ACT Government

CANBERRA'S LIVING INFRASTRUCTURE
INFORMATION PAPER

FEBRUARY 2018

Telephone: 02 6207 1923
Website: www.environment.act.gov.au

Accessibility

The ACT Government is committed to making its information, services, events and venues as accessible as possible.

If you have difficulty reading a standard printed document and would like to receive this publication in an alternative format, such as large print, please phone Access Canberra on 13 22 81 or email the Environment, Planning and Sustainable Development Directorate at EPSDDComms@act.gov.au

If English is not your first language and you require a translating and interpreting service, please phone 13 14 50.

If you are deaf, or have a speech or hearing impairment, and need the teletypewriter service, please phone 13 36 77 and ask for Access Canberra on 13 22 81.

For speak and listen users, please phone 1300 555 727
and ask for Canberra Connect on 13 22 81.

For more information on these services visit http://www.relayservice.com.au

PRINTED ON RECYCLED PAPER

CONTENTS

SUMMARY

WHAT IS LIVING INFRASTRUCTURE

Natural systems and processes can be harnessed to protect communities against excessive heat or flooding. They can improve air, soil and water quality, as well as increase public amenity.

When natural elements and features such as wetlands, the urban forest and green refuges are incorporated into the design and operation of cities, this is called 'living infrastructure'.

Living infrastructure requires a specific approach to design. The approach combines both natural and engineered elements to perform a range of functions that deliver combined environmental, social and economic outcomes.

This approach compels a strategic and holistic approach to the planning, design, construction, maintenance and renewal of our communities.

WHY WE NEED A LIVING INFRASTRUCTURE PLAN

Canberra's original "garden city principles" incorporated living infrastructure in its planning and design.

As Canberra grows and evolves to become a compact city with more intensively developed urban areas, the importance of incorporating living infrastructure into the city's form and function increases.

Importantly, living infrastructure will play a key role as the city adapts to the impacts of climate change.

Developing and implementing a living infrastructure plan will enable and support a number of the Government's strategic priorities. The anticipated beneficial outcomes include: enhancing liveability and social inclusion; enabling urban renewal and active living; increasing property values; and improving natural resource management and urban biodiversity.

PROPOSED NEXT STEPS

Action 15 of the *ACT's Climate Change Adaptation Strategy* included the development of a living infrastructure plan. This will be included as part of the *ACT's Climate Strategy to a Net Zero Emissions Territory*, providing the community with clear policy that integrates both adaptation and mitigation actions. The land use sector of the new Climate Strategy will:

- define living infrastructure components and identify regulatory, planning, construction and maintenance requirements
- identify the need for living infrastructure in the ACT to protect the Canberra community against extreme weather events and provide ecosystem services in the urban fabric
- articulate the case for renewed investment in adopting a strategic approach to living infrastructure in the ACT
- provide standardised cross-directorate guidance for the way living infrastructure principles are incorporated into urban planning and design decisions
- develop and implement practical processes for the design, costing and operation of individual examples of living infrastructure
- establish demonstration projects to test the operational performance of living infrastructure examples and assess triple-bottom-line outcomes.

This initiative is integrated with other Environment, Planning and Sustainable Development Directorate (EPSDD) work, particularly on water sensitive urban design, active living and placemaking, that will help achieve a more liveable and sustainable city.

EPSDD is working in close collaboration with key agencies and the community to prepare the Climate Strategy.

In a survey undertaken to inform the Green Infrastructure Project for South Australia the overwhelming majority of respondents (87%) stated that they "consider green infrastructure to be either 'very' or 'extremely important' for the planning and design of urban environments in South Australia".

When asked to rate the importance of potential benefits, respondents rated temperature moderation the most significant benefit, followed by psychological well-being and air quality. When asked to rate the importance of different elements, all respondents rated parks and reserves as 'very important' or 'extremely important' followed by street trees.

GREEN INFRASTRUCTURE SURVEY REPORT BY SUSTAINABLE FOCUS PTY FOR THE BOTANIC GARDENS OF ADELAIDE, 2013

INTRODUCTION

This *Living Infrastructure Information Paper* was prepared to inform the Government on what a Living Infrastructure Plan might contain.

Following Government's decision to proceed with developing a plan, it was included in the *ACT Climate Change Adaptation Strategy (2016)* as action 15 to be completed by the end of 2018.

However to make clear the many co-benefits of an integrated approach to climate change, the new *ACT's Climate Strategy to a Net Zero Emissions Territory*, being developed in 2018, has both mitigation and adaptation activities. Consequently, the Living Infrastructure Strategy is being included as part of the land use sector, rather than a stand-alone document.

