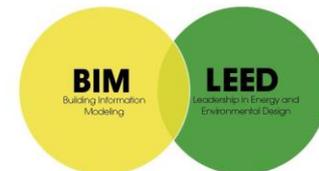


PART 6 – Sustainable sites (SS)

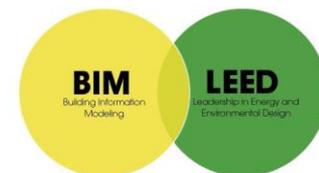


PART 6 – Sustainable sites (SS)

This part will discuss both the importance of sustainable sites and their effects on the green building design.

The Sustainable Sites credit category will be discussed under six major sections:

1. Site assessment
2. Site design
3. Minimizing construction impacts
4. Rainwater management
5. Heat island effect
6. Site management

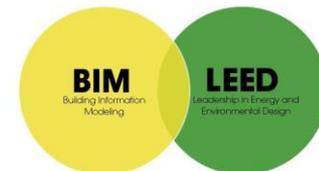


Site assessment

As an important aspect of the integrated process of creating sustainable site, a site assessment first needs to be conducted in order to have the relevant information that will be necessary for the site design.

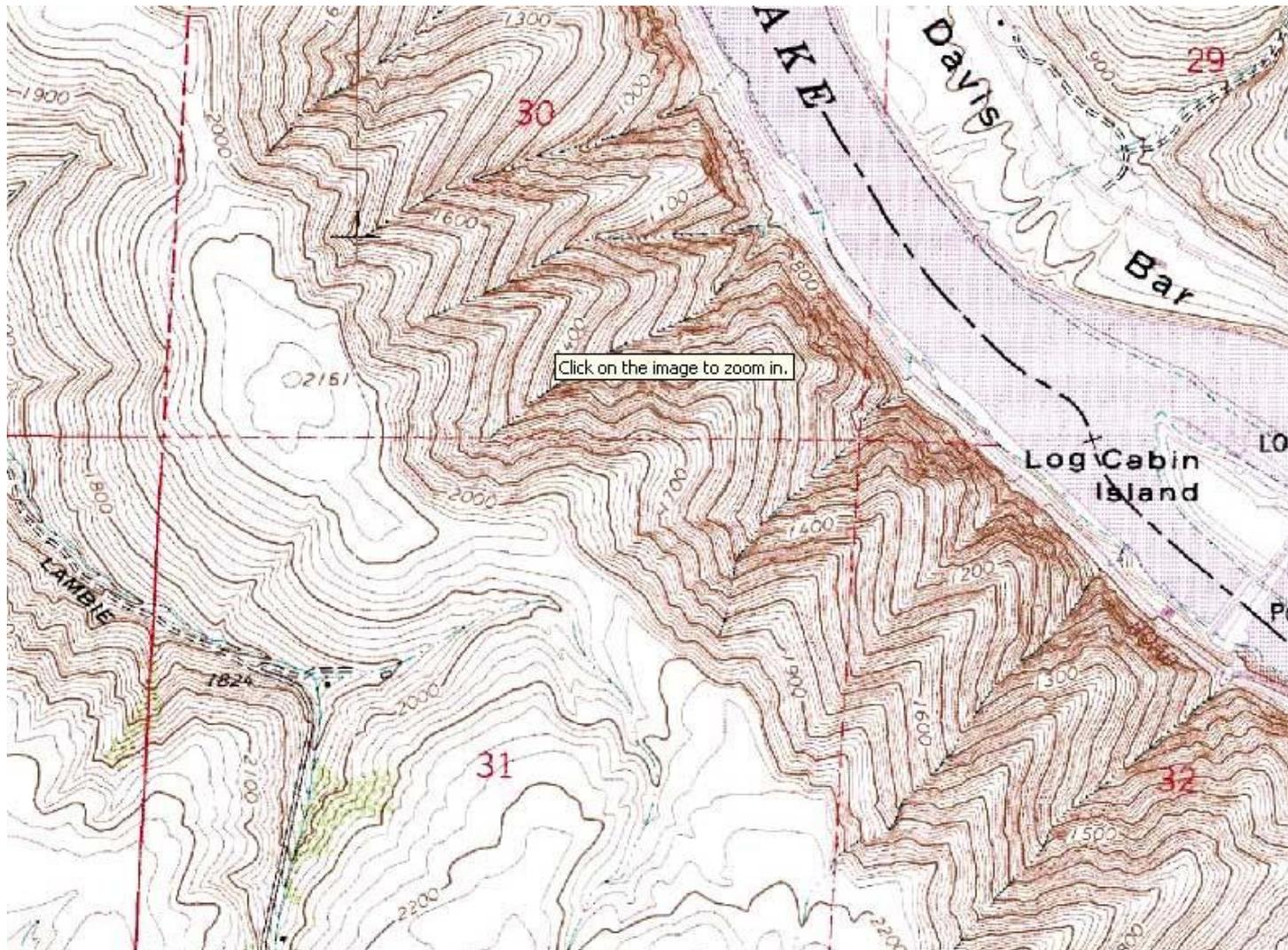
The project team can conduct an assessment evaluating the following site features:

