

NEW WATER WAYS SPEAKER SERIES
Dep. Of Water; 168 St George's Tce, Perth

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**GREEN INFRASTRUCTURE PLANNING FOR 21ST
CENTURY CITIES**

An introduction

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PRESENTATION OUTLINE

- **Designing for adequate tree canopy coverage**
- **Planning the urban forest – Comprehensive Urban Forest Plans**
- **International comparisons**
- **Tree-based approach to stormwater planning**
- **Soil Volume & Canopy Size**
- **Achieving adequate soil volumes**
- **Some solutions: Structural Cells, Permeable Pavements**

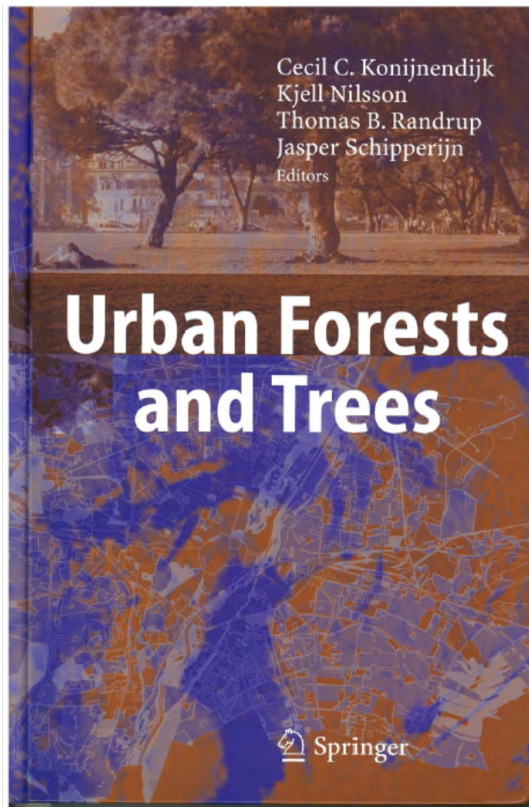
Municipal Arboriculture

Specialized field of arboriculture

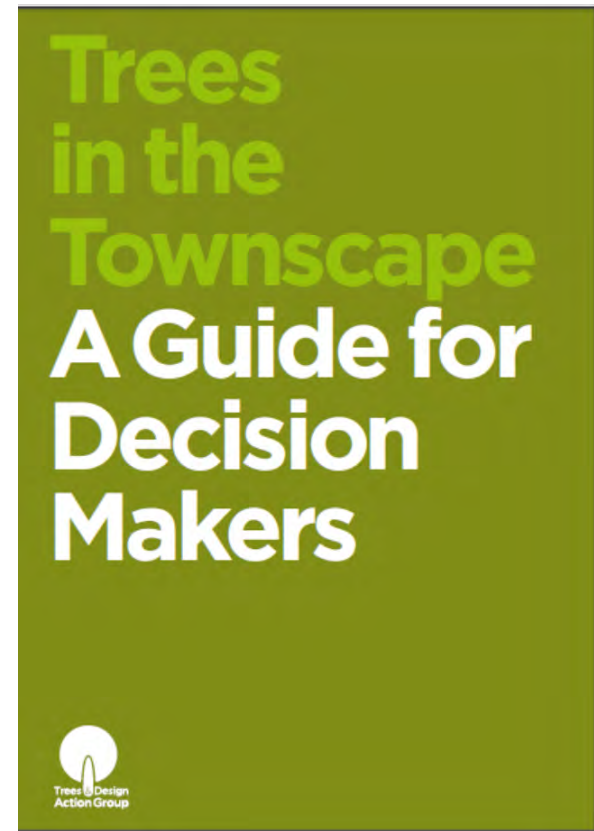
**Science and management of trees in
communities on public land**

