Cool Roofs: Standards & Options

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Cool Roofing Standards

Critical Issues

- ENERGY EFFICIENCY
- ENVIRONMENTAL RESPONSIBILITY
- BUILDING CODE CONFORMANCE

Cool Roofing Standards

Critical Issues

- Energy Efficiency
  - Reduce annual heating / cooling costs
  - Reduce initial equipment sizing
- Environmental Responsibility
  - Reduce CO^2 emissions / global warming
  - Reduce heat emissions / urban heat islands
  - Reduce VOC / ozone emissions
  - Reduce storm water runoff / improve water quality
  - Reduce solid waste / increase recycling
  - Reduce long-term waste / increase roof life cycle
- Code Conformance
  - Life Safety (Fire, Wind)
  - Durability (Sun, Rain, Hail, Temperature)

Cool Roofing Options

Current Cool Roofing Alternatives

- Highly Insulated Roofs
- Highly Reflective Roofs
- Vegetative Roofs
- Ballasted Roofs
- Hybrid Designs

Cool Roofing Options

Highly Insulated Roofs

Highly Insulated Roofs

Why Increase Roof Insulation?

Globally: Increased energy efficiency is the only way to reduce green house gas emissions between now and 2030

Locally: Rising energy costs and local incentives make it a good economic payback almost everywhere

Highly Insulated Roofs

Current Insulation Standards

- **Old Code Standard:**
  ASHRAE 90.1- 1999
  "Energy Standard for Buildings"

- **New Code Standard:**
  ASHRAE 90.1- *2007*
  "Energy Standard for Buildings"

- **Proposed "Above the Code" Standard:**
  ASHRAE 189.1P
  "Standard for the Design of High Performance Green Buildings"

Highly Insulated Roofs

Current Insulation Standards

Minimum R-Values:
Low-Slope Commercial Roof Insulation

ASHRAE Climate Zone	Typical City Example	Old ASHRAE 90.1	New ASHRAE 90.1 - 2007	Proposed ASHRAE 189.1P
1	Miami	10	15	20
2	Houston	15	20	25
3	Atlanta	15	20	25
4	Baltimore	15	20	25
5	Chicago	15	20	25
6	Milwaukee	20	25	30
7	Minneapolis	25	30	35

Old Code Standard (Current)

New Code Standard (As Adopted)

Proposed "Above the Code" Standard

Highly Insulated Roofs

Why Go "Above the Code?"

- Code Standards are Minimum Standards
  - Minimum needed to protect human occupants
- Code Standards are based on Past Events
  - Past energy costs
  - Past environmental impacts
- Above-Code Standards reflect Future Events
  - Rising energy costs
  - Increasing environmental impacts
- Above-Code Standards support Reachable Goals
  - Roadmaps from the past to the future

Highly Insulated Roofs

Comparing the Codes:

