Strataflow™

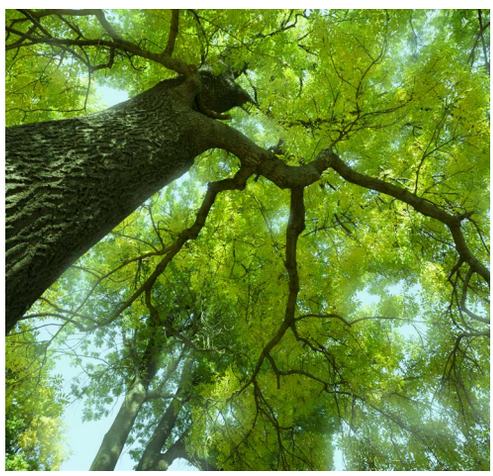
DELIVERING HEALTHY TREES AND CLEANER STORMWATER IN URBAN ENVIRONMENTS

citygreen™
URBAN LANDSCAPE SOLUTIONS

transforming grey spaces into green

Why do we need to change our approach to green and blue?

Green Infrastructure



The presence of healthy green infrastructure (trees, plants, grasses, creepers) in our cities is important for cooling microclimates, cleaning the air we breathe, shading hard-surfaces, and filtering water around them.

Quality Soil Volume – There is a direct correlation between a tree's canopy size, and its root mass. Trees thrive when they are provided with enough soil volume, and nutrients. Trees planted in conventional small holes in urban environments often fail to mature to their full potential, don't survive at all, or actively seek out nearby spaces beneath pavement and in service trenches.

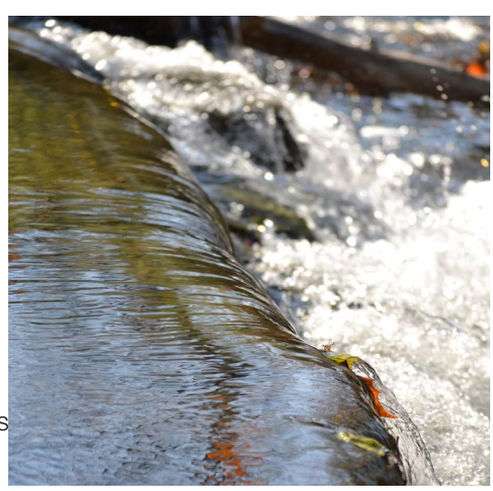
Access to Water – Trees need sufficient water to grow. The common issue urban trees face is the soil is not regularly replenished by rainwater as the tree pit is containerised, sealed over by impermeable pavements, making limited potential for rainwater from the surface to infiltrate into the soil layer.

Constrained urban trees in these poor conditions will be forced to seek out space and moisture to survive, and can cause damage to surrounding pavements and utilities through uplift and root intrusion.

For us to increase the canopy size and health of our trees, we need to address it from the roots up.

Blue Infrastructure

Well managed waterways, the blue infrastructure, is crucial for healthy communities and ecosystems. Everything living needs water.



Traditional stormwater systems were designed to take rainwater from our streets and roofs, and 'pit-and-piped' into the closest waterway. Unlike sewage, stormwater is not treated before it enters our waterways. In most cases it flows directly from our streets and gutters into our creeks, rivers, bays and the ocean.

Water Quantity - In urban areas, the increase in the number and size of impervious areas has reduced the amount of rain that infiltrates the ground or is retained by green infrastructure. Consequently, more stormwater run-off enters the drains system and nearby waterways, at a higher, causing scouring (in-stream erosion).

Water Quality - When stormwater run-off flows over hard surfaces like roads, carparks, driveways, roofs, it accumulates pollutants such as fuel and oil, excess fertilisers and soaps, litter, and sediment.

Maintaining our water quality is a challenge we all play a role in. As our population grows and urban development continues, we must be aware of the direct link between how we capture and control stormwater and the health of our environment we live in - our rivers, creeks and bays.