Resources & References

**European Reference Book
(DK2005)**

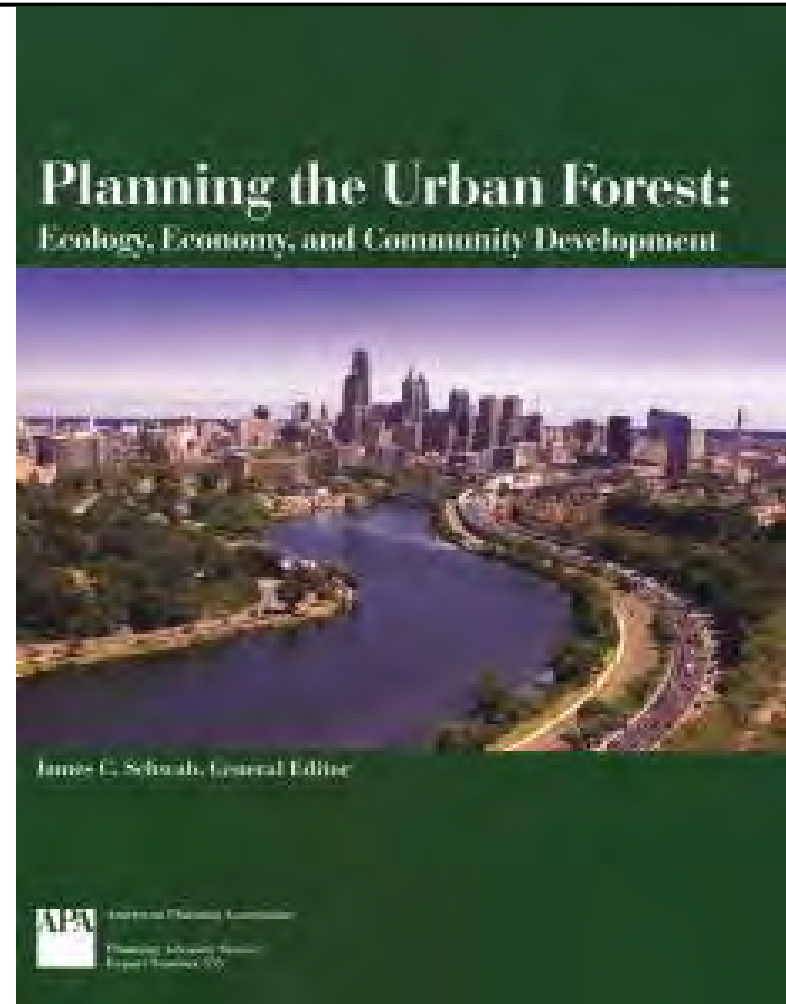
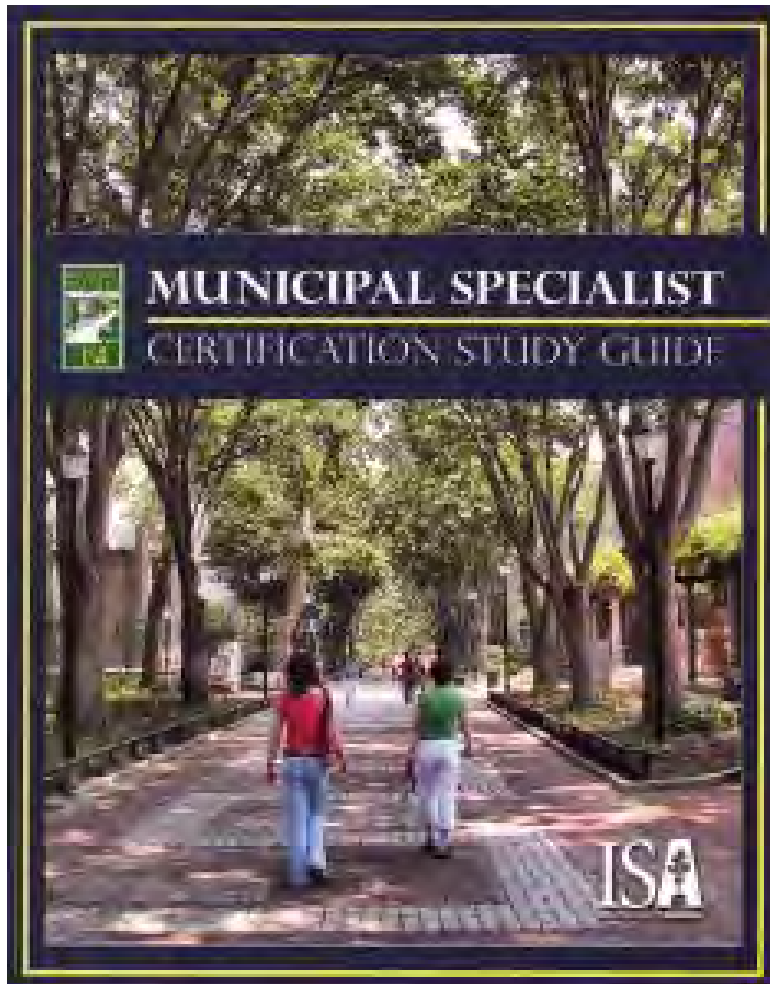


