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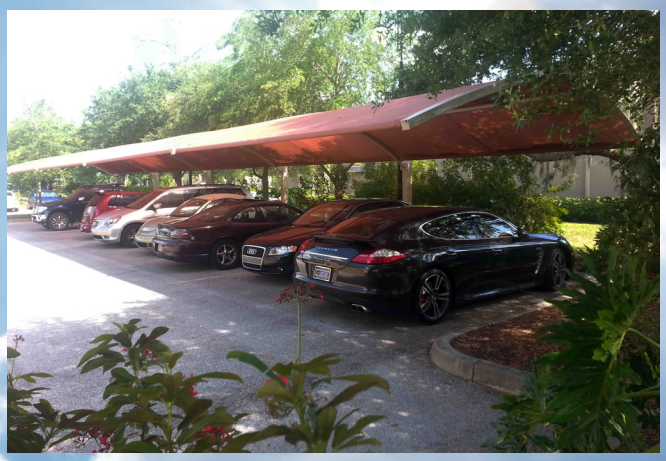
Green Parking & Shade



Green Parking And Shade

Buck Abbey, Landscape Architect
Green Laws Research Project

Many local governments have enacted
tree and landscape ordinances, which are most useful for adding parking lot shade.
EPA, Reducing Urban Heat Islands, Compendium of Strategies 2008

Shading & Cooling Parking Lots

Large conventional parking lots in cities have harmful effects on people and society. Some are social, others are environmental. They include problems associated with water quality, urban temperature, air emissions, non-point pollution generation, removal of native habitat, influx of invasive species, removal of open space and accommodating urban sprawl. [1] There has been much written in the last decade about how 'green parking lots' can solve some of these problems. This greening designation was defined by both the LSU School of Landscape Architecture and the US Environmental Protection Agency. Simply put, this definition suggests putting parking lots to work providing "ecosystem services." [2] Strategies have been developed to green parking lots manage stormwater, filter the air, produce oxygen, preserve native soil, cool cities, increase biodiversity and improve human health and well being. Suddenly, science and design have come together to green cities and the parking lot is a main target of city greening. Figure 1.0 shows some typical greening methods. *Greening a parking lot transforms a hot, dusty, dirty layer of paving that has been striped to temporarily store automobiles into a more wholesome urban forest setting.*

Going green is something the public is demanding and local landscape codes are helping to push the trend toward improving the environment of cities. Landscape codes are enacted to ensure that parking lots contain trees and other vegetation. Some codes stress stormwater management and others stress preserving native habitat. Many are pointing the way toward better parking lot design. One of the most common parking lot design standards found in landscape codes is concerned with planting trees. Planting of trees in parking lots provide many ecosystem services. These include the ability of trees to reduce greenhouse gases, store carbon, and provide shade. Parking lot trees also reduce the scale and size of a paved areas and provide therapeutic views of nature for urban dwellers. In addition, new research is working on the social determinant of planted trees in the urban forest as a restorative factor in human health outcomes. [3] Tree planted parking lots are an important element of the urban forest of American cities.

Parking lot trees are often planted in three locations. They are planted within the interior of the vehicle use area (VUA) and around its perimeter for the purpose of providing shade. Parking lot screens are planted with small trees and hedges to cut reflective glare and reduce the scale of parking lots. A typical example of a landscape code, that greens parking lots by providing shade is the one from hot and steamy Miami, Florida. [4] The purpose of Miami's shading standard is to cool parking lots by "channeling breezes, thereby helping to offset global warming and local heat island effect through the added absorption of carbon dioxide." *Many communities, such as Montgomery County Maryland are adopting canopy and shading standards in their community landscape code which is evidence that communities see more shade in the city as an environmental benefit*.

Shade trees in parking lots also provide oxygen for breathing, sequester carbon by absorbing carbon dioxide and will filter the air of dust and airborne debris.

There are other communities that set shade standards for parking lots based upon the extent of shadows created to cool the pavement. Often shade is calculated as being the same measure as the crown diameter of the tree. Technically, this calculates shadow extent at noon when the sun is directly overhead on June 21 at latitude $23^{O}26'$N. This is the way the City of Fresno, California requires tree shadows to be managed. [5] However, no landscape code exists that bases shading on moving shadow patterns. [6] Moving shadows recognize morning shade as well as afternoon shade. This requires a careful calculation measured by total area shaded as a percentage of pavement area on a solar daylight basis at a proscribed series of daylight hours at a specific geolocation coordinate. This is a calculation a little too difficult for many to do, yet computer modeling has the capability to do so. Moving shadows cool parking lots more thoroughly from sunrise to sunset.

More cities have become aware that parking lot shading is an important tool to reduce the heating of cities. It is recommended that small parking lots (10-30 spaces) have moving shade coverage (MSC) requirement of 70% and that large parking lots (+30 spaces) have a moving MSC OF 50%.

Greening the Parking Lot

Sustainability based codes are the coming wave of landscape code technology. *New landscape design standards are anchored in science so their effect upon the environment is measurable.* The landscape code for the City of New Orleans is one such pioneering sustainability based landscape code. [7] This coastal city place emphasis on parking lot paving, stormwater management, reducing urban heat, saving the consumption of energy and increasing species diversity. Louisiana sustainable gardening principals are also included in the code. This code is leading the city toward the design of green parking lots.

Large cities such as Miami, New Orleans and suburban Washington DC have large expanses of heat generating paving. Strip shopping centers have up to 2 acres of paving while schools, churches, government centers may have 10 acres and regional shopping malls up to 60 acres of environmentally sterile paving. Heat build up in cities called the "urban heat island" (UHI) is largely a result of building roofs and parking lot paving. [8] Heat build up from parking lots in the city not only causes personal discomfort but increase the use of energy in buildings as well as causing problems with air and water quality, human health and urban wildlife habitat.

Two green building programs have been created over the last decade to allow for the design of green buildings and green building sites both of which include parking lots. These green building programs are known as LEED v4.1 and SITES v2. Should be incorporated into local building and landscape codes. [9] Both provide 'credits' that are evidence based guidelines and performance bench marks to produce and measure ecosystem services. These trademarked design standards are documented in design manuals and have 'score cards' in which the degree of sustainability is measured and noted as "certified, silver, gold, or platinum" levels of sustainability.

SITES and LEED practices are known to reduce energy usage, make building sites healthier and conserve or protect scarce natural resources. This material can be found in the Sustainable Sites Initiative-*Guidelines and Performance Benchmarks 2015, SITES v2,* www.sustainablesites.org/report/.

Parking Lot Shading Criteria

The purpose of SITES Credit 4.12 (LEED SS Credit: Heat Island Reduction) is to reduce the urban heat island effect. As we have noted, parking lots play a big roll in urban heating. *The UHI effect can be modified in three ways, add shade with trees or overhead shade structures, increase the reflectivity of pavement or convert up to 30% of the paved area as human or wildlife habitat landscape space.*

Paving must have a raised reflectance level (solar reflectivity) that reduces heat buildup. Heat build up is reduced if ultra white concrete or a very light colored stone material is used as pavement. Regular concrete and asphalt would be replaced with less heat absorbing material. Any paving that uses a colored high-albedo surface material will achieve the required 0.30 reflectance level required by the SITES program. The use 'open grid paving' that consists of a combination of hard paving and a grass infill reduces heat build up with the added advantage of allow stormwater to reduce runoff though percolation.

Shady parking lots are cooled when large canopied trees are used to reduce temperature build up on pavement surfaces. Planting trees with high shade canopies within interior parking bays and along the perimeter is also recognized by SITES as a method of reducing urban heat. Evergreen trees are more effective in the South while deciduous trees work better in the North. A southern live oak is a great example of a shade producer in the South while the White Oak is excellent in the North and Valley Oak in the West.

Overhead architectural features can also be designed to reduce heat build up from parking lots and achieve SITES credits.

Overhead structures must be designed with a solar reflectance (SR) value of 0.28 or better. *Shade on parking surfaces maybe created with overhead stretched fabric, wooden arbors, shade pergolas or even possible with the use of trellised overhead woody vines.* Solar energy captured by these structures is an extra benefit. The structure can be put to use powering parking lot lighting, irrigation systems, decorative elements such as fountains or even supplementing energy removed by electric charging stations that are often included in green parking lots.

Lowering the temperature below sun screens reduce evaporative emissions of volatile organic compounds (VOCs) that emanate from cars stored in the sun. Interior temperatures within parked cars are reduced greatly as anyone who parks under a shady tree will attest. Shaded walkways within parking lots also can cool pavements but perhaps more importantly allow people to walk back and forth without exposure to harmful rays that cause skin cancers.

Replacing 30% of parking lot paving with natural areas that can be planted is a third method of reducing urban heat emanating form paved surfaces. *Rainfall is another valuable resource to capture when overhead structures are used*. Since planting beds for trees or shrubs are often adjacent to overhead structures it is possible to capture rain fall and channel it into nearby planting beds, bioswales, constructed wetland features or restored aquatic systems.

Miami-Dade County, Florida and Montgomery County Maryland landscape codes require the use of storm water retention/detention facilities that can capture parking lot runoff. [10] Overhead structures work well as a feeder devises to transfer rain to these small on-site water collectors. This is a smart way to allow a shade producer to capture, convey and manage on-site stormwater as a resource or an amenity. Additional credit is possible in the SITES green building program for rain water capture in parking lots. (see Water Credit 3.5).

Sun Screens To Green Parking Lots

Perhaps the most effective way to shade pavements and to reduce the urban heat island problem is with the use of pre-engineered fabric shade structures. These, often called sun screens are very popular in the torrid south and southwest where parking lots can cook an egg sunny side up in a matter of seconds.

Greening a parking lot is largely about maximizing shade, blocking the sun and reducing urban heating as a result of excess pavement. [11] Shade structures have the capability of reducing air temperature up to 20 degrees while blocking up to 96% of the sun's ultraviolet strength. Car interiors parked under a shade structure can be 100° cooler than those parked in an open lot. [12]

Shade structures are manufactured with engineered structural framing and custom cut specially treated UV tolerant polyethylene fabric. Many colors for framing and fabric are available.The fabric is warrantied for its great durability, UV protection, aerial strength and it's ability to shade out harmful solar radiation. [13]

Shade structures can complement any building exterior trim and easily connect to walkways and landscape planting beds. Not only do these fabric screens have a relatively long life span, but when replacement is needed, it is easy and quick to change out the fabric. Worn out fabric is recycled.

The most often used form for parking lot structures are modular cantilever screens. *Parking bay shade structures work best if designed in tandem with the planting features of a parking lot.* [14] This way they can accompany the planting of shade trees or other landscape plantings that also reduce urban heat build up. Planting extends the amount of shade generated in the parking lot and helps to visually blend parking into the surrounding city. Modular shade structures are easy to work into the pattern of interior driveways, parking bays, planter islands and the interior walkway system. When properly sited in a North-South direction shade patterns move from sunrise to sunset covering on average between 80% and 40% of the parking surface. Figure 2.0 illustrates shade tree coverage only at 12 noon on June 21 at latitude 25°45' in Miami, Florida.

Fabric structures can also be designed to cover walkways. A walk from a building to a parked car under a sun screen never exposes skin to solar radiation as well as providing moderate cover during rain storms or snow events. The shade structures in parking lots can be equipped with lighting systems, surveillance devices, solar panels and electric charging stations. And of course, sun screens can be used at drop off and pick up zones as well as for bus parking bays within parking lots.

Using fabric structures to earn sustainability credits under one or both green building systems is practical and is perhaps one of the major distinctions of a green parking lot. Some variation in canopy material is possible. *Green parking lots that provide shade is one giant step toward building sustainability into the design of the urban forest of a city*. [15] A well designed green infrastructure system in which shade in green parking lots plays an important roll is a goal all cities in America should strive to achieve.