Improving stormwater quality in our cities requires effective capture of these pollutants, as well as treatment and reuse of stormwater at the source.

" A major cause of dead and stunted trees is lack of access to adequate space and water. A major cause of polluted and flooding waterways is lack of treatment at the source. Why can't they help each other? "

Strataflow – one smart solution, solving two big issues.

Strataflow addresses both the needs of large healthy trees, and the needs of proper stormwater treatment.

How Strataflow can provide a better solution

Advanced structural treepits, such as those which can be created using the Stratavault system, are used to support tree health. By using a structural treepit, the soil area available to a tree can be expanded underground, while still supporting other uses on the surface such as car parking, roadways and pedestrian pavements.

Strataflow is a design modification which allows stormwater from surrounding paved surfaces to flow into the structural soil cells. The provision of water further enhances tree health, while also delivering a number of stormwater management benefits.

Benefits of a dual purpose solution

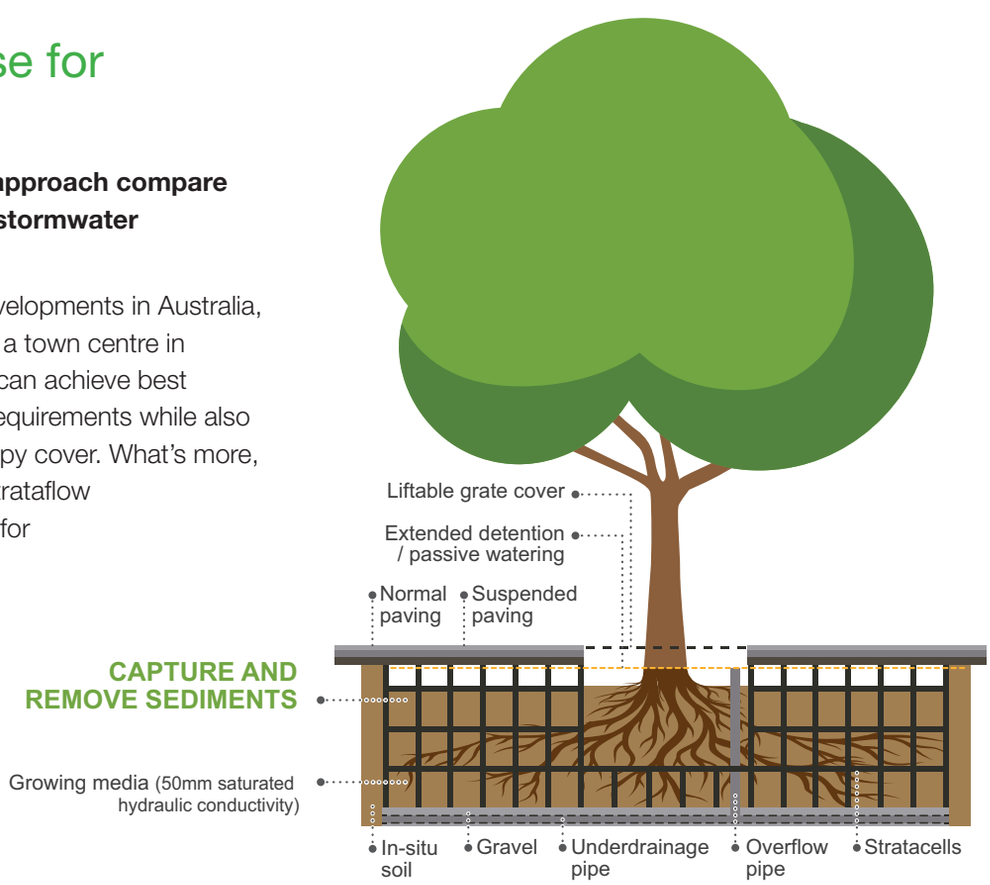
Advanced structural soil cells can be used to create an expanded soil area and receive stormwater runoff from surrounding surfaces, simultaneously supporting tree health and providing stormwater management benefits:

