City of Cambridge
Community Development Department

Climate Resilience Zoning Task Force
Cool Factor Discussion

Thursday, February 13, 2020 | City Hall Annex, 5:30-8:00

Agenda

1. Cool Factor selection
2. Cool Factor comparison with green factors and Cambridge stormwater standards
3. Cool Factor effectiveness in reducing UHI and greening the City
4. Reviewing scoring and weighting

Cool Factor Selection

How the Cool Factor Meets CRZTF Objectives

1. Elevate and Floodproof
2. Design to Protect/Recover
3. Promote Passive Resilience

RESILIENT BUILDINGS

4. Green Infrastructure
5. Preserve Vegetation
6. Create Vegetation
7. Limit Paved Areas
8. Provide Shading
9. Use Reflective Surfaces

SITE/COOL FACTOR

10. Shelter in Emergencies
11. Create Emergency Plans
12. Implement Area-Wide Strategies (Social Resilience)

EMERGENCY RESPONSE PLANNING

13. Implement Area-Wide Strategies (Hazards)

Cool Factor Focus

	Objective	Flooding	Cooling
3	Integrate Green Infrastructure	X	X
4	Preserve Existing Vegetation		X
5	Create Vegetation	X	X
6	Limit Paved Areas	X	X
7	Provide Shading		X

The Cambridge Cool Factor introduces performance-driven standards which contribute to public realm cooling, the mitigation of heat island effects, and a greener Cambridge.

Cool Factor Comparison with Other Standards

(Seattle, Somerville and stormwater requirements)

Comparing Standards

Items in yellow are not included in the Cool Factor.

	Strategies	Somerville Green Factor	Seattle Green Factor	Cool Factor
Non-Planting	Turfgrass, mulch, inorganic surface materials	X	X	*turf valued under "lawn or turf area"
	Pervious Paving	X	X	*does not provide substantial cooling benefit
	Structural soil systems		X	*included in soil requirements
Planting	Landscaped Area	X	X	X
	Vegetation *(less than 2' tall at maturity)*	X	X	X
Roof + Wall	Vegetated Wall	X	X	*not included due to their intensive maintenance requirements, but could count toward an "innovation bonus"
	Green Roofs	X	X	X
Trees	New Trees	X	X	X
	Preserved Trees	X	X	X
Water-Related	Rain Garden, Bioswales, and storm water planters	X		*valued under planting area
	Bioretention facilities		X	*valued under planting area
	Water features		X	*planted solutions preferred because of co-benefits

Comparing Standards: Bonus Factor Points

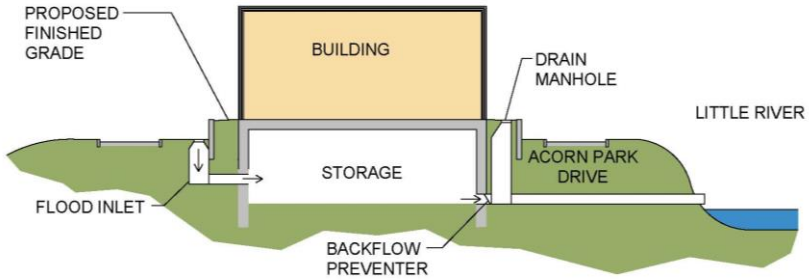
Items in yellow are not included in the Cool Factor Bonus Credits.

Bonus Factor Points	Somerville Green Factor	Seattle Green Factor	Cool Factor
Drought-tolerant or native plant species		X	
Landscaped areas where at least 50% of annual irrigation needs are met using harvested rainwater	X	X	
Landscaping visible to the passerby from adjacent public right of way or public open spaces		X	X
Landscaping in food cultivation	X	X	
Native species	X		
High value species	X		
De-paved lot area	X		

