Right Start, Right Result: Beginning With the Site

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Site sustainability addresses the environmental impacts involved in the process of site design, development and post-development activities. Buildings and associated development often disrupts natural ecosystems and increases the negative effects of erosion, storm water runoff and summer heat sinks. The location of a building site can impact greenhouse gas emissions and other pollutants based on available options for alternative modes of transportation including pedestrian proximity to basic services and residential communities.

The intent of site sustainability is to support smart growth planning, protect environmentally sensitive lands, reduce heat island effect, minimize site light pollution, maximize pervious surfaces, retain native and biodiverse vegetation and manage on-site storm water through reuse, infiltration or evapotranspiration.

Figure 1 Compliance paths.

Mandatory Provisions
Site Selection: Section 5.3.1
Mitigation of Heat Island Effect: Section 5.3.2
Reduction of Light Pollution: Section 5.3.3

Then, Choose One:

Prescriptive Option
Site Development: Section 5.4.1

OR

Performance Option
Site Development: Section 5.5.1

Mandatory Provisions

Mandatory site provisions include site selection, mitigation of heat island effect and the reduction of light pollution (*Figure 1*).

Site Selection

The intent of this section is to minimize development on greenfields and undeveloped sites. Development must occur on sites that have existing infrastructure, including building reuse and modifications to an existing building envelope. This includes

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Section 5:

Site Sustainability

The intent of site sustainability is to support smart growth planning, protect environmentally sensitive lands, reduce heat island effect, minimize site light pollution, maximize pervious surfaces, retain native and biodiverse vegetation and manage on-site storm water.

Figure 2 Sample map of pedestrian connectivity in the immediate area surrounding the building site.

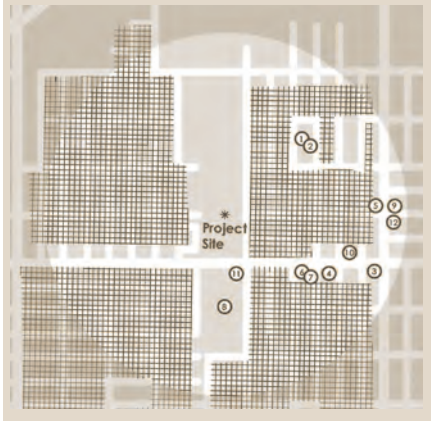
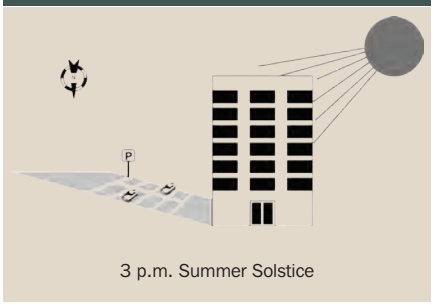


Figure 3 Sample diagram of hardscape shading cast by a building on summer solstice.



development on existing greyfields or mitigated brownfield sites.

Development cannot occur on a greenfield site unless conditions exist that support pedestrian connectivity in the immediate area surrounding the site (*Figure 2*). These conditions include proximity to residential density (10 units per acre), 10 basic services (with 0.5 mile [0.8 km]) and train service (within 0.5 mile [0.8 km]) or other adequate transit service (within 0.25 mile [0.4 km]). Finally, development can occur on a greenfield site that is classified as agricultural, forest or designated park land when the specific function of the building is related to the respective use of the land.

In addition to site selection, Standard 189.1 limits development in flood hazard areas, fish and wildlife habitat conservation areas, and wetlands.

Mitigation of Heat Island Effect

The intent of this section is to minimize the effect of heat-absorbing materials used for site hardscape, walls and roofs. At least 50% of the site hardscape must be provided by any one or combination of strategies involving shade provided by vegetation, structures and/or paving materials with a solar reflective index (SRI) of at least 29 (*Figure 3*). The shade coverage on hardscape must be based on the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on summer solstice. Climate Zones 6, 7 and 8 are exempt from this requirement.

