A CALL TO ACTION AND A COMPREHENSIVE GUIDE TO SUSTAINABLE URBAN DESIGN

“This book celebrates the magical power of design and of an emerging pattern of human settlement—Sustainable Urbanism—that holds the promise of strengthening the interdependence of all life on earth. . . This book is a strategic call for leadership in the design and development of the places where Americans live, work, and play.” —From the Preface

Written by the chair of the U.S. Green Building Council’s LEED for Neighborhood Development (LEED-ND) Core Committee, Sustainable Urbanism: Urban Design with Nature is both an urgent call to action and a comprehensive introduction to “Sustainable Urbanism”—the growing sustainable design convergence that integrates walkable and diverse places with high-performance infrastructure and buildings.

Providing a historical perspective on the standards and regulations that got us and keep us on the course toward sprawl and unsustainable development, along with earlier attempts at reform, Douglas Farr makes a powerful case for Sustainable Urbanism, showing how architects and urban designers need to shape the built environment for the benefit of both humans and nature. He then explains how to implement Sustainable Urbanism in cities, towns, and neighborhoods through coordinated leadership and communication. Essays written by Farr and others delve into such issues as:

- Increasing sustainability through density
- Integrating transportation and land use in an auto-dependent era
- Creating sustainable neighborhoods with walk-to-work neighborhood centers of locally owned businesses, share cars on every block, and walkable neighborhoods
- The health and environmental benefits of linking humans to nature, including walk-to-open spaces, neighborhood stormwater systems and waste treatment, and food production
- High-performance buildings and neighborhood-scale infrastructure including district energy systems

Enriching the argument are in-depth case studies in Sustainable Urbanism, from BedZED in London, England, and Newington in Sydney, Australia, to New Railroad Square in Santa Rosa, California, and Dongtan, Shanghai, China. An epilogue looks to the future of Sustainable Urbanism over the next 200 years.

At once solidly researched and passionately argued, Sustainable Urbanism is the ideal guidebook for urban designers, planners, and architects who are eager to make a positive impact on our—and our descendants—buildings, cities, and lives.

DOUGLAS FARR, an architect and urban designer, is the founding principal and president of Farr Associates. He has served as cochair of the Environmental Task Force of the Congress for the New Urbanism, chair of the AIA Chicago Committee on the Environment, and chair of the U.S. Green Building Council’s LEED for Neighborhood Development (LEED-ND) Core Committee.

Farr Associates is a Chicago-based firm focused on sustainable design in architecture and urban design. Founded in 1990, Farr Associates was the first architecture firm in the world to have designed at least two buildings to be certified with a LEED Platinum rating: the Chicago Center for Green Technology and the Center for Neighborhood Technology, also in Chicago. The firm designed its own office in the historic Monadnock Building as a LEED for Commercial interiors pilot project.

FOREFWORD BY ANDRES DUANY

COVER IMAGE: plan for Coyote Valley in San Jose, California. Image © WBEISolomon ETC. | COVER DESIGN: David Reddy

ISSN 978-0-471-77751-9 05/2007

WILEY-INTERSCIENCE

Cover Image: plan for Coyote Valley in San Jose, California. Image © WBEISolomon ETC. | Cover Design: David Reddy

WILEY-INTERSCIENCE
Chapter 1
The Built Environment: Where We Are Today

The American Lifestyle on the Wrong Course

“We have seen the enemy and he is us.”

Pogo, by Walt Kelly

It’s the American way to celebrate our robust range of life choices. We pride ourselves on being able to pick where we work, whom we live with, where we shop, and how we play. We decide on our government. We treasure the right to vote. For centuries we’ve believed that the sum total of these highly personal decisions will lead to an optimal society, that community can best evolve through every individual pursuing his or her own “rational,” enlightened self-interested. That presumption is now being put to severe test—and many of us would argue it has failed us badly. Our lifestyle, to put it simply, is on the wrong course.

The evidence is all around us. The lifestyle we, the American middle class, have selected has led to a serious deterioration in public health. We have become a sedentary population, deprived of exercise, and the result is a rising incidence of obesity. In 1991 the four states with the highest levels of adult obesity had rates between 15 percent and 19 percent. A mere fifteen years later, the proportion of all adults nationally over age twenty who are obese has reached a shocking 30 percent, dramatized in Figure 1.1. To provide another perspective, weight-related health problems account for 9.1 percent of all health care expenditures in the United States. But according to a study by the National Institutes of Health, over the next few decades the greatest price that obesity may exact from society, if we fail to change course, is a life expectancy that is up to five years lower.

Why have we grown obese? Several reasons can be found in the spatial environment we’ve designed for ourselves. While four-, five-, and even six-story residential walk-up buildings were commonplace in most large American cities during the nineteenth century, the use of stairs has been actively discouraged by the fine house code requirements of twentieth- and twenty-first-century U.S. building codes. At one time, most Americans got to their destinations by foot; many never ventured far from home their entire lives. People lived locally; they settled in one place and stayed there. They did not require mechanical means to get them across town to Costco. Children walked to school. Abraham Lincoln famously walked six miles each way to reach the library; today we walk as little as an average of four minutes a day.