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Note 1: Power Quotes those best used for advertising are italicized.

Note 2: also on page five two Apollo facts are used to indicate the percentage of temperature reduction and UV energy blockage are cited. In the two pieces of Apollo literature cited in 12 and 13 directly above have facts that are contradictory. Your two cited publications do not agree with each other.

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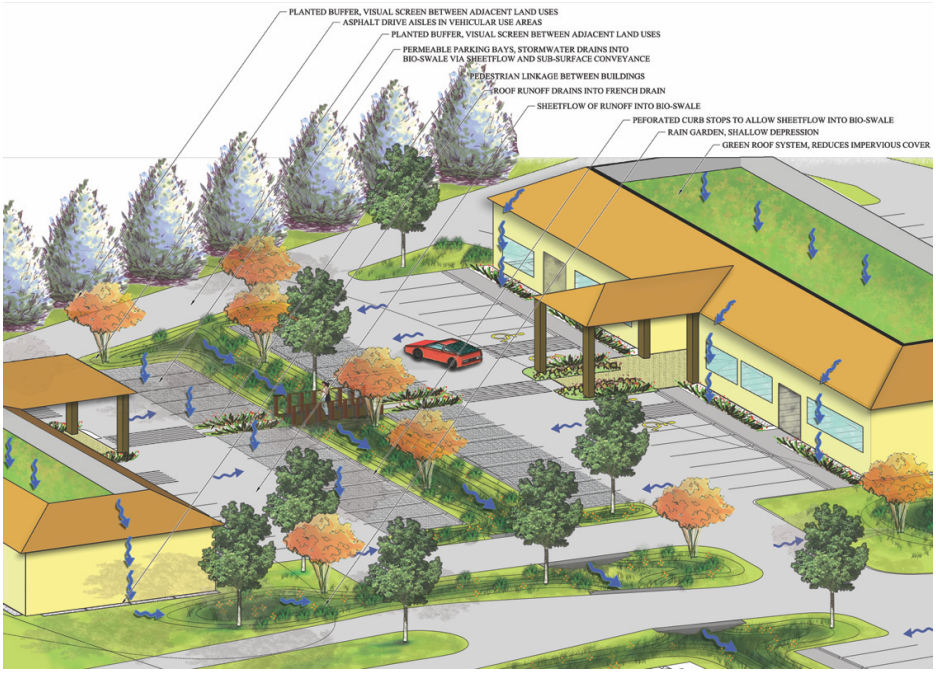

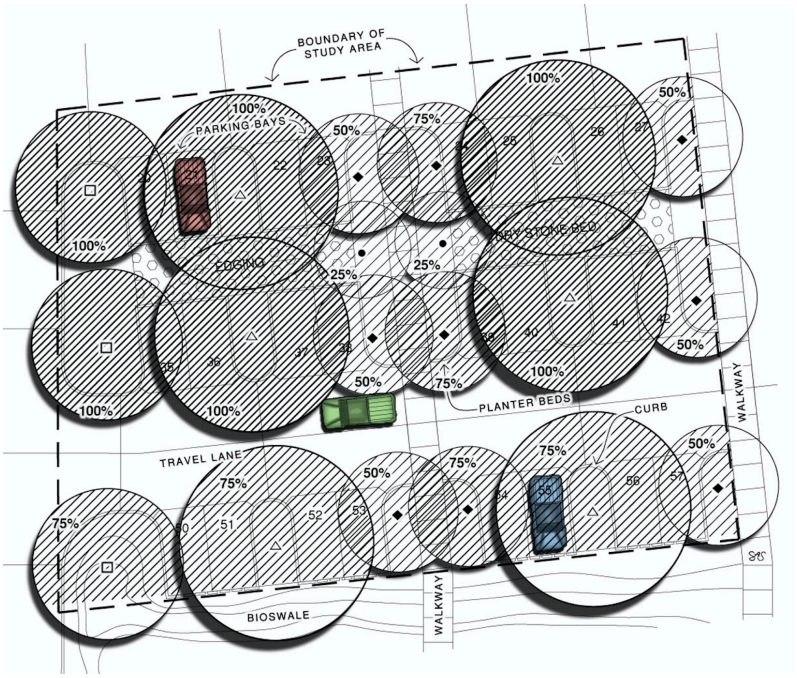

Figure 1.0 Green Parking Lot Design, Adam McGovern, Abbey Associates, Inc.

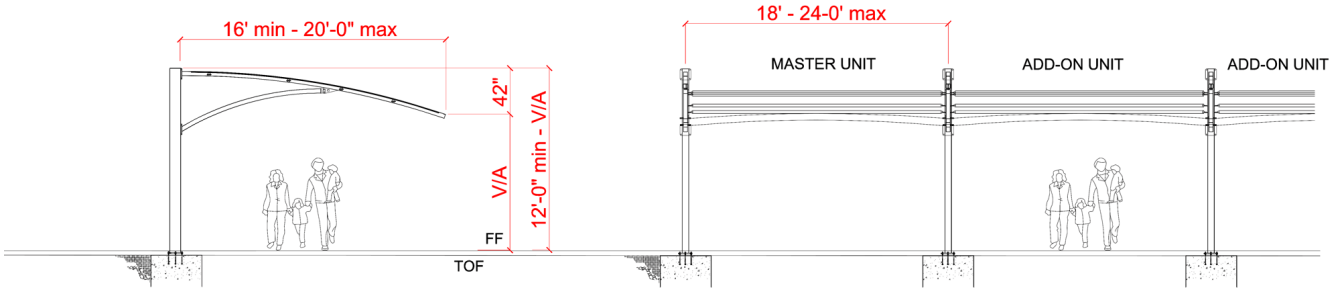

Fig. 2.0 Green Parking Lot Shading Study, Abbey Associates, Inc. Landscape Architects

Fig. 3.0 Patented Sun Screen, Apollo Sunguard, Sarasota, Florida

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Landscape Design Sketchbook

-green laws, municipal codes & landscape design -

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Green Parking & Shade

Parking Lots

An old landscape architect's saying suggests "the most used landscape in the United States is the parking lot."

This seems to be true since most people in the country begin their day in a parking lot, stop there while working, leave the parking lot, stop by the store to pick up eggs and then go home to park the car in the driveway which is a small personal parking lot. In most instances, the parking spaces are in full sun and the climate of this place is not good.

Yes, a parking lot is American's most often used outdoor space. It is in general a hot, exposed, oily slab of reinforced concrete or uneven and pitted asphalt with absolutely no ecology. Parking lots have no ecology and support no known surface life. Some parking lots can actually be toxic to humans as well as small creatures. Runoff can carry this toxicity to other locations.

Various studies have been conducted to examine urban land use. Scientists point out that open parking occupies approximately 46.3% of all urban space in the central part of American cities. [1]

It can be fairly said that parking lots comprise the most open space in cities yet they are used for one purpose only.

On average, at the site design level up to 95% of the building site is devoted to buildings, parking and walkways. At the residential site scale one may find up to 20% of the site plan is used as open space most often in form of grass lawns and their ecological capability is challenged as well.

When sidewalks, roof tops and roadways are added together in the center of a city

more than 90% of the land area is built up

One recent study of parking and green laws found that parking lots occupy about 10 percent of the land in U.S. cities, and can be as much as 20 to 30 percent of the land in downtown CBD areas. A study, by Dr. Kathleen Wolf, University of Washington, 2004 estimated that 80 to 90 percent of all U.S. parking demand is provided by surface parking lots.[2]

Due to zoning requirements that often over state the amount of parking required per land use, 2 or 3 times as much space is dedicated to parking as compared to floor space in the building being served by the parking. Lots for regional malls can be as large as 60 acres and mostly paved. Parking lots in cities push nature out.

Within city centers and very dense neighborhoods of large cities such as Los Angles, Chicago, New York, New Orleans or Miami the percentage of paved over and built over land can rise even higher, perhaps reaching 100% of impermeable coverage. Nature has been all but kicked out of these densely built up places.

It is time that landscape architects and others take a second look at the way parking lots are designed. Presently, parking lots provide one service and one service only, that is to store automobiles. There is a better way. We have been designing, often under-designing parking lots the same way for a long period of time. Perhaps at least since the 1930's parking design has changed little. By the 1960's parking lots began consuming cities not only removing all natural elements but pushing out the life of the city as well.

Parking lots are rarely designed as gardens but new research on the topic is increasingly suggesting that parking spaces might be designed by landscape architects and others to bring nature back into the city. We will find out more about how this is done below. Green parking lots, by definition is easily understood. Green Parking Lots do environmental work.

This is what gardens, parks, natural areas and backyard gardens do for the city. We might think of green parking as a special urban garden where people park their cars and the lots themselves provide environmental services to the community.

There is no doubt that parking lots impact the quality of life for those who live in urban areas. Study after study point out that urban living effects people in many ways both physically, emotionally and psychologically.

Experts agree cities suffer by not having ample parks, greenways, tree canopied plazas, waterfronts, sidewalk cafes and

places where people can interact with nature and with each other. They also suffer from having many large paved parking lots that give off tremendous amounts of urban heat, slightly polluted stormwater runoff and much visual clutter in the landscape.

One of the least understood ways parking lots impact urban living is though changes to ambient temperatures. The heat of the city is elevated due to excess paving and rooftops and the lack of landscaped spaces.

Urban Heat Island Effect

Many say the most devastating impact to cities caused by parking lots is the "urban heat island effect." This obscurity of nature was first noticed in the 1970s. The EPA defined this temperature change phenomenon and has been seeking ways to reduce its effect upon city living.

The built up, deforested nature of a city with buildings, streets, paved areas and especially parking lots attracts solar energy that heats up the city. This heat energy is temporarily stored and is released long into the night. Surrounding temperatures in the suburbs and rural areas are cooler and are falling at a faster rate. In the evening the temperature variation can be as great at 22 degrees F making city living more uncomfortable as well as more expensive.

According to the Environmental Protection Agency urban heat island effect (UHI) is problematic in that it can increase peak energy demand, add to building air conditioning costs, increase air pollution and generate greenhouse gas emissions. These are all detrimental to climate and promote heat related illness, mortality of older citizens and local water pollution.

We all have experienced the heat of walking across a parking lot in the middle of July. Notice too, when you get in your car how the temperature is even hotter. Cars sitting in parking lots can have internal temperatures of well over 120 degrees. Have you ever felt stickiness on the steering wheel on a really hot day? This is the weeping of polyurethane, a form of evaporative emission that almost seems to be melting from the steering wheel. Shading parking lots reduces heat build up within automobiles. Ever wonder why the first employee to arrive at work parks under the shade tree?

Parking lots are one of the greatest causes of UHI effect. According too the EPA there are several ways to reduce atmospheric warming in parking lots. They include the planting of shade trees, changes to or reduction in the use of pavement materials to increase reflectivity and using overhead pre-manufactured shade structures. Of the

three the use of the shade structures is the least well known yet it offers the greatest potential for cooling parking lots.

The EPA suggests that the most effective way to make changes to the UHI effect in cities is to incorporate strategies into landscape codes, tree preservation ordinances, parking lot shade ordinances and local zoning laws. They also stress using incentives such as tax breaks, grants, urban forestry education and awards to reduce UHI Effect and increase parking lot shade. Some cities have done this by incorporating parking lot shading standards within their municipal zoning laws.