CANBERRA'S LEGACY

The ACT has been one of the leading jurisdictions in Australia in implementing living infrastructure. We are the beneficiaries of the intrinsic living infrastructure in the Griffin Plan for Canberra and the legacy of Canberra's first 100 years of development when 'designing with nature' was incorporated.

The expansive national capital open space system which includes hills, ridges and buffers, wetlands and waterways, makes Canberra unique amongst major Australian cities in the provision of living infrastructure.

Canberra enjoys the ameliorated microclimate of tree-lined streets and irrigated parks. However, the trees that help make the high quality urban forest are ageing and we need to look ahead to address the challenges of our second century.

As the city becomes more densely populated and the impacts of a warming climate become more apparent, the environmental services and highly valued amenity provided by living infrastructure will play a more essential role in maintaining our city's liveability.

CONTEXT

CURRENT URBAN DEVELOPMENT HAS REDUCED OPPORTUNITIES FOR LIVING INFRASTRUCTURE. CLEAR POLICY GUIDANCE IS NECESSARY TO REVERSE THIS TREND.

There is an emerging awareness of the social, economic and environmental (triple bottom line) benefits of living infrastructure, including the important role it can play in climate change adaptation such as ameliorating the urban heat island effect associated with cities.

A desk top literature review by EPSDD found an extensive Australian body of knowledge in addition to work being done in Europe and North America.

The current work by research bodies such as universities, CSIRO, and the Cooperative Research Centres (CRC for Water Sensitive Cities and the CRC for Low Carbon Living) on living infrastructure can be brought to bear in developing a Living Infrastructure Strategy for Canberra.

Case study snapshots and key references are provided in Appendices 1 and 2 at the end of this information paper.

Constructing, retrofitting and maintaining living infrastructure directly affects the work of a number of ACT Government agencies.

- **Transport Canberra and City Services (TCCS)** – in maintaining the city's public land and being responsible for the design standards.
- **Environment, Planning and Sustainable Development Directorate (EPSDD)** – in being responsible for the Territory Plan codes and policy settings that determine the nature of urban development.
- **Treasury in Chief Minister, Treasury and Economic Development Directorate (CMTEDD)** – in leading the development of criteria for valuation of economic benefits and whole-of-life costing and its application in assessing capital works proposals.
- **Suburban Land Agency (SLA) and City Renewal Authority (CRA)** – in delivering land development projects in accordance with government policies, codes and standards.
- **Emergency Services Agency (ESA)** – in ensuring the benefits of living infrastructure are delivered in reducing impacts from extreme weather events such as storms.
- **Health** – in managing impacts from heatwaves and recreational water quality in waterways.

Governments around Australia and the world are introducing policies and requirements to make their cities more liveable and communities healthier by reducing urban heat. Key to this is increasing the quantity of vegetation, particularly large shady trees. Appendix 2 lists useful references.

NEED FOR LIVING INFRASTRUCTURE

COMPONENTS

The four basic components of living infrastructure are:

- plants (native and exotic vegetation)
- open spaces (parks, pathways, verges)
- lakes, ponds, and waterways (stormwater treatments)
- soils and surfaces.

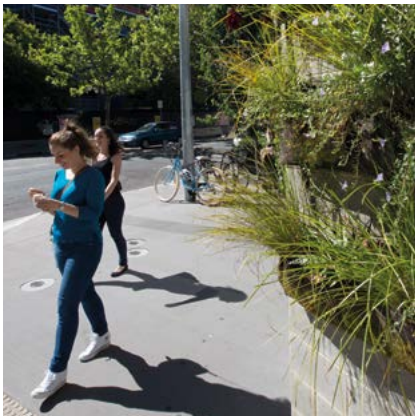
Living infrastructure is an essential component of our city. It occurs on and applies to:

- **PUBLIC LAND:** parks, open spaces and reserves, waterways and wetlands, streets and transport corridors, squares and plazas, sports and playing fields and
- **PRIVATE LAND:** front gardens and backyards, building roofs and building facades and walls.

There are 12 ways the four basic components can be applied. These are described in the illustration on pages 12–13.

Living infrastructure components perform more than one function, simultaneously providing a range of social, environmental and economic benefits. For example a large shady street tree provides:

- clean air with oxygen for us to breathe by filtering out pollution
- cooling in summer through evapo-transpiration, humidifying and shading surfaces below it
- rainfall detention in a storm, slowing the flow into the stormwater system and allowing gradual ground water recharge
- amenity for people and an increase in property values
- habitat for wildlife.



