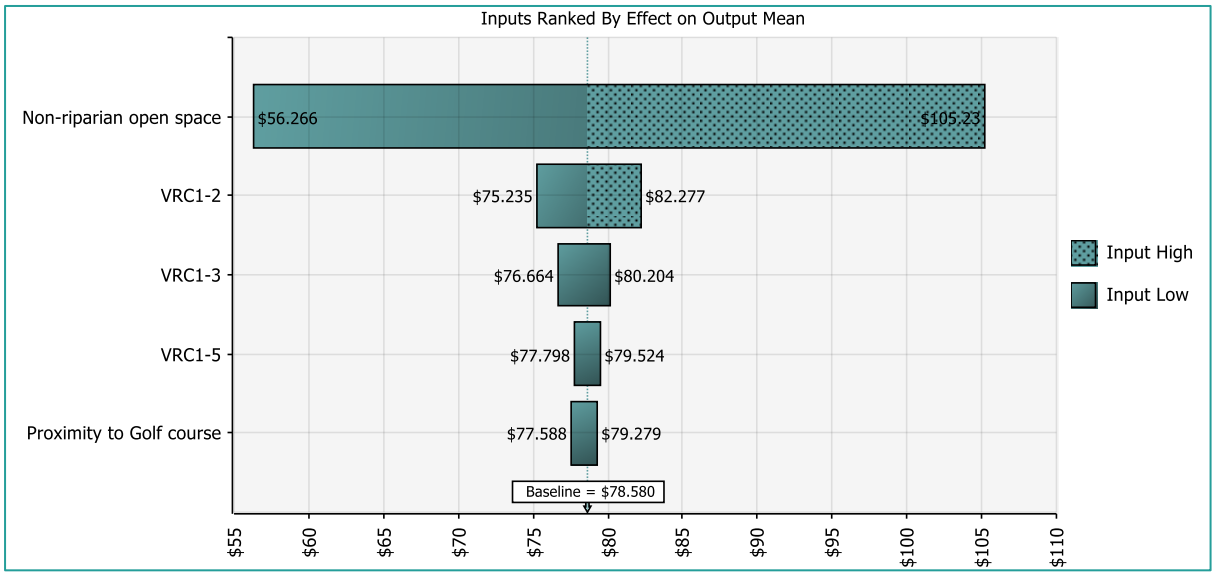

Figure 7. Sensitivity of estimated property price premium to key input parameters ($, million pa)

Key findings

The estimated property price premium in Moreland is $71 million per annum (range $57 - $105 million).

Overall, based on current median prices, open spaces contribute 2.56% to the value of nearby properties in Moreland City Council area.

4.2 Recreation values

The methodology described in Section 3.6 was used to estimate recreation benefits. The benefits were estimated for open spaces without public access restrictions. Thus, open spaces with restricted or limited access such as cemeteries, fenced off transport reservations and swimming pools were excluded. The average recreation benefit per annum was estimated to be $9.1 million (range $6.1 to 12.1 million), based on 445 ha of open space. The total recreation benefit was disaggregated to suburb level by area of public open space in each suburb. Figure 8 shows the estimated annual benefit of recreation by suburban area. Coburg North which has the largest amount of public open space with no access restrictions (92 ha) is assigned a higher value for recreational benefits. Hadfield has a large number of open spaces however this is dominated by a cemetery (restricted access), and the Fawkner Memorial Park. The memorial park occupies more than a third of the whole suburb. Thus, Hadfield has the lowest recreation value for public and open spaces.

[15] The remaining properties were located closest to open spaces with waterways and thus a VRC approach was used to estimate their impact on property values

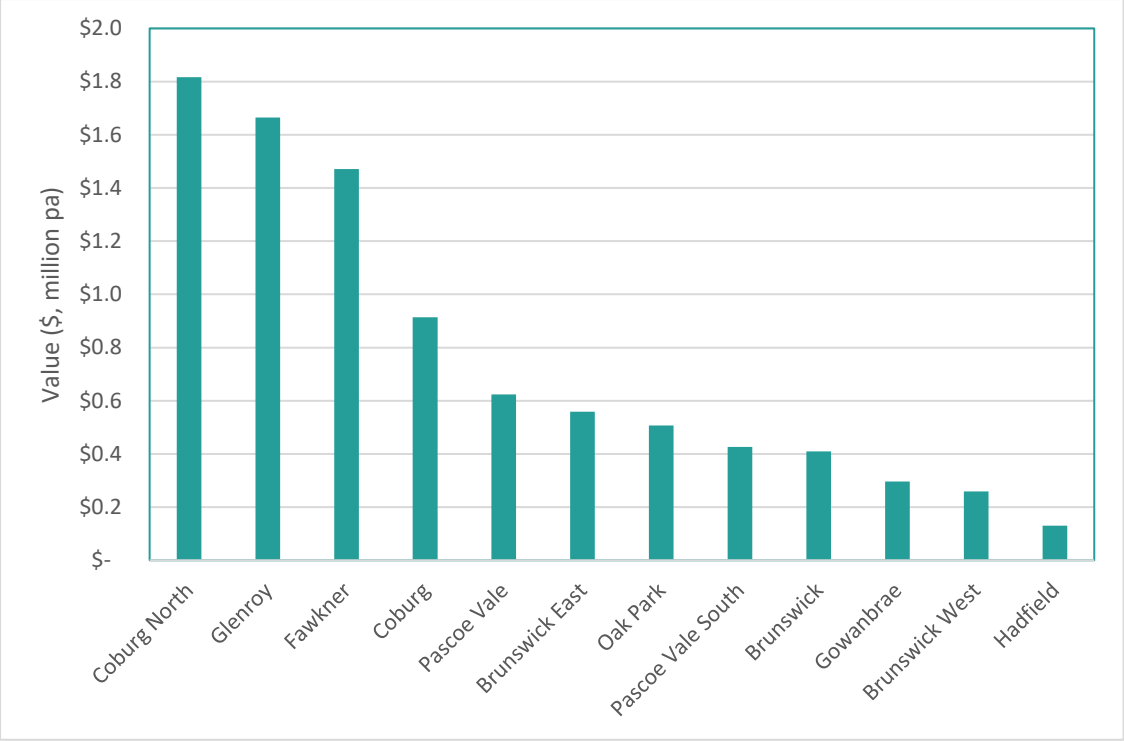

Figure 8. Estimated annual recreation value by suburb area ($, million pa)

Figure 9 shows the distribution of the estimated annual recreation benefits across the study area by suburb. Suburbs with a larger concentration of open spaces have relatively higher recreation benefits. This is an outcome of the open space distribution and assumptions on assigning benefits to suburbs. It was assumed that open space recreation is driven by the area of open space, however it is likely that in some area, smaller parks may commander higher visitation rates than some larger parks. To be able to capture this information, a study visitation rates per park will be required.

