Urban Densification, Urban Forestry, and Porous Pavements as Ecological Interventions

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We must live,
We must work,
We must play,
We must shop

Its so much smarter if we can do all these things in the same neighborhood

Urban densification

Smart growth sorts of interventions:

- **Higher densities**
- **Mixed land uses**
- **Transit-oriented development**
- **Mixed income housing**
- **Native vegetation**

Takes underdeveloped areas

And transforms them

Into mixed-use neighborhoods

Revitalizes existing communities

To create walkable communities

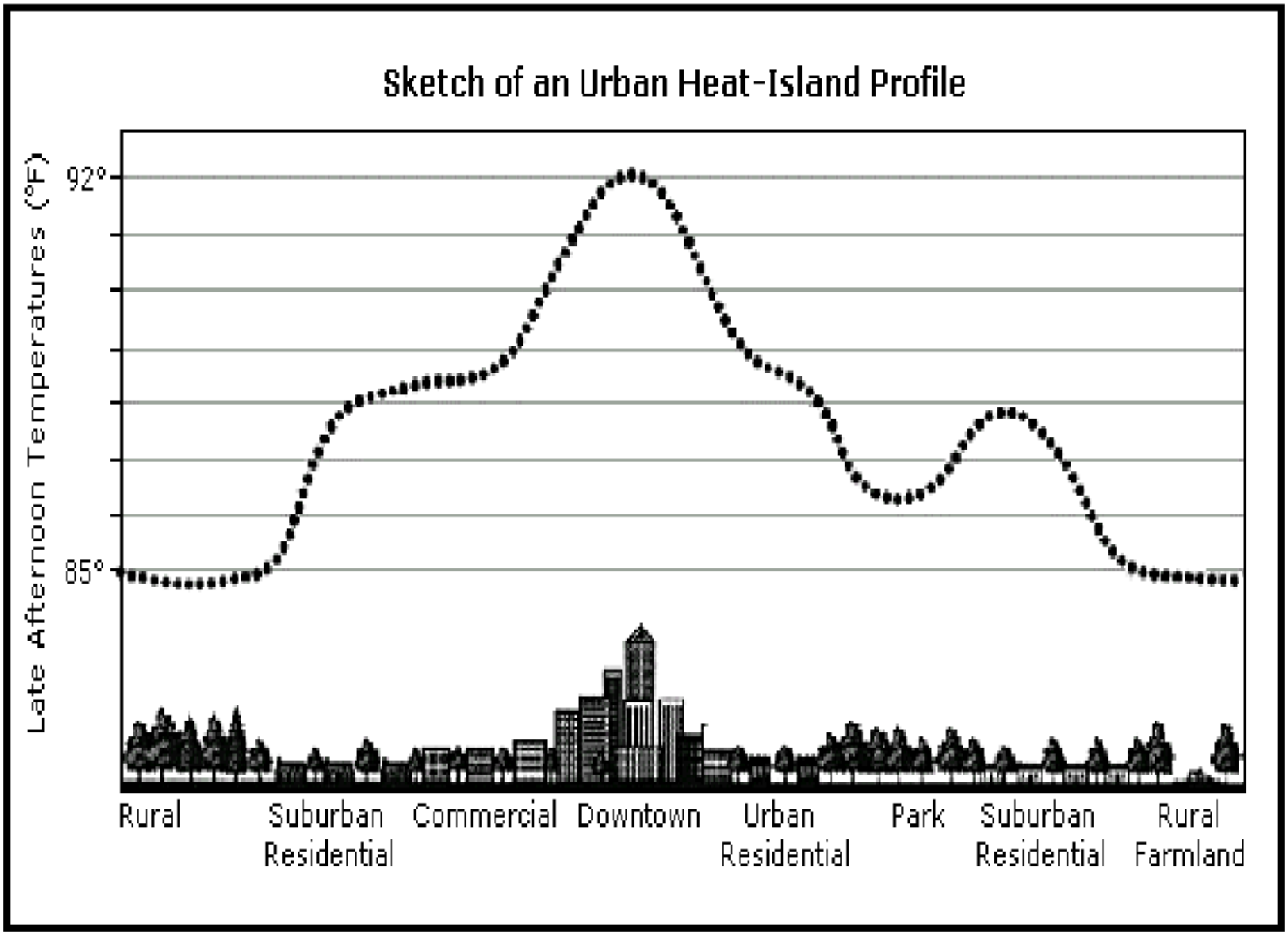
Urban heat islands

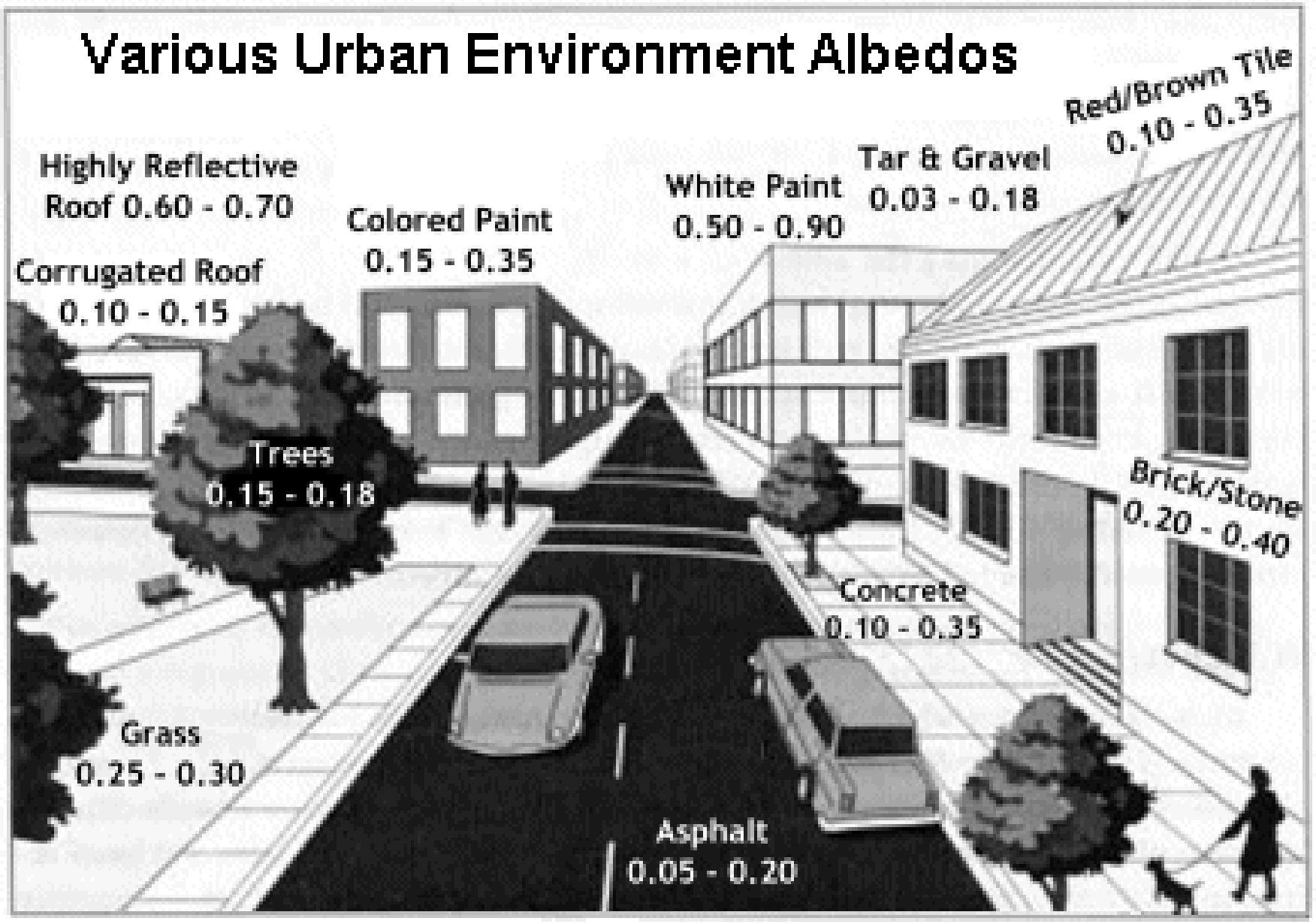
Urbanized areas tend to be 4°F to 8°F hotter than the countryside