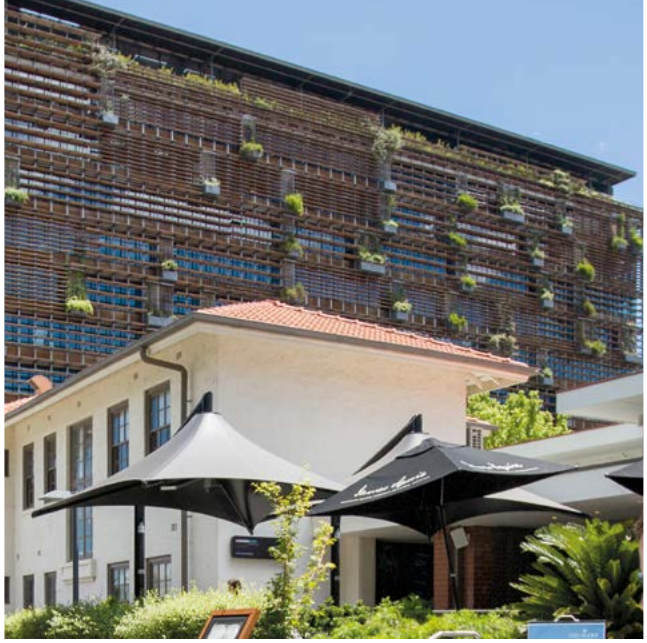


Table 1: Comparative analysis of benefits and contributing components

	BENEFITS \ COMPONENTS	Plants on buildings	Large trees	Shrubs	Parks/green space	Community garden	Waterways in open space	Watered grass	Stormwater reuse	Rain gardens	Ponds & wetlands	Porous pavements	Soils	Most benefits
SOCIAL	Improves mental wellbeing	2	2	2	2	2	2	2	1		2			17
	Improves amenity and aesthetics	2	2	2	2	2	2	2	1	2	2	1	1	19
	Improves community cohesion		1		2	1	1	1	2		1			10
	Improves community education	1	1	1	1	1	1			1	1		1	10
	Increases recreation opportunity	1	2		2	2	2	2	2		2		1	16
	Increases physical activity oppportunity		2		2	2	2	2	2		2		1	15
	Increases food production	1	1	1	1				1				1	8
ENVIRONMENTAL	Improves air quality	2	2	2	2	2	2	2		1	2			15
	Improves water quality	1	2	1	2	2	2	2		2	2	2	1	17
	Increases groundwater recharge		2	2	2	2	2	2	2	2	2	2	2	22
	Increases urban biodiversity	2	2	2	1	2	2	1	2	1	2		2	19
	Increases habitat connectivity	2	2	2	2	2	2			1	2			11
	Reduces noise pollution	2	2	2	2	2	2	2		1		1		14
	Reduces urban heat	2	2	2	2	2	2	2		2	2	1		17
	Reduces drought impacts	1	2	1	2	2	2	2	1	2	2	1	2	19
	Reduces flooding impacts	2	2	1	2	2	2	2		2	2	2	2	19
	Reduces bushfire risk	1	1	1	1	1	1	1			2			9
ECONOMICS	Increases property values	2	2	2	2	2	2	2			2			14
	Increases carbon storage	1	2	2	2	2	2			1	1		2	13
	Increases city desirability	2	2	1	2	2	2	2	1	1	2			16
	Reduces potable water use		1						2	1		2	2	8
	Reduces energy use	1	1					1						3
	Reduces public health costs	1	1	1	2	1	1	1			1			9
	Reduces engineered utilities				1					2	1	2		6
	Most beneficial components	27	39	28	38	18	36	32	18	22	35	14	18	

