THE SUSTAINABLE SITES INITIATIVE™

GUIDELINES AND PERFORMANCE BENCHMARKS 2009

American Society of Landscape Architects

Lady Bird Johnson Wildflower Center
at The University of Texas at Austin

United States Botanic Garden

The Sustainable Sites Initiative is a partnership of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center, and the United States Botanic Garden in conjunction with a diverse group of stakeholder organizations to establish and encourage sustainable practices in landscape design, construction, operations, and maintenance.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 (hereinafter, *Guidelines*) is modeled after the Leadership in Energy and Environmental Design Green Building Rating System™ (LEED®) and draws from LEED and the related resource materials, the *LEED Reference Guides* of the U.S. Green Building Council ("USGBC"). The content of LEED® and the *Reference Guides* incorporated in the *Guidelines* is used with the permission of and under license with USGBC.

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The American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden strongly encourage all applicable building projects to seek to achieve LEED certification in addition to incorporating sustainable elements described in the *Guidelines* to the greatest extent possible and practicable.

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INTRODUCTION

The services people enjoy from healthy ecosystems are the unobtrusive foundation of daily life. Trees help regulate local climate by providing shade and acting as windbreaks. Through evaporation, transpiration, and the uptake and storage of carbon, plants moderate the climate of the world and provide a breathable atmosphere. Thousands of different pollinator species visit their respective flowers and promote the growth of myriad plants and crops. Healthy wetlands protect against floods and help to improve water quality. Soils and vegetation purify stormwater seeping through to groundwater and underground aquifers.

Ecosystem services like these occur at a variety of scales, in habitats ranging from equatorial rainforests to urban parks (see page 6). Yet because these services occur largely in the background, governments and businesses don't include them in their conventional cost accounting. In fact, people often underestimate or simply ignore these benefits and services when making land-use decisions—only to realize later how difficult, expensive, and sometimes impossible it is to replicate ecosystem services once they are lost.

The Sustainable Sites Initiative™ is dedicated to fostering a transformation in land development and management practices that will bring the essential importance of ecosystem services to the forefront. For purposes of the Initiative, land practices are defined as sustainable if they enable natural and built systems to work together to "meet the needs of the present without compromising the ability of future generations to meet their own needs."* To that end, the Guiding Principles listed on page 7 not only inform the work of the Sustainable Sites Initiative but should also inform all aspects of sustainable site development.

The Initiative's central message is that any landscape, whether the site of a large subdivision, a shopping mall, a park, an abandoned rail yard, or a single home, holds the potential both to improve and to regenerate the natural benefits and services provided by ecosystems in their undeveloped state. (For more information on the relationship between ecosystem services and sustainable landscaping see *The Sustainable Sites Initiative: The Case for Sustainable Landscapes*, 2009.)

Since 2006, the 55 individuals who make up the Initiative's volunteer Technical Subcommittees, Steering Committee, Executive Committee, and Initiative staff have been developing clear and rigorous criteria for sustainable landscape design, construction, operations, and maintenance. This effort has also included

***Note**: This definition of sustainability is from* Our Common Future, *the 1987 report prepared by the United Nations World Commission on Environment and Development, chaired by Gro Harlem Brundtland, then-Prime Minister of Norway. The report is often referred to as the Brundtland Report*.

Ecosystem Services

Ecosystem services are goods and services of direct or indirect benefit to humans that are produced by ecosystem processes involving the interaction of living elements, such as vegetation and soil organisms, and non-living elements, such as bedrock, water, and air.

Researchers have come up with a number of lists of these benefits, each with slightly different wording, some lists slightly longer than others. The members of the Sustainable Sites Initiative's committees and staff have reviewed and consolidated the research into the list below of ecosystem services that a sustainable site can strive to protect or regenerate through sustainable land development and management practices.

Global climate regulation
Maintaining balance of atmospheric gases at historic levels, creating breathable air, and sequestering greenhouse gases

Local climate regulation
Regulating local temperature, precipitation, and humidity through shading, evapotranspiration, and windbreaks

Air and water cleansing
Removing and reducing pollutants in air and water

Water supply and regulation
Storing and providing water within watersheds and aquifers

Erosion and sediment control
Retaining soil within an ecosystem, preventing damage from erosion and siltation

Hazard mitigation
Reducing vulnerability to damage from flooding, storm surge, wildfire, and drought

Pollination
Providing pollinator species for reproduction of crops or other plants

Habitat functions
Providing refuge and reproduction habitat to plants and animals, thereby contributing to conservation of biological and genetic diversity and evolutionary processes

Waste decomposition and treatment
Breaking down waste and cycling nutrients

Human health and well-being benefits
Enhancing physical, mental, and social well-being as a result of interaction with nature

Food and renewable non-food products
Producing food, fuel, energy, medicine, or other products for human use

Cultural benefits
Enhancing cultural, educational, aesthetic, and spiritual experiences as a result of interaction with nature

reviewing and incorporating myriad public comments on two prior drafts. With the publication of *The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009*, the Initiative aims to supplement existing green building and landscape guidelines as well as to provide a stand-alone tool for site sustainability.

Describing sustainable practices

In the course of identifying the specific and measurable criteria for site sustainability, members of the Initiative's several committees recognized the need to acknowledge that different regions of the country have distinct requirements and conditions. The committees therefore worked to develop performance benchmarks that would shift the market toward sustainability while remaining practical and achievable on a regional basis.

Guiding Principles of a Sustainable Site

Do no harm
Make no changes to the site that will degrade the surrounding environment. Promote projects on sites where previous disturbance or development presents an opportunity to regenerate ecosystem services through sustainable design.

Precautionary principle
Be cautious in making decisions that could create risk to human and environmental health. Some actions can cause irreversible damage. Examine a full range of alternatives—including no action—and be open to contributions from all affected parties.

Design with nature and culture
Create and implement designs that are responsive to economic, environmental, and cultural conditions with respect to the local, regional, and global context.

Use a decision-making hierarchy of preservation, conservation, and regeneration
Maximize and mimic the benefits of ecosystem services by preserving existing environmental features, conserving resources in a sustainable manner, and regenerating lost or damaged ecosystem services.

Provide regenerative systems as intergenerational equity
Provide future generations with a sustainable environment supported by regenerative systems and endowed with regenerative resources.

Support a living process
Continuously re-evaluate assumptions and values and adapt to demographic and environmental change.

Use a systems thinking approach
Understand and value the relationships in an ecosystem and use an approach that reflects and sustains ecosystem services; re-establish the integral and essential relationship between natural processes and human activity.

Use a collaborative and ethical approach
Encourage direct and open communication among colleagues, clients, manufacturers, and users to link long-term sustainability with ethical responsibility.

Maintain integrity in leadership and research
Implement transparent and participatory leadership, develop research with technical rigor, and communicate new findings in a clear, consistent, and timely manner.

Foster environmental stewardship
In all aspects of land development and management, foster an ethic of environmental stewardship—an understanding that responsible management of healthy ecosystems improves the quality of life for present and future generations.

Among other things, a site can be sustainable over the long term only if it addresses competing demands on three fronts—not just environmental but also economic and social. The committees thus took human health and well-being into account as they developed the measures of sustainability because healthy ecosystems are the source of the many less tangible benefits that humans derive from a relationship with nature. Similarly, the committees looked at the economic costs and benefits associated with sustainable landscape practices. Throughout the process, the Initiative has aimed to encourage innovation and inspire a change in thinking.

Many local and regional efforts now provide guidelines for improved land development and management practices, and the Initiative is interested in information sharing and partnering on these efforts. The more site designers put sustainable land practices to work, the greater the possibility of creating a profound change in society's approach to stewardship of the land. Market transformation accelerates as more examples of sustainable land practices occur—realizing the benefits of healthy communities, economic prosperity, and functioning ecosystems.

HOW TO USE THE GUIDELINES AND PERFORMANCE BENCHMARKS

The Guidelines and Performance Benchmarks encompass a series of prerequisites and credits for measuring site sustainability.

- Benchmarks outlined under prerequisites are required and must be met in order for a site to participate in this voluntary program.
- Benchmarks outlined under credits are optional, but a certain number of them must be attained for a project to achieve eventual recognition as a Sustainable Site.

In this document the Sustainable Sites Initiative aims to describe benchmarks that are based on sustainable outcomes rather than on strict prescriptions and specific technology, thereby encouraging innovation, inspiring a change in thinking, and providing flexibility.

Audience

The target audience for the Sustainable Sites benchmarks includes those who influence land development and management practices and can address increasingly urgent global concerns such as climate change, loss of biodiversity, and resource depletion. This audience also includes those who design, construct, operate, and maintain landscapes.

Site types

The benchmarks apply nationwide on a site-by-site basis, accommodating regional differences and the variations inherent in different site types, whether urban or rural, already developed or undeveloped. In so doing, many benchmarks allow for a site's existing condition and function in arriving at recommended performance criteria.

The benchmarks apply to sites of new construction as well as to projects that include major renovations to an existing site. They can apply to sites both with and without buildings, including but not limited to:

- Open spaces, local, state and national parks, conservation easements, buffer zones, utility corridors, and transportation rights-of-way.
- Sites with buildings including industrial, retail and office parks, military complexes, airports, botanical gardens, streetscapes and plazas, residential and commercial developments, and public and private campuses.

Although the *Guidelines and Performance Benchmarks* may inform larger-scale projects or planning efforts, they are not designed for use in regional planning. Similarly, they do not address large-scale agricultural practices in as much as organizations such as the Leonardo Academy and the Rainforest Alliance are developing or have already developed systems to do so. That said, the benchmarks do encourage food production, community gardening, and edible landscapes as potential components of a site.

Rating System and Certification for Pilot Program

An important feature of the *Guidelines and Performance Benchmarks 2009* report is the addition of a rating system. The Sustainable Sites committee members completed a series of weighting exercises to establish a ranking system for the 51 credits based on the Initiative's Guiding Principles (see page 7). This resulted in the development of a 250-point system as outlined below. It reflects committee members' current consensus regarding the potential level of impact that given benchmarks may have on improving site sustainability. Prerequisites are required and therefore are not assigned a point value. Credits are assigned a point value and in many cases they offer a range of points, providing projects additional flexibility in selecting the level (or benchmark) that is appropriate and achievable for them. (See Sustainable Sites Pilot Program, below, for a discussion on revising the rating system.)

Landscapes are dynamic, regenerative systems. Vegetation grows and matures, maintenance practices evolve, and, as adjacent land uses change over time, so too does the relationship of a given site to its surroundings. The Initiative's certification process requires projects to incorporate appropriate long-term maintenance plans, along with continuing communication among members of the project's integrated design team. In addition, the Initiative will reward projects for monitoring the performance of their sustainable practices.

During the pilot project phase, the Sustainable Sites Initiative will recognize projects that have achieved all the prerequisites and at least 40 percent of total points as achieving one "Star." Beyond this basic certification level, projects may implement practices to improve site sustainability by completing additional credits, thereby earning additional points toward achieving higher levels of pilot certification. Projects that have achieved a level of certification by the end of the program will be recognized as certified pilot projects. The Sustainable Sites Initiative anticipates refining the 2009 rating system after the completion of the pilot project program.

2009 Rating System:	**250 Points Total**
One Star:	100 points (40% of total points)
Two Stars:	125 points (50% of total points)
Three Stars:	150 points (60% of total points)
Four Stars:	200 points (80% of total points)

Sustainable Sites Pilot Program

As with all measurements of success, continued evaluation and improvement are essential. The Initiative has instituted a pilot program to help ensure that the *Guidelines and Performance Benchmarks* 2009 are both practical and effective as a tool for recognizing projects that incorporate sustainability at every stage of development. Specifically, the pilot program will evaluate the appropriateness of the point system and of credit weights in a variety of climate zones, geographic areas, and project types —e.g., public, private, greenfield, brownfield, greyfield, urban, suburban, rural, commercial, residential, cultural/historical, small and large sizes.

During the pilot program, the Initiative will be testing, evaluating, and potentially adjusting not only the point system but also the performance benchmarks themselves.

Structure of prerequisites and credits
The prerequisites and credits are organized into nine sections that are based on the process of site development and can guide an integrated design team through the project phases. The Initiative strongly urges project teams to review and consider all the benchmarks at the beginning of the process, rather than waiting until the pertinent stage of development.

1. Site Selection
2. Pre-Design Assessment and Planning
3. Site Design—Water
4. Site Design—Soil and Vegetation
5. Site Design—Materials Selection
6. Site Design—Human Health and Well-Being
7. Construction
8. Operations and Maintenance
9. Monitoring and Innovation

These sections demonstrate that achieving a sustainable site begins with proper site selection, even before the design is initiated, and continues through effective and appropriate operations and maintenance. The final section rewards exceptional performance and encourages projects to monitor sustainable practices over time to improve the body of knowledge on long-term sustainability. Each prerequisite and credit includes the following sub-sections:

Intent
Summarizes the goal that the credit or prerequisite aims to accomplish.

Requirements
Describes the benchmark(s) a site must meet to achieve the credit or satisfy the prerequisite. For certain credits, the requirements section is split into multiple point values that represent incremental improvements toward fully achieving the intent of the credit. In other words, the lowest point value represents the minimum benchmark a site must meet to achieve the credit, while the highestpoint value represents the ultimate benchmark for success for that credit.

Submittal documentation
Summarizes the materials a site should prepare and submit to demonstrate that the requirements of the credit or prerequisite have been met. In some cases, additional materials may be required to prove that the intent of the credit has been achieved.

Potential technologies and strategies
Provides examples of methods or site practices that could be used to achieve the credit or prerequisite. The technologies and strategies listed in this section are not all-inclusive and sites are encouraged to use creative solutions to meet the requirements and intent of a credit or prerequisite.

Calculation guidelines
Provides additional tools or direction for assessing a performance benchmark and for submitting documentation. This section is considered supplementary information for the requirements and submittal documentation sections.

Links to other Sustainable Sites credits
Suggests the interrelationships and synergies among the credits. It is intended to guide and inspire project teams toward achieving higher levels of sustainability by outlining the connections between credits and performance criteria.

Resources
Provides examples of resources to give readers additional guidance. The resources listed are not all-inclusive. They were suggested by technical experts and, where possible, include references published through a vetted, transparent process and accepted by regional stakeholders.

Definitions
Provides more information relevant to the prerequisite and credit. Additional words may be found in the glossary.

Economic and social benefits
Includes examples (highlighted in a sidebar box) of the range of economic and social benefits associated with ecosystem services that a credit or prerequisite could provide. The economic benefits may take the form of avoided costs—such as avoided health-care costs from improved air quality, avoided stormwater treatment and infrastructure costs from increased interception and infiltration of rainwater, or avoided energy expenditures for air-conditioning and heating when buildings are shaded and protected from wind by trees. Some economic benefits of ecosystem services are apparent in existing financial markets—for instance, clean water is a factor in a range of benefits from enhanced recreational and ecotourism opportunities to improved fisheries. Ecosystem services also provide benefits to human health by contributing to physical, mental, and social well-being.

Alternative paths or strategies
Not all prerequisites and credits apply to all site locations and types. On some sites, low baselines due to contamination or local restrictions may prevent a site from meeting the requirements of a credit. For example, brownfield sites may be required to adhere to specific guidelines for remediation that may not be compatible with certain credits. Similarly, in some regions, meeting the requirements of a credit may compromise certain other environmental conditions. For example, increased infiltration may help achieve *Credit 3.5: Manage stormwater on site* but may negatively affect local ecology in areas with historically low levels of infiltration.

In these unique instances, a site can still achieve points if the intent of the credit can be met using an alternate path. In submittal documentation, project managers should describe the conditions or restrictions of the site, the alternative strategies taken to meet the intent of the credit, and the monitoring results or outcomes of the alternative strategy.

INDEX OF PREREQUISITES AND CREDITS

8. Operations and Maintenance 23 possible points

Maintain the site for long-term sustainability

9. Monitoring and Innovation 18 possible points

Reward exceptional performance and improve the body of knowledge on long-term sustainability

Prerequisite 1.1 REQUIRED — Limit development of soils designated as prime farmland, unique farmland, and farmland of statewide importance

Intent

Protect soils designated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) as prime farmland, unique farmland, or farmland of statewide importance to conserve for future generations the most productive farmland in the United States.

Economic and social benefits

Soils designated as prime farmland, unique farmland, or farmland of statewide importance have important biological, physical, and chemical characteristics needed to produce high yields of crops. They have been judged to be the best soils for producing food, fiber, feed, and high value crops in the United States. Once converted to industrial and urban uses, this productive farmland is lost and cannot be regained.

Background

World consumption of many grain, oilseed, and meat commodities currently exceeds world production[1] and more than 900 million people suffer today from hunger and malnutrition.[2] Meeting this demand for agricultural products, including crops for biofuels, has placed a heavy burden on the productivity of American farms and their soil resources. In 1981, concerned by the irreversible loss of some of the United States' best farmland to industrial and urban uses, Congress charged the Soil Conservation Service, since renamed the Natural Resources Conservation Service (NRCS), with delineating "the extent and location of the best land for producing food, feed, fiber forage, and oilseed crops."[3] The NRCS mapped two types of farmland most important to agricultural production in the United States: prime farmland (the highest quality farmland) and unique farmland. The mapping of these farmlands from 1982 to 1997 revealed a loss for that period of 10 million prime farmland acres, an area greater in size than all of Maryland.[4] Moreover, in most states, the conversion of prime farmland to non-agricultural uses occurred at two to four times the rate of conversion of other, less productive farmland.[5] NRCS reported a further decline in overall cropland acreage of 8.5 million acres between 1997 and 2003, a rate of loss 14 percent greater than the decline that occurred from 1982 to 1997.[6] To better assist American farmers in managing their land, the NRCS prioritized the distribution of soil data via the Internet. Farmland designations for most of the United States can now be accessed at the county level from SSURGO soil surveys (*http://soildatamart.nrcs.usda.gov/*) and for areas of 10,000 acres or less from the Web Soil Survey (*http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*).

Requirements

The requirements below apply to sites with healthy soils and soils with minimal soil disturbance as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*).

- No soils defined by the NRCS as prime farmland, unique farmland, or farmland of statewide importance shall be stripped from an off-site location for importation to the site.
- At least 95 percent of all prime farmland, unique farmland, or farmland of statewide importance on a site must be designated as a ***vegetation and soil protection zone***.
- No restrictions (e.g., conservation easements) shall be placed on at least 95 percent of all prime farmland, unique farmland, or farmland of statewide importance on the site that may prevent land from being easily converted back to farmland for agricultural food production if necessary.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel shall be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation

Provide site plans showing the location of any on-site soils that have been designated by NRCS as prime farmland, unique farmland, or farmland of statewide importance and the location of new development. Indicate the extent of all vegetation and soil protection zones to demonstrate that at least 95 percent of the total surface area of these soils is protected. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones. For any imported soil, provide documentation indicating the source location of the soil and proof the soil is not designated as prime farmland, unique farmland, or farmland of statewide importance.

Potential technologies and strategies

Refer to local NRCS soil survey data to determine if soils designated as prime farmland, unique farmland, or farmland of statewide importance are present on site. Locate development activities to minimize disturbance of these soils.

Links to other Sustainable Sites credits

Sites that were previously used for agricultural purposes may need to be managed for invasive plant species, as addressed in *Prerequisite 4.1: Control and manage known invasive species found on site*.

Resources

Online soil surveys are available at *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*
The steps are outlined below:

1. Click on the "Start WSS" button
2. Navigate to and Select an Area of Interest (AOI) >
3. Soil Data Explorer >
4. Suitabilities and Limitations for Use >
5. Suitabilities and Limitations Ratings >

6. Land Classifications >
7. Farmland Classification >
8. View Rating. A table will be generated detailing whether the soils for which a report has been requested have been designated as prime farmland, unique farmland, or farmland of statewide importance.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. Please see the ISA website *(http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx)* for guidance.
- *Farmland of statewide importance* refers to soils designated by each state Natural Resources Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland which does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods. [7]
- *Healthy soils* are all areas of soils that have not been significantly disturbed by previous human development activities. Indicators of healthy soils may include one or more of the following:
  - soil horizons that are similar to the reference soil
  - bulk densities that do not exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - organic matter content that is equal to or exceeds that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) similar to that of the reference soil
  - absence of compounds toxic to the intended plants
  - presence of vegetation that is representative of native plant communities.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Minimal soil disturbance* describes soils that are minimally graded and/or compacted, such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A, but not covered with impervious surfaces. Examples of soils that are minimally disturbed include areas with minor modifications or very limited development but not covered with buildings or paved surfaces, such as areas that have been compacted by livestock or heavy foot traffic.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. SOM content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Prime farmland* refers to soils designated by the Natural Resources Conservation Service as "prime farmland." This does *not* include soils that would be prime farmland if drained, irrigated, protected from flooding, etc. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when

treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.[8]

- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Unique farmland* refers to soils designated by the Natural Resources Conservation Service as "unique farmland." Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.[9]

Prerequisite 1.2 REQUIRED — Protect floodplain functions

Intent

Protect floodplain functions by limiting new development within the 100-year floodplain for waterways of all sizes.

Requirements

The requirements apply only to the 100-year floodplain.

- **Greenfields** (i.e., sites that have not been previously developed or graded, including previous agricultural fields): Designate any area within the 100-year floodplain as a ***vegetation and soil protection zone (VSPZ)***. Demonstrate that any minimal impact site development within this area does not singularly or cumulatively increase flood elevations, does maintain or increase existing floodplain storage, and is designed so as not to be damaged by floods.
- **Greyfields and Brownfields** (i.e., sites that have been previously developed or graded or sites with environmental contamination): Demonstrate that any new development within this area does not singularly or cumulatively increase flood elevations, does maintain or increase existing floodplain storage, and is designed so as not to be damaged by floods.

Rehabilitation activities for enhancement of floodplain functions may occur under this prerequisite and are eligible for credit (see Links to other Sustainable Sites credits section below).

Vegetation and soil protection zones must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the vegetation and soil protection zone to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Economic and social benefits

Floodplains store and/or convey water from spring rains, floods, hurricanes and other events. Floodplains can help remove pollutants from floodwaters by providing areas for sediment carried by floodwaters to be deposited and used to nourish and replenish floodplain vegetation and soils. Floodplains can provide areas for groundwater recharge and habitat corridors for plants and animals. They can provide an urban oasis for human health and well-being. Protecting floodplain functions reduces flood risks to property owners and local ecosystems. It also minimizes risks associated with flooding to the health and safety of the general public. In addition, water-quality improvement as a result of setback protection can lead to increased recreational opportunities and improved fisheries.

Submittal documentation

Provide contour maps showing boundaries of the 100-year floodplain (including FEMA Flood Zone V and/or Zone A). Provide calculations or modeling results and a brief narrative to demonstrate that final post-development floodplain elevations have not been singularly or cumulatively increased and that floodplain storage meets or exceeds the existing, pre-development floodplain storage. In addition, provide the following:

- **Greenfields:** On the contour map, show the locations of any new development to demonstrate that only minimal impact site development occurs within the 100-year floodplain. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the vegetation and protection zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.
- **Greyfields and Brownfields:** On the contour map, show the locations of new and existing development. Provide a brief narrative to describe how any new development in the floodplain has been designed so as to avoid damage by flooding. Provide modeling results and a brief narrative to demonstrate that final post-development floodplain storage meets or exceeds the existing floodplain storage.

Potential technologies and strategies

Design the site to limit development and disturbance in the 100-year floodplain. Design new development, such as trails or boardwalks so as not to be damaged by flooding and result in no negative impact to existing floodplain storage or conveyance. Re-establish areas of vegetated floodplain on greyfield or brownfield sites, and manage invasive plant species where necessary. New development should be carefully placed to avoid erosion, and to avoid directing sediment and potential contaminants in storm water runoff into receiving waters. Roadways and utilities that must cross the floodplain should be constructed perpendicular to the 100-year floodplain to minimize the floodplain area disturbed. The number of roadways crossing through a vegetation and soil protection zone should be minimized and constructed only when necessary, such as when a significant portion of the site can only be reached by crossing a vegetation and soil protection zone. Structures that must cross through a vegetation and soil protection zone should be designed to minimize their impact on terrestrial and aquatic habitat connectivity.

Links to other Sustainable Sites credits

- A site may protect or enhance additional floodplain function by preserving or rehabilitating stream and shoreline buffers as described in *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*.
- Controlling erosion and sedimentation during construction to protect receiving waters is addressed in *Prerequisite 7.1: Control and retain construction pollutants*.

Resources

- For more information on FEMA flood maps, see the online Map Service Center at *http://msc.fema.gov/*, including the digitized Flood Insurance Rate Maps (FIRMs).
- For guidance on protecting riparian buffers during construction, see local sediment and erosion control regulations. If no local guidance is available, refer to the following resources:
  - Delaware's Sediment and Stormwater Management Program, *http://www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx*.
  - 2005 Stormwater Management Manual for Western Washington, *http://www.ecy.wa.gov/biblio/0510030.html*.
  - Sediment Source Control Handbook, *http://www.ierstahoe.com/pdf/research/SSCH%202008%20FINAL.pdf*.
- For more information on Low Impact Development techniques, see the Low Impact Development Center website, *http://www.lowimpactdevelopment.org/*.

- "Floods, Floodplains, and Folks" (National Park Service, ASFPM, Association of State Wetland Managers and FEMA, 1996) features 19 multi-objective project descriptions and is available through the Association of State Floodplain Managers, *http://www.floods.org/PDF/PUBSLIST.pdf*.
- "Natural and Beneficial Functions of Floodplains" (FEMA Publication 409) explores the valuable functions of pristine or restored floodplains and their contributions to flood reduction and prevention and is available through FEMA, *http://www.fema.gov/library/viewRecord.do?id=1546*.

Definitions

- *100-year floodplain* includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99, V, and VE; however, in some areas they may need to be calculated by the site development team.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.

Prerequisite 1.3 REQUIRED — Preserve wetlands

Intent

Avoid development of areas that contain wetlands, including isolated wetlands.

Requirements[10]

The requirements apply only to portions of sites with wetlands, including isolated wetlands as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*).

Delineate the full extent of the wetland(s) according to U.S. Army Corps of Engineers guidance (see Resources section below). Designate a ***vegetation and soil protection zone*** for the area within 100 feet of any wetland(s) or within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent. Restoration activities may occur within this zone to increase the quality of the wetland. An existing wetland cannot be utilized for primary water quality treatment.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Economic and social benefits

Wetlands provide many benefits to society, including habitat for fish and wildlife, natural water quality improvement, flood storage, shoreline erosion protection, and opportunities for recreation and aesthetic appreciation.They are among the most productive and biodiverse ecosystems in the world— comparable to rain forests and coral reefs.[11] Estuaries and their coastal marshes are important nursery areas for the young of many game (recreational) and commercial fish and shellfish.

Wetlands help improve water quality, including that of drinking water, by intercepting surface runoff and removing or retaining inorganic nutrients, processing organic wastes, and reducing suspended sediments before they reach open water.[12]

More than half of all adults in the United States hunt, fish, birdwatch or photograph wildlife, annually.[13] As an outdoor activity, recreational birding is growing even faster than biking, walking, skiing or golf. A large proportion of recreational birding is associated with wetlands and aquatic habitats in large part because many birds are wetland-dependent.[14]

Submittal documentation

The site assessment *(see Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* will document locations of wetlands, including isolated wetlands. If the site contains wetlands, provide site plans showing the full extent of the delineated wetland(s) and the extent of all vegetation and soil protection zones. Include the distances from edge of delineated wetland(s) to edge of vegetation and soil protection zones. Show the locations and percent of total area for any minimal impact site development that will occur in the vegetation and soil protection zones. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.

Potential technologies and strategies

During the site selection process, give preference to sites that do not include wetlands. Design the site to minimize disruption to existing wetlands.

Links to other Sustainable Sites credits

- Other aquatic habitats, such as riparian and coastal areas, are addressed in *Prerequisite 1.2: Protect floodplain functions*.
- Protection and restoration of buffers for wetlands are addressed in *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*.
- Rehabilitation of modified or otherwise degraded wetlands is addressed in *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*.

Resources

For guidance on delineating wetlands, see U.S. Army Corps of Engineers resources, *http://www.usace.army.mil/CECW/Pages/techbio.aspx*. Many wetlands are digitally mapped and downloadable from the National Wetlands Inventory, *http://www.fws.gov/wetlands/*; or from state, county, or municipal GIS departments or Natural Resources Conservation Service offices.

Definitions

- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Isolated wetlands* are wetlands with no surface water connections to other aquatic resources.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Wetlands* are defined by the Clean Water Act (U.S. Code of Federal Regulations 40 CFR 230.3) as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Prerequisite 1.4 REQUIRED — Preserve threatened or endangered species and their habitats

Intent
Avoid development of areas that contain habitat for plant and animal species identified on federal or state threatened or endangered lists or on the International Union for Conservation of Nature Red List of Threatened Species as critically endangered or endangered.

Requirements
The requirements apply only to portions of sites specifically identified as habitat for any plant or animal species on federal or state threatened or endangered lists or on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species as critically endangered (CR) or endangered (EN), as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*).

Designate the full extent of threatened and endangered species habitat on the site as a ***vegetation and soil protection zone***. All listed animals and plants must be protected from damage or removal. Construction activities for minimal impact site development and maintenance activities within the VSPZ shall only occur during seasons/times when the animal species is not present.

Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) the process for avoiding impacts during site maintenance to threatened and endangered species and their habitats. Restoration activities may occur within this zone to increase the quality of the habitat.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Economic and social benefits

Species extinctions can disrupt the interactions and feedback mechanisms of natural ecosystems that have developed over time to be relatively stable and resistant to pests and diseases. Stable natural ecosystems control more than 95 percent of the potential crop pests and carriers of human diseases.[15] Ecosystems that contain wildlife habitat also support recreational and ecotourism activities, such as hiking and birdwatching, and opportunities for environmental education.[16]

Submittal documentation

The site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) will document locations of potential threatened or endangered species habitat. Provide documentation (e.g., habitat assessment) that the site does or does not contain habitat for plant and animal species listed as threatened or endangered on federal or state lists or as critically endangered (CR) or endangered (EN) on the IUCN Red List of Threatened Species. If the site contains habitat for listed species, provide site plans to show the extent of all vegetation and soil protection zones. Show the locations and percent of total area for any minimal impact site development that will occur in the vegetation and soil protection zones. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.

Potential technologies and strategies

During the site selection process, channel development to sites that do not include habitat for threatened or endangered plant and animal species. Design the site to minimize disruption to existing habitats. Design to allow species connectivity through the site and to adjacent sites.

Links to other Sustainable Sites credits

Preservation of habitats may also help achieve *Credit 4.6: Preserve or restore appropriate plant biomass on site* and *Credit 4.8: Preserve plant communities native to the ecoregion*.

Resources

- Refer to federal lists of threatened and endangered species by state, *http://ecos.fws.gov/tess_public/StateListing.do?state=all*.
- Refer to lists of plants listed as endangered on federal or state lists, *http://plants.usda.gov/threat.html*.
- Refer to the IUCN Red List, *http://www.iucnredlist.org*, for a database searchable by location and assessment classification (e.g., critically endangered or endangered).

Definition

- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.

Credit 1.5	Select brownfields or greyfields for redevelopment
5–10 Points	

Intent

Channel development to urban areas to reduce pressure on undeveloped land, reduce resource consumption and restore ecosystem services to damaged sites.

Economic and social benefits

Brownfield and greyfield redevelopment reduces pressure on undeveloped land, thereby protecting habitat and preserving natural resources. Using existing infrastructure and on-site materials as resources can reduce project costs for new materials. The rehabilitation of a site with environmental contamination is an opportunity to improve the environmental quality and resources available to local communities. Such properties may also cost less and be offered for sale with tax incentives.

Requirements[17]

- **5 points**: Greyfield redevelopment
  Select a previously developed site.

OR

- **10 points**: Brownfield redevelopment
  Select a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program) or a site defined as a brownfield by a local, state, or federal government agency.

Submittal documentation

- **5 points:** Greyfield redevelopment
  - Provide a site vicinity plan (e.g., sketches, block diagrams, maps, and aerial photographs) showing the project site and the surrounding sites and buildings. Describe how the site is a greyfield (e.g., previous use, percentage of impervious surfaces).
- **10 points:** Brownfield redevelopment
  - Provide confirmation that the existing site was documented as contaminated or defined as a brownfield.
  - Provide a detailed narrative describing the site contamination.

Potential technologies and strategies

During the site selection process, give preference to previously developed or brownfield sites. Coordinate site development plans with remediation activity and use of existing infrastructure and materials as appropriate.

Links to other Sustainable Sites credits

- Selecting an infill site or a site near existing neighborhood shops, services or facilities may also help achieve *Credit 1.6: Select sites within existing communities*.
- Selecting a site near existing sidewalks, bicycle lanes, bicycle networks, and/or transit service stop(s) may help achieve *Credit 1.7: Select sites that encourage non-motorized transportation and use of public transit.*

Resources

- U.S. Environmental Protection Agency's Brownfields and Land Revitalization, *http://www.epa.gov/brownfields/*.
- Sanborn maps, *http://sanborn.umi.com/*.
- Local (city or county) assessor records.
- Smart Growth Online, *http://www.smartgrowth.org*.
- Urban Land Institute, *http://www.uli.org/*.

Definitions

- *Brownfield* is an abandoned, idled, or underused industrial and commercial facility/site where expansion or redevelopment is complicated by real or perceived environmental contamination; a site documented as contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program; a site defined as a brownfield by a local, state, or federal government agency.
- *Greyfield* is a site that has been previously developed or graded.
- *Previously developed site* consists of at least 75 percent of the site area that has preexisting paving, construction, or altered landscapes. This does not apply to a street, roadway, or altered landscapes resulting from current agricultural use, forestry use, or use as preserved natural area.

Credit 1.6	Select sites within existing communities
6 Points	

Intent
Encourage site development within existing communities to reduce pollution and development impacts, support local economy and improve human health.

Requirements[18]
- **Option 1:** Locate project on an infill site.

OR
- **Option 2:** Design and locate project near existing neighborhood shops, services, and facilities in operation so that at least one entrance to the project is within 0.5 mile walk distance of at least five, or within 0.75 mile walk distance of at least seven basic services.

Submittal documentation
- **Option 1:** Provide a map of the vicinity demonstrating that the project is located on an infill site. Describe how the surrounding properties have been previously developed.

OR
- **Option 2:**
  - Provide a site and/or vicinity map showing the project boundary and walking routes to basic services from list.
  - Provide a table of walk distances between the nearest project entrance and each relevant basic service from list. Each basic service may only be counted once, unless there is a separate exterior entrance for each, and no more than half of the minimum number can be situated in a single building or under a common roof. A type of basic service can only be counted twice (e.g., a restaurant) and a single retail store of any type may only be counted once even if it sells products associated with multiple-use types.

Economic and social benefits

A significant economic benefit of infill development is the reduction or elimination of new infrastructure, including new roads, utility services, and other amenities. Municipal and county incentives for urban infill projects, especially brownfields, may also be available. Urban sprawl affects quality of life because commuters must spend increasing time in their auto-mobiles. The redevelopment of urban areas helps restore, invigorate, and sustain established urban living patterns, creating a more stable and interactive community.

Potential technologies and strategies
During the site selection process, give preference to sites within existing developments that have pedestrian access to a variety of services or sites where pedestrian access to a variety of existing services is planned as part of the project.

Links to other Sustainable Sites credits
- Selecting a site near existing sidewalks, bicycle lanes, bicycle networks, and/or transit service stop(s) may help achieve *Credit 1.7: Select sites that encourage non-motorized transportation and use of public transit.*
- Selecting a site that is an existing brownfield or greyfield will also achieve *Credit 1.5: Select brownfields or greyfields for redevelopment.*

Resources
- Urban Land Institute, *http://www.uli.org/*.
- Congress for New Urbanism, *http://www.cnu.org/*.

Definitions

- *Basic services* include, but are not limited to: bank, child-care facility (licensed), community/civic center, convenience store, hair care, hardware store, health club or outdoor recreation facility, laundry/dry cleaner, library, medical/dental office, pharmacy (stand-alone), place of worship, police/fire station, post office, restaurant, school, senior-care facility, supermarket, museum and theater.
- *Infill site* is a site that must have at least 75 percent of its perimeter bordering sites that consist of at least 75 percent previously developed land. Any fraction of the perimeter that borders waterfront will be excluded from the calculation.
- *Previously developed site* consists of at least 75 percent of the site area that has preexisting paving, construction, or altered landscapes. This does not apply to a street, roadway, or altered landscapes resulting from current agricultural use, forestry use, or use as preserved natural area.
- *Walk distance* is the distance that a pedestrian must travel between destinations without obstruction, in a safe and comfortable environment such as on sidewalks, footpaths, or other pedestrian facilities. Sidewalks adjacent to urban roads of 40 mph or higher must have a buffer zone between the road and sidewalk.

Credit 1.7	Select sites that encourage non-motorized transportation and use of public transit
5 Points	

Intent

Encourage site development that is accessible by pedestrians and bicyclists and near public transit to reduce pollution and improve human health.

Economic and social benefits

Car-dependent cities and suburbs spawn a sedentary lifestyle and associated health problems such as obesity, adding as much as $76 billion annually to U.S. medical expenses by one estimate.[20] Riding public transportation and living with one less car in a household can save an individual $8,670 a year (based on the April 8, 2009 national average gas price and the unreserved monthly parking rate).[21]

Requirements[19]

- **Option 1**: Locate the project on a site that is accessible to pedestrians and bicyclists by one or a combination of the following features.
  - Continuous sidewalks or trails that span 8 blocks (approximately 1 mile) in each direction (must directly connect to project entrance)
  - A street with bicycle lanes or Shared Lane Markings (SLMs) on both sides of the street (must directly connect to project entrance)
  - A bicycle network of at least 5 continuous miles in length (must be located within 0.25 mile bicycling distance from project entrance)
    - In the case of a planned sidewalk, street with bicycle lanes or SLM, or bicycle network, show that the relevant agency has committed in a legally binding warrant to provide the designated feature and has identified all funding necessary to do so within the time period of project certification.
    - If a project connects to a street with bicycle lanes or SLMs and/or a bicycle network, the project must also provide secure bicycle racks and/or storage within 200 yards of an entrance to a regularly occupied building (if applicable) or at a convenient and accessible location for 5 percent or more of total site users (Full-Time Equivalent (FTE) occupants and Temporary occupants).

OR

- **Option 2:** Locate the project on a site with existing transit service so that at least one project entrance is within 0.25 mile walk distance of bus or streetcar stops or within 0.5 mile walk distance of bus rapid transit stops, light or heavy passenger rail stations or ferry terminals, and the transit service at those stops in aggregate meets the minimums listed in Table 1.7-A (both weekday and weekend trip minimums must be met).

Weekend trips must include service on both Saturday and Sunday. Commuter rail must serve more than one Metropolitan Statistical Area (MSA) and/or the area surrounding the core of an MSA.

TABLE 1.7-A: MINIMUM REQUIREMENTS FOR TRANSIT SERVICE

	Weekday: Minimum Daily Trips	Weekend: Minimum Daily Trips
Projects with a Combination of Transit Service Types (Bus, Rail, or Ferry Service)	72	40
Projects with ONLY Commuter Rail or Ferry Service	24	6

In the case of planned service, show that the relevant transit agency has committed in a legally binding warrant to provide the high-frequency transit service at or before the beginning of the transit agency's first service year and has identified all funding necessary to do so within the time period of project certification.

Submittal documentation

- Option 1:
  - Provide a site and/or vicinity map showing the project boundary, the entrance(s) to the project, any and all sidewalks, bicycle lanes, SLMs, and bicycle networks.
  - In the case of planned sidewalks, bicycle lanes, SLMs, or bicycle networks, provide documents from the relevant agency indicating when the identified feature will be instituted and the source of funding.
  - If a project connects to a street with bicycle lanes or SLMs and/or a bicycle network, provide the following documentation:
    - Provide the FTE occupancy and Temporary occupancy for the project.
    - Provide project drawings to show the location(s) of the secure bicycle storage areas.
    - Confirm the quantity of bicycle racks and/or storage provided.

OR

- Option 2:
  - Provide a site and/or vicinity map showing the project boundary, the entrance(s) to the project, any and all sidewalks, transit stops, and walking routes to those stops.
  - Provide walk distances between project entrance(s) and the closest transit stop, and the number and percentage of entrances that lie within the specified distances. Include a diagram that shows walk distances across or around barriers such as freeways.
  - Provide official schedules for each type of transit that meets the frequency criterion in Table 1.7-A
  - For planned transit routes, provide documents from the relevant transit authority indicating when service will be instituted and the source of funding.

Potential technologies and strategies

Perform a transportation survey of future site users to identify transportation needs. Select a site near existing or planned mass transit, sidewalks, streets with bicycle lanes and bicycle networks.

Links to other Sustainable Sites credits

- Selecting an infill site or a site near existing neighborhood shops, services or facilities may contribute to *Credit 1.6: Select sites within existing communities*.
- Selecting a site that is a greyfield or brownfield may contribute to *Credit 1.5: Select brownfields or greyfields for redevelopment*.
- Providing additional trails, bicycle networks, and bicycle racks/storage on site may contribute to *Credit 6.6: Provide opportunities for outdoor physical activity*.

Resources

- Center for Transit-Oriented Development, *http://www.reconnectingamerica.org/public/tod*.
- Public Transportation, *http://www.publictransportation.org*.
- Smart Growth Online, *http://www.smartgrowth.org*.
- Building Community through Transportation at the Project for Public Spaces, *http://www.pps.org/transportation/info/building_community_through_transportation*.

Definitions

- *Bicycle lane* is a striped lane used for one-way travel on a street or highway. The standard bicycle lane width measured from the front edge of curb to the painted boundary should be at least 4 feet wide. If on-street parking is allowed, the minimum width is 5 feet.
- *Bicycle network* is a continuous bicycle or multi-use facility that is completely separate from the vehicular right-of-way but can be shared with pedestrians. The standard bicycle network has pavement that is at least 8 feet wide with a 2-foot-wide unpaved clear zone on each side; 10 feet of pavement is recommended, along with

the 2-foot-wide clear zones to minimize conflicts between pedestrians and bicyclists.

- *Bicycle racks and storage* must be secure (e.g., bicycle racks, lockers, and storage rooms). These spaces should be easily accessible by site users during all periods of the year and free of charge.
- *Brownfield* is an abandoned, idled, or underused industrial and commercial facility/site where expansion or redevelopment is complicated by real or perceived environmental contamination; a site documented as contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program; a site defined as a brownfield by a local, state, or federal government agency.
- *Full-Time Equivalent (FTE) occupants* are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0 while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.
- *Greyfield* is a site that has been previously developed or graded.
- *Infill site* is a site that must have at least 75 percent of its perimeter bordering sites that consist of at least 75 percent previously developed land. Any fraction of the perimeter that borders waterfront will be excluded from the calculation.
- *Regularly occupied building(s)* are buildings where occupants (workers, students, etc.) are seated or standing inside for extended periods of time.
- *Shared Lane Markings (SLMs)* are markings on streets (typically with a speed limit below 35 mph) that help bicyclists position themselves to travel side by side within the same traffic lane in lanes too narrow for a motor vehicle and a bicycle. They encourage safe passing of bicyclists by motorists, reduce the chance of a bicyclist's hitting the open door of a parked vehicle in a shared lane with on-street parallel parking, alert road users of the lateral location bicyclists may occupy, and reduce the incidence of wrong-way bicycling.
- *Temporary occupants* are occupants such as students, visitors and customers that are on a site intermittently. The calculation for temporary occupants is based on an average expected volume per day (excluding special events). Note that calculations for Temporary Occupants must be consistently used throughout documentation.
- *Walk distance* the distance that a pedestrian must travel between destinations without obstruction, in a safe and comfortable environment such as on sidewalks, footpaths, or other pedestrian facilities. Sidewalks adjacent to urban roads of 40 mph or higher must have a buffer zone between the road and sidewalk.

Prerequisite 2.1 REQUIRED — Conduct a pre-design site assessment and explore opportunities for site sustainability

Intent

Conduct an accurate and detailed assessment of site conditions and explore options for sustainable outcomes prior to design to inform decisions about site design, construction, operation, and maintenance.

Economic and social benefits

A site assessment evaluates resources and opportunities that can be incorporated into site design. For instance, social gathering spaces can be sited near existing large trees to take advantage of their shade, or existing materials can be reused, saving money and resources.

Requirements

With the integrated design team, collect and assess information to help identify opportunities to protect and improve ecosystem services and use sustainable strategies to guide the design, construction, operation, and maintenance of the site.

Complete the relevant sections of the *Site Assessment and Regional Resource Identification Worksheet* on the following pages:

- *Mapping and assessment of existing site conditions:* Describe and map existing site conditions and resources.
- *Identifying additional information about the site, local resources, and regional context:* Collect information on the site and surrounding areas to assess opportunities for sustainable site outcomes.

Use the blank cells in the worksheet to explain how the identified site conditions and resources will influence the sustainable design of the site. Not all topics in the worksheet apply to every site and each site may contain additional important unique elements that are not explicitly addressed here. Include additional topics not listed, if any, and provide reasons for not addressing certain topics.

Submittal documentation

Submit the completed *Site Assessment and Regional Resource Identification Worksheet* with relevant project information (both narrative descriptions and maps, where applicable). Include additional topics not listed, if any, and provide reasons for not addressing certain topics. All integrated design team members must sign off that a review of the worksheet and relevant discussions were conducted.

WORKSHEET: SITE ASSESSMENT AND REGIONAL RESOURCE IDENTIFICATION			
Mapping and assessment of existing site conditions			
Climate and Energy			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Site specific conditions such as microclimate that may affect site design decisions, building orientation, and plant selections should be taken into account. These conditions include, but are not limited to, excessive noise, wind direction, sun angles, slope, microtopography, other microclimate conditions, and any other unique factors that influence specific areas of the site.	*Credit 4.10: Use vegetation to minimize building heating requirements* (for wind only)		
	Credit 4.11: Use vegetation to minimize building cooling requirements (for sunlight only)		
	Credit 6.6: Provide opportunities for outdoor physical activity		
	Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration		
	Credit 6.8: Provide outdoor spaces for social interaction		
Locations with opportunity to generate renewable energy on site (e.g., wind, solar, geothermal, low-impact hydro).	*Credit 8.5: Use renewable sources for landscape electricity needs*		
Hydrology			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
100-year floodplain, as determined by FEMA (or using calculations specific to the site if no 100-year floodplain elevations have been calculated for the site).	*Prerequisite 1.2: Protect floodplain functions*		
Full extent of the delineated wetland(s), including isolated wetlands and their buffer.	*Prerequisite 1.3: Preserve wetlands*		
Existing buffer for shorelines and streams with an identifiable channel.	*Prerequisite 1.2: Protect floodplain functions*		
	Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers		
Streams, wetlands, or shorelines that have been artificially modified (e.g., buried, piped, drained, channelized, bulkheaded, or armored). Determine existing conditions and dimensions, and the historic extent of the stream, wetland, or shoreline (e.g., aerial photographs or maps of the historic location).	*Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*		

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Hydrology, *continued*			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Topography and direction of overland water flow on site and its effects on the watershed as a whole.	*Prerequisite 7.1: Control and retain construction pollutants*		
	Credit 3.5: Manage stormwater on site		
	Credit 3.6: Protect and enhance on-site water resources and receiving water quality		
Existing and potential pollution sources (both point and nonpoint sources) and health hazards, including on-site sources and off-site sources in adjacent areas that may impact the site.	*Credit 1.5: Select brownfields or greyfields for redevelopment*		
	Credit 3.6: Protect and enhance on-site water resources and receiving water quality		
	Credit 7.3: Restore soils disturbed by previous development		
Soils			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Soils defined by the NRCS as prime farmland, unique farmland, or farmland of statewide importance.	*Prerequisite 1.1: Limit development of soils designated as prime farmland, unique farmland, and farmland of statewide importance*		
Healthy soils found on site.	*Prerequiste 4.3: Create a soil management plan*		
Soils disturbed by previous development. Identify degree of disturbance (minimal, moderate, or severe). Identify the following characteristics: organic matter content and depth, texture and bulk densities, infiltration rates, soil biological function, and soil chemical characteristics.	*Credit 7.3: Restore soils disturbed by previous development*		

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Vegetation			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Potential threatened or endangered species habitat. Include plant and animal species identified on federal or state threatened or endangered lists or on the International Union for Conservation of Nature Red List of Threatened Species as critically endangered or endangered.	*Prerequisite 1.4: Preserve threatened or endangered species and their habitats*		
Zones of land cover or vegetation types. Note whether each zone contains the following: • invasive plants as listed by federal, state, and regional entities • native plants • native plant communities • special status plants For trees, it may be helpful to note their diameter at breast height (DBH).	*Prerequisite 4.1: Control and manage known invasive plants found on site*		
	Credit 4.5: Preserve all vegetation designated as special status		
	Credit 4.6: Preserve or restore appropriate plant biomass on site		
	Credit 4.8: Preserve plant communities native to the ecoregion		
	Credit 4.9: Restore plant communities native to the ecoregion		
	Credit 4.10: Use vegetation to minimize building heating requirements		
	Credit 4.11: Use vegetation to minimize building cooling requirements		
	Credit 4.12: Reduce urban heat island effects		
	Credit 6.6: Provide opportunities for outdoor physical activity		
	Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration		
	Credit 6.8: Provide outdoor spaces for social interaction		

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Materials Inventory			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Existing landscape materials and other site elements (e.g., structures, roads, parking lots, and pathways). It may be helpful to note which materials could be safely retained, reused, or recycled.	*Credit 5.2: Maintain on-site structures, hardscape, and landscape amenities*		
Human Use of Site			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Provide title of map(s) where information is identified and include any additional notes OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Nearby shops, services, and facilities in operation that have pedestrian access to site. Map the walk distance to these basic services from planned project entrance.	*Credit 1.6: Select sites within existing communities*		
Building and landscape features that are significant to local culture and histories.	*Credit 6.4: Protect and maintain unique cultural and historical places*		
Interesting or unique features that will enhance the user experience and encourage site use such as view corridors, large shade trees, site landmarks, and water (natural or designed).	*Credit 6.5: Provide for optimum site accessibility, safety, and wayfinding*		
	Credit 6.6: Provide opportunities for outdoor physical activity		
	Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration		
	Credit 6.8: Provide outdoor spaces for social interaction		

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Identifying additional information about the site, local resources, and regional context			
Reference Conditions for Soil and Vegetation			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Briefly summarize findings OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Identify the site's reference soil. Determine the following characteristics of the reference soil: organic matter content and depth, texture and bulk densities, infiltration rates, soil biological function, and soil chemical characteristics.	*Credit 4.4: Minimize soil disturbance in design and construction*		
	Credit 7.3: Restore soils disturbed by previous development		
EPA Level III ecoregion AND Major native plant community types of the region.	*Credit 4.7: Use native plants*		
	Credit 4.8: Preserve plant communities native to the ecoregion		
	Credit 4.9: Restore plant communities native to the ecoregion		
Potential risk of catastrophic wildfire in both on-site and adjacent landscapes.	*Credit 4.13: Reduce the risk of catastrophic wildfire*		
Climate and Energy			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Briefly summarize findings OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Average annual and average monthly precipitation patterns and temperature conditions for the site.	*Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*		
	Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline		
	Credit 3.5: Manage stormwater on site		
	Credit 3.7: Design rainwater/stormwater features to provide a landscape amenity		
	Credit 3.8: Maintain water features to conserve water and other resources		
	Prerequisite 4.2: Use appropriate, non-invasive plants		
	Credit 4.6: Preserve or restore appropriate plant biomass on site		
Opportunities for using renewable energy through green-power energy contracts.	*Credit 8.5: Use renewable sources for landscape electricity needs*		

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Hydrology			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Briefly summarize findings OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Watershed conditions, including common stormwater pollutants and specific pollutants of concern that have been identified. Existing local, regional, or state watershed plans for the site's watershed.	*Prerequisite 1.2: Protect floodplain functions*		
	Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers		
	Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines		
	Credit 3.5: Manage stormwater on site		
	Credit 3.6: Protect and enhance on-site water resources and receiving water quality		
Initial water storage capacity of the site, using TR-55 curve number or other continuous simulation models.	*Credit 3.5: Manage stormwater on site*		
Existing and potential pollution sources (both point and nonpoint sources) and health hazards, including sources both on-site and adjacent to the site.	*Credit 1.5: Select brownfields or greyfields for redevelopment*		
	Credit 3.6: Protect and enhance on-site water resources and receiving water quality		
	Credit 7.3: Restore soils disturbed by previous development		
Seasonal groundwater elevations or problems with over-infiltration that may affect BMP selection.	*Credit 3.5: Manage stormwater on site*		
	Credit 3.6: Protect and enhance on-site water resources and receiving water quality		
Potable and non-potable water sources for the site, and opportunities to capture, treat, and reuse rainwater and graywater.	*Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*		
	Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline		
	Credit 3.5: Manage stormwater on site		
	Credit 3.7: Design rainwater/stormwater features to provide a landscape amenity		
	Credit 3.8: Maintain water features to conserve water and other resources		

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Material, Plant, and Soil Procurement			
Identify and map the following information:	Information collected can help achieve the following Sustainable Sites Prerequisites and/or Credits:	Briefly summarize findings OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.
Materials manufacturers that actively implement better business practices to reduce negative impacts to human health and the environment.	*Credit 5.10: Support sustainable practices in materials manufacturing*		
Plant nurseries that actively implement better business practices to reduce negative impacts to human health and the environment.	*Credit 5.9: Support sustainable practices in plant production*		
Local sites or suppliers that may have materials and appropriate vegetation that could be salvaged for use on site.	*Credit 5.4: Reuse salvaged materials and plants*		
Materials, plants, and soils that are extracted, manufactured, or grown within the region.	*Credit 5.7: Use regional materials*		
Suppliers of wood-based materials and products that are third party certified.	*Credit 5.6: Use certified wood*		
Suppliers of materials with recycled content.	*Credit 5.5: Use recycled content materials*		
Additional Considerations			
Use the space below to list any other unique opportunities, characteristics, and constraints of the site.	Information collected can help achieve the Sustainable Sites Prerequisites and Credits for (projects to determine):	Briefly summarize findings OR provide reasons for not addressing topics.	Provide narrative describing how information gathered could influence site design.