- **Darker surfaces**
- **Roofs and paving**
- **Less vegetation**
- **More heat generating machines**

This tends to increase:

- Air Pollution
  - Ozone formation
  - Particulate matter
- Energy Consumption
- Stormwater Runoff


Sketch of an Urban Heat-Island Profile
Late Afternoon Temperatures (°F)
92°
85°
Rural
Suburban Residential
Commercial
Downtown
Urban Residential
Park
Suburban Residential
Rural Farmland

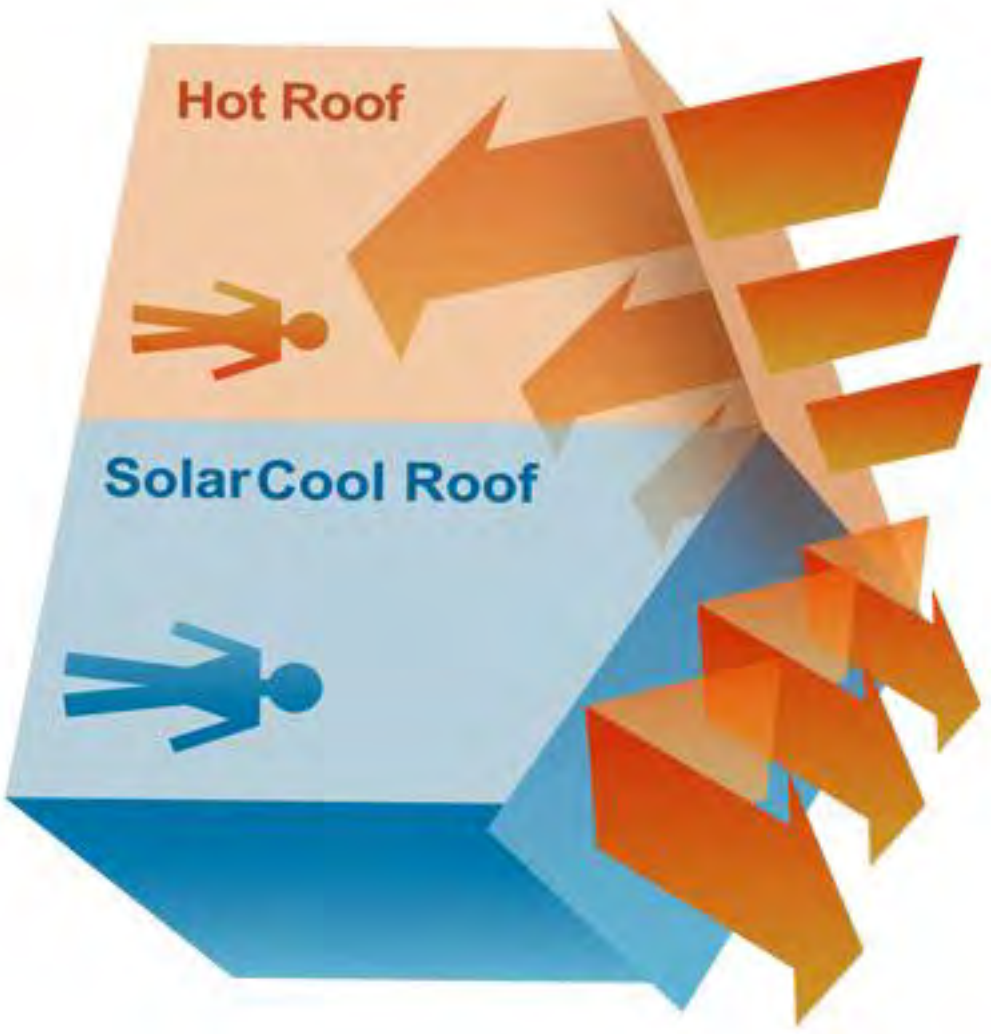

Various Urban Environment Albedos
Highly Reflective Roof 0.60 - 0.70
Corrugated Roof 0.10 - 0.15
Colored Paint 0.15 - 0.35
White Paint 0.50 - 0.90
Tar & Gravel 0.03 - 0.18
Red/Brown Tile 0.10 - 0.35
Trees 0.15 - 0.18
Brick/Stone 0.20 - 0.40
Concrete 0.10 - 0.35
Grass 0.25 - 0.30
Asphalt 0.05 - 0.20