In fact, a very good study of parking lot shading ordinances was conducted in California. The purpose of the study was to analyze the effectiveness of producing parking lot shade according to the use of local landscape ordinances.[3] This study found that by combining both parking lot shade structures with tree plantings produced optimum shade in parking lots. The study found that maximum shade in one of fifteen parking lots was 55% coverage. However, the study only calculated the effective tree shade area (ETSA) as being within the drip line of trees and directly below overhead shade structures. If the shade calculations had taken into consideration latitude 38.57N and its seasonal adjustments and daily sun movement consisting of altitude, azimuth and hours the effective shade area (ESA) within the parking lots would be greatly increased.[4] Perhaps, to the extent of 70 or 80 percent of coverage in both the mid morning and mid afternoon hours when heat build up is at its greatest level. In early morning and late afternoon when shadows are long cast, ESA would be near 100%. Coverage of this magnitude would greatly reduce the UHI effect. Intercepting the movement of the sun from the early morning hours to the early evening hours is the most

effective way to reduce heat buildup over the city.

Landscape Codes and Parking

Shading just one tool that can be used to design make parking areas do environmental work, which is by definition the purpose of a green parking lot.

Figure 1. Green Parking Lot in Mandeville, Louisiana

Shading a parking lot reduces heat build up over paved areas in the city and this in turn reduces solar radiation and impact on personal comfort by moderating the micro-climate.

Community landscape codes within zoning law generally require the shading of parking lot pavement. Conventionally, these ordinances require a prescribed percentage of parking lot pavements to be shaded. Percentages of pavement coverage can vary from 40% to 80% during a specific part of the day or on a seasonal basis. The ordinances set forth suggested species of trees with suitable size limits, canopy diameters and growth rates to be included with the interior of a parking lot. Technical standards within the ordinance give specific instructions as to size of planting space and where trees are to be planted in regard to car or pedestrian movement. A successful shading ordinance will generally require the shade tree to fully perform its shading function within a proscribed number of growth years such as 10, 15, or 20. Spacing of trees is important and this is often based up the distance of a parking spaces from a shade tree. Some landscape codes suggest perimeter plantings within property buffers to cast shade onto paved areas or over pedestrian walkways leading to or from parking spaces. Loading areas, driveways and other paved areas may be subject to shading requirements too.

Some communities not only draft landscape codes to shade parking lots but draft language to reduce the use of certain types of heat absorbing pavement and replace it with a so called ‘cool pavement’ such as an open grid pavement that does not all heat trapping or build up. The small little coastal town of Mandeville, Louisiana has built parking lots in their historic district where only the travel lanes are hard paved. All parking stalls use a sand gravel mix and ample interior islands, medians and peninsulas as well as perimeter buffers are planted with vegetation. These green parking lot have a high ratio of planted area to paved area and that really helps reduce urban heat build up. Not only are these parking lots shady, but they reduce the amount of heat gain by changing out pavement for planted areas.

On top of this, these parking lots are very beautiful since they are planted with coastal live oaks and shade tolerant dwarf palmettos and cast iron plants.

In Southern states evergreen trees such as camphor tree, Southern magnolia, American holly and spruce pine are better for parking lot shading while in Northern climates, deciduous trees such as maples, oaks, and ashes that allow winter sun to melt off snow and ice.

Across the country many communities require parking lots to be shaded. Some of the better landscape ordinances include Orlando, Miami, New Orleans, Sacramento, Seattle, Lenexa Kansas, Chicago, Prince George's County, Maryland, Charlotte-Raleigh North Carolina and Alpharetta, Georgia. The little island community of Grosse Ile, Michigan and the coastal community of Mandeville, Louisiana are appropriate for small communities

Most communities in sun scorched Louisiana require the planting of trees in parking lots to produce shade.

The New Orleans landscape code, Comprehensive Zoning Ordinance (CZO), Art. 23, Landscape & Screening is Louisiana's most recent landscape code. This landscape codes is one of the few in the nation at this time predicated to sustainability. Its stated purpose is "to assist in the development of a sustainable New Orleans by encouraging sustainable practices for landscape design, construction and landscape maintenance".

Section 23.7 of this ordinance directly sets forth parking lot design standards. These standards promote sustainability by attempting to reduce the urban heat island effect which is the scourge of Southern cities. All parking lots of ten or more spaces must have landscape plans designed to obtain a building permit. The interior of the parking lot must be designed to reduce heat build up, promote diversity in vegetation, manage storm water, promote water conservation, provide shade and improve the visual environment. A perimeter parking lot screen is to be designed with trees, shrubs and ground covers. Alternatively, tree canopy, landscape design elements, non-reflective auto canopies such as pre-manufactured fabric shade structures, solar panels and covered electric auto recharging stations may be used to "shade a minimum of fifty percent (50%) of the parking lot paved surface within five years of completion."

Another important element of this code is that it is the only landscape code in the State of Louisiana that specifically addresses

sustainability. The EPA does recognize several other cities in the nation that have tree or landscape ordinances that support sustainability. They include Atlanta, San Antonio, Annapolis, Orlando, Seattle, Chicago, and Sacramento. More importantly the New Orleans code recommends in Sec. 23.5 that the Louisiana Yards & Neighborhood program published by the LSU AgCenter be used as a tool in assisting landscape architects in drafting "notes, specifications and details" to guide landscape horticulturist, contractors, master gardeners, and green industry service companies in using sustainable practices when assisting in the building of well designed landscapes.

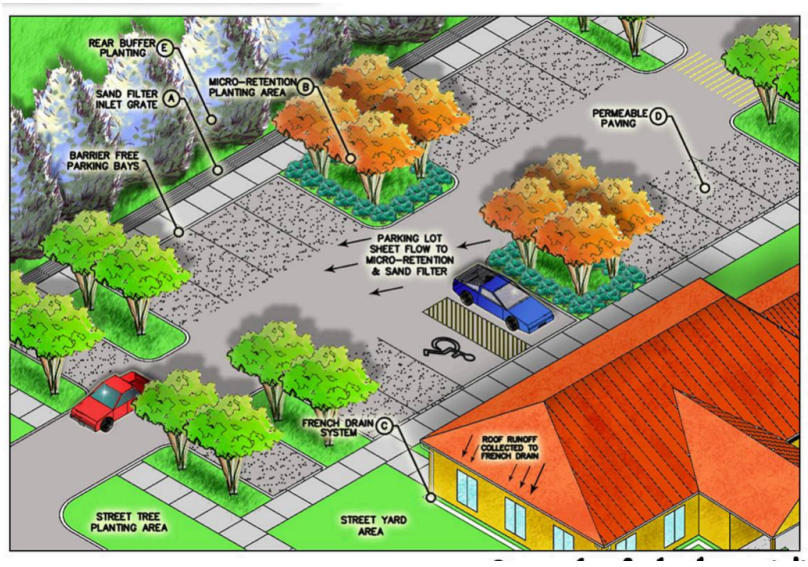
Figure 2. A Green Parking Lot, Louisiana State University

Greening Parking Lots

In addition to looking pretty and providing shade for cars in parking lots, trees and landscape materials do a large amount of environmental work. But the most important work may be reducing the UHI Effect. Landscape codes should inspire the planting of wide canopy parking lot trees around perimeters and though the paved area. Parking lot trees offer a host of environmental benefits to the city that include filtering air, reducing noise, interception of erosion, enrichment the soil, capturing parking lot run-off, stilling non-point pollutants, and providing wildlife benefits.

More importantly parking lot shade trees and particularly prefabricated fabric shade structure protect human skin and facilitate community use of parking lots, especially on weekend for community events. With ample shade, parking lots can have multiple uses that increase the "social compact" of living in cities. Green parking lots, a new source for city open space can be used part time for farmer's markets, craft sales, social events and community gatherings for concerts, outdoor movies or antique shows. Every city should require well shaded parking lot

surfaces where not only cars can be shaded, but humans can be shaded too.



Green Parking Lots

We have defined green parking lots as areas that not only store and park automobiles but areas that are designed to do environmental work. In other words, parking lots must not be designed for the single function of car parking but designed to perform environmental services. There is not much literature on this subject. A decade ago green parking was defined by the EPA as parking surfaces that helped to manage on-site stormwater. In 2008 the EPA upgraded its definition in the *Green Parking Resource Guide* as a parking area that incorporates a variety of environmentally preferable features that might include a minimized footprint and or parking pavement that use impervious surface materials or utilize other stormwater best management practices (BMP) in its design. They even suggest that cool pavements and cool rooftops be used to reduce the Urban Heat Island effect.

A series of articles originating at the School of Landscape Architecture at LSU developed a more complex definition of green parking.[6] This definition not only notes that parking lots ought to perform environmental services but specifically mentions design strategies that creates a more sustainable built environment.

What makes a parking lot green? The answer to this question is still being formulated across the nation. But progress is being made as you will see below. As you can see the original definition by the EPA above from about ten years ago suggested green parking consisted primarily of treating parking lot run off and disconnecting it from the stormwater train. The purpose here was to separate sediments, oils, grease, bacteria, toxins, urban detritus and solid waste from parking lot run off. This is still a a prime purpose so the parking lot micro-detention designed to intercept these wastes is important element of green

parking. But there are others defined at the LSU School of Landscape Architecture, They include; incorporating energy efficiency, water conservation, storm water management, construction waste minimization, non-point pollution prevention, micro-climate modification. The use of resource efficient materials and the establishment of outdoor environmental quality in respect to air, water, soils, wildlife and visual quality are important design factors as well. But perhaps more importantly green parking is designed to promote human health and well being.

It is a concept based upon several sustainable landscaping strategies. The 'first principles of green parking' include bringing nature into the parking lot to do environmental work. Green parking lots should help do the work of nature and in some instances mimic nature's natural systems though the efforts of landscape design. In addition another principle is concerned with increasing the social compact of cities by allowing multiple human uses, and improving human health and well being in these important urban spaces. And finally perhaps the most important first principal is green parking lots becomes a garden in the city that does environmental work that make cities better places to live.

Some of the functions of a green parking lot include the following. They utilize on-site storm water management practices to clean surface waters. Shade is generated to reduce the UHI effect and make parking lots more comfortable for both people and parked cars. In addition to reducing ambient temperature, shading protects people from solar radiation that can cause skin cancers. It is very important in green parking lots to provide shaded parking spaces as well as parking lot walkways leading to buildings. Walkway shade structures will increase the area of parking lots that are shaded to reduce the UHI Effect. Trees planted within parking lots to also produce shade clean, filter and cool the air and screen vehicles within the parking environment from the very violent summer sun.

Green parking is also provides permeable paving that allows storm water to enter the ground to replenish ground water. Micro-detention of surface run off cleans storm water of harmful pollutants. Low impact development strategies brought to green parking lots protect trees and native habitat that support urban wildlife populations. In addition green parking is concerned with car sorting and pedestrian management that allow circulation to function more safely

when people and cars share the same space.

Green parking is also mindful of fresh water wastage. Proper irrigation management within parking lots is an important water conservation practice. And finally, green parking lots can successfully repurpose many building materials that reduce energy use, costs and wastage. Recycling green waste within parking lots cuts down on landfill waste while providing nutrients for tree and landscape plantings within parking areas.

Parking Lot Vocabulary

Parking lots across the county vary greatly.[7] They vary in size, the way they are arranged and the method of which they are constructed. Most parking lots are defined in local zoning laws or building codes. Community landscape codes carry design criteria as to how parking lots are planted, screened or buffered. Some landscape codes provide requirements for preserving trees where parking lots are to be constructed and set design standards for amount of tree canopy to be provided, the composition of landscape materials for buffers and screens and ground coverings. Pavements, pavement foundations, drainage, circulation systems, and lighting are generally set in engineering technical manuals. Irrigation design and planting specification are usually provided by the landscape architect.

Figure 3. E-Vehicle Parking Sign, Cal Green

The parts of a parking lot vary according to parking demand, size and the number of cars or other vehicles to be accommodated. Parking lots are carefully designed since they have a particular function, specific sizing requirements, technical construction methods and a particular arrangement to site features and building orientation. The most common designed elements of a city include buildings and parking lots and as we have seen, together they occupy some 90 to 95% of the available land.