1. Topography
2. Hydrology
3. Climate
4. Vegetation
5. Soil
6. Human use
7. Human health effects



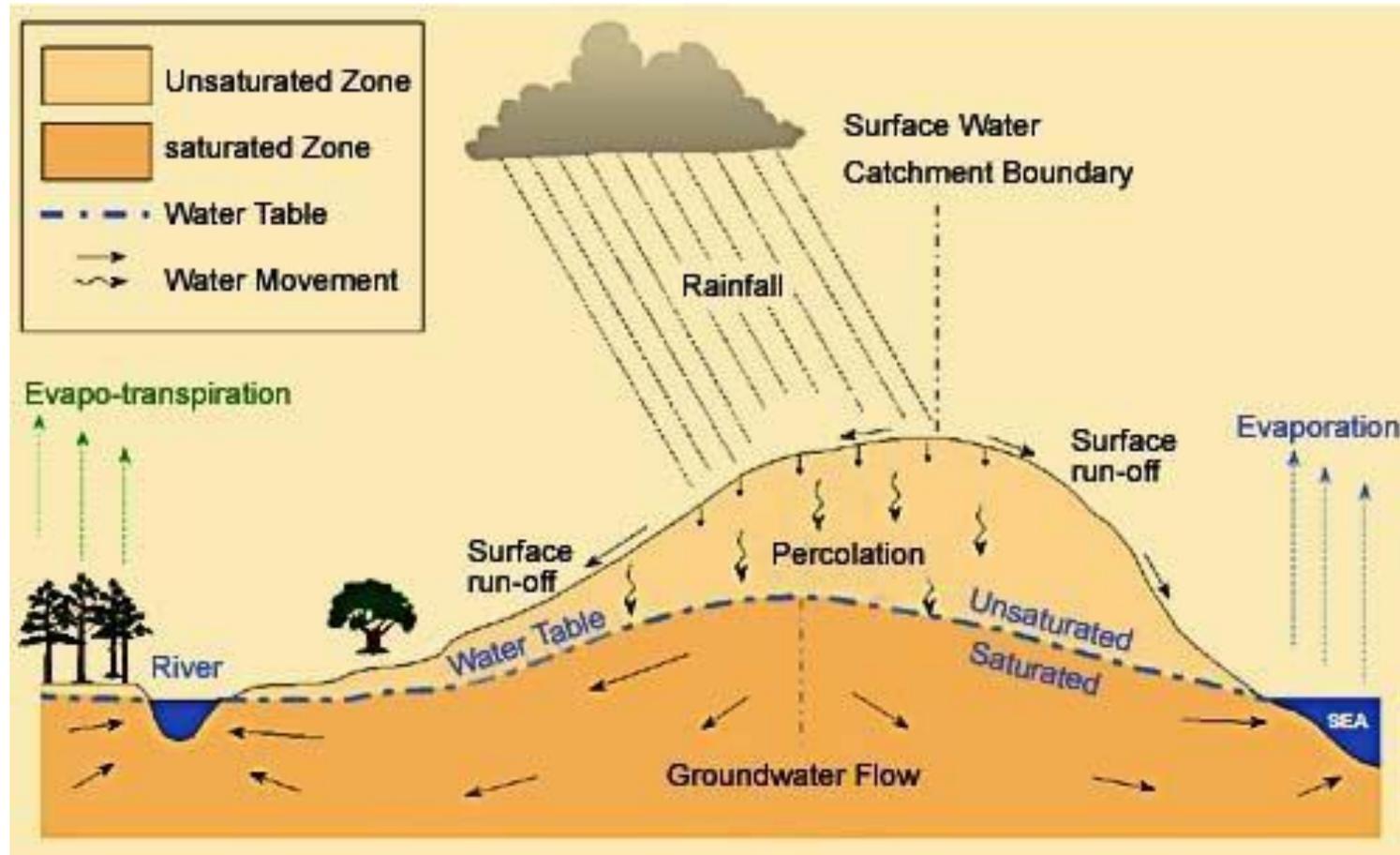
Site assessment

Topography



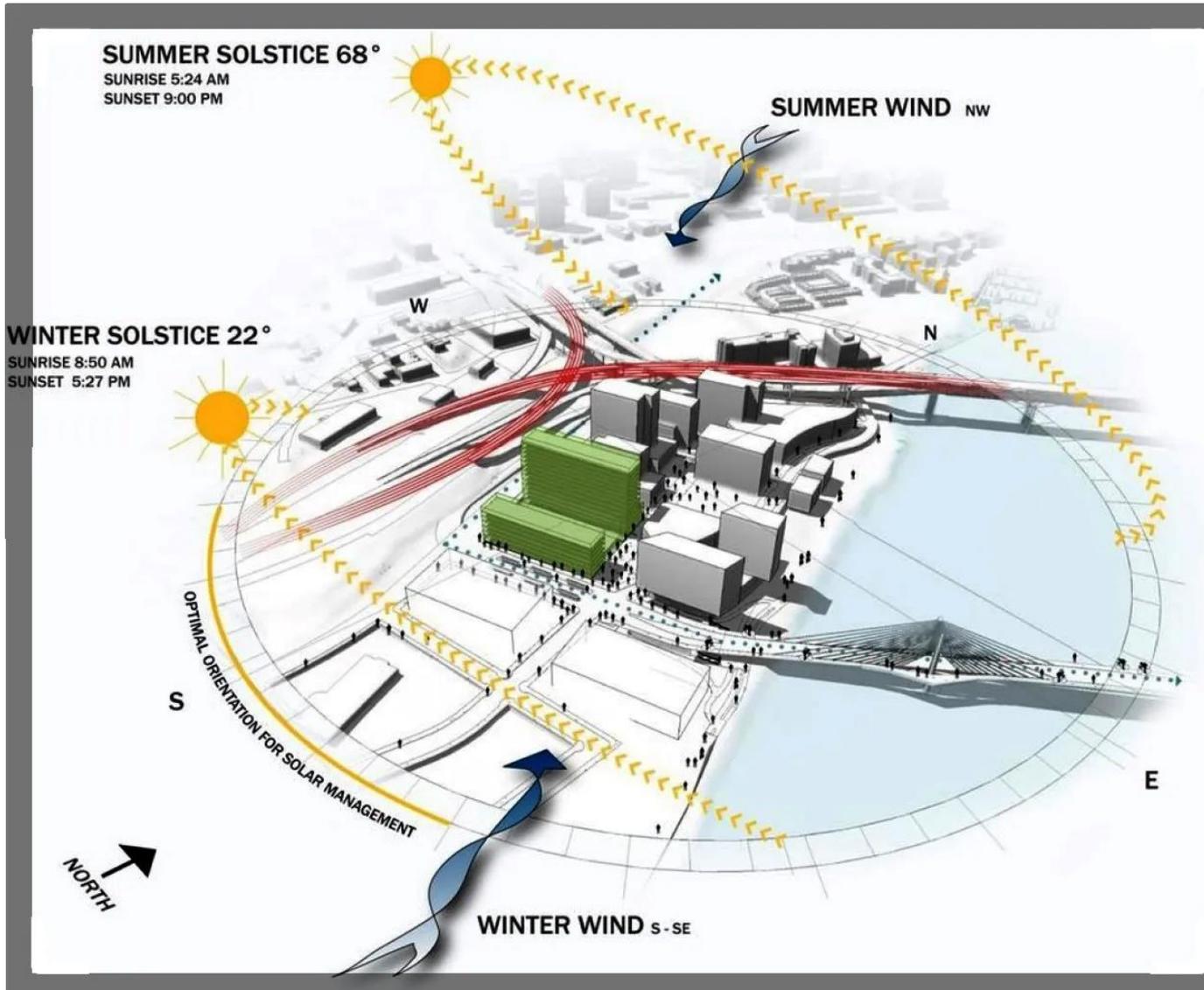
Site assessment

Hydrology



Site assessment

Climate



Site assessment Vegetation

Site vegetation analysis



Single-use farmland

Wild-rice-stem-is-planted-in-this-wide-farmland. Wild-rice-stem-is-widely-planted-in-eastern-China,