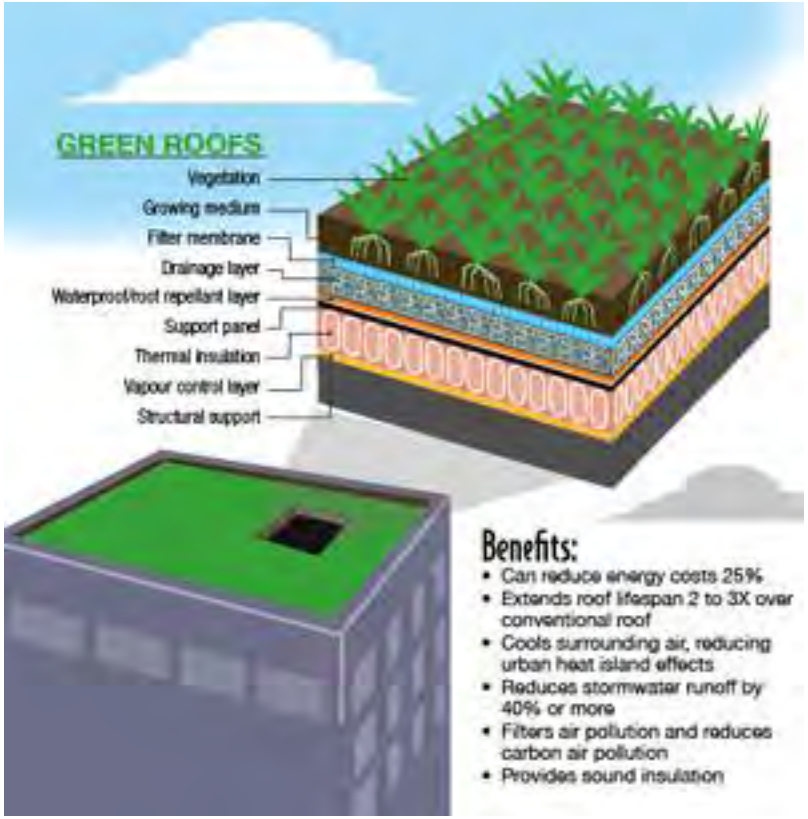
Two Potential Strategies:

- **Surface Albedo Modification**
- **Urban Forestry**

Surface Albedo Modification *"Cool Roofs, Cool Pavements"*

- **Lighter colors**
- **Thermal materials**


Hot Roof
SolarCool Roof


GREEN ROOFS
Vegetation
Growing medium
Filter membrane
Drainage layer
Waterproof/root repellant layer
Support panel
Thermal insulation
Vapour control layer
Structural support
Benefits:
• Can reduce energy costs 25%
• Extends roof lifespan 2 to 3X over conventional roof
• Cools surrounding air, reducing urban heat island effects
• Reduces stormwater runoff by 40% or more
• Filters air pollution and reduces carbon air pollution
• Provides sound insulation

Urban Forestry

- Tree plantation
- Tree replacement
- Landscaping


Plant on the west and northwest to provide mid-to-late afternoon shade in most locations.
Shade east and west windows, but prune lower branches to prevent blocking the view.
N
Plant shade trees over patios, driveways, and air-conditioning units.