Potential technologies and strategies

Consult with local experts and the community to evaluate existing site conditions and identify sustainable strategies prior to design. Evaluate the impact a design approach may have on sustainability during construction, operations, and maintenance (e.g., pruning requirements, deadheading to maintain formalized designs and uses of plants).

Resources

See individual prerequisites and credits for resources.

Definitions

- *100-year floodplain* includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99, V, and VE; however, in some areas they may need to be calculated by the site development team.
- *Basic services* include, but are not limited to: bank, child care facility (licensed), community/civic center, convenience store, hair care, hardware store, health club or outdoor recreation facility, laundry/dry cleaner, library, medical/dental office, pharmacy (stand-alone), place of worship, police/fire station, post office, restaurant, school, senior care facility, supermarket, museum and theater.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Farmland of statewide importance* refers to soils designated by each state Natural Resources Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland which does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods.[22]
- *Healthy soils* are all areas of soils that have not been significantly disturbed by previous human development activities. Indicators of healthy soils may include one or more of the following:
  - soil horizons that are similar to the *reference soil*
  - bulk densities that do not exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content that is equal to or exceeds that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) similar to those of the reference soil
  - absence of compounds toxic to the intended plants
  - presence of vegetation that is representative of native plant communities.
- *Integrated design team* includes the owner and/or client and professionals knowledgeable in landscape design, construction, and maintenance. Team members should be selected to meet the unique constraints and opportunities of the site.
- *Invasive species* are species that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health.[23]
- *Isolated wetlands* are wetlands with no surface water connections to other aquatic resources.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. Use at least two references (or local reference sites) to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant

communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Prime farmland* refers to soils designated by the Natural Resources Conservation Service as "prime farmland." This does *not* include soils that would be prime farmland if drained, irrigated, protected from flooding, etc. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.[24]
- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped)
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Salvaged materials* are construction materials recovered from existing buildings or sites and reused on site.
- *Soils disturbed by previous development* are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include one or more of the following:
  - soil horizons that differ significantly in either depth, texture, physical or chemical properties from the *reference soil*
  - bulk densities that exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content lower than that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil
  - presence of compounds toxic to the intended plants
  - presence of weedy, opportunistic, or invasive plant species.
- *Special status plants* refers to vegetation designated as important by local, state, or federal entities. Designations may be for size, species, age, rare or special collections, ecological and environmental value, unique genetic resources, aesthetics, location, or other unique characteristics. Groves/clusters may also be designated special status.
- *Unique farmland* refers to soils designated by the Natural Resources Conservation Service as "unique farmland." Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.[25]

- *Walk distance* is the distance that a pedestrian must travel between destinations without obstruction, in a safe and comfortable environment such as on sidewalks, footpaths or other pedestrian facilities. Sidewalks adjacent to urban roads of 40 mph or higher must have a buffer zone between the road and sidewalk.
- *Wetlands* are defined by the Clean Water Act (U.S. Code of Federal Regulations 40 CFR 230.3) as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Prerequisite 2.2 REQUIRED — Use an integrated site development process

Intent

Use a multidisciplinary team of professionals experienced in sustainable practices to collaborate on the design, construction and maintenance of the site in an integrated design and implementation process.

Economic and social benefits

Innovative solutions are more likely to emerge when experts from several disciplines pool their talents and expertise. Sustainable goals and practices are easier and often less expensive to achieve when different perspectives are brought to bear on common goals.

Requirements

1. **Team formation:** At a minimum, the integrated design team should include the following roles: owner and/or client, and professionals knowledgeable in site design, construction, and maintenance. Team members should be selected to meet the unique constraints and opportunities of the site. The integrated design team should include professionals experienced in sustainable practices and in disciplines relevant to the proposed site design. In addition to the owner and/or client, the team will, at a minimum, include expertise in vegetation, water/hydrology, soil, landscape ecology, materials, and human health and well-being.
2. **Communication process:** Outline the agreed upon communication method(s) for team members. The method should be collaborative and allow the viewpoints and perspectives of all members to be considered in the decision-making process. Designate the team member(s) responsible for overseeing and ensuring a collaborative communication process.
3. **Sustainability principles and goals:** Identify the principles and goals of the project (both short- and long-term). Include an associated timeline and specific measurables for each goal to determine when achieved. Designate the team member(s) responsible for tracking project goals throughout the development process.
4. **Program plan:** Integrate the sustainability principles and goals into the program plan. Develop a program plan that at minimum includes the following:
   - The unique opportunities, characteristics, and constraints of the site. Utilize information collected for the *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability* and other information as applicable.
   - General project parameters, purpose and the design intent.
   - A diagram or description of the intended function, arrangement, and relationship of features and approximate dimensions and/or capacity of the design.
   - A description of how the sustainability principles and goals will be incorporated into the design.
5. **Stakeholders and user groups:** Identify project stakeholders and the full range of potential users for the site. List the primary and secondary user groups. Describe the process by which stakeholders and site users were identified.
6. **Construction oversight:** Designate the team member(s), other than the contractor, responsible for verifying that the site is built as per the construction specifications and drawings. Prior to construction, the designated team member(s) will meet with construction contractor(s) to review construction specifications and drawings and convey the project's principles and goals. Describe agreed upon method(s) whereby changes can be made in the field during construction.
7. **Maintenance plan:** All team members participate in the development of the site maintenance plan *(see Prerequisite 8.1: Plan for sustainable site maintenance)*.

Submittal documentation

The following documentation must be signed by all members of the project team.

1. Document the project team members. Specify the name, role, and expertise of each member. If an individual fulfills more than one role on the project, demonstrate that the individual has the various skill sets (e.g., relevant experience from other projects, training/education in the specified areas).
2. Briefly describe the collaborative communication process. Identify the team member(s) responsible for overseeing and ensuring collaborative communication. Provide documentation that all team members participated in the collaborative communication process as outlined.
3. List the sustainability principles and goals developed by the project team. Provide the timeline and specific measurables for each goal. Identify the team member(s) responsible for tracking project goals throughout the design, construction, and maintenance process.
4. Provide the program plan that includes the required components listed under the Requirements section (#4).
5. List project stakeholders and primary and secondary user groups. Describe the process by which stakeholders and site users were identified.
6. Identify the team member(s) responsible for construction oversight.
7. Provide the maintenance plan (i.e., *Prerequisite 8.1: Plan for sustainable site maintenance)*

Potential technologies and strategies

Form a team of qualified professionals as early as possible; team members will coordinate with one another throughout the life of the project. For optimal interaction and communication, ensure multiple face-to-face meetings for the project team.

Links to other Sustainable Sites credits

- Selecting measurable outcomes for each project goal in the planning phase of development will help achieve multiple credits. In addition, the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) will provide information on a site's unique opportunities, characteristics and constraints.
- Identifying stakeholders and user groups will contribute to *Credit 2.3: Engage users and other stakeholders in site design*.
- Developing the site maintenance plan will achieve *Prerequisite 8.1: Plan for sustainable site maintenance*.

Resources

- Whole Building Design Guide resources, *http://www.wbdg.org/design/engage_process.php*.
- DR Macaulay and F McLennan, *Integrated Design* (Bainbridge Island, WA: Ecotone Publishing, 2008).

Definitions

- *Integrated design team* includes the owner and/or client and professionals knowledgeable in landscape design, construction, and maintenance. Team members should be selected to meet the unique constraints and opportunities of the site.
- *Principles and goals* are defined as follows: principle—guiding overarching concept; goal—observable and measurable end result having one or more objectives to be achieved within a more or less fixed time frame.
- *Program Plan* is a narrative or written design that provides a mechanism for clearly stating the vision and desired outcomes of the project and setting the direction of the design team.
- *Stakeholders* may include, but are not limited to, the following: neighbors (e.g., residential, commercial, industrial, institutional-education, religious, government, non-profit), interest groups (e.g., growth management, environmental, transportation), public officials from local jurisdictions, regulators, community leaders, business organizations, etc.

Credit 2.3	Engage users and other stakeholders in site design
4 Points	

Intent

Engage with site users and other stakeholders in meaningful participation during the site design process to identify needs and to supplement professional expertise with local knowledge.

Economic and social benefits

Users and other stakeholders can contribute ideas resulting in designs that better serve the people most affected by the site, maximizing benefits and minimizing adverse effects. Involving the public in such decision-making builds social ties among neighbors and trust between the community and planning organizations.[26,27,28,29] Public participation enhances stewardship, sense of place, and feelings of ownership for site users, providing shared expectations for the project's results. Public input often results in innovations that enhance community economic development.[30]

Requirements

Positively engage a diverse group of potential site users/stakeholders in the following phases:

1. Identify site users/stakeholders (see *Prerequisite 2.2: Use an integrated site development process.*)
2. Engage with site users and other stakeholder in the site assessment process and the program plan:
   - Provide a minimum of two opportunities for participation that are accessible for site users/stakeholders.
   - Share with the participants a plan, model, and/or aerial photographs of the site with known site features including written descriptions.
   - Incorporate the knowledge gained about the site and local area as identified by the participants during the site assessment (see *Prerequisite 2.1 Conduct a pre-design site assessment and explore opportunities for site sustainability*). This may include but is not limited to the following: current and historic land use and management, locations of interesting or unique features, known or perceived cultural and historical significance, and environmental issues, etc.
   - Identify the programmatic and functional needs of the various groups (e.g., recreational opportunities, walking/biking trails, playground, community garden, community gathering places).
3. Engage with site users and other stakeholder in schematic design review:
   - Provide a minimum of two opportunities for participation that are accessible for site users/stakeholders.
   - Provide a minimum of two schematic design alternatives and their associated outcomes using visual representations (e.g., sketches, models, photo simulations).
4. Engage with site users and other stakeholders in the design development presentation and review:
   - Provide a minimum of two opportunities for participation that are accessible for site users/stakeholders.
5. Present the final design to the public:
   - Present the final design to site users/stakeholders in at least two forms (e.g., website, community meeting, newspaper, civic display). The final design must be made available to the public for a minimum of one month.

Submittal documentation

1. List site users and other stakeholders, as identified in *Prerequisite 2.2: Use an integrated site development process*.
2. Site users/stakeholders input in the site assessment process and the program plan:
   - Describe the opportunities provided for participation (a minimum of two).
   - Based on stakeholder input, outline the programmatic and functional needs of the various groups.
   - Provide the applicable section(s) of the site assessment (*see Prerequisite 2.1 Conduct a pre-design site assessment and explore opportunities for site sustainability*) that describe the knowledge about the site and local area, as identified by the participants.

3. Site users/stakeholders input in schematic design review:
   - Describe the opportunities provided for participation (a minimum of two).
   - Submit copies of the schematic design alternatives (a minimum of two) provided to the participants. Describe the associated outcomes of each alternative that was shared with the participants.
   - Summarize the feedback on the schematic designs received from site users/stakeholders.
4. Design development presentation and review:
   - Describe the opportunities for participation (a minimum of two).
   - Submit a copy of the design.
   - Summarize the feedback on the design received from site users/stakeholders.
   - Describe how the design reflects stakeholder feedback. If feedback was not incorporated, describe the justifications (e.g., projects constraints, costs, scope).
5. Final design:
   - Describe the opportunities for site users/stakeholders to view and understand the final design (must be available for a minimum of one month). Where applicable, submit the locations of where the final design was displayed.
   - Submit a copy of the final design.

Potential technologies and strategies

Solicit input and feedback in imaginative and flexible ways, such as through websites, surveys, visual preference questionnaires, charrettes, focus groups, field visits and tours, workshops, GIS (geographic information system) modeling and mapping, and facilitated, interactive exercises. Consider using web-based approaches to garner more widespread public participation and to present designs. Engage a wide variety of community members by providing food, child care, transportation, mediators, interpreters, and written translations during public meetings. Take meetings to people at churches, community development centers, and other local social gathering places.

Links to other Sustainable Sites credits

- *Prerequisite 2.2: Use an integrated site development process* will help identify stakeholders and the full range of users for the site.
- Engaging local groups prior to the design phase during the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) will help identify knowledge of the site and local area as identified by site users and stakeholders.
- The knowledge gained about a site's historical or cultural significance will help achieve *Credit 6.4: Protect and maintain unique cultural and historical places*.
- Identifying and meeting the needs of potential sites users and other stakeholders may help achieve additional credits such as *Credit 6.1: Promote equitable site development, Credit 6.2: Promote equitable site use, Credit 6.6: Provide opportunities for outdoor physical activity,* and *Credit 6.8: Provide outdoor spaces for social interaction*.

Resources

For additional information on identifying, engaging, and planning with the community, refer to the following resources:

- For tools and techniques, see Community Toolbox from the National Park Service Rivers, Trails and Conservation Assistance, *http://www.nps.gov/phso/rtcatoolbox/*.
- Project for Public Spaces resources, *http://www.pps.org/parks_plazas_squares/info/community*.
- National Charrette Institute, *http://www.charretteinstitute.org*.
- B Lennertz and A Lutzenhiser, *The Charrette Handbook: The Essential Guide for Accelerated, Collaborative Community Planning* (Chicago: American Planning Association, 2006).
- H Sanoff, *Community Participation Methods in Design and Planning* (New York City: John Wiley & Sons, 1999).

Definitions

- *Opportunities for participation* are opportunities where information is shared and received through formal and informal methods such as charrettes, community meetings/workshops, newsletters, press releases, surveys, or website.
- *Program Plan* is a narrative or written design that provides a mechanism for clearly stating the vision and desired outcomes of the project and setting the direction of the design team.
- *Schematic design* is the concept and basic framework for the design of the project.
- *Stakeholders* may include, but are not limited to, the following: neighbors (e.g., residential, commercial, industrial, institutional-education, religious, government, non-profit), interest groups (e.g., growth management, environmental, transportation), public officials from local jurisdictions, regulators, community leaders, business organizations, etc.

Prerequisite 3.1 REQUIRED — Reduce potable water use for landscape irrigation by 50 percent from established baselines

Intent
Reduce the use of potable water, natural surface water (such as lakes, rivers, and streams), and groundwater withdrawals for landscape irrigation after plant establishment.

Requirement [31]
Reduce use of potable water, natural surface water (such as lakes, rivers, and streams), and groundwater withdrawals for landscape irrigation after the plant establishment phase by 50 percent from a baseline case (see Irrigation Calculator below). Install flow meters to record and monitor water use in the landscape irrigation areas. Reductions can be attributed to any combination of the following items:

- Plant species factor
- Irrigation efficiency
- Use of captured rainwater
- Use of air-conditioner condensate
- Use of recycled graywater
- Use of recycled wastewater
- Use of blowdown water from boilers and cooling towers
- Use water treated and conveyed by a public agency specifically for non-potable uses.

Note exemptions: This prerequisite applies only to long-term water use. Water volume used for the following purposes is exempt from irrigation calculations:

- Water used during establishment phase. The maximum establishment phase is considered three years for trees, two years for shrubs, and one year for herbaceous cover.
- Water used to irrigate non-commercial food production gardens. Irrigation used on edible plants should not harm human health.
- Water used as required by local regulations in fire-prone areas for fire-suppression systems.

Submittal documentation
Provide a brief narrative describing the landscaping and irrigation design strategies employed by the project. Submit construction drawings (as-built) that include planting schedule, plant types (ground cover, shrubs, trees, and/or turfgrass), landscape coefficients, and irrigation set (i.e., drawings indicating locations and specifications for irrigation system), and clearly indicate water sources in the drawings. Using the Irrigation Calculator provided below, submit the calculations made for Baseline Landscape Water Requirement (BLWR), Designed Landscape Water Requirement (DLWR), Non-Potable Sources (NPS), and results. Submit average monthly evapotranspiration and average monthly rainfall for the site's peak watering month, including references for the sources of information. (See the Resources

Economic and social benefits

In the United States, landscape irrigation uses more than 7 billion gallons per day. For the average family of four, approximately 30 percent of the water used daily is devoted to outdoor uses such as watering lawns and gardens,[32] while in drier parts of the country, landscape irrigation can account for an even greater proportion of potable water use—65 percent in Utah, for example.[33]

Typically, half of irrigation water can be wasted as a result of evaporation, wind, improper system design, and overwatering.[34] Selecting efficient irrigation systems, planting vegetation appropriate for site conditions and climate, and using captured rainwater or graywater can reduce water waste and conserve sources of potable water.

Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by city governments in the United States.[35] Because a substantial portion of municipal energy demand is used to pump, clean, and process water, a site reduces energy consumption by reducing potable water demand. Reducing water waste and potable water use also reduces utility costs for water pumping and water treatment.

section below for references to help determine the site's local peak month reference evapotranspiration.) Provide a brief narrative (including references, if applicable) to support the use of the selected landscape coefficient values (K_L) for the plant types on site. Describe the methodology used to determine that site water use will not exceed the allowable volume for irrigation. For projects using non-potable water, include specific information regarding source and available quantity of non-potable supplies.

Potential technologies and strategies

Use low-water-demand vegetation (xeriscape) and high-efficiency equipment (e.g., drip irrigation) and/or climate-based controllers for irrigation systems. If turfgrasses are to be used, they should be selected to be regionally appropriate and to minimize post-establishment requirements for irrigation. Reuse graywater, captured rainwater, and/or condensate water for irrigation to decrease potable water use for irrigation as well as to create a net benefit to the local watershed by making the landscape part of the natural water-treatment process. If graywater or wastewater is to be recycled for landscape irrigation, consider conducting tests to determine suitability for reuse. Design irrigation systems so that trees, shrubs, and ground cover are irrigated in separate hydrozones such that watering can be discontinued by zone as plants become established.

Irrigation calculator [36]

Part 1: Baseline Landscape Water Requirement (BLWR)

Determine the BLWR for a site in your region by entering the site landscape information into the white cells of the worksheet below (sample data shown here). The calculations for BLWR are adapted from the U.S. Environmental Protection Agency WaterSense Water Budget Tool's equation for Landscape Water Allowance (May 2009 revision, *http://www.epa.gov/watersense/specs/homes.htm#tool)*.

$$BLWR = ET_0 \times A \times C_u$$

Where:

ET_0 = average reference evapotranpiration (ET_0) for the site's peak watering month, provided locally (inches/month).
A = Area of irrigated landscape in square feet (area designed with permanent irrigation systems)
C_u = Conversion factor (0.6233 for results in gallons/month)

Part 1: BASELINE LANDSCAPE WATER REQUIREMENT			
ET_0 (inches/month)	A (square feet)	*Cu*	BLWR (gallons/month)
4	10,000	0.6233	24,932

Part 2: Designed Landscape Water Requirement (DLWR)

Determine the DLWR for the actual site by entering the average monthly precipitation (inches/month) for the site's peak watering month, the area of each hydrozone (in square feet), and the plant type, landscape coefficient, and distribution uniformity for each hydrozone in Part 2 of the Irrigation Calculator (sample data shown here). Note that the sum of the hydrozone areas must equal the total area of the irrigated landscape entered in Part 1 of the calculator. The calculations for DLWR are revised from the U.S. Environmental Protection Agency WaterSense Water Budget Tool's equation for Landscape Water Requirement (May 2009 revision, *http://www.epa.gov/watersense/specs/homes.htm#tool)*.

$$DLWR_H = RTM \times [(ET_0 \times K_L) - R_a] \times A \times C_u$$

Where:

RTM = Run time multiplier, equal to 1/low quarter distribution uniformity (dimensionless)
ET_0 = average reference evapotranpiration (ET_0) for the site's peak watering month, provided locally (inches/month)
K_L = Landscape coefficient for type of plant in that hydrozone
R_a = Allowable rainfall (25% of average monthly rainfall for the site's peak watering month, provided locally (inches/month))
A = Area of hydrozone (square feet)
C_u = Conversion factor (0.6233 for results in gallons/month)

The sum of all DLWRs for each hydrozone equals the site DLWR. Reference evapotranpiration (ET_0) and average monthly rainfall are provided locally (inches/month) for the site's peak watering month.

- Information for the landscape coefficient (K_L) is provided in Table 1 below.
- Information on the distribution uniformity is provided in Table 2 below.
- Area of the hydrozone is the area (in square feet) to be watered.

Part 2: DESIGNED LANDSCAPE WATER REQUIREMENT				
ET_O = Average monthly reference evapotranspiration for the site's peak watering month (inches/month) as entered in Part 1			R_a = Allowable rainfall = 25% of average monthly rainfall for the site's peak watering month (inches/month)	
4			2	
Area of hydrozone (square feet)*	Plant type within hydrozone	K_L = Landscape coefficient**	Distribution uniformity*** (enter fraction %, i.e. 80%=.80)	Landscape water requirement (gallons/month)
5,000	Trees	0.5	0.75	6,233
5,000	Turfgrass	0.7	0.75	9,557
Designed Landscape Water Requirement (gallons/month)				15,790

** The sum of the areas of all hydrozones should match the total area of the landscape designed with permanent irrigation systems in Part 1-BLWR.*
*** See Table 1 below.*
**** See Table 2 below.*

TABLE 1: PLANT TYPE AND ESTIMATED LANDSCAPE COEFFICIENT (K_L)			
Plant Type	K_L		
	Water Requirements		
	Low	Medium	High
Ground Cover	0.2	0.5	0.7
Shrubs	0.2	0.5	0.7
Trees	0.2	0.5	0.7
Turfgrass	0.6	0.7	0.8

Note: *The estimated K_L values in Table 1 are taken from the U.S. EPA WaterSense Water Budget Tool (May 2009 revision).*

TABLE 2: DISTRIBUTION UNIFORMITY	
Irrigation Type	$DU_{(LQ)}$ or EU*
Drip - Standard	70%
Drip - Press Comp	90%
Fixed Spray	65%
Micro Spray	70%
Rotor	70%

Note: *The lower quarter distribution uniformity values in Table 2 are taken from the U.S. EPA WaterSense Water Budget Tool (May 2009 rev.). Original source: The Irrigation Association, "Landscape Irrigation Scheduling and Water Management," IA 2005.*

*Lower quarter distribution uniformity $DU_{(LQ)}$ applies to sprinker zones and **emission uniformity** (EU) applies to drip/micro-irrigation zones.

Part 3: Non-potable sources (NPS)

Non-potable sources for irrigation may include: captured rainwater, air-conditioner condensate, recycled graywater, or recycled wastewater. Natural surface or subsurface water resources available are NOT acceptable NPS. Estimate the volume of NPS for irrigation in the white cells of the worksheet below (sample data entered here).

Part 3: NON-POTABLE SOURCES
Volume of non-potable sources used for irrigation (gallons/month)
0

Part 4: Results

Calculate the designed landscape's percentage reduction in potable water use from the baseline case as follows (sample data entered below):

(BLWR – (DLWR – NPS))/BLWR

Part 4: RESULTS	
Baseline Landscape Water Requirement from Part 1 (gallons/month)	24,932
Designed Landscape Water Requirement from Part 2 (gallons/month)	15,790
Non-Potable source from Part 3 (gallons/month)	0
Percentage reduction in potable water use from baseline case	37%

Links to other Sustainable Sites credits

- Irrigating with potable water only during the establishment period or using only non-potable water sources for irrigation will further reduce usage of potable water and may help achieve *Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline*.
- Reuse of captured rainwater to meet this prerequisite may also help achieve *Credit 3.5: Manage stormwater on site*.

Resources

- For evapotranspiration information specific to your region, see resources such as the International Water Management Institute's (IWMI) World Water and Climate Atlas, *www.iwmi.cgiar.org/WAtlas/Default.aspx;* note that results are provided in millimeters/day and must be converted to inches/month. The U.S. Environmental Protection Agency also is developing a tool to provide average monthly evapotranspiration by zip code for users in the United States.
- For rainfall data specific to your region, see the National Ocean and Atmospheric Administration (NOAA) 1971–2000 dataset at *http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl* and click on the link for "Monthly Station Normals 1971-2000").
- For more information on efficient irrigation products, refer to the Irrigation Association, *http://www.irrigation.org*.
- For information on evapotranspiration, see lists provided by the Irrigation Association, *http://www.irrigation.org/gov/default.aspx?r=1&pg=et_connection.htm*.
- For more information on water-efficient landscaping, see resources such as the U.S. Environmental Protection Agency's "Water-Efficient Landscaping: Preventing Pollution and Using Resources Wisely," *http://www.epa.gov/npdes/pubs/waterefficiency.pdf*.
- For more information on collecting and reusing rainwater and graywater, see American Rainwater Catchment Systems Association, *http://www.arcsa.org*.
- The University of California-Davis Biometeorology Program's resources on irrigation scheduling, *http://biomet.ucdavis.edu/irrigation-scheduling.html*.

Definitions

- Baseline Landscape Water Requirement (BLWR) is the water requirement for a similarly-sized landscape consisting of vegetation at the local reference evapotranspiration, or, specifically, the amount of water required by a landscape consisting of cool-season grass of a uniform height of 4.7 inches (12 centimeters), actively growing, completely shading the ground and not short of water.
- *Graywater* is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.
- *Landscape coefficient* is a constant used to modify the reference evapotranspiration. It takes into account the species factor, density factor, and microclimate factor. For the purposes of the Irrigation Calculator, the density factor and microclimate factor are both assumed to approximately equal one, to reduce the complexity of the calculations. In general, a high landscape coefficient value is used for plants that need a lot of water, and a low value is used for plants that need little water.
- *Peak watering month* is the month with the highest evapotranspiration rate. This is the month when the plants in the site's region require the most water. For most regions in the United States, the peak watering month is July.
- *Potable water* is municipally treated water or well water that is suitable for drinking.

Credit 3.2	Reduce potable water use for landscape irrigation by 75 percent or more from established baseline
2–5 Points	

Intent

Limit or eliminate the use of potable water, natural surface water (such as lakes, rivers, and streams), and groundwater withdrawals for landscape irrigation. Encourage alternative irrigation methods and water conservation strategies.

Requirements[37]

- **2 points:** Reduce use of potable water, natural surface water (such as lakes, rivers, and streams), and groundwater withdrawals for landscape irrigation after the plant establishment phase by 75 percent from a baseline case. Refer to the Irrigation Calculator as used in *Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*. (***Note:*** *This credit requires an additional 25 percent reduction in potable water use beyond the requirements of* Prerequisite 3.1.*)* Install flow meters to record and monitor water use in the landscape irrigation areas.
- **3 points:** Use no potable water, or other natural surface or subsurface water resources, for landscape irrigation beyond the establishment phase. During the plant establishment phase, temporary irrigation systems that use potable water may be used only if they are removed or disconnected within three years of installation for trees, two years for shrubs, and one year for herbaceous cover. If temporary irrigation systems are used, describe the process and timeline for removing/disconnecting the temporary irrigation system in the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*). After the establishment phase, use only captured rainwater, recycled wastewater, recycled graywater, air-conditioner condensate, blowdown water from boilers and cooling towers, or water treated and conveyed by a public agency specifically for non-potable uses.
- **5 points:** Use no potable water, or other natural surface or subsurface water resources, for landscape irrigation both during and after the establishment phase. Use only captured rainwater, recycled wastewater, recycled graywater, air-conditioner condensate, blowdown water from boilers and cooling towers, or water treated and conveyed by a public agency specifically for non-potable uses.

Reductions can be attributed to any combination of the following items:

- Plant species factor
- Irrigation efficiency
- Use of captured rainwater
- Use of air-conditioner condensate
- Use of recycled graywater
- Use of recycled wastewater

Economic and social benefits

In the United States, landscape irrigation uses more than 7 billion gallons per day. For the average family of four, approximately 30 percent of the water used daily is devoted to outdoor uses such as watering lawns and gardens,[38] while in drier parts of the country, landscape irrigation can account for an even greater proportion of potable water use—65 percent in Utah, for example.[39]

Typically, half of irrigation water can be wasted as a result of evaporation, wind, improper system design, and overwatering.[40] Selecting efficient irrigation systems, planting vegetation appropriate for site conditions and climate, and using captured rainwater or graywater can reduce water waste and conserve sources of potable water.

Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by city governments in the United States.[41] Because a substantial portion of municipal energy demand is used to pump, clean, and process water, a site reduces energy consumption by reducing potable water demand. Reducing water waste and potable water use also reduces utility costs for water pumping and water treatment.

- Use of blowdown water from boilers and cooling towers
- Use water treated and conveyed by a public agency specifically for non-potable uses.

Note exemptions: This prerequisite applies only to long-term water use. Water volume used for the following purposes is exempt from irrigation calculations:

- Water used during establishment phase. The maximum establishment phase is considered three years for trees, two years for shrubs, and one year for herbaceous cover.
- Water used to irrigate non-commercial food production gardens. Irrigation used on edible plants should not harm human health.
- Water used as required by local regulations in fire-prone areas for fire-suppression systems.

Submittal documentation

Provide a narrative document describing the landscaping and irrigation design strategies employed by the project. Submit construction drawings (as-built) that include planting schedule, plant types (ground cover, shrubs, trees, and/or turfgrass), landscape coefficients, and irrigation set (i.e., drawings indicating locations and specifications for irrigation system), and clearly indicate water sources in the drawings. For projects using non-potable water, include specific information regarding source and available quantity of non-potable supplies. For projects using temporary irrigation systems, describe the type of irrigation system used and the process for decommissioning the system at the end of the specified establishment period.

For the lowest point value, use the provided calculator and submit the calculations made for Baseline Landscape Water Requirement (BLWR), Designed Landscape Water Requirement (DLWR), Non-potable sources (NPS), and results. Submit average monthly evapotranspiration and average monthly rainfall for the site's peak watering month, including references for the sources of information. Provide a brief narrative (including references, if applicable) to support the use of the selected landscape coefficient values (K_L) for the plant types on site.

Potential technologies and strategies

Use low-water-demand vegetation (xeriscape) and high-efficiency equipment (e.g., drip irrigation) and/or climate-based controllers for irrigation systems. If turfgrasses are to be used, they should be selected to be regionally appropriate and minimize post-establishment requirements for irrigation. Reuse graywater, captured rainwater, and/or condensate water for irrigation to decrease potable water use for irrigation as well as create a net benefit to the local watershed by making the landscape part of the natural water-treatment process. If graywater or wastewater is to be recycled for landscape irrigation, consider conducting tests to determine suitability for reuse. Design irrigation systems so that trees, shrubs, and ground cover are irrigated in separate hydrozones such that watering can be discontinued by zone as plants become established.

Links to other Sustainable Sites credits

- The requirements of this credit go above and beyond the requirements of *Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*.
- Reuse of captured rainwater to meet this credit may also achieve *Credit 3.5: Manage stormwater on site*.

Resources

- For evapotranspiration information specific to your region, see resources such as the International Water Management Institute's (IWMI) World Water and Climate Atlas, *www.iwmi.cgiar.org/WAtlas/Default.aspx*. Note that results are provided in millimeters/day and must be converted to inches/month. The U.S. Environmental Protection Agency also is developing a tool to provide average monthly evapotranspiration by zip code for users in the United States.

- For rainfall data specific to your region, see the National Ocean and Atmospheric Administration (NOAA) 1971–2000 dataset, *http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl* and click on the link for "Monthly Station Normals 1971-2000."
- For more information on efficient irrigation products, refer to the Irrigation Association, *http://www.irrigation.org*.
- For more information on water-efficient landscaping, see resources such as the U.S. Environmental Protection Agency's publication "Water-Efficient Landscaping: Preventing Pollution and Using Resources Wisely", *http://www.epa.gov/npdes/pubs/waterefficiency.pdf*.
- For more information on collecting and reusing rainwater and graywater, see American Rainwater Catchment Systems Association, *http://www.arcsa.org*.
- The Irrigation Association lists sources of evapotranspiration information, *http://www.irrigation.org/gov/default.aspx?r=1&pg=et_connection.htm*.
- The University of California-Davis Biometeorology Program provides resources on irrigation scheduling, *http://biomet.ucdavis.edu/irrigation-scheduling.html*.

Definitions

- Baseline Landscape Water Requirement (BLWR) is the water requirement for a similarly sized landscape consisting of vegetation at the local reference evapotranspiration, or, specifically, the amount of water required by a landscape consisting of cool-season grass of a uniform height of 4.7 inches (12 centimeters), actively growing, completely shading the ground and not short of water.
- *Graywater* is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.
- *Landscape coefficient* is a constant used to modify the reference evapotranspiration. It takes into account the species factor, density factor, and microclimate factor. For the purposes of the Irrigation Calculator, the density factor and microclimate factor are both assumed to approximately equal one, to reduce the complexity of the calculations. In general, a high landscape coefficient value is used for plants that need a lot of water, and a low value is used for plants that need little water.
- *Peak watering month* is the month with the highest evapotranspiration rate. This is the month when the plants in the site's region require the most water. For most regions in the United States, the peak watering month is July.
- *Potable water* is municipally treated water or well water that is suitable for drinking.

Credit 3.3	Protect and restore riparian, wetland, and shoreline buffers
3–8 Points	

Intent

Preserve and enhance riparian, wetland, and shoreline buffers to improve flood control and water quality, stabilize soils, control erosion, and provide wildlife corridors and habitat.

Economic and social benefits

Improved water quality as a result of riparian buffers can increase property values of waterside properties by up to 15 percent,[43] provide increased recreational opportunities (such as fishing and swimming), and improve fisheries.

Requirements

The requirements apply to sites with shorelines, wetlands, and streams with an identifiable channel. Streams, wetlands, and shorelines that have been artificially modified (e.g., buried, piped, drained, channelized, bulkheaded, or armored) and rehabilitated as per the requirements of *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines* are eligible for this credit. If more than one stream, wetland, or shoreline exists on a site, the requirements must be fulfilled for at least one stream, wetland, or shoreline to be awarded credit.

Preserve (and restore, if necessary) the riparian, wetland, or shoreline buffer on the site and designate it a ***vegetation and soil protection zone***. Restoration must include:

- Stabilization of stream channel or shoreline. Bulkheads are not an acceptable stabilization measure for this credit.

AND

- Re-vegetation with native plant communities.

Point values are calculated based on the improvement from initial to final average buffer width. Use Table 3.3-A below to look up the applicable point values based on initial and final average buffer widths.

Table 3.3-A: Point value look-up table for initial and final average buffer widths. Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the initial average buffer width and final average buffer width on the site. Buffer widths in this table are for one side of the stream.

TABLE 3.3-A: POINT VALUE LOOK-UP TABLE

Initial average buffer width	Final Average buffer width*						
	0–10 ft	>10 ft–25 ft	>25 ft–50 ft	>50 ft–100 ft	>100 ft–200 ft	>200 ft–300 ft	> 300 ft
0–10 ft	No Credit	3 points	5 points	8 points	8 points	8 points	8 points
>10 ft–25 ft	No Credit	No Credit	3 points	5 points	8 points	8 points	8 points
>25 ft–50 ft	No Credit	No Credit	No Credit	3 points	5 points	8 points	8 points
>50 ft–100 ft	No Credit	No Credit	No Credit	No Credit	3 points	5 points	8 points
>100 ft–200 ft	No Credit	No Credit	No Credit	No Credit	3 points	5 points	8 points
>200 f–300 ft	No Credit	No Credit	No Credit	No Credit	No Credit	5 points	8 points
> 300 ft	No Credit	No Credit	No Credit	No Credit	No Credit	No Credit	8 points

**As buffer width increases, improved riparian functions are gained:*[42]

- ***< 50 feet:*** *Minimal protection of streams and wetlands*
- ***51–100 feet:*** *Protection from human disturbance, protection of aquatic habitat*
- ***101–200 feet:*** *Protection of water quality*
- ***201–300 feet:*** *Protection of wildlife habitat*
- ***301 feet or greater:*** *Protection of wildlife migration corridors and habitat for threatened, endangered, and sensitive species*

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation

Provide contour maps showing the boundaries of the existing buffer and buffer areas that will be preserved and/or restored, and include calculations of the initial and final average buffer widths. On the contour map, show the locations of any new development to demonstrate that only minimal impact site development occurs within the buffer. Provide a narrative to describe how the VSPZ will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the VSPZ. Provide a description of the restoration plan, including a plant list (with scientific names) and description of riparian/shoreline stabilization techniques. Provide information from at least two references (or local reference sites) to show that the preserved and/or restored vegetation on the site has the same dominant plant species, relative species abundances, and other characteristic elements of native plant community/communities. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the VSPZ. Provide a narrative description of any special circumstances or non-standard compliance paths taken by the project.

Potential technologies and strategies

Design the site to avoid development and disturbance in riparian, wetland, and shoreline buffers. Design new development, such as trails or boardwalks, to not be damaged by flooding and result in no negative impact to existing floodplain storage or conveyance. Re-establish areas of vegetated floodplain on greyfield or brownfield sites, and manage invasive plant species where necessary. New development should be carefully placed to avoid erosion, and to avoid directing sediment and potential contaminants in stormwater runoff into receiving waters. Roadways and utilities crossings that must cross the floodplain should generally be constructed perpendicular to the 100-year floodplain to minimize the floodplain area disturbed.

Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective restoration techniques and vegetation for the site. Plant appropriate native vegetation, re-grade soils where necessary, and use soft engineering techniques to restore the functions of riparian and shoreline buffers. Concrete channelization, rip rap, etc., should be avoided.

Links to other Sustainable Sites credits

- Preserving and/or restoring native plant communities for this credit may help achieve *Credit 4.8: Preserve plant communities native to the ecoregion* and *Credit 4.9: Restore plant communities native to the ecoregion*.
- Vegetated riparian, wetland, and shoreline buffers may help achieve *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*.
- Rehabilitation of features that have been artificially modified, such as buried streams and drained wetlands, are addressed in *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*.
- Riparian, wetland, and shoreline buffers may provide educational opportunities for users, which may help achieve *Credit 6.3: Promote sustainability awareness and education*.

Resources

- For guidance on protecting riparian buffers during construction, see local sediment and erosion control regulations. If no local guidance is available, refer to the resources at Delaware's Sediment and Stormwater Management Program, *http://www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx,* or 2005 Stormwater Management Manual for Western Washington, *http://www.ecy.wa.gov/biblio/0510030.html*.
- For guidance on restoring riparian buffers, see *Stream Corridor Restoration: Principles, Processes, and Practices,* Federal Interagency Stream Restoration Working Group, 08/2001 revision of 10/1998 version, *http://www.nrcs.usda.gov/Technical/stream_restoration,* and Center for Watershed Protection resources, including T Schueler, "The Architecture of Urban Stream Buffers," *Watershed Protection Techniques* 1 (1995): pp. 159–163, *http://www.cwp.org*.

Definitions

- *100-year floodplain* includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99, V, and VE; however, in some areas they may need to be calculated by the site development team.
- *Average buffer width* can be calculated using perpendicular transects every 50 feet along a water body for at least 90 percent of the stream or shoreline length within the boundaries of the site. For final average buffer widths, a minimum buffer width of at least 10 feet must be maintained at all points along the buffer. Buffer widths for rivers, streams, and tributaries are measured on each side of the stream from the top of bank.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. Use at least two references (or local reference sites) to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.
- *Receiving waters* include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.

Credit 3.4	Rehabilitate lost streams, wetlands, and shorelines
2–5 Points	

Intent

Rehabilitate ecosystem functions and values of any streams, wetlands, or shorelines that have been artificially modified, using stable geomorphological and vegetative methods.

Economic and social benefits

Rehabilitating streams, wetlands, and coastal habitats can improve water quality, provide educational and recreational opportunities, and revitalize neighborhoods. The water quality benefits of rehabilitated habitats can provide recreational opportunities and improved fisheries.

Requirements

The requirements apply to sites with streams, wetlands, or shorelines that have been artificially modified (e.g., buried, piped, drained, channelized, bulkheaded, or armored).

- **2 points:**
  - **Option 1:** Rehabilitate 30 percent of the full length of a stream channel or shoreline within the property boundary to a stable condition using geomorphological and vegetative methods. Rehabilitation must provide native plant communities, appropriate aquatic habitat, floodplain connection, water quality improvements, and stable geomorphological conditions.

  OR
  - **Option 2:** Rehabilitate 30 percent of the full area of an existing degraded or lost wetland. Rehabilitation must provide wetland hydrology, hydric soils, native plant communities, and habitat improvements.
- **3 points:**
  - **Option 1:** Rehabilitate 60 percent of the full length of a stream channel or shoreline within the property boundary to a stable condition using geomorphological and vegetative methods. Rehabilitation must provide native plant communities, appropriate aquatic habitat, floodplain connection, water quality improvements, and stable geomorphological conditions.

  OR
  - **Option 2:** Rehabilitate 60 percent of the full area of an existing degraded or lost wetland. Rehabilitation must provide wetland hydrology, hydric soils, native plant communities, and habitat improvements.
- **5 points:**
  - **Option 1:** Rehabilitate 90 percent of the full length of a stream channel or shoreline within the property boundary to a stable condition using geomorphological and vegetative methods. Rehabilitation must provide native plant communities, appropriate aquatic habitat, floodplain connection, water quality improvements, and stable geomorphological conditions.

  OR
  - **Option 2:** Rehabilitate 90 percent of the full area of an existing degraded or lost wetland. Rehabilitation must provide wetland hydrology, hydric soils, native plant communities, and habitat improvements.

Submittal documentation

Submit design plans, sections, details, hydrological calculations, specifications, and a brief narrative to demonstrate that the rehabilitated stream or shoreline provides the required components/functions. Provide documentation to show the existing conditions and dimensions of the stream, wetland, or shoreline to be restored. Provide documentation to show the historic extent of the stream, wetland, or shoreline (e.g., aerial photographs or maps of the historic location). Provide a description of the rehabilitation plan, including dimensions of the area to be rehabilitated and the species of vegetation on site, and describe how the functions of the stream, wetland, or shoreline will be improved.

Potential technologies or strategies

Remove physical modifications to streams, wetlands, and shorelines. Replace road crossings or remove dams or other structures that may be obstructing aquatic species movement or disrupting sediment transport and stability. Remove or treat stormwater elements that may be degrading water quality, reducing channel stability, or impacting habitat and morphology. Example strategies include daylighting streams, removing armoring, restoring geomorphology, controlling livestock access, restoring marsh grass, and adding habitat structure. Rehabilitation includes restoring soils if needed by decompacting and adding compost, planting appropriate native vegetation, re-grading, and soft engineering techniques to restore habitat functions, floodplain connection, and floodplain function.

Links to other Sustainable Sites credits

- Restoring native plant communities in streams, shorelines, or wetlands for this credit may help achieve *Credit 4.9: Restore plant communities native to the ecoregion*.
- Restoring the soil in these areas may help achieve *Credit 7.3: Restore soils disturbed by previous development*.
- Restoration of buffers for streams and shorelines that have been artificially modified and rehabilitated is addressed in *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*.
- Restored streams, shorelines, or wetlands may also provide educational opportunities for users, which may help achieve *Credit 6.3: Promote sustainability awareness and education*.

Resources

- For guidance on stream restoration, including procedures to assess existing conditions, refer to the following resources:
  - *Stream Restoration: A Natural Channel Design Handbook* by the North Carolina Stream Restoration Institute and North Carolina Sea Grant, *http://www.bae.ncsu.edu/programs/extension/wqg/srp/sr_guidebook.pdf*.
  - USDA NRCS *Stream Restoration Design Handbook* (2007), *http://www.nrcs.usda.gov/news/thisweek/2007/100307/techtip100307.html*.
  - AL Riley and L Leopold, *Restoring Streams in Cities: A guide for planners, policy makers, and citizens* (1998).
- For guidance on wetland repair and restoration, see "An Introduction to Wetland Restoration, Creation, and Enhancement" (2003), Federal Interagency Workgroup on Wetland Restoration, *http://www.epa.gov/owow/wetlands/restore/finalinfo.html*.
- For guidance on restoring coastal habitats, see NOAA Fisheries Restoration Center resources, *http://www.nmfs.noaa.gov/habitat/restoration/index.html*.
- The National River Restoration Science Synthesis, *http://nrrss.nbii.gov/*, may be a helpful resource in the future when their assessment is complete.
- For additional guidance on compost use in wetland restoration projects, see the Clean Washington Center's "Compost Use in Wetland Restoration Projects," *http://www.cwc.org/organics/org962rpt.pdf*.
- For guidance on effective and least invasive methods for erosion and sediment control, see the specs for compost blankets, berms, and socks at the U.S. Environmental Protection Agency's NPDES Construction Site Stormwater Runoff Control menu of BMPs, *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4*.

Definition

- *Geomorphological and vegetative methods* focus on the creation of a stable dimension, pattern, and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time, the stream is self-maintaining (able to transport the flow and sediment of its watershed without aggrading or degrading). This can include a broad range of measures, including the removal of the watershed disturbances that are causing stream instability; installation of structures and planting of vegetation to protect streambanks and provide habitat; and the reshaping or replacement of unstable stream reaches into appropriately designed functional streams and associated floodplains.

- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. Use at least two references (or local reference sites) to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.
- *Rehabilitate* is defined as ecological restoration that strives to alter the biota and physical conditions at a site, with an emphasis on the reparation of ecosystem processes, productivity, and services.
- *Wetlands* are defined by the Clean Water Act (U.S. Code of Federal Regulations 40 CFR 230.3) as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Credit 3.5	Manage stormwater on site
5–10 Points	

Intent

Replicate the hydrologic condition (infiltration, runoff, and evapotranspiration) of the site based on historic, natural, and undeveloped ecosystems in the region.

Background and Methodology

In order to achieve the intent of this credit, the site designer must design the site to maintain or restore the water balance of the site. Hydrologic models are typically used by site designers to understand site hydrodynamics in order to properly design and size appropriate runoff management systems.

This credit was developed based on the assumption that continuous simulation modeling is the most accurate method to design a site from a hydrologic perspective. However, continuous simulation modeling is complicated and expensive and requires a high level of expertise. Given the familiarity and widespread use of the TR-55[44] methodology for site design, a surrogate methodology was developed that uses a modified TR-55 curve number approach to approximate the results one would obtain using continuous simulation modeling. Because of limitations in the TR-55 methodology (i.e., TR-55 inadequately represents depressional storage on the site), it was determined that the TR-55 methodology could not be used without modification to achieve the goals of this credit. As a result, the Stormwater Management Model (SWMM) was used to develop the methodology presented here. The curve numbers here thus represent the results of SWMM modeling analyses and provide a simplified system that designers can use without having to conduct full continuous simulation modeling efforts.

Economic and social benefits

Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by municipal entities in the United States.[45] Capturing, treating, and reusing runoff on a site may help reduce potable water consumption on a site, leading to reduced public and private utility costs and energy expenditures for pumping, cleaning, and processing water. Retaining water on site also decreases discharges to stormwater management systems, which can reduce combined sewer overflow, thus minimizing effects on aquatic habitat and enhancing recreational opportunities such as fishing and birdwatching. This effort can also lead to reduced infrastructure requirements for stormwater collection and treatment.

To verify this approach, a series of continuous simulation models were run using SWMM to test the hypothesis that a modified curve number approach could be used as a surrogate for continuous simulation modeling. The objective of these modeling exercises was to design sites and runoff management systems that reduce the number of minutes that streams are exposed to erosive flows discharged from the development or redevelopment project. As noted in the intent above, the designers of this method also believe that preserving or restoring the hydrologic condition of the site will also protect other water resources including groundwater, lakes, and coastal water bodies (including bays and estuaries) from changes in hydrologic regime and increased pollutant discharges.

Given the geographic and meteorological variability across the United State, five sites were selected that represent a range of climates and locations. The following locations were modeled using the SWMM model: Raleigh, NC, Chicago, IL, Portland, OR, Denver, CO, and Los Angeles, CA. These locations represent humid, semiarid, and arid conditions across the U.S.