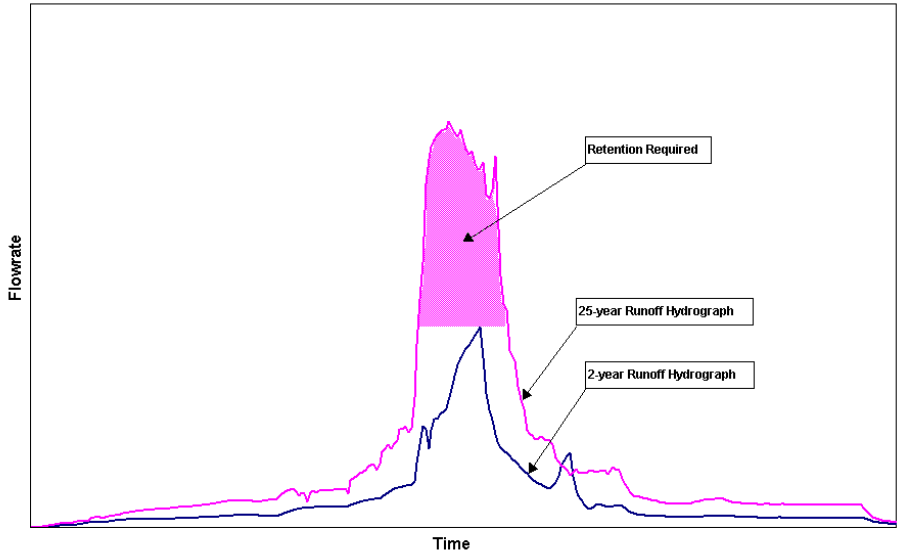
Stormwater Management in Cambridge

Currently focus on performance-based criteria, met through combination of green and grey infrastructure.

- 25:2 Requirement. Post-development discharge hydrograph for the 25-year event less than or equal to the 2-year rainfall event pre-development. Stored or recharge difference on site.
- Post-development peak discharge rates cannot exceed pre-development peak discharge rates.
- Water quality improvements – TSS and phosphorus.
- Sewer Holding tanks in Kendall Square and Alewife areas; 8-hour volume.



NORMAL RIVER ELEVATION



Should Vegetated Walls Be Included in the Cool Factor?

Relative Temperature Reduction

Largest temperature differentials were recorded mid-late afternoon, where air adjacent to vegetated walls was 3 °C cooler than non-vegetated walls.

(Cameron, Ross & Taylor, Jane & Emmett, Martin. (2014). What's 'cool' in the world of green façades? How plant choice influences the cooling properties of green walls. Building and Environment. 73. 198–207. 10.1016/j.buildenv.2013.12.005.)

Considerations:

- Extreme weather conditions, with freezing cold weather, snow or temperature swings can put stress on vegetated walls
- Maintenance is intensive
- Can be successful if plants are selected based on the climatic conditions

Source: https://www.sempergreen.com/us/about-us/news/outdoor-green-walls-can-thrive-even-in-climates-like-chicago-or-toronto-or-montreal

Clarification of SRI and Solar

Cool Roof Prerequisite of the Cool Factor

Cool Roof Benefits:

- Reduce local air temperatures (sometimes referred to as the urban heat island effect)
- Lower peak electricity demand, which can help prevent power outages
- Reduce power plant emissions, including carbon dioxide, sulfur dioxide, nitrous oxides, and mercury, by reducing cooling energy use in buildings.

A cool roof is up to 50-60˚F cooler than a regular roof, which can reach peak temperatures of 190˚F.

SRI requirements are based on LEED V4.1 standards for the Urban Heat Island Reduction

