Greening Infrastructure: building a green city

We have defined Green Infrastructure as *Natural and engineered ecological systems which integrate with the built environment to provide the widest possible range of ecological, community and infrastructure services*

Green Infrastructure Research Group

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Challenges for urban infrastructure

Improved understanding of sustainability

Global warming – mitigation and solutions

Increasing age and risk of failure in urban infrastructure

Resource availability - energy, water, construction materials, food

Increasing livability and improving human health

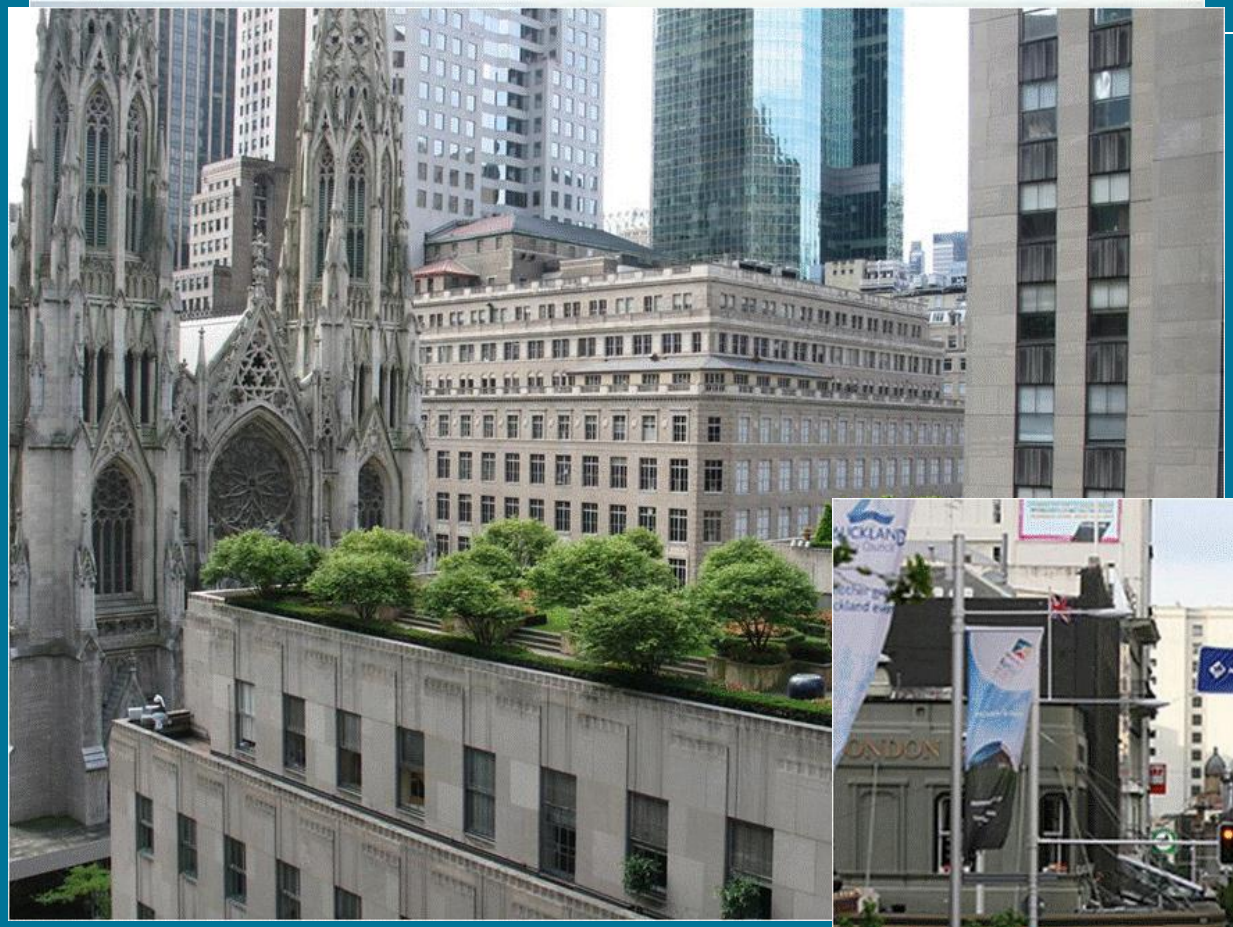
Building and strengthening

communities

Increasing urbanisation

and population

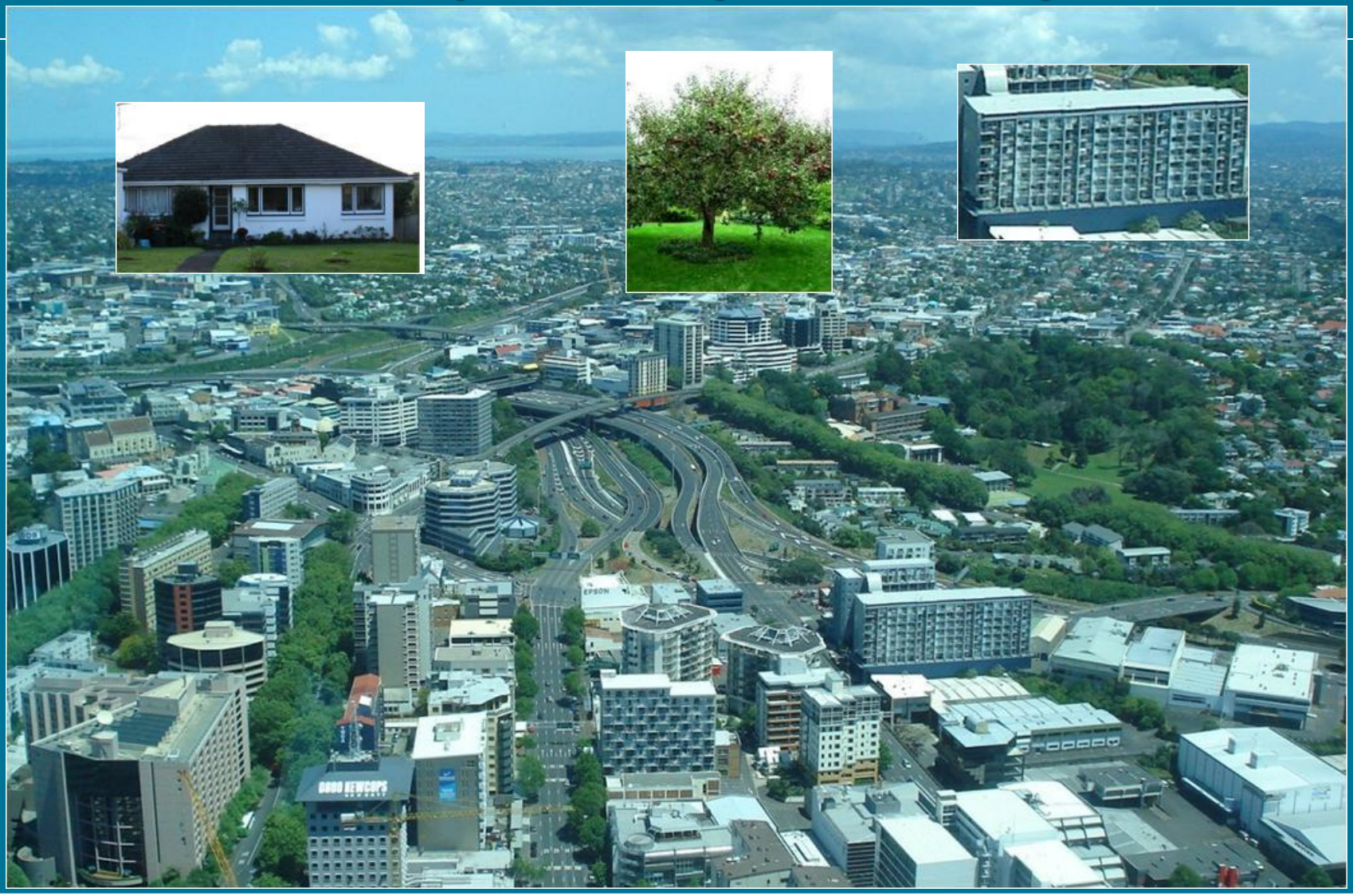
Grey cities, grey infrastructure



New York city – high density

Auckland – low density

Cities as complex, dynamic systems



Role of plants in urban sustainability

Micro level – individual elements - house, building or tree scale

Shading for heat control in summer, wind breaks, rain gardens, storm water management, erosion control