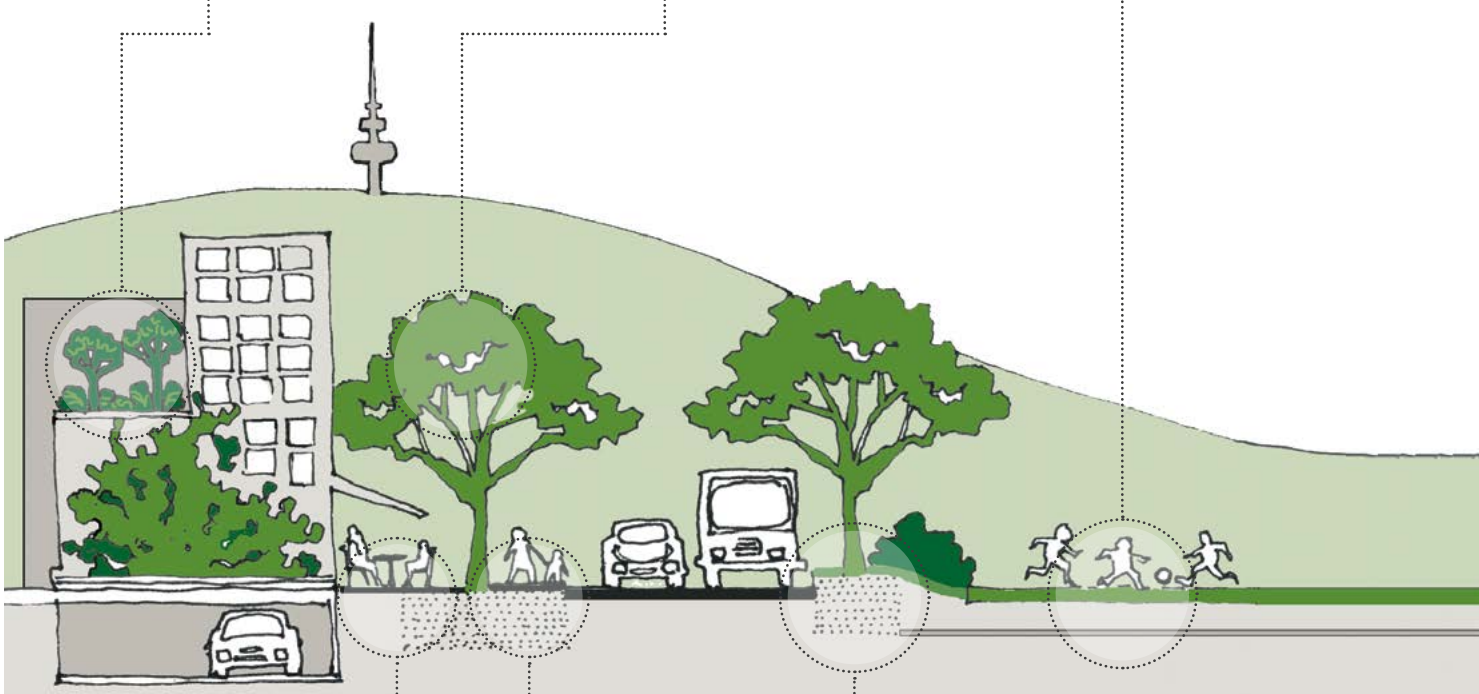
2 points 1 point

COMPONENTS OF LIVING INFRASTRUCTURE AND THEIR APPLICATION ACROSS THE URBAN LANDSCAPE (REFER TABLE 1)

PLANTS ON BUILDINGS
PROVIDE INSULATION

LARGE TREES
PROVIDE SHADE

WATERED GRASS
PROVIDE COOL AREAS AND AMENITY



POROUS PAVEMENTS
ALLOW WATER TO RECHARGE

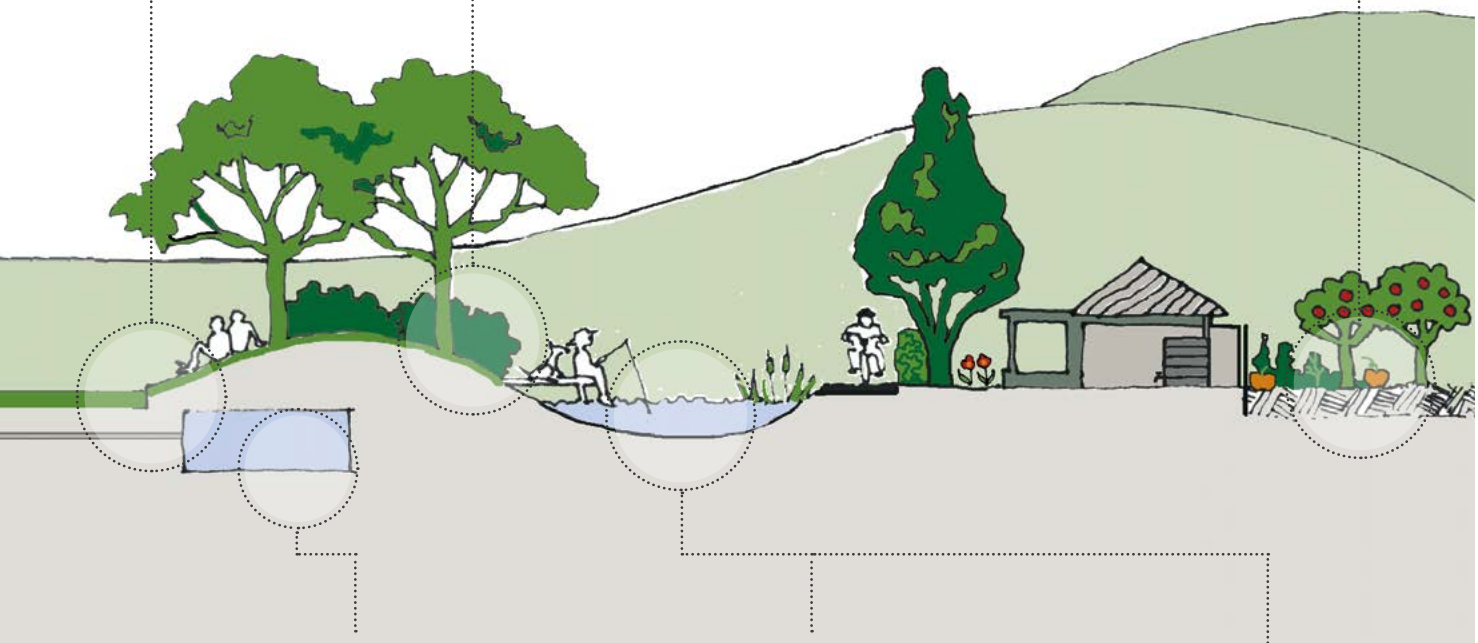
SOILS
HIGH QUALITY NEEDED TO SUPPORT VEGETATION