Parking lots are complex building forms. All too often, the important functions of the new facility's parking area are overlooked. The components of a medium to large surface parking lot consist of several elements that must be carefully designed. These include entry-exit points, main approach driveway, travel lanes, parking bays, parking stalls, arrival-drop off spaces, refuse pickup points as well as interior and perimeter walkways and interior islands, medians and peninsulas. Of course curbs, gutters and paint striping and pavement foundations are critical to the design of well functioning parking lot too.

There are special elements that are included into modern parking lots. Each of these require specific design consideration. These include ADA parking that have design requirements spelled out in Federal law. Also, some states or cities require special parking for compact cars, electric vehicles (EV), EV charging stations and bicycle parking. [8]

Some modern urban parking lots sort cars by size parking location carrying capacity or vehicle propulsion system. Bus parking and service area approach and large vehicle turns may need to be accommodated. Planting of parking lot interiors, perimeters and buffers are required in most communities with over 50K residents. Also of concern to designers are regional influences related to sun, soil, rainfall and temperature. Parking lots in Anchorage are different from those in New Orleans but this does not concern us as much here since our objective is to understand how to "green up" parking lots to allow them to do environmental work.

Additional accouterments found in parking lots may include benches, free standing shade structures, charging stations, porte cochère drop off, wheel stops, interior walkways, fountains, signage, sculpture and artwork. And as we will find out in our discussion of green parking there are new demands for parking lot design.

One of the latest inventions to hit parking lot design came on the scene in the late 1950s. This of course is the drive thru the first of which was Red's Giant Hamburger stand along Route 66 This parking lot addition added special drive up lanes with signboard ordering equipage, stacking space for up to 6 or 7 cars and often a covered overhead portico at the service window. Special drive thru planting is generally used now to separate this special parking lot addition from surrounding travel lanes and parking bays.

Sustainability & Greening

In the late 1960's the country was getting back to work following WWII. The stock market was thriving with the Nifty 50 stocks on the move, people were building ranch homes with VA home loans and buying automobiles since cities were expanding into the suburbs. Parking design was beginning to change to accommodate more auto parking. The very small un-paved or gravel store front parking areas were seeing more drive up customers so additional space was needed to meet the demand. This space would be built from concrete paving or newly established asphalt mixes that were laid by machine rather than poured by hand.

By the late 1960's car culture was coming on strong in Southern California. The Interstate Highway system was connecting the West Coast to the East Coast and bringing car culture to the East. The big Detroit automakers were designing flashier cars with big block V8 engines and shiny chrome ornamentation known as muscle cars. The 1960 T-bird, 62 Corvette, 64 Ford Mustang 66 GTO and 67 Shelby Cobra ruled the streets. Though out California drive thru restaurants, strip shopping centers, drive in movie shows and regional shopping malls with large parking demands were popping up. Parking would no longer be in small store front parking areas but would be designed in wide open spaces where hundreds of cars could be conveniently located within an easy walk to the shops.

In the late 1950s on Hilton Head Island, South Carolina at a development project called Sea Pines Plantation the planting of parking lots drew attention. Private landscape codes were created by developer Charles E. Fraser that for the first time required the screening of parking lots and the planting of trees and shrubs within the parking lot interior. It did not take long for this idea of requiring parking lots to be planted and screened to move into the public sector. Boca Raton and Palm Beach Florida were among the first communities in the nation to adopt public landscape codes that required that parking lots be planted with trees, shrubs and ground covers. Landscape codes often set forth planting and design details for parking lots. By the mid 1960s the idea of planting parking lots had spread to the West Coast and their local landscape regulations included parking lot planting. The American Society of Planning Officials in 1964 issued a technical document concerning parking lot aesthetics. In this document they pointed out that most "most parking lots are ugly." To end this they pointed out this problem could be solved using design techniques to soften the unpleasant effects of noise, glare, disruption, smoke, distracting color combinations within parking lots. The

planting of trees, shrubs, flowers ground covers and hedges in combination with walls, fences, graded earthen berms can screen the disruption and guide parking lot traffic, provide shade and frame views. With good design, parking lots could be transformed into "parking plazas" a form of city garden. [11]

By the 1980's Landscape codes became very common across the nation. In Broward County, Florida for instance 29 community landscape codes were examined by the committee of the Society of Landscape Architects (ASLA). Ninety (90) percent of the communities had enacted vehicular use area planting standards in their local zoning laws. [12]

Community landscape codes, often called landscape ordinances in some states set forth predicable standards for the planting and design of parking lots.

Experts will agree that the primary purpose of parking lot landscape design shall be to reduce its apparent size, efficiently provide for safe traffic maneuver, pedestrian safety, enhancement of visual and environmental conditions and reducing the various impacts of parking on surrounding areas. It is important that local landscape codes address the design of parking lots. Throughout the United States hundreds of cities, counties and communities of all sizes have landscape codes address the design and planting of parking lots. [13] In coming years, these codes will very likely address sustainability issues such as shading, storm water management, solar radiation control reduction in the urban heat island effect and the provision of urban wildlife habitat. This will all be in addition to making parking lots more beautiful and well planted.

Not every city sets forth the same standards for parking lot design. They do vary somewhat by region or size of the city. But taken as a whole most experts agree there is a broad range of concerns expressed in the codes. Some of the elements of a well written code concern planting of street yard buffers, parking screens, property edge buffers and parking lot interiors. Some codes address paving and some address drainage. All address plantings particularly tree planting and hedges. Tree plantings often address shading. However the shading of cars with free standing fabric structures is not found as a requirement. Curbs, tire stops, irrigation and lighting are expressed in some codes. A few codes will address loading docks and drive through service areas also known as secondary business elevations. Very few set standard for parking lot walkways nor sustainability practices. Perhaps they will someday. A good example of an average community code that addresses parking lot design is

code found as Art. 13 Landscaping, Screening and Walls,§285-13.3 Landscaping Requirements Island-town of Grosse Ile, Michigan. [14]

Doing Environmental Work

Our working definition for green parking is simple. Parking lots must do environmental work, they must support the ecology of the place in which they are used. Parking lots may be designed to reduce the use of energy, improve environmental quality and to ensure more healthy wholesome conditions for people. Further parking lots should be planned and designed to reflect regional landscape types with an ecology that is appropriate for its specific location as determined by longitude, latitude, climate and soils of the location.

In our discussion above, titled Green Parking Lots, it was pointed out several ways in which parking lots could be designed to do environmental work. These methods were directed out but without giving minute details as to how to accomplish parking lot greening. Most of these methods are used in the general practice of landscape architecture, architecture or engineering. Designers have learned from professional experience how to deal with sun, shade, climate, air, water, vegetation, soils, habitat (wildlife, pollination, renewables, waste) and human health or wellbeing. In practice, before the advent of LEED and SITES there was never a way to measure greening. Any two designers might approach greening differently.

In recent years there are two recognized green building systems. Both systems have been created by for profit organizations for the express use by architects, landscape architects, engineers, contractors and related support businesses.

Both systems provide educational programming, certify accredited design professionals, license the use of a technical design manual, rate levels of sustainability, with the use of "guidelines and performance benchmarks, prerequisites, credits and publications". [15]

LEED[tm] the Leadership in Energy and Environmental Design program is built around architecture and engineering to produce green buildings, neighborhood development and infrastructure. This program is owned and administered by the U S Green Building Council (USGCB).

SITES[tm] the Sustainable Sites Initiative is a program built around ecology and landscape architecture to produce sustainable land design and development

(green building sites) and preserve and manage natural areas such as parks and open space systems. This program is owned and administered by the Green Business Certification, Inc (GBCI).

Both programs have been designed as industry standards to promote sustainability. This means these programs assure the avoidance of the depletion of natural resources in order to maintain and ecological balance and insure that the needs of the present are met without compromising the ability of future generations to meet their needs, Both programs aim to preserve our natural world and the precious resources of nature.

Of the two green programs the SITES program generated in part by the American Society of Landscape Architects working with the University of Texas and the U. S. Botanical Garden is the most appropriate for the design of sustainable landscapes and especially green parking lots. This program managed by Green Business Certification Inc a company related to the U.S. Green Building Council (USGBC). GBCI is the credentialing body for several sustainable programs including LEED

To design, build and maintain green parking, plant materials and other materials of construction must be used in ways that will support ecology and sustainability. Several ***sustainable landscaping principles*** are contained with the SITES v2 Rating System are suggested. [16] These include design based upon the following SITES v2 **principles**. They include;

1. Site Context
2. Pre-Design Assessment
3. Water
4. Soil & Vegetation
5. Materials (used in construction)
6. Health and Human Well Being
7. Construction
8. Operations & Maintenance
9. Education and Performance Monitoring
10. Innovation

These principles guide the designer of projects by allowing them to create ecosystem services that mimic natural systems found locally. Those designers may be landscape architects, architects, engineers, environmental consultants or any professional that understands the SITES program and can organize a team for designing, building and maintaining a project associated with land development.

The one who controls the site plan for a project such as for a green parking lot will be the leader of the team. Sub-consultants (technical experts), contractors, sub-contractors, product suppliers (such as

shade system fabricators) and maintenance companies who work under the building plans of the team leader all play their part in producing "rating credits" which is how sustainability is measured in both the SITES and LEED programs.

Under each principle mentioned above are found several SITES v2 **rating credits**. These credits are used to measure the extent of sustainability. These credits must be worked into the design by any member of the team under their particular responsibility. For instance, a pre-manufactured fabric shade supplier will find their main point of emphasis within Soil+Veg Credit 4.9 as found on page 49 of the SITES v2 design manual.

Soil+Veg Credit 4.9

This credit is largely involved with reducing the UHI Effect which means minimizing effects on microclimate, human and wildlife habitat by using vegetation and reflective materials to reduce heat island effect. This is to say, reduce the build up of temperature, humidity changes and affect upon localized wind or rainfall. This is accomplished by controlling solar radiation by producing shade, increasing solar reflectivity and lowering heat build up from parking lot paving.

Producing shade is the essence of reducing the UHI Effect in cities. Since the sun is largely responsible for heating effects and solar glare these two factors must be controlled with any attempt to reduce UHI in cities. Shade and shadow must be controlled. There are several ways to produce shade. They include the use of vegetation, the construction of overhead structure or the erection of remanufactured fabric shade structures. Though manipulation of ground surface heat build up can also be reduced in cities.

To understand the control of shade one must understand the relationship of the sun to the earth. Since all energy, including the energy found in nature is derived from the sun, one must have knowledge of the relationship between the movement of the earth and sun throughout the year. This relationship must be understood during each month and on each day from sunup till sun down.

LEED and Green

Green parking lots can be designed under these two green building program. They do not define green parking in particular but if one examines all of the credit opportunities within the program(s) you can see that their definition is quite similar to the one mentioned above in that the LEED and SITES credit system rewards parking lot

design that does environmental work. Some of the things these programs are interested in include reducing the heat build up from paving, introducing vegetation, protecting native habitat, manage stormwater runoff, using parking lot shade to solve problems, reducing the visual scale of parking lots, conserve healthy soil, increase species diversification, minimize the use of energy, design for adaptability, disassembly, and just of recycled and salvaged materials. In addition, there are opportunities to promote human health and welfare reduce waste during construction and introduce maintenance specifications that maximize the recycling of organic matter, reduce energy consumption and minimize the use of pesticides and fertilizer and use renewable sources for landscape electrical amenities, fixtures or equipment.

Parking Lot Shade

Long before Stonehenge the ancients noted the movement of the sun on the horizon and how it affected the length of daylight. For many generations we have been able to chart the movement of sun rise, high noon and sun set.

To understand shade one must be able to predict the path of the sun from sun up to sun down within in the "skyvault" This is the circular space which contains the daily travel path of the sun. The location of the sun within the sky can be predicted by calculation, by model, by computers or by use of practical sun path diagrams. The diagram is a by hand graphic method for accurately locating the sun's position by degrees at any hour, day or month of the year.