Macro level – multiple, mixed elements - community/urban areas

Influencing water management within urban infrastructures

- storm water, erosion, runoff quality

Influencing energy (heat/cool and light) within urban

- shading pathways, rest areas, relaxation/recreation areas
- wind breaks, reducing urban heat

Improving air quality

- CO_2/O_2, NOx, CO, ozone, SO_2, VOCs, PAHs, particulates

Urban forests and parks

Provide recreational areas – open spaces for group activities, forested areas with walk/running/cycling tracks

Provide biodiversity, flood management, a focus for community activities

Can often include complex ecosystems, with a mixture of plants and animals

Shown to increase physical activity, particularly for nearby neighbourhoods

Can raise issues regarding allergies, pests, invasive species

Green stormwater management

Green roofs, rain gardens, swales, permeable pavement, increased green spaces and corridors, green walls, wet and dry ponds, constructed wetlands

Flood control and mitigation – over 60% of runoff, peak flow reduction over 90%

Sediment control

Removal of pollutants – heavy metals (Zn, Cu), oils/greases, herbicides/pesticides, fertilisers/nutrients, organic waste

Systems must be designed to manage rainfall and drought, temperature fluctuations, pollution flushes, peak flood levels

Built environment energy management

Green roofs, tree planting and landscaping, green walls, green spaces

Park areas can be over 1°C cooler than surrounding non-green areas

Reductions in summer temperatures due to green spaces result in energy, CO_2, human health savings

As extreme temperatures rise due to global warming, green spaces will be essential in providing heat refuges during heat waves

Over the long term, such spaces are less costly to maintain than man-made structures

Climate change mitigation

Green roofs, tree planting and landscaping, green spaces

These reduce the heat absorbed from sunlight and store carbon

As concrete produces significant quantities of CO_2 during manufacture, replacing concrete with vegetation reduces CO2 emissions

While maintenance of vegetation (mowing grass verges etc.) does emit CO_2, over 50 years vegetation produces less CO_2 than concrete

Food production

Green spaces, urban gardens, green roofs, tree planting and landscaping, green walls

Increasing focus on planting fruit bearing trees along verges

Problems with mess, pests and theft

Green roofs

Green roofs are being established across the US and Europe; new buildings in some US cities are required to include green roofs where possible

While many such roofs focus on small, drought resistant plants, others use trees to create roof-top parks and even provide fruit

However, water availability often means that drought resistant plants are necessary

Such roofs not only manage stormwater, they also assist in temperature control

Green roof – Auckland

20 green roofs in Chicago to reduce heat island effect, reduce storm water, reduce energy consumption, recycle water..