RAIN GARDENS
CAPTURES AND FILTERS STORMWATER

PARKS & OPEN SPACES
PROVIDE COOL AREAS

SHRUBS
PROVIDE AMENITY AND AESTHETICS

COMMUNITY GARDENS
PROVIDE AMENITY AND SOCIAL COHESION



STORMWATER RE-USE
NECESSARY TO SUPPORT VEGETATION

PONDS & WETLANDS
PROVIDE AMENITY AND GROUND WATER RECHARGE

WATERWAYS
RETAIN AND FILTER STORMWATER

NEXT STEPS

THERE IS A NEED FOR A STRATEGIC POLICY FRAMEWORK TO PROVIDE DIRECTION IN THE ADOPTION OF LIVING INFRASTRUCTURE BY GOVERNMENT AGENCIES.

Both Sydney and Melbourne have recognised the need to maintain and expand their living assets with large-scale initiatives to introduce more street trees watered using stormwater, and incentivise private development of green roofs and walls. Both city councils see the importance of living infrastructure and its multiple benefits.

The ACT can draw on those examples and establish a comprehensive and strategic approach that will ensure we retain Canberra's place as one of the world's most liveable cities.

INVESTIGATION

To determine the living infrastructure components most suitable to Canberra under a warming climate scenario, EPSDD will investigate:

- treatments to develop healthy soils
- approaches to equitable distribution, across the city, of quality green spaces
- approaches to equitable distribution and sufficient quantity of shade trees
- plant species that are suitable in a changing climate
- opportunities to enhance urban biodiversity values
- design and materials to optimise infiltration of rainfall to replenish ground water
- cost-effective ways to improve water quality in urban catchments and
- design and engineering required to capture and re-use stormwater.

A key component in developing actions under a Strategy is the need to further quantify their benefits and costs. A study is needed to calculate the monetary value of the triple bottom line benefits that can inform the 'case for change' from today's business-as-usual approach. This work would include whole of life value of benefits, the costs of action and the cost of inaction for living infrastructure components.

INTEGRATION

Living infrastructure can only deliver its range of benefits if its components are fully integrated. Longer term planning for assets needs to include how they are designed, built and then managed through their lifecycle. Consequently the development of a Plan necessarily requires close collaboration between key agencies to deliver the on-ground results.

A Plan would be part of the suite of policy and action plans that guide the incorporation of living infrastructure as the city is designed, built, maintained and operated.

Canberra's infrastructure management and asset plans need to build in whole-of-lifecycle costing so maintenance regimes and ongoing operational activities are both sufficiently funded and resourced to ensure desired outcomes.

IMPLEMENTATION

Achieving effective, functioning living infrastructure needs change in the design, construction and operation and maintenance of urban areas, particularly in soil and stormwater.

The barriers and solutions to delivery of living infrastructure need to be identified. As part of this, small scale research/demonstration projects could be undertaken in partnership with research and academic institutions connecting with the existing research underway through the National Environmental Science Programme's Clean Air and Urban Landscapes (CAUL) Hub.

Based on desktop research and information stemming from local demonstration projects the Plan would include targets, actions, and a monitoring, evaluation and reporting framework tailored to the local environment.

APPENDIX 1
SNAPSHOTS

ENVIRONMENTAL SERVICES

FRESH AIR

All plants produce the oxygen we breathe and improve the air quality by reducing pollution in urban areas.

Large deciduous shade trees reduce the need for energy to cool and heat our buildings. Parks with watered grass, trees and shrubs make cities more aesthetically pleasant and 'liveable'.

The benefits of plants are both qualitative and quantitative.