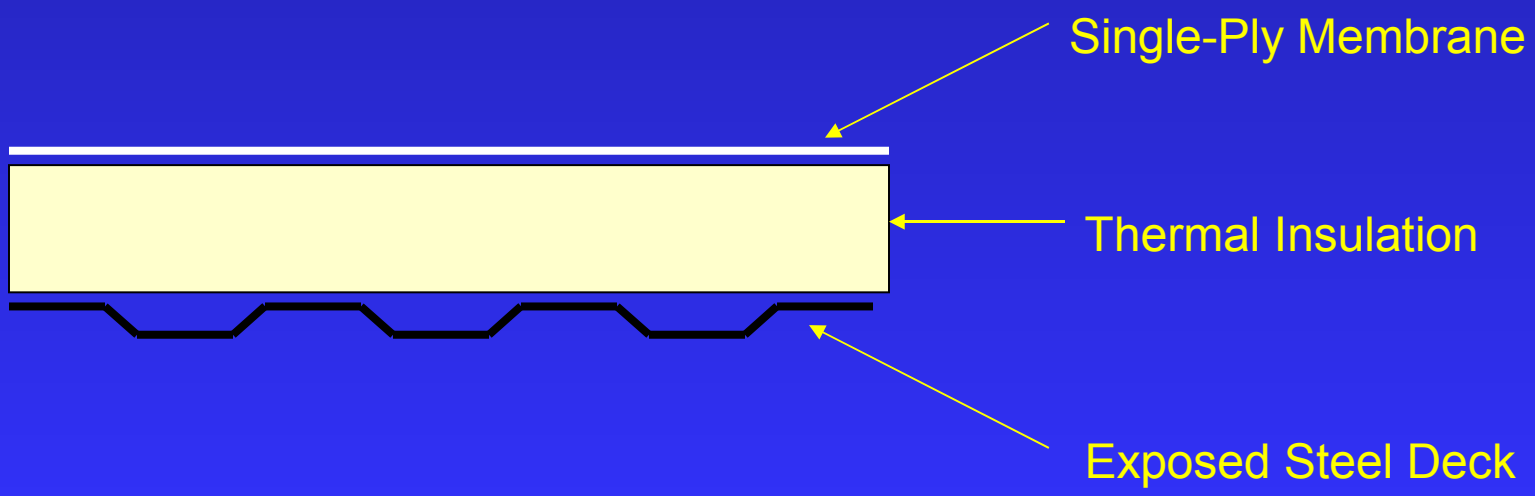
Old / New / Above

Example:

100,000 Square Foot Warehouse

Chicago, Illinois

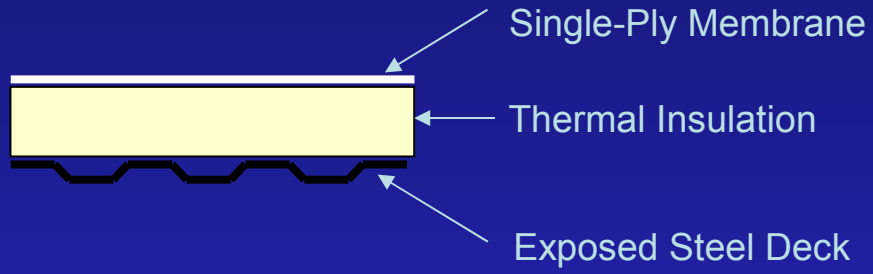
(Roof System Only - Gas Heat & Elec. Air Conditioning)



Highly Insulated Roofs

Comparing the Codes

100,000 Square Foot Warehouse
Chicago, Illinois
Heated & Air Conditioned



Scenario:	Insulation R Value:	Total Annual Heating / Cooling Cost:	Annual Savings:
Old Code (ASHRAE 90.1)	15	$15,295	-
New Code (ASHRAE 90.1 – 2007)	20	$13,172	$4,083
Above the Code (ASHRAE 189.P-1)	**25**	**$10,855**	**$6,400**

Source: EnergyWise Online Calculator (http://energywise.specright.net)

Cool Roofing Options

Highly Reflective Roofs

Cool Membrane Roofs

Ice Mountain
Brea, CA

Cool Metal Roofs

Lindberg Terminal
St. Louis , MO

Highly Reflective Roofs

Why Increase Roof Reflectivity?

- Reduced overall cooling costs
- Reduced peak cooling costs
- Minimal cost penalty compared to alternatives
- Field studies suggest long-term benefit with minimal maintenance*

* But at a reduction in actual reflectivity.

Highly Reflective Roofs

Current Standards

Reflectivity Standards:
Low-Slope Commercial Roofing Products

Reference Standard:	Minimum Initial Reflectance:	Minimum Aged Reflectance:	Minimum Initial Emittance:
EPA Energy Star	65%	50%	n/a
California Title 24 Product Rating Standard	70%	n/a	0.75
California Title 24 Recommended Long-Term Calculation Value	n/a	**50%**	n/a

Highly Reflective Roofs
Long-Term Performance

Actual Reflectivity Values:
Various Commercial Roof Coatings
MRCA / WSRCA Weathering Studies

Product:	Initial Reflectance:	Aged Reflectance:	Years Aged:
Acrylic Coatings	75% - 90%	54% - 61%	5
Aluminum Coatings	55% - 75%	40% - 57%	5
Emulsions	15% - 55%	33% - 54%	5
TPO Membranes	83%	59% - 76%	4

Source: MRCA 5-Year Weathering Study for Coatings, WSRCA 4-Year Weathering Study for TPO

Highly Reflective Roofs
Geographic Comparison

Example:

100,000 Square Foot Warehouse
Heated & Air Conditioned
in…..