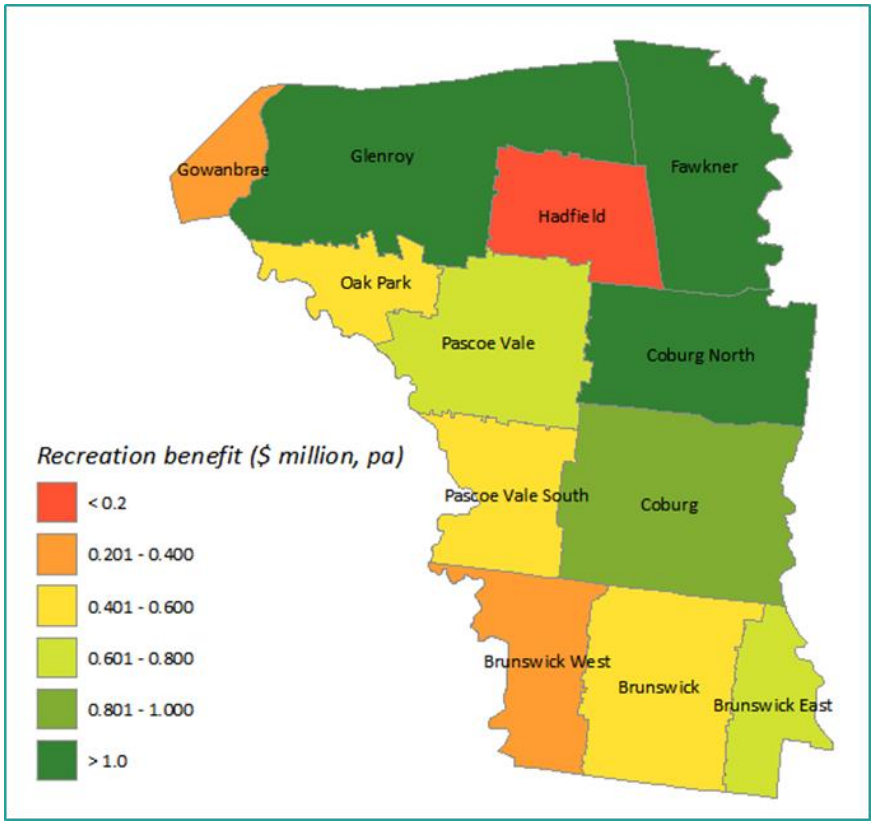

Figure 9. Distribution of annual recreation value by suburb area ($, million pa)

Sensitivity analysis and confidence rating

Sensitivity analysis was undertaken on the key input parameters used in the estimation. The fifth and 95th percentile estimates, and reliability of the estimated recreation benefits are given in Table 5. We are somewhat confident with the estimated recreation benefits. The estimation relied on recent reported Australian visitation patterns, local community demographics and an Australian unit value. An investigation on visitation rates between local residents and non-locals could reduce the variability in the attribution of benefits to visitor-types. This would reduce the potential for double accounting of recreation benefits between home owners and non-local residents.

Table 5. Estimated annual recreation value ($, million pa)[16]

Benefit	Average	p5 value	p95 value	Reliability of estimates
Recreation	9.1	6.1	12.5	

Sensitivity analysis suggests that the most significant driver of the estimated recreation value of open space is the assumption regarding the split of benefits between homeowners and non-local residents. That is, changes in the assumptions about use by homeowners and non-local residents has the largest impact on aggregated benefits (see Figure 10). The assumed number of visits per month is also a key driver of variability in the estimated benefits.

[16] The reported recreation values are adjusted to account for potential double-counting. If no double counting is assumed the average recreation average benefit amount is $18.2 million per annum.

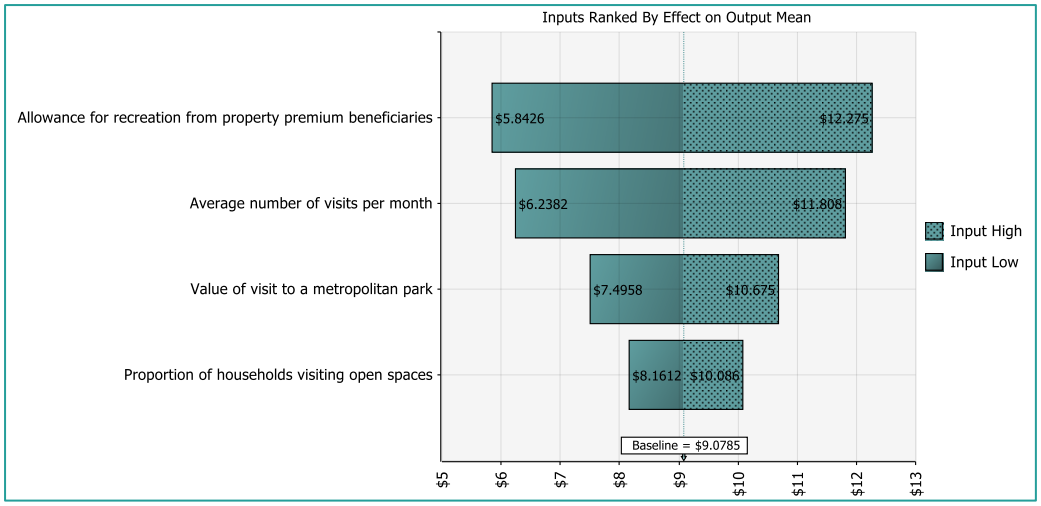

Figure 10. Sensitivity of estimated recreation benefits to key input parameters ($, million pa)

Key finding

Open spaces have an estimated annual recreation value of $9.1 million (range $6.1 to 12.1 million).

Access to open spaces for recreation is highly valued by nearby residents and visiting users. Accounting for double-counting benefits accruing to nearby property owners and the number of visits are key drivers in the variability of the estimated benefit.

4.3 Avoided health costs

Based on the visitation rates reported in Veal (2006) and Lin et al. (2014) and the cost of physical inactivity as discussed in Section 3.7, the avoided health cost benefit for the adult population of Moreland is estimated to be $13.6 million per annum (range $9.4 to $18.5 million).[17] The estimated avoided costs were allocated to each suburb based on the proportion of Moreland's total adult population within each suburb. Brunswick and Coburg suburbs have the highest estimated avoided health costs (see Figure 11), reflecting higher proportion of the adult population in these two suburbs.