Three Benefit Streams:

- Improvements in Air Quality
- Improvements in Energy Efficiency
- Improvements in Groundwater

Improvements in Air Quality

- **Urban heat island mitigation reduces Ozone formation**
- **Trees and leaves capture airborne dust**
- **Trees and albedo modification improve thermal comfort**

Shade Trees in Parking Lots

- **Reduce evaporative losses from automotive fuels in parked cars**
- **Mitigate greenhouse gas emissions**
- **Reduce heat load within automobiles**

Air quality benefits from urban heat island mitigation

- **10-15% Reduction in VOC emissions for Running Losses from Mobile Sources**
- **15-30% Reduction in VOC emissions from Parked Vehicles**
- **15-20% Reduction in Exceedance Exposure to Ozone**
- **Additional Emission Reductions from Area and Stationary Sources**

Improvements in Energy Efficiency

- Strategically chosen and planted trees cut thermal load
- Cool roofs and thermal insulation reduce indoor temperatures
- Albedo modification reduces urban heat island effect

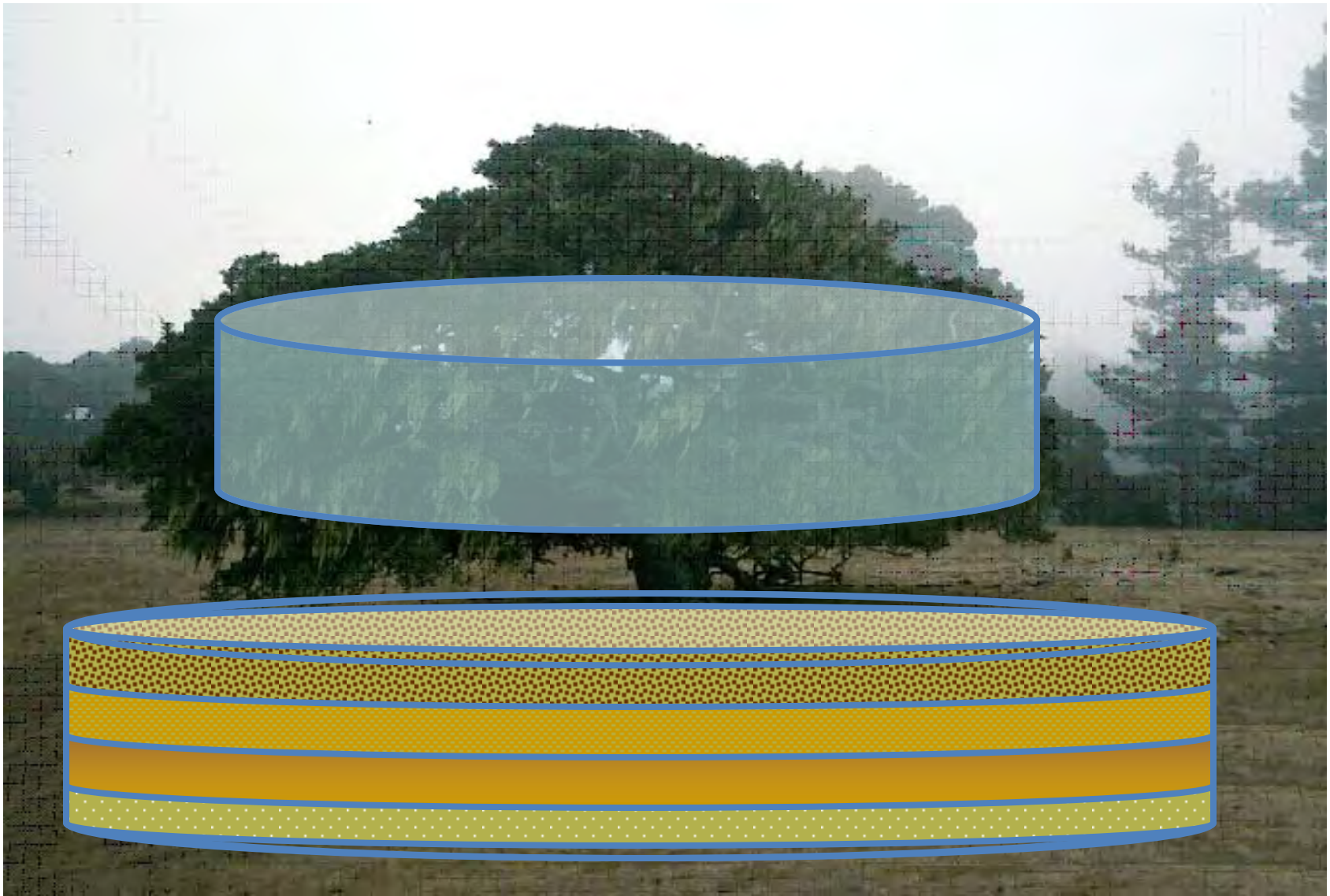
Estimated Energy-saving Potential of Light Colored Roofs