- To understand the methodology used, the following points and assumptions apply:
  - The object of these modeling efforts is to maintain or restore the water storage capacity of the site. **Water storage capacity** is defined as the capacity of a landscape or site to temporarily store and release water through infiltration, evapotranspiration, and water harvesting/storage (e.g., cisterns). To meet target water storage capacities (i.e., increase or maintain the storage capacity of a site through design), a designer can employ any or all of these three temporary storage measures.
  - For the purposes of this credit, the water storage capacity of the site can be **represented by the TR-55 Curve Number (CN)**. Higher CNs indicate lower storage capacity (i.e., a flat roof with virtually no sorptive capacity has a CN of 98), and low CNs indicate higher storage capacities (i.e., a sand dune has an estimated CN in the low 30s).
  - Separate methodologies were used for greenfields and greyfields/brownfields, as described below.
- **Greenfields**
  - The methodology selected for **greenfield development** is intended to replicate existing site hydrology (i.e., cause no negative changes in site hydrology) in order to protect the channel stability of receiving waters.
  - It is recognized that there may be instances where greenfield development may need to be regenerative to compensate for past land uses, but this credit does not address that issue.
  - For a greenfield development, two water storage capacities (as represented by TR-55 CNs) need to be determined: the target and the final post-development water storage capacities. The target storage capacity is the pre-development water storage capacity.
  - **To achieve this credit, the new development must be designed to achieve the same water storage capacity present on the site before development occurs.** In other words, to be awarded points for this credit, the final post-development water storage capacity must equal or exceed the target water storage capacity .
- **Greyfields and Brownfields**
  - The methodology for **greyfields** and **brownfields** was selected with the intent to increase site water storage capacity based on the recognition that site factors may severely constrain the site designer's options to restore the site to predevelopment conditions. Extenuating factors may include existing uses, a high degree of imperviousness, high land costs, impermeable soils, utilities, structural issues, etc. For greyfields and brownfields, the existing water storage capacity is usually insufficient to adequately protect receiving waters. The hydrologic goal for this credit is to increase the water storage capacity of the site to reduce receiving water impacts (e.g., stormwater discharges and combined sewer overflows).
  - For these types of developments and redevelopments, three water storage capacities (as represented by TR-55 CNs) need to be determined: the target, the initial, and the final post-development water storage capacities. For greyfields and brownfields, the target water storage capacity has been established as the typical background condition for selected locations across the U.S. and is representative of local conditions. For more information on how the target curve numbers for each location were selected, please see the FAQ section below.
  - To achieve this credit, greyfields and brownfields must be designed to increase the amount of water storage capacity on the site using the target condition as an ideal to strive for. The difference between target and initial water storage capacity is considered the "ultimate" or "optimal desired" treatment goal. The amount of this difference is dependent upon the initial water storage capacity of the site. Credit received is thus based on the incremental improvements in storage capacity from initial condition toward the target condition desired.
  - **Points are awarded based on the fraction of the difference that the designer can "make up" between the initial water storage capacity and the target condition**. For greyfield and brownfield development, the figures in the tables below are used to look up the net gain in water storage capacity, using TR-55 curve numbers to represent the initial condition and final post-development condition. As water storage capacity increases (and consequent annual runoff volumes decrease), the potential to earn more credit increases.

- In **greyfields**, maximum credit is awarded for achieving at least 90 percent improvement from the initial water storage capacity toward the target condition. Reduced levels of credit are also awarded for achieving at least 60 percent (mid point value) or at least 30 percent (low point value) of the water storage capacity difference between initial and target conditions.
- In **brownfields**, because widespread infiltration is not often an option due to contaminated soils and the potential for groundwater contamination, less improvement in water storage capacity is needed to achieve credit. Maximum credit is awarded for achieving at least 60 percent improvement from the initial water storage capacity toward the target condition. Reduced levels of credit are also awarded for achieving at least 40 percent (mid point value) or at least 20 percent (low point value) of the water storage capacity difference between initial and target conditions.

Requirements

- Determine and document the initial, final post-development, and target water storage capacities, using TR-55 CNs to describe site conditions. *(**Note:** Other continuous simulation modeling methods may be used in place of the modified TR-55 CN approach described above. Adequate documentation regarding the methods employed and the results obtained must be submitted.)* For the purposes of this credit, target water storage capacity is defined as follows:
  - **For greenfields,** the target water storage capacity is the pre-development water storage capacity.
  - **For greyfields and brownfields,** the target water storage capacity has been established as the typical background condition for selected locations across the U.S. and is representative of local conditions.
    - Humid East Coast (e.g., Raleigh) – 70
    - Humid Midwest (e.g., Chicago) – 70
    - Humid West Coast (e.g., Portland) – 70
    - Semiarid West (e.g., Denver) – 60
    - Arid Southwest (e.g., Los Angeles) – 85
- Determine and document that any increased infiltration occurring on site will not exacerbate regional ecological or safety problems. For example, increased infiltration in arid climates may alter historic stream types, converting ephemeral to perennial streams.
- Determine and document that site design will not negatively affect receiving waters by changing the site water balance so that detrimental impacts to baseflow, nutrient cycling, sediment transport and groundwater recharge occur. For example, water harvesting techniques should not be used that "starve" the receiving systems of adequate flows necessary to maintain the ecological function of the downstream systems.
- The requirements specific to **greenfield, greyfield,** and **brownfield sites** are described below.
- **Greenfields** (i.e., sites that have not been previously developed or graded, including previous agricultural fields):
  - **5 points:** No low point value options for greenfields.
  - **7 points:** No mid point point value options for greenfields.
  - **10 points:** Final post-development water storage capacity meets or exceeds the target water storage capacity. The target water storage capacity for greenfields is the pre-development water storage capacity.
- **Greyfields** (i.e., sites that have been previously developed or graded):
  - For greyfields and brownfields, the target water storage capacity has been established as the typical background condition for selected locations across the U.S. and is representative of local conditions.
  - **5 points:** Achieve 30 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables below to find the initial and final CNs that correlate to this net gain in water storage capacity.
  - **7 points:** Achieve 60 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables below to find the initial and final CNs that correlate to this net gain in water storage capacity.

- **10 points:** Achieve 90 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables below to find the initial and final CNs that correlate to this net gain in water storage capacity.

- **Brownfields** (i.e., sites with environmental contamination): If infiltration on site is beneficial, refer to the point values for greyfield sites that have been previously developed or graded above.
  - **5 points:** Achieve 20 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables section below to look up the initial and final CNs that correlate to this net gain in water storage capacity.
  - **7 points:** Achieve 40 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables section below to look up the initial and final CNs that correlate to this net gain in water storage capacity.
  - **10 points:** Achieve 60 percent improvement in water storage capacity. Percent improvement is based on the difference between initial water storage capacity and target water storage capacity. Use the table appropriate for your climatic zone in the region-specific look-up tables section below to look up the initial and final CNs that correlate to this net gain in water storage capacity.

Submittal documentation

Provide calculations of the initial, final, and target water storage capacities of the site (as described by TR-55 CNs; see the Resources section below for more guidance). *(**Note:** Other continuous simulation modeling methods may be used in place of the modified TR-55 CN approach described above. Adequate documentation regarding the methods employed and the results obtained must be submitted.)* Provide a site map or aerial photograph to demonstrate initial and final site conditions. Describe the strategies used to meet the target water storage capacity (greenfields) or improve performance toward the target water storage capacity (greyfields/brownfields). Some practices may not correlate with a land-use type/TR-55 CN in existing references. If this is the case, make an argument for a different method of determining water storage capacity. Determine and document that any increased infiltration occurring on site will not exacerbate regional ecological or safety problems

Potential technologies and strategies

Consider all components of the hydrologic cycle (evapotranspiration, runoff, and infiltration) in design. Minimize impervious cover, and maximize cover of pervious or semipervious surfaces that allow water to infiltrate into soil. Use soil- and vegetation-based methods, such as compost-amended soil, multilayered plantings, green roofs, or bioretention facilities to capture, slow, and treat runoff. Where infiltration is not desirable because of pollutant loadings, use other techniques (e.g., rainwater harvesting, green roofs, or bioretention) to reduce runoff from the site. Attempt to replicate frequency, timing, and locations of runoff patterns and discharge points into receiving waters. Compost-based erosion and sediment control BMPs (compost blankets, berms, and socks) also contribute to long-term vegetation establishment and infiltrative capacity.

Links to other Sustainable Sites credits

- Meeting the requirements of this credit may help achieve other credits such as *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*.
- Soil- and vegetation-based systems may help achieve this credit while simultaneously achieving credits such as *Credit 4.6: Preserve and restore plant biomass on site* and others.
- Restoring soil function, as addressed in *Prerequisite 7.2: Restore soils disturbed during construction* and *Credit 7.3: Restore soils disturbed by previous development*, and minimizing soil disturbance, as addressed in *Credit 4.4: Minimize soil disturbance in design and construction*, may also help achieve the intent of this stormwater credit.

Resources

Several tools are available to determine the TR-55 CNs that represent the greenfield target water storage capacity, the initial greyfield/brownfield water storage capacity, the final greenfield water storage capacity, and the final greyfield/brownfield water storage capacity. These tools include:

- "Technical Release-55: Urban Hydrology for Small Watersheds," U.S. Department of Agriculture, Natural Resources Conservation Service, 2nd ed., June 1986, *http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=22162.wba*, Tables 2-2a-d.
- The Center for Neighborhood Technology's Green Values calculator, *http://greenvalues.cnt.org/national/calculator.php*.
- The WinTR-55 model, *http://www.wsi.nrcs.usda.gov/products/W2Q/H&H/Tools_Models/WinTR55.html*.

Definitions

- *Brownfield* is an abandoned, idled, or underused industrial and commercial facility/site where expansion or 2 contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program; a site defined as a brownfield by a local, state, or federal government agency.
- *Greenfield* is a site that has not been previously developed or graded, including previous agricultural fields.
- *Greyfield* is a site that has been previously developed or graded.
- *Receiving waters* include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.

EXAMPLE: USING THE TR-55 CURVE NUMBER POINT VALUE LOOK-UP TABLES

Assume a greyfield site is located in the Southeast United States. Its initial water storage capacity is described by a CN of 92. By using bioretention, green roofs, and water harvesting practices and converting some of the existing developed area into to green space, the designer is able to increase the water storage capacity and reduce the final curve number to 82. How much credit has this designer obtained?

Using the Table 3.5-TK. Humid East Coast (Raleigh, NC), find the initial CN on the y-axis and move right to the 82 final CN on the x-axis. Based on a CN of 82, the low point value (5 points) is achieved for this redesigned and improved greyfield. This CN correlates to a reduction in annual runoff from this site of between 30 percent and 59 percent. To obtain additional credit, the designer must increase water storage capacity and lower the CN to 80 or below. If this goal were to be achieved, more than 60 percent of the annual runoff would be reduced, and the design would now receive the mid point value (7 points).

The method does *not* require that runoff be calculated for a design storm. The water storage capacity of a site is independent of *any* design storm.

Several tools are available to determine the TR-55 CNs that represent the greenfield target water storage capacity, the initial greyfield/brownfield water storage capacity, the final greenfield water storage capacity, and the final greyfield/brownfield water storage capacity. See the Resources section below.

FAQ

- **What design storm should be selected?**
  No design storm needs to be selected. To simplify the approach, the designers of this credit used a selection of developed site condition scenarios and ran hundreds of long-term simulations using the hydrologic model SWMM to evaluate the water storage capacity of different sites. This background work was done to make hydrologic determination easier for users of the Sustainable Sites Initiative metrics.
- **What locations and site conditions were selected for the simulations and why were they selected?**
  Representative locations from across the United States were selected based on meteorology and climate. It was assumed that these five locations reflect the range of site conditions a typical designer would encounter in the U.S. and the designers wanted to verify whether this approach was valid for all of these generalized locations. Target CNs for greyfields and brownfields in the cities selected for modeling were based on natural, undeveloped soils and vegetation conditions. The target curve numbers for greyfields 2Chicago–70. The hydrologic soils group was assumed to be C for each location.
- **What if my site has a lower CN than 70 (or 60 or 85, depending upon location)?**
  The simulations showed that the long-term hydrologic differences between sites with storage capacity less than 70 were minor. In short, meeting the minimum of 70 or 60 is assumed to adequately protect the receiving environment by preserving or restoring the hydrology of the site.
- **Why does the Arid Southwest (Los Angeles) have a target CN of 85, when the other sites were substantially lower?**
  The design team for this method had design experience that showed the water storage capacity of sites in the Southwest was lower than the rest of the country and the higher target CN reflects this fact.
- **My major concern is stream erosion. Does this methodology address this issue?**
  Two major elements were examined by the long-term simulations of SWMM: runoff volume and erosive flows. The number of minutes at which flow in a stream was at or above an established erosive flow (0.5 x Peak Flow of 1-Yr, 24-hr storm) was tabulated for each developed condition. Sites with lower water storage capacities (higher CN) produce flow regimes of higher magnitude and longer cumulative duration (i.e., they result in more erosive minutes of flow). Fortuitously, the results of erosive flow minutes metric and runoff volume metric were closely related, so a standard that targets and rewards runoff volume reduction would similarly reward erosive flow reduction.
- **Are continuous computer simulations a more accurate way to determine long-term flow volumes?**
  Continuous simulations are regarded as the best way to determine hydrology (runoff vs. non-runoff volumes) over a multi-year period. Although the user of this credit only sees charts in this document, a well-regarded continuous simulation model (SWMM) was used to create the charts. The Sustainable Sites Initiative has attempted to simplify the design process for the user and avoid the need for continuous simulation modeling (for the purposes of these credits). ***Note:*** *The designer may believe that a site with unique characteristics is not adequately described by the figures presented herein. In such cases, the designer may use continuous simulation models to predict target hydrology, initial hydrology, and final condition hydrology in lieu of the information presented herein.*
- **Does this method account for frequent small storms that produce little runoff?**
  Yes. By running 10-year simulations, hundreds of small storms were included in this analysis.

TABLE 3.5-A: HUMID EAST COAST (Reference Site: Raleigh, NC)																											
GREYFIELD / Target Curve Number = 70																											
	Final Curve Number																										
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
98																													
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5 points = 30 percent reduction in runoff volume
7 points = 60 percent reduction in runoff volume
10 points = 90 percent reduction in runoff volume

TABLE 3.5-B: HUMID EAST COAST (Reference Site: Raleigh, NC)

BROWNFIELD / Target Curve Number = 70

Initial Curve Number	Final Curve Number																											
	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
98									5	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10
97										5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10
96										5	5	5	5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
95										5	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
94											5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
93											5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
92												5	5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10
91													5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10
90													5	5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10
89														5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10
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76																								5	7	10	10	10	10
75																									5	7	10	10	10
74																										5	7	10	10
73																											5	10	10
72																												7	10
71																													10
70																													

5 points = 20 percent reduction in runoff volume

7 points = 40 percent reduction in runoff volume

10 points = 60 percent reduction in runoff volume

TABLE 3.5-C: HUMID MIDWEST (Reference Site: Chicago, IL)																											
GREYFIELD / Target Curve Number = 70																											
Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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5 points = 30 percent reduction in runoff volume

7 points = 60 percent reduction in runoff volume

10 points = 90 percent reduction in runoff volume

TABLE 3.5-D: HUMID MIDWEST (Reference Site: Chicago, IL)

BROWNFIELD / Target Curve Number = 70

Initial Curve Number	Final Curve Number																											
	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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Low point value = 20 percent reduction in runoff volume

Mid-point value = 40 percent reduction in runoff volume

High point value = 60 percent reduction in runoff volume

TABLE 3.5-E: HUMID WEST COAST (Reference Site: Portland, OR)																											
GREYFIELD / Target Curve Number = 70																											
Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
98																													
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5 points = 30 percent reduction in runoff volume

7 points = 60 percent reduction in runoff volume

10 points = 90 percent reduction in runoff volume

TABLE 3.5-F: HUMID WEST COAST (Reference Site: Portland, OR)																												
BROWNFIELD / Target Curve Number = 70																												
	Final Curve Number																											
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
98																													
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5 points = 20 percent reduction in runoff volume
7 points = 40 percent reduction in runoff volume
10 points = 60 percent reduction in runoff volume

TABLE 3.5-G: SEMIARID WEST (Reference Site: Denver, CO)

GREYFIELD / Target Curve Number = 60

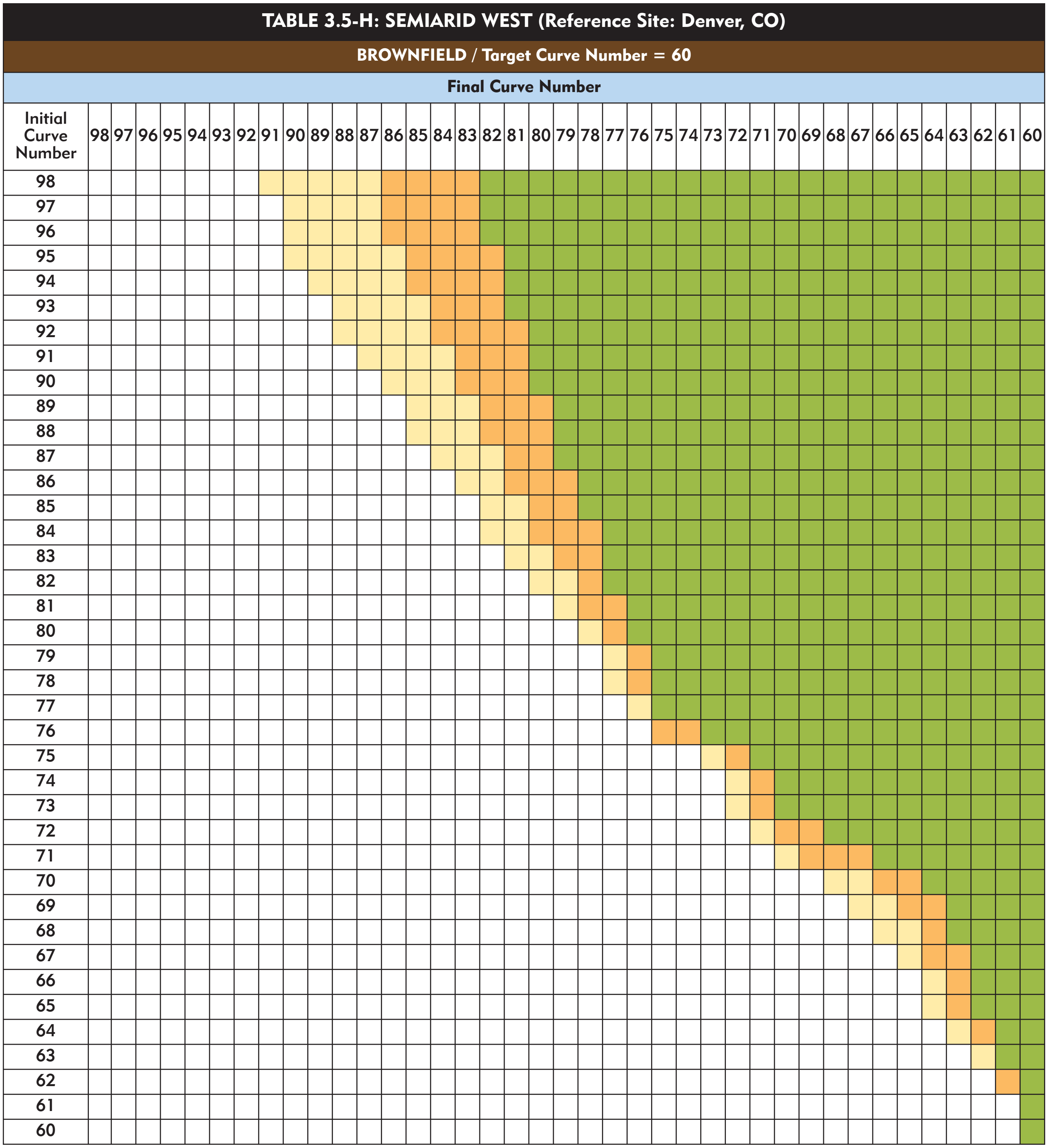
Final Curve Number

Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60
98											5	5	5	5	5	5	7	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
97											5	5	5	5	5	5	7	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
96											5	5	5	5	5	5	7	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
95											5	5	5	5	5	5	5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
94												5	5	5	5	5	5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
93													5	5	5	5	5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
92													5	5	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
91														5	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
90														5	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
89															5	5	5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
88																5	5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
87																5	5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
86																	5	5	5	5	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
85																		5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
84																		5	5	5	5	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
83																			5	5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
82																				5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
81																					5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10	10
80																					5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10	10
79																						5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10
78																							5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
77																							5	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10
76																								5	5	7	7	7	10	10	10	10	10	10	10	10	10	10	10
75																										5	5	7	10	10	10	10	10	10	10	10	10	10	10
74																											5	5	10	10	10	10	10	10	10	10	10	10	10
73																												5	10	10	10	10	10	10	10	10	10	10	10
72																													5	5	10	10	10	10	10	10	10	10	10
71																													5	5	5	10	10	10	10	10	10	10	10
70																																5	5	10	10	10	10	10	10
69																																	5	5	10	10	10	10	10
68																																		5	5	10	10	10	10
67																																			5	5	10	10	10
66																																			5	5	10	10	10
65																																				5	10	10	10
64																																					5	10	10
63																																					5	10	10
62																																						5	10
61																																							10
60																																							

5 points = 30 percent reduction in runoff volume

7 points = 60 percent reduction in runoff volume

10 points = 90 percent reduction in runoff volume



5 points = 20 percent reduction in runoff volume
7 points = 40 percent reduction in runoff volume
10 points = 60 percent reduction in runoff volume

TABLE 3.5-I: ARID SOUTHWEST (Reference Site: Los Angeles, CA)														
GREYFIELD / Target Curve Number = 85														
	Final Curve Number													
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85
98														
97														
96														
95														
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5 points = 30 percent reduction in runoff volume
7 points = 60 percent reduction in runoff volume
10 points = 90 percent reduction in runoff volume

TABLE 3.5-J: ARID SOUTHWEST (Reference Site: Los Angeles, CA)														
BROWNFIELD / Target Curve Number = 85														
	Final Curve Number													
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85
98														
97														
96														
95														
94														
93														
92														
91														
90														
89														
88														
87														
86														
85														

5 points = 20 percent reduction in runoff volume
7 points = 40 percent reduction in runoff volume
10 points = 60 percent reduction in runoff volume

Credit 3.6	Protect and enhance on-site water resources and receiving water quality
3–9 Points	

Intent

Prevent or minimize generation, mobilization, and transport of common stormwater pollutants and watershed-specific pollutants of concern to receiving waters, including surface water and groundwater, and combined sewers or stormwater systems.

Economic and social benefits

Improved water quality supports recreational opportunities and fisheries resources. Water treated on site can also lead to reduced expenditures for infrastructure and energy associated with public and private stormwater treatment. When a receiving water body does not meet water quality standards (e.g., total maximum daily loads), municipalities incur an additional cost and liability.

Requirements

The requirements below address common stormwater pollutants and specific pollutants of concern in the site's watershed.

- Document that all exterior materials were selected to minimize contribution of common stormwater pollutants and specific pollutants of concern to stormwater runoff.
  AND
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) appropriate maintenance activities designed to reduce the exposure of pollutants to stormwater (see examples in the Potential technologies and strategies section below) and appropriate maintenance procedures and schedules for all Best Management Practices (BMPs) to ensure ongoing pollutant removal.
  AND
- Provide stormwater treatment for common stormwater pollutants and specific pollutants of concern by achieving, at a minimum, an average discharge concentration of less than or equal to 25 milligrams/liter total suspended solids (TSS)—as a surrogate for most urban pollutants—for the volume treated. In cases where receiving waters are impaired or threatened by specific pollutants of concern, treatment must be provided for these pollutants (e.g., if dissolved copper is a specific pollutant of concern, the selected BMP is proven to treat dissolved copper). Develop a matrix that documents the unit processes used on site to treat runoff (see Resources section below for more guidance on developing a matrix). Innovative technologies for stormwater treatment may be employed; however, these innovative technologies should commit to monitoring for a minimum of two years or 12 storm events to demonstrate adequate pollutant removal unless the systems are comprised of unit processes that have generally accepted performance data.
  - **3 points:** A total of 80 percent of average annual volume of runoff discharged from the developed portion of the site receives stormwater treatment for pollutants of concern.
  - **5 points:** A total of 90 percent of average annual volume of runoff discharged from the developed portion of the site receives stormwater treatment for pollutants of concern.
  - **8 points:** A total of 95 percent of average annual volume of runoff discharged from the developed portion of the site receives stormwater treatment for pollutants of concern.
  - **Additional point:** Site uses soil- and vegetation-based systems to treat 100 percent of the treated water volume.
- ***Note:*** *BMPs must be sized to account for the additional volume of runoff entering the BMP from tributary areas offsite. In cases where the off-site run-on is from developed areas without stormwater treatment, the incremental volume from these areas can be used to achieve the 5 and 8 points as long as at least 80 percent of the runoff generated on site is treated. For example, if the offsite runoff volume is equal to the difference between 80 and 90 percent on-site capture, then that amount counts toward achieving the 5 points. Off-site contributing areas that are either undeveloped or developed with stormwater treatment must be accounted for, but no additional credits are available.*

Submittal documentation

Provide a list of all exterior materials used with a brief narrative to describe how the selected materials minimize contribution of common stormwater pollutants and specific pollutants of concern to stormwater runoff.

Describe measures implemented at the site to reduce the volume of stormwater runoff. Provide calculations to document how the 80/90/95 percent of the annual runoff volume was estimated as well as documentation regarding how off-site runoff is treated and to what level it is treated. If applicable, provide calculations and site plans to demonstrate that soil- and vegetation-based systems are expected to treat 100 percent of the treated water volume.

Provide a list of specific pollutants of concern, if any, and submit a copy of the matrix that documents the unit processes used to treat the specific pollutants of concern. Demonstrate through peer-reviewed data that the selected BMPs are expected to address the specific pollutants of concern. For innovative practices without proven effectiveness, provide plans for ongoing monitoring (commitment to fund monitoring over a minimum of two years or 12 storm events, whichever is less) to show that the new practice is effective in removing specific pollutants of concern.

Provide the applicable section(s) of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describe the activities designed to reduce the exposure of pollutants to stormwater and appropriate maintenance procedures and schedules for all BMPs.

Potential technologies and strategies

- Implement strategies to reduce the volume of stormwater runoff, such as:
  - Reduce impervious cover
  - Disconnect impervious cover
  - Provide depression storage in the landscape
  - Convey stormwater in swales to promote infiltration
  - Use biofiltration to provide vegetated and soil filtering
  - Evapotranspire (e.g., use engineered soils and vegetation on green roofs or in biofiltration areas/landscaping to maximize evapotranspiration potential)
  - Infiltrate stormwater (infiltration basins and trenches, permeable pavement, etc.)
- Materials used in building, hardscape, and landscape materials that can be a source of pollutants in stormwater include:
  - Copper and zinc roofs, roof gutters and downspouts, and siding
  - Galvanized materials (fences, guardrails, signposts)
  - Treated lumber
  - Parking lot coal tar sealants
  - Fertilizers
  - Pesticides.
- Plan for and implement maintenance activities designed to reduce the exposure of pollutants to stormwater, such as:
  - Minimizing exposure to rainfall of stored materials that could contribute pollutants
  - Developing and implementing a spill response plan
  - Avoiding non-stormwater discharges (e.g., wash water)
  - Minimizing the use of salt for deicing
  - Avoiding routine maintenance of construction equipment on site to reduce pollutant loadings of oils, grease, hydraulic fluids, etc.
  - Avoiding fueling of vehicles on site to the maximum extent practicable.

- Ideally, a variety of treatment practices will be implemented in series (a treatment train) to provide multiple pollutant removal processes (runoff reduction through evapotranspiration and infiltration, sedimentation, filtration, adsorption, biological degradation/uptake) to reduce the concentrations of pollutants in stormwater and to provide redundancy in the system. Soil- and vegetation-based controls are preferred due to their ability to reduce runoff through evapotranspiration, maintain infiltration rates, and regenerate adsorption capacity. Stormwater treatment systems that have been demonstrated to achieve the 25 milligrams/liter TSS discharge concentration include:
  - Water quality wet ponds
  - Constructed stormwater wetlands
  - Bioretention
  - Biofiltration (e.g., raingardens)
  - Vegetated buffer strips
  - Sand filters
  - Bioswales (as the initial BMP in a treatment train configuration)
- BMPs that are not considered sufficiently effective individually to qualify for this credit include many below grade vaults and hydrodynamic separators, inlet inserts, and dry extended detention basins, although these could be used in combination with the proven BMPs listed above in a treatment train.

Links to other Sustainable Sites credits

- Meeting the requirements of this credit may help achieve other credits such as the following:
  - *Credit 3.5: Manage stormwater on site*
  - *Credit 4.9: Restore plant communities native to the ecoregion*
  - *Credit 3.7: Design rainwater/stormwater features to provide a landscape amenity*
  - *Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*
  - *Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent from established baseline*
- Soil- and vegetation-based systems may help achieve this credit while simultaneously achieving credits such as *Credit 4.6: Preserve or restore appropriate plant biomass on site*.

Resources

- For information on BMP performance, see International Stormwater BMP Database resources, *http://www.bmpdatabase.org/BMPPerformance.htm* and U.S. Environmental Protection Agency's National Menu of Stormwater Best Management Practices, *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm*.
- Also see EW Strecker, WC Huber, JP Heaney, et al., *Critical Assessment of Stormwater Treatment and Control Selection Issues*, Report No. 02-SW-1, Water Environment Research Federation (2005).
- The U.S. EPA's National Management Measures to Control Nonpoint Source Pollution from Urban Areas, *http://www.epa.gov/nps/urbanmm/*.
- For BMP design guidance, follow local requirements or,where none exist, use a recognized manual such as the following:
  - *California Stormwater Best Management Practices Handbooks*, *www.cabmphandbooks.org*.
  - *Maryland Department of the Environment Stormwater Design Manual*, *http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp*.
  - *North Carolina Division of Water Quality Stormwater BMP Manual*, *http://h2o.enr.state.nc.us/su/bmp_updates.htm*.
  - Texas Commission on Environmental Quality's "Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices," *http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-348/index.html*.

- *Washington State Department of Ecology Stormwater Management Manual, http://www.ecy.wa.gov/PROGRAMS/wq/stormwater/manual.html.*
- *City of Santa Barbara Storm Water BMP Guidance Manual, http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf.*

Definitions

- *Common stormwater pollutants* that can adversely impact receiving waters include the following:
  - Landscape chemicals: pesticides, fertilizers, herbicides, detergents, oil, grease
  - Metals: copper, zinc, lead
  - Nutrients: nitrogen, phosphorus
  - Pathogens: bacteria, viruses, protozoa
  - Regional pollutants: salts, alcohol, temperature
  - Solids: soil, tire particles, road abrasion material, etc.
- *Receiving waters* include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.
- *Specific pollutants of concern* include those listed for the site's receiving water on the Clean Water Act Section 303(d) impairment lists by the state water-quality agency.

Credit 3.7	Design rainwater/stormwater features to provide a landscape amenity
1–3 Points	

Intent

Integrate visually and physically accessible rainwater/stormwater features into the site in an aesthetically pleasing way.

Requirements

The requirements apply to rainwater/stormwater features that use rainwater and stormwater as their sole source and that function as stormwater management elements.

- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) appropriate maintenance activities for the feature(s) without the use of chemicals likely to harm aquatic life, such as chlorine and bromine. Include maintenance activities to ensure that the water feature(s) will not create habitat for mosquitoes.
  AND
- Document that the rainwater falling on the site is treated as an amenity through the way it is received, conveyed and managed on the site, and made accessible to site users.
  - **1 point:**
    - At least 50 percent of rainwater/stormwater features on site are designed as amenities and are visible from high-use portions of the site.
  - **2 points:**
    - 75 percent of rainwater/stormwater features on site are designed as amenities and are visible from high-use portions of the site.
      AND
    - At least one rainwater/stormwater feature is visible and accessible from sidewalks, and contact is not prohibited. Water elements where limited human contact is allowed must meet local and/or state health requirements. In some situations, this may require additional treatment methods such as ozonation or thermal treatment.
  - **3 points**
    - 100 percent of the rainwater/stormwater features on site are designed as amenities and are visible and accessible from the high-use portions of the site.
      AND
    - At least one rainwater/stormwater feature is completely accessible and intended for full contact (i.e., primary contact recreation, such as swimming). Water intended for human contact must meet local and/or state health requirements. In some situations, this may require additional treatment methods such as ozonation or thermal treatment.

Economic and social benefits

Water is a key element in landscape settings that provide opportunities for restorative experiences and reflection. Such activities may promote healing, stress reduction, and work productivity.[46] While other credits address the importance of restoring and maintaining natural hydrology and water quality in the landscape, this credit deals specifically with the benefits of people having a stronger connection to water and local climate.

Submittal documentation

Submit the site plan indicating the location and configuration of rainwater/stormwater features and the proximity and relationship to proposed high-use portions of the site. For features designed for limited or full human contact, provide a drawing or brief narrative to explain how users can physically access the feature and demonstrate compliance with local and/or state health standards.

Provide a list of all materials used for structured rainwater conveyance with a brief narrative to describe how the selected materials minimize contribution of common stormwater pollutants and specific pollutants of concern to stormwater runoff.

Provide the applicable section(s) of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describe the activities to maintain water feature(s) without the use of chlorine, bromine, or other harmful chemicals.

Potential technologies and strategies

Employ artists and craftsmen to collaborate with the design team to create rainwater systems that combine function and amenity. Design and maintain water features as natural ecosystems, with water source(s), plants, and other aquatic organisms appropriate for local conditions. Natural swimming pools or other water features intended for human contact may require additional treatment methods such as ozonation or thermal treatment.

Links to other Sustainable Sites credits

- Rainwater/stormwater features on site may achieve hydrologic objectives to help meet the requirements of *Credit 3.5: Manage stormwater on site* and *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*.
- Water features that meet the requirements of this credit may be eligible for *Credit 3.8: Maintain water features to conserve water and other resources*.
- Features that use energy-efficient pumps and/or renewable energy sources for water features may be eligible for *Credit 8.4: Reduce outdoor energy consumption for all landscape and exterior operations* and *Credit 8.5: Use renewable sources for landscape electricity needs*.
- Water features that provide landscape amenities may also help achieve *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration* and *Credit 6.8: Provide outdoor spaces for social interaction*.
- Constructed wetlands or natural swimming pools may be vegetated with native plants and native plant communities, which may help achieve *Credit 4.7: Use native plants* and *Credit 4.9: Restore plant communities native to the ecoregion*.
- Use of constructed wetlands may help achieve *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*.

Resources

- For more information on adding amenity value to stormwater management techniques, see the article by S Echols and E Pennypacker, "From Stormwater Management to Artful Rainwater Design," *Landscape Journal* 27 (2008): pp. 268–290.
- For more information on integrating water elements into site design, see H Dreiseitl and D Grau, eds., *New Waterscapes: Planning, Building, and Designing with Water* (Basel: Birkhäuser, 2005).

Definitions

- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. Use at least two references (or local reference sites) to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

- *Primary contact recreation* includes activities in which there is prolonged and intimate body contact with the water (Secondary contact recreation includes activities with incidental water contact in which the probability of ingesting appreciable quantities of water is minimal).
- *Rainwater/stormwater features* use rainwater and stormwater as their sole source and function as stormwater management elements. Examples include pools, fountains, stormwater BMPs, water gardens, channels/runnels for local conveyance, raingardens, and water art. Features can include those intended for limited human contact or for full human contact.

Credit 3.8	Maintain water features to conserve water and other resources
1-4 Points	

Intent

Design and maintain water features created in the landscape with minimal or no make-up water from potable sources or other natural surface or subsurface water resources.

Economic and social benefits

Using non-potable water sources, such as graywater, reclaimed water, and rainwater in water features reduces water waste and conserves potable water for higher-priority uses, such as drinking water. This practice simultaneously reduces the infrastructure, energy expenditure, and costs associated with pumping, cleaning, and processing municipal water. Municipal water- and wastewater-treatment facilities account for up to 50 percent of the electricity consumed by city governments in the United States.[47]

Requirements

The requirements apply to sites with created water features. All created water features on site must meet the requirements to be awarded this credit. Features that are designed to store water without making it visible for aesthetic purposes (e.g., cisterns, storage tanks) are excluded from these requirements.

- Determine and document that the water feature(s) will not negatively affect receiving waters by changing the site water balance resulting in detrimental impacts to baseflow, nutrient cycling, sediment transport and groundwater recharge or by discharging pollutants or unsustainable volumes to receiving waters. For example, water harvesting techniques should not be used that "starve" the receiving systems of adequate flows necessary to maintain the ecological function of the downstream systems.
  AND
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance)* appropriate maintenance activities for the water feature(s) without the use of chemicals likely to harm aquatic life, such as chlorine and bromine. Include maintenance activities to ensure that the water feature(s) will not create habitat for mosquitoes.
  AND
- Water feature(s) has/have limited make-up water from potable sources or other natural surface or subsurface water resources.
  - **1 point:** 50 percent of annual make-up water for water feature(s) comes from sustainable water sources OR site water feature(s) require(s) 10,000 gallons or less of potable water annually, whichever is less. Initial filling may be derived from potable water if under 37,500 gallons (approximately 5,000 cubic feet).
  - **2 points:** 75 percent of annual make-up water for water feature(s) comes from sustainable water sources OR site water feature(s) require(s) a total of 5,000 gallons or less of potable water, whichever is less.
  - **3 points:** 100 percent of annual make-up water for water feature(s) comes from sustainable water sources.
  - **Additional point:** All water features use gravity for water movement or recirculation and require no purchased electricity. Features that use energy-efficient pumps and/or renewable energy sources for water features are covered under other credits (see Links to other Sustainable Sites credits section below).

Submittal documentation

Submit a site plan showing the locations of all created water feature(s) on site.

Provide specific information regarding the source and available supplies of sustainable water sources (i.e., non-potable water). Include calculations demonstrating that on-site water features can meet their water requirements with sustainable water source supplies (and with no electricity, if applicable). Demonstrate compliance with local and/or state health standards, if applicable. Provide a brief narrative to demonstrate that construction and

maintenance of the water feature(s) will not adversely affect receiving waters, including downstream water bodies and groundwater.

Provide the applicable section(s) of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describe the activities to maintain all proposed water feature(s) without the use of chlorine, bromine, or other chemicals that may be harmful to aquatic life.

Potential technologies and strategies

- Design water features that match or mimic water in the natural environment. Avoid water features that are incompatible with the local ecological context (e.g., a lake in a desert).
- Estimate volumes of rainwater or other non-potable sources available on site for use in water features, and design water features that that are integrated with the site so as to utilize this water on site, and not require additional water from potable water sources.
- Collect and reuse non-potable water from sources such as rainwater from rooftops, graywater, reclaimed water or stormwater basins.
- Design and maintain water features as natural ecosystems, with water source(s), plants, and other aquatic organisms appropriate for local conditions.
- Water quality can be enhanced in created water features with biologically-based water treatment including certain beneficial bacteria, enzymes, mineral, and oxygen-based additives, especially during initial establishment.
- Natural swimming pools or other water features intended for human contact may require additional treatment methods such as ozonation or thermal treatment.

Links to other Sustainable Sites credits

- Created water features on site may help achieve hydrologic objectives to help meet the requirements of *Credit 3.5: Manage stormwater on site* and *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*.
- Created water features that provide a landscape amenity may help achieve *Credit 3.7: Design rainwater/stormwater features to provide a landscape amenity*, *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration*, and *Credit 6.8: Provide outdoor spaces for social interaction*.
- Features that use energy-efficient pumps and/or renewable energy sources for water features may be eligible for *Credit 8.4: Reduce outdoor energy consumption* and *Credit 8.5: Use renewable sources for landsacpe electricity.*
- Constructed wetlands, which may be used to meet the requirements of this credit, may also help achieve *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines* and *Credit 4.9: Restore plant communities native to the ecoregion*.

Resources

- For more information on landscapes that are sensitive to water management issues, see the RL France, ed., *Handbook of Water Sensitive Planning and Design* (2002).
- For more information on adding amenity value to stormwater management techniques, see the article by S Echols and E Pennypacker, "From Stormwater Management to Artful Rainwater Design," *Landscape Journal* 27 (2008): pp. 268–290.
- For more information on integrating water elements into site design, see H Dreiseitl and D Grau, eds., *New Waterscapes: Planning, Building, and Designing with Water* (Basel: Birkhäuser, 2005).

Definitions

- *Created water features* are features with water made visible for aesthetic purposes. These features can include ponds, streams, pools, fountains, water gardens, created wetlands (ornamental or for water cleansing), and any other water element in the landscape with permanent or seasonal, occasional, or otherwise intermittent

water. Created water features can include those intended for limited human contact or for full human contact. Note that water intended for human contact must meet local and/or state health requirements. In some situations, this may require additional treatment methods such as ozonation or thermal treatment.

- *Graywater* is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.
- *Receiving waters* include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.
- *Reclaimed water* is effluent derived in any part from sewage from a wastewater-treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur and is no longer considered wastewater.
- *Sustainable water sources* are non-potable sources and can include harvested rainwater, surplus water from building or site operations that has been appropriately cleansed and cooled, and surplus site water that is not needed to maintain existing or restored site ecology. Potable water or other natural surface or subsurface water resources are not sustainable water sources.

Prerequisite 4.1 REQUIRED — Control and manage known invasive plants found on site

Economic and social benefits

Invasive species compete with and harm plant and animal communities. Some 5,000 plant species have escaped into natural ecosystems, resulting in millions of dollars in control costs.[48]

Intent

Develop and implement an active management plan for the control and subsequent management of known invasive plants found on site to limit damage to local ecosystem services.

Requirements

Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) an active multi-year invasive species management plan for control and subsequent management of any plant species currently listed on any of the following lists as invasive: regional lists (when listing occurs through a vetted, transparent process and has been accepted by the regional stakeholders), State Noxious Weeds laws, or Federal Noxious Weeds laws. The following components must be included in the invasive species management plan:

- Integrated pest management (IPM) strategies
- A procedure for identifying and monitoring for additional invasive species that may colonize the site and new species as they are recognized by local authorities
- Initial treatment, follow-up treatments, long-term control including monitoring, and methods to dispose of invasive plant materials to prevent spread.

Begin implementation of the invasive species management plan before or during the construction phase of the project. Note that invasive species present within any ***vegetation and soil protection zones*** (such as threatened and endangered species habitat protected under *Prerequisite 1.4* or floodplains protected under *Prerequisite 1.2*) on site must be treated using equipment that can be carried in and out of the zone on foot.

Submittal documentation

The site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* will document locations and species of invasive plants (as listed by federal, state, and regional entities). Provide the applicable section(s) of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the invasive species management plan. Submit drawings and written specifications as part of construction documents that illustrate how contractor(s) will identify, control, and manage invasive plants during construction.

Potential technologies and strategies

Contact local and regional governmental agencies, consultants, and educational facilities as resources for the most appropriate and effective management techniques for invasive species identified on site.

Links to other Sustainable Sites credits

- Locations of existing invasive species on site will be documented in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*).
- Plans for future control and management of invasive species will be documented in the site maintenance plan as part of *Prerequisite 8.1: Plan for sustainable site maintenance*.
- Removal and management of invasive species is likely a part of a strategy to support threatened and endangered species which may contribute to *Prerequisite 1.4: Preserve threatened or endangered species and their habitats*.

Resources

- For help identifying invasive plants in your area, refer to the USDA Natural Resources Conservation Service Plants Database, *http://plants.usda.gov/*, specifically the webpage on invasive and noxious weeds, *http://plants.usda.gov/java/noxiousDriver.* The University of Montana also provides a searchable database of the noxious weed lists for all U.S. states and six southern provinces of Canada, *http://invader.dbs.umt.edu/Noxious_Weeds/*. See also Plant Conservation Alliance, *http://www.nps.gov/plants/alien/factmain.htm#pllists*.
- For additional links, management tools, etc., see the Global Invasive Species Team's website, *http://www.invasive.org/gist/*; the Center for Plant Conservation's comprehensive list of links, *http://www.centerforplantconservation.org/invasives/Links.html*; and the Center for Invasive Plant Management, *http://www.weedcenter.org/*, including the resources on invasive plant management, *http://www.weedcenter.org/management/mgmt_overview.html*.

Definitions

- *Control of invasives* is the appropriate eradication, suppression, reduction, or management of invasive species populations, prevention of the spread of invasive species from areas where they are present, and taking steps such as restoration of native or appropriate species and habitats to reduce the effects of invasive species and to prevent further invasion.[49]
- *Integrated pest management (IPM)* is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks. IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. The IPM approach places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.
- *Invasive species* are species that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health.[50]
- *Management of invasives* is the implementation of control measures to prevent the spread of invasive species or lessen their impacts when they appear to be permanently established. Control and management of invasive species encompasses diverse objectives such as eradication within an area, population suppression, limiting spread, and reducing effects. Complete eradication is not generally feasible for widespread invasive species or where adequate control methods are not available. Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks. Consideration of cumulative environmental impacts requires that environmentally sound methods be deployed, especially in vulnerable areas.[51]

Prerequisite 4.2 REQUIRED — Use appropriate, non-invasive plants

Intent
Use only plants that are non-invasive and appropriate for site conditions, climate, and design intent to improve landscape performance and reduce resource use.

Requirements
- Use only non-invasive plant species that are not currently listed on any of the following lists as invasive at the site location: regional lists (when listing occurs through a vetted, transparent process and has been accepted by regional stakeholders), State Noxious Weeds laws, or Federal Noxious Weeds laws.
- Use only plants that are nursery grown, legally harvested, or salvaged for reuse from on or off site. All nursery grown plants must use an applicable regional standard or regionally adopted guidelines. If no regional standards or guidelines exist, nursery grown plants must use the ANSI Z60.1-2004 American Standard for Nursery Stock.
- Use only plants that are appropriate for site conditions, climate, and design intent.

Submittal documentation
Provide species lists of plants, including scientific names, that will remain on site and those that will be added to the site. Document (using at least two references) that the plants used are appropriate for site conditions (cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements) and meet the program needs and design intent of the site. Attach or provide links to federal, state, and regional lists (e.g., from a regional Invasive Plant Council) of invasive plants to confirm that no plant on these lists will be brought to the site.

Economic and social benefits
Plants adapted to site conditions, climate, and design intent need fewer resources and less maintenance.

Invasive species compete with and harm plant and animal communities. Approximately 5,000 plant species have escaped into natural ecosystems, resulting in millions of dollars in control costs. For example, purple loosestrife *(Lythrum salicaria)*, an invasive herbaceous species introduced as an ornamental plant in the United States, has aggressively spread to 48 states, resulting in control costs of almost $45 million per year nationwide.

Illegal harvesting can reduce both the numbers and genetic diversity of wild plant populations, threatening their survival. Illegal harvesting of wild plants also harms ecosystems, through damage during collection and by removal of species upon which natural communities depend.

Potential technologies and strategies
Select appropriate native plants or regionally appropriate species. Select plants that will thrive in the climate and conditions of the site, avoiding invasive species that may jeopardize local ecosystems. If turfgrasses are to be used, they should be selected to be regionally appropriate and minimize post-establishment requirements for irrigation, pesticide, fertilizer, and maintenance. Contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of plants appropriate for the site.

For tree plantings, use the ANSI A300 Best Management Practices for Tree Planting as a guide. Plant diversity provides resistance to insect and disease pests; as a general guide for larger sites, plant no more than 10 percent of any species, no more than 20 percent of any genus, and no more than 30 percent of any family.[52] For smaller sites, select species that contribute to the plant diversity of the community/region as a whole.

Links to other Sustainable Sites credits

- Reusing salvaged plants from on or off site may help achieve *Credit 5.4: Reuse salvaged materials and plants*.
- Selecting non-invasive, appropriate plants that are also native may help achieve *Credit 4.7: Use native plants*.
- Where native plant communities are used, a site may be able to achieve *Credit 4.9: Restore plant communities native to the ecoregion*.
- Selecting appropriate plants with low water requirements may also help achieve *Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline* and *Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline*.

Resources

- For information on native and appropriate plants, see North American Native Plant Society, *http://www.nanps.org* and the Native Plant Information Network's Native Plant Database, *http://www.wildflower.org/plants/*.
- For information on invasive species, see regional and local sources as well as national sources such as National Invasive Species Information Center, *http://www.invasivespeciesinfo.gov/*; the Center for Plant Conservation's comprehensive list of links, *http://www.centerforplantconservation.org/invasives/Links.html*; or National Invasive Species Council, *http://www.invasivespecies.gov/*. The University of Montana also provides a searchable database of the noxious weed lists for all U.S. states and six southern provinces of Canada, *http://invader.dbs.umt.edu/Noxious_Weeds/*.
- Local colleges and universities and USDA Cooperative Extension System Offices, *http://www.csrees.usda.gov/qlinks/partners/state_partners.html*, may also provide helpful regional resources.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Invasive species* are species that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health.[53]
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

Prerequisite 4.3 REQUIRED — Create a soil management plan

Intent

Develop and communicate to construction contractors a soil management plan (SMP) prior to construction to limit disturbance, assist soil restoration efforts, and define the location and boundaries of all vegetation and soil protection zones.

Economic and social benefits

Healthy soils reduce site maintenance costs by providing improved ecosystem services and reduced use of resources. Clearly defining and communicating soils goals to all site contractors will help protect valuable soil functions and minimize expensive restoration requirements.

Requirements

- Refer to the mapped locations of healthy soils and soils disturbed by previous development as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*), and calculate the total surface area of each.
- The SMP should include the following information :
  1. On the soils map, site plan, or grading plan, indicate designated soil management areas for all site soils, including, but not limited to:
     - Soils that will be retained in place and/or designated as ***vegetation and soil protection zones***.
     - Soils that will be disturbed during construction, restored, and re-vegetated.
     - Soils disturbed by previous development that will be restored in place and re-vegetated.
  2. Indicate locations for all laydown and storage areas, haul roads and construction vehicle access, temporary utilities and construction trailers, and parking (all of which must be located outside of the vegetation and soil protection zones).
  3. Describe how areas of restored soils will be protected from compaction (e.g., vehicle traffic or storage), erosion, and contamination until project completion.
  4. Describe treatment details for each zone of soil that will be restored, including the type, source, and expected volume of materials (e.g., compost amendments, mulch, topsoil, etc.). See *Prerequisite 7.2: Restore soils disturbed during construction* and *Credit 7.3: Restore soils disturbed by previous development* for guidance.
  5. Outline the footprint of buildings and hardscape (e.g, trails, roads, etc.) and any areas of vegetation that will be preserved in place.
- Communicate the SMP to site contractors in site drawings and written specifications.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.

- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation

Provide a copy of the SMP for the site that includes maps and treatment types for each soil zone on the site, including locations of all vegetation and soil protection zones, with signatures of the client and site contractors to demonstrate that the plan was communicated in site drawings and written specifications.

Potential technologies and strategies

Consider existing soils conditions during site design, and communicate clearly with all site contractors to ensure that soils goals are understood and achieved. Integrate the SMP with site erosion and sediment control planning (e.g., Stormwater Pollution Prevention Plan [SWPPP] or Erosion and Sedimentation Control Plan [ESC]; see *Prerequisite 7.1: Control and retain construction pollutants*), for instance by using compost blankets, berms, or socks for erosion and sediment control and then reusing the compost for amendment in soil restoration at the end of the project.