Demolished factories

There-are-some-factories-in-original-site. Factories-are-demolished-now-because-



scale 1 : 5000



cedar

Hybrid-use farmland

Four-types-of-agriculture-features-are-planted-in-



edible canna



corn



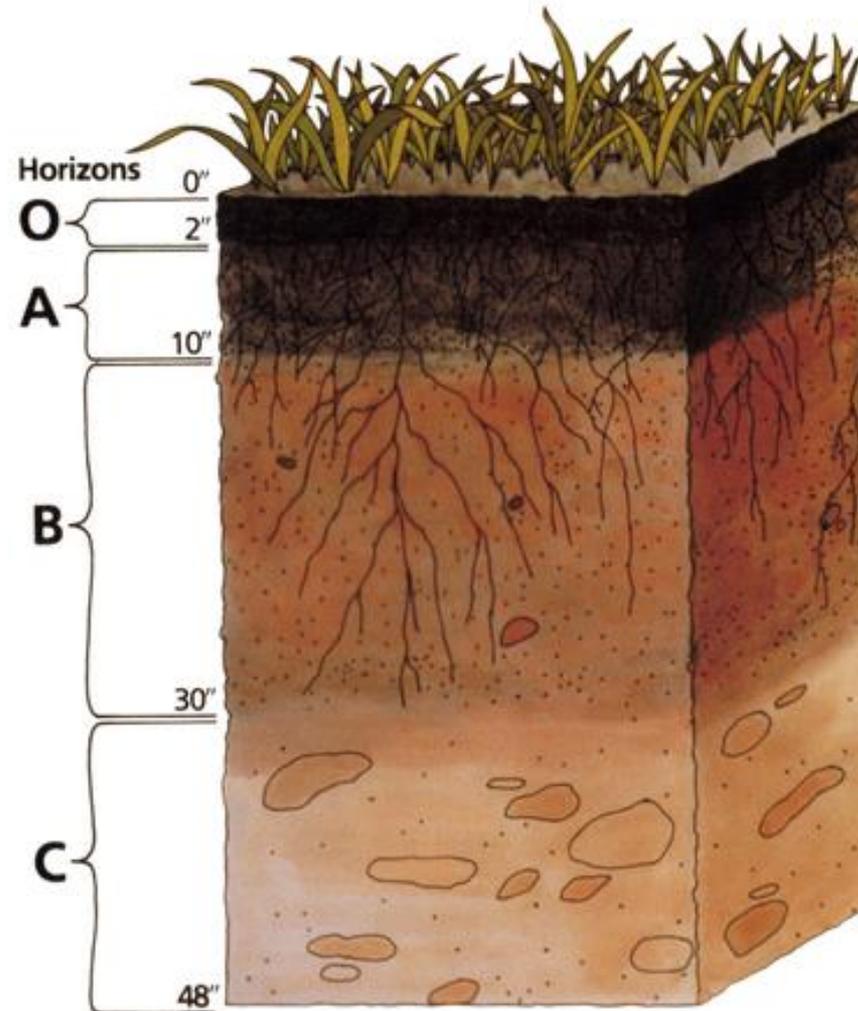
radish



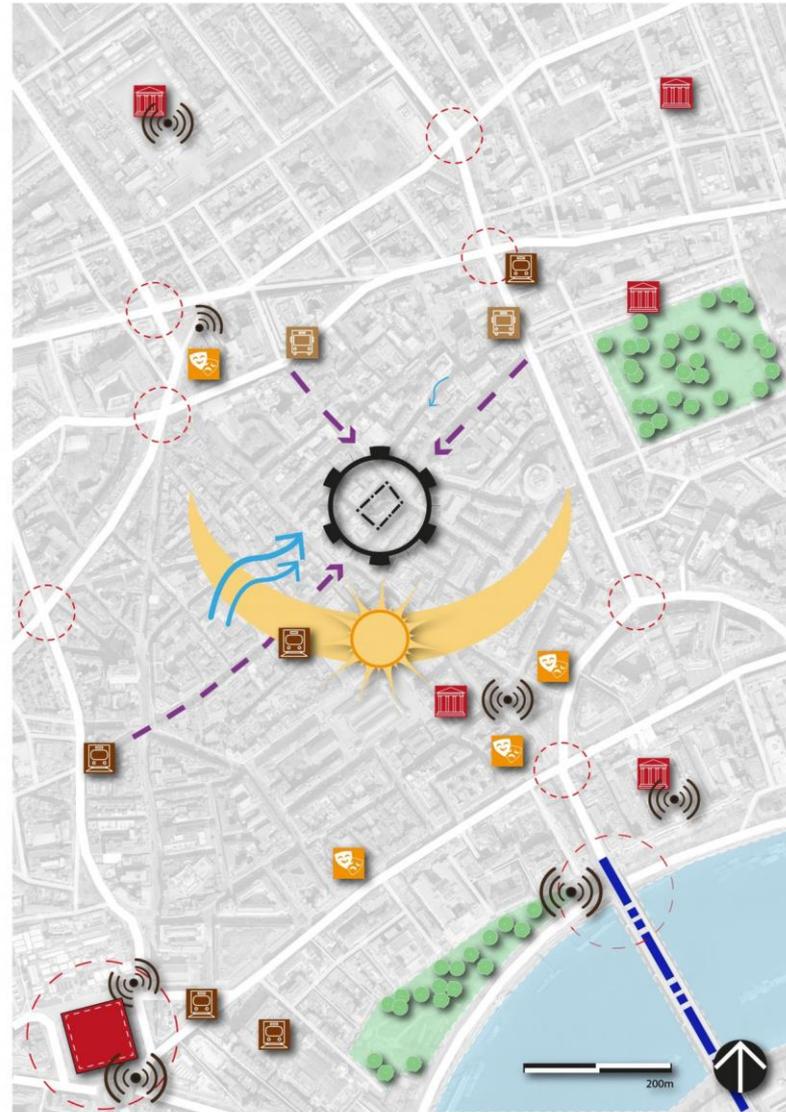
wild rice stem

Site assessment

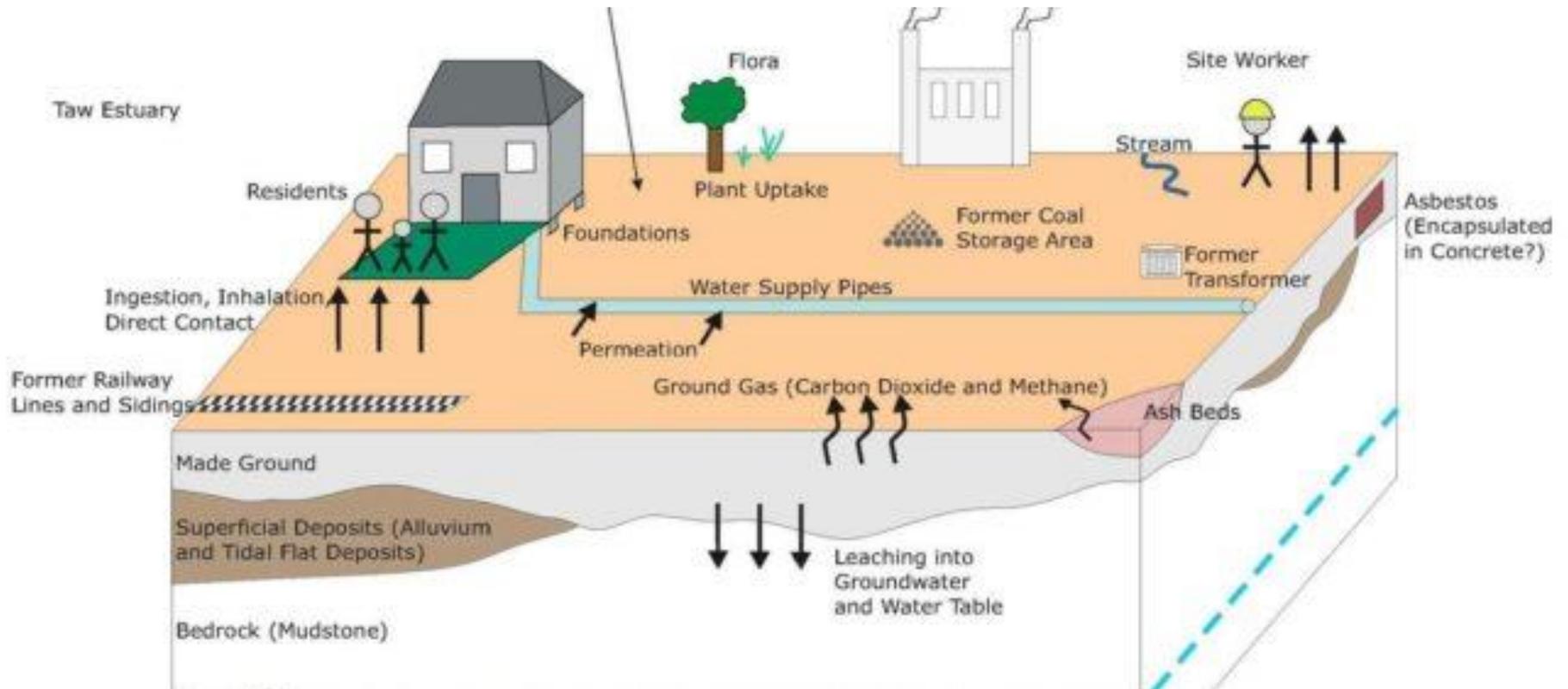
Soil



Site assessment *Human use*



Site assessment Human health effect



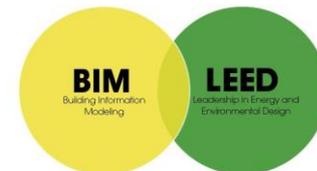
Site design

When designing the site, all the development footprint of the project should be considered as a whole.

A **building footprint** is the area the building sits on, and the **development footprint** is the sum of all the areas that are affected by the project's activity in the project site. Thus, the development footprint will cover the building footprint and the sidewalks, access roads, hardscapes, parking lots, etc.).

The project team should always think about preserving open space. In addition, if there are any damaged areas on the project site, the project team can work on restoring them to support the environment.

Damaged
vegetation



Site design

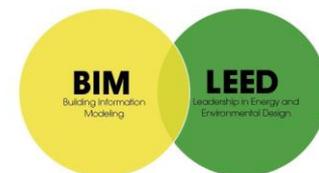
Choosing the type of vegetation to be used in the project is an important decision that will greatly impact outdoor water use consumption.

Native plants (or indigenous plants) are the type of plants that occur and develop naturally in a specific location.

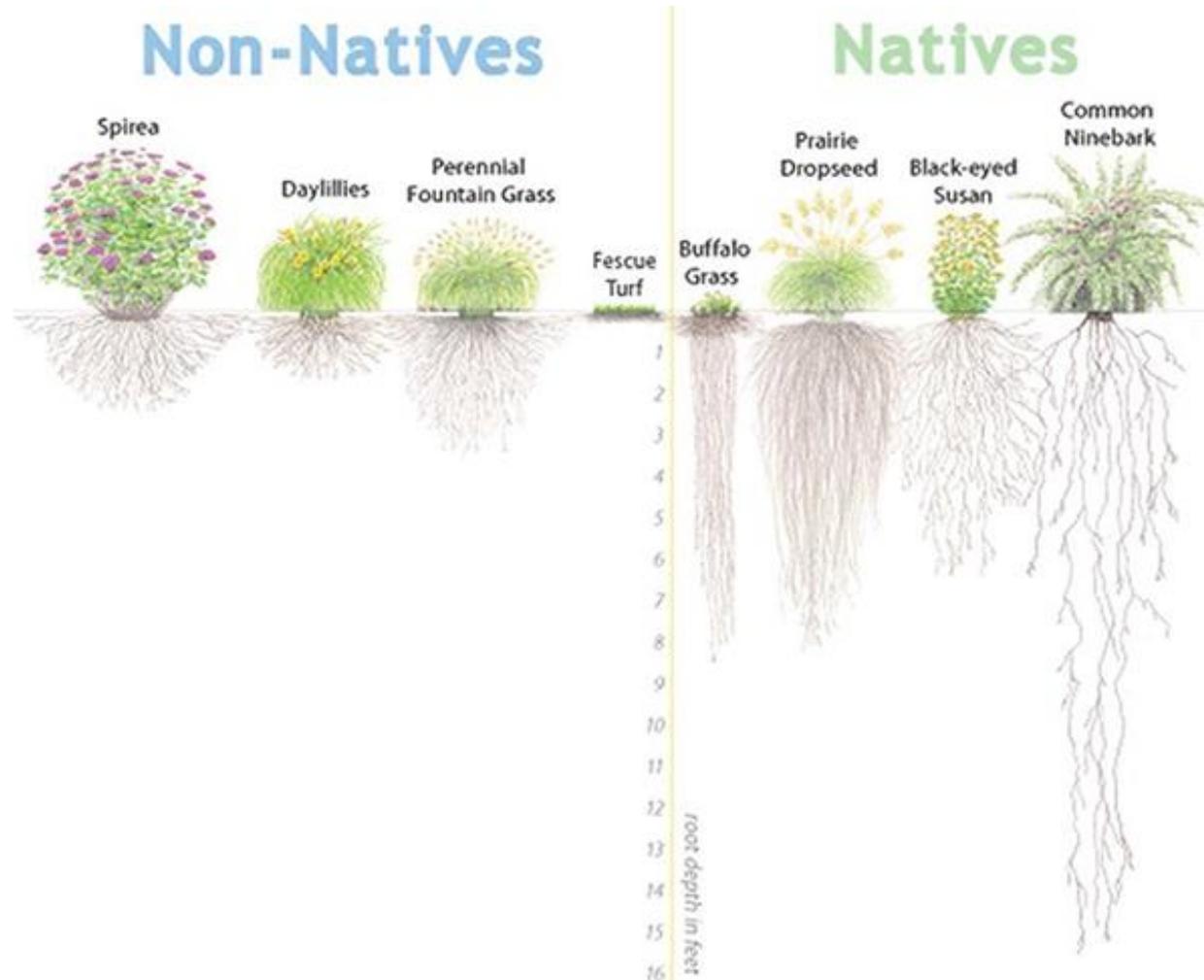
Adapted plants are the types of plants that do not occur naturally in a specific location, but they can nonetheless adapt easily to the climate of the region.

In summary, both native and adapted plants can thrive without extensive irrigation, pesticides, and fertilizers. Other types of plants will require more maintenance and consume more irrigation water, which will result in increased maintenance costs.

Invasive plants are the types of plants that spread and damage the environment.