Not only are we sedentary, but we’ve chosen a life that is increasingly lived indoors. A baby born in the United States will spend close to 87 percent of his or her lifetime indoors and another 4 percent in enclosed transit. (see Figures 1.1 A & B and Chart 1.1) The reason? We’ve become experts at creating shelter with ever-increasing levels of indoor comfort. The possibility of cooling a room with an air conditioner became a reality in the 1960s. Soon entire buildings sealed themselves off from the outside with grid-powered mechanical ventilation. Open windows were a thing of the past. The welcome frigid blast of an air conditioner in summer has obscured the price we pay in health costs; the U.S. Environmental Protection Agency estimates that indoor air is two
to five times more polluted than outdoor air because of smoking, indoor combustion, material off-gassing, and mold. Children are at an even greater risk than adults due to their faster breathing rates, greater activity levels, and still-developing lungs and other tissues.

There is an economic cost, too. In substituting mechanical means for what was otherwise free in nature, a significant amount of the energy consumed by the average building is used to circulate oxygenated air, formerly the work of open windows.

We pay a psychic price as well. In choosing to become an indoor species, we have cut ourselves off from the natural world, making us increasingly oblivious to what we are doing to our immediate outdoor surroundings. Private yards and public streets alike are asphalted, floodlit (Figure 4-5), and filled with hot, noisemaking mechanical devices (Figure 4-6). While air conditioning condensers provide comfort and security to people indoors, they amount to a de facto plan to keep people indoors. The unpleasant characteristics of today's outdoor spaces are especially harmful in close urban settings, actually deterring people from spending time outdoors and reinforcing the tendency to stay indoors and close the windows. This neglect is hardly surprising given that adult Americans spend five times more hours driving a car than exercising and playing sports. In other words, we spend more time traveling, typically by car, to the next building than we do enjoying outdoor spaces between them.

"We found that an average white male living in a compact community with nearby shops and services is expected to weigh 60 pounds less than his counterpart in a low-density residential-only subdivision." —Lawrence Frank, associate professor at the University of British Columbia's School of Community and Regional Planning

Not surprisingly, perhaps, the more time we spend indoors, the more indoor space we have come to demand. Not only are Americans themselves getting bigger, their homes are getting bigger. From 1970 to 2000, the average household size in the United States shrank from 3.14 to 2.62 people, while the size of the typical new American house increased from 1,385 square feet to 2,140 square feet, a rise of 54 percent (see Figure 4-7). All of this time spent indoors deprives humans of the physical and mental benefits of walking, outdoor exercise, and time immersed in nature. Much new development is designed to discourage outdoor living. New streetscapes are hostile to pedestrians and discourage travel by foot. New buildings are designed with air-conditioning for indoor living rather than with open windows and doors that draw people outdoors. These design choices contribute directly to our obesity epidemic and likely impact our mental acuity. According to the Wolf Street Journal, a recent gerontology study concludes that "as little as three hours a week of aerobic exercise increased the brain's volume of gray matter (actual neurons) and white matter (connections between neurons),...to that of people three years younger."

The lack of human contact with nature has imprinted deeply into our psyche. The human organism is designed to need a regular intake of sunlight, clean air, and water. The sun is necessary not only for photosynthesis, which produces oxygen and food, but also for the biological clock that governs our bodies. A lack of sunlight translates into a lack of vitamin D, which is necessary for bone health and a functioning immune system. When we are exposed to sunlight, our bodies produce serotonin, a neurotransmitter that regulates mood and sleep. A lack of serotonin can lead to depression, anxiety, and other mental health issues. The amount of sunlight that we receive also affects our circadian rhythm, or biological clock, which regulates our sleep-wake cycle. If we don't get enough sunlight, our bodies may not produce enough melatonin, a hormone that helps us sleep. This can lead to sleep disorders like insomnia and other sleep-related health problems.

Figure 4-5 Overlapping contributes to sleep disorders and stress ties to nature. Image © Cantor & Associates.

Figure 4-6 These hot, buzzing air conditioning condensers encourage people to go indoors and close windows.