82 SRI for low slope ≤ 2:12

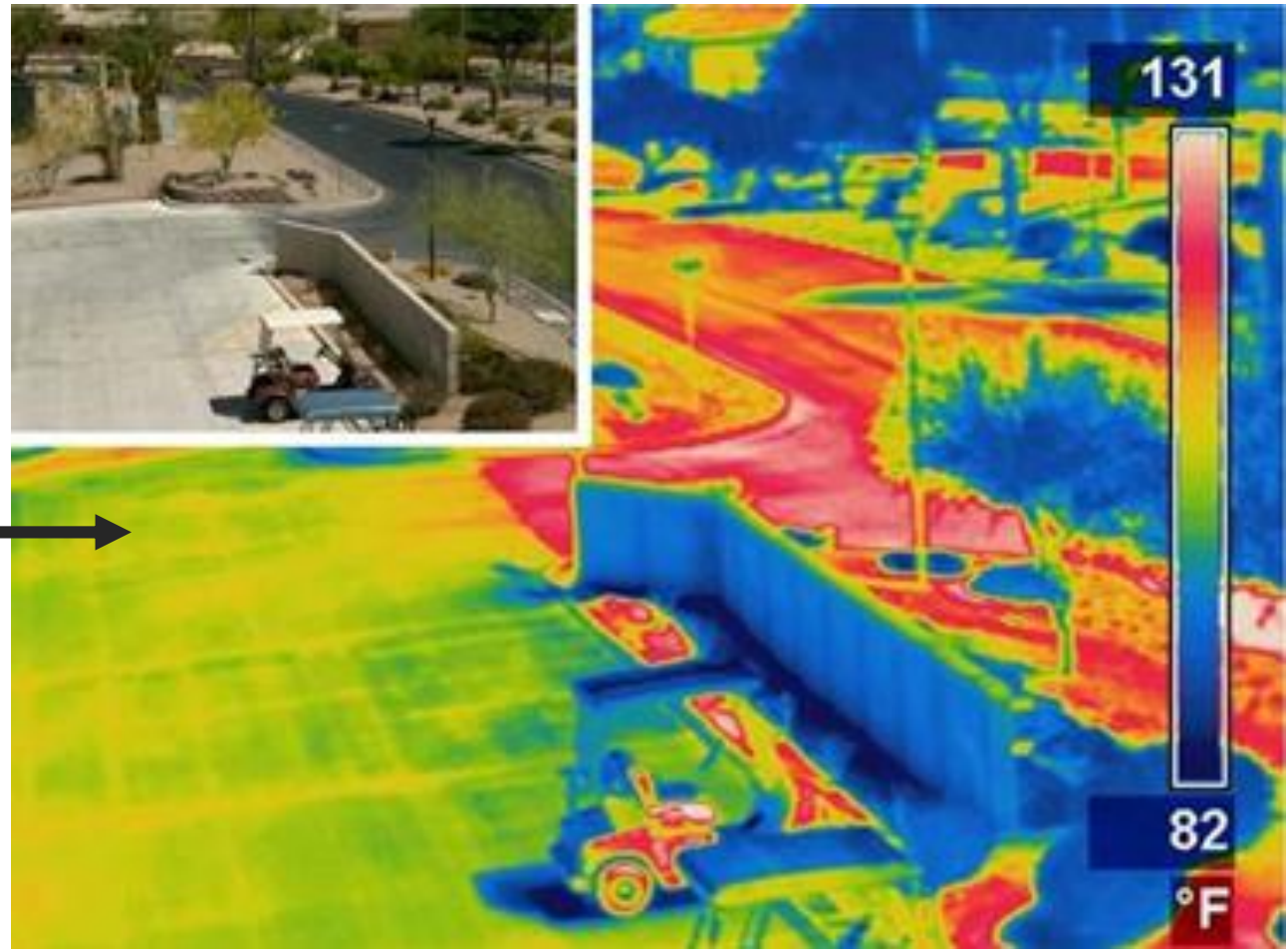
39 SRI for steep slope > 2:12

High SRI Paving

Included in the Cool Factor for its cooling benefit

Dark pavements get hot in the sun because they absorb 80-95% of sunlight.
(https://heatisland.lbl.gov/coolscience/cool-pavements)

Reflective 'cool' materials contributed to at least 1˚ F and in many cases an excess of 3˚ F. On a hot day contributed to reduction of up to 6˚ F.
(Louisville Urban Heat Management, Urban Climate Lab)



Source: http://archiveglobal.org/nyc-heat-waves-health-housing/cool-pavement-asu-copy/

High SRI Paving

Included in the Cool Factor because some surface functions require paving

Source: https://heatisland.lbl.gov/coolscience/cool-pavements

Examples of uses requiring paving:

- Driveways;
- Parking lots (e.g., school, medical facility);
- Pathways for ADA accessibility;
- Small patios for enjoying outdoor spaces.

The Cool Factor includes required 'aged SRI' values aligned with LEED V4 Heat Island Standards