Plants grow using sunlight (energy), carbon dioxide (CO_2), and water with nutrients (from the soil). They transpire (breathe out) oxygen and water vapour.

CLEAN WATER

Canberra's lakes and ponds rely on water sensitive urban design (WSUD) to remove pollutants and keep them usable.

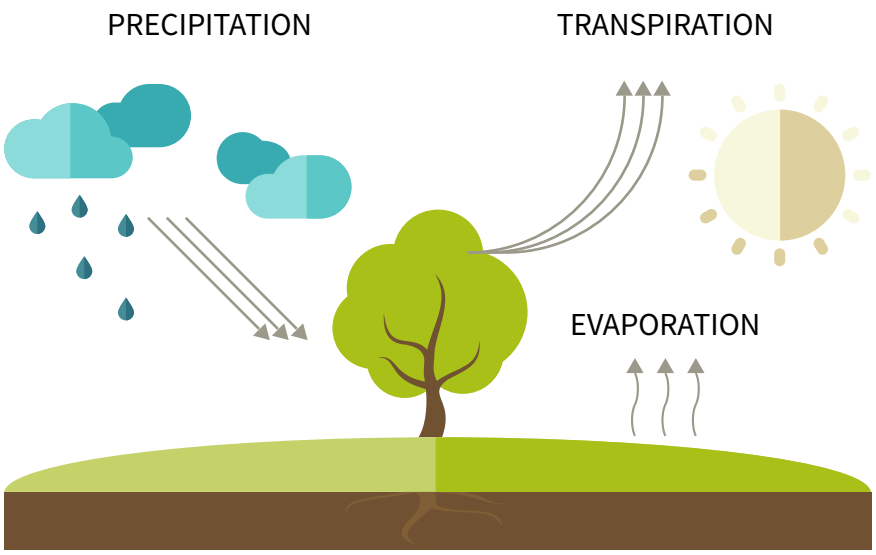
Taking a living infrastructure approach means copying natural systems to improve quality in water bodies. This means providing opportunities for stormwater runoff to undergo a series of steps through various media (physical and biological) as is found in wetlands. This method of cleaning of sediment and pollutants from stormwater avoids the cost of water treatment, ensures a better environment for wildlife and provides recreational space for residents.

HEALTHY SOILS

The ACT has a range of soils with varying fertility and capacity to sustain vegetation growth and production, hold water, withstand erosion and store carbon.

Urban development damages and depletes the soils' ability to provide these functions. Therefore positive action is required to improve soil health.

The former Governor General, Major General the Honourable Michael Jeffery, as Australia's National Advocate for Soil Health, has stated the importance of restoring and maintaining a'landscape fit for purpose' and that 'soil underpins all life'.



BIODIVERSITY

Canberra's nature reserves and bushland is a significant lifestyle and tourist attraction. Maintaining biodiversity in the city means increasing connectivity of habitat throughout. This is achieved by prioritising living infrastructure as part of urban planning and estate development, as well as contribution by individuals through stewardship of nature strips and maintaining plant rich gardens.

CARBON SEQUESTRATION

Plants remove the carbon from the atmosphere (as carbon dioxide) and store it (biological sequestration) in their structure (wood). Having more woody plants helps reduces greenhouse gas emissions and thereby helps climate change.

CLIMATE CHANGE ADAPTATION

Canberra is already experiencing climate warming and this trend is projected to continue to increase, along with greater frequency and severity of extreme weather events such as heatwaves. Living infrastructure can be a powerful tool to ameliorate the impacts of climate change and retain amenity so that our city stays one of the most liveable in the world.

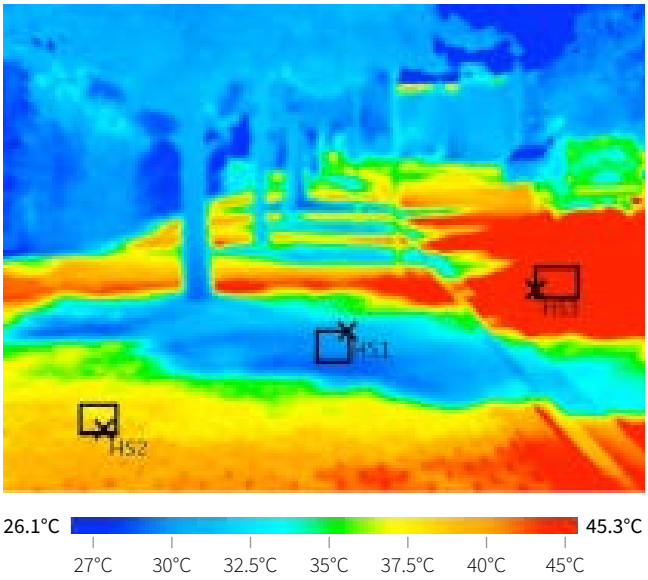
The *ACT Climate Change Adaptation Plan (2015)* proposes enhancing the use of living infrastructure as one of the key ways to strengthen Canberra's resilience to the projected climate impacts of heat, drought, more variable rainfall, storms, flash flooding and bushfires.