Extrapolated National Savings - $ 0.75 Billion/year

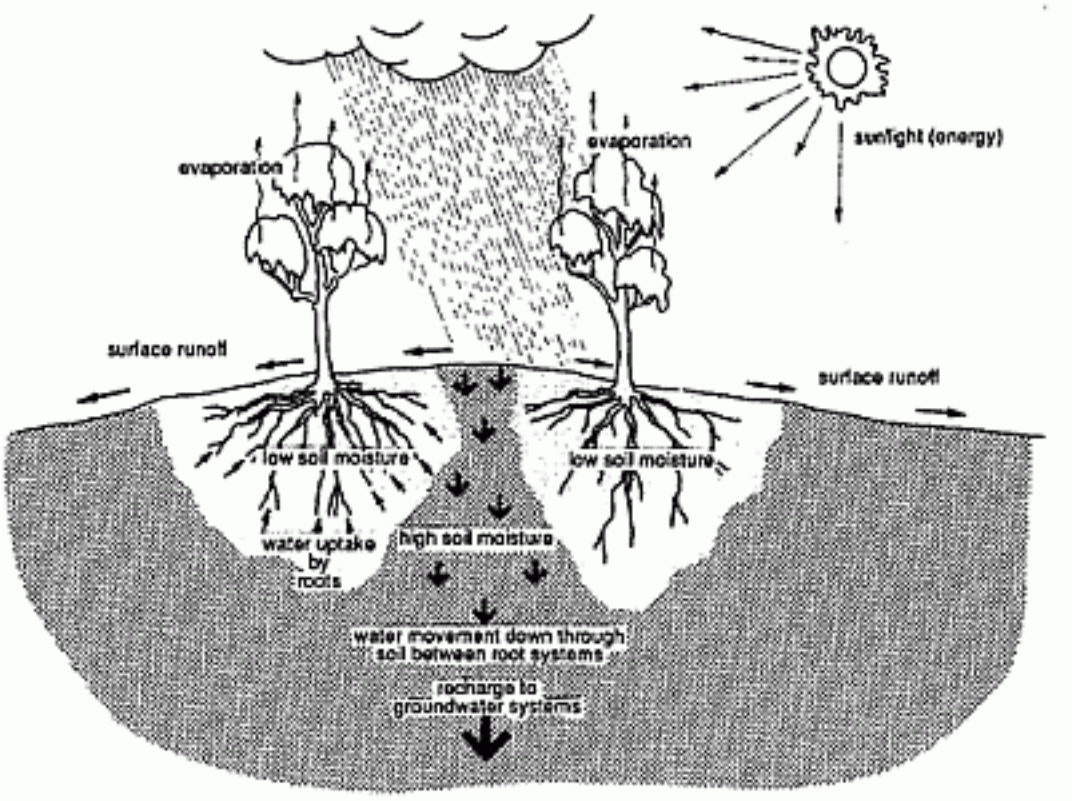
Source: Heat Island Group, LBNL, Berkeley

Improvements in Groundwater Recharge

- Trees capture and entrain rainwater into the ground
- Underground cisterns can store and then release rainwater and stormwater
- Porous pavement allows groundwater recharge and reduces stormwater runoff



Tree Roots Entrain Rainwater for Ground Water Recharge

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Air Quality Benefits

- Ozone Reduction
- PM10 Reduction
- Global Warming Mitigation
  (carbon sequestration)

Electric Energy Benefits

- Electricity Consumption Reductions

Water Quality Benefits

- Groundwater Recharge
- Stormwater Retention

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