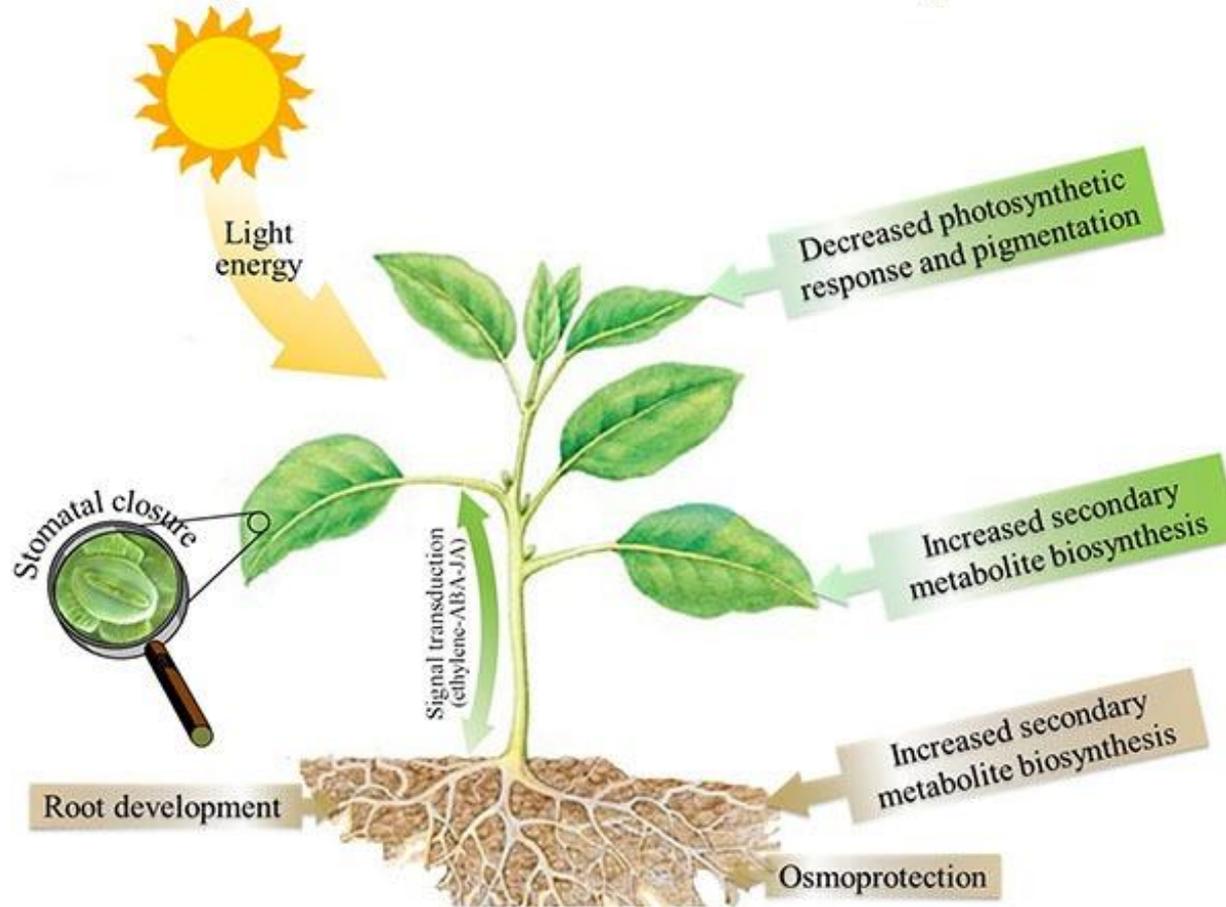


Site design



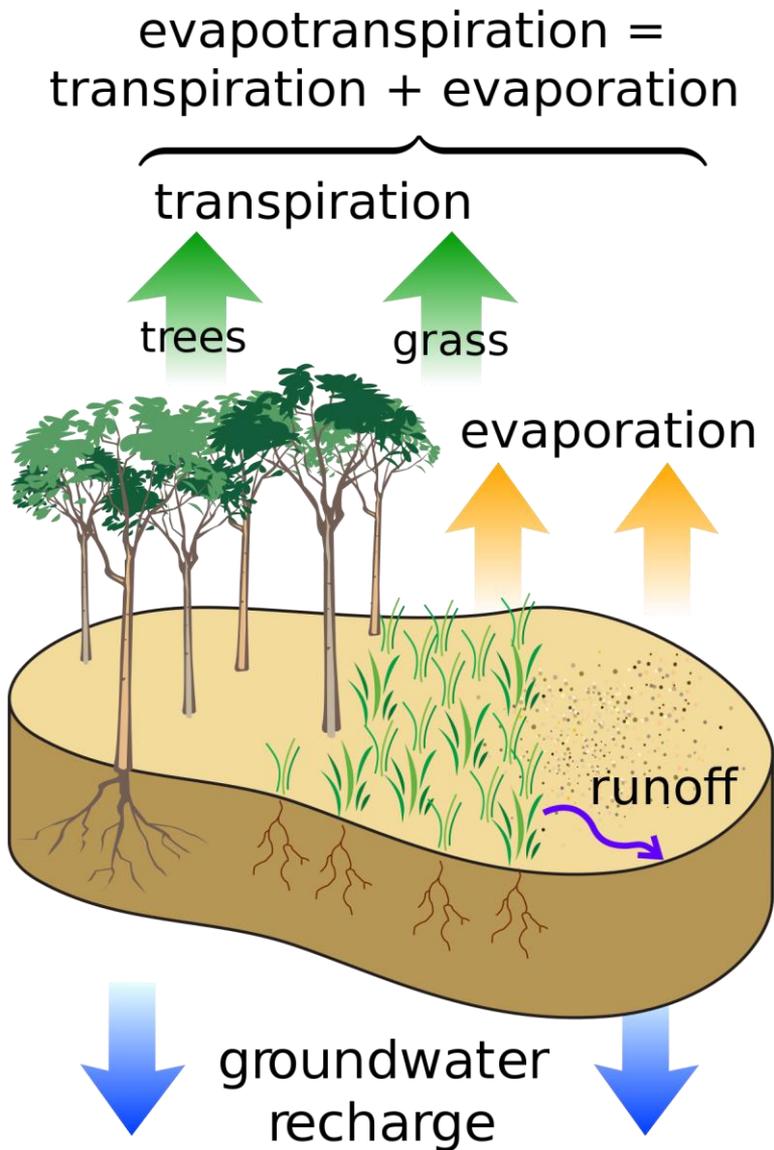
Site design

Adaptation of Plants to Temperature



Site design

Plants can be selected to minimize **evapotranspiration**, which is the term used for the return of water to the atmosphere through evaporation from plants.