**TDAG: Trees and Design Action
Group (UK2012)**



(1) ISA Municipal Specialist (2) Planning the Urban Forest

(Collaborative: APA, American Forests, USDA Forest Service, ISA)



URBAN DENSIFICATION & GREEN INFRASTRUCTURE DESIGN

- To design inadequately is - in effect – to design for the widespread elimination of canopy
- Cannot be rectified
- Will have to live with it for next 50 – 80 years

Inadequate planning mechanisms



Failure or Consensus?



CITY OF BELMONT – NEW DEVELOPMENT & INFILL CONSENSUS?



WHY PLAN? WHAT IS THE INTENT?

- **SUSTAINABLE URBAN FOREST**
- **How?**
- **Comprehensive Urban Forest Plan**

PLANNING FOR A SUSTAINABLE THE URBAN FOREST

- **SUSTAINABILITY:**
- the maintenance of ecological, social, and economic functions and benefits over time
- Components of the urban forest will change over time (as trees die / replaced) but the function is sustained

Urban Forest: multi-disciplinary domain

- **Political dynamics**
- **Land-use conflicts**
- High density uses – strong dynamics – very challenging
- Bargaining process
- Positive attitudes toward green space vs political power of development interests
- Positive attitudes not manifested in policies
- Green space ‘concepts’ & implementation failures:
Failures are a result of inadequate planning mechanisms

Dilemma

- Very limited potential for implementation of well-planned urban forestry
- Comprehensive urban forest plan shows the way – **but....**
- Each step: overwhelming economic and political forces
- Urban planning is a very weak partner for urban forestry
- **Reality:** urban green is a residual factor
- **Reality:** To implement will be an exhausting fight against interests mostly stronger than urban forestry
- **Reality:** The policy standard chosen determines whether sustainable management will be achieved, or not

DEVELOPING URBAN FOREST PLANS

What are they?

- Urban forest plans are documents that analyze and summarize how a community wants to design and manage its urban forests
- **Forms the basis of policy**
- Is ***the*** most valuable tool and implementation guide for city tree managers

TYPES AND HIERARCHY OF DOCUMENTS

- **Urban Forest Strategy / Master Plan**
- **Urban Forest Management Plan**
- Tree Risk Management Plan
- Work Plans
- Tree Technical Manual.

URBAN FOREST STRATEGY

- Big picture at the urban forest
- Private and public land
- Identifies broad goals for the urban forest program

URBAN FOREST MANAGEMENT PLAN

- Describes how to accomplish the goals defined in the Strategic Plan
- Detailed action plan for each goal
- Well-defined action plan enable staff to gauge success or failure in accomplishing goals

STRATEGY vs. MANAGEMENT PLAN

STRATEGY

- *Guiding document*
- Greater longevity
- Looks 20 years + into the future

MANAGEMENT PLAN

- *Procedural document*
- 5 to 10 years
- Includes a critical review process

What Are Other Cities Doing?

- They **plan** for the Urban Forest – they adopt **Urban Forest Policy**
- Urban forests are managed as a distinct entity
- Focus is not on statutory control of individual trees (e.g. TPO's), but on the trees collectively
- Now starting in Australia

Key Strategies & Policies

- **Cities set and achieve canopy targets**
- **Cities invest in green infrastructure**

- **City of Melbourne:** Current: 22% - Specified **40%** target by 2040
- **Sydney** – Current: 15% - Specified **23%** (2030); **27%** by 2050
- **Vancouver** – Current: 22% - Specified **40%** target
- **Seattle** - Current: 18% - Specified **30%** target
- **Baltimore** – 20% (2007) - Specified **40%** by 2037
- **Phoenix** – Current: 8% - Specified: **25%** by 2030
- **Pittsburgh**– Current: 42% - Specified: **60%** by 2032
- **Las Vegas** – Double to **20%**

Suburban residential: 50%

Urban residential: 25%

Central bus districts: 15%

Overall Average: 40%

URBAN TREE CANOPY TARGETS

- U.S. Conference of Mayors Best Practices
- Survey (2008) of 135 Cities; > 30,000 pop.
- **47% of survey-cities had set Tree Canopy Targets,**
typically 25 – 40% city-wide