[17] We used a cost avoided approach and the transferred costs that are associated with the physical inactivity related costs for the adult population. While children are at risk, 95% of the actual costs such as mortality and productivity related costs are actual incurred at the adult stage (Medibank 2008).

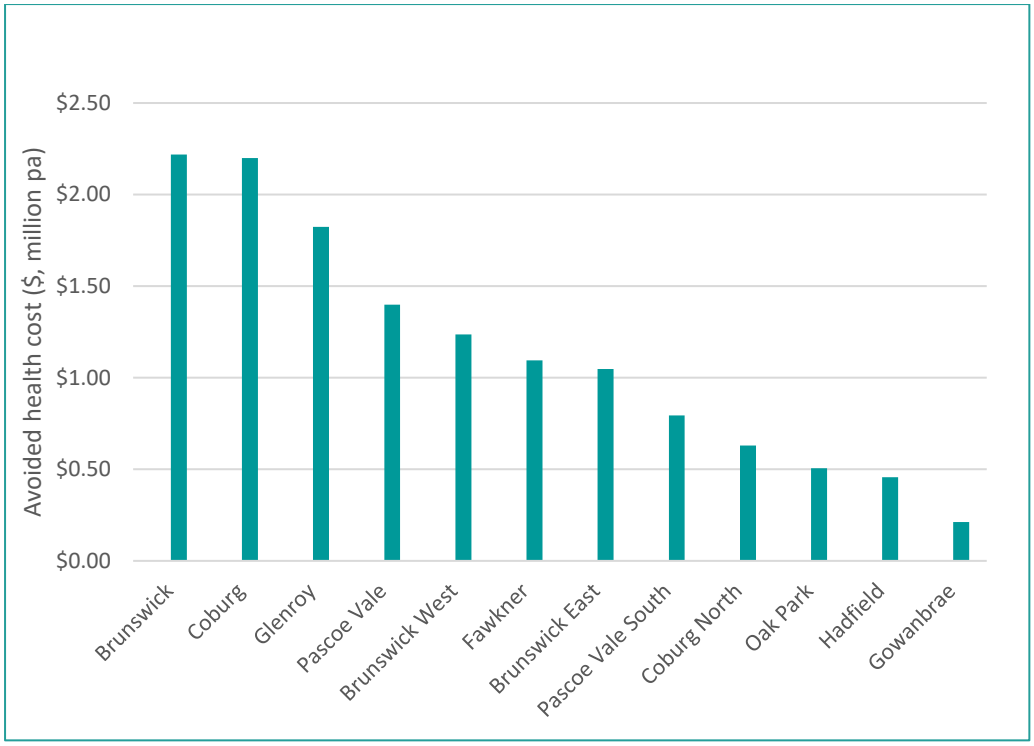

Figure 11. Avoided health costs by suburb ($, million pa)

Figure 12 shows the distribution of the estimated annual health benefits across the study area by suburb. The health benefit was influenced by the density of adult population across the study area.

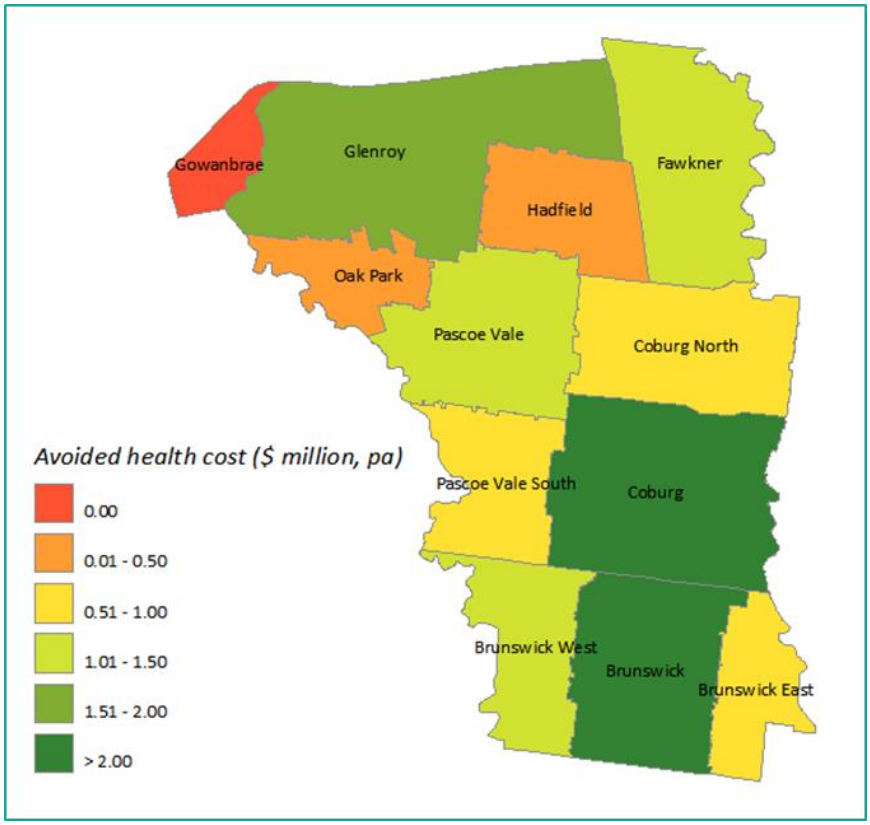

Figure 12. Distribution of annual avoided health costs by suburb area ($, million pa)

Sensitivity analysis and confidence rating

Sensitivity analysis on the key input parameters indicates that the 90% confidence interval ranges from $9.4 to $18.5 million (Table 6). Overall, even under conservative assumptions, the avoided health costs per annum are significant. The estimated benefits are indicative due to uncertainties around attribution of open spaces to increased physical activity for the local population. The benefit estimation process was reliant on data availability. The estimated benefit is indicative as other key benefits from active transport such as walking to work and non-bicycle active transport for non-work purposes were not covered.

Table 6. Estimated annual avoided health costs ($, million pa)

Benefit	Average	p5 value	p95 value	Reliability of estimates
Recreation	13.6	9.4	18.5	

Sensitivity analysis suggests that the most significant driver of the estimated recreation value of open space is the cost of physically inactive person per year and the attribution of any gains in physical activity to local council open spaces. The data used to estimate the cost of a physically inactive person could be improved by a dedicated new study on the cost of physical inactivity. The estimates used in this study were calculated from reported estimates in Bauman et al., (2008) and a value reported in Mekala (2015). Additionally, a survey of physical activity in the study area can provide valuable information to reduce the variability of the estimated value.