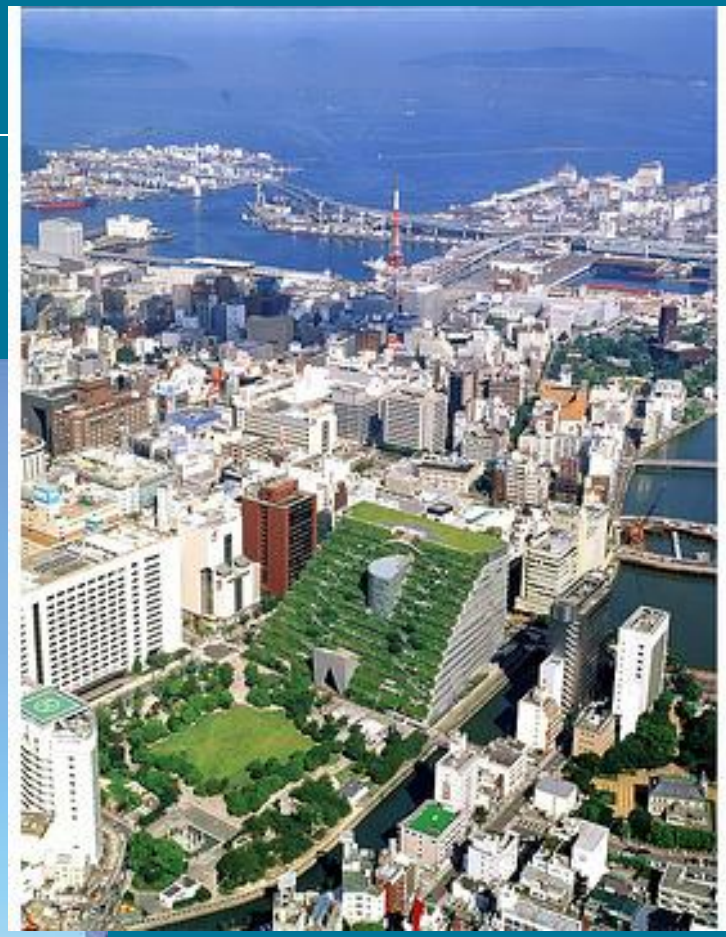
Green walls

Green walls are now being used to manage stormwater and provide design features

Exterior green walls can manage stormwater, improve air quality and assist in temperature control

However, care must be taken in selecting plants and maintaining the system, particularly for water delivery

Green roof/wall



Green walls

Green walls

Swales, rain gardens, wet and dry ponds, permeable pavements etc

Assist in intercepting and soaking rain water to prevent rapid runoff and flooding

Can assist in removing pollutants, trapping sediment, slowing water speed

Constructed wetlands

Can assist with stormwater management, removal of pollution, biodiversity, water and wastewater treatment

Can range in size from small, residential systems treating grey or sewage water to large scale ecosystems treating urban wastewater

Can also be used to remove residual nitrogen/phosphorus from treatment plant effluent

Limitation is the land area required so often used at multiple small scale rather than large scale

Wastewater ecosystems

Will treat wastewater, either grey or sewage

Uses a combination of aquatic systems and wetlands, in some cases both internal and external to the building

Usually effective enough to allow recycling of most water

Design must consider quantities and quality of water and there may be restrictions on what can be put into the system