Tree health benefits	Stormwater management benefits
✓ Extended tree lifetime	✓ Increased interception of stormwater by canopy and tree pit
✓ Improved canopy cover	✓ Reduction of pollutants entering waterways and bays
✓ Increased shade and cooling	✓ Reduction and slowing of stormwater entering to underground drains to reduce flood risk
✓ Better amenity value	✓ Local use of stormwater as an alternative water source for irrigation
✓ Enhanced biodiversity value	✓ Achieves best practice pollutant reduction targets
✓ Reduced pavement uplift and root intrusion	
✓ Reduced need for irrigation and tree care	

The Business case for using Strataflow

So how does the Strataflow approach compare to traditional street tree and stormwater management approaches?

Analysis of two typical urban developments in Australia, being a carpark in Brisbane and a town centre in Canberra, show that Strataflow can achieve best practice stormwater treatment requirements while also significantly increasing tree canopy cover. What's more, because of their dual function Strataflow provide significant cost-benefits for both the developer and the ongoing asset managers.



Case Study Application:

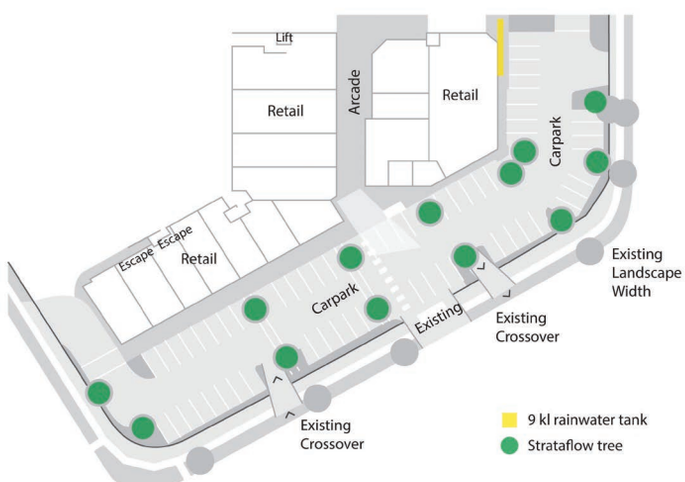
Commercial Carpark in Brisbane, QLD

Case Study Overview:

- The 13 conventional tree pits and a best practice bioretention system in the car park is replaced by 13 Strataflow tree pits to improve tree health while also providing stormwater management for the car park.
- The Strataflow system is used to create a 12m^3 soil volume per tree pit.
- Sandy loam soil with higher water holding capacity then typical bioretention media is used to provide an excellent soil base.
- A tree, with moderate to high water needs and evapotranspiration rate, is planted in each tree pit.
- The Strataflow tree pits are sized to provide a soil volume for healthy root growth (equivalent to canopy area) and to maintain a level of soil moisture needed to support tree health. For this case study the volume of each Strataflow pit is 12m^3 (4m L x 5m W x 0.6m D) most of which is located under suspended pavement, to support a medium sized tree (5m diameter) representing 6.8% of the drained impervious catchment area.

Conventional Method

Strataflow Method



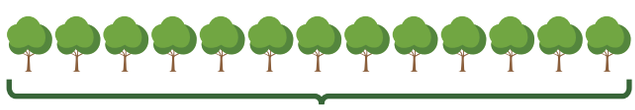
Cost-benefit performance:

Compared with the conventional approach, the use of Strataflow is cost neutral as a capital cost and has an added upfront benefit of additional developable land availability representing $92,000 in value. In comparison to the conventional proposal, Strataflow **decreases** the total 50 year life cycle costs and **increases** the benefit by **$279,000**. This strategy **achieves**, and actually exceeds, best practice stormwater treatment and creates **320m²** of canopy cover[1] (**294m²** more than a conventional response).