Meets SRI requirements

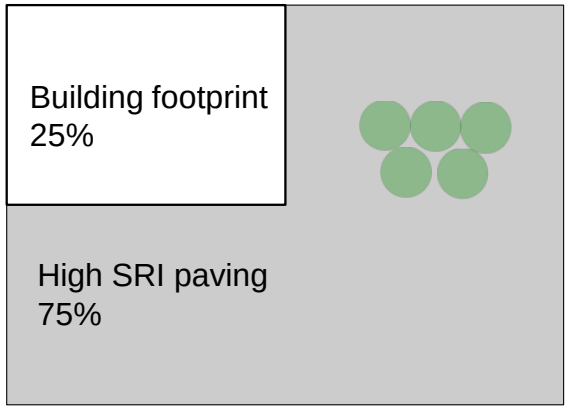
Source: Hanover Paver

High SRI Paving

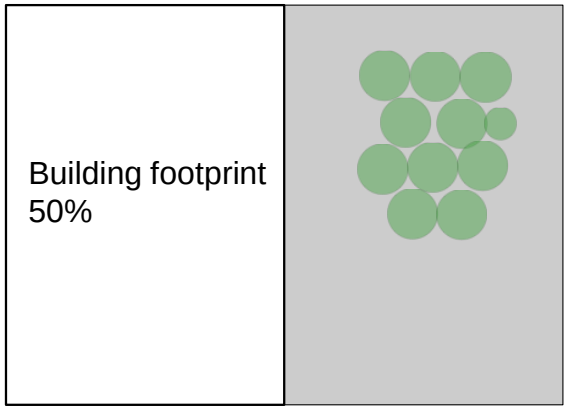
Should there be a cap on high SRI paving?

4 options all have a Cool Factor score of 1 given a cooling target of 15%:

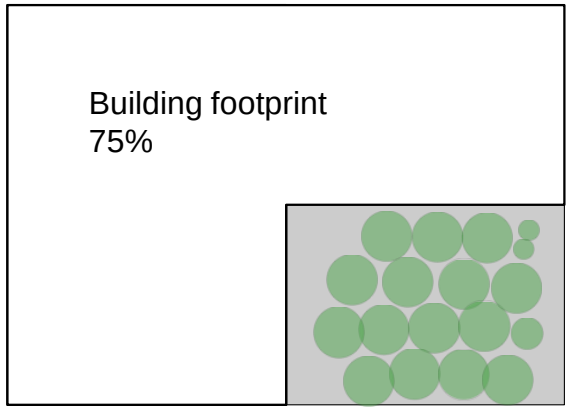
1.0 pts high SRI paving



0.75 pts high SRI paving
0.25 pts large canopy trees



0.50 pts high SRI paving
0.50 pts 10 large canopy trees, 1 medium canopy



0.25 pts SRI paving
0.75 pts 15 large canopy trees, 1 medium canopy tree 2 small canopy trees

Because there is a minimum cooling target of 15% of the site area, and the cool factor multiplication factor for high SRI paving is 0.15, one could never build on a site and satisfy cool factor through high SRI paving alone.

Solar and Green Roofs

Source: https://livingroofs.org/green-roof-award-2018-solar-wildflowers/

Source: http://hawaiirenovation.staradvertiser.com/2014/11/exterior/fix-roof-installing-solar-pv/

Considerations:

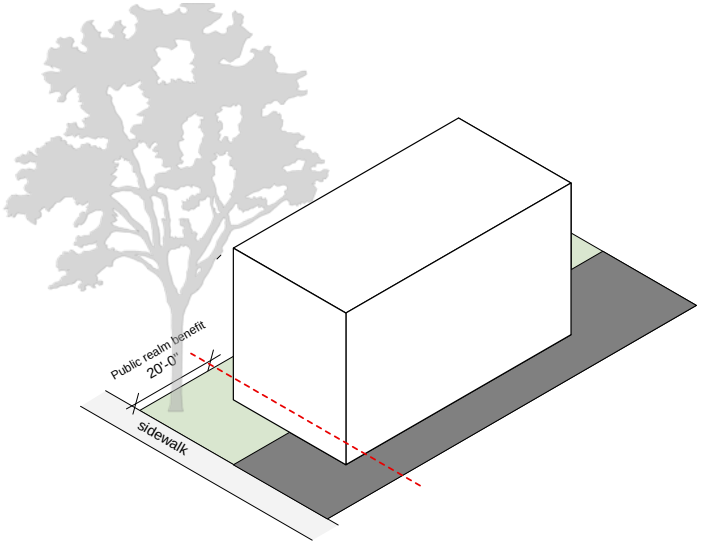
- Green roofs and solar panels can successfully co-exist.
- While the area covered by solar panels does not have the same SRI benefits as high SRI paving, it is not detrimental enough to disincentivize them.