The travel path can be found though calculations which most of us are not able to do. But "solar path diagrams" have been created for most latitudes of the populated earth from 25 degree to 49 degree. These sun path diagram that show 'latitude', 'angle' and 'azimuth' of the sun so that the location of the sun can be determined on the 21st day of each month of the year and drafted each hour of the day from sun rise to sun set. These shadows dan be approximated by interpolation each 15 minutes of each hour if desired.

The angle of the sun is determined by noting the displacement of the sun from the South meridian. This can be read on the sun path diagram by noting the angle on the outside concentric circle. The altitude of the sun can be read on the sun path diagram on concentric circles that show angles from 0 degrees to 90 degrees which would be directly overhead. The azimuth of the sun is shown on the diagram in 10^{o} (degree) radii intervals over the North-South meridian line. You will see at any latitude the altitude

degree measurement falls between 20 degrees (52°N) and 90 degrees (24° N). You will also note that the azimuth of the sunrise on June 21 varies by latitude. In northern climates such as Birmingham England the sunrises at 130° N and sets at 130°. And at low latitudes such as Havana the azimuth of the sunrise and sun set is at 115°. Obviously, shadow length is the same at 6am, 9am, 11am and 6pm, 3pm and 1pm. Shadow length is the same at 12noon both in Havana and Birmingham. It is interesting to note that Havana sits all most directly on the Tropic of Cancer latitude which is 23°26'N and Birmingham is at 52°47'N.

When drawing shadows in plan view we can carefully calculate the coverage of shadow patterns on the surface of the ground. Drawing this information by hand or even with computer modeling programs tells us about the movement of the earth in relation to the sun. We get information that is used as a way to determine the length of shadows and the extent of ground coverage by the cast shadow during each hour of the day.

Sun Diagrams Showing Shadow Pattern & Length for general area of Miami, Florida based upon 24°N latitude sun path diagram.

a=angle°, az=azimuth° (length of shadow')

6am-6pm a10° az115° (infinity)
7am-5pm a21° az110° (100')
8am-4pm a32° az110° (75')
9am-3pm. a48° az100° (54')
10am-4pm a62° az95° (45')
11am-5pm a75° az88° (30')
12noon a90° az0° (0')

You can see from the data above that shadow length throughout the day at any geolocation lengthens from infinity at sun rise to infinity at sunset. //during the mid morning and mid afternoon shadow patterns cover a much larger area of surface than directly under the shade structure which is indicated at 12noon. For each morning hour the angle and azimuth of the sun as well as the cast shadow length is similar to the corresponding hour of the afternoon. This then proves that shadow pattern is not limited to the area beneath the shade structure alone. The shadow constantly moves throughout the day.

We noted above the Sacramento landscape code that requires parking lot shading. In this community the extent of shadow is calculated at noon on June 21, the longest day of the year. On this day at this hour the cast shadow is almost the exact same area as the diameter of the tree crown. This is when the total extent of shadow is calculated. A better way to determine shadow coverage is to use geolocation modeling in which shadow patterns are based upon the information found on a 'solar path diagram' such is

found in the handbook Architectural Graphic Standard,

However, we know it is possible to determine the length of shadow at different hours of the day during different seasons of the year. Furthermore, shadows length varies by latitude. To get a true picture of shadow coverage we must be able to determine the extent of shadow at various latitudes. For instance, shadow patterns are longer in geolocations of high latitude such as such as Manchester, England (52ºN and shorter at low latitudes such as Miami at 9 am. This is due to the fact that the angle of the sun is lower at Manchester than at Miami at the same hour of the day.

Knowing this and using the appropriate Sun Diagram we can calculate the moving shade pattern in a parking lot on any day of the year.

We refer to this as geolocation shade modeling

Knowing this tells the parking lot designer that to get maximum shadow coverage throughout the day all travel lanes should be arranged from North to South to take advantage of long cast shadows in mid morning and mid afternoon. Shadows are longest at 6 am and 6pm. They are and shortest at 12 noon when the sun seems to be directly overhead at the equator. Time of day of course is relevant in determining the length of shadow. Time is read on the sun path diagram on the heavy north-south lines for each month of the year. Time range is from 6am to 6pm. So you can easily understand that on the autumn equinox the sun rises at 6am and sets exactly at 6pm. The same can be said for the spring equinox since on the 21 of March the sun rises at 6am and sets at 6pm. The longest day of the year is June 21 and the longest night of the year is December 21. The sun is in the same place two days a year. All of this can easily be seen on the sun earth diagram. And of course, remember the earth moves around the sun, not the sun around the earth. [17]

Shade Structures

Producing shade for parking lots in most communities is based upon tree planting of parking lot interiors. Most landscape codes set standards for parking lot greening based upon car spacing or upon the percent of the parking lot interior to be devoted to planting. As we have seen the green building programs mentioned here call for more shading to reduce heat buildup over cities by shading pavements.

The planting of parking lots however is becoming more sophisticated. More than

trees are being added to parking lots since reducing paving and adding landscape area make parking lots more environmentally friendly. Green parking lots often get the name green parking because vegetation in the form of both trees, shrubs, ground covers, grass and landscape amenities such as plazas, terraces, seating areas, fit courses and even outside eating areas are being added. All of these landscape features tend to reduce the urban heat island effect troubling cities. as Converting parking lots into open spaces that can serve other purposes than merely storing cars. In fact, as cities become more pedestrian friendly and mass transit become more popular we may see not only more planting of parking lots but fewer parking spaces as well.

Perhaps the best way to shade pavements is with the use of pre-engineered fabric shade structures. These are very popular in the torrid South where parking lots can cook an egg sunny side up in a matter of seconds between March and December. Shade structures are manufactured with engineered structural framing and custom cut specially treated UV tolerant polyethylene fabric. Select colors for framing and fabric are available.The fabric is warrantied for its great durability, UV protection, aerial strength and it's shading potential. Fabric has a relatively long life span but when replacement time comes it is rather easy and quick to change out the fabric. The fabric can be styled in several shapes including squares, rectangles, polygons, triangles and even circles if so designed. Steel framing can be designed in many patterns and structural shapes. Maintenance is minimal once installed.

Those most often used for parking are modular cantilever forms. There are several forms that are available where structural design features are stylized. For parking lots rectangular designs that match the length and width of standard parking bays generally to the size of any size parking bay that is incorporated into the parking grid. Parking bay shade structures work best if designed in tandem with the planting features of a parking lot. This way they can accompany the planting of shade trees or other landscape plantings. Planting extends the amount of shade generated in the parking lot and helps to visually blend parking into landscaping. Planting and shade structures are easy to work into the pattern of the interior walkway system as well. Fabric structures also provide planting beds for the installation of shade loving shrubs and ground covers that can not normally be planted in exposed parking locations due to excessive sun exposure.

Fabric structures can also be designed to cover walkways so the walk from a building to a parked car never exposes skin to solar radiation and provide moderate cover during rain storms. Fabric structures in parking lots can be equipped with lighting systems, surveillance devices, solar panels and electric charging stations.

And of course fabric structures can be used for drop off and pick up zones and used for bus parking stations to guide riders to building door.

Using fabric structures to earn sustainability credits under one or both green building systems is very possible and is perhaps one of the major distinctions of a green parking lot.

In addition, Credit 4.9 of the SITES program allows a number of strategies to reduce UHI Effect. They include preserve existing plant material or add new plant material to provide shade over paving. Trees and vines can be used effectively to cast shade. Installation of planters or diamond cutouts can be used within parking. Overhead structure that can cast shade as well as produce renewable energy for thermal heaters, photovoltaics or wind turbines, especially if they power night time lighting or other safety devices. Provide shade with architectural devices such as shade canopies that have an SR value at installation of at least 1/3 of a percent. (0.33). Shade can also be provided with vegetative structures such as gridded vine canopy, arbors, or pergolas. Fabric shade cloth can be added to each of these.

These can be used over travel lanes, over travel lane intersections, parking stalls, parking bays, parking lot drop off points, parking lot entries, near bus parking areas and over walkways that traffic people to building entrances.

Overhead structures can be used in combination with high reflectivity paving or an open grid paving system with a high reflectivity SR value of at least 0.28. The open grid would consist of 50% paving and 50% of grass or other wearable ground cover. A common solution ‘grasscrete’ tm, one of the easiest ways to achieve LEED or SITES credit.

Credit 4.12 can result in up to 4 points of credit.

There are other credits contained in LEED v4 and SITES v2 that shade structures might be a qualifying parking lot feature to produce SITES credits.

They include Water Credit 3.2 Reduce water for landscape irrigation. Locate overhead shade structure in parking lots and design they to capture rainfall and directs it flow into special hydrozone landscape beds so artificial irrigation with potable water is not required.

Water Credit 3.4 Reduce Outdoor Water Use. Reduce the use or eliminate the use of potable water or withdrawal of natural water by capturing rainwater within parking lots with remanufactured shade structures that direct water into special hydozone landscape beds.

Water Credit 3.5 Design Functional Stormwater Features as Amenities. Overhead fabric shade structures can be used within parking lots to capture rainfall and direct the water to special hydrozone landscape beds or functional storm water features.

Soil + Veg Credit 4-10 Use Vegetation to Minimize Building Energy Use. Use vegetation in the form of trees or heavily leafed vines in combination with free standing fabric shade structures along East, South or West facing building walls to reduce the use of energy within buildings for heating and cooling mechanical devices. Trees and vines should be deciduous and fabric should be easy to remove and stored during winter to allow solar energy to warm building interiors.

Material Credit 5.2 Maintain on-site shade structures and paving. Site shade structures should be designed to reduce maintenance and extend the life cycle of fabric structure.

Material Credit 5.3 Design for Adaptability and Disassembly. Shade structures within parking lots and site open spaces should be easily adaptable and changed out in regard to color, shape or size as needed and reused or recycled in meaningful ways when color, shape or size of fabric ceases to meet original design goals.

Material Credit 5.9 Support for Sustainability in Materials Manufacturing. Manufacture predesigned free standing shade structures using sustainable materials for fabrics, structure, foundations and fittings produced by suppliers whose practices increase energy efficiency, reduce resource consumption and waste, and minimize negative effects o human health and the environment.

Human Health + Well-Being Credit 6.4. Support Mental Restoration. Shade structures can be used in parking lot interiors or at entry points to that provide places for social gathering (playgrounds, resting areas, wildlife observation points, along sidewalks) to provide physical

connections to restorative places near buildings.

Human Health + Well-Being Credit 6.5 Support for Physical Activity. Free standing shade structures within parking lot perimeter planted buffers could be used to facilitate fit trails and exercise positions for a variety of land uses from office buildings to senior citizen congregate housing.

Human Health and Well-Being Credit 6.6 Support Social Connection. Fabric structures can be used to encourage social connection by providing outdoor gathering areas for family use, children's play activities or senior socializing. Why not fabric covered reading areas within gardens outside of public libraries?

Human Health + Well Being Credit 6.9 Encourage Fuel Efficient and Multi-modal Transportation. Provide shade structures or within or near green parking lots for car pool parking, compact or E vehicle parking, van pool pickup points, car share points, neighborhood bus stop or transit hub, bike parking areas or electric recharge stations.

Readers can see from the above examples that the SITE v2 program offers multiple points in which free standing, pre-manufactured fabric structures can be incorporated into green parking lots or used within sustainable landscapes for SITES or even LEED designed projects.

An analysis of the above point of entry into both of these green building programs is beyond the scope of this paper.

It will be recognized by readers that parking lots are more sustainable if LEED and SITES guidelines are followed. Parking lots are greened when several design elements are included in the design. [18]

Parking lot greening elements maximize shade with free standing canopies or vegetation, capture rainwater and incorporate natural drainage through bioretentiion and porous paving, reduction of solar impact with overhead structure, use energy efficient lighting with renewable energy generation (charging stations) and have safe and shaded walkways and throughout.