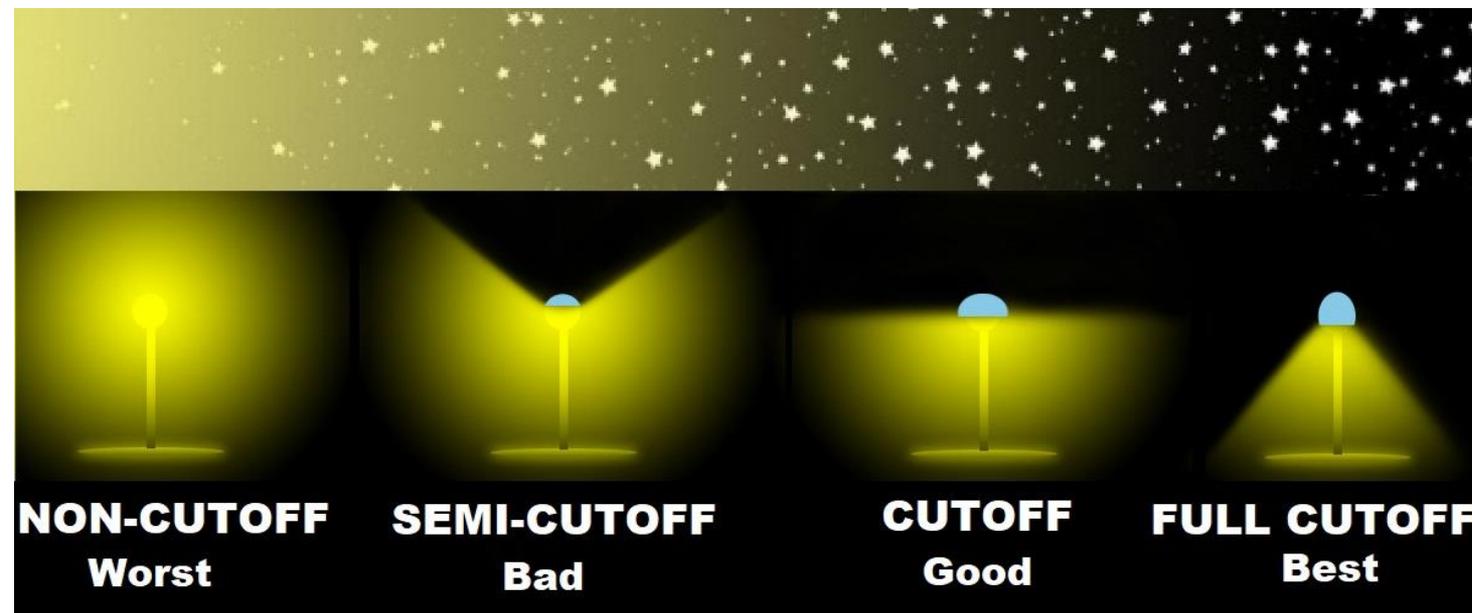


Site design

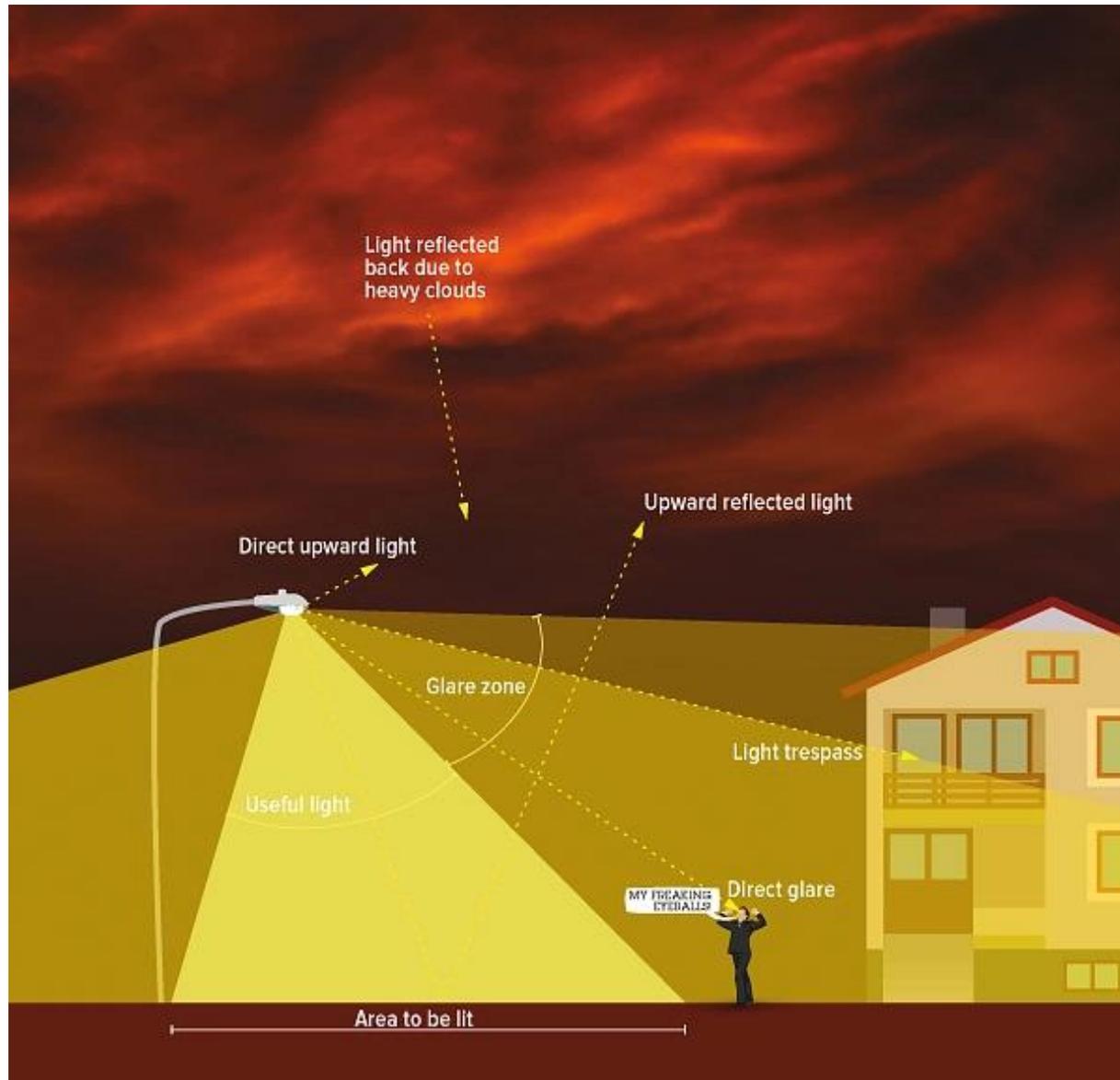
For a LEED certification, the careful selection and placement of lighting fixtures is needed during the site design phase. There are two types of lighting pollution. The first type is the annoying light that intrudes on an otherwise natural or low-light setting, and the second type is the excessive light that leads to discomfort and adverse health effects.

During the lighting design, the project team should eliminate up-lighting, glare, over-lighting, and light trespass (light spilling out of the project boundary) in order to conserve energy and to not create discomfort in the adjacent properties.

Direct full cut-off fixtures should point down-ward to illuminate the project site.



Site design



Site design

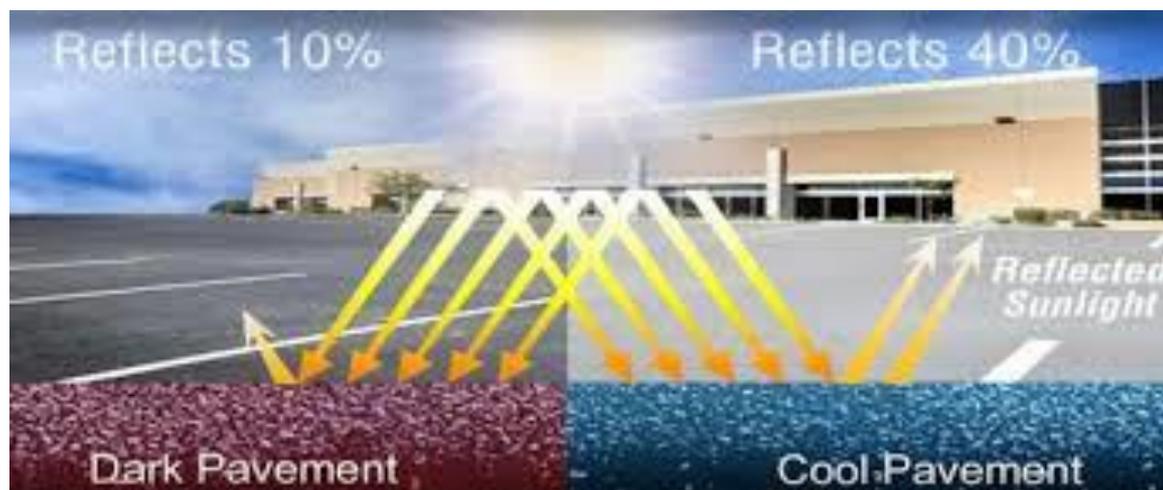
Innovative approaches can also be discovered for more efficient lighting.



Dark pavement



Light pavement

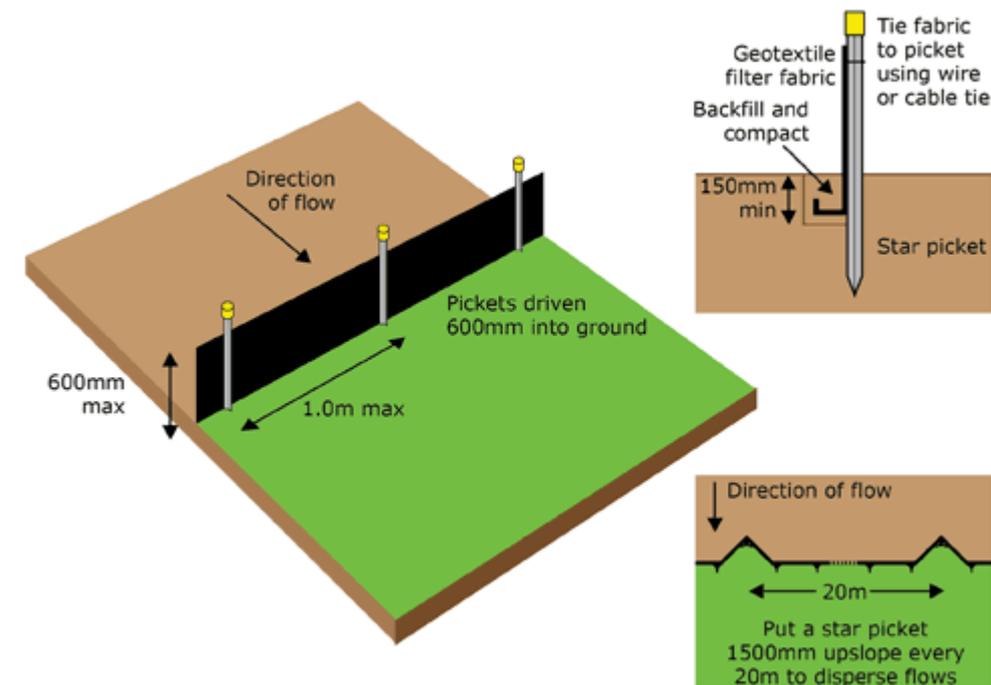


Minimizing construction impacts

The environmental impacts of construction activities should be minimized, and the necessary strategies should be evaluated before the start of construction. While grading the project site, the project team should take measures to prevent erosion and sedimentation.

Sediment fences can be installed around the project site to prevent soil runoff and excessive erosion.

Projects close to wetlands and water bodies should take extra precautions.



Minimizing construction impacts

In order to protect the neighborhood, necessary precautions should be taken to prevent dust caused by construction activities from polluting the neighborhood.