Heat is the 'silent killer' and in Australia it is estimated that more people die. The public health implication is that reducing urban heat requires careful planning and investment. Continuing business-as-usual in land development, urban renewal and city maintenance will not increase resilience to the increasingly severe impacts of climate change.

Cooling the city will increase Canberra's resilience to climate change by reducing urban heat and therefore improving human health, particularly for more vulnerable people. The findings from research by the Cooperative Research Centre for Low Carbon Living show that in our climate, urban cooling is most effectively done with canopy shade trees, water in the landscape and heat reflective (albedo) surfaces (roofs and pavements).

The ACT Government engaged the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to undertake a heat mapping study of Canberra and identify areas where high land surface temperatures coincide with areas where vulnerable populations live.

Thermal image and ordinary photo of Soward Way in Tuggeranong town centre on a 35°C day in February 2015.



ECONOMIC PROSPERITY

There are many economic benefits from living infrastructure, however they are not consistently quantified or assigned a monetary value. In recent times the whole-of-life benefits of living infrastructure have not been factored in to cost benefit analyses, with the benefits being overshadowed by perceptions of lower land yield and higher maintenance costs. Jurisdictions and cities around Australia are now addressing this topic, particularly the City of Melbourne.

Some economic benefits are easily understood by business and households. For example, streets with attractive large canopy trees have increased property value and business patronage. (This value uplift is used in the calculation of the value of trees in construction project contracts to nominate the penalties for damage or loss and replacement.)

Canberra's living infrastructure makes the city attractive as a place to live and as a tourist destination. Some of Canberra's major tourist attractions, Parliament House, Floriade and the Arboretum showcase living infrastructure. The economic benefits of these attractions are routinely quantified as dollar value to the city's economy.

Living infrastructure benefits are also derived from cost savings over the asset lifetime, as well as future costs that are avoided. Some examples include:

- saving water supply (utility) costs by decreasing potable water use through utilising stormwater
- saving health system costs by improved health and wellbeing from reduction of heat and air pollution
- saving costs on replacement of existing stormwater infrastructure by protection and or extension of useful life through runoff reduction
- reducing use of energy for heating and cooling in buildings by using plants on roofs and walls
- reducing greenhouse gas emissions by increasing carbon sequestration in vegetation and soils
- reduced engineered infrastructure costs by utilising ecosystem services such as surface waterways
- reduced insurance losses on life and property
- reduced public health costs with sports and active lifestyles encouraged.

HEALTH AND WELLBEING

The health benefits of 'fresh air and exercise' have been known for centuries and the ACT Government's Healthy Weight Action Plan promotes physical activity outdoors.

Having sufficient, well placed and accessible open spaces that are of suitable quality to meet community needs for recreation and leisure activities ensures a healthier and happier community.

In highly urbanised environments, having sufficient open space with vegetation is important for both mental and physical health and wellbeing. Investment in quality open spaces contributes to minimising health system costs now and in future.

Community gardens across Canberra allow people of all ages to socialise, get exercise, enjoy nature and produce healthy fresh food for their families.

Plants provide more than shade and shelter. The seasonal changes bring beauty and the enjoyment of nature as well. The desire to be in contact with nature, is 'hard wired' into humans (called biophilia).

Reducing heat and solar radiation and the extremes of weather, cooler in heat waves and more sheltered in wild storms, makes being outside more safe and encourages active living.

Parks (urban open space) beside lakes are heavily used for sport and recreation and are an important part of making a city more liveable and a desirable place to be.

Several studies have shown that exposure to green spaces can be psychologically and physiologically restorative by promoting mental health, reducing non-accidental mortality, reducing physician-assessed morbidity, reducing income-related health inequality's effect on morbidity, reducing blood pressure and stress levels, reducing sedentary leisure time, as well as promoting physical activity. In addition, green space may enhance psychological and cardiovascular benefits of physical activity, as compared with other settings. Moreover, experimental research has demonstrated that interacting with natural environments can have beneficial effects – after brief exposures – on memory and attention for healthy individuals and for patient populations. In addition, having access to views of natural settings has been found to reduce crime and aggression and improve recovery from surgery.

RESEARCH BY KARDAN, O. ET AL. NEIGHBORHOOD GREENSPACE AND HEALTH IN A LARGE URBAN CENTER TORONTO, CANADA, 2015

CANBERRA'S URBAN FOREST

In 2017, Canberra's urban forest had over 800,000 trees, about twice our human population. The urban forest is both expanding as the city grows and as the replacement program addresses ageing trees.