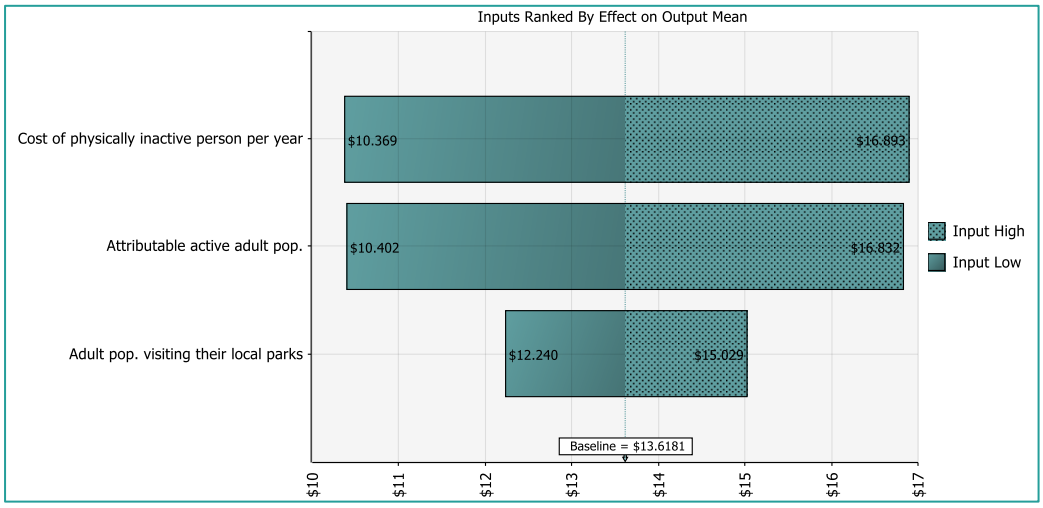

Figure 13. Sensitivity of estimated annual avoided health costs to key input parameters ($, million pa)

Key finding

The estimated recreation value from Moreland open spaces is $13.1 million (range $9.4 to $18.5 million).

The assumed cost of physical inactivity and attribution of benefits to the open spaces are significant drivers of variability in the estimated benefit.

4.4 Avoided traffic congestion

The total decongestion value was estimated to be $0.7 million per annum ($0.3 million and $1 million per annum range). Only the bicycle commute trips were included in this estimate and the modest value is due to data limitations. Figure 14 shows the estimated value by suburb. The estimated benefit is a function of reported rates of bicycle commutes and assumptions on distance travelled. Suburbs in the north of the LGA have low bicycle commutes and thus will have lower values, however, the assumed distance will be longer hence each trip will command a higher value. Coburg and Brunswick have the highest two decongestion values. All else being equal, the estimated values for Coburg compared to Brunswick are driven by the longer commute distance. Thus, even though Brunswick has a higher bicycle commute rate, it is still a short distance to the places of work when compared to Coburg.

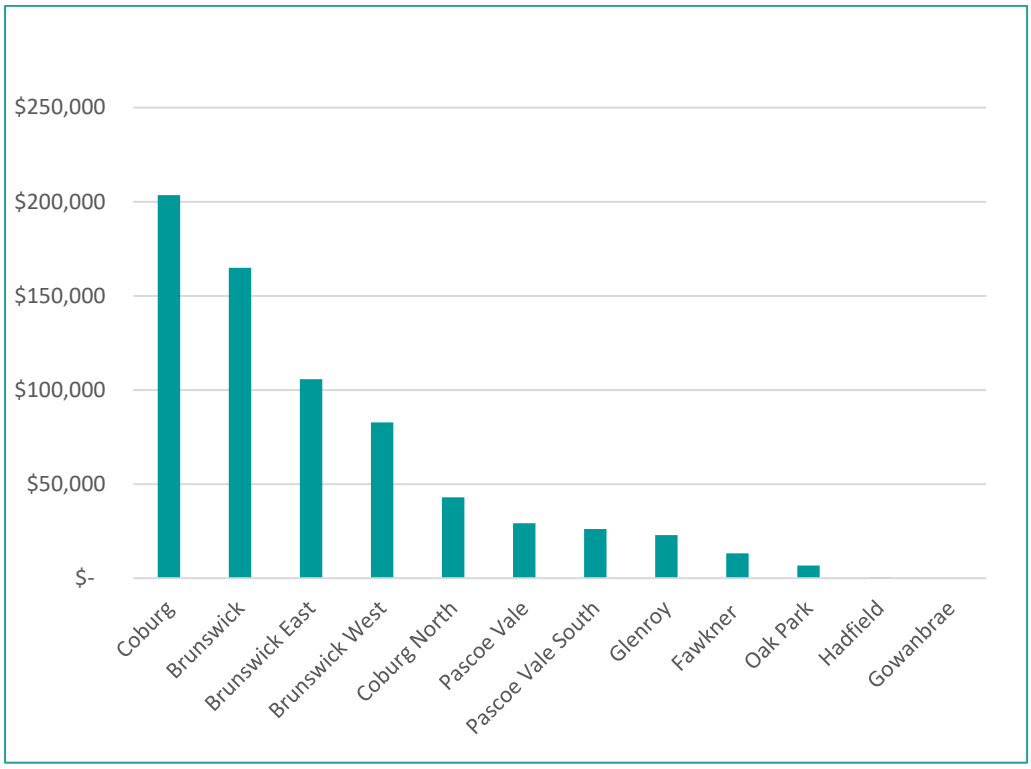

Figure 14. Estimated decongestion value by suburb ($, pa)

Figure 15 shows the distribution of the estimated annual decongestion benefits across the study area by suburb. This benefit is more concentrated in suburbs closer to the Melbourne central business district. The benefit was driven by both the ABS census reported commute data and the distance travelled. These results, indicate that while the southern suburbs travel shorter distances to work (located largely in the south), the number of people commuting is a relatively much higher in these southern suburbs.