Scoring Methodology

Existing Tree Removal

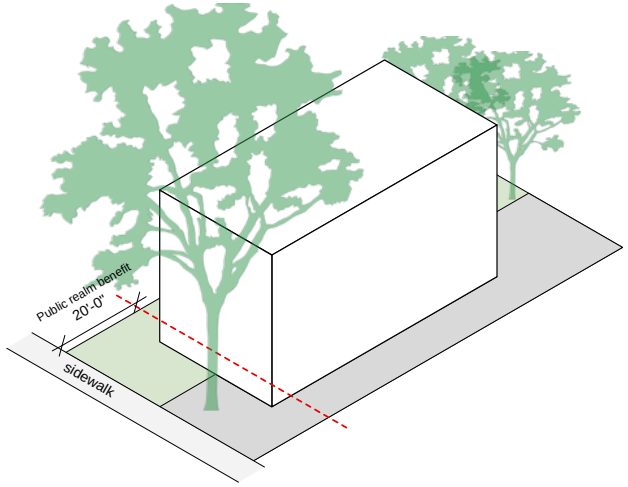
Preserving an existing large tree achieves the most points

preserve existing large canopy tree	0.51
turf	0.37



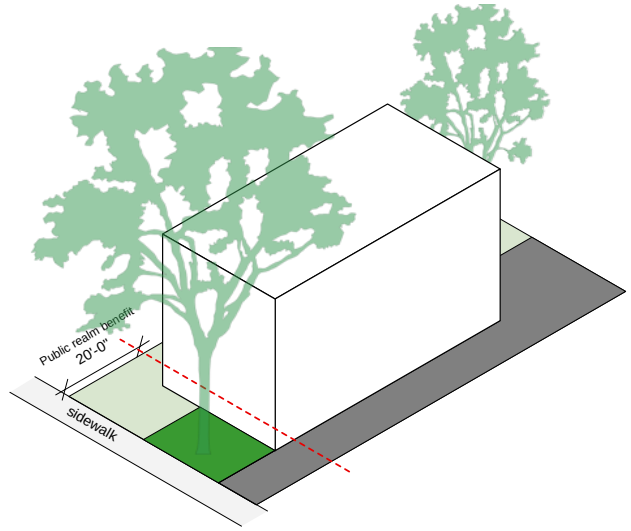
0.88

(1) new large canopy tree	0.29
(2) new small canopy trees	0.06
high SRI paving	0.16
turf	0.37



0.88

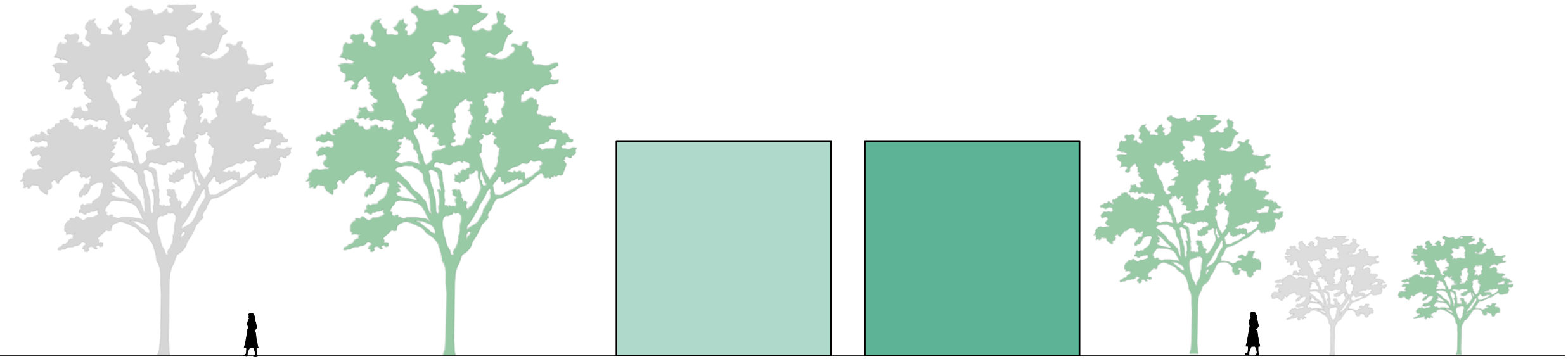
(1) new large canopy tree	0.29
(1) new medium canopy tree	0.11
new planting area	0.11
turf	0.37



0.88

Cool Factor Scoring

Encourages tree canopy over green roofs



Preserve large tree	Plant new large tree	25’x25’ Intensive green roof	25’x25’ green roof	Plant new medium tree	Preserve Small tree	Plant new Small tree
700	400	375	188	175	160	45

Discussion

Should the following updates to the score sheet be considered?