The study *Where are all the Trees* by the Institute for Sustainable Futures (ISF) in 2014 for the 202020 Vision program, identified that Canberra has uneven distribution of trees in its different districts. Some places have fewer canopy trees. Localities without trees are not equally able to ameliorate climate impacts such as heat and intense storms. This disparity is in part due to age, as the trees have not yet grown, but when Gungahlin is as old as North Canberra, there will still not be the same canopy of trees because the underlying design and investment in living infrastructure is quite different. The images on the left, taken in 2017, show differences in North Canberra (top left) developed in the 1960s, and Gungahlin (bottom left), built in the 1990s.

Key differences affecting living infrastructure are:

- the quantity of large street trees (public land) due in part to verge size and surface treatments
- relative proportion of open space across the neighbourhood to grow plants
- the quantity of impermeable surfaces (roofs and pavements) to allow water to infiltrate the soil.

MELBOURNE'S URBAN FOREST

Melbourne City Council developed their Urban Forest Strategy: Making A Great City Greener 2012-2032, with the vision that clearly drew the links between the health and wellbeing of the community, a resilient landscape and economic prosperity from a liveable and sustainable city.

The key challenges for Melbourne city are population growth and increasing urbanisation; age and health of the urban forest today and climate change impacts of increasing heat, drought and water availability.

To drive change the strategy has a suite of desired outcomes with strategies and priority actions to meet specific targets. The targets include a canopy cover of 40% by 2040.

The City of Melbourne has prepared a scientifically-based formula for calculating the amenity value of its trees. The formula is based on factors including tree condition, species type and growth rate, aesthetics value and locality values. A rough estimate of the City of Melbourne's urban forest amenity value is around $700 million. We can also calculate the value of environmental benefits of trees through a tool called i-Tree Eco. Air pollution amelioration, carbon storage and sequestration, energy savings benefits of trees and structural values of the urban forest can be calculate using i-Tree.

Initial results using i-Tree to assess trees in Royal Parade, Collins Street, Swanston Street Lonsdale Street and Victoria Parade show that the 982 trees measured:

- remove 0.5 metric tonnes of air pollution per year at a dollar benefit of $3,820
- store 838 metric tonnes of carbon at a dollar value of $19,100
- sequester additional 24 metric tonnes of carbon each year at a dollar value of $548 per year
- save $6,370 in energy costs each year through shading buildings in summer and providing solar access in winter
- have a structural value (replacement cost) of approximately $10.4 million.

Extrapolation of these figures across the entire population of 70,000 trees provides a clear indication that the urban forest is a very valuable environmental asset.

APPENDIX 2
KEY REFERENCES

CLIMATE AND ADAPTATION ISSUES

- Mapping surface urban heat in Canberra, CSIRO, December 2017
- Risks to Australia's Urban Forest, Clean Air and Landscapes (CAUL) Hub, November 2017
- Planning and Implementing Living Infrastructure in the ACT, CURF, May 2017
- Australian Capital Territory climate change snapshot, NSW Government, November 2014
- A carbon sequestration audit of vegetation biomass in the ACT, ANU Fenner School 2008 Microclimate modelling for urban heat island mitigation, Matthias Irger, 2016
- Living Cities Workshop report, Australian Institute of Landscape Architects, 2016
- Green Infrastructure, adapting to climate change, Australian Institute of Landscape Architects, 2016

LIVING INFRASTRUCTURE IN THE ACT

- Cost benefit analysis and future growth and lifecycle cost modelling for Canberra's public urban tree assets, ANU Fenner School, 2016
- Benchmarking Australia's Tree Canopy, Institute for Sustainable Futures, UTS, 2014
- ACT Urban Forest Audit, Tree Logic, 2012

LIVING INFRASTRUCTURE IN OTHER CITIES

- Greener Places, NSW Government, November 2017
- NSW Urban Tree Cover Technical Guidelines, NSW Government, 2015
- Adelaide Design Manual, Green Infrastructure Guidelines, Adelaide City Council, 2014
- Melbourne Forest Strategy 2012-32, City of Melbourne, 2012
- Green Infrastructure Economic Framework, Victoria University, 2015

URBAN PLANNING ISSUES

- Toward improved public health outcomes from urban nature, American Journal of Public Health, March 2015
- Creating Liveable Cities in Australia, RMIT, October 2017
- A report card on liveability in our cities, RMIT, October 2017
- Urban green space interventional and health, World Health Organisation, 2016

Telephone: 02 6207 1923
Website: www.environment.act.gov.au