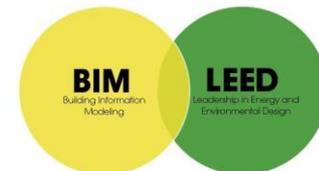


Rainwater management



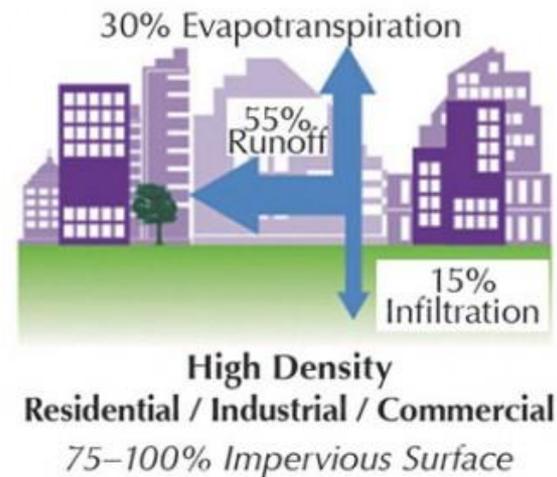
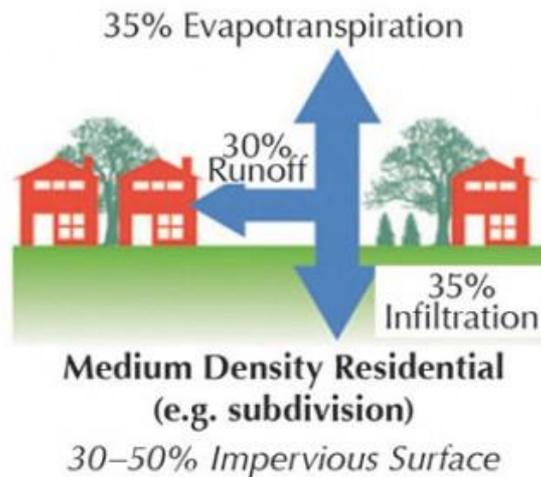
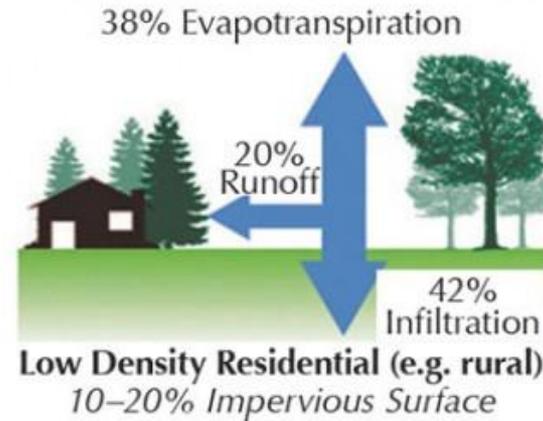
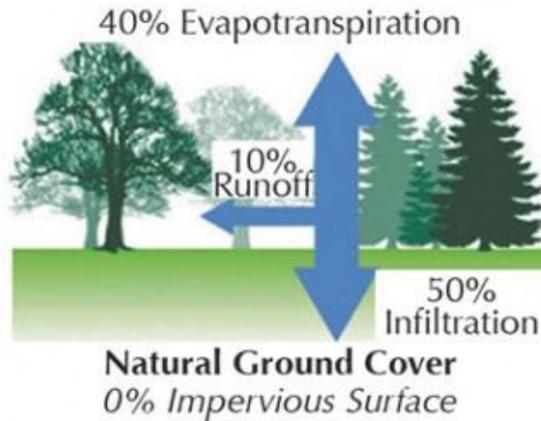
After we started developing the world, soil was replaced by impervious surfaces, through which the rainwater cannot be absorbed by the soil.

Green buildings need to address rainwater management to protect the environment. The first goal of a green building for rainwater management should be for it to contain the least number of impervious surfaces.



Rainwater management

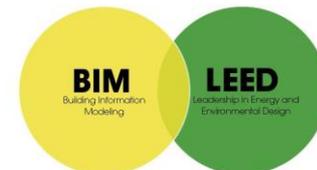
EFFECTS OF IMPERVIOUSNESS ON RUNOFF AND INFILTRATION



Rainwater management

With the stormwater runoff, water gets contaminated by harmful chemicals and then flows into natural bodies of water such as seas, oceans, or lakes, resulting in a degraded surface water quality, which consequently harms aquatic life and prevents recreational opportunities.

This type of pollution is also called **nonpoint source pollution** since the point of the pollution source cannot be identified. The natural hydrology of the ecosystem cannot work anymore.



Rainwater management

The rainwater that falls onto the pervious surfaces should be collected and retained (this is called **on-site water retention**), or at least its flow should be slowed down.



Impervious 'hard' surfaces (roofs, roads, large areas of pavement, and asphalt parking lots) increase the volume and speed of stormwater runoff. This swift surge of water erodes streambeds, reduces groundwater infiltration, and delivers many pollutants and sediment to downstream waters.



Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters.

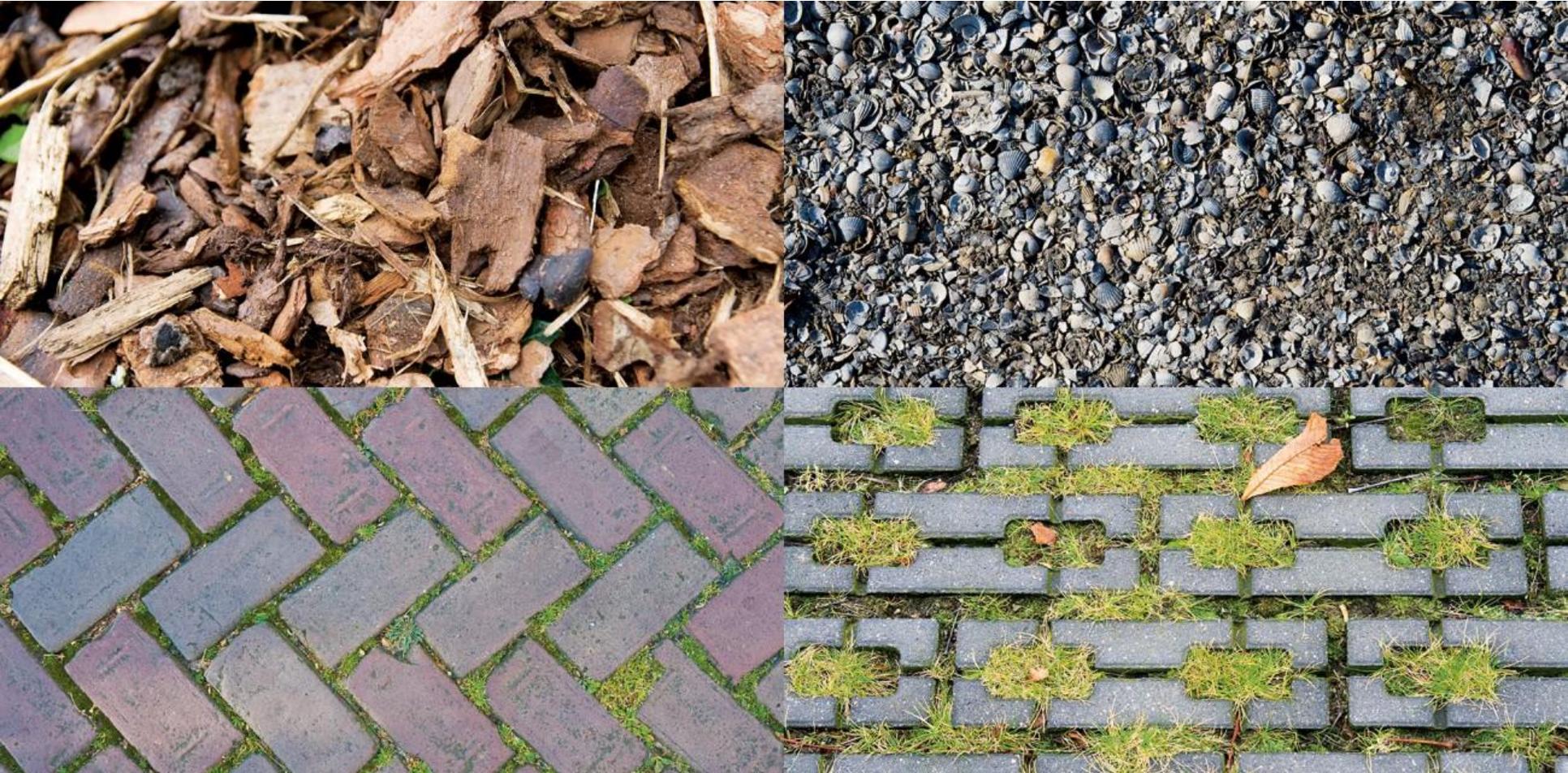
Rainwater management



Rainwater management



Rainwater management



For LEED, an impervious surface is a surface that contains less than 50% perviousness.

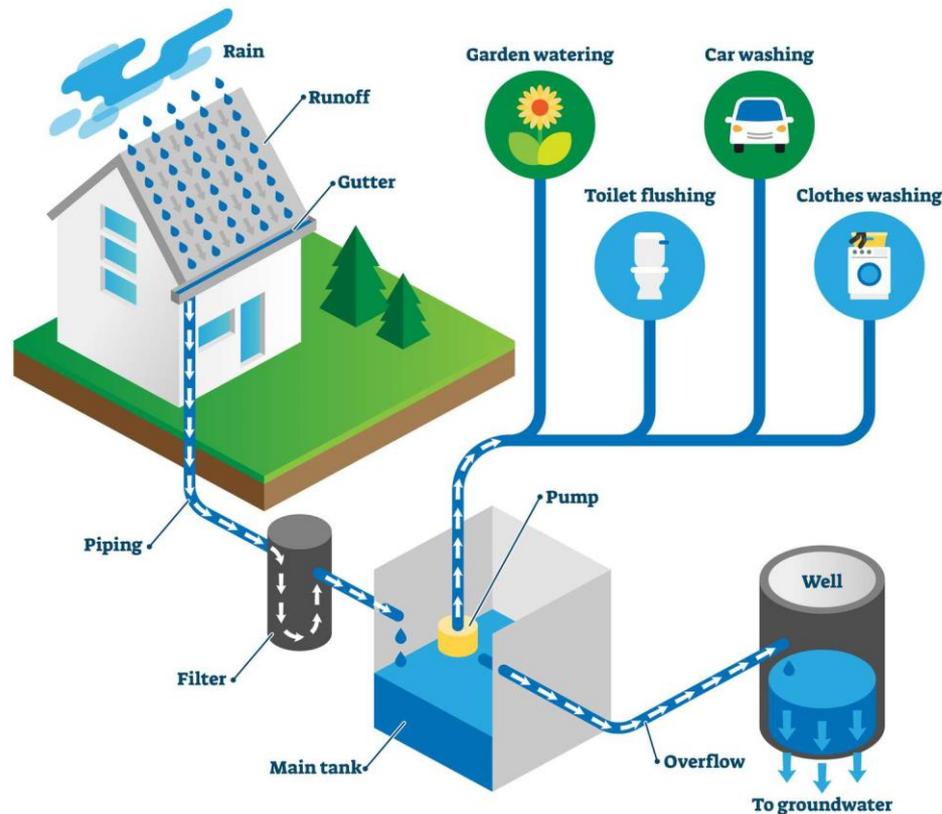
Rainwater management



Rainwater management

Rainwater harvesting, another aspect of rainwater management, is a process whereby rainwater is collected and filtered to be reused as an alternative to potable water. The filtered rainwater can be used for irrigation, for toilet and urinal flushing, or even for process water in cooling towers. For storing the filtered rainwater, installing cisterns will be necessary.