And of course the most important work of a green parking lot is to reduce the urban heat island effect. [19]

When all parking lot elements are designed to do environmental work a parking lot is transformed into an environmental asset. When the environment a city is made healthier that citizen's health and welfare improves and living in the city means happier, more productive citizens and

families. [20] That after all is that not why we want parking lots to do environmental work?

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Note on Sources

It must be noted that the Louisiana Yards & Neighborhood Program mentioned in reference to the New Orleans landscape code developed by the LSU AgCenter based upon the Florida Friendly Landscaping Program developed by the University of Florida Cooperative Extension Service. The Florida program has been widely adapted into landscape codes throughout the State of Florida. Both have added content to this discussion.

This paper is also based in part upon ideas found in LEED v4.1 and the ASLA Sustainable Sites Initiative SITES v2 programs developed in part by the U.S. Green Building Council and or Green Business Certification Inc. The California Stop Waste.org, Bay Friendly, Sustainable Landscaping Program has also provided context for this work. Much of this work was originally conducted at the Robert Reich School of Landscape Architecture at Louisiana State University 2005-2013 and in the office of Abbey Associates Landscape Architects 2013-2020.

ENVIRONMENTAL ASPECTS OF GREEN PARKING

Water: This recognizes storm water as a resource. Therefore water should be harvesting, conserved and reused. This principle requires more use of rainwater and less use of potable water. Storm water may be taken from parking lot surfaces and cleaned of non-point pollutants. Once filtered and cleaned it may be recycled through irrigation systems or allowed to infiltrate back into the ground. Water from nearby rooftops can be harvested as well. Harvested and recycled water can be used to water lawns, beds and trees and used for cleaning certain site areas such as trash collection areas often associated with service areas or trash. Porous paving, slotted curbs, bioswales and parking lot detentions are design methods that can be used to put storm water to work and preserve potable water.

Air: This principle recognizes air as the most important resource on the planet. The goal of this strategy is to reduce air pollution and air born particulate matter and to lower the Urban Heat Island Effect (UHI). The driving forces within the SITES program involved with the production of shading and solar control will be found in Section 4. and involve the reduction of UHI. See Soil+Veg Credit 4.12.

Since oxygen is generated by vegetation and carbon dioxide, a poison is removed, plants

are an integral part of generating cleaner air. Shade is a major benefit to a green building site that can be produced by trees and vegetation and freestanding fabric shade structures or overhead solar energy producing photovoltaic cells can be used under the both LEED and SITES to reduce UHI Effect.

Trees and shrubs can be used in and around parking lots to clean the air.

Secondary business elevations (drive through windows) should be minimized in favor of green parking lots to reduce carbon introduction. Idling automobiles in a drive thru causes tremendous carbon build up and heat generation in cities and minor damage to the automobile itself.

Soil: This recognizes productive soil as a resource and that wasted soil that enters fresh water bodies as a pollutant. Vegetation, mulching and proper earth grading will minimize top soil loss and polluted runoff. Productive top soil is essential for growing healthy vegetation. Sediment basins should be used to trap soil from roof top and parking lot runoff.

Vegetation: This recognizes vegetation as one of the most important elements of nature in the city. In many of the principles set forth here, vegetation plays a role as an agent of environmental work so therefore is an important an essential resource for urban areas. Vegetation in its many forms such as forbes (herbaceous flowering plants), ferns, grasses (graminoides (grasses, sedges, rushes), ground covers, vines, shrubs, trees and flowering perennials color plants are important environmental workers in that they serve pollinators such as bees, hummingbirds, butterflies, flies, beetles, and bats. These hard working creatures serve by pollinating flowers that deliver such useful crops as apples, peaches, cherries, pecans and almonds and over 90 different varieties of fruits, vegetables and essential crops such as alfalfa, hay, sugarcane and wheat. The nation's food supply is highly dependent upon the work or our insect friends and their pollinating associates. Plants are involved with many of the principles listed here.

Annual color plants, an important part of the horticulture industry are wonderful additions to any landscape but are recognized for their environmental debits rather than credits. Annual plant production recognized for providing color accents in city landscapes requires inordinate amounts of water, energy, fertilizers, root stimulants, artificial soil creation and waste. Annual plants are grown for seasonal interest and once marketed last for several months generally with heavy maintenance, extra irrigation and the use of garden chemicals

to keep them growing. Some self-seeding annuals may become invasive species.

Climate: Climate is becoming a better know resources in communities. In fact, we now understand that cities, human development and added carbon loads caused by fossil fuel use changes the climate not only of cities, but of the globe as well. Climate is a particular resource that can be modulated with the use of plant materials, especially trees. We note above that the UHI Effect is moderated with the use of free standing fabric shade structures. These overhead climate modifying elements heavily reduce the climatic impact of solar energy and not only moderate the climate of the parking lot but the conditions inside the enclosed parked vehicle. Climatic regimes consisting of temperature, moisture, wind, heat buildup and sun can all be modified to some extent by vegetation and shade structures. This is particularly so in regard to blocking the sun, allowing access to the sun and utilization of sun, temperature and moisture to hasten the capture of solar energy and conversion to useful biomass.

Trees are the most effective natural solar control devise. Planting trees in and around parking lots will produce a shade grove in the urban heat island that will moderate summer or winter temperatures in parking lots. Trees can be planted in such a manner that cooling breezes can be induced or blocked. Leaves of trees that emit oxygen also send off moisture that can add humidity into very dry air spaces. Trees may also be used to near buildings to reduce internal temperature and the amount or duration of mechanical air conditioning. Freestanding shade structures near building walls also reducing energy usage in buildings. Deciduous trees are best in Northern climates since leaf fall will allow some winter warming on south and west facing walls requiring less energy usage to artificially heat in the winter.

Wildlife: This recognizes native wildlife as an important resource of the city. Certainly many wilder forms of wildlife will not cohabit the city but many small creatures and active pollinators do. They need shelter, food, water and land area to allow them to properly reproduce their species. Preserved habitat in various form within the city serves this purpose for small animals, birds, insects, and reptiles. Many of these species are important to mankind as well. Honeybees for instance allow us to grow crops and fruit producing trees and shrubs though their ability to transport pollen. Bats for instance help control the mosquito which in turn can suppress the outbreak of tropical disease.

Preserved Habitat: Preserved habitat within cities not only supply wildlife necessities, but they provide many environmental services and values to mankind as well. Preserved areas provide homes for living creatures including mankind as well. Preserved habitat in the form of tree groves, forests, wetlands, parks, nature areas and wildlife preserves offer many recreational activities that keep urban residents happy and healthy while at the same time providing homes of small creatures. Preserved habitat need not be extensive, but it must be connective. Thin slices of nature known as "greenways" linked across town become wildlife highways that allow species to roam as they wish and these same linked spaces become important arteries for bike trails, hiking paths, fitness courses and jogging trails and water edge "blueways" where rowing, kayaking, boating, sailing and fishing take place as water sports.

Preserved habitat also provide places where native plant species can take root and thrive. In fact, most urban wildlife require native plants and their cover as well as their fruiting bodies. The seeds of native plants are often sewn by wildlife who are responsible in part for building the forest.

Green Parking lots may be connected to preserved habitat in the form of property buffers, bioswales or constructed wetlands. Parking lots may even be built within preserved parcels of land as means of better screening them from view and minimizing the clutter they create in the landscape.

Visual Control: The visual character of a parking lot is an important element of the city. Green parking lots have a responsibility to blend car storage areas into the community and not exist as a visual distraction. Using plant materials to screen and beautify the parking helps to make car storage areas consistent with the visual character of the entire community is an important principle of greening. Most communities have landscape codes that require parking lot shading, screening and interior plantings. This is the first step toward greening. Parking lots are generally screened with low hedges from public street and single family residential districts. Parking lots are shaded with perimeter trees on East, South and West sided to reduce heat build up. Interior plantings are used to divide up the parking area into bays and sections and to cast shade to cool pavements, These interior planting spaces can be used as tree wells for additional shade tree planting. The trees allow parking lot water to inter through slotted curbs thereby reducing the need for artificial irrigation .

One note about visual control must be mentioned. Since parking lots in some neighborhood may be dangerous after dark, the local police caution about ensuring some visibility from the street to allow roving squad cars to observe any suspicious activity. To encourage this, plantings should be layered with ground cover plants, planted hedges no taller than 30 inches and limbed up trees to about 8 feet in height. Security lighting of parking lots from on-site generated power cells is encouraged.

It is recommended that a visual opacity rating for parking lot screening not exceed 60%. This will be adequate for screening the parking lot while providing visual safety access. Views to parking areas should be left un-screened above 30"from all adjacent building windows. Low planting areas and pedestrian walks should be used to separate parking from buildings. Walkways with articulated crossing points should be provided for safe passage to buildings. See the discussion on safety below.

Further, green parking lots should allow visual control at night using solar cell lighting capable of producing a minimum of 500-750 foot candles of night lighting. Hard wired lighting should be avoided. Recycled lamp posts would be more sustainable than using new posts to hold the fixtures.

Auditory Control: This recognizes that urban noise makes environments dysfunctional as well as an urban nuisance. Urban sound permeates into a development site from outside and from within. Outside noise can be controlled to some extent by heavily planted property buffer. Use plants of dense character and fine texture that are evergreen. Use double or triple rows of plants and vary the species with the idea of breaking up sound wave.

Urban walls, especially those that are vine covered also can be used to redirect outside sounds. Wall plantings louvered screens will attenuate sound and prevents its bouncing around the parking lot.

But noise can also be generated on the site. This noise created by leaf blowers, weed whackers and lawn mowers should be avoided. Particularly the use of gas powered lawnmowers that are very environmentally destructive. Then too, lawn grass is to be avoided within green parking lots. Lawn grass should be passed over as a ground cover around green parking lots unless type 2 grass, (long meadow grass) which is lawn grass that is only mowed about two or three times a year. Interesting how common lawn grass stops growing when allowed to go to seed. Many communities will only allow a small percentage of a site to be lawn grass do to the heavy maintenance, excessive

irrigation and amount of lawn chemical which are used to keep the grass looking excellent.

Reducing the amount of lawn in favor of meadow grass, preserved habitats that are allowed to revert to natural conditions or heavily mulched landscape beds can reduce urban noise.

Use of Yard Chemicals and Nutrient Recycling: Unpolluted water, soil, air and health to wildlife and humans is seen as an important measure of a clean sustainable environment. Landscaping practices that eliminate the use of garden chemicals is huge step forward in keeping an environment healthy and clean. The EPA estimates that home owners use ten (10) times the amount of pesticides that farmers apply to their fields. Sixty to seventy million birds die each year from chemical poisoning according to EPA studies. Some 67 million pounds of pesticides are applied to lawns each year. Nitrogen and phosphorus used to grow quality type 1 lawn grass washes into freshwater bodies and streams. The EPA suspects that 40-60% of the nitrogen found in surface waters emanates from lawns.

Some of the larger horticultural industry suppliers and manufacturers are working hard to develop earth friendly products and agricultural products that can be used harmlessly in urban environments. Using natural methods of pest control suggested by the industry will mark our green industry greener.

Returning nutrients to the soil with the use of natural mulching will not only eliminate yard waste but will make healthier more productive soil.

The EPA has estimated that one hour of grass mowing uses enough gasoline to power a car for twenty miles. Lawn mowers emit 5% of ozone-forming VOCs (volatile organic compounds) that pollute the air. Fifty-five (55) tons of VOCs per day were estimated to be released in a study conducted in the Baltimore-Washington D.C. area. The EPA understands that carbon emitting VOCs are linked to human health problems and play a part in the production of green house gasses and global warming.