DRAFT URBAN FOREST STRATEGY – CITY OF BELMONT

- Principal Objectives
- Excerpt - Table Of Contents

Note: not finalized – ongoing negotiation

5.3 Towards Our Future Forest

- The City's **Urban Forest Strategy** is the comprehensive plan that serves as the blueprint for the long-range planning of the City's urban forest. **The principle objectives of the blueprint are:**
- Trees will form an essential part of all new developments
- There will be no net loss of the city's canopy coverage
- The City will set and achieve canopy targets
- The value of urban trees will be explicitly recognised by local government, neighbourhood communities and individuals

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TREES & STORMWATER

Trees reduce Storm Water Runoff and Erosion

- Roofs, roads and pavements have major effects on urban hydrology.
- Tree canopies intercept rain, the result is a reduction of runoff and soil erosion.
- The scale and intensity of interception is directly related to the amount of canopy cover.

CANOPY SIZE & ANNUAL STORMWATER INTERCEPTION

STEM DBH

- 12cm = 1000 litres
- 40cm = 5,500 litres
- 60cm = 10,000 litres
- Source: US Forest Service

Intercept Rain – Proportionate to Canopy Cover



- Large trees can intercept between 10 to 20mm of rainwater in their canopies alone

Some Cities Are Using a Tree Based Approach To Stormwater Management

- Captures water and eases it down into the root-zone which can hold 10s of 1000s of gallons of water
- Ground under tree acts as a giant sponge
- Absorbs and filters the water before it flows into the aquifer below. Filtration is further increased by root growth and decomposition
- Trees take up trace amounts of harmful chemicals from the soil. Transformed and stored inside tree

CITY OF PHILADELPHIA

- Recognized stormwater as an asset
- Green Stormwater Infrastructure
- PWD's ***Green City, Clean Waters*** Program
- City authorized (June 2011)
Philadelphia Water Dept to spend \$2 billion < 25 years on green infrastructure projects

Municipalities set policies:

- **Minimum Soil Volume Standards**
- **Stormwater credits**
- By means of grants, tax rebates, development incentives, stormwater discounts
- **Shade Ordinances**
- I.e. Permeable Pavements