Phoenix, AZ

Los Angeles, CA

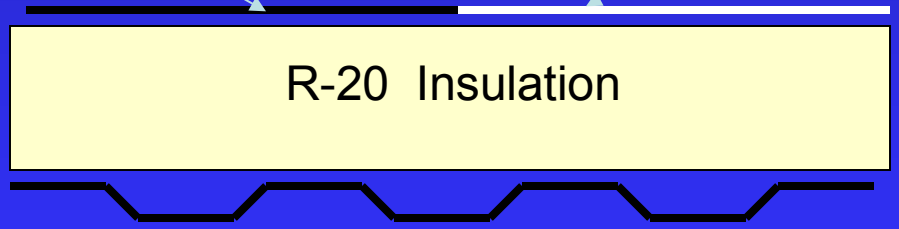
Portland, OR

Chicago, IL

Atlanta, GA

Black Roof
(5% Long-Term Reflectivity)

Reflective Roof
(50% Long-Term Reflectivity)



Highly Reflective Roofs
Geographic Comparison

Heating & Cooling Comparison:
Reflective Roof (0.50) versus Black Roof (0.05)

City:	Heating Degree Days:	Cooling Degree Days:	Solar Load (BTU/ SF/ Day)	Annual Savings for Reflective Roof:
Phoenix, AZ	1154	3815	1839	$4300
Los Angeles, CA	1291	470	1579	$3100
Atlanta, GA	3090	1611	1478	$1400
Chicago, IL	6450	749	1243	$0
Portland, OR	4461	279	1127	(-$300)

Source: J.L. Hoff (2005). “The Economics of Cool Roofing: A Local and Regional Approach”

Reflectivity and R-Value

Balancing Energy Efficiency

Annual Heating / Cooling Cost Savings:

Reflective Roof versus Non-Reflective Roof

(Dollars per 100,000 Sq. Ft. Roof Area / R-20 Insulation / Energy Star Rated Roof)

Source: J.L. Hoff (2005) “The Economics of Cool Roofing: A Local and Regional Approach”

Cool Roofing Options
Vegetative Roofs

Chicago City Hall
Chicago, IL

US Environmental Protection Agency
Denver, CO

Vegetative Roofs

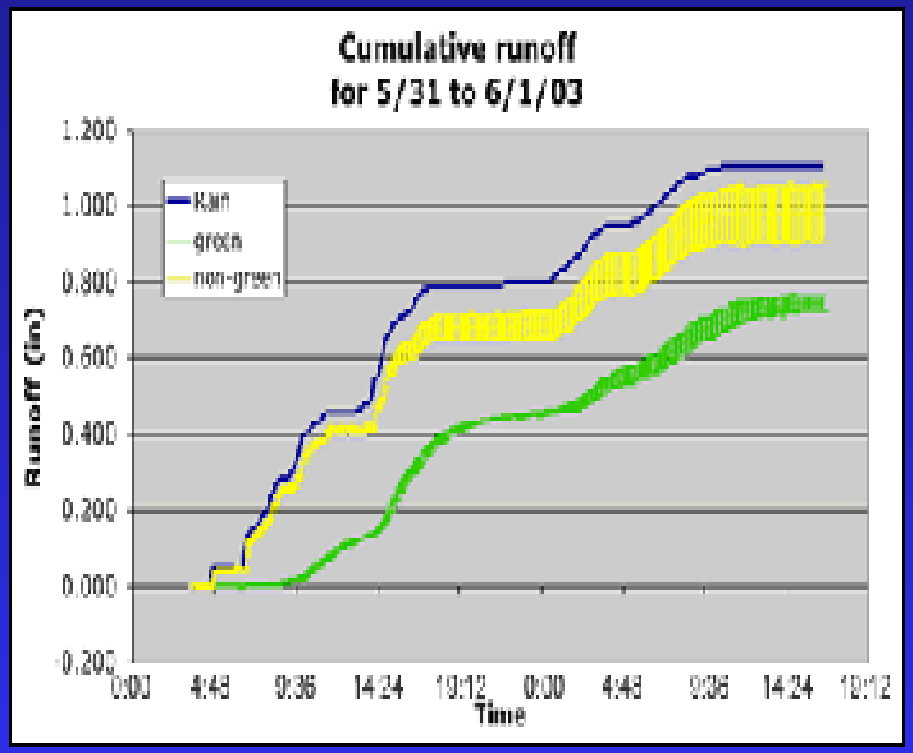
Why Vegetation?