In the **Brisbane carpark** case study,

EVERY TREE

planted in Strataflow (sized for both tree health and stormwater management) could:



Provide the same canopy cover as

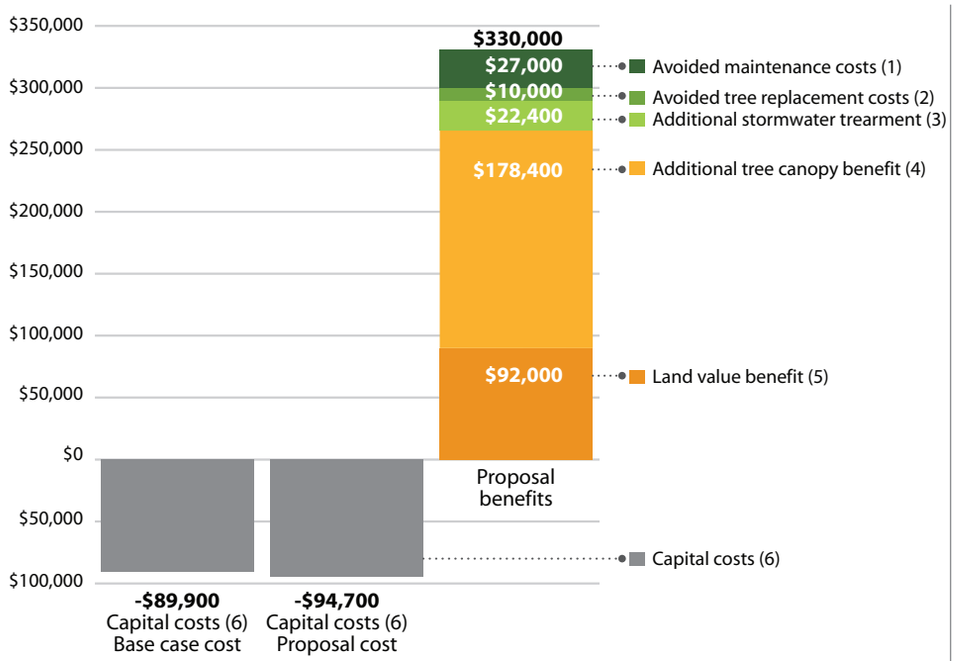
12.3 TREES planted in conventional tree pits

PREVENTS

ongoing costs of pavement uplift and root intrusion

1. Based on Hitchmough, J. 1994 Roof gardens and other landscapes involving finite volumes of artificial soils. Urban Landscape Management. Inkata Press, Sydney.

Comparative cost-benefit of base case and Strataflow proposal - Brisbane Carpark



[1] Melbourne Water- water sensitive urban design life cycle costing data, October 2013. Base case uses on-street raingardens <50m2 and test case uses tree pits pro rata maintenance cost on catchment area ratio

[2] Test case based on replacement of trees every 13 years (typical urban tree lifetime) Skiera, B. and G. Moll. 1992. The Sad State of City Trees. *American Forests,* March/April: 61-64. This assumes a tree provided with adequate soil and water achieves its natural lifetime of 50+ years

[3] Based on cost of additional on-site bioretention area using an average performance rate for nitrogen removal

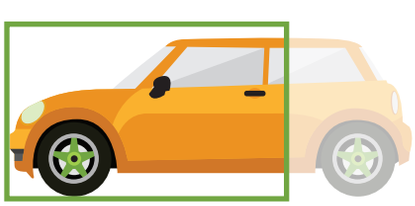
[4] Structural value is the cost of installing equivalent trees in conventional tree pits to provide the same canopy cover. The value reflects the cost of a tree and its installation, not the value of the benefits it provides in terms of amenity, shade and biodiversity – these benefits are likely to outweigh the cost of a tree, but are not monetised here. An estimation of benefits can be conducted using iTree and other tools.