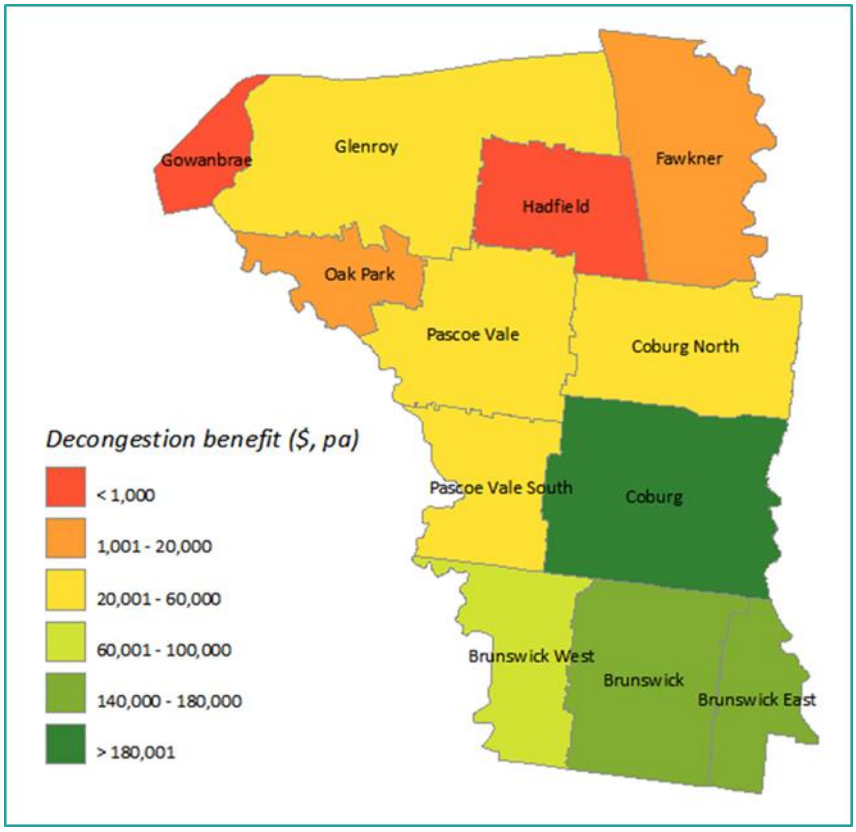

Figure 15. Distribution of annual traffic decongestion benefit by suburb area ($, pa)

Sensitivity analysis and confidence rating

Sensitivity analysis results for the fifth and 95th percentile for estimated annual decongestion value are shown in Figure 7. The decongestion benefit provided in this study is conservative. The estimated benefits are only those captured through cycling to work. Decongestion benefits that may come from cycling to non-work destination or even walking to work were not quantified due to limited data availability. Lastly, there was no available information on cycling commute distances and some conservative assumptions were made to estimate the annual decongestion value.

Table 7. Estimated annual decongestion value ($, million pa)

Benefit	Average	p5 value	p95 value	Reliability of estimates
Recreation	0.7	0.3	1.0	

The key drivers of variability in the estimated decongestion benefit are the assumed decongestion value and the attribution of bicycle commute to Moreland open spaces (see Figure 16).

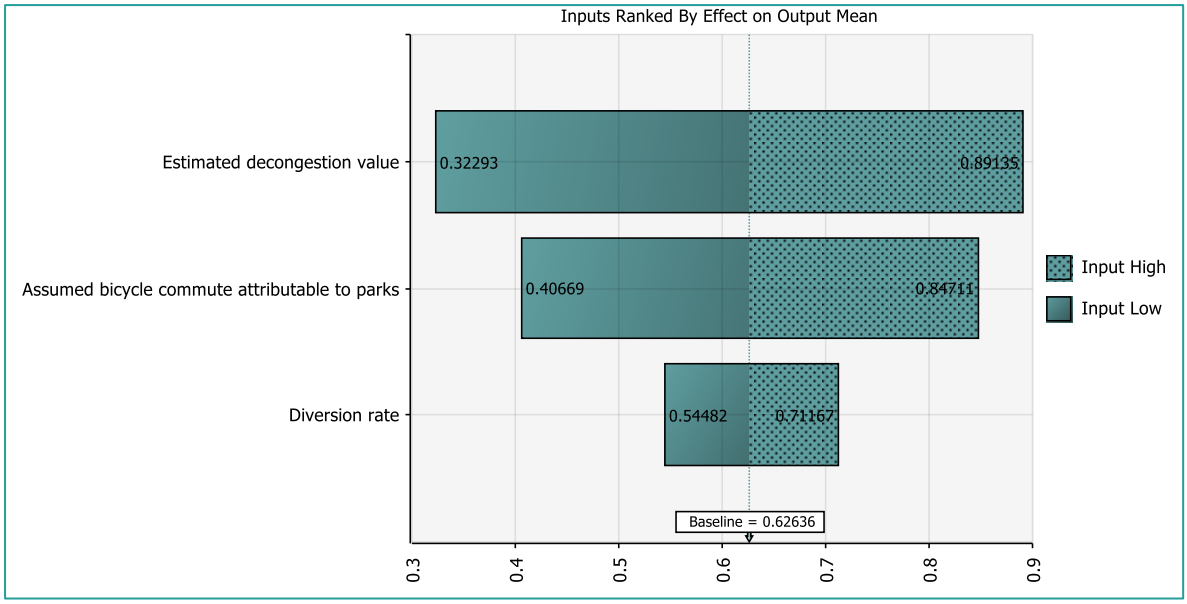

Figure 16. Sensitivity of estimated decongestion benefits to key input parameters ($, million pa)

Key finding

The decongestion value attributable to open spaces is a modest $0.7 million per annum. Its range is $0.3 million and $1 million per annum.

The value and range reflect the data challenges in estimating the impact open spaces on decongestion (both commute and non-commute travel).

4.5 Aggregated benefits

The estimated economic value for different ecosystem services and benefits were aggregated to provide an estimate of the annual value from open spaces. In aggregating the estimated ecosystem values, care was taken to avoid double counting of benefits. For example, only 50% of the recreation benefits were included to allow for benefits captured through property price premiums.

The aggregated economic value of open spaces in Moreland City Council is estimated at $94.3 million per annum. A Monte-Carlo simulation analysis was undertaken with all uncertain parameters as inputs. The results indicate that 90 per cent of the time, the aggregated annual benefits are between $79 million and $129 million (see Figure 17).