- Reduced heating & cooling costs
- Reduced peak electric consumption
- Reduced ambient air temperature
- Reduced storm water runoff / improved storm water quality
- Require as little as 3 or 4 inches of planting medium and minimal maintenance

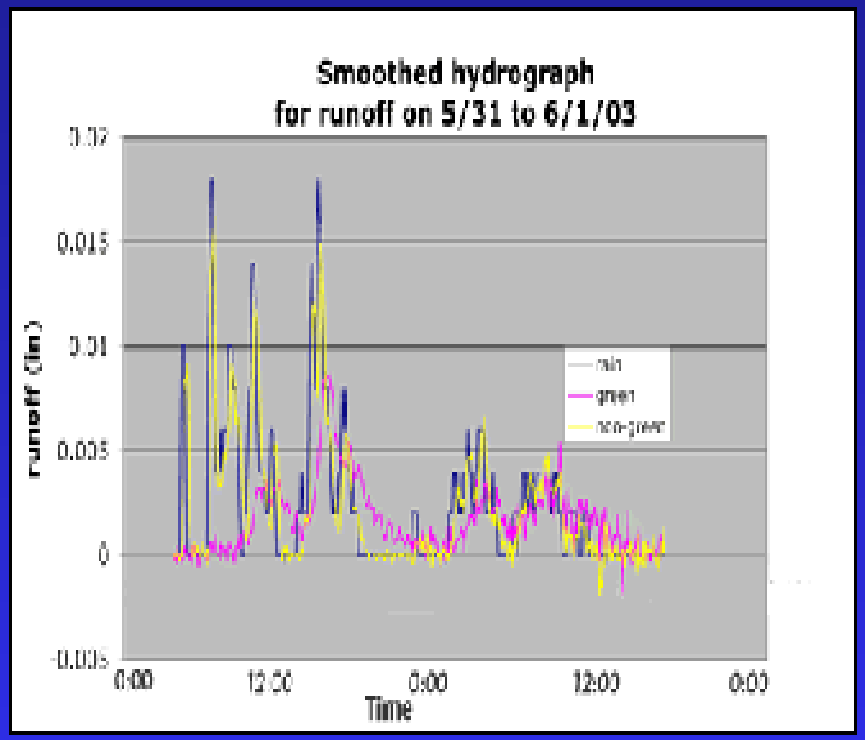
Vegetative Roofs

Reduced Storm Water Runoff

Both Cumulative…



And Peak…



Source: Penn State University Cool Roofing Program

Vegetative Roofs

Improved Storm Water Runoff

Source: Penn State University Cool Roofing Program

Vegetative Roofs
Minimal Maintenance

May28, 2002

July 15, 2002

August 25, 2002

Typical Plant Growth in Central Pennsylvania

Selected Sedum over Engineered Growing Medium

Note: Growing Season Included a 30-Day Record Drought!

Source: Penn State University Cool Roofing Program

Vegetative Roofs

Current Standards

Standard:	Status:
Fire Resistance	Research In Progress
Wind Resistance	Research In Progress
R-Value	Research In Progress
Water Retention	Research In Progress
Maintenance	Research In Progress
Field Installation	NRCA Green Roof Systems Manual