[5] Using average value of vacant land in Brisbane 2015

[6] Base case capital cost includes 13 conventional tree pits and bioretention systems totalling 59m^2. Test case includes 13 Strataflow systems

Stormwater Treatment Performance

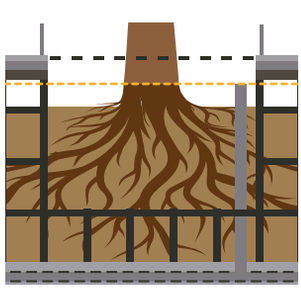
Development Type	Small scale commercial with carpark				
Site Area	0.42 ha	98% Impervious			
Stormwater Treatment Performance	**SEQ Targets**	**Base Case (Bioretention + 9kL rainwater tank)**		**Test Case (Strataflow + 9kL rainwater tank)**	
TSS	80%	83%	867 kg/y	95%	975.4 kg/y
TP	60%	60%	1.2 kg/y	73%	1.4 kg/y
TN	45%	49%	4.6 kg/y	64%	6 kg/y



Give back
0.7 CAR SPACES
equivalent in developable land area

Support trees to live
3X as long

Capture and remove
75KG OF SEDIMENT
from waterways each year (10kg more than best practice requirements)



And provides a cost-benefit advantage of over $200,000

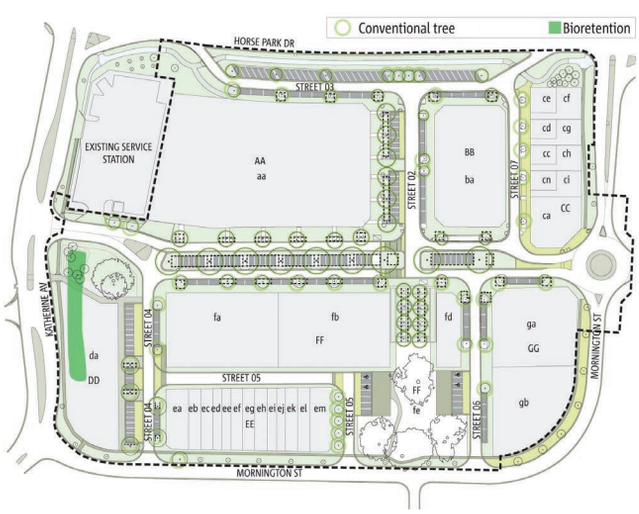
Case Study Application:

Town Centre in Canberra, ACT

Case Study Overview:

- 47 conventional tree pits in the street and a best practice bioretention system within the site is replaced with 47 Strataflow tree pits to improve tree health while also providing stormwater management for the site.
- The Strataflow system is used to create a 12m3 soil volume per tree pit.
- Sandy loam soil with higher water holding capacity then typical bioretention media is used to provide an excellent soil base within the Strataflow system.
- A tree, with moderate to high water needs and evapotranspiration rate, is planted in each tree pit.
- The Strataflow tree pits are sized to provide a soil volume for healthy root growth and to maintain a level of soil moisture needed to support tree health. For this case study the volume of each Strataflow pit is 12m3 (4m L x 5m W x 0.6m D) most of which is located under suspended pavement, to support a medium sized tree (5m diameter) representing 4.2% of the drained impervious area.

Conventional Method



Citygreen Method

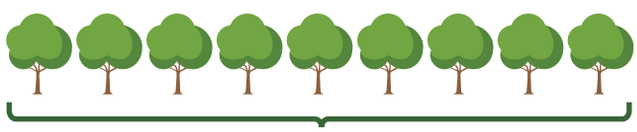
Cost-benefit performance:

Compared with the conventional approach, the use of Strataflow represents an increased upfront investment of less than 1% (factoring in additional developable land value). In comparison to the conventional proposal, the Strataflow system **decreases** the total 50 year life cycle costs and **increases** benefits by **$385,000**. This strategy **actually exceeds**, best practice storm-water treatment and creates **714m²** of canopy cover[1] (**631m²** more than a conventional response).