At least 30% of east and west above-grade walls must be shaded from grade level to a height of 20 ft (6 m) by any one or combination of strategies involving vegetation, building projections, architectural screening elements, existing buildings and/or topographical land features such as hillsides (*Photos 1* and *2*). The shade coverage calculations must be based on summer solstice at 10 a.m. for eastern exposed walls and 3 p.m. for western exposed walls. There are a number of exceptions based on east/west wall orientation and climate zone.

In Climate Zones 1, 2 and 3, at least 75% of the roof surface must comply with one or a combination of strategies involving a minimum solar reflectance index (SRI) of 78 for a low-slope roof (≤2:12), and an SRI of 29 for a steep-sloped roof (>2:12), vegetated roofing, roof-covered solar energy systems and/or a roof complying with ENERGY STAR criteria. An exception exists for roofs used to cover parking and for buildings that demonstrate energy cost savings through an energy analysis simulation in accordance with Energy Efficiency Sections 7.5.2 and 7.5.3.

The sidebar covers the relationship between heat island effect and building heat gains.

Reduction of Light Pollution

The intent of this section is to minimize nighttime site illumination. Adverse effects include light trespass, glare, sky glow, decreased visibility and wasted energy.

Light pollution is a broad term used to describe unwanted or unnecessary nighttime illumination, classified as light trespass, glare and skyglow. Light trespass is light that strays from the intended purpose and becomes an annoyance, a nuisance, or a detriment to visual performance.[1] Sky-glow is the brightening of the night sky that results from the reflection of radiation.[1] Glare refers to light that hinders or bothers the human eye.[2]

The light pollution requirements in Standard 189.1 are applied in five different lighting zones (*Table 1*). These

Photo 1 (left) West wall protection in Climate Zone 2 (photo: Will Bruder + Partners).

Photo 2 (below) Shade on the west wall in Climate Zone 5 (photo: CTLGroup).

lighting zones are defined to reflect different nighttime ambient lighting conditions ranging from inherently dark to higher ambient urban settings. The lower lighting zones (LZ0) have much more restrictive requirements than the higher zones. Based on the type of light pollution, the building project must use the backlight, uplight and glare (BUG) ratings developed in IESNA TM-15 to determine fixture requirements for the various lighting zones. This section also requires adherence to the exterior lighting power allowances of ASHRAE/IES Standard 90.1 Addendum *i* in an attempt to balance visual needs with the desire to eliminate unnecessary light.

Prescriptive Option

For those building projects choosing the prescriptive compliance path, additional site-related requirements must be followed to demonstrate compliance with the Standard. These requirements address the effective perviousness of surfaces and the preservation of native plants.

Effective Pervious Area

At least 40% of the site must incorporate any one or combination of strategies involving native vegetation, vegetated roofs, porous pavers, permeable pavement or open-graded aggregate (*Photo 3*). A number of exceptions are based on the percentage of rainfall that is captured and reused for site or building water use. There is also an exception for locations with an average annual rainfall of less than 10 in. (254 mm).

Greenfield Sites

A minimum of 20% of a site must consist of local native plants or adapted plants based on predevelopment site conditions. A minimum of 60% of such vegetated area must consist of biodiverse plantings. Once again, there is an exception for locations with an average annual rainfall of less than 10 in. (254 mm).

Exterior Zone & Lighting Level	
LZ0: Very Dark	Remote fire station located in an undeveloped portion of a National Park
LZ1: Dark	Gas station in a rural location outside a small town
LZ2: Low	Grocery store adjacent to a residential neighborhood
LZ3: Medium	Commercial district including retail and restaurant establishments
LZ4: High	Hotel located in a high density, metropolitan area

Table 1 Lighting zone designations.

Photo 3 Pervious concrete (photo: CTLGroup).

Figure 4 Rainwater collection and reuse.