Cool Roofing Options

Ballasted Roofs

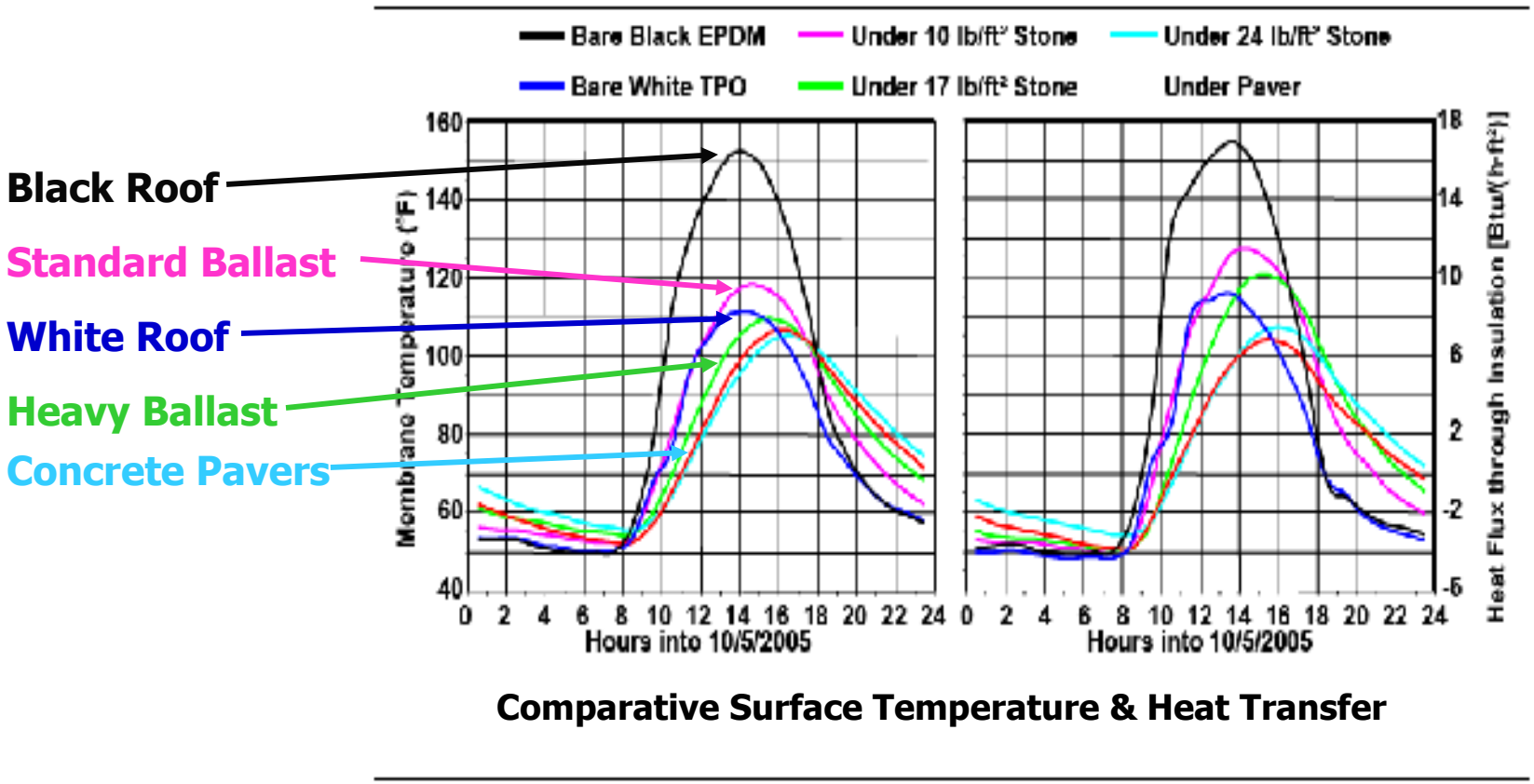
Cool Roofing Options

Ballasted Roofs

Why Ballast?

- Reduced heating & cooling costs
- Reduced peak electric consumption
- Reduced ambient air temperature
- Potential for reduced storm water runoff
- Economical cool roof alternative

Cool Roofing Options
Ballasted Roofs



Comparative Surface Temperature & Heat Transfer

Ballasted roofs can provide the same peak energy savings and reduced air temperatures as "cool" roofs ...and their performance doesn't degrade over time!

Cool Roofing Standards

Ballasted Roofs

Ballasted Roofs will be recognized as "Cool Roofs" in 2008 version of California Title 24:

"Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft² are exempt from the minimum requirements for solar reflectance and thermal emittance"

Ballasted Roofs

Current Standards

Standard:	Status:
“Cool” Ratings	Moving toward Acceptance
Fire Resistance	UL Class A
Wind Resistance	Code-Approved Design Tables
Maintenance	Established Procedures
Field Installation	Established Procedures
Water Retention	Research Needed