Links to other Sustainable Sites credits

- Communication with site contractors about the details of the soil management plan is important to ensure soil treatment occurs as planned during site development; this is further addressed in *Prerequisite 2.2: Use an integrated site development process*.
- Proper protection of healthy soils and existing vegetation and/or restoration of soils that will be re-vegetated may also help achieve credits such as *Credit 4.5: Preserve all vegetation designated as special status*, *Credit 4.6: Preserve and restore appropriate plant biomass on site*, *Credit 4.7: Use native plants*, *Credit 4.8: Preserve plant communities native to the ecoregion*, *Credit 4.9: Restore plant communities native to the ecoregion*, and/or *Credit 7.3: Restore soils disturbed by previous development*.
- Elements of soils management and erosion and sediment control planning (see *Prerequisite 7.1: Control and retain construction pollutants*) during construction may overlap and could be considered together.

Resources

- For a guide to developing a soil management plan, see Soils for Salmon resources, *http://www.soilsforsalmon.org*, including the Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13, *http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf*. The Guidelines, along with links to EPA-approved compost erosion control BMPs, are also available at *www.buildingsoil.org*.
- The King County booklet, "Achieving the Post-Construction Soil Standard," *http://www.metrokc.gov/dnrp/swm/forms/ls-inf-SoilPost-ConStd.pdf*.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.

- *Healthy soils* are all areas of soils that have not been significantly disturbed by previous human development activities. Indicators of healthy soils may include one or more of the following:
  - soil horizons that are similar to the *reference soil*
  - bulk densities that do not exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content is equal to or exceeds that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) similar to that of the reference soil
  - absence of compounds toxic to the intended plants
  - presence of vegetation that is representative of native plant communities.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Soils disturbed by previous development* are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include one or more of the following:
  - soil horizons that differ significantly in either depth, texture, physical or chemical properties from the *reference soil.*
  - bulk densities that exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A.
  - *organic matter* content lower than that of the reference soil.
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil.
  - presence of compounds toxic to the intended plants.
  - presence of weedy, opportunistic, or invasive plant species.

Credit 4.4	Minimize soil disturbance in design and construction
6 Points	

Intent

Limit disturbance of healthy soil to protect soil horizons and maintain soil structure, existing hydrology, organic matter, and nutrients stored in soils.

Economic and social benefits

Healthy soils effectively cycle nutrients; store carbon as organic matter; minimize runoff and maximize water holding capacity; absorb excess nutrients, sediments, and pollutants; provide a healthy rooting environment and habitat to a wide range of organisms; and maintain their structure and aggregation. Preserving soil horizons saves money by reducing the need for soil restoration and surface drainage improvements. By limiting grading, sites can also reduce costs for construction machinery and transport of imported soils.

Requirements[54]

- **Option 1:** Locate 100 percent of soil displacement and disturbance on soils disturbed by previous development with moderate or severe soil disturbance as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* and Soil Management Plan, as described in *Prerequisite 4.3: Create a soil management plan*). Designate any healthy soils on site as ***vegetation and soil protection zones***. Areas with minimal soil disturbance may be restored and need not be included within vegetation and soil protection zones.

OR

- **Option 2:** On all areas of healthy soils or soils with minimal soil disturbance as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*), limit disturbance to 40 feet beyond the building perimeter; 10 feet beyond surface walkways, patios, surface parking, and utilities less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area. Designate the remaining healthy soils on site as ***vegetation and soil protection zones***. Soils with minimal disturbance may be restored and need not be included within vegetation and soil protection zones.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.

- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation

- **Option 1**: Provide information on the site's baseline conditions including information from the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* to show the extent of soils disturbed by previous development and the degree of disturbance of these soils. Provide a copy of the construction drawings to demonstrate that 100 percent of the total area of all soils zoned for disturbance is located within soils disturbed by previous development. On the drawings, show the extent of all VSPZs. Provide a narrative to describe how VSPZs will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.

OR

- **Option 2**: Provide a copy of the construction drawings along with information on the site's baseline conditions including information from the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* to demonstrate that the designated site disturbance boundaries are not exceeded for areas of healthy soils and soils of minimal disturbance. On the drawings, show the extent of all VSPZs. Provide a narrative to describe how VSPZs will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.

Potential technologies and strategies

Limit grading for planting mounds or other topological forms to areas of previously disturbed soils. Establish clear construction boundaries to minimize disturbance to healthy soils.

Links to other Sustainable Sites credits

- Limiting disturbance to a tight envelope around development will reduce the area of soil that needs to be restored after construction as required under *Prerequisite 7.2: Restore soils disturbed during construction*.
- Locating soil displacement and disturbance within areas of previously disturbed soil will reduce the area of soil that would need to be restored prior to planting and may also help achieve *Credit 7.3: Restore soils disturbed by previous development*.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.

- *Healthy soils* are all areas of soils that have not been significantly disturbed by previous human development activities. Indicators of healthy soils may include one or more of the following:
  - soil horizons that are similar to the *reference soil*
  - bulk densities that do not exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content is equal to or exceeds that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) similar to that of the reference soil
  - absence of compounds toxic to the intended plants
  - presence of vegetation that is representative of native plant communities.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Minimal soil disturbance* describes soils that are minimally graded and/or compacted, such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A, but not covered with impervious surfaces. Examples of soils that are minimally disturbed include areas with minor modifications or very limited development but not covered with buildings or paved surfaces, such as areas that have been compacted by livestock or heavy foot traffic.
- *Moderate soil disturbance* describes soils in which topsoil is compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A or is partly removed and/or not present, and in which subsoils are compacted or mixed with topsoil. Examples of soils that are moderately disturbed include previously developed or graded areas that are not covered with buildings or paved surfaces, such as unpaved ranch roads.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.
- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Severe soil disturbance* describes soils in which topsoil is removed and/or is not present; subsoils are compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A; and/or topsoil or subsoil is covered with impervious cover or is chemically contaminated. Examples of soils that are severely disturbed include areas that are covered with buildings or paved surfaces, or areas that are defined as brownfields by local, state, or federal agencies.

- *Soils disturbed by previous development* are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include one or more of the following:
  - soil horizons that differ significantly in either depth, texture, physical or chemical properties from the *reference soil*
  - bulk densities that exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content lower than that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil
  - presence of compounds toxic to the intended plants
  - presence of weedy, opportunistic, or invasive plant species

Credit 4.5	Preserve all vegetation designated as special status
5 Points	

Intent
Identify and preserve all vegetation designated as special status by local, state, or federal entities.

Economic and social benefits

Mature trees and other plants are significant community resources because of their cultural, aesthetic, or historic relevance. Special status vegetation may be deemed important because they are associated with a significant historic event or place, are located in a place that provides critical functions (such as soil stability along a stream), or are species that are relatively rare in an area.[55]

Requirements
The requirements apply only to trees and other plants designated as special status by local, state, or federal entities. This credit is limited to individual trees and other plants or clusters of individual trees or plants. Native plant communities and cultural landscapes are addressed in other credits (see the Links to other Sustainable Sites credits section below).

Establish ***vegetation and soil protection zones*** to protect special status trees and other plants.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation
The site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) will document locations of trees or other plants that may meet special status designations. On a site map, indicate the locations of all special status plants, noting the species and size (DBH and/or canopy width) of each. Indicate the extent of all vegetation and soil protection zones, with distances from protected vegetation marked on the site map. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that

describes the on-going management activities to protect the integrity of the vegetation and soil protection zones. Include a description of how the critical aspects of the special status plants' culture and habitat are being protected and maintained, including hydrology, associated plant communities, exposure, etc.

Potential technologies and strategies

Design the site to minimize harm to special status trees and other plants. Consult with local experts qualified in plant health and safety to determine special protection measures. For trees, ground-penetrating radar (GPR) or air excavation can be used to determine the location of tree roots.

Links to other Sustainable Sites credits

Protection of native plant communities and cultural landscapes are addressed in *Credit 4.8: Preserve plant communities native to the ecoregion* and *Credit 6.4: Protect and maintain unique cultural and historical places*, respectively.

Resources

- International Society of Arboriculture's Tree Ordinance Guidelines, *http://www.isa-arbor.com/publications/tree-ord/heritage.aspx,* to identify heritage, historic, or landmark trees.
- Consult with State Forest Resource agencies for lists of champion trees.
- RW Harris, N Matheny, and JR Clark, *Arboriculture: Integrated Management of Landscape Trees, Shrubs, and Vines*. 3rd ed. (Upper Saddle River, NJ: Prentice Hall, 1999).

Definitions

- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Special status plants* are vegetation designated as important by local, state, or federal entities; designations may be for size, species, age, rare or special collections, ecological and environmental value, unique genetic resources, aesthetics, location, or other unique characteristics. Groves/clusters may also be designated special status.

Credit 4.6	Preserve or restore appropriate plant biomass on site
3–8 Points	

Intent
Maintain or establish regionally appropriate vegetative biomass to support the ecosystem service benefits provided by vegetation on site.

Requirements
Preserve or restore vegetation biomass on site to a level appropriate to the site's region. See the Calculation guidelines section below to determine applicable point values.

Submittal documentation
Provide calculations for the Existing Site BDI (biomass density index) and Planned Site BDI, and provide a site map/aerial photographs, and site plans to demonstrate existing and planned site conditions (using estimates of cover within 10 years of installation).

Potential technologies and strategies
On greenfield sites, carefully design the site to minimize disruption to existing appropriate vegetation. Use trees, green roofs, or vegetated structures (e.g., trellises) to cover non-vegetated surfaces such as walkways, roofs, or parking lots, and select vegetation-based methods to achieve stormwater management goals for the site. To support healthy vegetation, provide adequate soil volume to sustain root development (i.e., for trees, provide at least 2 cubic feet of plant-usable rooting soil for each square foot of mature tree canopy, with a minimum depth of 2 feet and a maximum depth of 4 feet).

Calculation guidelines
Determine the BDI for existing and planned conditions for the site, using the guidelines below. BDI can be thought of as the density of plant layers covering the ground. Existing BDI is calculated for the site as it stands prior to site design (as identified in the site assessment, see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*). Planned BDI is calculated for the site as designed and anticipated within 10 years of vegetation installation.

Economic and social benefits

Vegetation on a site is associated with increased benefits such as pollutant interception, water absorption, greenhouse gas regulation, and microclimate regulation. The benefits provided by vegetation are tied to plant processes, including photosynthesis, respiration, evapotranspiration, and mineral uptake from the air and ground. The degree to which these processes occur depends on the amount of green matter on a site.

To calculate the Existing Site BDI, use information from the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) to draw a map of the zones of land cover or vegetation types existing on the site, and determine the percent of total area for each distinct zone. All vegetation or land cover zones should fall into only one category and should not overlap. BDI calculations include all vegetation or land cover zones (including roof area), as well as all other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas) on the site. Exclude areas of open water and areas of invasive species in calculations; these areas shall be excluded from the total site area.

Table 4.6-A: Calculations for Existing Site BDI. For each zone in colum A, enter the percent of total area in column C below. Multiply those percentages by their respective biomass density values from column B and enter the result in column D. Existing Site BDI is the sum of all data in column D.

TABLE 4.6-A: CALCULATIONS FOR EXISTING SITE BDI

Land cover/vegetation type zone	Biomass density value* for this zone	Percent of total site area for this zone	Biomass density value x percent of total site area (column B x column C)
A	B	C	D
Trees with understory	6		
Trees without understory (less than 10 percent herbaceous/shrub cover)	4		
Shrubs	3		
Desert plants	1.5		
Annual plantings	1.5		
Grasslands and turfgrass	2		
Wetlands**	6		
Impervious cover or bare ground not shaded by vegetation or vegetated structures	0		
SUBTOTAL (sum of all rows)	n/a	100%	
ADDITIONAL VALUE for other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas), if applicable: Calculate the total surface area of the vegetated surface, multiply by a biomass density value of 1, and divide by the total site area.			
Existing Site BDI (sum of Subtotal and Additional Value)			

* *The biomass density values in column B are based on a literature review of leaf area index for various vegetation types.*
** *This category includes wetlands with emergent vegetation and does not include open water.*

To calculate the Planned Site BDI, use site design and planting plans to map the zones of land cover or vegetation types at 10 years following landscape installation and determine the percent of total area for each distinct zone. All vegetation or land cover zones should fall into only one category and should not overlap. BDI calculations include all vegetation or land cover zones (including roof area), as well as all other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas) on the site. Exclude areas of open water in calculations; these areas shall be excluded from the total site area. Include area of green roofs and green walls in the calculations.

Table 4.6-B: Calculations for Planned Site BDI. For each zone in colum A, enter the percent of total area in column C below. Multiply those percentages by their respective biomass density values from column B and enter the result in column D. Planned Site BDI is the sum of all data in column D.

TABLE 4.6-B: CALCULATIONS FOR PLANNED SITE BDI

Land cover/vegetation type zone	Biomass density value* for this zone	Percent of total site area for this zone	Biomass density value x percent of total site area (column B x column C)
A	B	C	D
Trees with understory	6		
Trees without understory (less than 10 percent herbaceous/shrub cover)	4		
Shrubs	3		
Desert plants	1.5		
Annual plantings	1.5		
Grasslands and turfgrass	2		
Wetlands**	6		
Impervious cover or bare ground not shaded by vegetation or vegetated structures	0		
SUBTOTAL (sum of all rows)	n/a	100%	
ADDITIONAL VALUE for other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas), if applicable: Calculate the total surface area of the vegetated surface, multiply by a biomass density value of 1, and divide by the total site area.			
Planned Site BDI (sum of Subtotal and Additional Value)			

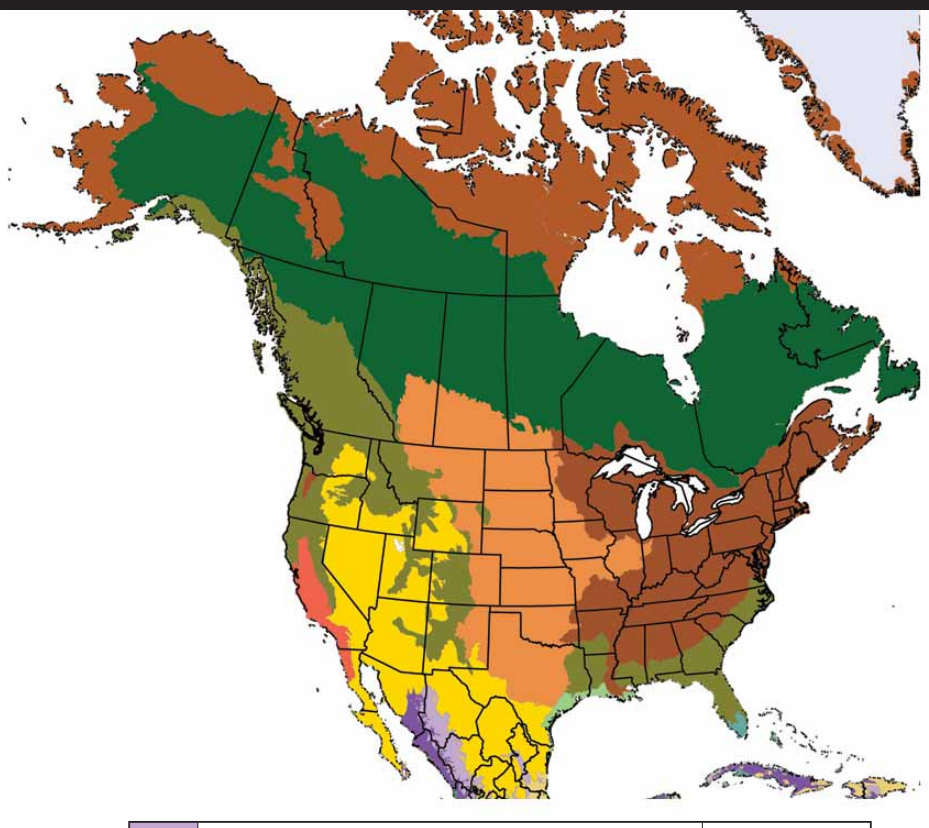
* The biomass density values in Column II are based on a literature review of leaf area index (LAI) for various vegetation types which included LAI for approximately 1,000 historical estimates of LAI summarized by biome/cover type in JMO Scurlock, GP Asner, and ST Gower, *Worldwide Historical Estimates of Leaf Area Index, 1932-2000* (Oak Ridge, TN: Oak Ridge National Laboratory, 2001).

** This category includes wetlands with emergent vegetation and does not include open water.

Region-specific point value look-up tables: The region-specific point value look-up tables below show Existing Site BDI values along the y-axis and Planned Site BDI values along the x-axis. Use Figure 4.6-A below to determine the biome within which the site is located. Then find the corresponding look-up table (Tables 4.6-C–K) for point values specific to that biome. Differences in point values between biomes are based on mean leaf area index (LAI) for approximately 1,000 historical estimates of LAI summarized by biome/cover type in JMO Scurlock, GP Asner, and ST Gower, *Worldwide historical estimates of leaf area index, 1932–2000* (Oak Ridge, TN: Oak Ridge National Laboratory, 2001).

Figure 4.6-A: Terrestrial Biomes in North America. Use this figure to determine the biome within which the site is located and the applicable point value look-up table for that biome. *[Shapefile source:* The Nature Conservancy, *Terrestrial Ecoregional Boundaries and Assessments Geodatabase (TNC) 4/6/09, http://conserveonline.org/workspaces/ecoregional.shapefile]*

FIGURE 4.6-A: TERRESTRIAL BIOMES IN NORTH AMERICA



	Tropical & Subtropical Coniferous Forests	see Table 4.6-C
	Temperate Broadleaf & Mixed Forests	see Table 4.6-D
	Temperate Conifer Forests	see Table 4.6-E
	Mediterranean Forests, Woodlands & Scrub	see Table 4.6-F
	Deserts	see Table 4.6-G
	Temperate Grasslands, Savannas & Shrublands	see Table 4.6-H
	Boreal Forests & Taiga	see Table 4.6-I
	Tropical & Subtropical Grasslands, Savannas & Shrublands	see Table 4.6-J
	Flooded Grasslands & Savannas	see Table 4.6-K

Table 4.6-C: Point value look-up table for sites in **Tropical and Subtropical Coniferous Forests biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-C

Existing Site BDI	Planned Site BDI				
	0–1	1–2	2–3	3–4	4 or above
0–1	No Credit	3 points	5 points	8 points	8 points
1–2	No Credit	No Credit	3 points	5 points	8 points
2–3	No Credit	No Credit	No Credit	3 points	8 points
3–4	No Credit	No Credit	No Credit	No Credit	8 points
4 or above	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-D: Point value look-up table for sites in **Temperate Broadleaf and Mixed Forests biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-D

Existing Site BDI	Planned Site BDI					
	0–1	1–2	2–3	3–4	4–5	5 or above
0–1	No Credit	3 points	5 points	8 points	8 points	8 points
1–2	No Credit	No Credit	3 points	5 points	8 points	8 points
2–3	No Credit	No Credit	No Credit	3 points	5 points	8 points
3–4	No Credit	No Credit	No Credit	No Credit	3 points	8 points
4–5	No Credit	No Credit	No Credit	No Credit	No Credit	8 points
5 or above	No Credit	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-E: Point value look-up table for sites in **Temperate Conifer Forests biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-E

Existing Site BDI	Planned Site BDI					
	0–1	1–2	2–3	3–4	4–5	5 or above
0–1	No Credit	3 points	5 points	8 points	8 points	8 points
1–2	No Credit	No Credit	3 points	5 points	8 points	8 points
2–3	No Credit	No Credit	No Credit	3 points	5 points	8 points
3–4	No Credit	No Credit	No Credit	No Credit	3 points	8 points
4–5	No Credit	No Credit	No Credit	No Credit	No Credit	8 points
5 or above	No Credit	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-F: Point value look-up table for sites in **Mediterranean Forests, Woodlands and Scrub biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-F

Existing Site BDI	Planned Site BDI				
	0–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0 or above
0–0.5	No Credit	3 points	5 points	8 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points	8 points
1.0–1.5	No Credit	No Credit	No Credit	3 points	8 points
1.5–2.0	No Credit	No Credit	No Credit	No Credit	8 points
2.0 or above	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-G: Point value look-up table for sites in **Deserts biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-G

Existing Site BDI	Planned Site BDI			
	0–0.5	0.5–1.0	1.0–1.5	1.5 or above
0–0.5	No Credit	3 points	5 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points
1.0–1.5	No Credit	No Credit	No Credit	3 points
1.5 or above	No Credit	No Credit	No Credit	No Credit

Table 4.6-H: Point value look-up table for sites in **Temperate Grasslands, Savannas and Shrublands biome.** Use this table to look up the applicable point value (no credit, low point value, mid point value, or high point value) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-H

Existing Site BDI	Planned Site BDI				
	0–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0 or above
0–0.5	No Credit	3 points	5 points	8 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points	8 points
1.0–1.5	No Credit	No Credit	No Credit	3 points	8 points
1.5–2.0	No Credit	No Credit	No Credit	No Credit	8 points
2.0 or above	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-I: Point value look-up table for sites in **Boreal Forests and Taiga biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-I

Existing Site BDI	Planned Site BDI				
	0–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0 or above
0–0.5	No Credit	3 points	5 points	8 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points	8 points
1.0–1.5	No Credit	No Credit	No Credit	3 points	8 points
1.5–2.0	No Credit	No Credit	No Credit	No Credit	8 points
2.0 or above	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-J: Point value look-up table for sites in **Tropical and Subtropical Grasslands, Savannas and Shrublands biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-J

Existing Site BDI	Planned Site BDI				
	0–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0 or above
0–0.5	No Credit	3 points	5 points	8 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points	8 points
1.0–1.5	No Credit	No Credit	No Credit	3 points	8 points
1.5–2.0	No Credit	No Credit	No Credit	No Credit	8 points
2.0 or above	No Credit	No Credit	No Credit	No Credit	8 points

Table 4.6-K: Point value look-up table for sites in **Flooded Grasslands and Savannas biome.** Use this table to look up the applicable point value (no credit, 3 points, 5 points, or 8 points) for the difference between the Existing Site BDI and Planned Site BDI on your site.

TABLE 4.6-K

Existing Site BDI	Planned Site BDI				
	0–0.5	0.5–1.0	1.0–1.5	1.5–2.0	2.0 or above
0–0.5	No Credit	3 points	5 points	8 points	8 points
0.5–1.0	No Credit	No Credit	3 points	5 points	8 points
1.0–1.5	No Credit	No Credit	No Credit	3 points	8 points
1.5–2.0	No Credit	No Credit	No Credit	No Credit	8 points
2.0 or above	No Credit	No Credit	No Credit	No Credit	8 points

EXAMPLE: USING THE CALCULATION GUIDELINES AND REGION-SPECIFIC POINT LOOK-UP TABLES

Assume a 3,000-square-foot greyfield site is located in northern Florida. On the existing site, 90 percent of the site area is impervious cover or bare ground, and the remaining 10 percent of the site is trees without understory. Using Table 4.6-A to calculate Existing Site BDI, multiply percent of site area by the associated biomass density value for each land cover or vegetation type, and then find the sum of the products. The biomass density value for impervious cover or bare ground is zero (90 percent x 0 = 0) and for trees without understory is four (10 percent x 4 = 0.4). The Existing Site BDI is the sum of these values (0 + 0.4 = 0.4).

The site design for the planned development includes a building with a green roof and a re-vegetated area with trees, shrubs, and turfgrass. Using the estimated cover within 10 years of installation, the percent area for trees, shrubs, and turfgrass is 20 percent, 10 percent, and 10 percent, respectively. The building is designed for 40 percent of the site area and will be completely covered with a green roof containing mostly grasses. The remaining 20 percent of the site area will be impervious cover for sidewalks. In addition, a 300-square-foot green wall will be added. Using Table 4.6-B to calculate Planned Site BDI, multiply percent of site area by the associated biomass density value for each land cover or vegetation type, and then find the sum of the products. The biomass density value for trees without understory is four (20 percent x 4 = 0.8), shrubs is three (10 percent x 3 = 0.3), turfgrass and grasslands is two [(10 percent for lawn + 40 percent for green roof) x 2 = 1.0], and impervious cover is zero (20 percent x 0 = 0). The 300-square-foot green wall also contributes to the Planned Site BDI, which can be calculated by multiplying the size of the green wall by one and dividing by the total area of the site: (300 square feet x 1)/(3,000 square feet) = 0.1. The Planned Site BDI is the sum of these values (0.8 + 0.3 + 1.0 + 0 + 0.1 = 2.2).

Using the map in Figure 4.6-A, northern Florida is located in the Temperate Conifer Forests biome, which is associated with Table 4.6-E. Find the Existing Site BDI on the y-axis and the Planned Site BDI on the x-axis. Table 4.6-E indicates that an Existing Site BDI of 0.4 and a Planned Site BDI of 2.2 is awarded 5 points.

Links to other Sustainable Sites credits

- A site can meet this credit using appropriate, non-invasive vegetation (see *Prerequisite 4.2: Use appropriate, non-invasive vegetation*) and sustainable irrigation requirements (see *Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline*).
- If native plants or native plant communities are maintained or used to achieve this credit, a site may also be eligible for *Credit 4.7: Use native plants*, *Credit 4.8: Preserve plant communities native to the ecoregion*, and *Credit 4.9: Restore plant communities native to the ecoregion*, respectively.

Resources

GP Asner, JMO Scurlock, and JA Hicke, "Global synthesis of leaf area index observations: Implications for ecological and remote sensing studies," *Global Ecology & Biogeography* 12 (2003): pp. 191–205.

Definitions

- *Greenfield* is a site that has not been previously developed or graded, including previous agricultural fields.

Credit 4.7	Use native plants
1–4 Points	

Intent
Plant appropriate vegetation that is native to the ecoregion of the site.

Requirements
- **1 point:** 50 percent of the site vegetated area is composed of native plants. The area containing native plants must be at least 2,000 square feet.
- **3 points:** 75 percent of the site vegetated area is composed of native plants. The area containing native plants must be at least 2,000 square feet.
- **4 points:** 100 percent of the site vegetated area is composed of native plants. The area containing native plants must be at least 2,000 square feet.

Percent calculations are measured by surface area of vegetated area, using estimated vegetated cover within 10 years of installation.

Economic and social benefits

Native plants can provide habitat for native wildlife, including important pollinator species (e.g., insects, birds, and bats) that are necessary for plant reproduction, including cultivation of crops. Up to 80 percent of the world's food plant species are dependent on pollination by animals.[56] Wildlife habitat also supports recreational and ecotourism activities, such as fishing and birdwatching, and opportunities for environmental education.[57]

Submittal documentation
Provide a site plan showing all vegetated areas, and indicate the portions of the vegetated area that contain native plants. Provide calculations to demonstrate that requirements for percent area have been met. Submit a planting/seeding plan and written specifications with performance requirements. Provide a list of all native plant species within the vegetated area, including scientific names.

Potential technologies and strategies
Native plants can be used for both formal and naturalistic designs. On sites with existing native vegetation, design the site to preserve native plants where possible. On previously developed sites, contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of native plants appropriate for the site.

Links to other Sustainable Sites credits
- Sites that preserve or restore native plant communities can achieve credit under *Credit 4.8: Preserve plant communities native to the ecoregion* and *Credit 4.9: Restore plant communities native to the ecoregion*.
- Soil restoration prior to re-vegetation may help support newly planted vegetation and help achieve *Credit 7.3: Restore soils disturbed by previous development*.

Resources
For more information about native plants, refer to the following resources:
- U.S. Environmental Protection Agency's Green Landscaping resources page, *http://www.epa.gov/greenacres/index.html*, including the Native Plants Factsheet, *http://www.epa.gov/greenacres/nativeplants/factsht.html*.
- The North American Native Plant Society, *http://www.nanps.org*.
- The Lady Bird Johnson Wildflower Center's Native Plant Information Network's Native Plant Database *http://www.wildflower.org/plants/*.

Definitions

- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.
- *Vegetated area* describes all portions of the site that will support vegetation.

Credit 4.8	Preserve plant communities native to the ecoregion
2–6 Points	

Intent

Preserve plant communities native to the ecoregion of the site to contribute to regional diversity of flora and provide habitat for native wildlife.

Requirements

The requirements apply to existing native plant communities as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) in which evidence of human disturbance is minimal and exotic and invasive plants make up less than 25 percent of the total area. Plant communities in which evidence of human disturbance is moderate to severe or exotic and invasive plants make up more than 25 percent of the total area can also achieve credit for restoration of native plant communities (see *Credit 4.9: Restore plant communities native to the ecoregion*).

Preserve existing native plant communities on site. Preserved area must be contiguous and a minimum of 2,000 square feet.

- **2 points:** Preserve at least 25 percent of the total area of existing native plant communities on site, and designate the native plant communities as a ***vegetation and soil protection zone.***
- **3 points:** Preserve at least 50 percent of the total area of existing native plant communities on site, and designate the native plant communities as a vegetation and soil protection zone.
- **5 points:** Preserve at least 75 percent of the total area of existing native plant communities on site, and designate the native plant communities as a vegetation and soil protection zone.
- **Additional point:** Preserve native plant communities to provide habitat corridors connecting to off-site natural areas or buffers adjacent to off-site natural areas for migrating wildlife. This option applies to habitat for species of concern within your region as identified by state Wildlife Action Plans, state wildlife agencies, federal wildlife agencies, or other entities.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.

Economic and social benefits

Native plants can provide habitat for native wildlife, including important pollinator species (e.g., insects, birds, and bats) that are necessary for plant reproduction, including cultivation of crops. Up to 80 percent of the world's food plant species are dependent on pollination by animals.[58] Wildlife habitat also supports recreational and ecotourism activities, such as fishing and birdwatching, and opportunities for environmental education.[59]

- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Submittal documentation

Provide information from the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) indicating the original area and characteristics of existing native plant communities on site. Include a plant species list with scientific names. On the site plan, indicate the area of existing native plant communities that will be preserved, and provide calculations to demonstrate that requirements for percent area have been met. Provide information from at least two references (or local reference sites) to show that the preserved vegetation on the site has the same dominant plant species, relative species abundances, and other characteristic elements of native plant community/communities. Provide a narrative to describe how vegetation and soil protection zones will be preserved during construction (e.g., fence or other physical barrier that cannot be easily moved) and describe efforts to educate all construction personnel about the location and protective measures of the protective zones. Provide a copy of the section of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describes the on-going management activities to protect the integrity of the vegetation and soil protection zones.

If applicable, provide a map of the site within its broader context to show the off-site habitat corridors to which the site's native plant communities are connected.

Potential technologies and strategies

Native plants can be used for both formal and naturalistic designs. On sites with existing native plant communities, design the site to minimize damage to existing healthy native plant communities, especially those areas that provide opportunities for connectivity.

Links to other Sustainable Sites credits

- Use of native plants (not necessarily full native plant communities) is addressed in *Credit 4.7: Use native plants*.
- Sites that have been previously developed, graded, or otherwise disturbed by humans such that no native plant communities exist or exotic and invasive plants make up more than 25 precent of the total area of the native plant communities can achieve credit for restoring native plant communities in *Credit 4.9: Restore plant communities native to the ecoregion*.
- Preserving existing vegetation may help achieve *Credit 4.6: Preserve or restore appropriate plant biomass on site*.
- If preserved areas include riparian areas or shorelines, the site may also be eligible for *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*.
- Activities to manage preserved vegetation and control invasive species shall be included into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) as per *Prerequisite 4.1: Control and manage known invasive species found on site*.

Resources

- For more information about native plants, refer to the following resources:
  - U.S. Environmental Protection Agency's Green Landscaping resources page, *http://www.epa.gov/greenacres/index.html*, including the Native Plants Factsheet, *http://www.epa.gov/greenacres/nativeplants/factsht.html*.
  - The North American Native Plant Society, *http://www.nanps.org*.
  - The Lady Bird Johnson Wildflower Center's Native Plant Information Network's Native Plant Database, *http://www.wildflower.org/plants/*.
- For more information on state wildlife action plans, see *http://www.wildlifeactionplans.org/about/index.html*.

- Local colleges and universities and USDA Cooperative Extension System Offices, *http://www.csrees.usda.gov/qlinks/partners/state_partners.html*, may also provide helpful regional resources.

Definitions

- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

Credit 4.9	Restore plant communities native to the ecoregion
1–5 Points	

Intent

Restore appropriate plants and plant communities native to the ecoregion of the site to contribute to regional diversity of flora and provide habitat for native wildlife.

Requirements

The requirements apply to sites that have been previously developed, graded, or otherwise disturbed by humans such that no native plant communities exist or exotic and invasive plants make up more than 25 percent of the total area of the native plant communities as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*). Existing native plant communities in which evidence of human disturbance is minimal and exotic and invasive plants make up less than 25 percent of the total area can also achieve credit for preservation of native plant communities (see Links to other Sustainable Sites credits section below).

Economic and social benefits

Native plants can provide habitat for native wildlife, including important pollinator species (e.g., insects, birds, and bats) that are necessary for plant reproduction, including cultivation of crops. Up to 80 percent of the world's food plant species are dependent on pollination by animals.[60] Wildlife habitat also supports recreational and ecotourism activities, such as fishing and birdwatching, and opportunities for environmental education.[61]

Restore native plant communities on site. To count toward this credit, all restored native plant communities must be a minimum of 2,000 contiguous square feet.

- **1 point:** Restore native plant communities to comprise at least 25 percent of the site vegetated area.
- **3 points:** Restore native plant communities to comprise at least 50 percent of the site vegetated area.
- **4 points:** Restore native plant communities to comprise at least 75 percent of the site vegetated area.
- **Additional point:** Restore native plant communities to provide habitat corridors connecting to off-site natural areas or buffers adjacent to off-site natural areas for migrating wildlife. This option applies to habitat for species of concern within your region as identified by state Wildlife Action Plans, state wildlife agencies, federal wildlife agencies, or other entities.

Percent calculations for all sites are measured by surface area of vegetated area, using estimated vegetated cover within 10 years of installation.

Submittal documentation

Provide a site plan showing all vegetated areas, and indicate which parts of the vegetated area will contain native plant communities. Provide calculations to demonstrate that requirements for percent area have been met. Submit a planting/seeding plan and written specifications with performance requirements. Provide a list of all restored vegetation species, including scientific names. Provide information from at least two references (or local reference sites) to show that the restored vegetation on the site has the same dominant plant species, relative species abundances, and other characteristic elements of native plant community/communities.

If applicable, provide a map of the site within its broader context to show the off-site habitat corridors to which the site's native plant communities are connected.

Potential technologies and strategies

Native plants can be used for both formal and naturalistic designs. On previously developed sites, contact local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of native plants appropriate for the site.

Links to other Sustainable Sites credits

- Use of native plants (not necessarily full native plant communities) is addressed in *Credit 4.7: Use native plants*.
- Sites with existing native plant communities in which evidence of human disturbance is minimal and invasive plants make up less than 25 percent of the total area can achieve credit for preserving native plant communities in *Credit 4.8: Preserve plant communities native to the ecoregion*.
- Restoring vegetation may also help achieve *Credit 4.6: Preserve or restore appropriate plant biomass on site*.
- If restored areas include riparian areas or shorelines, the site may also be eligible for *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*.
- If restored areas include previously degraded streams, wetlands, or coastal habitat, the site may also be eligible for *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*.
- Soil restoration prior to re-vegetation may help support newly planted vegetation and help achieve *Credit 7.3: Restore soils disturbed by previous development*.
- Activities to manage restored vegetation and control invasive species shall be incorporated in the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) as per *Prerequisite 4.1: Control and manage known invasive species found on site*.

Resources

- For more information about native plants, refer to the following resources:
  - U.S. Environmental Protection Agency's Green Landscaping resources page, *http://www.epa.gov/greenacres/index.html*, including the Native Plants Factsheet, *http://www.epa.gov/greenacres/nativeplants/factsht.html*.
  - The North American Native Plant Society *http://www.nanps.org*.
  - The Lady Bird Johnson Wildflower Center's Native Plant Information Network's Native Plant Database *http://www.wildflower.org/plants/*.
- For more information on state wildlife action plans, see *http://www.wildlifeactionplans.org/about/index.html*.
- Local colleges and universities and USDA Cooperative Extension System Offices *http://www.csrees.usda.gov/qlinks/partners/state_partners.html* may also provide helpful regional resources.

Definitions

- *Native plant communities* are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Vegetated area* describes all portions of the site that will support vegetation.

Credit 4.10	Use vegetation to minimize building heating requirements
2–4 Points	

Intent

Place vegetation in strategic locations around buildings to reduce energy consumption and costs associated with indoor climate control for heating.

Economic and social benefits

Vegetation used as windbreaks can result in heat energy savings of up to 40 percent.[64] Vegetation insulates buildings, by reducing wind velocity and air movement into buildings. A study of street trees in New York City, for example, found that natural gas savings from avoided heating requirements resulted in $20.8 million in savings annually.[65]

Requirements

The requirements apply only to buildings using mechanical heating systems.

Use trees and dense shrubs to serve as a windbreak for building(s). The windbreak shall meet the following requirements:

- Locate the windbreak at least 60 feet and no more than 200 feet from the building wall(s) facing the prevailing winter wind (the windbreak provides ideal wind protection at distances two to five times the mature height of the trees[62]).
- Locate the windbreak such that it does not cast shadows on the building.
- Use spacing guidelines in Table 4.10-A below for trees and shrubs in the windbreak to provide vegetation density that is adequate to protect the building. Note that spacing between rows and within rows should allow for proper use of suitable maintenance equipment.

TABLE 4.10-A: SPACING GUIDELINES FOR TREES AND SHRUBS IN WINDBREAK[63]

Vegetation Type	Within-row Spacing
Shrubs and Narrow-Crowned Deciduous Trees	3–6 feet
Small Evergreen Trees	6–12 feet
Medium Evergreen Trees	10–20 feet
Large Evergreen Trees	Up to 20 feet
Small Deciduous Trees	8–12 feet
Medium Deciduous Trees	12–20 feet
Large Deciduous Trees	Up to 24 feet

- Use densely branched trees and dense shrubs branched to the ground in row(s) to increase the density of the windbreak:
  - **2 points:** Provide at least one row of trees and dense shrubs that extends for the full length of the building's wall(s) facing the prevailing winter wind.
  - **4 points:** Provide at least two rows of trees and dense shrubs in a staggered planting formation, with rows planted 12–20 feet apart, extending at least 50 feet longer than the building's wall(s) facing the prevailing winter wind.

Submittal documentation

Provide a site plan showing the direction of prevailing winds, building footprint, and locations of windbreak vegetation relative to the building. Include a plant list with scientific names and the estimated mature size (height and width) of the windbreak vegetation. On the site plan, indicate distances between individual plants (both within-row and between-row distances, if applicable).

Potential technologies and strategies

Consult a local professional (e.g., arborist) for information on plant species that maximize benefits appropriate to the climate. Select tree and shrub species that can provide additional benefits to the site, such as food and habitat for wildlife or visual barriers from highways.

Links to other Sustainable Sites credits

- Maintaining or enhancing vegetation and vegetated structures may also help achieve *Credit 4.6: Preserve or restore appropriate plant biomass on site* and *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration*.
- Using native plants and native plant communities to meet the requirements of this credit may also help achieve *Credit 4.7: Use native plants*, *Credit 4.8: Preserve plant communities native to the ecoregion*, and *Credit 4.9: Restore plant communities native to the ecoregion*.

Resources

- For additional guidance on planning a site windbreak, see resources from state extension services, such as the following:
  - Missouri: *http://extension.missouri.edu/xplor/agguides/forestry/g05900.htm*.
  - Utah: *http://extension.usu.edu/forestry/Reading/Assets/PDFDocs/NR_FF/NRFF005.pdf*.
  - Nebraska: *http://nfs.unl.edu/documents/windbreakdesign.pdf*.
  - Montana: *http://www.mt.nrcs.usda.gov/technical/ecs/forestry/technotes/forestryMT17/*.
- Additional resources may be found in the NRCS Windbreak Series *http://www.unl.edu/nac/windbreaks.htm*, or the National Renewable Energy Laboratory's resources for Landscaping for Energy Efficiency, *http://www.nrel.gov/docs/legosti/old/16632.pdf*.

Credit 4.11	Use vegetation to minimize building cooling requirements
2–5 Points	

Intent

Place vegetation and/or vegetated structures in strategic locations around buildings to reduce energy consumption and costs associated with indoor climate control.

Economic and social benefits

Vegetation provides cooling benefits through shading and evapotranspiration and helps prevent heat loss in buildings by reducing wind speed.[66] A study of street trees in New York City, for example, found that the climate moderating benefits provided by trees resulted in annual energy savings of $27.8 million, or $47.63 per tree.[67]

Requirements

The requirements apply only to buildings using air-conditioning systems.

- **Option 1**:
  - **2 points**: Use vegetation or vegetated structures to reduce annual building electricity use for cooling by 5 percent.
  - **3 points**: Use vegetation or vegetated structures to reduce annual building electricity use for cooling by 7 percent.
  - **5 points**: Use vegetation or vegetated structures to reduce annual building electricity use for cooling by 10 percent.

  See Calculation guidelines for Option 1 section below.

OR

- **Option 2**: Use vegetation or vegetated structures to shade 100 percent of the surface area (excluding ground-facing surface) of all HVAC units within 10 years of installation AND achieve one of the following options to shade building walls and roof area:
  - **2 points**: Use vegetation or vegetated structures to shade 30 percent of the surface area of west, southwest, southeast, and east walls and 30 percent of total roof area within 10 years of installation.
  - **3 points**: Use vegetation or vegetated structures to shade 60 percent of the surface area of west, southwest, southeast, and east walls and 60 percent of total roof area within 10 years of installation.
  - **5 points**: Use vegetation or vegetated structures to shade 90 percent of the surface area of west, southwest, southeast, and east walls and 90 percent of total roof area within 10 years of installation.

  See Calculation guidelines for Option 2 section below.

Submittal documentation

Provide a site plan showing the cardinal directions, building footprint, and locations of vegetation providing cooling benefits. Include a plant list with scientific names and the estimated size (including height) within 10 years of installation of the vegetation providing cooling benefits. In addition, provide the following:

- **For Option 1**: Provide calculations and information sources used to estimate electricity use for cooling purposes and the annual energy savings from vegetation and vegetated structures.

OR

- **For Option 2**: Use plan and cross-section drawings to demonstrate the anticipated shading of wall and/or roof area (and HVAC unit, if applicable). Provide calculations documenting that the shaded surface area requirements will be met.

Potential technologies and strategies

Consult a local professional for information on plant placement and plant species that maximize benefits appropriate to the climate. In addition to trees, use shade trellises, green roofs, green facades, and green walls to increase shading. Select deciduous trees that allow access to the sun in winter and provide shade in summer.

Calculation guidelines for Option 1

First, estimate the building's baseline electricity use for cooling purposes. Use the U.S. Department of Energy Commercial Buildings Energy Consumption Survey, *http://www.eia.doe.gov/emeu/cbecs/*, or multiply the building square footage by the average electricity intensity (kWh/square foot) for cooling for all non-mall buildings (averages listed below by census region, see map here to determine your region *http://www.census.gov/geo/www/us_regdiv.pdf*):

- Northeast: 0.8 kWh/square foot
- Midwest: 0.9 kWh/square foot
- South: 3.1 kWh/square foot
- West: 1.8 kWh/square foot

Next, calculate the estimated annual energy savings (kWh saved) from the vegetation or vegetated structures, using estimated size within 10 years of installation. The Tree Benefits Estimator (developed by the American Public Power Association) at *http://www.appanet.org/treeben/calculate.asp* and the National Tree Benefit Calculator (developed by Casey Trees and Davey Tree Expert Co.) at *http://www.treebenefits.com/calculator/* can be used to help calculate energy savings of trees. (***Note:*** *These calculators provide estimates of energy savings based on tree characteristics, but other modeling methods may be used to predict energy savings. Adequate documentation regarding the methods employed and the results obtained must be submitted.)*

Calculation guidelines for Option 2

Shade calculations shall be based on the arithmetic mean of the percent wall and roof coverage at 10 a.m., noon, and 3 p.m. on the summer solstice. Wall and roof surfaces taller than 20-year old trees of average growth size for the region may be excluded from total wall surface area calculations. Roof surfaces shaded by solar photovoltaic panels may be excluded from total roof area calculations.

Links to other Sustainable Sites credits

- Green roofs, green walls, or trees used to help achieve this credit may also help achieve *Credit 4.12: Reduce urban heat island effects* and *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration*.
- Maintaining or enhancing vegetation and vegetated structures may also help achieve *Credit 4.6: Preserve or restore appropriate plant biomass on site*.
- Using native plants and native plant communities to meet the requirements of this credit may also help achieve *Credit 4.7: Use native plants* and *Credit 4.8: Preserve plant communities native to the ecoregion* and *Credit 4.9: Restore plant communities native to the ecoregion*, respectively.

Resources

- For additional guidance on tree placement, tree selection, and other techniques to maximize energy savings, refer to regional Community Tree Guides by the Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service, *http://www.fs.fed.us/psw/programs/cufr/tree_guides.php*, and "Carbon Dioxide Reduction through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters," *http://www.fs.fed.us/psw/programs/cufr/products/cufr_43.pdf*
- A comprehensive Tree Carbon Calculator for sites in California has been developed by the Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service, *http://www.fs.fed.us/ccrc/topics/urban-forests/ctcc/*
- The U.S. Department of Energy also provides resources for landscaping to reduce cooling costs, *http://www.energysavers.gov/your_home/landscaping/index.cfm/mytopic=11910*

Credit 4.12	Reduce urban heat island effects
3–5 Points	

Intent

Use vegetation and reflective materials to reduce heat islands and minimize effects on microclimate and on human and wildlife habitat.

Requirements[68]

- **3 points:** Use any combination of the following options to reduce urban heat island effects for 30 percent of all site hardscape and structures (including roads, sidewalks, courtyards, shelters, and parking lots).
- **5 points:** Use any combination of the following options to reduce urban heat island effects for 60 percent of all site hardscape and structures (including roads, sidewalks, courtyards, shelters, and parking lots).

Shade calculations shall be based on the arithmetic mean of the percent wall and roof coverage at 10 a.m., noon, and 3 p.m. on the summer solstice.

Options to reduce urban heat island effects:

- Provide shade within 10 years of landscape installation (using new and/or existing vegetation). Vegetation for this requirement must be in place at the time of certification application.
- Cover structures with solar photovoltaic panels, vegetated roofs, and/or surfaces with a solar reflectance index (SRI) of at least 29, and incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) activities to ensure these surfaces are cleaned to maintain high reflectivity, at a minimum of every two years.
- Use paving materials with an SRI of at least 29, and incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) activities to ensure these surfaces are cleaned at least every two years to maintain good reflectance.
- Use an open-grid pavement system (e.g., concrete-grass lattice).

Submittal documentation

Provide plans to show the total area of site hardscape and structures and the total area covered by any combination of the coverage strategies. Provide documentation to demonstrate that selected materials have an SRI of at least 29.

Potential technologies and strategies

Select strategies, materials, and landscaping techniques that reduce heat absorption. Use shade from appropriate trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation. Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop. Position photovoltaic cells to shade impervious surfaces. Neither pervious concrete nor pervious asphalt meet the definition of open-grid paving system because both are more than 50 percent

Economic and social benefits

Urban heat island effects can lead to increased air-conditioning costs, air pollution levels, and heat- and pollution-related illness and mortality.[69] Use of vegetation, shade structures, and other techniques to cool the air can reduce costs associated with urban heat islands. Vegetation provides cooling through shading and evapotranspiration. Evapotranspiration alone can reduce peak summer temperatures by 2 to 9 degrees F.[70]

Shade trees planted in parking lots reduce evaporative emissions of volatile organic compounds (VOCs)—precursors to ground-level ozone—from parked cars.[71] Shade trees in parking lots also reduce solar exposure to the pavement, reducing heat absorption and emittance while potentially reducing pavement aging and maintenance requirements. Heat islands may provide winter benefits in colder climates, but these are often outweighed by harmful effects during the summer. Some heat island reduction strategies, such as using open-grid paving or shading with deciduous trees, can reduce summertime heat islands while providing wintertime benefits.[72]

Lighter-colored surfaces (as opposed to shiny, dark ones) also may cause less disorienting effects on birds and insects.[73]

impervious; however, pervious concrete does have an SRI greater than 29. Parking garages could comply with the option to provide cover with solar panels, vegetated roofs, or roof surfaces with an SRI of 29.

Links to other Sustainable Sites credits

Vegetation (including green roofs) that shades the roofs and walls of buildings can provide cooling benefits and may also help achieve *Credit 4.6: Preserve or restore appropriate plant biomass* on site and *Credit 4.11: Use vegetation to minimize building cooling requirements*.

Resources

- Resources at the Lawrence Berkeley National Laboratory, *http://heatisland.lbl.gov/*, and U.S. Environmental Protection Agency, *http://www.epa.gov/heatisland/mitigation/index.htm*
- Resources at U.S. Green Building Council including rating systems and reference guides, *www.usgbc.org*.

Definitions

- *Open-grid pavement* is pavement that is less than 50 percent impervious and contains vegetation in the open cells.
- *Solar reflectance index (SRI)* is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values for some materials will be available in the LEED 2009 Reference Guide. For more information on ASTM standards, see *www.astm.org*.

Credit 4.13	Reduce the risk of catastrophic wildfire
3 Points	

Intent

Design, build, and maintain sites to manage fuels to reduce the risk of catastrophic wildfire both on site and in adjacent landscapes.

Economic and social benefits

Designing defensible space around structures protects property from wildfire damage by reducing flame heights and making fires easier to extinguish.[74] When fuel loads exceed historical conditions, high intensity fires are more likely to occur, causing significant ecological damage.[75] Management of fuels on site reduces risks to local ecosystems, property, and lives.

Requirements

- All structures on the site must be designed using guidelines from the Firewise Construction Checklist, *http://www.firewise.org/usa/files/fwlistsz.pdf*
  AND
- Design, build and maintain the landscape within 30 feet of all sides of structures to:
  - include low stature plantings limited to carefully spaced, low-flammability species,
  - avoid "ladder fuels" that transmit fire from ground level to tree canopy
    AND
    incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) plans for maintaining plants to reduce accumulation of dead plant material.

  AND
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) a strategy to manage vegetative biomass and fuels at responsible levels throughout the vegetated portions of the site. Use prescribed fires or other fuel management techniques in frequencies and intensities similar to the natural fire regime for the ecosystem.

Submittal documentation

- List the techniques listed in the *Firewise Construction Checklist* that have been incorporated into site design and have the structure contractor/owner sign off on the design.
- For sites with structures, provide photographs, a plant list including scientific names, and a brief narrative to describe how the landscape design within 30 feet of the structure reduces fire risk.
- For all other vegetated areas of the site, provide text from the site maintenance plan that describes the vegetative biomass management strategies that reduces the risk of catastrophic wildfire. Describe how the plan is similar in technique, frequencies and intensities to natural fire regimes in the ecosystem.

Potential technologies and strategies

Contact local fire departments or state forestry agencies for recommendations on plant spacing, fire-resistant plant species, and fuel management practices appropriate to the local area.