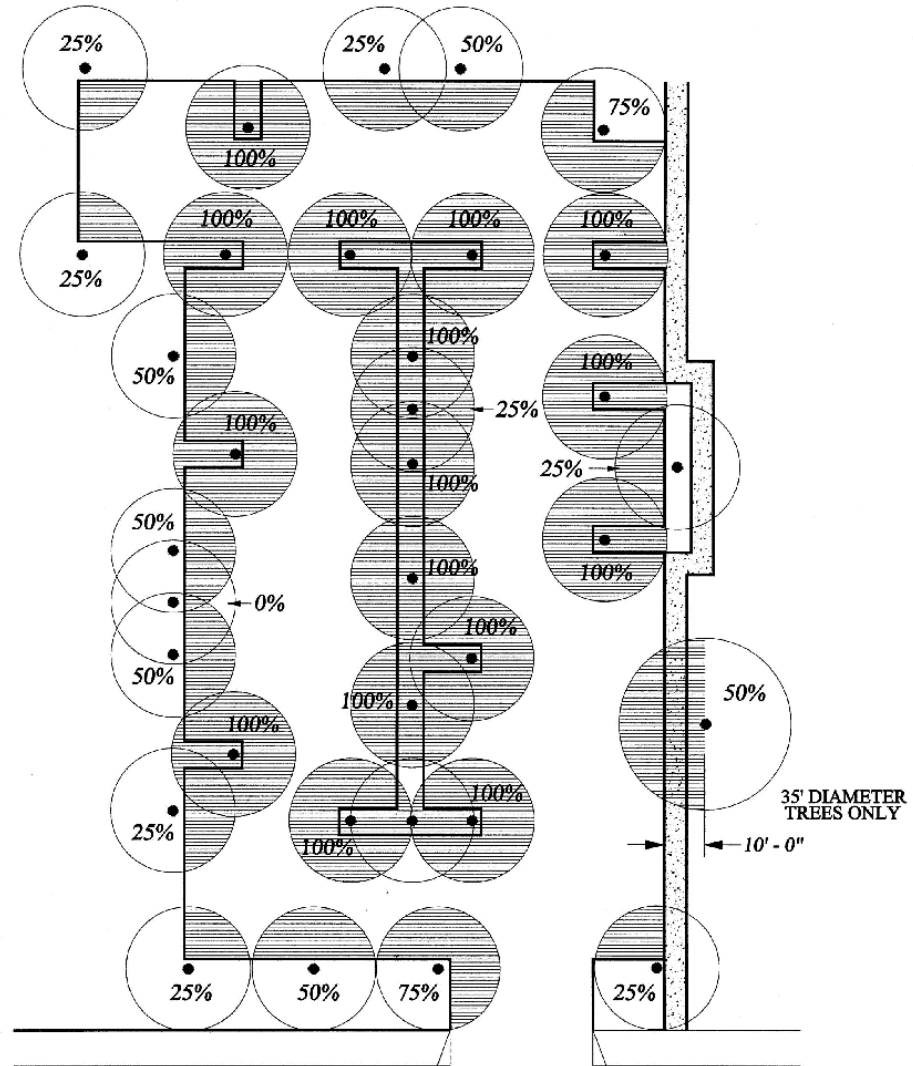
PLANNING FOR CANOPY

Tree Growth is limited by Soil
Volume

City of Sacramento Parking Lot Tree Shading Ordinance:

Planting designed
to result in 50%
shading < 15 years

Applies to: All new
impervious
surfaces on which
a vehicle can drive



PARKING LOT

- NOTES:**
1. This diagram is intended to reflect the manner in which shade is credited under various conditions. It is not necessarily an illustration of 50% coverage.
 2. Trees may receive 25%, 50%, 75% or 100% credit as shown.
 3. Shade overlap is not counted twice.

SPACE FOR ROOTS

- Compaction: normally 95% of peak density
- The (root penetration) cutoff level: 85% or 2.5 MPa
- IF the tree is in limited soil AND the roots are not able to break out of their confinement, then the tree will stay small and suppressed



Near nil growth and shade after more than 10-20 years since establishment

21 years ('91) – Mundaring shopping village



11 years ('01) Belmont operations car park



Asphalt vs. Shared Planter and Pavers

Claret Ash; 21 yrs



London planes; 21 yrs



Grossly inadequate soil volumes = minimal canopy coverage

- Liquidambar

est. 1991





Risely Street, Ardross

Successful?

To break-out is to succeed



SOIL VOLUMES

- How much soil does the tree need?
- A **small**-sized tree – canopy dia. of 4m: **5–15m³**
- A **medium**-sized tree – canopy dia. 8m: **20–40m³**
- A **large** -sized tree – canopy dia. 16m: **50–80m³**

These are minimum requirements.