The Future of Cool Roofing

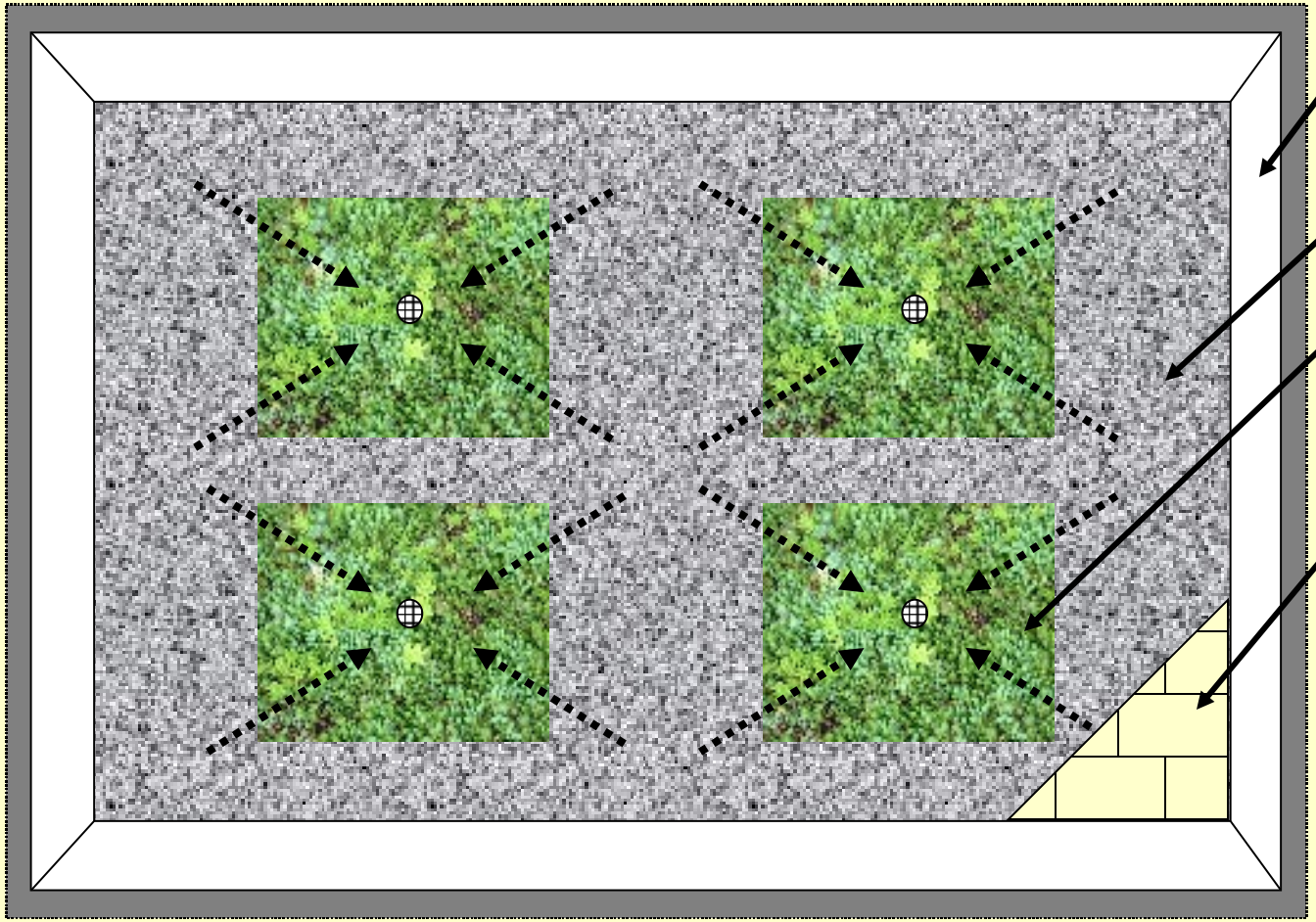
Hybrid Cool Roofs

Strategic Combinations of Cool Technologies:

- "Above the Code" Insulation
  - Energy Efficiency
  - Drainage Control (Tapered System)
- Cool Surfaces
  - Highly Reflective
  - Cool Ballast
- Storm Water Retention
  - Ballasted Areas to Direct and Hold Water
  - Vegetated Areas to Hold and Consume Water