Links to other Sustainable Sites credits

Fuel management strategies should be included in the site maintenance plan, as addressed in *Prerequisite 8.1: Plan for sustainable site maintenance*.

Resources

- For more information on designing for defensible spaces, see Firewise Communities resources *http://www.firewise.org/* or Fire Safe Council resources *http://www.firesafecouncil.org/*.
- For information on fire regimes and fire regime condition classes throughout the United States, see *http://www.landfire.gov/viewer/*.
- RF Brzuszek and JB Walker's "Trends in Community Fire Ordinances and Their Effects on Landscape Architecture Practice" *Landscape Journal* 27, no.1 (2008): pp. 142–153

Prerequisite 5.1 REQUIRED — Eliminate the use of wood from threatened tree species

Intent
Only purchase wood products extracted from non-threatened tree species to minimize negative effects on other ecosystems.

Requirements
For wood products, use no wood species listed by the Convention on International Trade in Endangered Species (CITES) as threatened with extinction (Appendix I) or requiring trade controls in order to avoid utilization incompatible with their survival (Appendix II) or on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species as endangered in the wild (EW), critically endangered (CR), and endangered (EN). For this requirement, threatened tree species are allowed if the wood product has been certified under a recognized, third-party sustainable forestry management certification program per *Credit 5.6: Use certified wood*.

Economic and social benefits

The interactions and feedback mechanisms of natural ecosystems have developed over time to result in relative stability and resistance to pests and diseases. Reducing populations of already threatened species can disrupt stable natural ecosystems, which control more than 95 percent of the potential crop pests and carriers of human diseases.[76]

Submittal documentation
Provide a species list and of all wood products purchased. Include the tree species classification by IUCN and CITES. For any threatened tree species used, provide documentation from provider(s) to demonstrate the product has been certified under a recognized, third-party sustainable forestry management certification per *Credit 5.6: Use certified wood*.

Potential technologies and strategies
Identify suppliers who provide wood products from sustainably managed forests. Consider using recycled plastic or composite lumber instead of wood.

Links to other Sustainable Sites credits
Use of third-party certified wood may also help achieve *Credit 5.6: Use certified wood*.

Resources
- The IUCN Red List of Threatened Species website is searchable by species at *http://www.iucnredlist.org/*.
- CITES provides an online searchable species database at *http://www.cites.org/eng/resources/species.html*.

Credit 5.2	Maintain on-site structures, hardscape, and landscape amenities
1–4 Points	

Intent

Maintain existing structures, hardscape, and landscape amenities (e.g., retaining walls and benches) in their existing form to extend the life cycle of existing building stock, conserve resources, and reduce waste.

Requirements[77]

- **1 point:** Maintain in their existing form 55 percent of the surface area of existing structures, hardscape, and landscape amenities on site.
- **3 points:** Maintain in their existing form 75 percent of the surface area of existing structures, harsdcape, and landscape amenities on site.
- **4 points:** Maintain in their existing form 95 percent of the surface area of existing structures, hardscape, and landscape amenities on site.

For complex landscape amenities (e.g., wrought-iron benches), estimate the area of each major surface (e.g., seat and back of bench) as if it were a solid surface. Structures and landscape amenities that are maintained in their existing form and moved to new locations on the site qualify for this credit. Materials thought to be hazardous to plants, animals, or humans are excluded from total surface area calculations.

Economic and social benefits

Retaining existing materials avoids the cost of disposing of them at a landfill. Using existing materials as resources for new site development (rather than viewing them as "waste") reduces costs for new purchased materials. Reusing existing landscape structures can also create a sense of place and connect site users to historical or cultural legacies, which may result in tourism opportunities and strengthened cultural pride.

Submittal documentation

Calculate the total surface area of all existing structures, hardscape, and landscape amenities on site (excluding hazardous materials from calculations), and the total surface area of these materials that will be used on site. Demonstrate that the specified percentages of existing structures, hardscape, and landscape amenities are retained.

Potential technologies and strategies

Identify opportunities to incorporate existing site materials into site design.

Links to other Sustainable Sites credits

- Maintaining on-site structures may also help achieve *Credit 5.4: Reuse salvaged materials and plants*.
- Reuse of on-site structures, hardscape, or landscape amenities with cultural or historical value may help also achieve *Credit 6.4: Protect and promote unique cultural and historical places*.
- Plants and soils are excluded from this credit and are covered under *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction;* additionally, plants salvaged from on site for reuse are eligible for *Credit 5.4: Reuse salvaged materials and plants*.

Credit 5.3	Design for deconstruction and disassembly
1–3 Points	

Economic and social benefits

Sites may generate revenue in the future for sale of materials salvaged from reusable or recyclable products on site.

Intent

Design to facilitate reuse and avoid sending useful materials to the landfill.

Requirements

The requirements apply to material assemblies, products and/or product components used for construction. Plants and soils are excluded from this credit.

- **1 point:** 20 percent of materials assemblies, products, and/or product components used for construction facilitate reuse and are designed for deconstruction.
- **2 points:** 40 percent of material assemblies, products, and/or product components used for construction facilitate reuse and are designed for deconstruction.
- **3 points:** 60 percent of material assemblies, products, and/or product components used for construction facilitate reuse and are designed for deconstruction.

Percentages are based on cost. In the case of mixed material assemblies, determine the portion of the total weight that is reusable. Multiply the proportion of total weight by the total cost to determine the proportion of product assembly that meets the requirements of this credit.

Submittal documentation

Calculate the total costs of material assemblies, products, and/or product components used for construction. Provide a list of products that are reusable and describe the appropriate way of deconstructing so that the product can be reused. Include possible reuse examples for each material assembly, product, and/or product component that is reusable. Demonstrate that the costs of reusable products comprise the specified percentage of total product costs during construction.

Potential technologies and strategies

Establish a project goal for reusable products and identify material suppliers who can help achieve this goal. Design construction details to facilitate deconstruction without damage to the material. Example strategies that can help achieve this credit include using bolt and screw connections and avoiding use of mortar, adhesives and welded connections and nailed connections that cannot be easily removed.

Resources

For more information designing for deconstruction, refer to the following:

- Resources available at Lifecycle Building Challenge, *http://www.lifecyclebuilding.org/resources.php*
- B Guy and N Ciamrimboli, *Design for Disassembly in the Built Environment: A Guide to Closed-Loop Design and Building* (Hamer Center for Community Design, The Pennsylvania State University, 2007)

Definitions

- *Deconstruction* is a process of carefully taking apart constructed elements with the intention of either reusing or recycling the materials. It may be undertaken during redevelopment, adaptation, or at the end of use on a site.

- *Design for deconstruction*, also called Design for Disassembly, is the design of buildings or products to facilitate future change and the eventual dismantlement (in part or whole) for recovery of systems, components, and materials. This design process includes developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal.
- *Reuse* is a process of utilizing a used product or material in a manner that generally retains its original form and identity with minor refurbishments. Materials reusable in whole form might include sand-set pavers, segmental retaining walls, or mechanical fasteners, connections, and/or joinery (e.g., avoidance of adhesives and mortar).

Credit 5.4	Reuse salvaged materials and plants
2–4 Points	

Intent
Reuse salvaged materials and appropriate plants to conserve resources and avoid sending useful materials to the landfill.

Requirements[78]
- **2 points:** 10 percent of all materials (including plants) used on site are salvaged.
- **4 points:** 20 percent of all materials (including plants) used on site are salvaged.

Percentages are based on cost or replacement value.

Economic and social benefits

Reusing materials and plants may reduce costs for site development by eliminating or minimizing the need for new purchased materials.

Submittal documentation
Provide the total cost or replacement value of project materials (including plants). Provide a tabulation of each material or salvaged plant that is reused. The tabulation must include a description of the material and/or salvaged plants and the product cost.

Potential technologies and strategies
Establish a project goal for salvaged materials and identify material suppliers or local projects who can help achieve this goal. Look for materials and salvageable plants existing on your site. Do not reuse materials that are a source of pollutants to stormwater.

Links to other Sustainable Sites credits
- Reusing materials and plants salvaged from on site may also help achieve *Credit 5.2: Maintain on-site structures, hardscape, and landscape amenities*, *Credit 7.4: Divert construction and demolition materials from disposal*, and *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.
- Reuse of on-site materials with cultural or historical value may help also achieve *Credit 6.4: Protect and maintain unique cultural and historical places*.
- Reusing materials and plants salvaged from other local projects may help achieve *Credit 5.7: Use regional materials*.
- Soils are excluded from this credit and addressed under *Credit 7.3: Restore soils disturbed by previous development*, *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*, and *Credit 5.7: Use regional materials*.
- Plants salvaged for reuse on site must be non-invasive and appropriate for site conditions (as per *Prerequisite 4.2: Use appropriate, non-invasive plants*), and reuse of native salvaged vegetation may help achieve *Credit 4.7: Use native plants*.

Resources
- For more information on salvaged materials, see resources such as the Green Building Research Guide's searchable database, *www.greenguide.com/exchange/search.html*, the Reuse Development Organization, *http://www.redo.org*, or the Building Materials Reuse Association's website, *www.buildingreuse.org*.
- For directories of reuse stores, see the Building Materials Reuse Association's website, *www.buildingreuse.org* and Habitat for Humanity's ReStore website, *http://www.habitat.org/env/restores.aspx*.

- For guidance on tree valuation protocols, see the Guide for Plant Appraisal, authored by representatives to the Council of Tree and Landscape Appraisers and available through the International Society of Arboriculture.
- Resources at U.S. Green Building Council including rating systems and reference guides, *www.usgbc.org*.

Definitions

- *Replacement value* can be determined by pricing a comparable material in the local market.
- *Reuse* is a process of utilizing a used product or material in a manner that generally retains its original form and identity with minor refurbishments. Materials reusable in whole form might include sand-set pavers, segmental retaining walls, or mechanical fasteners, connections, and/or joinery (e.g., avoidance of adhesives and mortar).
- *Salvaged materials* are construction materials recovered from existing buildings or sites and *reused* on site.

Credit 5.5	Use recycled content materials
2–4 Points	

Intent
Use materials with recycled content to reduce the use of virgin materials and avoid sending useful materials to the landfill.

Economic and social benefits

Using recycled content materials may reduce costs for site development by eliminating or minimizing the need for new purchased materials.

Requirements[79]

- **2 points:** Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 20 percent of the total value of the materials in the project.
- **4 points:** Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 40 percent of the total value of the materials in the project.

Percentages are based on cost or replacement value. The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value. Plants and soils are addressed in other credits and shall be excluded from the calculations in this credit (see Links to other Sustainable Sites credits section below).

Submittal documentation
Provide the total cost or replacement value of project materials. Provide a tabulation of each material used on the project that is being tracked for recycled content. The tabulation must include a description of the material, the product cost, and the percentage of post-consumer or total recovered-materials content.

Potential technologies and strategies
Establish a project goal for recycled content and identify material suppliers or local projects that can help achieve this goal. Example strategies that could be used to achieve this credit include: specifying plastic lumber made from recycled content, removing on-site concrete pavement and crushing it for aggregate, or utilizing spent iron and foundry sand as fine aggregate in concrete.

Links to other Sustainable Sites credits

- Recycling existing on-site materials (for instance, crushing concrete and using it as base material) may also help achieve *Credit 7.4: Divert construction and demolition materials from disposal*.
- Recycling materials from other local projects may help achieve *Credit 5.7: Use regional materials*.

Resources
For more information on industry materials recycling, see

- The U.S. Environmental Protection Agency Industrial Materials website, *http://www.epa.gov/industrialmaterials*
- The U.S. Environmental Protection Agency Comprehensive Procurement Guidelines, *www.epa.gov/cpg*
- Resources at U.S. Green Building Council including rating systems and reference guides, *www.usgbc.org*

Definitions

- *Pre-consumer material* is material diverted from the waste stream during the manufacturing process that could be used in a separate and different manufacturing process (e.g., reuse of flue gas desulfurization gypsum in drywall production). Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- *Post-consumer material* is waste material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.
- *Recycled content* is defined in accordance with the International Organization of Standards document, ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling). For more information on ISO, see *www.iso.org*.
- *Replacement value* can be determined by pricing a comparable material in the local market.

Credit 5.6	Use certified wood
1–4 Points	

Economic and social benefits

Sustainably harvested wood provides a stable source of lumber, minimizes negative effects on ecosystems, and benefits local economies.

Intent

Purchase certified lumber to encourage exemplary forest management that is both environmentally and socially responsible.

Requirements[80]

- **1 point:** Purchase a minimum of 50 percent (based on cost) of new wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components.
- **3 points:** Purchase a minimum of 75 percent (based on cost) of new wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components.
- **4 points:** Purchase 100 percent (based on cost) of new wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components.

Percentages are based on costs. Only materials permanently installed in the project need to be included in calculations. Wood products purchased for temporary use on the project (e.g., formwork, bracing, scaffolding, sidewalk protection, and guard rails) may be included in the calculations at the project team's discretion. If any such materials are included, all such materials must be included in the calculations.

Submittal documentation

- List all new wood products used on the project and identify which products are in accordance with the Forest Stewardship Council's principles and criteria, for wood building components.
- Provide receipts or vendor invoices documenting total cost of wood-based materials and products used on site, noting those purchased from providers that meet certification requirements.
- Provide documentation from provider(s) to demonstrate certification is in accordance with the Forest Stewardship Council's principles and criteria, for wood building components.

Potential technologies and strategies

Establish a project goal for certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the appropriate certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.

Links to other Sustainable Sites credits

- Using certified wood may also help meet requirements of *Credit 5.10: Support sustainable practices in materials manufacturing*.
- Sites that reuse timber harvested during the land-clearing phase of the project may be eligible for *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.

Resources

- For resources at the U.S. Green Building Council website, including rating systems and reference guides, *www.usgbc.org*.
- For more information on the Forest Stewardship Council, *http://www.fcsus.org/*

Credit 5.7	Use regional materials
2–6 Points	

Intent

Reduce energy use for transportation; increase demand for materials, plants, and soils that are extracted, manufactured, or grown within the region to support the use of local resources; and promote a regional identity.

Economic and social benefits

The use of local materials supports local business and feeds money into the regional economy, while also reducing the fossil fuels needed for transport, thus decreasing our dependence on non-renewable resources and lowering our carbon output.

Requirements[81]

Use materials, plants, and soils for construction that are sourced near the site. If only a fraction of a material is extracted/harvested/recovered and manufactured within the specified distances, then only that percentage (by weight) shall contribute to the regional value.

Material Type	Distance Requirements
Soils	Extraction, harvest or recovery, and manufacture must occur within 50 miles
Aggregate	Extraction, harvest or recovery, and manufacture must occur within 50 miles
Plants	All growing facilities for the plant must be located within 250 miles
All Other Materials	Extraction, harvest or recovery, and manufacture must occur within 500 miles

Existing on-site structures, hardscape, landscape amenities, and/or land-clearing materials that are maintained on site automatically meet the requirements for this credit and their replacement value can be included in the calculations of total cost of material transported to the site.

- **2 points:** 30 percent of all materials, plants, and soils are sourced within the distances specified above.
- **4 points:** 60 percent of all materials, plants, and soils are sourced within the distances specified above.
- **6 points:** 90 percent of all materials, plants, and soils are sourced within the distances specified above.

Percent calculations are based on cost or replacement value.

Submittal documentation

Provide a list of all materials, plants, and soils transported to the site, including the following information for each: cost or replacement value, the name of the manufacturer or grower, the distance between the site and the manufacturer or grower, and the distance between the site and the extraction location for each raw material contained within each product (or growing location for plants). For materials with only a fraction extracted/harvested/recovered and manufactured within the specified distance, indicate the percentage of product by weight that meets both the extraction and manufacture criteria. Determine the percent of regional materials by dividing the total cost of materials, plants, and soils extracted/harvested/recovered and manufactured, or grown, within the specified distances by the total cost of all materials, plants, and soils transported to the site.

Potential technologies and strategies

Identify regional sources for plants, soils, and other landscape materials, including those that are reused, salvaged, or contain recycled content. During construction, ensure that the specified local materials, plants, and soils are installed or used.

Links to other Sustainable Sites credits

- By maintaining existing structures on site, this credit may also help achieve *Credit 5.2: Maintain on-site structures, hardscape, and landscape amenities*.
- By identifying local projects that may have materials, soils, or plants available for reuse, this credit may also help achieve *Credit 5.4: Reuse salvaged materials and plants*.
- Using low-emitting, fuel-efficient vehicles to transport materials, plants, and soils to the site may also help achieve *Credit 7.6: Minimize generation of greenhouse gases and exposure to localized air pollutants during construction*.
- If land-clearing materials are retained and reused on site (e.g., plant material is recycled and used for mulch or rocks are reused for pathway borders), this may also help achieve *Credit 7.5: Reuse and recycle vegetation, rocks, and soil generated during construction*.

Definition

Replacement value can be determined by pricing a comparable material in the local market.

Credit 5.8	Use adhesives, sealants, paints, and coatings with reduced VOC emissions
2 Points	

Intent
Select paints, sealants, adhesives, coatings, and other products used in site development that contain reduced amounts of volatile organic compounds to reduce harmful health effects associated with air pollution.

Requirements[82]
- All adhesives and sealants used on site shall comply with the requirements of the latest editions and addenda of the following reference standards: South Coast Air Quality Management District Rule #1168 and Green Seal Standard for Commercial Adhesives GS-36.
  AND
- All paints and coatings shall comply with the requirements of the latest editions and addenda of the following reference standards: Green Seal Standard (GS-11) for architectural paints, coatings, and primers; Green Seal Standard (GC-03) for anti-corrosive and anti-rust paints; and South Coast Air Quality Management District Rule #1113 for architectural coatings.

Economic and social benefits

VOCs contribute to the formation of ground-level ozone, which is the primary component of smog. Ground-level ozone can cause respiratory infections, lung inflammation, and aggravation of respiratory diseases such as asthma.[83] Limiting VOCs on site can also make the site more accessible for users with chemical sensitivities.

Submittal documentation
Provide a list of each adhesive, sealant, paint, and coating used on site. For each product, include the manufacturer's name, product name, specific volatile organic compound (VOCs) data (in g/L, less water), and the corresponding allowable VOC from the referenced standard.

Potential technologies and strategies
Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section of specifications where adhesives, sealants, paints, and coatings are addressed.

Links to other Sustainable Sites credits
To specify continued use of low-emitting materials throughout site operations and maintenance, see the applicable sections of the site maintenance plan in *Prerequisite 8.1: Plan for sustainable site maintenance*.

Resources
- South Coast Air Quality Management District rules, *http://www.aqmd.gov/rules*
- Green Seal Standards, *http://www.greenseal.org/standards/commercialadhesives.htm*
- Resources at U.S. Green Building Council, including rating systems and reference guides, *www.usgbc.org*

Definition
Volatile organic compounds (VOCs) are a variety of organic compounds that vaporize at room temperature, including benzene, chloroform, p-Dichlorobenzene, formaldehyde, and tetrachloroethylene. VOCs are the principal component in atmospheric reactions that form ozone and other photochemical oxidants, causing a variety of negative health effects from dizziness, eye and respiratory tract irritation, nervous system damage, developmental effects, and cancer.

Credit 5.9	Support sustainable practices in plant production
3 Points	

Intent
Purchase plants from providers who reduce resource consumption and waste.

Requirements*
The requirements apply to the businesses from which the plants are purchased for the site. If multiple businesses are involved in plant production, the requirements apply to the business that grows the plant material until it is ready for sale (finishes the plant material).

Obtain 90 percent of purchased plants from businesses that employ at least six of the eight practices listed below. Seeds and sod are not covered by this credit and shall be excluded from calculations. Percentages are measured by quantity of individual plants purchased.

Economic and social benefits

Nurseries save costs by reducing resource consumption and minimizing waste generation. By eliminating the use and distribution of invasive species, nurseries also help reduce the costs of controlling and managing the damage done by invasive species in natural ecosystems.

Sustainable practices in plant production* for this credit include:

1. *Use sustainable soil amendments*. Use peat-free planting media or other sustainable sources.
2. *Reduce runoff from irrigation*. Capture and recycle all irrigation runoff water on site.
3. *Reduce greenhouse gas emissions*. Use on-site renewable energy sources to meet 10 percent of electricity demands OR engage in at least a two-year contract for the purchase of 35 percent of electricity from renewable energy sources.
4. *Reduce energy consumption*. Demonstrate that the energy use during the three most recent years is at least 25 percent less than the average energy use over the previous 10 years.
5. *Use integrated pest management (IPM)*. Employ a certified IPM practitioner OR use a IPM-certified nursery.
6. *Reduce use of potable water or other natural surface or subsurface water resources*. Use non-potable water (e.g., captured rainwater, recycled graywater, reclaimed/treated wastewater, water treated and conveyed by a public agency specifically for non-potable uses) for 70 percent of total irrigation volume.
7. *Reduce waste*. Conduct a waste audit to identify the weight or volume of on-going consumables, and reuse, recycle, or compost 50 percent of the on-going consumables waste stream.
8. *Recycle organic matter*. Compost and/or recycle 100 percent of vegetation trimmings on site for use in nursery operations or for sale to the public.

***Note:** Future versions of* Credit 5.9 Support sustainable practices in plant production *will likely include an additional option to prevent use and distribution of invasive species. This additional sustainable practice could include third-party certification that the plant material is not invasive or carrier of an invasive in the region where the plants are distributed. Third-party certification is not available at this time but likely will become available in the future.*

Submittal documentation
Provide a list of all purchased plants and a tabulation of each plant that is being tracked for sustainable plant production practices. The tabulation must include the plant provider and the sustainable practices employed by the plant provider. Include documentation from plant providers to demonstrate that sustainable practices are employed:

1. *Use sustainable soil amendments*. Submit a letter from the plant provider describing planting media and verifying that all planting media is peat-free.
2. *Reduce runoff from irrigation*. Submit a letter from the plant provider describing the methods by which all runoff from irrigation is captured and reused.

3. *Reduce greenhouse gas emissions*. Submit a letter from the plant provider describing renewable energy sources and the percent of annual energy use generated or purchased from each renewable source. Include contracts with utility company if applicable.
4. *Reduce energy consumption*. Submit calculations from the plant provider showing the average energy consumption over the previous 10 years and the average energy consumption over the threemost recent years. Consumption levels can be calculated using utility bills.
5. *Use integrated pest management.* Submit a letter from the plant provider that includes the name of the employed certified integrated pest management (IPM) practitioner or a copy of the IPM certification.
6. *Reduce use of potable water or other natural surface or subsurface water resources*. Submit calculations from the plant provider showing the total water volume consumed for irrigation and the total volume of non-potable sources. Include a brief description from the plant provider regarding the availability and sources of non-potable water used for irrigation.
7. *Reduce waste*. Submit a copy of the plant provider's waste audit and list of ongoing consumables. Include a description of the process for reusing, recycling, or composting at least 50 percent of the weight or volume of on-going consumables.
8. *Recycle organic matter*. Submit a letter from the plant provider describing the process for composting and/or recycling vegetation trimmings, and include a description of the end use of compost produced.

Potential technologies and strategies

Identify—and select plants from—nurseries that actively implement better business practices to reduce damage to the environment and conserve resources.

Links to other Sustainable Sites credits

- Materials produced by manufacturers using sustainable practices are covered under *Credit 5.10: Support sustainable practices in materials manufacturing*.
- For guidance on selecting plants that are appropriate for site conditions, climate, and design intent, see *Prerequisite 4.2: Use appropriate, non-invasive plants*

Definitions

- *Integrated pest management (IPM)* is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks. IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. The IPM approach places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.
- *On-going consumables* are materials that are regularly used and replaced through the course of business. These materials can include, but are not limited to, paper, glass, plastics, cardboard, and metals.
- Potable water is municipally treated water or well water that is suitable for drinking.
- *Renewable energy sources* must meet the Center for Resource Solutions (CRS) Green-e products certification requirements. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements.
- *Vegetation trimmings* include only non-invasive plant material free of disease.

Credit 5.10	Support sustainable practices in materials manufacturing
3–6 Points	

Intent

Support sustainable practices in materials manufacturing by purchasing materials from manufacturers whose practices increase energy efficiency, reduce resource consumption and waste, and minimize negative effects on human health and the environment.

Economic and social benefits

Publicly disclosing product chemical inventories supports a community's "Right-to-Know." Manufacturers can save money by reducing resource consumption and increasing energy efficiency. Manufacturing workers' and site visitors' health protection is supported through the use of safer chemicals.

Requirements*

The requirements apply to manufacturers of products purchased for use on site. Plants and soils are covered in other credits and shall be excluded from the calculations for this credit.

- **3 points:** 25 percent of purchased products for construction (by cost) are sourced from manufacturers who:
  - have developed an Environmental Management System (consistent with ISO 14001 or equivalent; certification not required) to reduce negative environmental effects and increase operating efficiency.
  - inventory and publicly disclose all intentionally added chemical constituents and all unintentional chemical residuals or impurities present at 100 ppm (0.01% w/w) or more.
  - employ three of the seven ***sustainable practices*** below.
- **6 points:** 50 percent of purchased products for construction (by cost) are sourced from manufacturers who:
  - have developed an Environmental Management System (consistent with ISO 14001 or equivalent; certification not required) to reduce negative environmental effects and increase operating efficiency.
  - inventory and publicly disclose all intentionally added chemical constituents and all unintentional chemical residuals or impurities present at 100 ppm (0.01% w/w) or more.
  - employ three of the seven ***sustainable practices*** below.

Percentages are based on costs. If multiple manufacturers are involved in the development of a product, the requirements apply to the manufacturer who adds the highest percentage of weight to the product.

Sustainable practices in materials manufacturing for this credit include:

1. Products do not contain intentionally added constituents that are deemed to be:
   - known or probable carcinogens
   - persistent, bioaccumulative, and toxic compounds
   - reproductive or developmental toxicants.
2. Document reductions of at least 20 percent per unit of product since the baseline year in at least two of the following three categories:
   - emission of hazardous air pollutants (HAPS) (per Clean Air Act)
   - emission of toxic water pollutants (per Clean Water Act)
   - generation of hazardous and non-hazardous waste (per Resource Conservation and Recovery Act).
3. A peer-reviewed full life cycle assessment (LCA) or an Environmental Product Declaration (EPD) has been conducted by the manufacturer or their consultants for the product and the results have been made public in references such as a peer-reviewed journal or the National Renewable Energy Laboratory (NREL) U.S. Life-Cycle Inventory Database. The LCA must follow the ISO 21930 or 14044 methodologies or ASTM E1991-05. The Environmental Product Declaration must be consistent with ISO 14025 and ISO 21930.

4. The product manufacturer demonstrates that the manufacturing process per unit of product consumes 25 percent less energy than average for the industry (e.g., using National Institute of Standards and Technology Building for Environmental and Economic Sustainability—BEES, National Renewable Energy Laboratory—NREL—U.S. Life-Cycle Inventory Database, or Commercial Buildings Energy Consumption Survey industry-specific data).
5. The product manufacturer uses on-site ***renewable energy sources*** to generate 10 percent of its electricity OR is engaged in at least a four-year contract for the purchase of 20 percent of electricity from renewable sources at the facility at which the product is made.
6. The product manufacturer demonstrates that thethree best years for carbon (or global warming potential equivalent) emissions (per unit of product) in the previous 10 years are at least 25 percent better than its corresponding 10-year average (per unit of product) OR the product manufacturer purchases carbon offsets from a legally binding trading system that provides independent third-party verification for 25 percent of its own carbon (or global warming potential equivalent) emissions.
7. Potable water use, or other natural surface or subsurface water resources, makes up less than 25 percent of total water consumption demands during manufacturing for the product line specified (i.e., non-potable sources are used to meet 75 percent of water consumption demands).

Renewable energy sources must meet the Center for Resource Solutions (CRS) Green-e products certification requirements. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements.

****Note:*** *Future versions of this credit may require a percentage of products to meet the requirements of Class 1, 2, and/or 3 in ASTM WK 18435 when the standard is finalized.*

Submittal documentation

Provide total costs for materials (excluding plants and soils) and a tabulation of each material used on the project that is being tracked for sustainable manufacturing practices. The tabulation must include a description of the material, the manufacturer of the material, the product cost, and the sustainable practices employed by the manufacturer. Include documentation from manufacturers (e.g., Environmental Management System contact, web link to chemical inventory, life cycle assessment (LCA), Environmental Product Declaration (EPD), utility bills, etc.) to demonstrate that sustainable practices are employed for 25 percent or 50 percent of purchased products.

Potential technologies and strategies

Identify and select materials from manufacturers that actively implement better business practices to reduce negative impacts to human health and the environment. For example, a site could meet the low point requirements for this credit by selecting wooden benches (for 10 percent of total costs) from a manufacturer that meets the requirements for reduced potable water and energy use, and concrete (for 15 percent of total costs) from a manufacturer that has conducted an LCA and uses at least 10 percent renewable energy.

Links to other Sustainable Sites credits

- Plants and soils are excluded from this credit; however, selecting plants from sustainable nurseries may help achieve *Credit 5.9: Support sustainable practices in plant production*.
- Products that meet the requirements of this credit that also contain recycled content or are designed for future reuse may also help achieve *Credit 5.5: Use recycled content materials* or *Credit 5.3: Design for deconstruction and disassembly*, respectively.
- Selection of products with reduced VOC content may help achieve *Credit 5.8: Use adhesives, sealants, paints, and coatings with reduced VOC emissions*.

Resources

- For more information on environmental management systems, *http://www.epa.gov/EMS/*.
- For more information on the National Renewable Energy Laboratory (NREL) U.S. Life-Cycle Inventory Database, *http://www.nrel.gov/lci/database/default.asp*.
- For more information on the National Institute of Standards and Technology Building for Environmental and Economic Sustainability (BEES) software, *http://www.bfrl.nist.gov/oae/software/bees*. Additional software that may be helpful in analyzing environmental performance include: Simapro, GaBi, *http://www.gabi-software.com*, Umberto, *http://www.umberto.de/en/*, and Open LCA ,*www.openlca.org*.
- For more information on the Hazardous Air Pollutants per Clean Air Act, see the list of hazardous air pollutants in the Code of Federal Regulations at 40 CFR 61.01, *http://ecfr.gpoaccess.gov*.
- For more information on toxic water pollutants per Clean Water Act, see the list of toxic pollutants in the Code of Federal Regulations at 40 CFR 401.15, *http://ecfr.gpoaccess.gov*.
- For more information on hazardous and non-hazardous waste per Resource Conservation and Recovery Act, see the Code of Federal Regulations at 40 CFR 261, *http://ecfr.gpoaccess.gov*. The U.S. Environmental Protection Agency's RCRA Online resources, including the RCRA Frequent Questions Database, *http://www.epa.gov/waste/inforesources/online/index.htm*.
- International Organization for Standardization, or ISO, *www.iso.org*.
- ASTM standards, *www.astm.org*.
- References for known or probable carcinogens include:
  - "Annual Report on Carcinogens," National Toxicology Program, *http://ehis.niehs.nih.gov/roc*.
    - A – Known to Be Human Carcinogens
    - B – Reasonably Anticipated to Be Human Carcinogens
  - EU Risk-Phrases, *http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/clasann2.htm*.
    - R45: May cause cancer
    - R49: May cause cancer by inhalation
  - California Proposition 65, *http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html*.
  - International Agency for Research on Cancer, *http://monographs.iarc.fr/ENG/Classification/index.php*.
    - Group 1: Carcinogenic to humans.
    - Group 2A: Probably carcinogenic to humans.
  - U.S. EPA Integrated Risk Information System (IRIS) Carcinogens List, *http://www.epa.gov/iris*.
    - "Carcinogenic to Humans"
    - "Likely to Be Carcinogenic to Humans"
  - National Institute for Occupational Safety and Health (NIOSH) Carcinogen List, *http://www.cdc.gov/niosh/topics/cancer/npotocca.html*.
    - "Group A - Human Carcinogen"
    - "Group B1 - Probable human carcinogen - based on limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals"
    - "Group B2 - Probable human carcinogen- based on sufficient evidence of carcinogenicity in animals"
  - European Commission, Enterprise and Industry DG Carcinogens List. See consolidated version of Annex I of Directive 76/769 EEC, which includes Annex I of Directive 65/548/EEC point 29 *http://ecb.jrc.it/documentation*, click on: "Documents", "Classification-Labelling", "Directive 67-548-EEC", "Annex I of Directive 67-548-EEC", and then either of the files listed as: "Annex I of Directive 67548EEC" ***(Note:** This reference is to be replaced by Annex XVII of REACH at a later date)*
    - Carcinogen Category 1: "known"
    - Carcinogen Category 2: "should be considered carcinogenic to humans."
- References for PBTs include:
  - United Nations Environment Programme (UNEP), Stockholm Convention Secretariat Stockholm

- Convention on Persistent Organic Pollutants, *http://chm.pops.int/Convention/12POPs/tabid/296/language/en-US/Default.aspx*.
- U.S. Environmental Protection Agency.
  - TRI PBT Chemical List, *http://www.epa.gov/triinter/trichemicals/pbt%20chemicals/pbt_chem_list.htm*.
  - Priority PBT list, *http://www.epa.gov/opptintr/pbt/pubs/cheminfo.htm*.
  - National Waste Minimization Program, Priority Chemicals, *http://www.epa.gov/epawaste/hazard/wastemin/priority.htm*.
- European Commission - Joint Research Centre - Institute for Health & Consumer Protection European Chemical Substances Information System, *http://ecb.jrc.it/esis/index.php?PGM=pbt*.
  - Fulfilling PBT criteria
  - Fulfilling POP criteria
  - Fulfilling vPvB criteria
- State of Washington, Department of Ecology, Chapter 173-333 WAC Persistent Bioaccumulative Toxins, PBT List *http://apps.leg.wa.gov/WAC/default.aspx?cite=173-333-310*.

- References for Reproductive/Development Toxicants include:
  - European Commission, Reproductive Toxicants List. See consolidated version of Annex I of Directive 76/769 EEC, which includes Annex I of Directive 65/548/EEC, *http://ec.europa.eu/enterprise/chemicals/legislation/markrestr/index_en.htm* ***(Note:*** *to be replaced by Annex XVII of REACH at a later date)*.
    - Reproduction category 1: "known" to impair fertility in humans or cause developmental toxicity in humans"
    - Reproduction category 2: "should be regarded as if" they impair fertility to humans or cause developmental toxicity to humans"
  - Joint Research Centre (DG JRC), Institute for Health and Consumer Protection (IHCP), Consumer Products Safety & Quality (CPS&Q) Unit, Substances with EU Risk & Safety Phrases (Commission Directive 67-548-EEC) *http://ecb.jrc.it/documentation*, click on: "Documents", "Classification-Labelling", "Directive 67-548-EEC", "Annext I of Directive 67-548-EEC", and then either of the files listed as: "Annex I of Directive 67548EEC"
    - R60 "May impair fertility"
    - R61 "May cause harm to the unborn child"
  - State of California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) "Proposition 65" (Safe Drinking water and Toxic Enforcement Act of 1986) list: Chemicals known to the state to cause cancer or reproductive toxicity, *http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html*.
    - "developmental"
    - "male" (reproductive)
    - "female" (reproductive)

Definition

Potable water is municipally treated water or well water that is suitable for drinking.

Credit 6.1	Promote equitable site development
1–3 Points	

Intent
During construction of the site, ensure that the project provides economic or social benefits to the local community.

Requirements
- **1 point:** Provide opportunities for job employment during construction (25 percent or higher of the labor component of the construction budget) to local, low-income individuals, locally owned and operated businesses and/or individuals from programs that support on-the-job training, green collar jobs, and youth development (e.g., AmeriCorps, Job Corps). Note that the 25 percent of the labor component of the construction budget must be comprised of positions within the lower 50 percent of the full job payroll scale. Ensure through multiple advertising and outreach strategies that job opportunities reach targeted individuals.
- **2 points:** Commit to a living wage requirement for 75 percent of workers employed during construction of the site.
- **3 points:** Develop a Community Benefits Agreement or other similar agreement that outlines how the project will be shaped to provide a range of community benefits during the construction of the site.

Economic and social benefits

Site development that addresses the effects on local residents can promote the long-term economic stability of local families and businesses. By capturing economic opportunities that result from site development and providing these opportunities to local residents, a site helps support resilient neighborhoods.[84]

Submittal Documentation
- **1 point:** Provide the following information:
  - The overall construction budget
  - The associated hiring timeline
  - A timeline with multiple strategies to advertise job opportunities to targeted individuals
  - Supporting payroll information that shows the percentage of construction employees that are local, low-income individuals, locally owned and operated businesses, individuals from programs that support youth development, on-the-job training, and green collar jobs, signed by appropriate contract holders (i.e., property owner, developer, contractors, and an appropriate community leader)
- **2 points:** Provide the following information:
  - The living wage for the project location
  - The total number of construction workers and the percentage receiving living wage
  - Supporting payroll information, signed by contract holders (i.e., property owner, developer, contractors, and an appropriate community leader)
- **3 points**: Submit a copy of the Community Benefits Agreement or other similar agreement signed by contract holders (i.e., developer, community leaders, and contractors). Explain how this applies to site development.

Potential technologies and strategies
Actively engage with the local community to identify and develop options for sharing economic and social benefits of the site's development. Select options that allow development of the site to benefit a wide range of local residents, beyond the primary user groups.

Links to Sustainable Sites credits

- Engaging local groups during the design phase of the project may help identify and respond to needs on site. For more information, see *Credit 2.3: Engage users and other stakeholders in site design*. Refer also to *Prerequisite 2.2: Use an integrated site development process*.
- Providing events that encourage social interaction such as a farmers' market may contribute to *Credit 6.8: Provide outdoor spaces for social interaction*.
- Providing opportunities for physical activity such as a community garden or guided nature hikes may contribute to *Credit 6.6: Provide opportunities for outdoor physical activity*.

Resources

- For more information on developing a Community Benefits Agreement or examples of living wage, see *http://www.communitybenefits.org* and *http://www.goodjobsfirst.org/pdf/cba2005final.pdf*.
- For example language for "first source" hiring systems, see Partnership for Working Families policies and tools, *http://www.communitybenefits.org/article.php?list=type&type=40*.
- To estimate the living wage for the site's location, see the Living Wage Calculator at *http://www.livingwage.geog.psu.edu/*.
- For more info on green collar jobs, see *http://www.greenforall.org/resources/green-collar-jobs-overview*.
- For more information on identifying, engaging, and planning with the community, see the following resources:
  - National Charrette Institute, *http://www.charretteinstitute.org*
  - Project for Public Spaces resources, *http://www.pps.org/parks_plazas_squares/info/community*
  - B Lennertz and A Lutzenhiser, *The Charrette Handbook: The Essential Guide for Accelerated, Collaborative Community Planning* (Chicago: American Planning Association, 2006)
  - H Sanoff, *Community Participation Methods in Design and Planning* (New York City: John Wiley & Sons, 1999)
  - CS Slotterback, M Beekman, C Carlson, and J Reed, *Enhancing Transportation: The Effects of Public Involvement in Planning and Design Processes*, Report No. CTS 07-10, Series: Moving Communities Forward (2007).

Definitions

- *Community Benefits Agreement* is an agreement made between the developer and coalition(s) of community organizations, addressing a broad range of community needs to ensure that affected residents share in the benefits of major developments. The agreement allows community groups to have a voice in shaping a project, to press for community benefits that are tailored to their particular needs, and to enforce developer's promises.
- *Living wage* is the wage that a full-year, full-time worker would need to earn to support a family of four at the poverty line. Cities and counties with a higher cost of living tend to have higher living wage levels.

Credit 6.2	Promote equitable site use
1–4 Points	

Intent

During site use, ensure that the project provides economic or social benefits to the local community.

Economic and social benefits

Site development that addresses the effects on local residents can promote the long-term economic stability of local families and businesses. By capturing economic opportunities that result from site development and providing these opportunities to local residents, a site helps support resilient neighborhoods.[85]

Requirements

- **1 point:** Provide events (minimum of two events per year in the first two years of operation) identified as a community need or desirable amenity during meetings with the local community. Examples of events may include, but are not limited to, the following: theater and music performances, art shows, guided nature hikes, etc.
  AND
  Provide and publicly announce free or discounted access opportunities to the site, including events held at the site (minimum of two events per year in the first two years of operation) to underserved community groups or populations that are economically and socially disadvantaged and who do not typically use the site. Ensure participation by conducting outreach and advertising to targeted individuals.
- **3 points:** Provide an on-site facility or desirable amenity that was identified as a community need during meetings with local community groups. Examples of facilities may include, but are not limited to, the following: recreational facility, day care, health-care center, pavilion for farmers' market, community garden site and public restrooms.
- **4 points:** Develop a Community Benefits Agreement or other similar agreement that outlines how the project will be shaped to provide a range of community benefits in regard to site use (post-construction).

Submittal documentation

- **1 point:** Provide the following:
  1. An outline of the feedback and needs of local community groups.
  2. A narrative of the events to be provided for the community.
  3. A letter confirming the intent to provide events, signed by the property owner and a locally elected or appointed community leader who represents the local community groups.
  4. A description of the underserved community groups or populations who do not typically visit the site and how they were indentified.
  5. A narrative that describes the access opportunities and events to be provided for the identified groups, including distinct options to address the access needs of specific user groups (e.g., additional access hours, transportation to and from the site, reduced entry fees, interpretation in multiple languages).
  6. A timeline with multiple strategies for outreach and advertising events to encourage participation from targeted individuals.
  7. A letter confirming the intent to provide free or discounted access opportunities, signed by the property owner and a locally elected or appointed community leader who represents the underserved community.
- **3 points:** Provide the following:
  1. An outline of the feedback and needs of local community groups.
  2. A site plan(s) and narrative that describe the facility to be developed with the community.
  3. A letter confirming the intent to provide the facility, signed by the property owner and a locally elected or appointed community leader who represents the local community groups.

- **4 points:** Submit a copy of the Community Benefits Agreement or other similar agreement signed by contract holders (i.e., developer, community leaders, and contractors). Explain how the agreement applies to site use post-construction.

Potential technologies and strategies

Actively engage with the local community to identify and develop options for sharing economic and social benefits of the site. Select options that allow use of the site to benefit a wide range of local residents, beyond the primary user groups.

Links to Sustainable Sites credits

- Engaging local groups during the design phase of the project may help identify and respond to needs on site. For more information, see *Credit 2.3: Engage users and other stakeholders in site design*. Refer also to *Prerequisite 2.2: Use an integrated site development process*.
- Providing events that encourage social interaction such as a farmers' market may contribute to *Credit 6.8: Provide outdoor spaces for social interaction*.
- Providing opportunities for physical activity such as guided nature hikes may contribute to *Credit 6.6: Provide opportunities for outdoor physical activity.*

Resources

- For more information on developing a Community Benefits Agreement, see *http://www.communitybenefits.org*
- For more information on identifying, engaging, and planning with the community, see the following resources:
  - National Charrette Institute, *http://www.charretteinstitute.org*
  - Project for Public Spaces resources, *http://www.pps.org/parks_plazas_squares/info/community*
  - B Lennertz and A Lutzenhiser, *The Charrette Handbook: The Essential Guide for Accelerated, Collaborative Community Planning* (Chicago: American Planning Association, 2006)
  - H Sanoff, *Community Participation Methods in Design and Planning* (New York City: John Wiley & Sons, 1999)
  - CS Slotterback, M Beekman, C Carlson, and J Reed, *Enhancing Transportation: The Effects of Public Involvement in Planning and Design Processes*. Report No. CTS 07-10, Series: Moving Communities Forward (2007)

Definition

Community Benefits Agreement is an agreement made between the developer and coalition(s) of community organizations, addressing a broad range of community needs to ensure that affected residents share in the benefits of major developments. The agreement allows community groups to have a voice in shaping a project, to press for community benefits that are tailored to their particular needs, and to enforce developer's promises.

Credit 6.3	Promote sustainability awareness and education
2–4 Points	

Intent

Interpret on-site features and processes to promote understanding of sustainability in ways that positively influence user behavior on site and beyond.

Requirements

- **2 points:** Provide a minimum of three educational or interpretive elements (e.g., maps, models, brochures, signage, and video) that draw attention to and explain sustainable features or processes of the site design, construction, operations, and/or maintenance. Help users and visitors understand how sustainability can be applied to off-site situations (e.g., homes, schools, and workplaces). Demonstrate and promote the connection to environmentally responsible behavior (i.e., comparison of unsustainable vs. sustainable practices). Only one of the three elements can be in the form of signage.
  - Guidelines for educational or interpretive elements:
    - Deliver one focused take-home message.
    - Make educational message(s) compelling (i.e., explain its importance rather than restating facts).
    - As much as possible, use visual illustrations to convey the educational message (e.g., photographs, graphics, diagrams).
  - For any text-based interpretation (e.g., signage, exhibits):
    - Limit main copy to an amount that could be read by an average reader in 45–60 seconds (approximately 200 words). No more than 200 words can be used on one sign/placard.
    - Limit sentence length to 10–15 words, where possible.
    - Use short paragraphs (approximately two- to four sentences). No more than 50 words in one paragraph.
    - Make text readable based on viewing distances (see Table 6.3-A below).
    - Use bulleted items.
- **4 points:** Provide one of the following options:
  - **Option 1:** Provide educational or interpretive elements that are interactive (a minimum of two elements or 30 percent of all education elements on site, whichever is greater). Interactive elements will allow site users and visitors to integrate understanding of on-site examples of sustainability with experiences that extend beyond the site. They may include, but are limited to the following: website, electronic kiosks, on-site demonstrations and tours. Where applicable, follow the guidelines stated in the low point value.

  OR

  - **Option 2:** Provide programming that welcomes, encourages, and expands sustainability learning and understanding on the site. Activities and programs should welcome diverse participants.

  OR

  - **Option 3:** Create partnerships to extend sustainability education to local community groups (e.g., schools, youth organizations, workforce commissions, church groups, NGOs, informal learning classes, senior centers, community centers).

Economic and social benefits

Sustainable sites give site users and visitors opportunities to observe first-hand the physical design elements that contribute to sustainability. Educating users and visitors can help spread sustainability practices from a single site to other sites and from a given land use to other land uses. Studies of environmentally responsible behaviors at the individual level demonstrate that education and awareness-building is an essential step in changing behavior.[86] Visitors develop understanding and support for resources and their values primarily through interpretive events or contacts.

TABLE 6.3-A: A GUIDE TO SELECTING TYPE SIZES FOR DIFFERENT DISTANCES				
Readability Depends on Viewing Distances				
Type of Text	Viewing Distances and Minimum Heights of Letters			
	1–4 ft (0–1.5 m)	4–6 ft (1.5–2 m)	30 ft (9 m)	60 ft (18 m)
Titles	2.0 cm (0.75 in)>72 pt.	2.5 cm (1.0 in)>96 pt.	10.0 cm (4.0 in)>384 pt.	15.0 cm (6.0 in)>576 pt.
Headings	1.3 cm (0.5 in)>48pt.	2.0 cm (0.75 in)>72 pt.	8.0 cm (3.0 in)>288 pt.	13.0 cm (5.0 in)>480 pt.
Body Text	0.6 cm (0.25 in)>24 pt.	1.3 cm (0.5in)>48pt.	6.0 cm (2.0 in)>192 pt.	10.0 cm (4.0 in)>384 pt.
Captions and Specimen Labels	0.5 cm (0.19 in)>18 pt.	0.6 cm (0.25 in)>24 pt	N/A	N/A

Note: *Sizes given are the minimum for each viewing distances. N/A = not applicable; exhibits intended to be viewed from this distance normally shouldn't include items requiring captions or labels.* ***(Source:*** *SH Ham,* Environmental Interpretation: A Practical Guide for People with Big Ideas and Small Budgets *(Golden, CO: North American Press,1992). Reprinted with permission.)*

Submittal documentation

- 2 points:
  - Provide a site plan and any supporting materials (e.g., photos, drawings) that indicate the design and locations of educational and interpretive elements.
  - Provide a narrative describing the content of these elements, the message of sustainability that is being conveyed, and how it meets user needs and/or site conditions.
- 4 points:
  - **Option 1:** Provide a site plan and any supporting materials (e.g., photos, drawings) that indicate the design and locations of all the educational elements (indicate which ones are interactive). Provide a narrative to describe the content of these elements, the message of sustainability that is being communicated, how it is interactive, and how it meets user needs and/or site conditions. Include copies of the narration and schedule for any guided tours or any technology-based interpretative elements.
  - **Option 2:** Describe the programming intentions, outcome goals, staffing plan, expected audience and participants, and how the site's physical elements will facilitate the programming.
  - **Option 3:** List community partnerships and their predicted contributions or applications. Provide copies of agreements, contracts or letters of support. Describe how this partnership promotes sustainability awareness and education.

Potential technologies and strategies

Design educational and interpretive elements with potential audiences in mind. Information might be provided in a number of formats (e.g., maps, models, brochures, electronic kiosks, or other displays, MP3-based or cell phone tours). Any natural element provided to improve environmental conditions could also include opportunity for user education and understanding. For instance, raingardens for stormwater management can be designed to provide a restorative setting, or a roof garden can serve as a break room. Identify those sustainability features that can be easily applied to off-site situations and design interpretative elements based on these applications. Tie programming to state-standards and local school district goals and learning initiatives. Consider including interpretative descriptions in multiple languages to meet a broader audience based on visitor/population demographics.

Links to other Sustainable Sites credits

Engaging the local community during the design phase of the project will help identify potential site users and their needs may contribute to achieving *Credit 2.3: Engage users and other stakeholders in site design*.

Resources

- National Association for Interpretation resources and publications, *http://www.interpnet.com/*, and the Interpreter's Handbook Series, *http://www.uwsp.edu/cnr/Schmeeckle/Handbooks/*
- L Beck and T Cable, *Interpretation for the 21st Century: Fifteen Guiding Principles for Interpreting Nature and Culture* (Champaign, IL: Sagamore Publishing, 2002)
- SH Ham, *Environmental Interpretation: A Practical Guide for People with Big Ideas and Small Budgets* (Golden CO: Fulcrum Publishing, 1993)
- D Knudson, T Cable and L Beck,. *Interpreting Cultural and Natural Resources*, 2nd ed. (State College, PA: Venture Publishing, 2002)
- North American Association for Environmental Education, *http://www.naaee.org/*
- National Science Standards, *http://www.educationworld.com/standards/national/science/index.shtml*

Credit 6.4	Protect and maintain unique cultural and historical places
2–4 Points	

Intent

Protect and maintain cultural and historical locations, attributes and artifacts to enhance a site's sense of place and meaning.

Economic and social benefits

Economic benefits of including cultural aspects in site design may include opportunities for increased employment, entrepreneurship, tourism, and resource and energy conservation.

Enhanced human experience and attachment to the land can result in a stronger sense of stewardship.

Requirements[87]

- **2 points:** Protect site features that are identified as significant to local culture and local histories, including cultural landscapes and other non-registered places, and, if existing, protect site features that have been, or are eligible to be:
  - designated, listed, or identified by a local government as historic or contributing to a locally designated historic district pursuant to a local preservation ordinance, and/or
  - designated, listed, or identified as historic or contributing to a historic district under a state historic register or on the National Register of Historic Places and/or National Historic Landmarks.