- Adding a requirement for some amount of strategies to be implemented at grade;
- Counting private ways as part of the public realm;
- Adding an open-ended “Innovation Strategy” to provide room for new strategies;
- Capping the number of points that can be achieved from strategies in the Hardscapes and Structures category.

Description of Strategies
(review)

Overview of Strategies

Hardscape + structures

Cool Factor Strategy	Relative Temperature Reduction	Multiplication Factor
Paving with SRI of 39 or higher * Aligned with LEED V4 requirements	Reflective 'cool' materials contributed to at least 1˚ F and in many cases an excess of 3˚ F. **On a hot day contributed to reduction of up to 6˚ F** (Louisville Urban Heat Management, Urban Climate Lab)	0.15
Shade structure with SRI of 39 or higher * Aligned with LEED V4 requirements	Shaded surfaces, may be **20–45°F cooler** than the peak temperatures of unshaded materials. (Environmental Protection Agency)	0.3

*additional weight for public realm cooling

Strategy examples

Overview of Strategies

Planting areas

Cool Factor Strategy + Prerequisites	Relative Temperature Reduction	Multiplication Factor
Lawn or turf area * Minimum 8” soil depth	**Between 1 and +2°F of cooling from tree planting and grass cover** (Louisville Urban Heat Management Study, Urban Climate Lab) *Taller planting + wider diameter canopy provides more shaded surface*	0.3
Low planting area – includes herbaceous or woody plants less than 2’ tall at maturity * Minimum 18” soil depth		0.4
Planting area – includes herbaceous or woody plants greater than 2’ tall at maturity * Minimum 24” soil depth		0.5

Example of planting types

*additional weight for public realm cooling

Overview of Strategies

Green roofs

Cool Factor Strategy + Prerequisites	Relative Temperature Reduction	Multiplication Factor
Extensive green roof * Minimum 4” soil depth	Green roof temperatures can be **30–40°F lower than those of conventional roofs and can reduce city-wide ambient temperatures by up to 5°F.** (Environmental Protection Agency) *Taller planting + wider diameter canopy provides more shaded surface*	0.3
Intensive green roof, less than 2’ tall at maturity * Minimum 18” soil depth		0.4
Intensive green roof, greater than 2’ tall at maturity * Minimum 24” soil depth		0.5

*additional weight for public realm cooling

Example of roof types

Overview of Strategies

Tree canopy: new trees

Cool Factor Strategy + Prerequisites	Relative Temperature Reduction	SF per tree	Multiplication Factor
Tree canopy for “small tree species” or equivalent • Canopy spread of 8’-15’, 1” caliper • minimum 600 cu ft of soil/tree	Shaded surfaces may be **20–45°F cooler** than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by **2–9°F** (Environmental Protection Agency) *Taller planting + wider diameter canopy provides more shaded surface*	75	0.6
Tree canopy for “medium tree species” or equivalent • Canopy spread of 16’-21’, 1” caliper • minimum 700 cu ft of soil/tree		250	0.7
Tree canopy for “large tree species” or equivalent • Canopy spread of 25’-30’, 2.5” caliper • minimum 800 cu ft of soil/tree		500	0.8

*additional weight for public realm cooling

Example of tree species types

Overview of Strategies

Tree canopy: existing / tree preservation

Existing tree size defined by canopy width at the time of score sheet submittal. Tree canopy preservation of existing trees with trunks 6"+ in diameter calculated at 20 sq ft per inch diameter. Prerequisite 800 cu ft of soil/tree.

Cool Factor Strategy + Prerequisites	Relative Temperature Reduction	Multiplication Factor
Tree canopy for “small trees” • Canopy spread of 6’-15’	Shaded surfaces may be **20–45°F cooler** than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by **2–9°F** (Environmental Protection Agency) *Taller planting + wider diameter canopy provides more shaded surface*	0.8
Tree canopy for “large trees” • Canopy spread of 16’+		1.4

*additional weight for public realm cooling