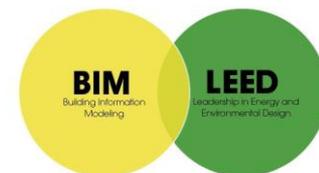
RAINWATER HARVESTING



Rainwater management

Another efficient rainwater management strategy is the use of **low-impact development (LID)**, which is an approach to mimic natural systems and to manage the stormwater closest to its source.

LID strategies include decreasing impervious surfaces and increasing vegetation on-site. LID is used to slow down the flow of rainwater out of site and ensures that the rainwater does not get contaminated.



Rainwater management

Dry ponds



Rainwater management

Green infrastructure (GI) technologies are accepted in LEED for managing the rainwater as well. Green infrastructure is known to direct the rainwater, collected from impervious surfaces, to vegetation and soil surfaces without routing it to the storm sewer system.

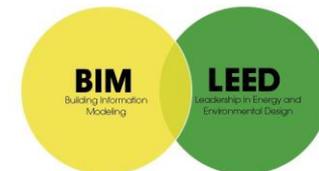
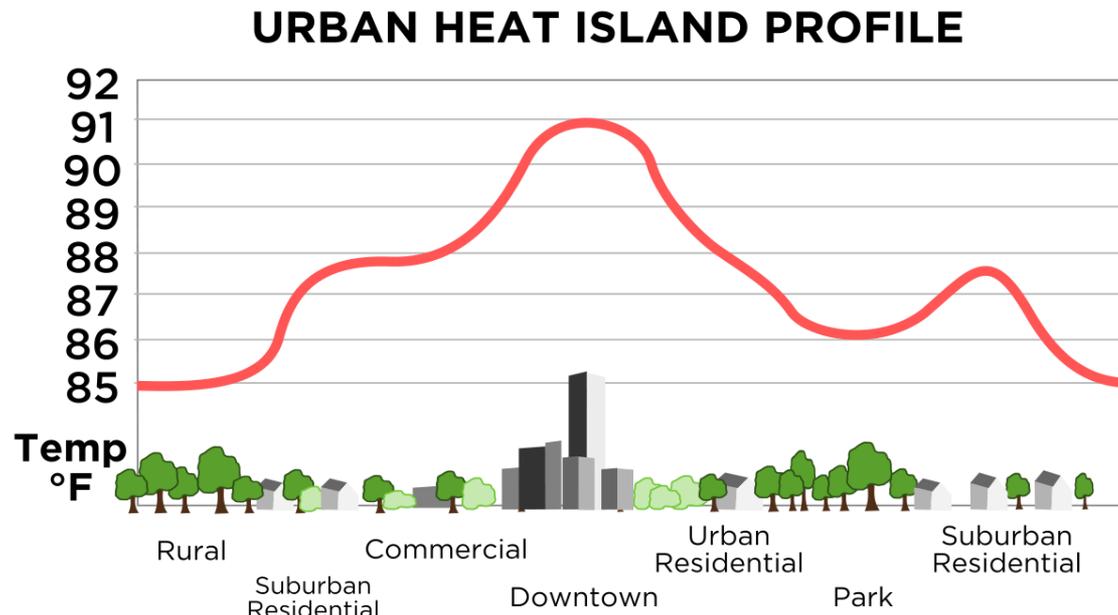


Heat island effect

Disturbing the environment with dark-colored, nonreflective surfaces causes the heat island effect. These surfaces absorb heat during hot weather and release it into the atmosphere.

Studies show that urban “heat islands” are responsible for 24.2% of global warming. And because of this effect, urban areas can have air temperatures that are 1.8°C to 22°C warmer than the surrounding suburban areas. Higher temperatures will also lead to smog or ground level ozone, which creates consequences for human health.

Heat islands are also responsible for increased cooling loads in buildings, which result in higher electricity usage and harm to plants and animals that are sensitive to temperature changes.

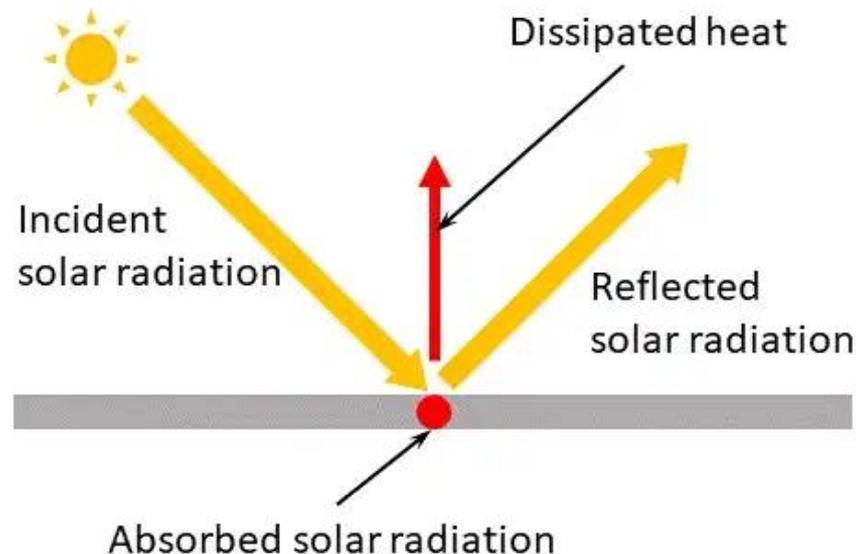


Heat island effect

A **solar reflectance (SR)** value will show the solar energy that is reflected by a surface on a scale of 0 to 1. A black surface will have an SR of 0 while a white surface will have an SR of 1.

A material's SRI value indicate a material's ability to stay cool by reflecting solar radiation and emitting thermal radiation. Thus, both the solar reflectance and **emissivity** of a material will be combined to rank the material.

Emissivity (infrared or thermal emittance) is a measure that shows how much heat or infrared radiation a material can shed back into the atmosphere.



Heat island effect

The SRI value of a material is measured from a scale of 0 to 100, and, within that scale, light-coloring materials are closer to scoring a 100 SRI while darker-colored materials are closer to scoring 0 SRI (lighter-colored materials are sometimes called high **albedo** materials, which is another type of reflectivity measurement). Thus, **the higher the SRI or SR, the lower the heat island effect.**

Material surface	Solar reflectance	Emittance	SRI*
Black acrylic paint	0.05	0.9	0
New asphalt	0.05	0.9	0
Aged asphalt	0.1	0.9	6
«White» asphalt shingle	0.21	0.91	21
Aged concrete	0.2 to 0.3	0.9	19 to 32
New concrete (ordinary)	0.35 to 0.45	0.9	38 to 52
New white portland cement concrete	0.7 to 0.8	0.9	86 to 100
White acrylic paint	0.8	0.9	100

*See also the section on LEED below



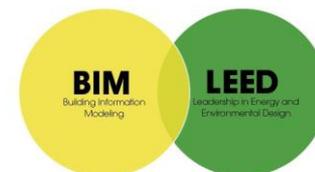
Heat island effect

In order to classify building materials according to their solar emissions and reflectance, the **solar reflectance index (SRI)** will be used for the roofing materials, and **solar reflectance (SR)** values will be used for the nonroof materials (such as hardscape) in LEED calculations.

And in addition to the initial SR and SRI values, three-year-aged SR and SRI values will also be needed for LEED credit calculations since the materials' performance will drop as the age.