Recycling: This recognizes recycling of used construction materials as an element of sustainable design. Recycling non-renewable resources can preserve scarce environmental resources while reducing construction costs. Eliminating waste to the landfill is an important idea of sustainable design. For instance, planted areas in and around green parking lots should be used as disposal sites for biomass, natural mulch and yard trimmings. Every sustainable landscape needs to have a natural composting area where all vegetation and organic matter can

be composted in place. If coffee grounds, egg shells, vegetable peelings, grass clippings, leaves, twigs, cardboard, leaves, straw, nut shells, saw dust, and wood ashes are available as waste they should be composed in place.

Health & Safety: This recognizes the health and safety of site users to be an important sustainability factor for the design of sustainable landscapes and green parking design. Public safety in parking lot design is largely about pedestrian safety, the safety of people being able to park and reach their intended destination without fear of being hit by a moving vehicle. It is surprising how many parking lots are designed without walkways and articulated crosswalks. Most do not have them. They are designed to have people walk between cars and along travel lanes. Green parking lots should be designed with all parking bay perpendicular to destination points such as shops, offices, schools, parks and shopping centers. Perpendicular parking allows for medians to divide up parking bays into landscaped pedestrian walkways so foot traffic between car and building entries are safe.

Food Production: One principle of sustainable landscape development is the production of food. This may be food for wildlife or for mankind. Green parking lots should utilize fruiting plants that will produce edible nuts, berries, drupes, legumes, pomes, tubers, rhizome, bulbs, corms or stem shoots. Green parking lots can easily feature plants that provide a variety of edible plants. Keep in mind however, many plants have toxic quality so care should be taken in specifying which plants to use in public places. Toxic plant rule number one is always suspect a plant to be toxic, unless, known otherwise.

Regional Design: Finally, the last but most important element of sustainable design directed toward green parking lots is a *regional based design strategy*. Regional design takes an earth systems approach to the design, construction and maintenance of landscapes. Earth systems of water, sunlight, soils, climate, vegetation, urban forests, natural habitat preservation and natural recycling are ought to be incorporated into any landscape design. Since any project in Louisiana is in fact built into a functioning ecosystem, it is important for that project to fit in with the wider regional system of climate, soils, sun, rainfall and vegetation. Earth friendly landscape design will utilize native plants and native landscape character. The site designer's first concern should be in preserving regional habitat. The second concern should be rebuilding native habitat in regard to soil and vegetation. And finally, the third concern should be capturing regional character in the design of housing,

industry, commerce and open space systems.

Regional character is derived from the state's various landscape features. In Louisiana these would be design concepts based upon the ecology of prairies, deltas, savannahs, beaches, ridges, *chenier's*, terrace faces and forests. These ecologies can all be utilized as regional concepts for the design of green parking lots. Regional based landscape design will eliminate the use of invasive species which tend to push native plants out of their way. Regional based design will use plant material that support the native wildlife population.

In summary, green parking is an important discovery dating to the early days of the twenty-first century. In fact, the greening of parking lots can be dated to the 1980s when community landscape codes first recognized that the planting of lots must be designed to enhance the environment and provide some ecosystem services in large cities. The original greening concepts were about improving the visual nature of parking lots, designing them to have features that improve the safety of parking and blending them into the natural elements of the city by requiring the planting of parking lots to produce shade and add natural elements to what was essentially a large, hot paved area of the city.

Experts agree that green parking lot design must perform environmental work and this involves air, temperature, sun, shade, stormwater, soil, vegetation, species diversity, wildlife protection and human health and well being. The key to getting parkings lots designed to be green should be easy if community landscape codes reflect public policy toward building a sustainable city. Fig 3 below shows the typical development site laid out in site plan format. The site plan must include greening strategies applied to the typical geography of a development site as seen in this image created by the School of Landscape Architecture at LSU. Greening strategies must be set forth in community landscape codes which are an essential part of public zoning law.

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Word Count 12,323

To contact the author, get in touch by email at lsugreenlaws@aol.com. Abbey Associates Landscape Architects at 504.654-9952

SEE GRAPHIC DRAWING BELOW

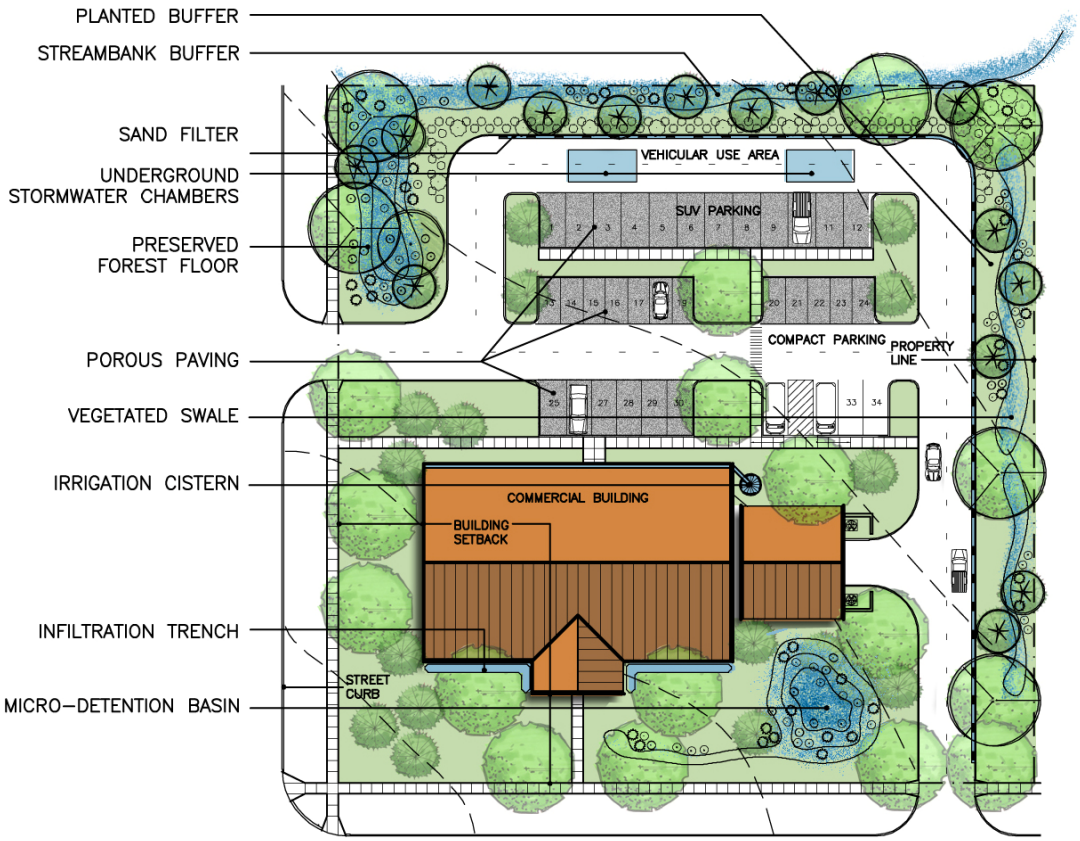

Fig. 4. Geography of a Development Site,- A Green Parking Lot, LSU Green Laws Research Project, Louisiana State University.

Green Parking And Shade

Buck Abbey
Green Laws Research Project

Many local governments have enacted
tree and landscape ordinances, which are most useful for adding parking lot shade.
EPA, Reducing Urban Heat Islands, Compendium of Strategies 2008

Shading & Cooling Parking Lots

Large conventional parking lots in cities have harmful effects on people and society. Some are social, others are environmental. They include problems associated with water quality, urban temperature, air emissions, non-point pollution generation, removal of native habitat, influx of invasive species, removal of open space and accommodating urban sprawl. [1] There has been much written in the last decade about how 'green parking lots' can solve some of these problems. This greening designation was defined by both the LSU School of Landscape Architecture and the US Environmental Protection Agency. Simply put, this definition suggests putting parking lots to work providing "ecosystem services." [2] Strategies have been developed to green parking lots manage stormwater, filter the air, produce oxygen, preserve native soil, cool cities, increase biodiversity and improve human health and well being. Suddenly, science and design have come together to green cities and the parking lot is a main target of city greening. Figure 1.0 shows some typical greening methods. *Greening a parking lot transforms a hot, dusty, dirty layer of paving that has been striped to temporarily store automobiles into a more wholesome urban forest setting.*

Going green is something the public is demanding and local landscape codes are helping to push the trend toward improving the environment of cities. Landscape codes are enacted to ensure that parking lots contain trees and other vegetation. Some codes stress stormwater management and others stress preserving native habitat. Many are pointing the way toward better parking lot design. One of the most common parking lot design standards found in landscape codes is concerned with planting trees. Planting of trees in parking lots provide many ecosystem services. These include the ability of trees to reduce greenhouse gases, store carbon, and provide shade. Parking lot trees also reduce the scale and size of a paved areas and provide therapeutic views of nature for urban dwellers. In addition, new research is working on the social determinant of planted trees in the urban forest as a restorative factor in human health outcomes. [3] Tree planted parking lots are an important element of the urban forest of American cities.

Parking lot trees are often planted in three locations. They are planted within the interior of the vehicle use area (VUA) and around its perimeter for the purpose of providing shade. Parking lot screens are planted with small trees and hedges to cut reflective glare and reduce the scale of parking lots. A typical example of a landscape code, that greens parking lots by providing shade is the one from hot and steamy Miami, Florida. [4] The purpose of Miami's shading standard is to cool parking lots by "channeling breezes, thereby helping to offset global warming and local heat island effect through the added absorption of carbon dioxide." *Many communities, such as Montgomery County Maryland are adopting canopy and shading standards in their community landscape code which is evidence that communities see more shade in the city as an environmental benefit*.

Shade trees in parking lots also provide oxygen for breathing, sequester carbon by absorbing carbon dioxide and will filter the air of dust and airborne debris.

There are other communities that set shade standards for parking lots based upon the extent of shadows created to cool the pavement. Often shade is calculated as being the same measure as the crown diameter of the tree. Technically, this calculates shadow extent at noon when the sun is directly overhead on June 21 at latitude $23^{O}26'$N. This is the way the City of Fresno, California requires tree shadows to be managed. [5] However, no landscape code exists that bases shading on moving shadow patterns. [6] Moving shadows recognize morning shade as well as afternoon shade. This requires a careful calculation measured by total area shaded as a percentage of pavement area on a solar daylight basis at a proscribed series of daylight hours at a specific geolocation coordinate. This is a calculation a little too difficult for many to do, yet computer modeling has the capability to do so. Moving shadows cool parking lots more thoroughly from sunrise to sunset.

More cities have become aware that parking lot shading is an important tool to reduce the heating of cities. It is recommended that small parking lots (10-30 spaces) have moving shade coverage (MSC) requirement of 70% and that large parking lots (+30 spaces) have a moving MSC OF 50%.

Greening the Parking Lot

Sustainability based codes are the coming wave of landscape code technology. *New landscape design standards are anchored in science so their effect upon the environment is measurable.* The landscape code for the City of New Orleans is one such pioneering sustainability based landscape code. [7] This coastal city place emphasis on parking lot paving, stormwater management, reducing urban heat, saving the consumption of energy and increasing species diversity. Louisiana sustainable gardening principals are also included in the code. This code is leading the city toward the design of green parking lots.

Large cities such as Miami, New Orleans and suburban Washington DC have large expanses of heat generating paving. Strip shopping centers have up to 2 acres of paving while schools, churches, government centers may have 10 acres and regional shopping malls up to 60 acres of environmentally sterile paving. Heat build up in cities called the "urban heat island" (UHI) is largely a result of building roofs and parking lot paving. [8] Heat build up from parking lots in the city not only causes personal discomfort but increase the use of energy in buildings as well as causing problems with air and water quality, human health and urban wildlife habitat.