  AND

  In the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*), outline the long-term strategies and identify short-term action plans to achieve preservation maintenance goals for the site's cultural/historic feature(s). The plan should include the following information:
  - Yearly and long-term goals for preservation and maintenance of the cultural/historic site feature(s).
  - Specific maintenance activities: The work performed for maintenance is recorded, and may include a series of as-built drawings, supporting photographic materials, specifications and a summary assessment. The plan may include detailed specifications related to the repair or replacement of features on the site. That is, when repairing or replacing a feature, every effort should be made to achieve visual and physical compatibility. Historic materials should be matched as appropriate in design, scale, color, and texture.
  - Skill level required to complete tasks.
  - Timeline and schedules: The maintenance program includes schedules (ideally, in calendar format) for monitoring and routine maintenance, appropriate preservation maintenance procedures, and on-going documentation of the work performed. The calendar records the frequency of maintenance work on built or natural landscape features.
- **4 points:**
  - Achieve the low point value

    AND
  - Ensure the lasting protection of the cultural/historical site feature(s) (e.g., conservation easements).

Submittal documentation

- **2 points:**
  - **Option 1:**
    - Provide supporting documentation that qualifies a site feature as historic—from the National Register of Historic Places and/or National Historic Landmarks, or from a qualified organization or agency within the community or the local government.

- **Option 2:**
  - Provide a letter confirming the significance of the site feature(s) and supporting its protection, signed by the property owner(s) and an appropriate local historian, archaeologist, and/or other appropriate community member.
  - Provide the relevant sections of the site assessment (see *Prerequisite 2.1 Conduct a pre-design site assessment and explore opportunities for site sustainability*) that describe the site feature(s) significant to local culture and histories. Please follow the outline below *(adapted from the National Park Service's Historic American Landscapes Survey (HALS): Guidelines for Historical Reports):*

    Part I. Historical Information

    A. Physical History
    1. Date(s) of establishment
    2. Landscape architect, designer, shaper, creator
    3. Builder, contractor, laborers, suppliers
    4. Original and subsequent owners, occupants
    5. Periods of development
    a. Original plans and construction
    b. Changes and additions

    B. Historical Context

    Part II. Physical Information

    A. Landscape Character and Description Summary (also include an evaluation of the integrity of the feature)

    B. Character Defining Features:
    1. Natural features:
    a. Topography
    b. Vegetation
    c. Water
    2. Spatial organization
    a. Land patterns
    b. Circulation
    c. Views and vistas
    d. Water
    e. Buildings and structures
    f. Small scale elements
    g. Archaeological sites
    3. Sources of information including site plan(s), photographs, and maps. Other sources of information may include interviews and drawings.
- **For both Options 1 and 2:** Provide the applicable section(s) of the site maintenance plan (*see Prerequisite 8.1: Plan for sustainable site maintenance*) that describe the activities designed to preserve cultural/historic resources on site.

- **4 points:** Provide a copy of the property title that shows that the cultural/historic site feature(s) has been protected in perpetuity as part of the project's effort. The title must list the organization holding the easement and the property owner.

Potential technologies and strategies

Communicate with local, state, and federal agencies, educational facilities, historical associations and the local community to identify important cultural or historic places, landscapes, or concepts to protect and incorporate into site design.

Links to other Sustainable Sites credits

- Conducting a thorough site assessment before design (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* will help identify information for potential historical and cultural features on site.
- Engaging the local community and preservation professionals during the design phase of the project will help identify important local histories or cultures that are not included on National or State Historic Registers and may contribute to achieving *Credit 2.3: Engage users and other stakeholders in site design*.
- Maintaining on-site structures and other built features may contribute to achieving *Credit 5.2: Maintain on-site structures, hardscape, and landscapes amenities*.

Resources

- For information on the National Register of Historic Places, refer to the National Register of Historic Places Fundamentals, *http://www.nps.gov/nr/national_register_fundamentals.htm*
- For treatment of historic properties, refer to the Secretary of the Interior's Standards, *http://www.nps.gov/history/hps/tps/standards_guidelines.htm*
- For information on National Historic Landmarks, *http://www.nps.gov/history/nhl/QA.htm#2*
- For information on historic and cultural landscapes, refer to the following:
  - National Park Service's Historical American Landscapes Survey (HALS), *http://www.nps.gov/hdp/hals/index.htm*
  - Cultural Landscape Foundation, *http://www.tclf.org/whatis.htm*
  - National Park Service's Historic Landscape Initiative—Protecting Cultural Landscapes Planning, Treatment and Management of Historic Landscapes, *http://www.nps.gov/history/hps/TPS/briefs/brief36.htm*
  - National Trust for Historic Preservation, *http://www.preservationnation.org*
- For information on historic preservation easements, refer to the National Park Service's Technical Preservation Services, *www.nps.gov/hps/tps/tax/easement.htm*

Definition

Cultural landscape is a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

Credit 6.5	Provide for optimum site accessibility, safety, and wayfinding
3 Points	

Intent

Promote site use by increasing user's ability to understand and safely access outdoor spaces.

Requirements

Develop and implement a plan for enabling site use without compromising sensitive site features (e.g., wetland, archaeological site, heritage tree). The plan shall list the techniques employed and how the techniques accomplish the following objectives. See specific requirements under each heading below.

- **Accessibility** *(Required*):* Provide site access and usability *beyond* required national and local accessibility standards (e.g., Americans with Disabilities Act).
- **Safety:** Improve actual and perceived safety of site users. Complete at least three of the five components below*:
  1. Clear, defined spaces and access control (e.g., public vs. private)
  2. Natural surveillance with lighting
  3. Natural surveillance with entrances and walkways
  4. Visibility and sight lines
  5. Variety of options are provided for access.
- **Wayfinding:** Create an environment that makes it easy and intuitive for users to orient themselves and navigate from place to place. Complete at least five of the eight components below*:
  1. Clear entrances/gateways
  2. Viewpoints and sight lines as vantage points
  3. Landmarks
  4. Decision points (nodes)
  5. Hierarchy of pedestrian circulation
  6. Distinct Areas and Regions
  7. Orientation Devices/Systems
  8. Maps/Brochures.

***Note:** Refer to the* Planning for Optimum Site Use Worksheet *below for description of components.*

Economic and social benefits

Safe, accessible, and legible sites encourage both use and enjoyment. Sites that are easy to navigate enhance users' sense of safety, minimize their anxiety, and improve their environmental awareness.[88, 89] The easier it is to use the site, the more likely it is that users will take advantage of opportunities for physical activity, mental restoration, and social interaction, as well as opportunities for recreation, stewardship and nature education.

Suggested submittal documentation

- Complete the worksheet below to describe how the site design will optimize accessibility, safety ,and wayfinding components of the site. If a component is not applicable to a site, explain why. Various design choices may achieve multiple components (e.g., a variety of pathways offered at a "decision point" that lead to different destinations provides the site user with "choice and control").
- Illustrate how the following components were addressed using site plans, drawings, and/or photos.

WORKSHEET: PLANNING FOR OPTIMUM SITE USE			
Accessibility (Required)			
Required component		How does the site design incorporate this component?*	Examples and additional description of component
Access for persons with disabilities	Site accessibility is improved beyond minimum standards set by local and national standards (e.g., Americans with Disabilities Act).	**When describing how a site improves upon the required accessibility standard, list the national and local standard(s) that were followed.*	*A site provides access (as well as seating) to all site amenities. A site provides signage or interpretations designed for persons who are visually or hearing impaired.*
Safety (Must complete at least three of the five below)			
Required component *(Some components were adopted from* Crime Prevention through Environmental Design*)*		How does the site design incorporate this component?*	Examples and additional description of component
Definition of space/ access control	Site attributes indicate how the space is public, semi-public, semi-private, or private.		*Walkways and landscaping direct visitors to the proper entrance and away from private areas. Property lines and private areas are defined with plantings, pavement treatments, short walls, or fences. Parking areas are clearly marked and separated from pedestrian walkways.*
Natural surveillance—lighting	Exterior spaces and parking lots are well lit.		*Place lighting in such a way that it allows people to be recognized from 25 feet away. Provide even, consistent lighting that illuminates faces and doesn't cast shadows (Must follow requirements of* Credit 6.9: Reduce light pollution *for compliance).*
Natural surveillance—entrances and walkways	Entrances and walkways are situated near building windows (if any) or other areas where users are typically present.		*Provide natural surveillance with views from adjacent buildings, streets, and other activity areas.*
Visibility—sight lines	Entrances and walkways are open and clearly visible for users.		*On walking trails, improve sight lines between knee height and eye level. At entrances, provide open sight lines and view corridors to allow users to assess the usability and safety of the site. (Note that the intent does not mean removing all understory plantings).*
Variety of options are provided for access	An appropriate variety of entrances, exits, and pathways are provided to offer choice and control for site users.		*A variety of entrances and exits are provided to prevent feelings of isolation or entrapment, to enable people to predict the behavior of others, and to safely choose different routes through their environment. Several path options are provided for free movement to allow the user to control his or her experience.*

Continued on next page

Wayfinding (Must complete at least five of the eight components below)			
Required component		How does the site design incorporate this component?*	Examples and additional description of component
Entrances and gateways	On-site entrances are made clear from both on and off the project site. On-site gateways indicate entrances to separate areas of the site.		*Gateways are often highlighted by separation between areas, such as fences, hedges, low walls, etc. Some traditional techniques include pairs of columns, gates, arches or changes in paving material.*
Viewpoints/vistas and sight lines	An overview of the site from a higher vantage point is provided to aid in wayfinding.		*A viewpoint, vista, or sight line could be an elevated overlook such as a tower or terrace. Note that sight lines to landmarks are critical from decision points.*
Landmarks	On-site landmarks are distinct, memorable objects or locations that are clearly visible.		*Landmarks may include unique natural features, vertical features such as towers, specimen trees. Landmarks should be visible from main paths, entrances, gateways, and decision points. Landmarks should be unique and distinct from their surroundings.*
Decision points (nodes)	Locations where users have multiple options to reach separate destinations are provided.		*Decision points are important areas to locate orientation devices. Choices should be limited to three to five destinations max. Decision points should be made visible from their surroundings. Signage should be the last resort for wayfinding although it may be necessary at critical decision points.*
Hierarchy of pedestrian circulation	Hierarchy of paths, from major to minor, is differentiated by width, material choice, and/or edging.		*A circulation system (plan) includes the hierarchy of paths, beginning and ending points. Main paths should lead to major destinations and entries.*
Distinct areas and regions	Organize and distinguish distinct areas using similar vegetation, paving, or spatial enclosures.		*An area can be distinct when it has unique materials and vegetation within a recognizable space, rather than one large undifferentiated space.*
Orientation devices/ systems	Site users are able to develop a mental map of the site to orient themselves to destinations.		*Creative strategies include models, interactive kiosks, audio tours, and even artwork, as well as aid in wayfinding for people of different abilities (i.e., blind, deaf, children). Signage should be the last resort for wayfinding although it may be necessary at critical decision points.*
Maps/brochures	Map(s) is/are created for users and is/are located on site at key decision points and/or distribution points for brochure maps.		*Maps should be oriented toward the view and/or in slightly aerial orientation. Axonometric views are easier to read than plans.*

Potential technologies and strategies

During site design, identify techniques appropriate to the site type and user groups to address safety and accessibility concerns. Identify techniques to improve legibility and understanding of the site's layout and intended uses.

Links to other Sustainable Sites credits

- Conducting a site assessment *(see Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* will help identify landmarks, areas of unique visual character, viewpoints, and potential areas for paths and decision points.
- Achieving *Credit 2.3: Engage users and other stakeholders in site design* will identify the needs of the community and may contribute to this credit.
- Creating exterior areas that are properly lit will help achieve *Credit 6.9: Reduce light pollution*.

Resources

- For more information on accessibility:
  - Americans with Disabilities Accessibility Guidelines (ADAAG), *www.access-board.gov/adaag/about*
  - The Center for Universal Design, *http://www.design.ncsu.edu/cud/about_ud/udresourcepage.htm*
- For more information on safety:
  - Crime Prevention through Environmental Design (CPTED), National Community Development & Crime Prevention Institute, *http://www.cpted-watch.com/*.
  - O Newman, *Creating Defensible Space* (Washington, DC: U.S. Department of Housing and Urban Development, Office of Policy Development and Research, 1996).
  - SE Michael and RB Hull IV, *Effects of Vegetation on Crime in Urban Parks* (Blacksburg, VA: Virginia Polytechnic Institute & State University, Department of Forestry, 1994).
- For use of lighting for safety, refer to the Illuminating Engineering Society (IES) standards and visit *http://www.facilities.ufl.edu/cp/pdf/Lighting%20Illumination%20levels.pdf*.
- For more information on wayfinding:
  - R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998), also includes information on safety.
  - P Arthurand and R Passini, *Wayfinding: People, Signs and Architecture* (New York: McGraw-Hill Ryerson, 1992).

Definition

Natural surveillance is the placement of physical features, activities, and people in a way that maximizes visibility.

Credit 6.6	Provide opportunities for outdoor physical activity
4–5 Points	

Intent

Provide on-site opportunities that encourage outdoor physical activity to improve human health.

Requirements[90]

1. Estimate the distribution of total potential users by age group (total users are based on Full-Time Equivalent (FTE) occupants and Temporary occupants). Identify the four largest user groups (e.g., elderly, families, teenagers, young adults, etc.) OR all the user groups that represent at least 20 percent of the total.
2. Develop and implement a plan that encourages outdoor physical activity for the potential user groups identified in Step 1. Provide at least two physical activity features that accommodate the potential site user groups. ***(Note:** If one feature satisfies the needs of multiple groups, provide rationalization)*
3. Indicate the techniques employed to address the following components (See the worksheet below for a complete description of components):
   - *Physical Activity Features:* Provide on-site features that provide site users opportunities for physical activity. All features should provide the opportunity to meet the Centers for Disease Control (CDC) and Prevention guidelines for physical activity. Provide at least two of the five features below.
     - Trail and/or bicycle network of sufficient length (For bicycle networks, projects must also provide secure bicycle racks and/or storage for at least 5 percent of total site users (both FTE and temporary occupants). For sites with regularly occupied building(s), bicycle racks and/or storage must be within 200 yards of a building entrance. For sites without regularly occupied building(s), secure bicycle racks and/or storage must be provided at a convenient and accessible location.)
     - Playgrounds that are physically challenging and engaging for variety of age groups
     - On-site programs that support physical activity
     - Site offers programming specifically for individual or team sports
     - Site provides year-round exercise equipment that encourages muscle strengthening.
   - *Support Services (Required):* Provide services to support site users during physical activity (e.g., drinking fountains, bike repair services and emergency call boxes).
   - *Accessibility (Required):* Design the physical activity features to meet standards set by the Americans with Disabilities Act (ADA).
   - *Safety:* Improve actual and perceived safety of the site. Must complete one of the three components below:
     - Natural surveillance with lighting
     - Visibility and sight lines

Economic and social benefits[91]

Physical inactivity (a lack of physical activity) is an independent risk factor for chronic diseases, and overall is estimated to cause 1.9 million deaths globally. According to the Centers for Disease Control, more than one-third of people in the United States are obese and nearly three-quarters do not get the recommended 30 minutes of physical activity on most days. Because many adults spend 20, 30, or 40 hours or more a week at work, adding physical activity to employee workdays may be one way to help working Americans become healthier.

Researchers found that the prevalence of overweight youth was lower among those that spent more time outdoors.[92] In 2000, the health costs of overweight and obesity were estimated at $117 billion.[93] In 2003 a study of the state of Michigan suggested that physical inactivity accounts for $8.9 billion dollars in indirect and direct costs.[94] Improved health is correlated with reduced health-care costs.[95,96,97] Daily moderate activity decreases the incidence of chronic diseases such as diabetes and heart disease. Physical activity and exercise can also improve mental health by reducing feelings of depression and anxiety, reducing stress, and promoting psychological well-being.[98] Community gardens, which provide opportunity for physical activity, have also been demonstrated to increase property values.[99]

  - Variety of options are provided for access
- *Vegetation and Microclimate Considerations (Required):* Address site microclimate and provide physical and/or visual access to vegetation when locating and orienting physical activity features.

- **Additional point:** Engage with potential site users and other stakeholders to assess the greatest physical activity need(s) of the four largest user groups OR all the user groups that represent at least 20 percent of the total. Provide a minimum of two opportunities for participation that are accessible for site users/stakeholders. Share with the participants a plan, model and/or aerial photographs of the site, including a narrative description of the project.

Submittal documentation

- List the four largest users groups
- Complete the *Planning for Physical Activity Worksheet* to describe how the site design will encourage site users to be physically active.
- Describe how the physical activity features are of interest to intended site users and accommodate a range of user groups.
- Illustrate how the following components were addressed using site plans, drawings, and/or photos. If bicycle racks and/or storage are provided, confirm the quantity and location of bicycle racks and/or storage.
- For additional point only:

1. Describe the opportunities provided for community participation (a minimum of two) in assessing the physical activity needs of potential site users.

AND

2. Based on participant input, describe the physical activity need(s) of the four largest user groups OR all the user groups that represent at least 20 percent of the total.

WORKSHEET: PLANNING FOR PHYSICAL ACTIVITY			
Physical Activity Features (Must complete at least two of the five components below)			
Required component		How does the site design incorporate this component and accommodate a variety of site users?	Examples and additional description of component
Trail or bikeway	Trails and/or bicycle network are of sufficient length. (For bicycle networks, projects must also provide secure bicycle racks and/or storage for at least 5 percent of total site users - FTE and Temporary occupants). *This component requires extra documentation (see* Submittal documentation).		*For sites with regularly occupied buildings, bike racks and/or storage must be within 200 yards of a building entrance. For sites without regularly occupied buildings, secure bicycle racks and/or storage must be provided at a convenient and accessible location.* *Trails that support 30 minutes of brisk walking or 20 minutes of running or jogging (i.e., 2 miles total). This amount of activity could be accomplished with trails of varying length. For instance, a 0.25-mile pathway with no automobile crossings (or a 0.5-mile pathway with no more than one automobile crossing) could meet this requirement if designed to be an engaging experience over repeated use for 2 miles of brisk walking, running, or jogging.* *Public sidewalks can be used for part of a trail or pathway as long as the walking route maintains safety and desirability. Provide seating option(s) for rest stops.*

Continued on next page

Physical Activity Features, *continued* (Must complete at least two of the five components below)			
Required component		How does the site design incorporate this component and accommodate a variety of site users?	Examples and additional description of component
Playground	Playgrounds are physically challenging and engaging for variety of age groups.		*Playgrounds should be adventurous and imaginative. Playgrounds are sited conveniently for users and provide nearby seating for family members and caretakers.*
Program	On-site programs support physical activity.		*Examples include equipment rentals (e.g., canoe, kayak, bike), instructed classes (e.g., aerobic, yoga, tai chi), and community gardening.*
Sports facilities	Site offers programming specifically for individual or team sports.		*Examples include tennis courts, soccer fields, frisbee golf course, skate park, and swimming pool.*
Workout stations	Site provides year-round exercise equipment that encourages muscle strengthening.		*Equipment is accessible to a variety of site users (e.g., children, elderly, persons with disabilities).*
Support Services Based on Physical Activity Feature (Required)			
Required component		How does the site design incorporate this component?	Examples and additional description of component
Support services	Services are offered to support site users during physical activity.		*Examples include drinking fountains, emergency call boxes, and bike repair service.*
Accessibility (Required)			
Required component		How does the site design incorporate this component?	Examples and additional description of component
Site accessibility	Accessible and usable site that provides physical activity opportunities for a variety of users. Meets standards set by the Americans with Disabilities Act (ADA)	*List the national and local standard(s) that were followed or improved upon.*	*A site provides access and exercise options for a variety of users (e.g., elderly, persons with disabilities).*
Safety (Must complete at least one of the three components below)			
Safety: Natural surveillance—lighting	Exterior spaces and parking lots are well lit.		*Must follow requirements of* Credit 6.9: Reduce light pollution *for compliance.*
Safety: Visibility—sight lines	Entrances and walkways are open and clearly visible for users.		*On walking trails, improve sight lines between knee height and eye level. At entrances, provide open sight lines and view corridors to allow users to assess the usability and safety of the site. (Note that the intent does not mean removing all understory plantings).*
Safety: Variety of options are provided for access	An appropriate variety of entrances, exits and pathways are provided to offer choice and control for site users.		*A variety of entrances and exits are provided to prevent feelings of isolation or entrapment, to enable people to predict behavior of others and to safely choose different routes through their environment. Several path options are provided for free movement to allow the user to control his or her experience.*

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Vegetation and Climate Considerations (Required)			
Microclimate and other site-specific considerations	Outdoor space(s) is/are comfortable and encourage/s use under a broad range of conditions. Existing stressful factors, such as wind and sun, are minimized.		*Design physical activity features such as workout stations with protective windbreaks, awnings, and other sources of shade, where necessary. Use vegetation, green walls, or barriers to minimize or buffer excessive wind, sunlight, traffic, or unsightly features.*
Access to vegetation	Visual and/or physical access to vegetation is provided.		*An exceptional view or grove of trees.*

Potential technologies and strategies

Identify potential site users and the physical activities preferred by intended user groups. Locate desirable and accessible spaces on site to enable and encourage physical activity. For small sites, creatively design meandering pathways to maximize on-site opportunities. If public sidewalks are used as part or all of a trail or pathway, consider conducting a walkability audit (see Centers for Disease Control and Prevention) to assess the safety and desirability of the walking route(s). If a private site provides access to the public, consider lighting as part of the design.

Links to other Sustainable Sites credits

- Conducting a site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) will help identify areas of unique visual character, viewpoints, and potential areas for physical activity features such as trails, bikeways, workout stations and playgrounds.
- Achieving *Credit 2.3: Engage users and other stakeholders in site design* will identify site users and their needs and can contribute to this credit.
- Creating exterior areas that are properly lit will help achieve *Credit 6.9: Reduce light pollution*.
- Providing a safe and accessible site will help achieve *Credit 6.5: Provide for optimum site accessibility, safety, and wayfinding*.
- Addressing microclimate and providing users access to vegetation may contribute to *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration* and *Credit 6.8: Provide outdoor spaces for social interaction*.
- Providing public access to a private site for the purpose of physical activity may contribute to *Credit 6.2: Promote equitable use of the site*.

Resources

- For more information on outdoor physical activity, see Centers for Disease Control and Prevention, Physical Activity Resources *http://www.cdc.gov/nccdphp/dnpa/physical/index.htm*, including information on active environments *http://www.cdc.gov/nccdphp/dnpa/physical/health_professionals/active_environments/index.htm*.
- For more information on creatively designed trails, see R Kaplan, S Kaplan, and RL Ryan, *With People in Mind: Design and Management of Everyday Nature* (Washington, DC: Island Press, 1998).
- American Association of State Highway and Transportation Officials (AASHTO). Design Guidance - Accommodating Bicycle and Pedestrian Travel: A Recommended Approach *http://www.fhwa.dot.gov/environment/bikeped/design.htm*.
- *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, 2004 (AASHTO Pedestrian Guide). Describes the minimum guidelines for the construction and design of sidewalks and street crossings, and may be appropriate for pedestrian trails serving a transportation purpose.
- D Snyder, A Rothschadl and M Marchello, *Inclusive Outdoor Recreation for Persons with Disabilities* (Enumclaw, WA: Idyll Arbor, Inc., 2007).

Definitions

- *Bicycle network* is a continuous bicycle or multi-use facility that is completely separate from the vehicular right-of-way but can be shared with pedestrians. The standard bicycle network has pavement that is at least 8 feet wide with a 2-foot unpaved clear zone on each side; 10 feet of pavement is recommended, along with the 2-foot clear zones to minimize conflicts between pedestrians and bicyclists.
- *Bicycle racks and storage* must be secure (e.g., bicycle racks, lockers, and storage rooms). These spaces should be easily accessible by site users during all periods of the year and free of charge.
- *Centers for Disease Control and Prevention (CDC) guidelines* recommend that adults have 150 minutes of moderate-intensity aerobic activity (e.g. brisk walking) each week, or 75 minutes of vigorous-intensity physical activity (e.g. jogging or biking) each week. Refer to the CDC website for physical activity needs for children and older adults.
- *Full-Time Equivalent (FTE) occupants are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0, while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.*
- *Natural surveillance* is the placement of physical features, activities, and people in a way that maximizes visibility.
- *Opportunities for participation* are opportunities where information is shared and received through formal and informal methods such as charrettes, community meetings/workshops, newsletters, press releases, surveys, or website.
- *Regularly occupied building(s)* are buildings where occupants (workers, students, etc.) are seated or standing inside for extended periods of time.
- *Temporary occupants* are occupants such as students, visitors and customers that are on a site intermittently. The calculation for temporary occupants is based on an average expected volume per day (excluding special events). Note that calculations for Temporary Occupants must be consistently used throughout documentation.

Credit 6.7	Provide views of vegetation and quiet outdoor spaces for mental restoration
3–4 Points	

Intent

Provide visual and physical connections to the outdoors to optimize the mental health benefits of site users.

Requirements

Develop and implement a plan to provide views of vegetation and access to quiet outdoor space(s) on site to optimize mental health benefits of site users.

- **Option 1**: For sites without regularly occupied building(s), provide quiet outdoor spaces that must be accessible to potential users and provide seating for 5 percent of total site users (Full-Time Equivalent (FTE) occupants and Temporary occupants).
  - Indicate the techniques employed to address the following:
    - Provide a variety of seating within small defined spaces
    - Minimize noise to an acceptable noise level
    - Consider microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.)
    - Provide an aesthetic experience and access to vegetation.

OR

- **Option 2**: For sites with regularly occupied building(s), provide quiet outdoor spaces that are accessible to potential users. These outdoor spaces must be within 200 feet of the building entrance(s) and provide seating for 5 percent of total site users (both FTE occupants and temporary occupants).
  - Indicate the techniques employed to address the following:
    - Provide a variety of seating within defined spaces
    - Minimize noise to an acceptable noise level
    - Consider microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.).
    - Provide an aesthetic experience and access to vegetation.
- **Additional point** (For sites with regularly occupied building(s) only):
  - Provide unobstructed views of appropriate plant species for 90 percent of the windows of rooms designated as common spaces (e.g., stairwells, office spaces, conference rooms, classrooms, lunch or break rooms, waiting rooms, or living/family/dining rooms)

  OR
  - Provide views of appropriate plant species for 75 percent of all building windows. Appropriate plant species must meet or exceed the low point value of *Credit 4.6: Preserve or restore appropriate plant biomass on site*.

Economic and social benefits

Vegetation and other natural elements have the potential to provide for restorative experiences in a number of ways.[100] People are inspired by and gain pleasure from the aesthetic experiences provided by nature.[101] Work that demands focused attention (such as desk work or studying) for a lengthy period can result in mental fatigue, which can be expressed as irritability, physical tiredness, and inability to concentrate; brief interludes in natural settings are mentally restorative, helping us to get back on track with work.[102]

Stress induced by noise can contribute to anxiety and a sense of helplessness in children.[103] Exposure to high levels of traffic noise can produce disturbances of daily necessities such as sleeping and relaxation, and general well-being.[104]

Submittal documentation

- Provide the total number of site users (FTE occupants and temporary occupants).
- Illustrate the locations and character of the outdoors spaces (i.e., components) using site plans, drawings, models and/or photos. If applicable, illustrate areas with excessive noise levels.
- Complete the worksheet below to describe how the site design will provide outdoor areas dedicated for quiet use and will optimize the mental health benefits of site users. If a component is not applicable to a site, explain why.

- Provide a copy of the relevant sections of local/state noise pollution ordinances and laws that pertain to the site.
- Provide noise level measurements for potential outdoor areas. Measure using a sound level meter according to ASTM E1014–08 Standard Guide for Measurement of Outdoor A-Weighted Sound Levels to determine if the area meets the acceptable noise level. If local/state ordinances are stricter than the acceptable level stated in credit, the stricter level shall be applied. Acceptable test method is defined in ASTM E1503–06 Standard Test Method for Conducting Outdoor Sound Measurements Using a Digital Statistical Sound Analysis System. If the level of noise is greater than the acceptable level, locate the outdoor space in an alternate area of the site, if possible, or include techniques used to abate the noise in the worksheet below.
- For additional point only:
  - Provide the total number of windows in each building, the total number of windows of rooms identified as common spaces and the percentage of total windows that have a view of vegetation.
  - Provide a site plan that identifies all building windows (including windows for common spaces).
  - Provide calculations for the low point value for *Credit 4.6: Preserve or restore appropriate plant biomass on site*, that includes the Existing Site BDI (biomass density index) and Planned Site BDI

    AND

    Provide a site map/aerial photographs and site plans to demonstrate existing and planned site conditions (using estimates of cover within 10 years of installation). See *Credit 4.6* for calculation guidelines.

WORKSHEET: DESIGNING FOR VIEWS OF VEGETATION AND QUIET OUTDOOR SPACES			
Required Components			
Component		How does the site design incorporate this component?	Examples and additional description of component
Variety of Seating	Variety of seating options within defined spaces.	*Include the amount and type of seating to be provided.*	*Moveable seating is preferred, if possible. Comfortable seating should be provided in both the sun and shade.*
Reduced noise pollution	Assess and abate (if necessary) noise on site to minimize negative effects on human health and functioning. *This component requires extra documentation (see "submittal documentation").*		*Understand local noise pollution ordinances/laws that pertain to the site and assess noise-generating activities (e.g., maintenance activities, traffic, etc.) on site to make sure that they are in compliance.*
Microclimate and other site-specific considerations	Features that make the space(s) comfortable and encourage use under a broad range of conditions. Existing stressful factors, such as wind and sun, are minimized.		*Design site with protective wind breaks, awnings and other sources of shade, where necessary. Use vegetation, green walls or barriers to minimize or buffer excessive wind, sunlight, traffic or unsightly features.*
Aesthetic experience and access to vegetation	Visual and/or physical access to vegetation is provided. Amenities or vegetation that enhance a multi-sensory aesthetic experience.		*An exceptional view, grove of trees, water feature, scents from flowers or foliage, tactile variation, art.*

Potential technologies and strategies

During the site assessment process, identify areas that are quiet and could optimize the mental health benefits of site users. Look for shade trees, views, vistas or site landmarks as well as potential stressful factors on or off site. During site planning and design, meet with stakeholders and potential site users to identify needs and techniques appropriate to the site type and user groups. Work with designers to design the project so that building(s) can optimize views of the natural surrounding and deflect surrounding noise.

Design a variety of smaller spaces conveniently located throughout a site rather than one large space. If possible, consider integrating these outdoor spaces with interior public spaces to enhance the connection to nature throughout a site. Design the outdoor spaces away from distractions, such as noise from mechanical systems, building/facility operations and traffic. To minimize noise levels from on or off site, incorporate multiple solutions (e.g. quieter pavement or road surfacing, dense foliage, earth berms, barriers or screens, schedule maintenance activities when site users are not present). To create a sense of enclosure, define seating areas with low walls, fences, vegetation and/or topography. Walls, fences and vegetation can also be used to break, guide, deflect or filter the wind and thereby alter its effects.

Studies show that noise is reduced with broad-leaved trees more than conifers and is strongest when foliage extends close to the ground.[105] The best location for a noise barrier is either very close to the source or very close to the receiver while the worst position for attenuation is halfway between them.[106]

Links to other Sustainable Sites credits

- Components of the sites assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability)* will help identify potential areas for mental restoration such as landmarks, areas of unique visual character, views, and vistas.
- Achieving *Credit 2.3: Engage users and other stakeholders in site design* will identify the needs of the community and may contribute to this credit.
- Proper protection or restoration of vegetation may contribute to *Credit 4.5: Preserve all vegetation designated as special status, Credit 4.6: Preserve or restore appropriate plant biomass on site, Credit 4.7: Use native plants, Credit 4.8: Preserve plant communities native to the ecoregion, and Credit 4.9: Restore plant communities native to the ecoregion*.
- Placing vegetation in strategic locations around buildings may also help reduce energy consumption and costs associated with indoor climate control which may contribute to *Credit 4.10: Use vegetation to minimize building heating requirements* and *Credit 4.11: Use vegetation to minimize building cooling requirements*.

Resources

- V Bucur, *Urban Forestry Acoustics* (New York: Springer, 2006).
- Noise Pollution Clearinghouse *www.nonoise.org*.
- Noise pollution ordinances and laws can be found at local/state health departments and/or local/state government websites.

Definitions

- *Acceptable noise level* is a maximum of 55dBa. This is a recommended level of noise adopted from the U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, 550/9-74-004 (March 1974), and the World Health Organization (WHO), Guidelines for Community Noise (April 1999).

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Full-Time Equivalent (FTE) occupants* are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0, while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.
- *Regularly occupied building(s)* are buildings where occupants (workers, students, residents, etc.) are seated or standing inside for extended periods of time.
- *Temporary occupants* are occupants such as students, visitors and customers that are on a site intermittently. The calculation for temporary occupants is based on an average expected volume per day (excluding special events). Note that calculations for Temporary Occupants must be consistently used throughout documentation.

Credit 6.8	Provide outdoor spaces for social interaction
3 Points	

Intent

Provide outdoor gathering spaces of various sizes and orientations to accommodate groups, for the purpose of building community and improving social ties.

Requirements

Develop and implement a plan for encouraging social interaction on site.

- **Option 1:** For sites with regularly occupied building(s), provide outdoor spaces that support and encourage social interaction. Outdoor spaces must be accessible to all potential users and provide seating for a minimum of four people. Outdoor spaces must be within 200 feet of the building entrance(s) and provide seating for 5 percent of total site users ((Full-Time Equivalent (FTE) occupants and Temporary occupants). Indicate the techniques employed to address the following:
  - Provide a variety of seating for moderate to large groups
  - Consider microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.)
  - Provide visual and/or physical access to vegetation
  - Provide other amenities, services, or activity spaces (e.g., games, wireless technology, food concessions, picnic/dining areas, outdoor auditorium, playground, etc.)

OR

- **Option 2:** For sites without regularly occupied building(s), provide outdoor spaces that support and encourage social interaction. Outdoor spaces must be accessible to all potential users and must accommodate 5 percent of total site users (FTE occupants and temporary occupants). Indicate the techniques employed to address the following:
  - Provide a variety of seating for moderate to large groups
  - Consider microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.)
  - Provide visual and/or physical access to vegetation
  - Provide other amenities, services, or activity spaces (e.g., games, wireless technology, food concessions, picnic/dining areas, outdoor auditorium, playground, etc.)

Submittal documentation

- Provide the total number of site users (FTE occupants and temporary occupants).
- Complete the *Designing for Social Interaction Worksheet* to describe how the site design will provide outdoor areas for social interaction. If a component is not applicable to a site, explain why. Various design

Economic and social benefits

A great deal of evidence links social connectedness to health and well-being, including such diverse outcomes as hormonal responses to stress,[107] resistance to colds,[108] resistance to dementia,[109] survival in cancer patients,[110] and healthy aging.[111] Not only are social ties important for individual health, but they are important for the healthy functioning of communities as well. There is evidence indicating that landscape design can have significant effects on social interaction, social ties, and indicators of neighborhood health. In neighborhoods, social ties can turn initially unconnected residents into a source of social support and sense of community[112,113] and a social unit more capable of forming local organizations,[114] defending against crime,[115,116] and mobilizing for political purposes.[117]

Green surroundings in residential areas are associated with greater social cohesion in neighborhoods. Studies indicate that residents of buildings with more trees and grass report that they know their neighbors better, socialize with them more often, have stronger feelings of community, and feel safer and better adjusted than do residents of more barren, but otherwise identical, buildings.[118]

Social interactions have implications for personal security. Neighbors and community members who have stronger social ties are more likely to monitor local activity, intervene if problem behaviors occur,[119] and defend their neighborhoods against crime.[120]

choices may achieve multiple components (e.g., a variety of seating options may include the dining area/picnic tables).

- Illustrate the locations and character of the outdoors spaces (i.e., components) using site plans, drawings, models and/or photos.

WORKSHEET: DESIGNING FOR SOCIAL INTERACTION			
Required components			
Component		How does the site design incorporate this component?	Examples and additional description of component
Variety of seating	Variety of seating options within defined spaces that accommodate groups of various sizes (for a minimum of four people).	*Include the amount and type of seating to be provided.*	*Moveable seating is preferred, if possible. Enclose and define seating areas with low walls and/or vegetation. Comfortable seating should be provided in both the sun and shade.*
Microclimate and other site-specific considerations	Features that make the space(s) comfortable and encourage use under a broad range of conditions. Existing stressful factors, such as wind and sun, are minimized.		*Design site with protective windbreaks, awnings and other sources of shade, where necessary. Use vegetation, green walls or barriers to minimize or buffer excessive wind, sunlight, traffic, or unsightly features.*
Aesthetic experience and access to vegetation	Visual and/or physical access to vegetation is provided. Amenities or vegetation that enhance a multi-sensory aesthetic experience.		*An exceptional view, grove of trees, water feature, scents from flowers or foliage, tactile variation, art.*
WORKSHEET: OPTIONAL COMPONENTS (Must do two of the four components below)			
Component		How does the site design incorporate this component?	Examples and additional description of component
Games and technology	Social interaction is enabled through work or play.		*Game tables, wireless Internet connection.*
Food and beverage services	Food concessions and dining/picnic areas or places for vendors encourage dining on site.		*Space for farmers market. Preference is to offer local and/or organic food.*
Activity spaces and/or services	Community building is enhanced through additional activity spaces and/or services.		*Auditorium, dog park, or picnic areas.*
Access for children	Materials and play structures are provided at an appropriate height and age for children to access and enjoy.		*Seating, games, and spaces specifically designed for children, such as a "tot lot" playground.*

Potential technologies and strategies

During the site assessment process, identify areas that could accommodate moderate and large groups. Look for shade trees, views, or vistas for areas that may encourage social interaction. During site planning and design, meet with stakeholders and potential site users to identify needs and techniques appropriate to the site type and user groups. Design a variety of smaller spaces conveniently located throughout a site rather than one large space.

Links to other Sustainable Sites credits

- *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability* will help identify potential areas of social interaction such as landmarks, areas of unique visual character, and viewpoints.
- Achieving *Credit 2.3: Engage users and other stakeholders in site design* may contribute to this credit by identifying the needs of the community.
- Making outdoor areas accessible for all users will contribute to *Credit 6.5: Provide for optimum site accessibility, safety, and wayfinding*.

Resources

- For information on seating that meets the needs of site users, see S Carr, M Francis, LG Rivlin, and AM Stone, *Public Space* (New York: Cambridge University Press, 1992).
- For information on designing spaces for social interaction, refer to the following:
  - CC Marcus and C Francis, *People Places: Design Guidelines for Urban Space* (New York: John Wiley & Sons, 1997).
  - WH Whyte, *The Social Life of Small Urban Spaces* (Washington, DC: Conservation Foundation, 1980).

Definition

- *Full-Time Equivalent (FTE) occupants* are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0, while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.
- *Regularly occupied building(s)* are buildings where occupants (workers, students, residents, etc.) are seated or standing inside for extended periods of time.
- *Temporary occupants* are occupants such as students, visitors and customers that are on a site intermittently. The calculation for temporary occupants is based on an average expected volume per day (excluding special events). Note that calculations for Temporary Occupants must be consistently used throughout documentation.

Credit 6.9	Reduce light pollution
2 Points	

Intent

Reduce light pollution by minimizing light trespass on site for the purpose of reducing sky-glow, increasing nighttime visibility and minimizing negative effects on nocturnal environments and human health and functioning.

Requirements[121]

The following pertain to exterior lighting only:

- Only light areas as required for safety and comfort. Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.
- All non-emergency lighting will use motion sensors to turn off or be automatically controlled to turn off after hours. Provide manual override capability for after-hours use with timed automatic shut-off.
- All sites will be classified under one of the following lighting zones (LZ), as defined in IESNA RP-33, and will follow all of the requirements for that specific zone:
  - **LZ1—Dark (park and rural settings):**
    Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.01 horizontal and vertical foot-candles at the site boundary and beyond. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down).
  - **LZ2—Low (residential areas):**
    Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.10 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 10 feet beyond the site boundary. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.
  - **LZ3—Medium (commercial/industrial, high-density residential):**
    Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site boundary. Document that 0 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.
  - **LZ4—High (major city centers, entertainment districts):**
    Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.60 horizontal and vertical foot-candles at the site boundary and no greater than 0.01 horizontal foot-candles 15 feet beyond the site boundary. Document that 1 percent of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site

Economic and social benefits

Light pollution can disrupt circadian rhythms and melatonin production, which has been linked to serious health concerns.[122] Reasonable use of outdoor lighting restores dark night skies and preserves the ambiance of the night. In addition, whether outdoor light is directly adjacent to a species habitat or located at some distance, as through sky glow, the combined effects of artificial lighting on vast numbers of nocturnal species have the potential to disrupt the functioning of entire ecosystems by disturbing balances in competition and predation.[123] Excessive night lighting of buildings kills thousands of migrating birds annually.[124]

boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

Submittal documentation

- Confirm the site zone classification (LZ).
- Provide copies of the exterior site plan that shows electrical lighting design.
- Provide copies of the construction documents with a lighting fixture schedule that documents the locations, time of use, and type of fixtures installed.
- Complete the Site Lumen Calculation (see Table 6.9-A for sample calculation). The following data will be required to complete the calculation: luminaire type, quantity installed, initial fixture lumens per luminaire, initial fixture lumens above 90 degrees from nadir.

TABLE 6.9-A: SAMPLE LUMEN CALCULATION

1	2	3	4	5	6
Luminaire type	Quantity of installed luminaire	Initial fixture lumens per luminaire	Total fixture lumens (column 2 x column 3)	Initial fixture lumens from luminaire above 90 Degrees	Total fixture lumens above 90 degrees (column 2 x column 5)
A	10	4,600	46,000	100	1,000
B	20	11,900	238,000	0	0
C	5	2,000	10,000	2,000	10,000
TOTAL			**294,000**		

Source: LEED-NC v2.2 SS Credit 8: Light Pollution Reduction

Potential technologies and strategies

Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Control the direction and spread of light by choosing the correct type of light fixtures**.** Consider specifying IES (Illuminating Engineering Society) "full cut off" or "fully shielded" designated fixtures, so that no light is visible above the lowest light emitting part of the fixture. Top-mounted sign lighting is recommended, with RLM (dish) type shields, provided that the light falls entirely on the sign and is positioned so that the light source (bulb) is not visible from any point off the property or into the roadway. Consider hiring a professional lighting designer to strategically place lighting for large projects over 15,000 lumens and/or for accent and wayfinding light placement.

Links to other Sustainable Sites credits

Using energy-efficient light bulbs will contribute to *Credit 8.4: Reduce outdoor energy consumption for all landscape and exterior operations*.

Resources

- "Simple Guidelines for Lighting Regulations for Small Communities, Urban Neighborhoods, and Subdivisions," International Dark Sky Association, *http://www.darksky.org/mc/page.do?sitePageId=58881* and "Recommendations for Effective Outdoor Lighting," *http://data.nextrionet.com/site/idsa/is012.pdf*
- "Guidelines for Good Exterior Lighting Plan," The Dark Sky Society (2009), *http://www.darkskysociety.org/handouts/LightingPlanGuidelines.pdf*

Definition

Light pollution is any adverse effect of artificial light, including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste (International Dark-Sky Association, 2008).

Prerequisite 7.1 REQUIRED — Control and retain construction pollutants

Economic and social benefits

Retaining pollutants and sediment on site improves water quality and provides associated benefits such as protection of aquatic habitat and opportunities for recreation such as fishing and swimming.

Intent

Prevent and minimize discharge of construction site pollutants and materials to protect receiving waters (including surface water, groundwater, and combined sewers or stormwater systems), air quality, and public safety.

Requirements[125]

Create and implement an erosion, sedimentation, and pollutant control plan—commonly referred to as SWPPP (Stormwater Pollution Prevention Plan) or ESC (Erosion and Sedimentation Control Plan)—for all construction activities associated with the project. The plan (SWPPP or ESC) shall conform to erosion and sedimentation requirements of the 2003 (or most current version) EPA Construction General Permit (regardless of project size) OR local erosion and sedimentation control standards and codes, whichever is more stringent. The plan shall list the best management practices (BMPs) employed and describe how the BMPs accomplish the following objectives:

- Prevent loss of soil during construction by stormwater runoff or wind erosion, including protecting topsoil by stockpiling for reuse
- Prevent sedimentation of storm conveyances or receiving waters or other public infrastructure
- Prevent polluting the air with dust and particulate matter
- Prevent runoff and infiltration of other pollutants from construction site (e.g., thermal pollution, concrete wash, fuels, solvents, hazardous chemical runoff, pH and pavement sealants) and ensure proper disposal
- Protect any vegetation and soil protection zones (such as threatened and endangered species habitat protected under *Prerequisite 1.4: Preserve threatened or endangered species and their habitats* or 100-year floodplain protected under *Prerequisite 1.2: Protect floodplain functions* and other areas of vegetation that will remain on site from construction activities.

The construction phase of the project is considered complete when the site is stabilized or a notice of termination is filed.

The Construction General Permit (CGP) outlines the provisions necessary to comply with Phase I and Phase II of the National Pollutant Discharge Elimination System (NPDES) program. Although the CGP applies only to sites greater than 1 acre, its requirements are applied to all projects for the purposes of this credit.

Submittal documentation

Provide copies of SWPPP or ESC or other local required plan (whichever is more stringent), the project drawings, and a brief narrative to describe and document the erosion and sedimentation control measures implemented on site. Provide confirmation regarding the compliance path taken by the project (i.e., NPDES Compliance or Local Erosion Control Standards). If a local standard has been followed, provide documentation to demonstrate that the local standard is equal to or more stringent than the referenced NPDES program.

Potential technologies and strategies

Employ strategies such as a combination of temporary and permanent seeding, mulching, earth dikes, sediment traps, sediment basins, filter socks, compost berms and blankets, secondary containment, spill control equipment, hazardous waste manifests, and overfill alarms. Implement post-construction stormwater management with

construction sequencing (i.e., infiltration systems constructed or rehabilitated at the end of the project). Account for weather conditions during construction activities (i.e., only apply pavement sealers when no rain is forecast or do not begin mass grading before a large storm).

Links to other Sustainable Sites credits

- *Prerequisite 4.3: Create a soil management plan* will help communicate to contractors the treatment plans and protective measures for all soils on site.
- Preserving existing soils and areas of vegetation on site may also help achieve *Credit 4.5: Preserve all vegetation designated as special status*, *Credit 4.6: Preserve or restore appropriate plant biomass on site*, *Credit 4.8: Preserve plant communities native to the ecoregion, and/or Credit 4.9: Restore plant communities native to the ecoregion*.
- Minimizing the footprint of disturbance may help meet the requirements of *Prerequisite 7.2: Restore soils disturbed during construction* and *Credit 4.4: Minimize soil disturbance in design and construction*.
- Recycling vegetation, soils, or rocks generated during the construction process may help achieve *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.
- Restoring previously disturbed soils will help achieve *Credit 7.3: Restore soils disturbed by previous development*.

Resources

- For more information on 2003 U.S. EPA General Construction Permit, *http://cfpub.epa.gov/npdes/stormwater/cgp.cfm*
- The U.S. EPA's resources on the National Pollutant Discharge Elimination System (NPDES), *http://cfpub.epa.gov/NPDES/*, and menu of stormwater best management practices, *http://cfpub.epa.gov/NPDES/stormwater/menuofbmps/index.cfm*, may also be helpful.
- Resources from the U.S. Green Building Council, including rating systems and reference guides, *www.usgbc.org*.

Definition

- *100-year floodplain* includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99, V, and VE; however, in some areas they may need to be calculated by the site development team.
- *Receiving waters* include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.

Prerequisite 7.2 REQUIRED — Restore soils disturbed during construction

Intent

Restore soils disturbed during construction in all areas that will be re-vegetated (all areas that will not be built upon) to rebuild soils' ability to support healthy plants, biological communities, water storage and infiltration.

Economic and social benefits

Addressing aspects of soil health such as compaction, organic matter, soil biological functioning, and soil volume can restore the ability of soils to provide healthy rooting environments for plants and store and infiltrate water. Soil restoration can save costs in the long run because healthy soils support healthy plant growth with less need for pesticides, fertilizers, and irrigation.[126,127]

Requirements

The requirements apply to all soil areas that are disturbed or compacted during construction (as identified in the soil management plan, or SMP, described in *Prerequisite 4.3: Create a soil management plan*) that will be part of the site's vegetated area.

The requirements do not apply to soil areas preserved in ***vegetation and soil protection zones*** (as identified in the SMP, *Prerequisite 4.3*), which are not required to be restored since they are not disturbed. Credit may be taken for restoring soil in previously disturbed areas (see Links to other Sustainable Sites credits section below), even if those areas fall within the current construction disturbance zone covered by this prerequisite.

Restore 100 percent of soils disturbed during construction in the site's vegetated area to meet the ***soil restoration criteria*** outlined below.

Imported topsoils or soil blends designed to serve as topsoil may not be mined from:

- soils defined by the Natural Resources Conservation Service as prime farmland, unique farmland, or farmland of statewide importance
- other greenfield sites, unless those soils are a byproduct of a construction process.

Soils must be reused for functions comparable to their original function (i.e., topsoil is used as topsoil, subsoil as subsoil, or subsoil is amended to become functional topsoil).

- ***Vegetation and soil protection zones (VSPZ)*** must meet the following requirements:
  - Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
  - VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
  - All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
  - VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.