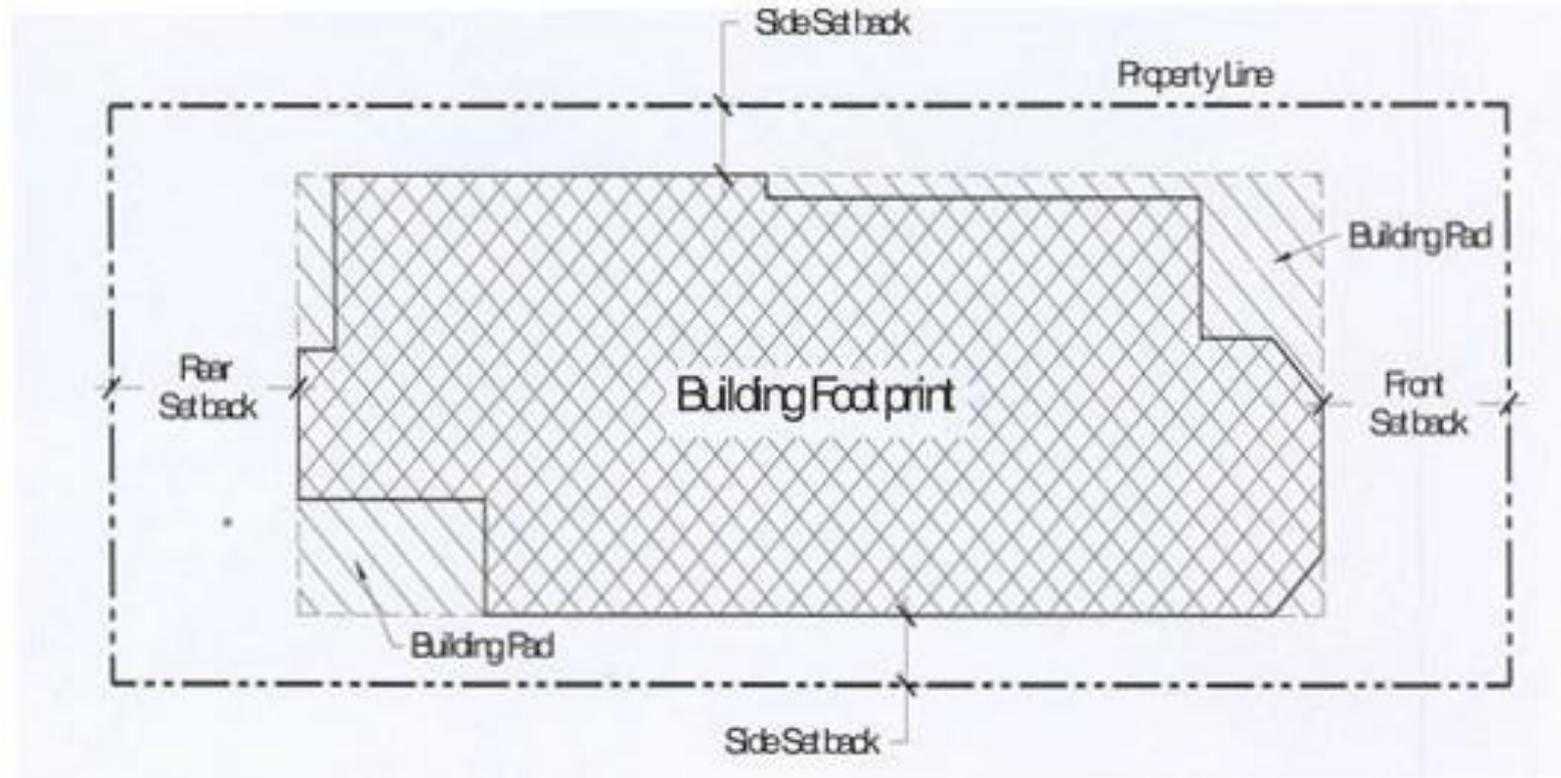
Typical Solar Reflectance Values for Standard Nonroof Materials		
Material	Initial Solar Reflectance	Three-Year Aged Solar Reflectance *
Gray cement concrete	0.26	0.18
White cement concrete	0.70	0.35
Asphalt concrete	0.05	0.10

*Three-year aged SR values are based on no cleaning.
Source: USGBC LEED Interpretation #10411, April 1, 2015



Heat island effect

Minimize building footprint



Heat island effect *Underground parking*



Heat island effect

Using hardscape materials with high SR values

Ground cover	Reflectance (ρ_g)
Grass	0.25
Water	0.1
Asphalt	0.12
Concrete and Pavement	0.5
Roof	0.08
Vegetation	0.16

Heat island effect

Reducing the area of paved surfaces exposed to sunlight



Heat island effect *Installing vegetated roofs*

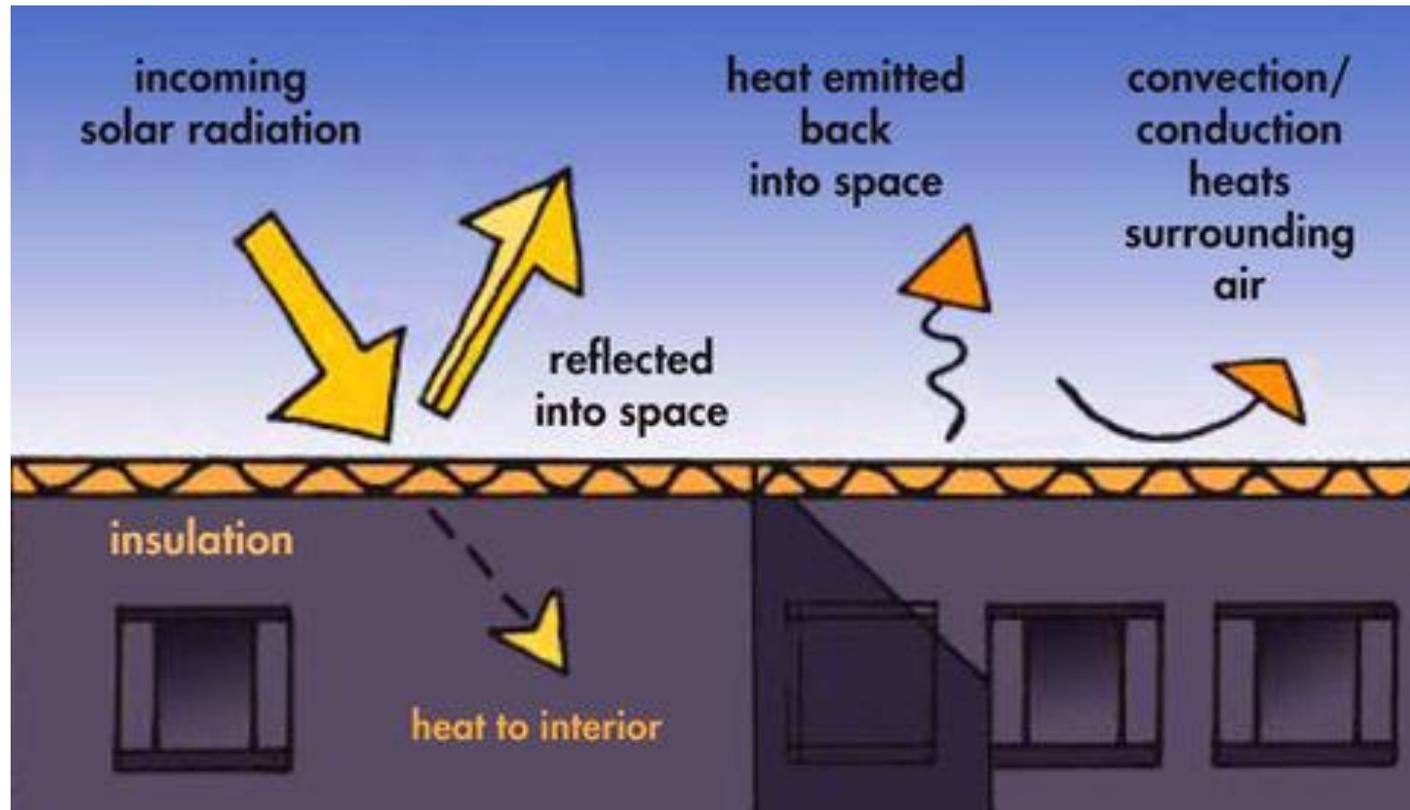


Heat island effect *Installing cool roofs*



Heat island effect

Using roof surfaces with high SRI values



Heat island effect

Providing shade



Heat island effect *Using solar panels on the roof*



Heat island effect *Using open-grid paving*



Heat island effect *Using cool pavements*



Site management

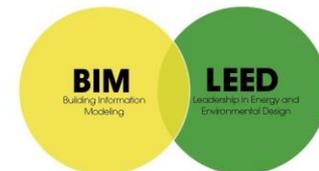
Careful plant selection, innovative irrigation systems, and an efficient outdoor lighting design are some strategies that will aid in sustainable site management. During the site management phase, strategies below can be implemented:

- Utilize **Integrated Pest Management (IPM)**
- Develop a sustainable site management plan
- Implement conservation program
- Use nontoxic chemicals for cleaning outside the building
- Careful use fertilizers and maintenance products in landscaping
- All site lighting should be fully cut-off and designed to eliminate night-time light pollution



Strategies to address location and transportation

- Protect and restore habitat
- Minimize construction impacts
- Conduct a construction assessment to assess and evaluate topography, hydrology, climate, vegetation, soil, human use, human health effects
- Preserve open space
- Use native landscaping (by using native and adapted plants)
- Minimize hardscapes
- Minimize the development footprint
- Minimize impervious areas and maximize pervious areas
- Incorporate stormwater management into the site design
- Control and redirect stormwater (by installing dry ponds, rain gardens, bioswales, etc.)
- Utilize low-impact development (LID) and green infrastructure (GI)
- Harvest rainwater
- Eliminate up-lighting, glare, over-lighting, and light trespass
- Maintain site lighting to prevent light pollution
- Reduce the heat island effect
- Install reflective roof surfaces
- Provide undercover/underground parking
- Reduce the area of paved surfaces exposed to sunlight
- Plant an urban forest or a green roof
- Use products with high SR and SRI values



Strategies to address location and transportation

- Develop a sustainable site management plan
- Implement conservation programs
- Use nontoxic chemicals for site cleaning
- Implement Integrated Pest Management (IPM)