Two green building programs have been created over the last decade to allow for the design of green buildings and green building sites both of which include parking lots. These green building programs are known as LEED v4.1 and SITES v2. Should be incorporated into local building and landscape codes. [9] Both provide 'credits' that are evidence based guidelines and performance bench marks to produce and measure ecosystem services. These trademarked design standards are documented in design manuals and have 'score cards' in which the degree of sustainability is measured and noted as "certified, silver, gold, or platinum" levels of sustainability.

SITES and LEED practices are known to reduce energy usage, make building sites healthier and conserve or protect scarce natural resources. This material can be found in the Sustainable Sites Initiative-*Guidelines and Performance Benchmarks 2015, SITES v2,* www.sustainablesites.org/report/.

Parking Lot Shading Criteria

The purpose of SITES Credit 4.12 (LEED SS Credit: Heat Island Reduction) is to reduce the urban heat island effect. As we have noted, parking lots play a big roll in urban heating. *The UHI effect can be modified in three ways, add shade with trees or overhead shade structures, increase the reflectivity of pavement or convert up to 30% of the paved area as human or wildlife habitat landscape space.*

Paving must have a raised reflectance level (solar reflectivity) that reduces heat buildup. Heat build up is reduced if ultra white concrete or a very light colored stone material is used as pavement. Regular concrete and asphalt would be replaced with less heat absorbing material. Any paving that uses a colored high-albedo surface material will achieve the required 0.30 reflectance level required by the SITES program. The use 'open grid paving' that consists of a combination of hard paving and a grass infill reduces heat build up with the added advantage of allow stormwater to reduce runoff though percolation.

Shady parking lots are cooled when large canopied trees are used to reduce temperature build up on pavement surfaces. Planting trees with high shade canopies within interior parking bays and along the perimeter is also recognized by SITES as a method of reducing urban heat. Evergreen trees are more effective in the South while deciduous trees work better in the North. A southern live oak is a great example of a shade producer in the South while the White Oak is excellent in the North and Valley Oak in the West.

Overhead architectural features can also be designed to reduce heat build up from parking lots and achieve SITES credits.

Overhead structures must be designed with a solar reflectance (SR) value of 0.28 or better. *Shade on parking surfaces maybe created with overhead stretched fabric, wooden arbors, shade pergolas or even possible with the use of trellised overhead woody vines.* Solar energy captured by these structures is an extra benefit. The structure can be put to use powering parking lot lighting, irrigation systems, decorative elements such as fountains or even supplementing energy removed by electric charging stations that are often included in green parking lots.

Lowering the temperature below sun screens reduce evaporative emissions of volatile organic compounds (VOCs) that emanate from cars stored in the sun. Interior temperatures within parked cars are reduced greatly as anyone who parks under a shady tree will attest. Shaded walkways within parking lots also can cool pavements but perhaps more importantly allow people to walk back and forth without exposure to harmful rays that cause skin cancers.

Replacing 30% of parking lot paving with natural areas that can be planted is a third method of reducing urban heat emanating form paved surfaces. *Rainfall is another valuable resource to capture when overhead structures are used*. Since planting beds for trees or shrubs are often adjacent to overhead structures it is possible to capture rain fall and channel it into nearby planting beds, bioswales, constructed wetland features or restored aquatic systems.

Miami-Dade County, Florida and Montgomery County Maryland landscape codes require the use of storm water retention/detention facilities that can capture parking lot runoff. [10] Overhead structures work well as a feeder devises to transfer rain to these small on-site water collectors. This is a smart way to allow a shade producer to capture, convey and manage on-site stormwater as a resource or an amenity. Additional credit is possible in the SITES green building program for rain water capture in parking lots. (see Water Credit 3.5).

Sun Screens To Green Parking Lots

Perhaps the most effective way to shade pavements and to reduce the urban heat island problem is with the use of pre-engineered fabric shade structures. These, often called sun screens are very popular in the torrid south and southwest where parking lots can cook an egg sunny side up in a matter of seconds.

Greening a parking lot is largely about maximizing shade, blocking the sun and reducing urban heating as a result of excess pavement. [11] Shade structures have the capability of reducing air temperature up to 20 degrees while blocking up to 96% of the sun's ultraviolet strength. Car interiors parked under a shade structure can be 100° cooler than those parked in an open lot. [12]

Shade structures are manufactured with engineered structural framing and custom cut specially treated UV tolerant polyethylene fabric. Many colors for framing and fabric are available.The fabric is warrantied for its great durability, UV protection, aerial strength and it's ability to shade out harmful solar radiation. [13]

Shade structures can complement any building exterior trim and easily connect to walkways and landscape planting beds. Not only do these fabric screens have a relatively long life span, but when replacement is needed, it is easy and quick to change out the fabric. Worn out fabric is recycled.

The most often used form for parking lot structures are modular cantilever screens. *Parking bay shade structures work best if designed in tandem with the planting features of a parking lot.* [14] This way they can accompany the planting of shade trees or other landscape plantings that also reduce urban heat build up. Planting extends the amount of shade generated in the parking lot and helps to visually blend parking into the surrounding city. Modular shade structures are easy to work into the pattern of interior driveways, parking bays, planter islands and the interior walkway system. When properly sited in a North-South direction shade patterns move from sunrise to sunset covering on average between 80% and 40% of the parking surface. Figure 2.0 illustrates shade tree coverage only at 12 noon on June 21 at latitude 25°45' in Miami, Florida.

Fabric structures can also be designed to cover walkways. A walk from a building to a parked car under a sun screen never exposes skin to solar radiation as well as providing moderate cover during rain storms or snow events. The shade structures in parking lots can be equipped with lighting systems, surveillance devices, solar panels and electric charging stations. And of course, sun screens can be used at drop off and pick up zones as well as for bus parking bays within parking lots.

Using fabric structures to earn sustainability credits under one or both green building systems is practical and is perhaps one of the major distinctions of a green parking lot. Some variation in canopy material is possible. *Green parking lots that provide shade is one giant step toward building sustainability into the design of the urban forest of a city*. [15] A well designed green infrastructure system in which shade in green parking lots plays an important roll is a goal all cities in America should strive to achieve.

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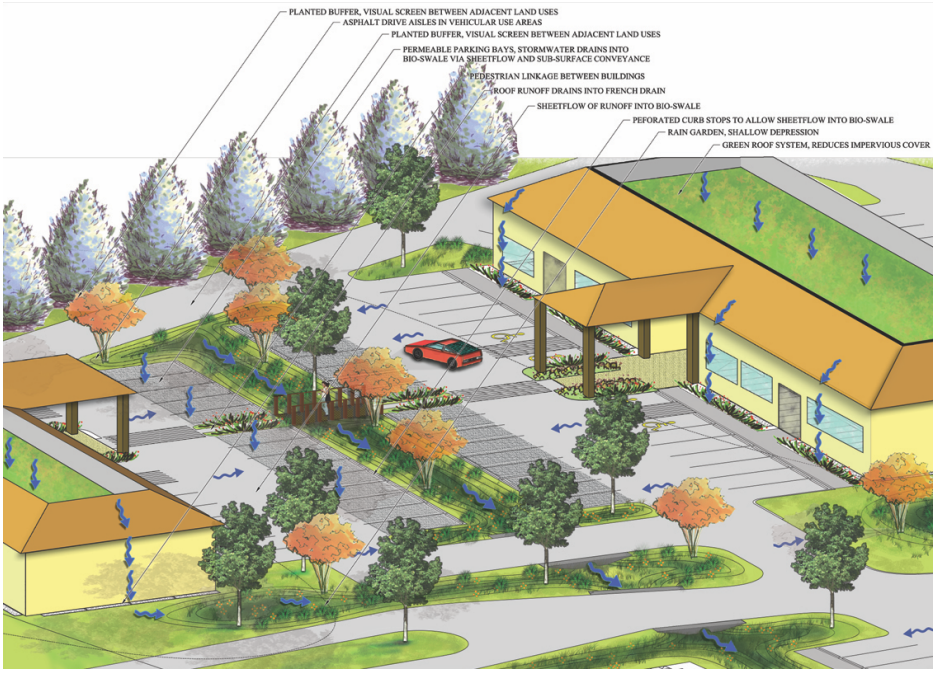
Note 1: Power Quotes those best used for advertising are italicized.

Note 2: also on page five two Apollo facts are used to indicate the percentage of temperature reduction and UV energy blockage are cited. In the two pieces of Apollo literature cited in 12 and 13 directly above have facts that are contradictory. Your two cited publications do not agree with each other.

See images below.



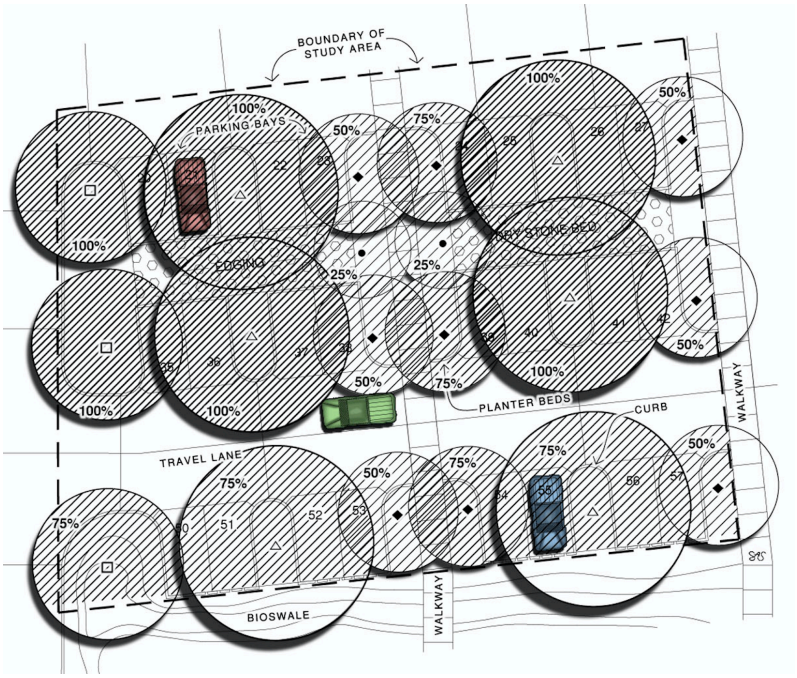


Figure 1.0 Green Parking Lot Design, Adam McGovern, Abbey Associates, Inc.

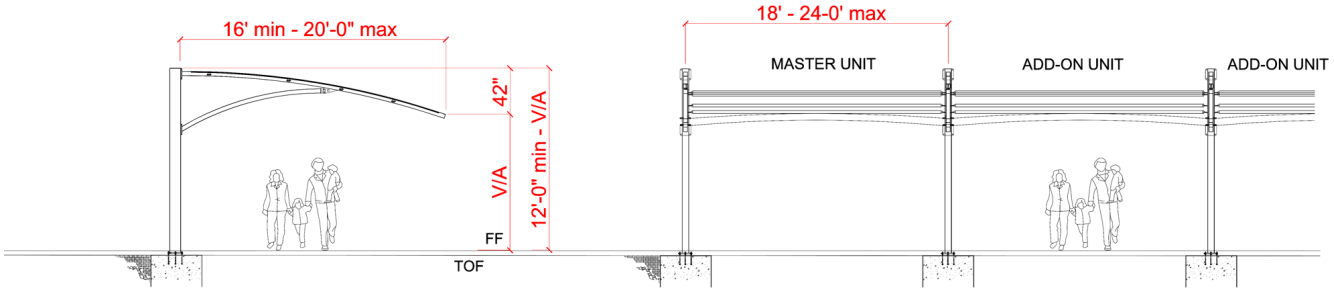


Fig. 2.0 Green Parking Lot Shading Study, Abbey Associates, Inc. Landscape Architects

Fig. 3.0 Patented Sun Screen, Apollo Sunguard, Sarasota, Florida

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