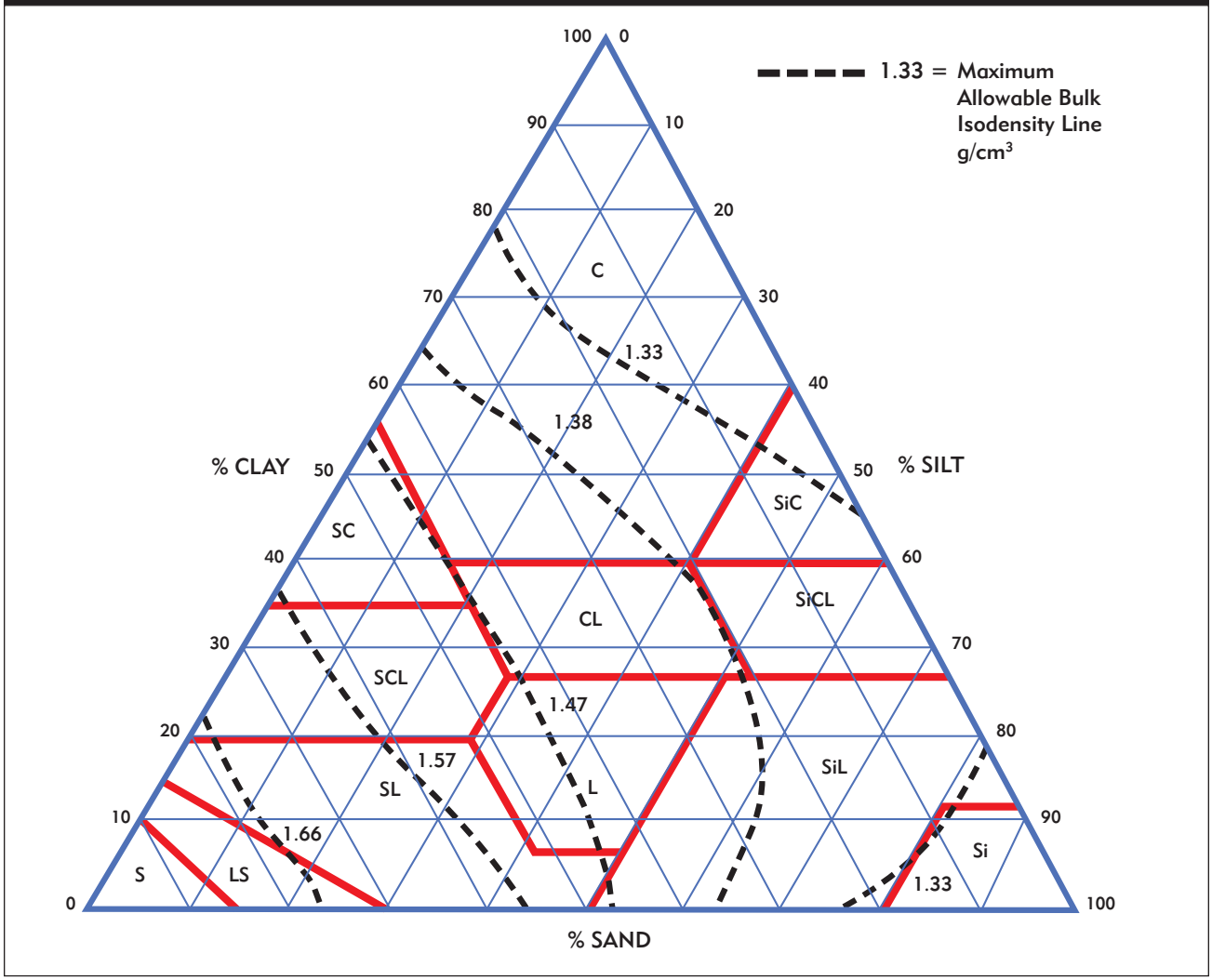
  - No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
  - Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.
- ***Soil restoration criteria*** are described fully in the section below. Restored soil must meet criteria in four of the five categories below, with organic matter as a required category:
  1. Organic matter (required for all sites)
  2. Compaction
  3. Infiltration rates
  4. Soil biological function
  5. Soil chemical characteristics.

1. **Organic matter:** Achieve appropriate organic matter for plant growth and for water storage and infiltration. Amend soils with a mature, stable compost material such that the top 12 inches of soil (at a minimum) contain at least 3 percent organic matter OR organic matter levels and organic matter depth are comparable to the site's reference soil. Do not use sphagnum peat or organic amendments that contain sphagnum peat.

   Acceptable test methods for determining soil organic matter include the most current version of ASTM D2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils and TMECC 05.07A Loss-On-Ignition Organic Matter Method.

2. **Compaction:** Ensure bulk densities within 100 percent of the root zone (minimum of 12 inches in depth OR depth comparable to the site's reference soil) do not exceed the maximum values given in Figure 7.2-A on the following page. Alternative compliance may use cone penetrometer readings with penetrometer readings not to exceed those given in Table 7.2-A.

FIGURE 7.2-A: MAXIMUM ALLOWABLE BULK DENSITIES[128]



Note: *Acceptable test methods include the most current versions of ASTM D 4564 Standard Test Method for Density and Unit Weight of Soil in Place by the Sleeve Method, ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method, or ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).*

Figure 7.2-A: Maximum Allowable Bulk Densities for sustainable soil management are based on 95 percent of the bulk density value at which growth limitations are expected for an average range of plant material, as described by Daddow and Warrington (1983). While these requirements are expressed as maximum allowable bulk densities, it is important to note that densities that are too low can also cause problems, especially for lawn areas or slopes. To calculate the maximum allowable bulk density for a soil:

- Obtain a laboratory analysis of the sand, silt, and clay percentages
- Sketch a parallel line for each percentage along the appropriate axis, and
- At the point of intersection, interpolate a value between the isodensity lines.

For example, in the figure above, CL reflects a soil comprised of 33 percent sand, 33 percent silt, and 33 percent clay. Interpolating a value between the 1.47 and 1.38 isodensity lines yields an approximate maximum allowable bulk density of 1.43 g/cm^3.

TABLE 7.2-A: ACCEPTABLE CONE PENETROMETER READINGS[129]			
Surface Resistance (PSI)		**Subsurface Resistance (PSI)**	
All Textures Sand	Sand *(includes loamy sand, sandy loam, sandy clay loam, and sandy clay)*	Silt *(includes loam, silt loam, silty clay loam, and silty clay)*	Clay *(includes clay loam)*
≤ 110	≤ 260	≤ 260	≤ 225

Note: *Acceptable test methods include ASTM D3441 Standard Test Method for Mechanical Cone Penetration or methods described in references such as* Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods, *2nd ed., EA Klute ed. (Soil Science Society of America: Madison, WI., 1986). Penetration reading must be taken when soil is at field capacity (several days after free drainage). Along with penetration readings, document the moisture level of soil and spacing interval for conducting the test. Apply slow, even pressure so the penetrometer advances in the soil at a rate of 4 seconds per 6 inches or less. Record the highest pressure at: 1) the surface of the restored soil, and 2) a depth of 12 inches OR at 90 percent of the total depth of the reference soil's A horizon.*

3. **Infiltration rates:** Achieve infiltration rates (inches/hour) or saturated hydraulic conductivity (millimeters/second) comparable to the site's reference soils.

   Acceptable test methods for determining infiltration rates include the most current versions of ASTM D3385 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer and ASTM D5093 Standard Test Method for Field Measurement of Infiltration Rate Using Double-Ring Infiltrometer with Sealed-Inner Ring. For sloped areas where the above methods cannot be used successfully, similar methods that are well-established in the scientific and technical literature (e.g., Amoozemeter) may be used as long as the same method is used to test both reference soil and on-site soil.

4. **Soil biological function:** Ensure that soil biological function is restored in remediated soils. Because soil biota assays are complex and vary regionally, potentially mineralizable nitrogen serves as a proxy assessment of biological activity. Note that counts of soil organisms are strongly influenced by soil status at the time of sampling (moisture, temperature, presence of roots, etc.). Here, potentially mineralizable nitrogen is used as a proxy to establish the capacity of the biotic community to decompose organic matter and release mineral (plant available) nitrogen. Table 7.2-B below provides potentially mineralizable nitrogen levels appropriate for sand, silt, and clay textured soils.

TABLE 7.2-B: ACCEPTABLE POTENTIALLY MINERALIZABLE NITROGEN		
Potentially mineralizable nitrogen (ugN/g dw soil/week)		
Sand *(includes loamy sand, sandy loam, sandy clay loam, and sandy clay)*	Silt *(includes loam, silt loam, silty clay loam, and silty clay)*	Clay *(includes clay loam)*
≥ 8.0	≥ 8.5	11.5

Note: *Acceptable test methods for determining potentially mineralizable nitrogen can be found in LG Bundy and JJ Meisinger,. "Nitrogen Availability Indices," in RW Weaver, S Angle, P Bottomley, et al. eds.,* Methods of Soil Analysis, Part 2, Microbial and Biochemical Properties *(Soil Science Society of America Book Series, No. 5: Madison, WI., 1994): pp. 951–984.*

5. **Soil chemical characteristics:** Restore appropriate soil chemical characteristics for plant growth. Match the pH, cation exchange capacity, and nutrient profiles of the original undisturbed soil or the site's reference soil. Salinity must be suitable for regionally appropriate vegetation. Choose soil amendments (and fertilizers if needed) that minimize nutrient loading to waterways or groundwater.

Submittal documentation

Provide site plans indicating the full extent of site vegetated area. On the site plan, indicate which areas of the vegetated area contain soils that are disturbed during construction, restored, and re-vegetated (as included in the soil management plan, *Prerequisite 4.3*).

Provide characteristics of the site's reference soils, including soil texture, bulk density, organic matter levels, infiltration rates, soil biological function, and soil chemical characteristics.

Provide documentation (such as receipts from soil/compost/amendments supplier) to demonstrate that techniques to restore soil occurred. Provide soil tests to demonstrate that the selected techniques achieved criteria for four of the five categories in restored soils: organic matter (required), compaction, infiltration, soil biological function, and soil chemical characteristics. At least two sets of tests are required for all sites, with at least one set of tests per 4000 square feet of soil disturbed during construction.

Potential technologies and strategies

Limit disturbance during construction to minimize the need for additional restoration. In areas that will be re-vegetated, restore soil characteristics necessary to support the selected vegetation types. Example methods to restore soils include the following:

- Stockpiling and reusing existing site topsoils, with organic amendment if needed.
- Amending site soils in place with organic matter and mechanically correcting compaction if needed (e.g., by ripping).
- Importing a topsoil or soil blend designed to serve as topsoil.

Select organic materials for on-site amendment or for blending of imported soils from sources that are renewable within a 50-year cycle. Compost is recommended as the best source of organic matter, for its stability, biological activity, and soil structure building qualities. If mature, stable compost is not locally available, look for locally available organic residuals that can be composted on or off site to produce a mature composted organic amendment. Involve a qualified horticultural or soil professional in selecting and balancing amendments for healthy plant growth.

Quality guidelines for compost include:

- A carbon to nitrogen ratio below 25:1. Higher C:N ratios may be acceptable if specified by a qualified professional to be more appropriate for the type of vegetation to be established.
- Does not exceed pollutant concentration limits established by the U.S. EPA in the 40 CFR Part 503 Biosolids Rule, section 503.13 table 3 "Pollutant Concentrations," or any applicable state or local regulations.
- Does not contain viable weed seeds or invasive plant propagules.
- Results in final soil conditions conducive to the type of vegetation to be established.

More information on methods and practices for soil amendment, including how to calculate the volume of compost to incorporate to meet a target soil organic matter content, is available in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth* (see Resources below).

Before placing stockpiled or imported topsoils, consider scarifying any areas of construction-compacted subsoil, except where this would damage existing tree roots. Ideally, the first lift of replaced soil is mixed into this scarification zone to improve the transition between the subsoil and overlying soil horizons.

Engineered growing media* (for instance soils for green roofs or street trees, or special soils specified for wetlands and environmental restoration sites) should meet the intent of this prerequisite, follow the requirements to the greatest extent practical, and follow current best available science and practice standards for that engineered growing media and use.

**Note:* *There is no current standard for engineered growing media, but if growing media are used on-site, these rough guidelines are recommended.*

Links to other Sustainable Sites credits

- Restoration of soils disturbed by previous development is eligible for credit under *Credit 7.3: Restore soils disturbed by previous development*.
- Minimizing the disturbance of soils during construction may also help achieve *Credit 4.4*: *Minimize soil disturbance in design and construction*.
- Stockpiling and reusing on-site soils may also help achieve *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.
- Imported topsoil or soil blends designed to serve as topsoil that comes from nearby projects may also help achieve *Credit 5.7: Use regional materials*.
- Restoring soils in areas that will be re-vegetated will also help support vegetation (see *Credit 4.6: Preserve or restore appropriate plant biomass on site*) and improve storage and infiltration of water (see *Credit 3.5: Manage stormwater on site*).
- Selection of plants that are suited to site soil conditions is addressed in *Prerequisite 4.2: Use appropriate, non-invasive plants*.

Resources

- For more information on improving soil quality, see USDA Natural Resources Conservation Service resources, *http://soils.usda.gov/sqi/*, and Cornell Soil Health Resources, *http://www.hort.cornell.edu/soilhealth/research/index.htm*.
- For additional information on planning and managing soils in urban areas, see USDA Natural Resources Conservation Service resources, *http://soils.usda.gov/use/urban/*, including the Urban Soil Primer, *http://soils.usda.gov/use/urban/primer.html*. Also refer to the resources available at Building Soil, *http://www.buildingsoil.org/*.
- For additional information on soil preservation and amendment, "Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMPT5.13" in *WDOE Stormwater Management Manual for Western Washington* is available with specifications and an amendment calculator, *www.soilsforsalmon.org* or *www.buildingsoil.org*.
- For additional information on soil stockpiling, see AASHTO Center for Environmental Excellence, *Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance*, Chap. 4 "Construction Practices," 4.11.4 Topsoil Preservation, *http://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/4_11.aspx*.
- For additional information on compost quality standards and test methods: US Composting Council, Seal of Testing Assurance Program, *http://www.compostingcouncil.org/programs/sta/*.
- For additional information on contaminant limits applicable to organic amendments, see *A Plain English Guide to the EPA Part 503 Biosolids Rule*, Chap. 2, p. 29, Table 2-1, column 2, "Pollutant Concentration Limits for EQ and PC Biosolids," *http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm*. Also see applicable state and local regulations on compost and biosolids.

- For additional information on erosion control with compost (which can then be reused to amend site soils): USEPA NPDES Construction Site Erosion Control, menu of BMPs, has the standard national specifications for compost blankets, berms, and socks, *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4*. Also see a short descriptive factsheet "Erosion Control with Compost" *www.buildingsoil.org*.
- For additional information on soil biology and soil quality: Natural Resource Conservation Service's *Soil Biology Primer* and other resources *http://soils.usda.gov/sqi/concepts/soil_biology/biology.html* and *http://soils.usda.gov/sqi/index.html*. Also see the Cornell Soil Health Assessment Training Manual.
- For additional information on soil surveys for native or reference soil data, the USDA Natural Resources Conservation Service's "Web Soil Survey" online database covers most areas of the United States well, *http://websoilsurvey.nrcs.usda.gov/app/*.
- For additional information on test methods for infiltration rates on sloped areas, see A Amoozegar and AW Warrick, "Hydraulic Conductivity of Saturated Soils: Field Methods," Chap. 29 in *Methods of Soil Analysis, Part I, 2nd ed.* (Madison, WI: ASA,1986): pp. 735–770.
- For more information on ASTM standards, *www.astm.org*.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Farmland of statewide importance* refers to soils designated by each state Natural Resource Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland which does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods.[130]
- *Mature, stable compost* is compost that tests at 6.0 or higher on the Solvita Compost Maturity Index Rating, which is a combination of Carbon Dioxide and Ammonia Maturity Tests (test information and equipment available at *www.solvita.com)*.
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Prime farmland* refers to soils designated by the Natural Resources Conservation Service as "prime farmland." This does *not* include soils that would be prime farmland if drained, irrigated, protected from flooding, etc. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water). It has the soil quality,

growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.[131]

- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resource Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Unique farmland* refers to soils designated by the Natural Resource Conservation Service as "unique farmland." Unique farmland is land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.[132]
- *Vegetated area* describes all portions of the site that will support vegetation.

Credit 7.3	Restore soils disturbed by previous development
2–8 Points	

Intent
Restore soil function in areas of previously disturbed topsoils and subsoils to rebuild the site's ability to support healthy plants, biological communities, water storage, and infiltration.

Economic and social benefits

Addressing aspects of soil health such as compaction, organic matter, and soil biology can restore the ability of soils to provide healthy rooting environments for plants and store and infiltrate water. Soil restoration can save costs in the long run because healthy soils support healthy plant growth with less need for pesticides, fertilizers, and irrigation.[133, 134]

Requirements
The requirements apply to soils disturbed by previous development as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) in all areas that will be re-vegetated.

Restore at least 90 percent of the total surface area of soil disturbed by previous development that will be re-vegetated to meet the ***soil restoration criteria*** as fully described in *Prerequisite 7.2: Restore soils disturbed during construction*. Point values are based on the surface area of soil disturbed by previous development that will be re-vegetated AND the degree of disturbance of those soils (minimal, moderate, or severe soil disturbance). See point value look-up table in Table 7.3-A below. Sites with less than 2,000 square feet of soils disturbed by previous development that will be re-vegetated are not eligible for this credit.

Imported topsoils or soil blends designed to serve as topsoil may not be mined from:
- soils defined by the Natural Resources Conservation Service as prime farmland, unique farmland, or farmland of statewide importance
- other greenfield sites, unless those soils are a byproduct of a construction process.

Soils must be reused for functions comparable to their original function (i.e., topsoil is used as topsoil, subsoil as subsoil, or subsoil is amended to become functional topsoil).

Table 7.3-A: Point value look-up table for restoration of soils disturbed by previous development that will be re-vegetated. Use this table to look up the applicable points based on the area of restored soil AND the degree of disturbance.

TABLE 7.3-A: POINT VALUE LOOK-UP TABLE

		Area of soil disturbed by previous development that will be restored and re-vegetated		
		2,000 sq ft–0.5 acre	0.5 acre–5 acres	> 5 acres
Degree of disturbance	Minimal	2 points	3 points	5 points
	Moderate	3 points	5 points	6 points
	Severe	5 points	6 points	8 points

***Note**: For sites with multiple degrees of disturbance, multiply the percent area of each disturbance type by the associated points and add the results. For example, consider a site with a total of 1 acre of soils disturbed by previous development. If 0.75 acre (75 percent of total surface area) is severely disturbed and the remaining 0.25 acre (25 percent of total surface area) is moderately disturbed, the points would be calculated as follows: (75 percent x 8 points) + (25 percent x 6 points) = 7.5 points.*

Submittal documentation

Provide information on the site's baseline conditions, including information from the soil management plan (see *Prerequisite 4.3: Create a soil management plan)* to show the total surface area of soils disturbed by previous development that will be re-vegetated (i.e., areas without buildings and paved areas) AND information from the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*) to show the degree of disturbance of these soils.

Provide characteristics of the site's reference soils, including soil texture, bulk density, organic matter levels, infiltration rates, soil biological function, and soil chemical characteristics.

Provide documentation (such as receipts from soil/compost/amendment supplier) to demonstrate that techniques to restore soil occurred. Provide soil tests to demonstrate that the selected techniques achieved criteria for 4 of the 5 categories in restored soils: organic matter (required), compaction, infiltration, soil biological function, and soil chemical characteristics (as fully described in *Prerequisite 7.2: Restore soils disturbed by previous development*). At least two sets of tests are required for all sites, with at least one set of tests per 4,000 square feet for larger sites. At least one set of tests is required for each level of soil disturbance (minimal, moderate, and severe) as identified in the site assessment (see *Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability*).

Potential technologies and strategies

Limit disturbance during construction to minimize the need for additional restoration. In areas that will be re-vegetated, restore soil characteristics necessary to support the selected vegetation types. Example methods to restore soils include the following:

- Stockpiling and reusing existing site topsoils, with organic amendment if needed.
- Amending site soils in place with organic matter and mechanically correcting compaction if needed (e.g., by ripping).
- Importing a topsoil or soil blend designed to serve as topsoil.

Select organic materials for on-site amendment or for blending of imported soils from sources that are renewable within a 50-year cycle. Compost is recommended as the best source of organic matter, for its stability, biological, and soil structure building qualities. If mature, stable compost is not locally available, look for locally available organic residuals that can be composted on or off site to produce a mature composted organic amendment. Involve a qualified horticultural or soil professional in selecting and balancing amendments for healthy plant growth.

Quality guidelines for compost include:

- A carbon to nitrogen ratio below 25:1. Higher C:N ratios may be acceptable if specified by a qualified professional to be more appropriate for the type of vegetation to be established.
- Does not exceed pollutant concentration limits established by the U.S. EPA in the 40 CFR Part 503 Biosolids Rule, section 503.13 table 3 "Pollutant Concentrations," or any applicable state or local regulations.
- Does not contain viable weed seeds or invasive plant propagules.
- Results in final soil conditions conducive to the type of vegetation to be established.

More information on methods and practices for soil amendment, including how to calculate the volume of compost to incorporate to meet a target soil organic matter content, is available in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth* (see Resources below).

Before placing stockpiled or imported topsoils, consider scarifying any areas of construction-compacted subsoil, except where this would damage existing tree roots. Ideally, the first lift of replaced soil is mixed into this scarification zone to improve the transition between the subsoil and overlying soil horizons.

Engineered growing media* (for instance soils for green roofs or street trees) should meet the intent of this credit, follow the requirements to the greatest extent practical, and follow current best available science and practice standards for that engineered growing media and use.

**Note: There is no current standard for engineered growing media, but if a growing medium is used on-site, these rough guidelines are recommended.*

Links to other Sustainable Sites credits

- Soils disturbed by previous development are eligible for this credit, even if those areas fall within the current construction disturbance zone covered by *Prerequisite 7.2: Restore soils disturbed during construction*. Soil restoration criteria are described fully in that prerequisite. Limiting disturbance to areas of previously disturbed soils may also help achieve *Credit 4.4*: *Minimize soil disturbance in design and construction*. Stockpiling and reusing on-site soils may also help achieve *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.
- Imported topsoil or soil blends designed to serve as topsoil that comes from nearby projects may also help achieve *Credit 5.7: Use regional materials*. Restoring soils in areas that will be re-vegetated will also help support vegetation (see *Credit 4.6: Preserve or restore appropriate plant biomass on site*) and improve storage and infiltration of water (see *Credit 3.5: Manage stormwater on site*).
- Selection of plants that are suited to site soil conditions is addressed in *Prerequisite 4.2: Use appropriate, non-invasive plants*.

Resources

- For more information on improving soil quality, see USDA Natural Resources Conservation Service resources, *http://soils.usda.gov/sqi/*, and Cornell Soil Health resources, *http://www.hort.cornell.edu/soilhealth/research/index.htm*.
- For additional information on planning and managing soils in urban areas, see USDA Natural Resources Conservation Service resources, *http://soils.usda.gov/use/urban/*, including the Urban Soil Primer *http://soils.usda.gov/use/urban/primer.html*. Also refer to the resources available at Building Soil, *http://www.buildingsoil.org/*.
- For additional information on soil preservation and amendment, "Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMPT5.13" in *WDOE Stormwater Management Manual for Western Washington* is available with specifications and an amendment calculator, *www.soilsforsalmon.org* or *www.buildingsoil.org*.
- For additional information on soil stockpiling, see AASHTO Center for Environmental Excellence, *Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance*, Chap. 4 "Construction Practices," 4.11.4 Topsoil Preservation, *http://environment.transportation.org/environmental_issues/construct_maint_prac/compendium/manual/4_11.aspx*.
- For additional information on compost quality standards and test methods, see U.S. Composting Council, Seal of Testing Assurance Program, *http://www.compostingcouncil.org/programs/sta/*.
- For additional information on contaminant limits applicable to organic amendments, see *A Plain English Guide to the EPA Part 503 Biosolids Rule*, Chapter 2, page 29, Table 2-1, column 2, "Pollutant Concentration Limits for EQ and PC Biosolids" *http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm*. Also see applicable state and local regulations on compost and biosolids.
- For additional information on erosion control with compost (which can then be reused toamend sites soils), USEPA NPDES Construction Site Erosion Control, menu of BMPs, has the standard national specifications for compost blankets, berms, and socks, *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4* Also see a short descriptive factsheet "Erosion Control with Compost," *www.buildingsoil.org*.

- For additional information on soil biology and soil quality, Natural Resource Conservation Service's *Soil Biology Primer* and other resources, *http://soils.usda.gov/sqi/concepts/soil_biology/biology.html* and *http://soils.usda.gov/sqi/index.html*. Also see the Cornell Soil Health Assessment Training Manual.
- For additional information on soil surveys for native or reference soil data, the USDA Natural Resources Conservation Service "Web Soil Survey" online database covers most areas of the United States well, *http://websoilsurvey.nrcs.usda.gov/app/*.
- For more information on ASTM standards, *www.astm.org*.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.
- *Farmland of statewide importance* refers to soils designated by each state Natural Resources Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland which does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods.[135]
- *Mature, stable compost* is compost that tests at 6.0 or higher on the Solvita Compost Maturity Index Rating, which is a combination of Carbon Dioxide and Ammonia Maturity Tests (test information and equipment available at *www.solvita.com)*.
- *Minimal soil disturbance* describes soils that are minimally graded and/or compacted, such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A , but not covered with impervious surfaces. Examples of soils that are minimally disturbed include areas with minor modifications or very limited development but not covered with buildings or paved surfaces, such as areas that have been compacted by livestock or heavy foot traffic.
- *Moderate soil disturbance* describes soils in which topsoil is compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in 7.2-A or is partly removed and/or not present, and in which subsoils are compacted or mixed with topsoil. Examples of soils that are moderately disturbed include previously developed or graded areas that are not covered with buildings or paved surfaces, such as unpaved ranch roads.
- *Native plants* are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.
- *Organic matter* in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.
- *Prime farmland* refers to soils designated by the Natural Resources Conservation Service as "prime farmland." This does *not* include soils that would be prime farmland if drained, irrigated, protected from flooding, etc. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.[136]

- *Reference soils* are defined as:
  - soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).
    OR
  - undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.
    OR
  - for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.
- *Severe soil disturbance* describes soils in which topsoil is removed and/or is not present; subsoils are compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A; and/or topsoil or subsoil is covered with impervious cover or is chemically contaminated. Examples of soils that are severely disturbed include areas that are covered with buildings or paved surfaces, or areas that are defined as brownfields by local, state, or federal agencies.
- *Soils disturbed by previous development* are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include one or more of the following:
  - soil horizons that differ significantly in either depth, texture, physical or chemical properties from the *reference soil*
  - bulk densities that exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
  - *organic matter* content lower than that of the reference soil
  - soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil
  - presence of compounds toxic to the intended plants
  - presence of weedy, opportunistic, or invasive plant species.
- *Unique farmland* refers to soils designated by the Natural Resources Conservation Service as "unique farmland." Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.[137]

Credit 7.4	Divert construction and demolition materials from disposal
3–5 Points	

Intent

Divert construction and demolition (C&D) materials generated by site development from disposal in landfills and combustion in incinerators. Recycle and/or reuse C&D materials on site, when possible, or redirect these materials back to the manufacturing process, other construction sites, or building materials reuse markets to support a net zero-waste site and minimize down-cycling of materials.

Economic and social benefits

Retaining C&D materials on site reduces the cost of disposal at a landfill. Using C&D materials as resources for new site development, rather than viewing them as "waste," reduces costs for new purchased material, such as wood, concrete and other types of masonry, and drywall.

Requirements[138]

The requirements apply to non-hazardous construction and demolition materials. Land-clearing materials (soils, mineral/rock waste, and plant material) generated during all phases of design and construction are addressed in a separate credit (see the Links to other Sustainable Sites credits section below) and shall be excluded from calculations in this credit. Maintaining structures, hardscape, or landscape amenities (e.g., benches, light poles, fencing, play equipment) on site in their existing form is addressed in a separate credit and the weight or volume of those materials shall be excluded from calculations in this credit (see Links to other Sustainable Sites credits section below).

- **3 points:** Recycle, reuse, and/or salvage at least 50 percent of structural materials and 95 percent of roads/infrastructure materials. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or comingled.
- **5 points:** Recycle, reuse, and/or salvage at least 75 percent of structural materials and 95 percent of roads/infrastructure materials. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or comingled.

Percent calculations may be based on weight or volume, but must be consistent throughout.

Submittal documentation

Provide a general description of each type/category of C&D materials generated, location of receiving agent, and quantity of waste diverted (by category) in tons or cubic yards. Provide a narrative describing the construction waste management plan.

Potential technologies and strategies

Reuse existing materials on site or recycle them for on-site use when possible. Develop a construction waste management plan to specify and communicate the expectations and requirements of the project. If materials are to be reused as soil amendments, soil tests should first be conducted to determine that the material would be appropriate for the site soils. Non-composted and non-organic materials should not be added to soil as an amendment unless these materials can be demonstrated to benefit site soils.

Links to other Sustainable Sites credits

- If C&D materials are reused and/or recycled on site, the site may be eligible for *Credit 5.4: Reuse salvaged materials and plants* and *Credit 5.5: Use recycled content materials*.
- Reusing and/or recycling land-clearing materials (soils, mineral/rock waste, and plant material) generated during all phases of design and construction is addressed separately in *Credit 7.5: Reuse and recycle vegetation, rocks, and soil generated during construction*.

- Maintaining structures, hardscape, or landscape amenities on site in their existing form is also addressed separately in *Credit 5.2: Maintain on-site structures, hardscape, and landscape amenities*.

Resources

- For guidance on developing C&D waste management specifications, see resources such as California Integrated Waste Management Board's Construction and Demolition Debris Recycling Specifications page, *http://www.ciwmb.ca.gov/condemo/Specs/* or WasteCap Wisconsin's page on Construction and Demolition Specifications, *http://www.wastecapwi.org/*.
- The U.S. Green Building Council website, including rating systems and reference guides, *www.usgbc.org*.

Definitions

- *Reuse* is a process of utilizing a used product or material in a manner that generally retains its original form and identity with minor refurbishments. Materials reusable in whole form might include sand-set pavers, segmental retaining walls, or mechanical fasteners, connections, and/or joinery (e.g., avoidance of adhesives and mortar).
- *Salvage* is the recovery of materials from existing sites for *reuse* on other sites.

Credit 7.5	Reuse or recycle vegetation, rocks, and soil generated during construction
3–5 Points	

Economic and social benefits

Retaining land-clearing materials on site eliminates the cost of waste disposal. Using existing site materials as a resource also reduces the need for new purchased materials and soil amendments such as compost and mulch.

Intent

Divert from disposal vegetation, soils, and mineral/rock waste generated during construction to achieve a net zero-waste site.

Requirements

The requirements apply to all on-site soils, mineral/rock waste, and plant material generated during the land-clearing activities of the site during all phases of design and construction. Contaminated soils and diseased and/or invasive plant materials need not be included in calculations of land-clearing material totals. Salvaged plants can be used to meet the requirements of this credit (see Links to other Sustainable Sites credits section below).

- **3 points:** Retain 100 percent of land-clearing materials for use within 50 miles of the site.
- **5 points:** Retain 100 percent of land-clearing materials on site.

Soils must be reused for functions comparable to their original function (i.e., topsoil is used as topsoil, subsoil as subsoil, or subsoil amended to become functional topsoil).

Submittal documentation

Provide an estimate of the vegetation, soils, and mineral/rock waste to be generated (in tons or cubic yards), the location of receiving agent, and quantity of materials (in tons or cubic yards) received by receiving agent. Provide documentation (such as receipts and photographs) to verify that land-clearing materials are retained according to requirements. Verify with a signature of owner or owner's representative that no land-clearing materials were disposed in a landfill.

Potential technologies and strategies

Use existing vegetation, soils, and mineral/rock materials as resources in site design. Recycle excess vegetation removed during land-clearing to develop compost, mulch, erosion-protection measures, retaining walls, and benches or other site furniture. Balance cut and fill, and reuse existing soils and rocks in site design instead of importing new materials to the site. If diseased and/or invasive plant materials are found on site, manage them to prevent spread by methods such as hot composting.

Links to other Sustainable Site credits

- Retaining, reusing, and/or recycling other materials during construction may help achieve *Credit 7.4: Divert construction and demolition materials from disposal*.
- Recycling organic matter generated during the operations and maintenance phase of a project can earn credit under *Credit 8.3: Recycle organic matter generated during site operations and maintenance*.
- Stockpiling and reusing soils on site or amending site soils in place may help also achieve *Credit 7.3: Restore soils disturbed by previous development*.
- If soils and plants are retained on site for reuse, the site may also be eligible for *Credit 5.7: Use regional materials* and *Credit 5.4: Reuse salvaged materials and plants*.

Resources

For more information, see U.S. Environmental Protection Agency's GreenScapes program, *http://www.epa.gov/epawaste/conserve/rrr/greenscapes/index.htm*

Credit 7.6	Minimize generation of greenhouse gas emissions and exposure to localized air pollutants during construction
1–3 Points	

Intent

Use construction equipment that reduces emissions of localized air pollutants and greenhouse gas emissions.

Economic and social benefits

Construction equipment generates emissions of nitrogen oxides and particulate matter, both of which contribute to human health problems, including lung disease and respiratory illness. Reduced emissions of these pollutants are projected to prevent premature deaths, hospitalizations, and work days lost and result in substantial benefits to public health.[140]

Requirements

The requirements apply to all diesel engines used on site during construction. Delivery vehicles are not covered by this credit and shall be excluded from calculations.

- Establish a policy to reduce diesel emissions of idling construction equipment, limiting unnecessary idling to no more than five minutes in any 60-minute period.
  AND
- Implement a preventative maintenance plan for all equipment according to engine manufacturer specifications.
  AND
- Use ultra low sulfur diesel fuel that meets American Society of Testing and Materials (ASTM) specifications with sulfur levels less than or equal to 15 ppm for all non-road diesel equipment.
  AND
- Select one of the following options:
  - **Option 1:** For all diesel engines not meeting Clean Air Non-road Diesel–Tier 4 Final Rule[139], employ strategies to reduce emissions by levels specified below. All aftermarket emissions control technologies must be verified by U.S. EPA or California Air Resources Board (CARB). Use the U.S. EPA's Diesel Emissions Quantifier or comparable calculator to estimate emissions. ***(Note:*** *Other modeling methods may be used to estimate construction emissions. Adequate documentation regarding the methods employed and the results obtained must be submitted.)*
    - **1 point:** Reduce emissions by an average minimum of 20 percent for particulate matter (PM) and/or non-methane hydrocarbon emissions (NMHC) and/or nitrogen oxides (NOx) levels.
    - **2 points:** Reduce emissions by an average minimum of 50 percent for particulate matter (PM) and/or non-methane hydrocarbon emissions (NMHC) and/or nitrogen oxides (NOx) levels.
    - **3 points:** Reduce emissions by an average minimum of 90 percent for particulate matter (PM) and/or non-methane hydrocarbon emissions (NMHC) and/or nitrogen oxides (NOx) levels.

  OR

  - **Option 2:** No construction equipment with Tier 0 engines is used AND construction equipment meets one of the following:
    - **1 point:** 50 percent of the construction equipment used on site is Tier 2 or higher engines.
    - **2 points:** 75 percent of the construction equipment used on site is Tier 3 or higher engines.
    - **3 points:** 70 percent of the construction equipment used on site is Tier 4 or higher engines.

Submittal documentation

Submit a copy of the idle-reduction policy and provide a brief narrative to describe how it will be enforced on the site. Provide a copy of the equipment maintenance plan to demonstrate engine is maintained according to manufacturer's specifications. Provide fuel purchase records demonstrating fuel used during site construction is ultra-low sulfur or biodiesel that meets ASTM standards.

- **Option 1:** Submit documentation through the U.S. EPA's Diesel Emissions Quantifier or comparable calculator that equipment has been retrofitted with verified retrofit devices such that the average minimum percentage reduction is achieved. Provide documentation to demonstrate that selected retrofit technologies have been verified by U.S. EPA or California Air Resources Board.
- **Option 2:** Provide a list of all construction equipment used on site, indicating the engine tier for each. Submit documentation of fleet inventory demonstrating that the appropriate percentage of equipment meets tier requirements.

Potential technologies and strategies

Select construction contractors who are committed to reducing diesel emissions from construction equipment and vehicles. Reduce construction emissions by reducing idling, enhancing maintenance practices, replacing older equipment with newer, cleaner engines and equipment, using cleaner fuels, and retrofitting engines with technologies designed to reduce emissions.

Links to other Sustainable Sites credits

Reducing generation of greenhouse gas emissions in other phases of the project, such as during operations and maintenance, are addressed in *Credit 8.4: Reduce outdoor energy consumption for all landscape and exterior operations*, *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*, and *Credit 8.5: Use renewable sources for landscape electricity needs*.

Resources

- For more information on reducing emissions during construction, see the resources available at the U.S. EPA's Clean Construction USA website, *http://www.epa.gov/otaq/diesel/construction/index.htm*. For more information on technologies and strategies for reducing diesel emissions, see U.S. EPA's National Clean Diesel Campaign, *http://www.epa.gov/cleandiesel/*.
- For more information on ultra low sulfur diesel, *www.clean-diesel.org/nonroad.html*.
- The U.S. EPA's Cleand Diesel emissions Quantifier, *http://cfpub.epa.gov/quantifier/view/index.cfm*
- U.S. EPA and the California Air Resources Board (CARB) have retrofit technology verification programs that evaluate the emissions performance of advanced emissions control technologies and engine rebuild kits. See list of EPA verified technologies, *http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm* and CARB's verification program, *http://www.arb.ca.gov/diesel/verdev/verdev.htm*.
- The U.S. EPA anticipates making available a guide in 2010 to help construction fleet owners find the information they need with respect to engine and vehicle information and tier levels.
- For more information on ASTM standards, *www.astm.org*.

Prerequisite 8.1 REQUIRED — Plan for sustainable site maintenance

Intent
Develop a site maintenance plan that outlines the long-term strategies and identifies short-term actions to achieve sustainable maintenance goals.

Requirements
- With the integrated design team (see *Prerequisite 2.2: Use an integrated site development process*), prepare a site maintenance plan by completing the *Site Maintenance Plan Worksheet* on the following pages. Use the blank cells in the worksheet to explain both the long-term strategic plan (i.e., 10 years desired outcome) and short-term actions to achieve sustainable maintenance goals.
- The maintenance contractor or site manager shall commit to educating maintenance personnel on the goals and implementation of the maintenance plan.

Submittal documentation
- Submit the completed *Site Maintenance Plan Worksheet* with relevant project information. Not all topics in the worksheet may apply to every site and each site may contain additional important unique elements that are not explicitly addressed. Provide reasons for not addressing certain topics in the worksheet and include additional topics not listed.
- All integrated design team members must sign off that review and discussions were conducted.
- Provide signed documentation confirming that the maintenance contractor or site manager has reviewed and agreed to implement the plan and has committed to communicating the plan with maintenance personnel.

Site Maintenance Plan Worksheet: This worksheet will help the integrated design team (including maintenance professionals) identify issues to consider for the future operations and maintenance of the site. It is recommended that the site maintenance plan be reviewed and updated annually. The worksheet is organized by activity and time of year to help guide maintenance contractors/managers and crews in their work.

WORKSHEET: SITE MAINTENANCE PLAN						
Maintenance plan topics to be addressed by the integrated design team (including the maintenance contractor or manager)	Required or Optional?	10-year desired outcome from maintenance practice	Required actions to achieve 10-year desired outcome (include specific details below)			
			Specific activities	Skill level required	Timeline/ schedule	Other details
Plant stewardship						
Plant maintenance: Describe the process for maintaining vegetation according to long-term plans for the site and adhering to recognized standards for professional horticultural practice.	Required for all sites					
Plant health: Describe the process for monitoring plant health to prevent problems. Identify the proper techniques for addressing dead, diseased, or pest-infested vegetation.	Required for all sites					
Site safety: Describe the process for maintaining vegetation to ensure site safety and meet the needs of the intended users of the site.	Required for all sites					
Plant replacement: Provide a list (include the common and scientific names) of potential appropriate, non-invasive plants that can be used for replacing plants. When replacing plants, consider maintenance needs of plants and design approach.	Required for all sites					
Pest management: Control pests, diseases and any unwanted species of plants and animals using Integrated pest management (IPM) techniques.	Required for all sites					
Invasive species management						
Provide a list (include common and scientific names) of plant species identified in the area that are currently on any of the following lists as invasive: regional lists (when listing occurs through a vetted, transparent process and has been accepted by the regional stakeholders), State Noxious Weeds laws, or Federal Noxious Weeds laws.	Required for all sites					

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Invasive species management, *continued*						
The following components must be included in the invasive species management plan: • Integrated pest management (IPM) strategies • A procedure for identifying and monitoring for additional invasive species that may colonize the site and new species as they are recognized by local authorities. • Initial treatment, follow-up treatments, long-term control including monitoring, and methods to dispose of invasive plant materials to prevent spread.	Required for all sites					
Organic materials management						
Healthy plant material management: Describe the process (e.g., composting or recycling) for managing excess organic plant material generated on site.	Required for all sites					
Diseased plant disposal: Dispose of organic plant materials generated on site that are not suitable for composting or recycling (e.g. diseased vegetation) in a manner that does not increase the likelihood of spread.	Required for all sites					
Prevention of wildfires: Describe the process for managing vegetative biomass to reduce the risk of catastrophic wildfire. If prescribed fires are to be used, describe a burn plan that is similar in technique, frequencies and intensities to natural fire regimes in the ecosystem.	Optional for all sites Necessary component of *Credit 4.13: Reduce the risk of catastrophic wildfire*					
Soil stewardship						
Soil amendments and fertilizers: Describe the process for identifying soil deficiencies, including conducting soil test(s) prior to adding amendments and fertilizers. Specify use of the least harmful amendments (e.g,. compost) when necessary.	Required for all sites					
Use of fertilizers: Describe the process for applying fertilizers (if needed) to ensure that application is effective and prevents harm to environmental and human health.	Required for all sites					
Erosion and compaction: Describe the process for alleviating soil erosion or compaction (due to site use or maintenance) that is detrimental to plant health.	Required for all sites					

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Irrigation and water use						
Irrigation allotment and schedule: Describe the anticipated watering schedule (frequency and duration) that allows the site to meet annual volume requirements and restrictions.	Required for all sites					
Irrigation water source: Describe the process for maintaining non-potable water sources used for landscape irrigation (e.g. harvested rainwater, air-conditioning condensate, graywater, reclaimed wastewater).	Required for all sites					
Temporary irrigation: Describe the process for disconnecting/removing temporary irrigation systems, if present, after the plant establishment period.	Optional for all sites Necessary component of the mid and high point values in *Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline*					
Stormwater management features and BMPs (including water features)						
Stormwater features and BMPs effectiveness: Describe the proper maintenance activities to ensure continued effectiveness of stormwater features and BMPs (e.g., replacement of vegetation and removal of accumulated sediment load).	Required for all sites					
Water treatment: Describe the process for treating water features, if present (e.g. avoiding chlorine or bromine).	Required for all sites					
Water quality: Describe the appropriate maintenance activities designed to reduce the exposure to and the mobilization and transport of pollutants in runoff.	Required for all sites					
Snow and ice (if applicable)						
Snow/ice management: Describe the process (including stockpiling) for managing snow/ice in ways that limit degradation of water quality and surrounding plants and soil health.	Necessary component for sites with snow/ice					
Snow/ice management: Describe the process for stockpiling areas and managing any snow-melt that will be used as a water source on site.	Optional for all sites					

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Materials management						
Materials replacement: Provide a list of preferred characteristics for replacement materials (e.g., materials from local and regional sources, recycled content materials, certified wood, energy-efficient lightings).	Required for all sites					
Functionality and extended use: Describe the process for repairing and maintaining hardscape, landscape amenities, and structures that reduces harm to environmental and human health (e.g., use of low-emitting adhesives, sealants, paints and coatings) and ensures the effectiveness of the material (e.g., clean pervious surfaces).	Required for all sites					
Site safety: Describe the process for maintaining hardscape, landscape amenities, and structures to ensure site safety and meet the needs of the intended uses of the site.	Required for all sites					
For materials intended to have high reflectivity (i.e., with an SRI of at least 29): Describe the timeline for surface cleaning to maintain high reflectivity (at least every two years).	Optional for all sites Necessary component of *Credit 4.12: Reduce urban heat island effects*					
Disposal of harmful materials: Describe the process for properly disposing of harmful materials.	Required for all sites					
Historic or cultural sites: Describe the process for maintaining the integrity of historic structures and cultural landscapes. Process to include detailed specifications related to the repair or replacement of features and any maintenance work to be documented for records. Describe the process for determining how conflicts between historic and environmental concerns will be addressed.	Optional for all sites Necessary component of *Credit 6.4: Protect and maintain unique cultural and historical places*					
Recyclable materials—paper, glass, plastics, and metals						
Recyclable materials: Describe the process for managing and collecting recyclable materials that will be generated on site.	Required for all sites					
On-site food waste: For sites that generate food waste, describe the process for on-site collection of compostable organics to prevent them from entering the municipal solid-waste stream.	Optional for all sites Necessary component of *Credit 8.3: Recycle organic matter generated during site operations and maintenance*					

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Landscape maintenance equipment						
Equipment maintenance: List the types of equipment (manual and powered) used on site. Describe the process for maintaining equipment.	Required for all sites					
Site user experience: Describe the maintenance schedule that minimizes users' exposure to noise, localized air pollution, and other disturbances.	Optional for all sites Necessary component of *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*					
Invasive species management: Describe the process for cleaning equipment to remove invasive species to prevent transport to other sites.	Required for all sites					
Sensitive site features						
Sensitive site management: Describe on-going management activities to protect the integrity of vegetation and soil protection zones.	• *Necessary component of Prerequisite 1.1: Limit development of soils designated as prime farmland, unique farmland, and farmland of statewide importance* • *Prerequisite 1.2: Protect floodplain functions* • *Prerequisite 1.3: Preserve wetlands* • *Prerequisite 1.4: Preserve threatened or endangered species and their habitats* • *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers* • *Credit 4.4: Minimize soil disturbance in design and construction* • *Credit 4.5: Preserve all vegetation designated as special status* • *Credit 4.8: Preserve plant communities native to the ecoregion*					
Sensitive site management: Describe the process for avoiding impacts during site maintenance to threatened and endangered species and their habitats.	Required for all sites					

Continued on next page

Adaptive management						
Update plan: Describe the process for re-evaluating the maintenance plan on an annual basis, and revising as needed to adapt to future conditions and unforeseen changes.	Required for all sites					

Links to other Sustainable Sites credits

The following prerequisites and credits have site maintenance plan requirements:

- *Prerequisite 1.1: Limit development of soils designated as prime farmland, unique farmland, and farmland of statewide importance*
- *Prerequisite 1.2: Protect floodplain functions*
- *Prerequisite 1.3: Preserve wetlands*
- *Prerequisite 1.4: Preserve threatened or endangered species and their habitats*
- *Prerequisite 2.2: Use an integrated site development process*
- *Credit 3.2: Reduce potable water use for landscape irrigation by 75 percent or more from established baseline*
- *Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers*
- *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*
- *Credit 3.7: Design rainwater/stormwater features to provide a landscape amenity*
- *Credit 3.8: Maintain water features to conserve water and other resources*
- *Prerequisite 4.1: Control and manage known invasive plants found on site*
- *Prerequisite 4.3: Create a soil management plan*
- *Credit 4.4: Minimize soil disturbance in design and construction*
- *Credit 4.5: Preserve all vegetation designated as special status*
- *Credit 4.8: Preserve plant communities native to the ecoregion*
- *Credit 4.12: Reduce urban heat island effects*
- *Credit 4.13: Reduce the risk of catastrophic wildfire*
- *Credit 6.4: Protect and maintain unique cultural and historical places*
- *Prerequisite 7.2: Restore soils disturbed during construction*
- *Credit 8.3: Recycle organic matter generated during site operations and maintenance*
- *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*

Resources

- See individual prerequisites and credits for resources.
- For an example of an IPM plan, see "Integrated Pest Management Program," Portland Parks and Recreation (4/1/2009), *http://www.portlandonline.com/parks/index.cfm?c=38296&a=116237*.

Definitions

- *Appropriate plant species* are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native plants are appropriate if they meet the above criteria.

- *Diameter at breast height (DBH)* is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.
- *Graywater* is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.
- *Integrated design team* includes the owner and/or client and professionals knowledgeable in landscape design, construction, and maintenance. Team members should be selected to meet the unique constraints and opportunities of the site.
- *Integrated pest management (IPM)* is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. The IPM approach places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.
- *Invasive species* are species that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health.[141]
- *Minimal impact site development* is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.
- *Vegetation and soil protection zones (VSPZ)* must meet the following requirements:
  - Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
  - VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
  - All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
  - VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
  - No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
  - Incorporate into the site maintenance plan on-going management activities to protect the integrity of the VSPZ.

Prerequisite 8.2 REQUIRED — Provide for storage and collection of recyclables

Intent
Provide space for collection of recyclable materials (including paper, glass, plastics, and metals) in outdoor areas to facilitate recycling and reduce waste generation and waste disposal in landfills.

Economic and social benefits

Recycling programs can reduce costs for disposal of waste at landfills and generate revenue through sales of materials collected for recycling.

Requirements[142]
- Conduct a waste audit to estimate the amount of recyclable materials generated in outdoor areas.
- Co-locate collection containers for recyclables next to all trash receptacles and ensure that service is provided for collection and recycling of recyclable materials.

Submittal documentation
Estimate the amount of recyclable materials that will be generated on site, and provide a brief narrative or calculations to demonstrate that the size and location of recycling collection areas are adequate for expected site program needs. Provide site plans to verify that recycling collection containers and storage areas have been designed to meet the needs of the site. Documentation should include types of materials that are being collected for recycling, the recycling location where materials will be deposited, and frequency of pickup for recyclables. Provide copy of contract with vendor or other documentation that service exists for collection and recycling of recyclable materials.

Potential technologies and strategies
Coordinate the size and function of the recycling areas with the anticipated collection services for glass, plastics, paper, and metals to maximize the effectiveness of the dedicated areas.

Links to other Sustainable Sites credits
Recycling food waste and other organic material in addition to paper, glass, plastics, and metals may help achieve *Credit 8.3: Recycle organic matter generated during site operations and maintenance*.

Resources
For information on estimating waste generation to set up recycling programs, see California Integrated Waste Management Board's Solid Waste Characterization page *http://ciwmb.ca.gov/WasteChar/*.

Definition
Waste audit is a systematic review of a site and its operations to quantify the types and amounts of waste generated, and the management practices that impact that waste generation. It includes an assessment of purchasing practices and identifies the areas and materials in which waste reduction efforts will be most effective. A waste audit also sets a baseline for measuring future progress of waste reduction efforts.

Credit 8.3	Recycle organic matter generated during site operations and maintenance
2–6 Points	

Intent

Design for recycling of vegetation trimmings and, where applicable, food waste to generate compost and mulch to support nutrient cycling, improves soil health and reduces transportation costs and materials going to landfills.

Economic and social benefits

Recovering landscape trimmings for use as compost or mulch saves money by reducing or eliminating the need for purchased fertilizers, pesticides, and irrigation.[143] Reusing landscape "waste" as a resource on site also reduces costs for waste disposal, transport costs for removing trimmings, and maintenance costs for annually amending soils. When clippings are mulched and left on the lawn, total lawn maintenance time may also be reduced.[144]

Requirements

- Conduct a waste audit to estimate the amount of vegetation trimmings (and food waste, if applicable) generated.
  AND
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) anticipated strategies for composting and/or recycling vegetation trimmings (and food waste, if applicable).
  - **2 points:** Compost and/or recycle 100 percent of vegetation trimmings off site within 50 miles.
  - **3 points:** Compost and/or recycle at least 50 percent of vegetation trimmings on site; compost and/or recycle the remaining organic matter off site within 50 miles.
  - **5 points:** Compost and/or recycle 100 percent of vegetation trimmings on site.
  - **Additional point value:** For sites that generate food waste, provide space for on-site collection of compostable organics to prevent them from entering the municipal solid-waste stream.

Submittal documentation

Provide text from the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) to describe the plans for composting and/or recycling vegetation trimmings (and food waste, if applicable). Provide calculations from a waste audit for the approximate amount of vegetation trimmings (and food waste, if applicable) and the process for composting and/or recycling. Provide site plans to verify that organic matter collection areas have been provided to meet the needs of the site. If composting and/or recycling takes place off site, provide a copy of contract with the receiving company and its distance from the site.