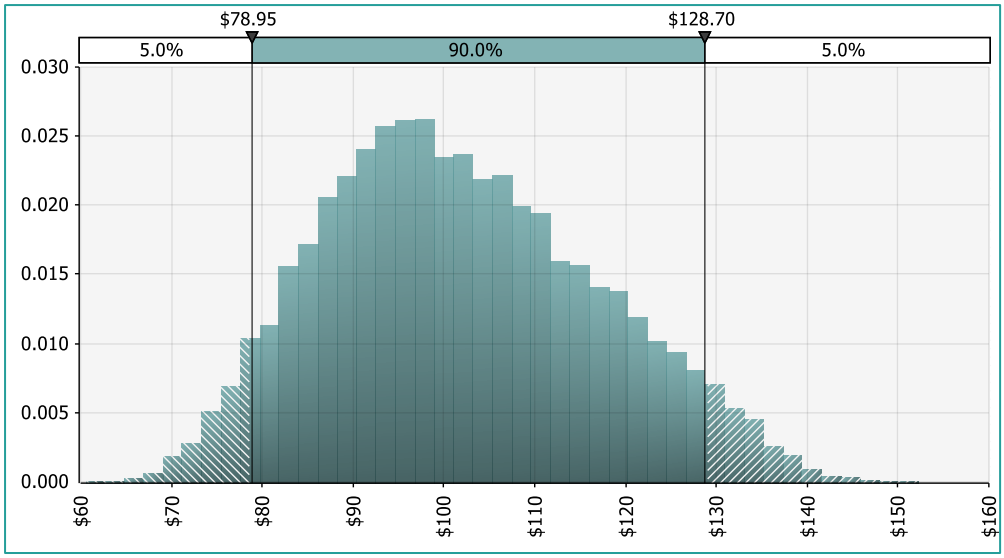

Figure 17. Annual aggregated benefits ($)

Figure 8 provides a list of the quantified benefits, their average estimated value and the 90% confidence interval from on a Monte-Carlo analysis on the input parameters. Property price premiums dominate the estimated benefits from urban spaces, the second highest benefits are from the avoided health costs. Decongestion benefits contribute the lowest amount at $0.7 million per annum.

Table 8. Base and range of annual economic benefits

Benefit	Average	90% Confidence interval
Property values	70.9	[56.7; 104.6]
Recreation	9.1	[5.1; 13.9]
Avoided health costs	13.6	[9.4; 18.5]
Decongestion	0.7	[0.3; 1]
Total quantified benefits	94.3	[79; 128.7]

A further analysis was undertaken to investigate the effect of the key input parameters on the estimated aggregate annual benefits (Figure 18). Changes in the assumed impact on property prices from non-riparian open spaces has the largest impact on aggregated benefits. This is not surprising given that most houses are close to these types of open spaces and that property values dominate the estimated aggregate benefit. Similarly, the recreation and health benefits assumptions have a significant effect on the aggregated benefit.

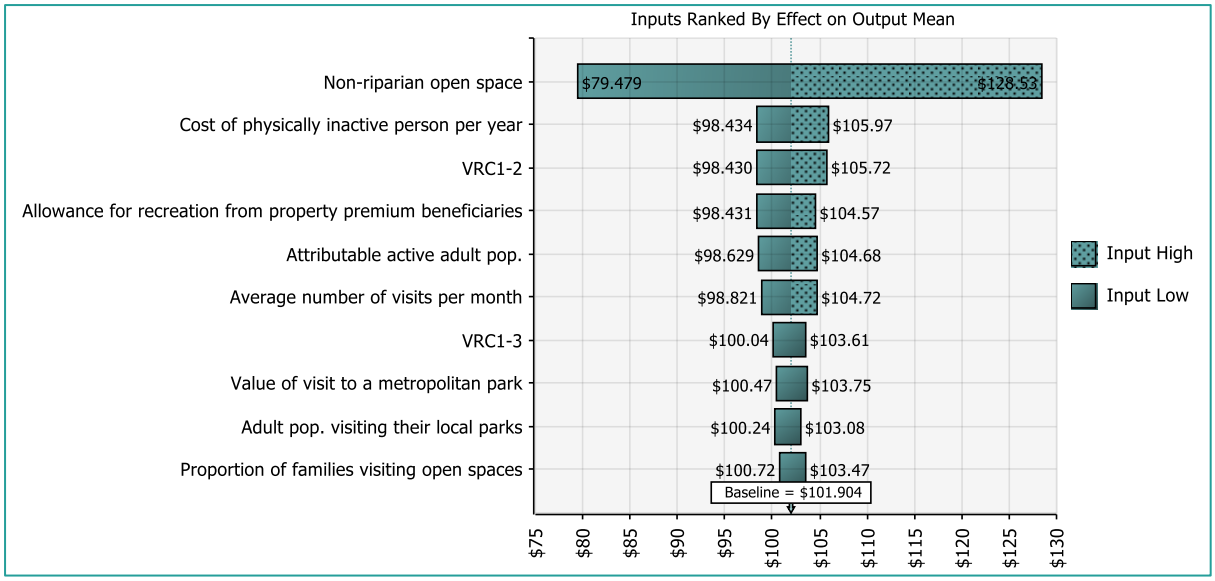

Figure 18. Key inputs ranked by effect on annual aggregated benefits ($)

The dearth of data on some of the identified benefits means that the estimated values are conservative as not all benefits were measured. Also, conservative assumptions were preferred where there were high uncertainties around key input parameters. However, the estimated average value of $94 million is a significant amount, it is equivalent to 46% of actual Moreland City Council income for year 2017/18.[18]

4.6 Overview of identified key benefits that were not quantified

The benefits of urban vegetation and vegetated open spaces has been subject to increased research interest over the past three decades. There is generally an established literature linking various benefits to ecosystem services emanating from urban open spaces (Livesley et al., 2016). However, the evidence-base to quantify and monetize these benefits is still developing with generalised formulas still lacking. Quantitative assessments often require analysis of multiple site-specific factors to gauge the multiple and interlinked benefits.

Carbon sequestration

One of the important ecosystem services from vegetated urban parks is carbon sequestration. The vegetation in urban parks plays a role in sequestering carbon. Mekala et al. (2015) estimated that an urban open space with 456 trees per ha aged between 5 and 20 years can capture a conservative 2.52 tonnes of carbon/ha/annum (tC/ha/year). The Australian carbon price was initially set by the government at $24.15/tonne for the year 2013-14; however, the clean energy mechanism that was adopted by the government was later repealed in 2014. So far, there have been seven Emissions Reduction Fund auctions, the carbon unit price has ranged from $10.23 to $13.95/tonnes (Clean Energy Regulator, 2018). This price is a reflection of the regulations surrounding emissions reduction.