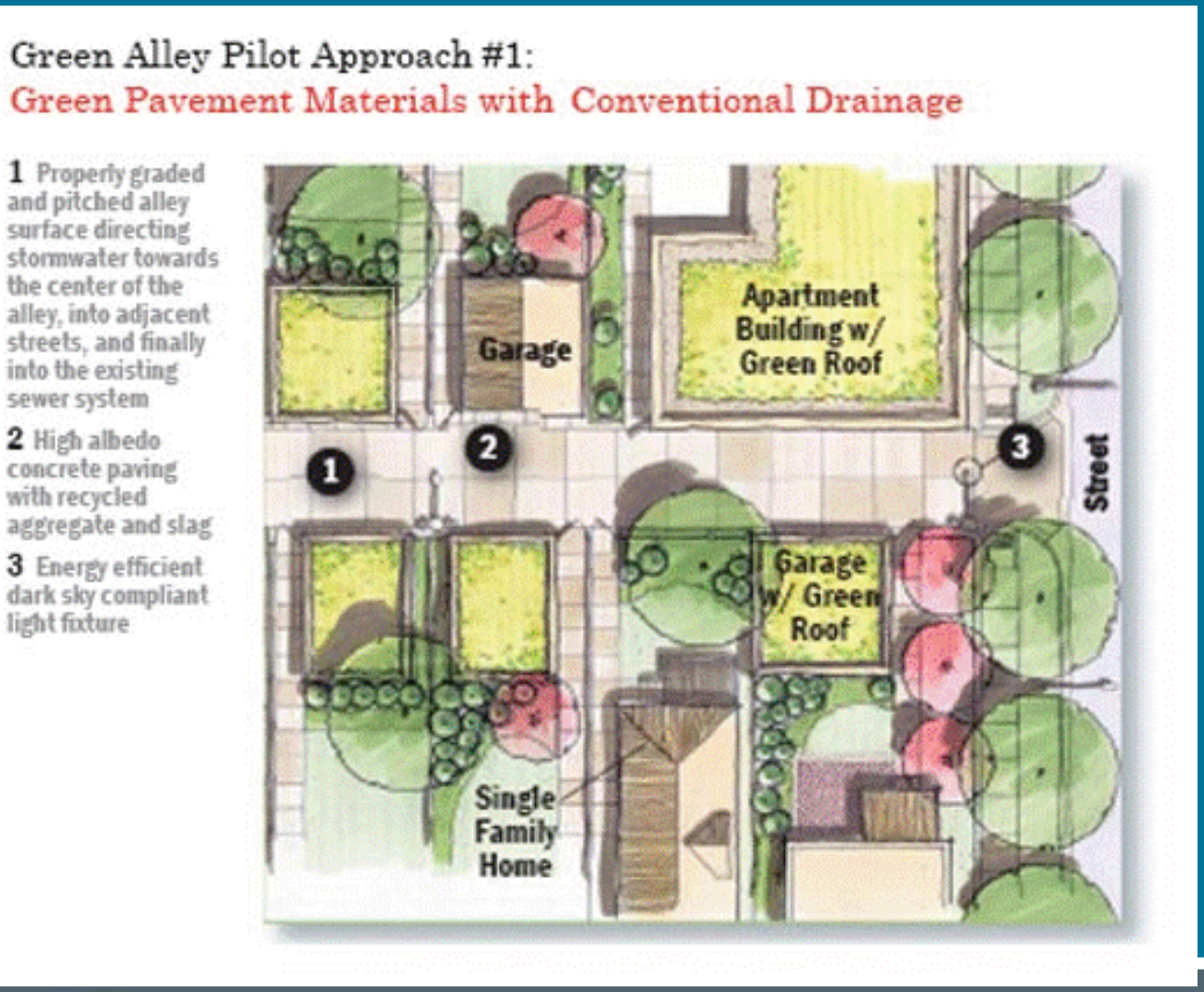
Stream rehabilitation

Includes removal of stream channelling to slow water speed, removal of noxious species, clean up of waste and debris, replanting with native species, flood control measure such as wetlands

Ecosystem and management considerations must be included to reduce pests such as rats and mosquitos

Community involvement can be critical to success

Green spaces, corridors



Improve biodiversity, air quality, liveability

While much of this is a traditional focus, new projects are arising such as the Green Alleys project in Chicago

Greening cities, changing transportation

Greening Auckland

Major component of the Auckland plan

Working groups on various aspects of green infrastructure include:

- Planning
- Stormwater
- Biodiversity
- Parks
- Transportation
- Energy and Climate Change Mitigation

Mapping of forested areas for Auckland is almost complete

Demonstration projects for green roofs, green walls, permeable paving, greenways for cycling/walking, stream restoration, constructed wetlands for stormwater management

Project Twin Streams

Opanuku &
Oratia Streams

2003-2013 & beyond?

Vision & Objectives

Initial objectives relating to healthy streams and strong communities:

- Improve water quality
- Manage flood risk and stormwater
- Secure ecosystem services
- Establish community responsibility

Expanded to a total of 24 objectives

Issues

Governance & continuity of management

Monitoring and feedback

Accountability and transparency

Too many objectives

Where to next (incl which catchments), and how to decide

Issues

Measure against what?

- Least impacted or historical state?
- Ecosystem services and benefit-cost?
- A mix of both?

Integration with Watercare

Project Twin Streams

One mechanism: Enviroschools

Existing school-based projects
eg Glen Eden Primary
and EcoMatters Environmental Trust

Ecological restoration

Monitoring programmes

Curriculum-based

Complement AC and CRI initiatives

Enviroschools Trust:
30% NZ schools
and roughly a reach
of 1 million people

Conclusion

Green infrastructure can improve the resilience of our infrastructure and make cities more liveable

Auckland already has a number of great initiatives which are underway across the city

Establishing the business case for green infrastructure as well as good standards and guidelines will greatly assist in further developments

Both engineers and planners need to understand the dynamics of the ecosystems involved in green infrastructure

References

Banking on Green: How Green Infrastructure Saves Municipalities Money and Provides Economic Benefits Community-wide. http://www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banking%20on%20Green%20HighRes.pdf

A Review of Green Infrastructure

http://www.creative.auckland.ac.nz/uoa/home/about/our-faculty/schools-programmes-and-centres/transforming-cities/tc-publications