In the **Canberra** case study,

EVERY TREE

planted in an advanced structural soil cell (sized for both tree health and stormwater management) could:



Provide the same canopy cover as

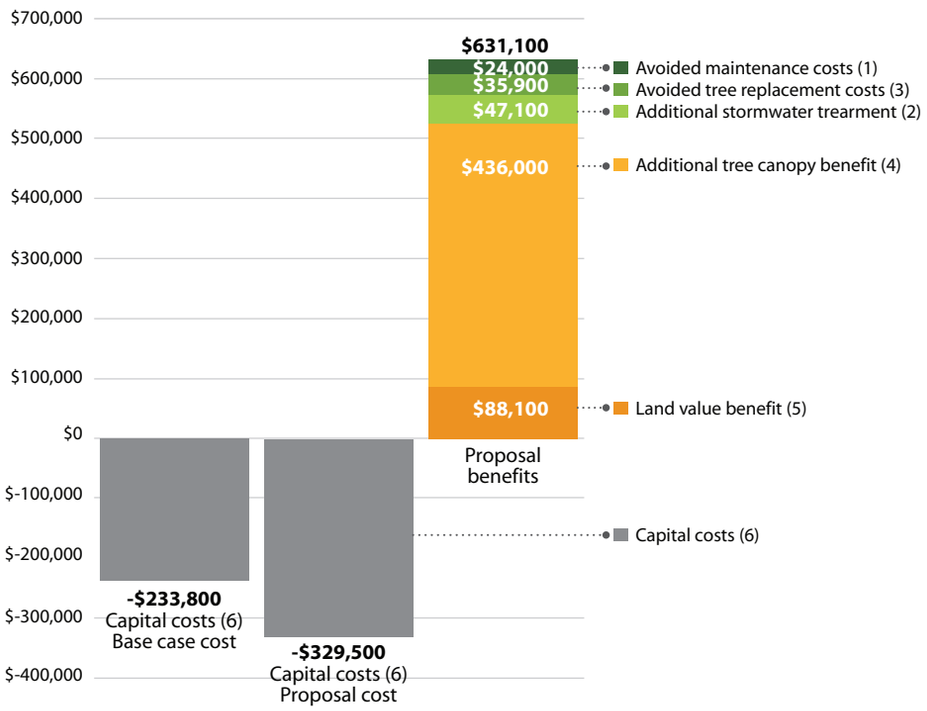
8.6 TREES planted in conventional tree pits

PREVENTS

ongoing costs of pavement uplift and root intrusion

1. Based on Hitchmough, J. 1994 Roof gardens and other landscapes involving finite volumes of artificial soils. Urban Landscape Management. Inkata Press, Sydney.tchmough, J. 1994 Roof gardens and other landscapes involving finite volumes of artificial soils. Urban Landscape Management. Inkata Press, Sydney.

Town Centre - comparative cost-benefit of base case (conventional approach) and Strataflow



[1] Melbourne Water- water sensitive urban design life cycle costing data, October 2013. Base case uses on-street raingardens 50-250m2 and test case uses tree pits pro rata maintenance cost on catchment area ratio

[2] Test case based on replacement of trees every 13 years (typical urban tree lifetime) Skiera, B. and G. Moll. 1992. The Sad State of City Trees. American Forests, March/April: 61-64. This assumes a tree provided with adequate soil and water achieves its natural lifetime of 50+ years

[3] Based on cost of additional on-site bioretention area using an average performance rate for nitrogen removal

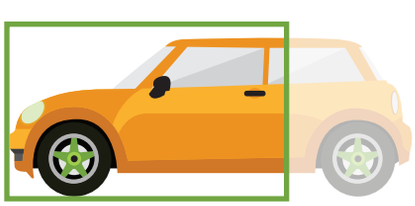
[4] Structural value is the cost of installing equivalent trees in conventional tree pits to provide the same canopy cover. The value reflects the cost of a tree and its installation, not the value of the benefits it provides in terms of amenity, shade and biodiversity – these benefits are likely to outweigh the cost of a tree, but are not monetised here. An estimation of benefits can be conducted using iTree and other tools.