[18] The forecaste actual 2017/18 income for Moreland City Council (from rates, statutory fees and fines, user fees, contributions, recurrent and non-recurrent grants and other income) is $192,738,000 (Moreland City Council, 2018b)

Given the limited reflection of the actual social cost of carbon pollution by regulation dependent prices, prior studies have pointed out that the correct cost of mitigating the impact of carbon pollution should be used in estimating the value of carbon sequestration. In the UK, the Department for Business, Energy and Industrial Strategy (2018) estimates the social cost or non-traded price of carbon at an equivalent of $118 for 2018 (in Australian dollars). The Interagency Working Group on the Social Cost of Greenhouse Gases (2016) estimates that the 2018 social cost of carbon dioxide ranges from $16 to $153, depending on the rate of discount and forecasted climate impact. The climate impacts considered in the social cost values are those related to changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. However, given the size of the park and proposed tree density, the carbon sequestration benefit was only minimal and was not included in this analysis. Due to limited data on the biomass of vegetation across the LGA, it was not possible to quantify the carbon sequestration benefit.

Mitigation of climate extremes including urban heat islands

Vegetated urban open spaces play a significant role in moderating climate extremes. Current literature indicates that vegetated open and street spaces can provide cost-effective solutions to manage urban heat island effects (Akbari and Kolokotsa, 2016; Sodoudi et al., 2018). The benefits of urban cooling are site specific. Estimating these benefits requires specific information about wind direction, location of vegetated areas from buildings, land cover, maximum temperatures and knowledge of thresholds, among other, to be able to quantify and monetize them. Thus, due to the limited scope of the current study, these benefits were not estimated.

Noise and air pollution reduction

Our increasingly dense and traffic congested cities are a source of increased noise and air pollution. Urban green infrastructure can play a significant role in mitigating both noise and air pollution. Urban trees and lower vegetation have been found to improve air quality by reducing gaseous and particulate pollutants (Jeanjean et al., 2017; Klingberg et al., 2017, Nowak et al., 2006).

Urban vegetation and trees also help to attenuate noise at frequencies produced by traffic (Klingberg et al., 2017). Green spaces have also been reported reduce perceptions of noise, and so to reduce subsequent annoyance (Dzhambov and Dimitrova 2015). Further, lower noise is correlated with higher frequency of relaxation and walking activities (Gozalo et al., 2018). While the attenuation of noise and air pollution are important benefits, these were no suitable data to measure these benefits. For example, measuring the noise pollution reduction benefit will require data on current noise levels and what they would otherwise be without vegetated urban space. This level of detailed data was not available.

Support for human well-being through improved physical activity, stress reduction and general relaxation

Benefits associated with increased physical activity were estimated. However, there was no data available to estimate the benefits associated with stress reduction of other mental well-being benefits of urban open space. There is a robust and extensive evidence based demonstrating the physical and mental health benefits of individual and communities from vegetated urban open spaces (Gascon et al 2018; van den Berg 2015; Wolch et al., 2014). For example, Akpinar (2016) reported that closer proximity to urban open spaces was associated with higher frequency of visitation rates and that the visits contributed to mental health well-being while duration of visits also led to improved physical health. The benefits associated with stress reduction and general relaxation were not estimated as there was insufficient information to reasonable attribute any improvements and attach a monetary

value to the attributable mental well-being benefits. A more targeted survey and investigation will be required to properly capture the mental well-being benefits.

Casual or commute trip connection passages/paths

Only an aspect of this benefit was quantified. The quantified benefits relate to reduced congestion through bicycle commute. Any decongestion benefits associated with non-commute bicycle trips and walking commute were not quantified due to the dearth of data about these trips.

5 CONCLUDING REMARKS AND STUDY LIMITATIONS

5.1 Value of open spaces

Urban open spaces provide multiple ecosystem services that are beneficial to human beings. However, given the non-market nature of the benefits, non-market valuation methods are used to measure these benefits. Revealed and stated preference methods can used to best capture society's willingness to pay for open space ecosystem services.

Given the desktop nature of this study, the estimated values are dependent on available data and unit values transferred from elsewhere. The unit values were combined with local physical data on open spaces, social facilities, psychographic (e.g. bicycle commuting rates), and socio-demographic data to estimate benefits. Counterfactuals for each valued benefit were defined.

The following key benefits for open spaces in Moreland were quantified:

- Property price premiums.
- Recreation.
- Avoided costs physical inactivity.
- Traffic decongestion from bicycle commute.

Based on the four benefits, open spaces have an estimated value of $94 million per annum. This base value was informed by some key input parameters and Monte-Carlo simulations results indicate that the range for the estimated value ranges from $79 million to $129 million per annum. The estimated values are based on 618 ha of open spaces in Moreland City Council area, (this excludes the open spaces with no public access and the crematorium located in Glenroy and Hadfield. The benefit transfer results indicate annual benefits of $152,000 per ha (with a range of 127,800 to 209,000 ha).

Some important ecosystem services that were identified but not quantified due to data limitations are:

- Carbon sequestration (regulating service).
- Mitigation of climate extremes including urban heat islands (climate regulating service).
- Noise pollution reduction (regulating service).
- Air quality improvements (regulating service).
- Visual amenity to local and visiting population (cultural services).
- Casual or commute trip connection passages/paths (cultural services).
- Benefits related to walking and non-commute active transport e.g. cycling for exercises or to non-work destinations (cultural services).

Because only a subset of all of the possible ecosystem services have been quantitatively estimated, our aggregate estimates should be considered underestimates. However, we are of the view that the majority of key benefits associated with the ecosystem services are captured. For example, benefits associated with air quality, noise reduction and mitigation of climate extremes are somewhat reflected in property value impacts. Furthermore, the risk of double counting would increase if some of the abovementioned benefits were also included.

5.2 Key limitations

While this desktop study provides significant insight on the value of open spaces, the lack of data to cover the non-quantified benefit is a limitation. Also, there are opportunities to better capture the benefits quantified in this study. Key limitations and recommendations for improvement on estimating benefits are discussed below.

Property prices

A single unit value on property price impact from local non-riparian open spaces was used. There is great variability in the attributes, quality and size of these parks. An investigation on how different attributes of non-waterway parks e.g. dog off-leash area, barbeque stand, sports area, kids play ground will enhance the estimation process. There is limited understanding on the impact of urban parks on non-detached dwellings from an Australian context, which also reduces the robustness of the estimates associated with non-detached property prices

Recreation

The variability in the recreation benefit can be reduced by undertaking a survey on the number of actual visitors in a week and where people come from to visit the park. Such a survey should capture visitation rates per population and their visitation frequency. Ideally, this study should be undertaken to inform a travel cost valuation.