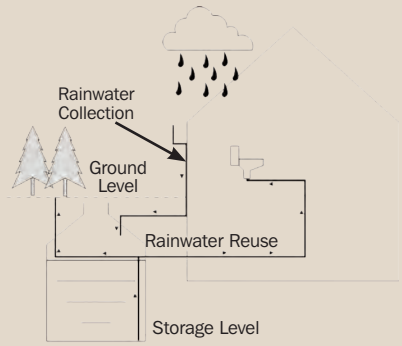
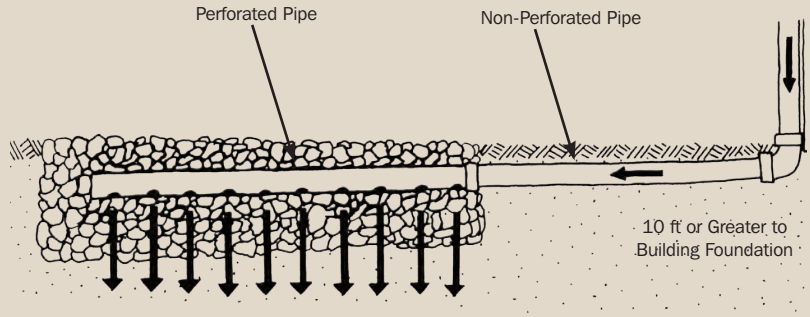


Figure 5 On-site infiltration of rainwater (figure: Ann Audrey).



Performance Option

For building projects that do not follow the prescriptive option, the performance option provides an alternative method to demonstrate compliance with requirements for on-site retention, collection and/or reuse of rainfall (*Figures 4* and *5*). As such, a percentage of the average annual rainfall on the development footprint (on-site impervious surfaces) must be managed through infiltration, reuse or evapotranspiration (ET) based on whether the site is on an existing building site, greyfield, brownfield or greenfield site. Existing greenfield sites require a minimum of 50% of the average annual rainfall to be managed through infiltration, reuse or ET. Whereas greyfield and brownfield sites require 40% and projects in an existing building envelope require only 20%.

References

1. IESNA. 2000. Technical Manual TM-10-00, *Addressing Obtrusive Light (Urban Sky Glow and Light Trespass) in Conjunction with Roadway Lighting*. New York: Illuminating Engineering Society of North America.

2. NEMA. 2000. *White Paper on Outdoor Lighting Code Issues*. Rosslyn, Va.: National Electrical Manufacturers Association. ■

Urban Heat Island Effect and Building Heat Gain

Confusion can easily arise when trying to balance the impact of the building surface reflectivity (expressed as SRI) on the urban heat island effect with the impact of building SRI or shading on the overall heat gain to the building and its resulting impact on cooling or heating loads. SRI takes into account thermal emittance as well as solar reflectance of building materials.

The requirements of Section 5 deal with the impacts on the surrounding environment *external* to the building. The urban heat island effect is a well-documented phenomenon that is caused by a number of factors, one of which is the absorption and later release of the sun's energy into the local atmosphere and surroundings. In this case, setting sufficiently high SRI values (or inclusion of shading provisions) will minimize the absorption of the sun's energy by the building exterior and reradiation or convective heat to the local environment (air and adjacent surfaces).

How much of the sun's energy gets absorbed by the building envelope impacts the building cooling and heating loads to some extent, and the requirements in Section 5.3.2 were written to take into account climate zone differences. For example, in a heating-load-dominated environment the absorption of solar energy by the envelope overall is a good thing overall (although not a lot of solar energy is available for absorption in the winter in most cold climates). The opposite is true for cooling-load-dominated climate zones. Cooling load dominated climate zones also would tend to have more of a problem with urban heat islands than heating-dominated climates, at least on a total number of hours per year.

How Cool Roofs Work

Conventional Roof
Reflects 30% to 60% of incident solar.
Absorbs 40% to 70% (heats roof and adds to cooling load and urban heat island).

Cool Roof
Reflects up to 80% of incident solar.
Absorbs ~20%