Cool Roofing Options

Hybrid Cool Roof Example



Highly Reflective Wall Flashings

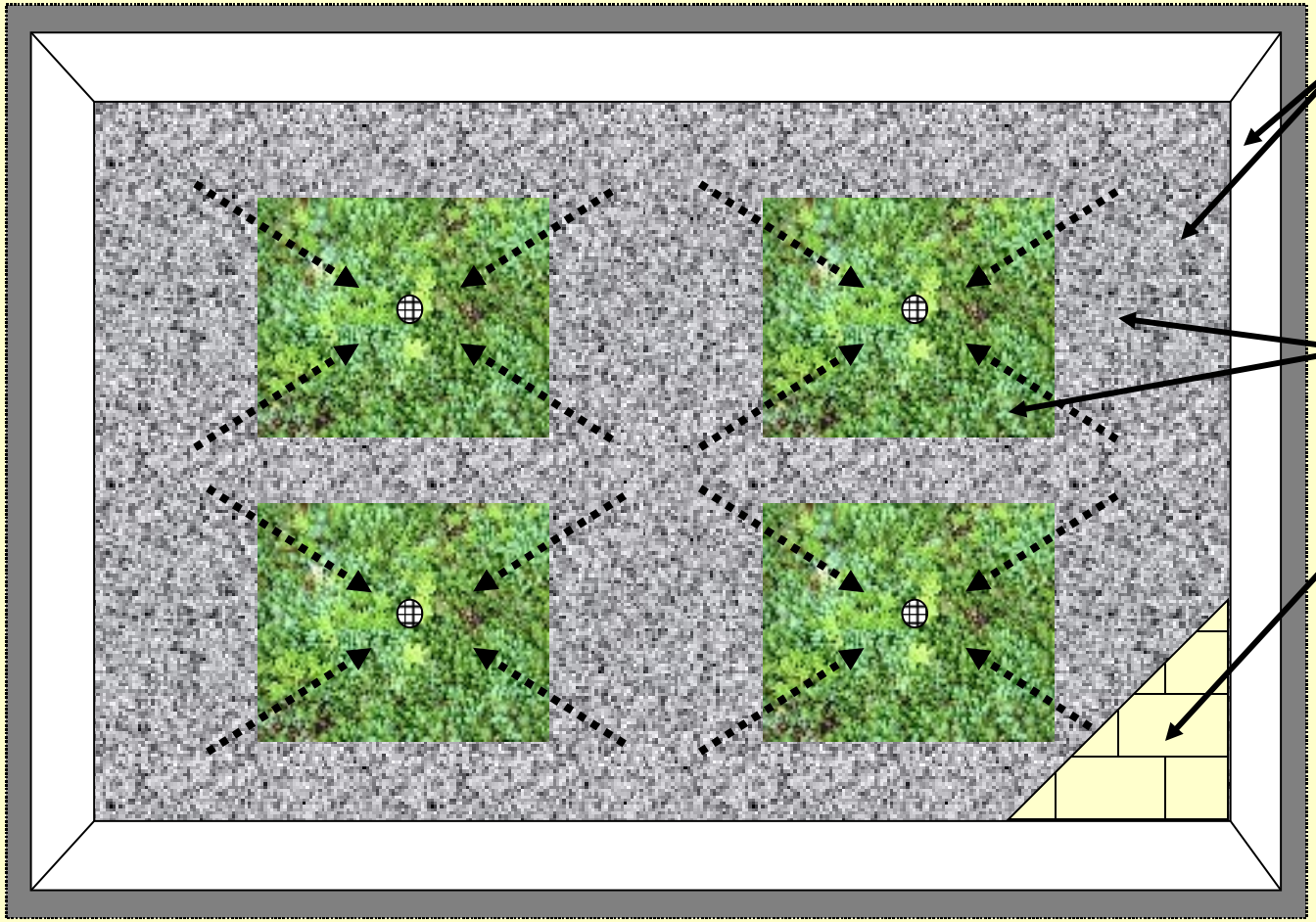
Cool Ballast

Vegetation Surrounding Roof Drains

"Above the Code" Insulation System w/ 4-Way Slope to Drains

Cool Roofing Options

Hybrid Cool Roof Example



Highly Reflective Wall Flashings & Cool Ballast Lower Summer Temperatures

Cool Ballast & Vegetation Retain Storm Water

"Above the Code" Insulation System Reduces Total Energy Costs

Cool Roofing Options

Hybrid Cool Roof Example

Fairmont Waterfront Hotel, Vancouver, WA

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