Potential technologies and strategies

Collect excess vegetation generated during site maintenance to divert to a composting facility on or off site. Consider grasscycling using a mulching mower and leaving plant materials in situ. Sites with limited space for composting can utilize neighborhood facilities/programs to process organic matter.

Links to other Sustainable Sites credits

- Recycling organic matter generated during the construction phase of a project can earn credit under *Credit 7.5: Reuse or recycle vegetation, rocks, and soil generated during construction*.
- Leaving vegetation trimmings in situ during operations and maintenance may help minimize emissions from maintenance equipment, which may help achieve *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*.

- Diseased and invasive plant trimmings are excluded from the calculations for this credit but should be managed on site to prevent spread; see *Prerequisite 4.1: Control and manage known invasive plants found on site* for more details.

Resources

- For more information, see the U.S. Environmental Protection Agency's GreenScapes program, *http://www.epa.gov/epawaste/conserve/rrr/greenscapes/index.htm*.
- For additional articles and links on composting and organics recycling, see *Biocycle Magazine*, *www.biocycle.net*, and the resources for small-scale composting from the Cornell Waste Management Institute, *http://cwmi.css.cornell.edu/composting.htm#smallcomposting*.
- For more information on conducting waste audits, see the U.S. EPA's WasteWise website, *http://www.epa.gov/epawaste/partnerships/wastewise/plan-program.htm#conduct*.

Definitions

- *Vegetation trimmings* include only non-invasive plant material free of disease.
- *Waste audit* is a systematic review of a site and its operations to quantify the types and amounts of waste generated, and the management practices that impact that waste generation. It includes an assessment of purchasing practices and identifies the areas and materials in which waste reduction efforts will be most effective. A waste audit also sets a baseline for measuring future progress of waste reduction efforts.

Credit 8.4	Reduce outdoor energy consumption for all landscape and exterior operations
1–4 Points	

Intent
Select energy-efficient outdoor fixtures and equipment to reduce energy consumption and costs associated with site use and operations.

Economic and social benefits

Energy-efficient outdoor appliances lead to reduced costs for electricity during operations. Exterior lighting alone represents an estimated 1.34 percent of California's total energy use.[146] Minimizing the energy needs of a site reduces the greenhouse gas emissions associated with consumption of purchased electricity.

Requirement[145]
- **1 point:** Select outdoor fixtures and equipment (lighting, water feature pumps, etc.) to achieve a 30 percent average annual energy reduction from the estimated baseline energy use for those products. The baseline energy use is that of the lowest-cost comparable item.
- **3 points:** Select outdoor fixtures and equipment (lighting, water feature pumps, etc.) to achieve a 60 percent average annual energy reduction below the estimated baseline energy use for those products. The baseline energy use is that of the lowest-cost comparable item.
- **4 points:** Select outdoor fixtures and equipment (lighting, water feature pumps, etc.) to achieve a 90 percent average annual energy reduction from the estimated baseline energy use for those products. The baseline energy use is that of the lowest-cost comparable item.

Submittal documentation
Provide a list of all outdoor appliances purchased for the site. For each appliance, indicate the energy requirements for the appliance, the energy requirements for the lowest-cost comparable item, and the percent reduction in energy requirements for the selected appliance relative to that of the lowest-cost comparable item. Provide calculations to demonstrate that the average annual energy reduction for outdoor appliances has been met.

Potential technologies and strategies
Research various alternatives for outdoor appliances to identify those that are most energy efficient. When possible, look for solar-powered alternatives to conventional products.

Links to other Sustainable Sites credits
- Exterior lighting designed to minimize light trespass is addressed in *Credit 6.9: Reduce light pollution*.
- Reduced energy consumption during construction and maintenance is addressed in separate credits, including *Credit 7.6: Minimize generation of greenhouse gas emissions and exposure to localized air pollutants during construction* and *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*.
- Another way to reduce the carbon footprint of the site is to use renewable energy sources for outdoor electricity, which is addressed in *Credit 8.5: Use renewable sources for landscape electricity needs*.

Resources
- For guidelines on efficient outdoor lighting (including system efficacy, controls, luminaire cutoff, and lighting power density), *Advanced Buildings Benchmark™ Version 1.1*, Section 5, Required 1.10, *http://www.advancedbuildings.net/documents/AB_Benchmark_1-1.pdf*.
  The U.S. Environmental Protection Agency's *Energy Star Building Upgrade Manual* also includes a section on exterior lighting in the lighting chapter, *http://www.energystar.gov/index.cfm?c=business.bus_upgrade_manual*.

- For additional information on specific lighting strategies, U.S. Department of Energy resources on Energy Efficiency and Renewable Energy, including LED Site (Parking Lot) Lighting Performance Specification, *http://www1.eere.energy.gov/buildings/retailer/subcommittees.html*, and solid-state lighting street light demonstration projects, *http://www1.eere.energy.gov/buildings/ssl/gatewaydemos_results.htm*.
- For information on conserving energy and reducing light pollution, the International Dark Sky Association, "Simple Guidelines for Lighting Regulations for Small Communities, Urban Neighborhoods, and Subdivisions," *http://www.darksky.org/mc/page.do?sitePageId=58881*.

Definition

Lowest-cost comparable item is the most inexpensive item that provides a desired function (such as light emittance) for the site. For example, the lowest-cost light bulb that meets the site's lumen requirements (whether it be conventional bulb, LED, compact fluorescent, or other bulb type) can be used as the "lowest-cost comparable item," regardless of the type of bulb selected for site use.

Credit 8.5	Use renewable sources for landscape electricity needs
2–3 Points	

Economic and social benefits

Renewable energy sources add an economically stable source of energy to the mix of U.S. generation technologies.

Intent

Use electricity from renewable sources to reduce the greenhouse gas emissions associated with site operations and minimize air pollution, habitat destruction, and pollution from fossil fuel-based energy production.

Requirements[147]

- **2 points:** Use on-site ***renewable energy sources*** to generate 50 percent of site outdoor electricity OR engage in at least a two-year contract for the purchase of 100 percent of site electricity from renewable sources.
- **3 points:** Use on-site renewable energy sources to generate 100 percent of site outdoor electricity OR engage in at least a four-year contract for the purchase of 100 percent of site electricity from renewable sources.

Renewable energy sources must meet the Center for Resource Solutions (CRS) Green-e products certification requirements. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements.

Submittal documentation

Provide documentation to demonstrate the renewable energy sources used and the percent of annual energy use generated or purchased from each renewable source.

Potential technologies and strategies

Assess the project for non-polluting and renewable energy potential, including solar, wind, geothermal, and low-impact hydro. Determine the energy needs of the site and investigate opportunities to engage in a green-power contract.

Links to other Sustainable Sites credits

Reducing energy consumption during construction, operations, and maintenance helps a site minimize its electricity requirements and may help achieve *Credit 7.6: Minimize generation of greenhouse gas emissions and exposure to localized air pollutants during construction, Credit 8.4: Reduce outdoor energy consumption for all landscape and exterior operations, and Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*.

Resources

- For more information about renewable sources and the Green-e program, *http://www.green-e.org*.
- The U.S. Green Building Council website including rating systems and reference guides, *www.usgbc.org*.

Definition

Site outdoor electricity is all electricity consumed for landscape purposes outside of the building.

Credit 8.6	Minimize exposure to environmental tobacco smoke
1–2 Points	

Intent
Minimize exposure of site users to environmental tobacco smoke (i.e. secondhand smoke) to improve human health.

Requirements [148]
- **1 point:** Develop and implement a policy to prohibit smoking outdoors at least 25 feet away from building entries, operable windows, air intakes, bus stops, parking for persons with disabilities, patios, overlooks, playgrounds, recreational fields, and other outdoor gathering areas where people could inadvertently come in contact with tobacco smoke when occupying, entering, or leaving the site. A site is not required to extend no-smoking zones beyond the boundaries of the site. Clearly designate outdoor smoking areas that meet the above requirements and provide adequate waste disposal.
- **2 points:** Develop and implement a policy to prohibit smoking within the entire site. To implement a tobacco-free policy, post appropriate signs in the specified tobacco-free area.

Suggested submittal documentation
Provide a copy of the smoke-free policy and implementation plan OR prepare a copy of the site plan indicating designated smoking areas and their distances from entries, operable windows, air intakes, outdoor gathering areas and other locations where occupants could inadvertently come in contact with tobacco smoke.

Potential technologies and strategies
Take into account prevailing winds and microclimate effects in locating exterior smoking areas. Consider innovative techniques, such as filters near air intakes or outdoor smoke rooms, to limit the effects of tobacco smoke on site users.

Links to other Sustainable Sites credits
Establishing a smoke-free environment may contribute to *Credit 6.6: Provide opportunities for outdoor physical activity*, *Credits 6.7: Provide views of vegetation and quite outdoor spaces for mental restoration*, and *Credit 6.8: Provide outdoor spaces for social interaction*.

Resources
- Centers for Disease Control and Prevention, *http://www.cdc.gov/tobacco/pubsl.html*.
- *Tobacco Free Partners, http://www.tobaccofreepartners.org*.
- For a model voluntary comprehensive non-smoking policy for businesses and organizations, California's Clean Air Project secondhand smoke resources for outdoor tobacco smoke, *http://www.ccap.etr.org/index.cfm?fuseaction=resources.outdoor*.

Economic and social benefits

Cleaner air is linked to reduced health-care costs. Individual cigarettes are point sources of air pollution; smokers in groups become an area source of secondhand smoke pollution. Secondhand smoke contains respirable particles that can cause breathing difficulty for those with chronic respiratory diseases or trigger an asthmatic attack in those with disabling asthma.

Outdoor tobacco-free zones reduce exposure to secondhand smoke, which is responsible for an estimated 3,000 lung cancer deaths and 46,000 heart disease deaths in non-smoking individuals each year in the United States.[149]

According to the U.S. Department of Health and Human Services, there is no risk-free level of exposure to secondhand smoke. Even low levels of exposure can harm non-smokers' health. Separating smokers from non-smokers, cleaning the air, and ventilating buildings cannot eliminate secondhand smoke exposure. Conventional air-cleaning systems can remove large particles, but not the smaller particles or the gases found in secondhand smoke. Establishing a smoke-free environment is the only effective way to protect non-smokers from secondhand smoke.[150]

- For example ordinances for smoke-free events and outdoor areas, Public Health Law & Policy Technical Assistance Legal Center, *http://talc.phlpnet.org/pubs/publications.php?choice=new_browse&search=1#events*.
- For ordinance lists, maps, and data, American Nonsmokers' Rights Foundation, *http://www.no-smoke.org/goingsmokefree.php?id=519*.

Credit 8.7	Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities
1–4 Points	

Intent

Reduce, avoid, or eliminate the use of landscape maintenance equipment that exposes site and adjacent building users to localized air pollutants and generates greenhouse gas emissions.

Economic and social benefits

Cleaner air is linked to reduced health-care costs. The estimated annual economic value of avoiding the effects of ozone and particulate matter in the air is nearly $10 billion in a four-county area of Southern California (the South Coast Air Quality Management District) alone.[152] Volatile organic compound (VOC) emissions from small non-road engines such as lawn mowers, leaf vacuums, and other outdoor power equipment contribute to the formation of ozone, which impairs lung function and is a key ingredient in smog.[153]

Requirements

The requirements apply to all power equipment used for landscape maintenance on site. Sites that require no power maintenance equipment are eligible for this credit.

- **1 point:** Plan for the use of power maintenance equipment only during hours when the site is closed for use or during periods when the lowest percentage of site occupants are potentially exposed to landscape maintenance emissions. In the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*), designate times for emission-generating maintenance equipment use to occur only when the site is closed to users (i.e., not during hours of operation). For sites with constant site users (e.g., college and university settings), designate times for maintenance equipment use to occur when the number of site users is typically at its lowest.
- **3 points:** In the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*), specify that at least 50 percent of the power maintenance equipment used on site meets one of the following:
  - Equipment is powered without the use of gasoline (e.g., electric, solar-powered, or fueled by compressed natural gas or propane).
  - Equipment engine is certified to meet emission levels in the U.S. EPA Final Emission Standards for New Nonroad Spark-Ignition engines, Equipment, and Vessels–Phase 3.[151]
- **4 points:**
  - **Option 1:** In the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*), specify that 100 percent of the power maintenance equipment used on site meets one of the following:
    - Equipment is powered without the use of gasoline (e.g., electric, solar-powered, or fueled by compressed natural gas or propane).
    - Equipment engine is certified to meet emission levels in the U.S. EPA Final Emission Standards for New Nonroad Spark-Ignition engines, Equipment, and Vessels–Phase 3.

  OR
  - **Option 2:** In the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*), specify that no power maintenance equipment is required for landscape maintenance.

Submittal documentation

Provide the applicable section(s) of the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) that describe(s) how the selected options to minimize localized air pollution and generation of greenhouse gas emissions will be implemented and enforced. For mid and high point values, provide a list of all power maintenance equipment anticipated to be used on site, and indicate which equipment meets the requirements above. Document that the site maintenance plan has been shared with and agreed upon by the maintenance contractor or personnel.

Potential technologies and strategies

Design the site to minimize requirements for gasoline-powered maintenance equipment. Select plants that require minimal maintenance or can be maintained by hand-powered tools. Select clean equipment that minimizes emissions of air pollutants and meets or exceeds EPA standards.

Links to other Sustainable Sites credits

- Restricting noise disturbance to times when site users are not present may help provide a quieter, more restorative setting for users and may help achieve *Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration*.
- Materials selection that affects localized air quality is addressed separately in *Credit 5.8: Use adhesives, sealants, paints, and coatings with reduced VOC emissions*.
- Selection of plants that are appropriate to the site (including appropriate for maintenance requirements) is addressed in *Prerequisite 4.2: Use appropriate, non-invasive plants*.
- Reducing generation of greenhouse gas emissions in other phases of the project, such as during construction and operations, is addressed separately in *Credit 7.6: Minimize generation of greenhouse gas emissions and exposure to localized air pollutants during construction*, *Credit 5.7: Use regional materials*.

Resources

For techniques to minimize emissions during landscape maintenance, see the U.S. Environmentqal Protection Agency's guidance, *http://www.epa.gov/otaq/equip-ld.htm* or *http://www.epa.gov/OMS/consumer/19-yard.pdf*. To compare emission reductions from alternative fuels, see the Alternative Fuel Comparison Factsheet by the Triangle Clean Cities Coalition, *ftp://ftp.tjcog.org/pub/cleancit/facts/compare.pdf*.

Credit 8.8	Reduce emissions and promote the use of fuel-efficient vehicles
4 Points	

Intent

Promote the use of vehicles that have reduced emissions and/or high fuel-efficiency to reduce pollution and land development impacts from automobile use.

Economic and social benefits

Although initial costs for alternative vehicles are higher than for conventional vehicles, these costs can be partially offset if federal, state, and local governments offer tax incentives for the purchase of such vehicles. For fuel-efficient vehicles, reduced operation costs on a per-mile basis can offset higher initial purchase prices or higher fuel cost.

Different alternative fuel vehicles need different refueling stations, and costs may vary. Hybrid vehicles are gaining traction in the marketplace, which should start to drive down their cost.

Requirements[154]

- **Option 1:** Provide on-road vehicles that have reduced emissions and/or high fuel-efficiency for 3 percent of Full-Time Equivalent (FTE) occupants **AND** provide preferred parking for these vehicles.

OR

- **Option 2:** Provide preferred parking for carpools or vanpools for 3 percent of the total vehicle parking capacity OR provide infrastructure and support programs to facilitate shared vehicle usage such as carpool drop-off areas, designated parking for vanpools, or car-share services, ride boards, and shuttle services to mass transit.

  AND

  Provide preferred parking for vehicles that have reduced emissions and/or high fuel-efficiency for 3 percent of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. In order to establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20 percent. This approach is acceptable as long as the discounted rate is available to all customers (not limited to the number of customers equal to 3 percent of the vehicle parking capacity), publicly posted at the entrance to the parking area and available for a minimum of two years.

OR

- **Option 3:** Install alternative-fuel refueling stations for 3 percent of the total vehicle parking capacity of the site (liquid or gaseous fueling facilities must be separately ventilated or located outdoors).

Submittal Documentation

- Provide the following for all options:
  - Provide the FTE occupancy for the project.
  - Provide the total vehicle parking capacity of the site AND one of the following three options:
- **Option 1:**
  - Provide project drawings to show the location(s) of the preferred parking spaces for vehicles that have reduced emissions and/or high fuel-efficiency.
  - Confirm the quantity of on-road vehicles that have reduced emissions and/or high fuel-efficiency and their make, model, and manufacturer.
  - Confirm whether each vehicle is a zero-emission vehicle or enter each vehicle's American Council for an Energy Efficient Economy (ACEEE) vehicle score.

- **Option 2:**
  - Provide project drawings to show the location(s) of the preferred parking spaces for carpoolers, OR provide a description of the infrastructure/programs that are in place to support and promote ride sharing.
  - Provide project drawings to show the location(s) of the preferred parking spaces for vehicles that have reduced emissions and/or high fuel-efficiency, OR provide the discounted parking rate and documentation that shows that the discounted rate was publicly offered to all site users (not limited to the number of site users equal to 3 percent of the vehicle parking capacity) for a minimum of two years.
  - Confirm the total number of preferred parking spaces provided for carpoolers and vehicles that have reduced emissions and/or high fuel-efficiency.
- **Option 3:**
  - Provide project drawings to show the location(s) of the alternative refueling stations.
  - Confirm the fuel type, number of stations, and fueling capacity for each station for an eight-hour period.

Potential technologies and strategies

Provide transportation amenities such as alternative fuel refueling stations. Consider sharing the costs and benefits of refueling stations with neighbors.

Links to other Sustainable Sites credits

Using vehicles with reduced emissions on site may contribute to *Credit 8.7: Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities*

Resources

- California Air Resources Board, Zero Emissions Vehicle (ZEV) Program, *http://www.arb.ca.gov/msprog/zevprog/zevprog.htm*.
- American Council for an Energy-Efficient Economy, *http://www.aceee.org/*.
- Online searchable green car guide based on a combination of tailpipe emission levels, *http://www.greenercars.org/index.htm*.
- Alternative Fuels and Advanced Vehicles Data Center, a section of the Department of Energy that has information on alternative fuels and alternative field vehicles, a locator for alternative refueling stations, and other related information, *http://www.afdc.energy.gov/afdc/*.

Definitions

- *Carpool* is an arrangement in which two or more people share a vehicle for transportation.
- *Full-Time Equivalent (FTE) occupants* are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0, while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.
- *Preferred parking* includes the parking spots that are closest to the main entrance of the project (exclusive of spaces designated for handicapped) or parking passes provided at a discounted price.
- *Vehicles that have reduced emissions and/or high fuel-efficiency* are vehicles that are either classified as Zero Emission Vehicles (ZEV) by the California Air Resources Board or have achieved a minimum green score of 40 on the American Council for an Energy Efficient Economy (ACEEE) annual vehicle rating guide.

Credit 9.1 10 Points	Monitor performance of sustainable design practices

Intent

Monitor and document sustainable design practices to evaluate their performance over time and improve the body of knowledge on long-term site sustainability.

Requirements

1. Monitor at least three prerequisites and/or credits included in Table 9.1-A on the following pages. Monitoring must be done by a third party or qualified person on the design team for independent peer review. Achievement of this credit is based on the completion and reporting of the evaluation; negative findings will not affect achievement of this or other prerequisites/credits.
2. Complete separate summary reports* for each of the prerequisites and/or credits that include the following components:
   - Describe site feature and/or program that were implemented for the sustainable site selected credit/prerequisite and define the performance or outcome that is being evaluated.
   - Describe the methodology used to assess performance (e.g., sampling, measures/instruments, and procedures).
   - Describe the results from performance monitoring process.
   - Provide documentation that supports and verifies performance data (e.g., tests, interview transcripts, survey results, site visits, etc.).
   - Include recommendations for improving performance in future designs.
3. Widely communicate the results to improve the body of knowledge on long-term site sustainability. Submit the summary reports to a discipline-wide professional magazine (e.g., *Planning*, *Landscape Architecture*), peer-reviewed scientific journal, professional national/international conference, or national/international public database.

***Note:** A separate summary report is not necessary if monitoring results are submitted to the National Stormwater BMP Database.*

Submittal documentation

- List the third party (name, company/organization) in charge of performance monitoring and demonstrate how the third party has expertise in specific area for evaluation.
- Submit the three summary reports with the components listed above.
- List all the locations (e.g., peer-reviewed journals, national/international website, professional national/international conferences or professional magazines) where the summary reports are made available. Provide confirmation (e.g., letter or email) that the summary reports were accepted to the relevant locations listed above.
- The third party and a member of the project team or the project owner/client must sign documentation.

Potential technologies and strategies

Communicate early in the design process that monitoring is a goal of the project. Set aside additional funding to ensure that monitoring will be conducted. Research peer-reviewed journals and/or professional magazines to understand requirements for submission and associated time frame.

TABLE 9.1-A: ELIGIBLE PREREQUISITES AND CREDITS FOR PERFORMANCE MONITORING

Prerequisites and Credits	Monitoring Requirements	Time frame
Prerequisite 4.1: Control and manage known invasive plants found on site	• Third-party review of biannual monitoring (spring and fall, at a minimum) data to determine effectiveness of control and management plan on the selected invasive species. • Provide vegetation monitoring data indicating species occurrences and percent aerial cover. • Monitoring methodology should include repeatable, accepted scientific standard monitoring procedures.	Provide baseline data from site assessment and biannual monitoring data for at least three years.
Prerequisite 3.1: Reduce potable water use for landscape irrigation by 50 percent from established baseline	• Third-party review of annual flow monitoring data compared to the midsummer baseline estimate of irrigation water needs. • Include documentation of water sources other than potable water supply (source and available quantity). • Document plant composition, mortality rates, and plant replacement rates.	Provide annual data for at least three years.
Credit 4.9: Restore plant communities native to the ecoregion	• Third-party review of biannual monitoring (spring and fall, at a minimum) to determine success of restoration activities. • Provide vegetation monitoring data indicating dominant species by percent aerial cover and frequency of dominant species (for wooded sites, include dominant canopy and ground cover measures). • Monitoring methodology should include repeatable, accepted scientific standard monitoring procedures and measures for dominance and frequency. Example accepted forms of data collection include time-meander sampling, transect sampling, hoop/quadrat sampling, stem counts, etc.	Provide baseline data from site assessment and biannual monitoring data for at least three years.
Credit 3.3: Protect and restore riparian, wetland, and shoreline buffers *AND/OR* *Credit 3.4: Rehabilitate lost streams, wetlands, and shorelines*	Review of annual monitoring using the Habitat Assessment (Ch. 5) and completed Habitat Assessment Field Data Sheet (Appendix A) in *Rapid Bioassessment Protocol for use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed.*[155]	Provide baseline data from site assessment and annual monitoring data for at least four years. Extended monitoring (every two years) for up to 10 years is encouraged.
Credit 7.3: Restore soils disturbed by previous development	Review of annual soil tests for the five categories included in the soil restoration criteria: organic matter, compaction, infiltration rates, soil biological function, and soil chemistry. Document techniques used to restore soil and any changes in soil characteristics over time.	Provide annual data for at least five years.
Credit 3.5: Manage stormwater on site *AND/OR* *Credit 3.6: Protect and enhance on-site water resources and receiving water quality*	Review of monitoring and submittal of data to the National Stormwater BMP Database. Use the *Urban Stormwater BMP Performance Monitoring: A Guidance for Meeting the National Stormwater BMP Database Requirements*[156] to design and implement the monitoring program. Data collected should be formatted according to Section 3.4.3.2 (Standard Format Examples). Monitoring should include completion of the following components: • General Test Site Information • Watershed Information • BMP Information (Structural or Non-Structural) • BMP Design Data (Choose appropriate form) • Monitoring Station Information • Precipitation Data • Flow Data	Monitoring program (frequency and total number of samples) should be adequate to meet the National Stormwater BMP Database Requirements regarding statistical confidence (Section 3.2.2).
Credit 3.8: Maintain water features to conserve water and other resources	Review of annual flow monitoring data for water features. Include documentation of water sources other than potable water supply (source and available quantity).	Provide annual data for at least five years.

Continued on next page

Prerequisites and Credits	Monitoring Requirements	Time frame
Credit 6.3: Promote sustainability awareness and education	Review of the level of education and sustainability awareness that was experienced from visiting the site including how an individual might change his/her behavior and put knowledge into action for off-site purposes.	A minimum of six months up to one year after substantial project completion and site occupation AND monitoring program (frequency and total number of samples) should be adequate to report results with statistical confidence or other accepted forms of validation.
Credit 6.5: Provide for optimum site accessibility, safety, and wayfinding	Review of site accessibility, safety and wayfinding using research methods that include, but are not limited to, questionnaire surveys, interviews and walk-through of the site during peak periods.	
Credit 6.6: Provide opportunities for outdoor physical activity	Review of how site features are used (e.g., frequency, user characteristics, types of activities other than as the intended physical activity feature). Address the reasons why people use or do not use the site and intended features for physical activity.	
Credit 6.7: Provide views of vegetation and quiet outdoor spaces for mental restoration	Review of which site feature(s) users prefer for mental restoration (and why). Assess whether or not the spaces are successful at providing rejuvenating and restful experiences, and the extent to which the spaces are used for this purpose. Evaluate other ways the spaces are used (e.g., social interaction).	
Credit 6.8: Provide outdoor spaces for social interaction	Review of the extent to which social interaction occurs across the site. Document the different kinds of interaction (e.g., one on one, spontaneous, informal interaction among independent users; small group; large gatherings) occurring in different places and assess the reasons why people use or do not use the site and intended features for social interaction.	

Resources

- For information on stormwater monitoring:
  - International Stormwater Best Management Practices (BMP) Database, a database of over 300 BMP studies, performance analysis results, tools for use in BMP performance studies, monitoring guidance and other study-related publications, *http://www.bmpdatabase.org/*
  - U.S. Environmental Protection Agency, "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements" (EPA-821-B-02-001, April 2002), *http://www.epa.gov/waterscience/guide/stormwater/monitor.htm*
- For information on post-occupancy evaluations:
  - *Learning from Our Buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation* (Washington, DC: National Academy Press, 2001)
  - J Gray, CG Watson, J Daish, and D Kernohan, "Putting POE to Work: A Case Study of POE in a Participatory Programming Process," *Proceedings of the Sixteenth Annual Conference of the Environmental Design Research Association*, 16 (1985): 275-286
  - W Preiser, H Z Rabinowitz, and E T White, *Post-Occupancy Evaluation* (New York: Van Nostrand Reinhold, 1988)
- For information on research methods:
  - C Robson, *Real World Research: A Resource for Social Scientists and Practitioner-Researchers* 2nd ed. (Malden, MA: Blackwell, 2007)
- For information on behavioral observation and behavior mapping techniques:
  - *How to Turn a Place Around: A Handbook for Creating Successful Public Spaces*. (New York: Project for Public Spaces, Inc., 2000)
- For information on survey research and sampling:
  - E R Babbie, *The Basics of Social Research*, 4th ed. (Belmont, CA: Wadsworth, 2008)
  - F J Fowler, Jr., *Survey Research Methods*, 4th ed. (Thousand Oaks, CA: Sage Publications, 2009)

- For information on case study research:
  - M Francis, "A Case Study Method for Landscape Architecture," *Landscape Journal*, 20, no.1 (2001): pp. 15–29.
  - R K Yin, *Case Study Research: Design and Methods*. 4th Edition. (Thousand Oaks, CA: Sage, 2009).
- For information on general text on behavior and environment research techniques:
  - J Zeisel, *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape, and Planning* (New York: W.W. Norton, 2006).
- For information on measuring physical activity:
  - SOPLAY: System for Observing Play and Leisure Activity in Youth, *http://www.activelivingresearch.org/node/10642*

Credit 9.2	Innovation in site design
8 Points	

Intent

To encourage and reward innovative sustainable practices for exceptional performance above requirements and/or innovative performance in sustainable sites categories not specifically addressed by the *Sustainable Sites Initiative Guidelines and Performance Benchmarks*.

Requirements [157]

Identify and document the intent of the proposed innovation credit, the proposed requirement for compliance, the proposed submittals to demonstrate compliance, and the design approach (strategies) that might be used to meet the requirements. This credit allows for up to two innovations (4 points each).

Submittal documentation

Provide all of the following for each innovation:

- Provide a narrative statement of the credit intent.
- Provide a narrative statement describing the credit requirements.
- Provide a detailed narrative with quantifiable data describing the project's approach to achievement of the credit. This narrative should include a description of the quantifiable environmental benefits of the credit proposal.
- Provide copies of site plans, construction drawing, exhibits, and/or photographs that will serve to illustrate the project's approach to the credit.
- Provide relevant resources to substantiate the purpose and claims of the innovation.

Potential technologies and strategies

Substantially exceed a Sustainable Sites performance credit that addresses materials, hydrology, soils, vegetation, materials, or human health and well-being. Apply strategies or measures that demonstrate a comprehensive approach and quantifiable environment and/or health benefits. Consider how the performance of a particular set of strategies can greatly exceed the intent of two or more credits in combination.

Endnotes

1 U.S. Department of Agriculture, Office of the Chief Economist, World Agricultural Outlook Board, prepared by the Interagency Agricultural Projections Committee, "USDA Agricultural Projections to 2017," Long-term Projections Report OCE-2008-1, 104 pp., http://www.ers.usda.gov/Publications/OCE081/OCE20081.pdf (accessed May 7, 2009).

2 Food and Agriculture Organization of the United Nations, Economic and Social Development Department, "The State of Food Insecurity in the World, 2008: High Food Prices and Food Security—Threats and Opportunities," ftp://ftp.fao.org/docrep/fao/011/i0291e/i0291e00.pdf (accessed May 7, 2009).

3 U.S. Department of Energy, *National Environmental Policy Act Compliance Guide, Vol. 3, Related Environmental Review Requirements*, http://gc.energy.gov/NEPA/nepa_documents/TOOLS/GUIDANCE/Volume3/Regulations/7_CFR_657_FPPA.pdf (accessed April 2, 2009).

4 USDA Natural Resources Conservation Service, Resource Assessment Division, "Percent Change in Prime Farmland Area, 1982–1997," Map ID: m5037 (2001), http://www.nrcs.usda.gov/technical/NRI/maps/mappdfs/m5037.pdf (accessed April 5, 2009).

5 "Detailed Information of the Farmland Protection Program Assessment," ExpectMore.gov, http://www.whitehouse.gov/omb/expectmore/detail/10000440.2005.html (accessed April 5, 2009).

6 USDA Natural Resources Conservation Service, "National Resources Inventory, 2003 Annual NRI," http://www.nrcs.usda.gov/technical/NRI/2003/nri03landuse-mrb.html (accessed April 5, 2009).

7 USDA Natural Resources Conservation Service, "Identification of Important Farmlands," Part 657.5 of Chapter VI of Title 7 of the Code of Federal Regulations (1-1-00 Edition), http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=7&PART=657&SECTION=5&YEAR=2000&TYPE=PDF (accessed 7/14/2009).

8 Ibid.

9 Ibid.

10 Adapted from the U.S. Green Building Council's LEED for New Construction and Major Renovations v2.2 SS Credit 1: Site Selection.

11 U.S. Environmental Protection Agency, "Wetland Functions and Values," http://www.epa.gov/watertrain/wetlands/index.htm (accessed September 23, 2009).

12 U.S. Environmental Protection Agency, "Wetland Functions and Values," http://www.epa.gov/watertrain/wetlands/module05.htm (accessed September 23, 2009).

13 U.S. Environmental Protection Agency, "Wetland Functions and Values," http://www.epa.gov/watertrain/wetlands/module09.htm (accessed September 23, 2009).

14 Ibid.

15 PR Ehrlich, "The Concept of Human Ecology: A Personal View," *IUCN Bulletin* 16, no. 4–6 (1985): pp. 60–61.

16 RS De Groot, MA Wilson, and RMJ Boumans, "A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services," *Ecological Economics* 41, no. 3 (2002): pp. 393–408.

17 Adapted from the U.S. Green Building Council's LEED for Neighborhood Development Pilot SLL Credit 1: Brownfields Redevelopment and LEED 2009 for New Construction and Major Renovations, SS Credit 3: Brownfield Redevelopment (High point value only).

18 Adapted from the U.S. Green Building Council's LEED 2009 for Neighborhood Development, SLL Prerequisite 1: Smart Location

19 Adapted from the U.S. Green Building Council's LEED 2009 for Neighborhood Development, SLL Prerequisite 1: Smart Location and SLL Credit 4: Bicycle Network and Storage. The bicycle racks/storage component was also adapted from the LEED 2009 for New Construction and Major Renovations, SS Credit 4.2: Alternative Transportation: Bicycle Storage & Changing Rooms.

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Glossary

100-year floodplain includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes, and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99, V, and VE; however, in some areas they may need to be calculated by the site development team.

Acceptable noise level is a maximum of 55dBa. This is a recommended level of noise adopted from the U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, 550/9-74-004, (March 1974), and the World Health Organization (WHO), Guidelines for Community Noise (April 1999).

Appropriate plant species are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.

Average buffer width can be calculated using perpendicular transects every 50 feet along a water body for at least 90 percent of the stream or shoreline length within the boundaries of the site. For final average buffer widths, a minimum buffer width of at least 10 feet must be maintained at all points along the buffer. Buffer widths for rivers, streams, and tributaries are measured on each side of the stream from the top of bank.

Basic services include, but are not limited to: bank, child care facility (licensed), community/civic center, convenience store, hair care, hardware store, health club or outdoor recreation facility, laundry/dry cleaner, library, medical/dental office, pharmacy (stand-alone), place of worship, police/fire station, post office, restaurant, school, senior-care facility, supermarket, museum, and theater.

Bicycle lane is a striped lane used for one-way travel on a street or highway. The standard bicycle lane width measured from the front edge of curb to the painted boundary should be at least 4 feet wide. If on-street parking is allowed, the minimum width is 5 feet.

Bicycle network is a continuous bicycle or multi-use facility that is completely separate from the vehicular right-of-way but can be shared with pedestrians. The standard bicycle network has pavement that is at least 8 feet wide with a 2-foot unpaved clear zone on each side; 10 feet of pavement is recommended, along with the 2-foot clear zones to minimize conflicts between pedestrians and bicyclists.

Bicycle racks and storage must be secure (e.g., bicycle racks, lockers, and storage rooms). These spaces should be easily accessible by site users during all periods of the year and free of charge.

Brownfield is an abandoned, idled, or underused industrial and commercial facility/site where expansion or redevelopment is complicated by real or perceived environmental contamination; a site documented as contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program; a site defined as a brownfield by a local, state, or federal government agency.

Carpool is an arrangement in which two or more people share a vehicle for transportation.

Centers for Disease Control and Prevention (CDC) guidelines recommend that adults have 150 minutes of moderate-intensity aerobic activity (e.g., brisk walking) each week, or 75 minutes of vigorous-intensity physical activity (e.g., jogging or biking) each week. Refer to the CDC website for physical activity needs for children and older adults.

Common stormwater pollutants that can adversely impact receiving waters include the following:

- Landscape chemicals: pesticides, fertilizers, herbicides, detergents, oil, grease
- Metals: copper, zinc, lead
- Nutrients: nitrogen, phosphorus
- Pathogens: bacteria, viruses, protozoa
- Regional pollutants: salts, alcohol, temperature
- Solids: soil, tire particles, road abrasion material, etc.

Community Benefits Agreement is an agreement made between the developer and coalition(s) of community organizations, addressing a broad range of community needs to ensure that affected residents share in the benefits of major developments. The agreement allows community groups to have a voice in shaping a project, to press for community benefits that are tailored to their particular needs, and to enforce developer's promises.

Control of invasives is the appropriate eradication, suppression, reduction, or management of invasive species populations, prevention of the spread of invasive species from areas where they are present, and taking steps such as restoration of native or appropriate species and habitats to reduce the effects of invasive species and to prevent further invasion.[1]

Created water features are features with water made visible for aesthetic purposes. These features can include ponds, streams, pools, fountains, water gardens, created wetlands (ornamental or for water cleansing), and any other water element in the landscape with permanent or seasonal, occasional, or otherwise intermittent water. Created water features can include those intended for limited human contact or for full human contact. Note that water intended for human contact must meet local and/or state health requirements. In some situations, this may require additional treatment methods such as ozonation or thermal treatment.

Cultural landscape is a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

Deconstruction is a process of carefully taking apart constructed elements with the intention of either reusing or recycling the materials. It may be undertaken during redevelopment, adaptation, or at the end of use on a site.

Design for deconstruction, also called Design for Disassembly, is the design of buildings or products to facilitate future change and the eventual dismantlement (in part or whole) for recovery of systems, components, and materials. This design process includes developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal.

Diameter at breast height (DBH) is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. For guidance, see the ISA website, *http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx*.

Farmland of statewide importance refers to soils designated by each state Natural Resources Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland which does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods.[2]

Full-Time Equivalent (FTE) occupants are the occupants of a site during a standard 8-hour period. An 8-hour period has an FTE value of 1.0, while a part-time occupant has a FTE value based on his/her hours per day divided by 8. (FTE Occupants = Occupant Hours/8 hours). If there are multiple shifts, use only the highest volume shift in the FTE calculation but consider shift overlap when determining peak site users. Note that FTE calculations must be consistently used throughout documentation.

Geomorphological and vegetative methods focus on the creation of a stable dimension, pattern, and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time, the stream is self-maintaining (able to transport the flow and sediment of its watershed without aggrading or degrading). This can include a broad range of measures, including the removal of the watershed disturbances that are causing stream instability; installation of structures and planting of vegetation to protect streambanks and provide habitat; and the reshaping or replacement of unstable stream reaches into appropriately designed functional streams and associated floodplains.

Graywater is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.

Greenfield is a site that has not been previously developed or graded, including previous agricultural fields.

Greyfield is a site that has been previously developed or graded.

Healthy soils are all areas of soils that have not been significantly disturbed by previous human development activities. Indicators of healthy soils may include one or more of the following:

- soil horizons that are similar to the *reference soil*
- bulk densities that do not exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
- *organic matter* content that is equal to or exceeds that of the reference soil
- soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) similar to that of the reference soil
- absence of compounds toxic to the intended plants
- presence of vegetation that is representative of native plant communities.

Infill site is a site that must have at least 75 percent of its perimeter bordering sites that consist of at least 75 percent previously developed land. Any fraction of the perimeter that borders waterfront will be excluded from the calculation.

Integrated design team includes the owner and/or client and professionals knowledgeable in landscape design, construction, and maintenance. Team members should be selected to meet the unique constraints and opportunities of the site.

Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. The IPM approach places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.

Invasive species are species that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health.[3]

Isolated wetlands are wetlands with no surface water connections to other aquatic resources.

Landscape coefficient is a constant used to modify the reference evapotranspiration. It takes into account the species factor, density factor, and microclimate factor. For the purposes of the Irrigation Calculator, the density factor and microclimate factor are both assumed to approximately equal one, to reduce the complexity of the calculations. In general, a high landscape coefficient value is used for plants that need a lot of water, and a low value is used for plants that need little water.

Light pollution is any adverse effect of artificial light, including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste. (International Dark-Sky Association, 2008).

Living wage is the wage that a full-year, full-time worker would need to earn to support a family of four at the poverty line. Cities and counties with a higher cost of living tend to have higher living wage levels.

Lowest-cost comparable item is the most inexpensive item that provides a desired function (such as light emittance) for the site. For example, the lowest-cost light bulb that meets the site's lumen requirements (whether it be conventional bulb, LED, compact fluorescent, or other bulb type) can be used as the "lowest-cost comparable item," regardless of the type of bulb selected for site use.

Management of invasives is the implementation of control measures to prevent the spread of invasive species or lessen their impacts when they appear to be permanently established.[4] Control and management of invasive species encompasses diverse objectives such as eradication within an area, population suppression, limiting spread, and reducing effects. Complete eradication is not generally feasible for widespread invasive species or where adequate control methods are not available. Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. Consideration of cumulative environmental impacts requires that environmentally sound methods be deployed, especially in vulnerable areas.

Mature, stable compost is compost that tests at 6.0 or higher on the Solvita Compost Maturity Index Rating, which is a combination of Carbon Dioxide and Ammonia Maturity Tests (test information and equipment available at www.solvita.com).

Minimal impact site development is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.

Minimal soil disturbance describes soils that are minimally graded and/or compacted, such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A, but not covered with impervious surfaces. Examples of soils that are minimally disturbed include areas with minor modifications or very limited development but not covered with buildings or paved surfaces, such as areas that have been compacted by livestock or heavy foot traffic.

Moderate soil disturbance describes soils in which topsoil is compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A or is partly removed and/or not present, and in which subsoils are compacted or mixed with topsoil. Examples of soils that are moderately disturbed include previously developed or graded areas that are not covered with buildings or paved surfaces, such as unpaved ranch roads.

Native plant communities are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At at least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

Native plants are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids, varieties, and cultivars of species native to the ecoregion are acceptable.

Natural surveillance is the placement of physical features, activities, and people in a way that maximizes visibility.

On-going consumables are materials that are regularly used and replaced through the course of business. These materials can include, but are not limited to, paper, glass, plastics, cardboard, and metals.

Open-grid pavement is pavement that is less than 50 percent impervious and contains vegetation in the open cells.

Opportunities for participation are opportunities where information is shared and received through formal and informal methods such as charrettes, community meetings/ workshops, newsletters, press releases, surveys, or website.

Organic matter in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using "loss on ignition" tests that measure the amount of the element carbon, a key constituent of all organic matter.

Peak watering month is the month with the highest evapotranspiration rate. This is the month when the plants in the site's region require the most water. For most regions in the United States, the peak watering month is July.

Potable water is municipally treated water or well water that is suitable for drinking.

Post-consumer material is waste material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is material diverted from the waste stream during the manufacturing process that could be used in a separate and different manufacturing process (e.g., reuse of flue gas desulfurization gypsum in drywall production). Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Preferred parking includes the parking spots that are closest to the main entrance of the project (exclusive of spaces designated for handicapped) or parking passes provided at a discounted price.

Previously developed site consists of at least 75 percent of the site area that has preexisting paving, construction, or altered landscapes. This does not apply to a street, roadway, or altered landscapes resulting from current agricultural use, forestry use, or use as preserved natural area.

Primary contact recreation includes activities in which there is prolonged and intimate body contact with the water (Secondary contact recreation includes activities with incidental water contact in which the probability of ingesting appreciable quantities of water is minimal).

Prime farmland refers to soils designated by the Natural Resources Conservation Service as "prime farmland."[5] This does *not* include soils that would be prime farmland if drained, irrigated, protected from flooding, etc. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Principles and goals are defined as follows: principle—guiding overarching concept; goal—observable and measurable end result having one or more objectives to be achieved within a more or less fixed time frame.

Program plan is a narrative or written design that provides a mechanism for clearly stating the vision and desired outcomes of the project and setting the direction of the design team.

Rainwater/stormwater features use rainwater and stormwater as their sole source and function as stormwater management elements. Examples include pools, fountains, stormwater BMPs, water gardens, channels/runnels for local conveyance, raingardens, and water art. Features can include those intended for limited human contact, or for full human contact.

Receiving waters include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and stormdrains.

Reclaimed water is effluent derived in any part from sewage from a wastewater-treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use, or a controlled use that would not otherwise occur, and is no longer considered wastewater.

Recycled content is defined in accordance with the International Organization of Standards document, ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling). For more information on ISO, see *www.iso.org*.

Reference soils are defined as:

- soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped).

OR

- undisturbed native soils within the site's region that have native vegetation, topography, and soil textures similar to the site.

OR

- for sites that have no existing soil, undisturbed native soils within the site's region that support appropriate *native plants* or *appropriate plant species* similar to those intended for the new site.

Regularly occupied building(s) are buildings where occupants (workers, students, etc.) are seated or standing inside for extended periods of time.

Rehabilitate is defined as ecological restoration that strives to alter the biota and physical conditions at a site, with an emphasis on the reparation of ecosystem processes, productivity, and services.

Renewable energy sources must meet the Center for Resource Solutions (CRS) Green-e products certification requirements. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements.

Replacement value can be determined by pricing a comparable material in the local market.

Reuse is a process of utilizing a used product or material in a manner that generally retains its original form and identity with minor refurbishments. Materials reusable in whole form might include sand-set pavers, segmental retaining walls, or mechanical fasteners, connections, and/or joinery (e.g., avoidance of adhesives and mortar).

Salvage is the recovery of materials from existing sites for *reuse* on other sites.

Salvaged materials are construction materials recovered from existing buildings or sites and *reused* on-site.

Schematic design is the concept and basic framework for the design of the project.

Severe soil disturbance describes soils in which topsoil is removed and/or is not present; subsoils are compacted such that compaction levels exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A; and/or topsoil or subsoil is covered with impervious cover or is chemically contaminated. Examples of soils that are severely disturbed include areas that are covered with buildings or paved surfaces, or areas that are defined as brownfields by local, state, or federal agencies.

Shared Lane Markings (SLMs) are markings on streets (typically with a speed limit below 35 mph) that help bicyclists position themselves to travel side by side within the same traffic lane in lanes too narrow for a motor vehicle and a bicycle. They encourage safe passing of bicyclists by motorists, reduce the chance of a bicyclist's impacting the open door of a parked vehicle in a shared lane with on-street parallel parking, alert road users of the lateral location bicyclists may occupy, and reduce the incidence of wrong-way bicycling.

Site outdoor electricity is all electricity consumed for landscape purposes outside of the building.

Soils disturbed by previous development are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include one or more of the following:

- soil horizons that differ significantly in depth, texture, or physical or chemical properties from the *reference soil*
- bulk densities that exceed the Maximum Allowable Bulk Densities shown in Figure 7.2-A
- *organic matter* content lower than that of the reference soil
- soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil
- presence of compounds toxic to the intended plants
- presence of weedy, opportunistic, or invasive plant species

Solar reflectance index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values for some materials will be available in the LEED 2009 Reference Guide. For more information on ASTM standards, see *www.astm.org*.

Special status plants refers to vegetation designated as important by local, state, or federal entities; designations may be for size, species, age, rare or special collections, ecological and environmental value, unique genetic resources, aesthetics, location, or other unique characteristics. Groves/clusters may also be designated special status.

Specific pollutants of concern include those listed for the site's receiving water on the Clean Water Act Section 303(d) impairment lists by the state water-quality agency.

Stakeholders may include, but are not limited to, the following: neighbors (e.g., residential, commercial, industrial, institutional-education, religious, government, non-profit), interest groups (e.g., growth management, environmental, transportation), public officials from local jurisdictions, regulators, community leaders, business organizations, etc.

Sustainable water sources are non-potable sources and can include harvested rainwater, surplus water from building or site operations that has been appropriately cleansed and cooled, and surplus site water that is not needed to maintain existing or restored site ecology. Potable water or other natural surface or subsurface water resources are not sustainable water sources.

Temporary occupants are occupants such as students, visitors and customers that are on a site intermittently. The calculation for temporary occupants is based on an average expected volume per day (excluding special events). Note that calculations for Temporary Occupants must be consistently used throughout documentation.

Unique farmland refers to soils designated by the Natural Resources Conservation Service as "unique farmland."[6] Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.

Vegetated area describes all portions of the site that will support vegetation.

Vegetation and soil protection zones (VSPZ) must meet the following requirements:

- Construction impacts from overall site development shall not decrease the capacity of the VSPZ to support the desired vegetation. For example, construction activities outside of the VSPZ should not change drainage patterns and microclimate effects within the VSPZ.
- VSPZ shall be protected with a fence or other physical barrier that cannot be easily moved (wildlife-permeable barrier, if appropriate) that protects the zone during construction from equipment parking and traffic, storage of materials, and other construction activities.
- All construction and maintenance personnel are to be educated about the locations and protective measures of the VSPZ. In construction documents, outline consequences to contractor if VSPZ boundaries are not respected.
- VSPZ can encompass one plant or can include several plants in a group. VSPZ boundaries for trees shall extend out from the trunk, to a distance of 2 feet radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system as determined by ground-penetrating radar. VSPZ boundaries for shrubs shall extend out from the stem to twice the radius of the shrub. VSPZ boundaries for herbaceous vegetation shall extend to encompass the diameter of the plant.
- No more than 10 percent of the total area of the VSPZ can contain development. Only minimal impact site development is allowed within the VSPZ.
- Incorporate into the site maintenance plan (see *Prerequisite 8.1: Plan for sustainable site maintenance*) on-going management activities to protect the integrity of the VSPZ.

Vegetation trimmings include only non-invasive plant material free of disease.

Vehicles that have reduced emissions and/or high fuel-efficiency are vehicles that are either classified as Zero Emission Vehicles (ZEV) by the California Air Resources Board or that have achieved a minimum green score of 40 on the American Council for an Energy Efficient Economy (ACEEE) annual vehicle rating guide.

Volatile organic compounds (VOCs) are a variety of organic compounds that vaporize at room temperature, including benzene, chloroform, p-Dichlorobenzene, formaldehyde, and tetrachloroethylene. VOCs are the principal component in atmospheric reactions that form ozone and other photochemical oxidants, causing a variety of negative health effects from dizziness, eye and respiratory tract irritation, nervous system damage, developmental effects, and cancer.

Walk distance is the distance that a pedestrian must travel between destinations without obstruction, in a safe and comfortable environment such as on sidewalks, footpaths, or other pedestrian facilities. Sidewalks adjacent to urban roads of 40 mph or higher must have a buffer zone between the road and sidewalk.

Waste audit is a systematic review of a site and its operations to quantify the types and amounts of waste generated, and the management practices that impact that waste generation. It includes an assessment of purchasing practices and identifies the areas and materials in which waste reduction efforts will be most effective. A waste audit also sets a baseline for measuring future progress of waste reduction efforts.

Wetlands are defined by the Clean Water Act (U.S. Code of Federal Regulations 40 CFR 230.3) as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

[1] The definition of "control" is modified from Executive Order 13112.
[2] USDA Natural Resources Conservation Service, "Identification of Important Farmlands," Part 657.5 of Chapter VI of Title 7 of the Code of Federal Regulations (1-1-00 Edition), http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=7&PART=657&SECTION=5&YEAR=2000&TYPE=PDF (accessed 7/14/2009).
[3] KG Beck, K Zimmerman, JD Schardt, J Stone, RR Lukens, et al. (2008),"Invasive Species Defined in a Policy Context: Recommendations from the Federal Invasive Species Advisory Committee," *Invasive Plant Science and Management* 1 (2008): pp. 414–421. This is an expansion of the federally adopted definition under Executive Order 13112.
[4] The definition of "management" is adapted from "Meeting the Invasive Species Challenge," National Invasive Species Council. Jan 18, 2001.
[5] USDA Natural Resources Conservation Service, "Identification of Important Farmlands," Part 657.5 of Chapter VI of Title 7 of the Code of Federal Regulations (1-1-00 Edition), http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=7&PART=657&SECTION=5&YEAR=2000&TYPE=PDF (accessed 7/14/2009).
[6] Ibid.

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