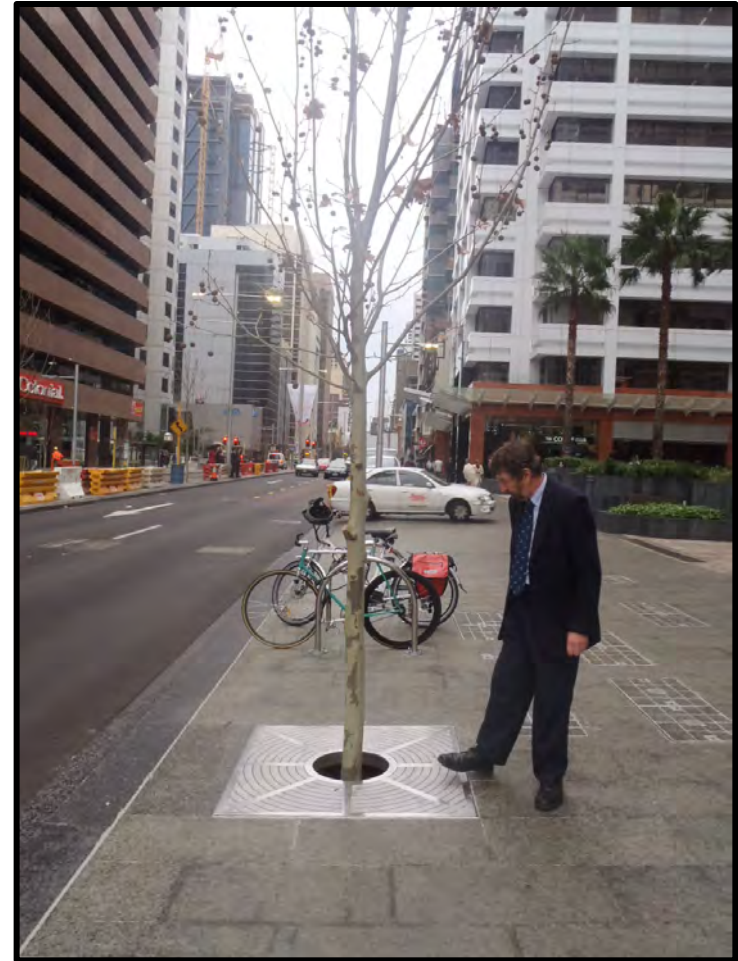
EXAMPLES OF CITIES WITH MINIMUM SOIL VOLUMES FOR TREES

- **NSW – LANDCOM (2008)** 20-40m³ (medium); 50-80m³ (large tree) – Street Tree Design Guideline for New Subdivisions
- **Toronto:** 15m³ shared planter; 30m³ single planter
- **Tigard:** 12m³ - 30m³; **Car Parks:** 30m³
- **Durham:** 10m³, 16 m³, 21m³ (size of spp.)
- **Oakville:** 15m³ shared planter; 30m³ single
- **Aspen:** 8m³, 30m³, 75m³ (subject to size of spp.)
- **Denver:** 25m³; “must use trenches, root paths, break out zones, structural cells, or other uncompacted soil technology”

EXTENDING TREE PITS BELOW PAVEMENT OPTIONS

1. Engineered soil mixes (A'dam Tree Soil)
2. Engineered structural soil mixes (ESM)
3. Geocells
 - **Structural RootCells (Strata & Silva)**
 - Permavoid Sandwich Construction (SC)

Structural cells – Suspended pavements – sustain W80 wheel load



CELLS AT 1.5M EITHER SIDE OF PLANTER



Faulkner Park – Cells at 3m both sides



Air & Water Inlet Pipes



Soil: Standard Landscape Mix — AS 4419 (Supplier: Amazon)



SHADE DESIGN TO MEET SPECIFIC TARGET



2 years after planting



PLANTER OPENING 1.6M WIDE – BUT PLANTER PIT EXTENDS UNDER PAVEMENT



Permeable & porous pavements, or impermeable?

- Trees growing in structural cells need air and water just the same
- Permeable pavements are the best choice
- If not, then: Install aeration & irrigation pipes



PERMEABLE PAVERS ABOVE CELLS (City of Newcastle)

STORMWATER MANAGEMENT

Pavement graded to permeable zone. Run-off then treated of contaminants via bioretention – pollutant filtering – under pavement



- Aggregate layer (roadbase) placed on permeable Geofabric
- Permeable pavement on aggregate (**no sand!**)
- Aggregate provides stormwater storage, additional to trees & soil
- Stormwater storage = c. 40 % of aggregate vol.
- Suitable for heavy traffic loads

Comparison: Forecasted Canopy Projection @ 15 years



Stormwater Management via Structural Root Cells (City of Toronto) — Source: Deeproot, San Francisco - SILVA



**Bioretention swale underneath parking bays & footpath –
Example manages run-off from 50mm/24hr rain event –stormwater
is cleaned, retained and detained by bioretention soil mix - Source:
Deeproot, San Francisco - SILVA**



Silva Cell decks go on



Asphalt covers the parking bay and pavers cover the sidewalk. Two new trees will be planted in the Silva Cell trench in Spring 2009.

STRUCTURAL LOAD CAPACITIES

- **STRATA SERIES 30 = 306 kPa – S 60 = 624 kPa**
- 100% Polypropylene reinforced with fibreglass
- No steel components – corrosion free
- High lateral strength – no risk of side-collapse
- **S30** – with **300mm** cover = **5T** per single axle load
- **S30** - with **450mm** cover = **9T** per single axle load or **15T** per dual axle (W80 AS5100.2)
- **S60** – W 80 wheel load with **300mm** cover

SINGAPORE – Strata Cells under Roadway



Strata Structural Cells under Roadway

SINGAPORE: *“City in a Garden”*



SUMMARY

Essential: **Comprehensive Urban Forest Plan / Strategy**

- **Get trees to the forefront of the planning/visioning process**
- Set city-wide canopy target
- Set minimum soil volumes
- Set minimum shade regulations
- Invest in green infrastructure technologies
- ***Take a 21st century approach to urban trees***

Thank You