Health

A general health benefit from improved physical activity was used. The health benefits can be better captured for both exercise and non-exercise related health benefits. Both physical and mental health benefits can be better captured.

Decongestion

A survey on distance and times travelled will help improve confidence rating for this benefit. Only the bicycle commute benefits were covered due to data limitations. Future investigations on walking commute, non-commute active transport travel will help boost the estimated benefit.

Biophysical data

There are limited data available for biophysical factors at the individual park scale. In particular, while there is a good inventory of street trees, accurate tree counts for Moreland open spaces are not known. This precludes quantification of carbon sequestration and other ecosystem services provided by these trees. Of the relevant biophysical factors, only data for waterways and waterbodies (as managed by Melbourne Water) are available at an appropriate scale and extent for our analysis.

6 POLICY INSIGHTS

There are two key interrelated policy insights that come from this analysis:

- Informing business cases. This information can be used in conjunction with the estimates of the costs of park establishment or park improvement works within formal business cases or cost-benefit analysis studies.
- Informing cost-sharing. The quantitative analysis can be used to understand and quantify the direct and indirect distribution of the benefits of parks. This can assist in establishing cost-sharing arrangements.

These are discussed briefly below.

6.1 Informing cost-benefit analysis and business cases

Using the same approaches that were applied in valuing benefits of parks in Moreland, a study can be undertaken to quantify benefits associated with improvements to some or all parks in the council area. For example, such works may include improving public access, planting more trees or removing aging concrete banks and replacing them with more natural rocks. The additional benefits from these works can be captures and compared against the actual project costs. A benefit cost analysis could then me undertaken to establish the net present value and benefit-cost ratio of that particular investment.

Using this information would enable the Park upgrade to be considered in the same economic analysis framework as any built infrastructure (e.g. a road). CBA has two tests to see if a project is economically viable:

- Net present value (NPV). This considers the lifecycle value of the benefits compared to the lifecycle values of the costs. Where the NPV is $>0, the project is economically viable.
- The benefit-cost ratio (BCR). This is the ratio of benefits to costs over the 30-year period. Where a BCR is >1.0, a project is economically viable.

Key point

The analysis can be used to underpin a cost-benefit analysis or business case.

6.2 Informing cost-sharing

The beneficiaries of open space upgrades can also be identified by broad stakeholder group. Therefore, the analysis can inform future cost-sharing arrangements. This is briefly outlined in Table 9. The cost-sharing considerations in Table 9 are only focusing on direct beneficiaries.

Table 9. Considering the distribution of benefits to inform cost-sharing

Benefit	Initial beneficiary	Ultimate beneficiary	Cost-sharing opportunities and rationale
Property values (new developments)	Developer (higher sales prices)	Buyers of new homes	It is reasonable that some of the increase in property value could be recovered from developers via a developer contribution. However, this would only be reasonable where the open space upgrade is undertaken *before* the new dwellings go onto the market (and a price premium is achieved by the developer). It should also be noted that, assuming no other changes to the framework used to calculate rates, the higher property values would also marginally increase rates revenues. Significant cost sharing opportunities.
Property values (existing)	Existing property owners	Existing property owners	Upgrading the open space provides a significant gain to property values for existing property owners. Limited cost-sharing opportunities.
Recreation	Park users	Open space users and local councils	These benefits accrue to open space users and the local councils. The transaction costs of recovering costs from individual users would be prohibitive. Negligible cost-sharing opportunities.
Avoided health costs	Park users	Health service providers	These benefits accrue to open space users and local councils. The transaction costs of recovering costs from individual users would also be prohibitive. Negligible cost-sharing opportunities.
Decongestion	Road commuters	Local residents and other commuters travelling through an area with non-active commute alternatives that are locate within/along open spaces	These benefits accrue to road-based commuters. The transaction costs of recovering costs from individual users would be prohibitive. Negligible cost-sharing opportunities.

To the extent that the benefits of the open spaces are reflected in property price premiums, local councils are likely to recover some costs over time through marginally higher rates.

In terms of capital contributions, there may be opportunities for some cost-sharing with developers where the open space upgrade is undertaken *before* the new dwellings go onto the market (and a price premium is achieved by the developer).

Because 'value capture' mechanisms are inherently complex, care should be taken in their design. There is sufficient information to suggest that there could be opportunities for 'value capture' via cost sharing for open spaces near new development zones. However, this would require the development of a council-wide or Greater Melbourne policy framework and cost-sharing approach.

Key point

There is sufficient information to suggest that there could be opportunities for 'value capture' via cost sharing for parks near new development zones. However, this would require the development of a council-wide or Greater Melbourne policy framework and cost-sharing approach.

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APPENDIX

Table A1. Summary of assumptions

Variable	Estimate/Assumption	Range	Source/s
Number of dwellings	47,950 detached and 23,431 unit		Moreland City Council cadastral data ??
Property value impact	VRC changes, counterfactual was VRC1 for riparian parks 2.08% for non-riparian parks	VRC range based on reported standard deviation 0.9 to 4.5% for non-riparian parks	Thomy et al. (2016) Google Earth (2018) Mekala et al. (2015)
Property value impact	0.82% of detached dwellings		Based on Green Infrastructure Valuation Network (2011)
Moreland households	40,057		ABS (2017)
Proportion of families visiting open spaces	52.5%	45-60%	Lin et al. (2014) Veal (2006)
Average number of visits per month	7.8 visits per month	4.4-11.2	Based on average monthly visit to parks with waterways in Melbourne and Veal (2006)
Value of an urban park visit	$9.22 (adjusted to 2018 AUD)		Parks Victoria and DELWP (2015)
Recreation: accounting for double-counting with property prices	50%	25-75%	NCE estimate
Average cost of physical inactive person	$1,305	$860 - $1,749	Bauman et al. 2008 Mekala et al. 2015
Adult population visiting local parks	50%	45-60%	Lin et al. (2014) Veal (2006)
Attribution of increased physical activity to the project	15%, as the park is linked to other pathways	10-20%	NCE estimate
Bicycle commuters in the study area	4,389		ABS (2017), total for all suburbs
Assumed bicycle commute attributable to parks	20%	10-30%	NCE estimate
Diversion rate	0.616		SKM and PwC (2010), and NCE estimate
Decongestion economic value per km	$0.99	$0.26-$1.39	CDM Research (2013)