[5] Using average value of vacant land in Canberra 2015

[6] Base case capital cost includes 47 conventional tree pits and bioretention systems totalling 160m2. Test case includes 47 Strataflow systems

Stormwater Treatment Performance

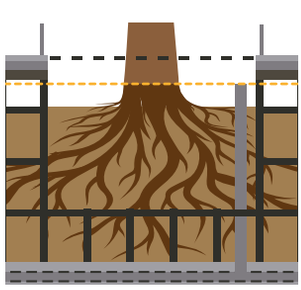
Development Type	Urban Centre		
Site Area	2.25 ha	95% Impervious	
Stormwater Treatment Performance	**ACT Targets**	**Base Case (Bioretention)**	**Test Case (Strataflow)**
TSS	60%	86% 3071 kg/y	96% 3445 kg/y
TP	45%	45% 1.4kg/y	57% 1.8 kg/yr
TN	40%	56% 23.8 kg/y	69% 29.4 kg/y



Give back **3.4m²**
in developable land area

Support trees to live
3X as long

Capture and remove
73KG OF SEDIMENT
from waterways each year (10kg more than best practice requirements)



And the proposal only costs 1% more than a conventional response.

Strataflow design considerations

- **Soil surface area and volume**: The sizing of the soil surface area and volume is crucial to its performance. A larger volume of soil is needed (compared to conventional bioretention designs) to provide adequate soil volume to support a healthy tree. The larger volume enables stormwater to be captured and detained in the tree pit and taken up by the roots.

- **Underdrainage**: Subsurface drainage ensures the tree pit does not become water logged. An overflow pipe set at 50mm above the soil surface avoids the tree pit from over filling.

- **Extended detention depth**: To allow stormwater to pond and gradually infiltrate into the soil, an air gap must be left between the soil surface and the ground surface/suspended pavement. The air gap also enhances oxygen availability for healthy soil-root conditions.

- **Soil media**: The soil media needs to be specially selected to provide the right balance of nutrient content and hydraulic conductivity. This is to ensure there is no leaching of nutrients from the soil and that stormwater discharging from the underdrainage has an appropriate level of treatment. A sandy loam with 50mm saturated hydraulic conductivity provides a good soil base and is more appropriate for healthy tree growth than bioretention filter media (typically loamy sand with 200mm hydraulic conductivity). There should be an even distribution of particle sizes and the organic matter content either <5% or be of low nutrient content. Orthophosphate content of <55 mg/kg.

- **Number and location of tree pits**: To provide effective stormwater management, Strataflow pits should be located where they can receive stormwater from an appropriately sized catchment. It is possible to locate and design Strataflow pits to manage stormwater and achieve, or exceed, best practice stormwater pollutant load objectives required by local regulations (which would otherwise need to be achieved by incorporating additional infrastructure at additional cost). The appropriate ratio of the surface area of the soil cell to the drained impervious catchment area will vary based on location, tree size and required rooting area and soil moisture.

Location	% surface area of soil cell compared to impervious area draining to soil cell[1]
Brisbane	3.8 - 10%
Canberra	2 - 5%

- **Tree species**: A moderate to high water use tree is recommended for Strataflow tree pits that receive stormwater runoff to maximise evapotranspiration.

Strataflow – one smart solution, solving two big issues.

Strataflow addresses both the needs of large healthy trees, and the needs of proper stormwater treatment.

Reference: E2Designlab, 2016. Strataflow Cost-Benefit Analysis. Prepared by E2Designlab for CityGreen.

1. % areas are those recommended from modelling of a tree pit 0.6m deep to both meet best practice stormwater management requirements and to maintain healthy soil moisture levels and soil volumes

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info@citygreen.com
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