Chapter 4: The Built Environment 31
resulting from our lifestyle, is also the most difficult to overcome, as the harm is slow to materialize (Figure 1.8) and does not present the sort of imminent external threat against which history confirms humanity can unite. 10

The metaphor of the "ecological footprint" approximates and visually illustrates the capacity of nature's systems to support the demands placed on it by contemporary lifestyle. It categorizes human demands on land into food, goods and services, transportation, housing, energy use, location, green practices, and income. According to research prepared by WWF, and displayed in Figure 1.9, starting around 1977 human resource demands exceeded the planet's capacity to provide them. 11 By far the most surprising and provocative finding concerns the energy-intensiveness of providing food to Americans. According to Michael Pollan, author of The Omnivore's Dilemma, America's food is "drenched in fossil fuel," reflecting both the energy-intensiveness of agribusiness and the 1,494-mile average that a plate of food is transported in the United States. 12

A prime villain in all this, and a lifestyle choice made early and rarely questioned, is our love affair with the automobile. We have become addicted to driving. Most Americans rely on cars to meet the most basic needs of life. We cherish the "freedom of the road" and safeguard it with a zealotry that suggests it was written into the Constitution. Americans drive more than any other society on Earth and are locked into doing so by choosing to live, work, and shop in out-of-the-way places that demand driving. A family chooses to buy a large house in a new subdivision at the edge of town because they understand they can get there by car. A job across town, remote from where they live and not served by public transit, is just as good as a job nearby. Whoever shops drives miles to a big-box store, bypassing numerous local stores that carry the same merchandise, in order to save a few cents per item.

People making these lifestyle choices are automobile dependent. As a result, roughly two-thirds of all oil consumed in the United States is processed into fuel for transportation. 13 While Americans might acknowledge our country's oil and auto dependence, indeed, even George W. Bush has declared the United States to be "addicted to oil," 14 most are too immersed in it to see it as an addiction (see Figure 1.10).
The joint addiction to driving and oil comes at an extremely high cost to individuals and families. The average cost of owning, operating, and maintaining a new car is now estimated to be $7,000 per year. The average vehicle is driven more than 12,000 miles per year, equivalent to halfway around the Earth. The average American household has 2.6 members and drives 24,500 miles per year. This translates to every family in America driving its cars a distance equivalent to 90 percent of the Earth’s circumference every year. These averages conceal the varied rates of family car ownership across a metropolitan region. The cost burden of car ownership falls disproportionately on suburban and exurban residents, where some families own one or even more cars per adult. These metropolitan differences are dramatized in Figure 5-11, showing that the average rural or exurban Atlanta area resident drives nearly eight times more each day (forty miles versus five miles) than the average central-city Atlantan.

Parking exacts its own toll on business, government, and the environment. Street networks and parking spaces are expensive to build. In 1973, Planner Victor Gruen estimated that every car in America is provided with four parking spaces, equivalent to a 25 percent occupancy rate for America’s roughly one billion parking spaces. This alarming statistic is still cited by today’s acknowledged parking expert, Donald Shoup, a professor of urban planning at UCLA. If this were all surface parking, it would cover roughly the entire state of Maryland. The cost of constructing parking spaces is high, anywhere from $2,500 to $5,000 for a surface spot to between $30,000 and $50,000 for underground spaces—a national capital investment of between $5 trillion and $10 trillion. Despite this enormous investment in parking, it is generally offered free to users (see Figure 5-22), paid for by the private sector through increased prices and by the public sector in taxes. Donald Shoup singles out free parking as possibly the most powerful inducement to own and drive cars in the built environment, an unlikely but essential link in our addiction to driving and oil (see Figure 5-13).

![Figure 5-11: You are where you live: exurban Atlantans drive an average of eight times more than urban Atlantans, Criterion Planners, Impact Analysis of Smart Growth Land Use Planning, Georgia Regional Transportation Authority, Atlanta, GA, April 2000. Image © 2000 Edlet Allen, Criterion Planners.](image1)

![Figure 5-12: Abundant, free parking creates demand for driving.](image2)

![Figure 5-13: Parking itself is made of oil or coal byproducts and creates toxic runoff.](image3)

![Figure 5-14: Erasing sprawl, multitude suburbs will require complete redevelopment to support a sustainable urban lifestyle.](image4)

Our subsidies and inducements to drive do not end there. There are 8,271,117 lane-miles of highways, roads, and streets in the United States, nearly all of which are free to the motorist. Less than 1 percent of these roadways charge tolls, with gas taxes paying most of the cost of highway construction and maintenance, while the vast majority of local roads are paid for with local taxes. Ready for more bad news? America’s investment in automobiles and roads has resulted in an unprecedented rate of land consumption. During the past generation, Americans have chosen to develop land at up to ten times the rate of population growth. The external harm from this pattern of development is its consumption of undeveloped land that would otherwise provide natural habitat or land for agriculture. Internally this low-density development increases the travel distance between any two destinations (see Figure 5-14), making it ever more likely that people will drive.

This low-density development results in the highest per capita demands on natural systems and habitats. In a comparative analysis of two projects in Sacramento, California (Figure 5-55), the lower-density development resulted in across-the-board per capita increases in impervious land cover, miles driven, water use, energy use, air pollution, and greenhouse gas production. At one extreme of the sustainable lifestyle spectrum is the Manhattan family who lives in a compact apartment, has no excess space to amass consumer goods, chooses to walk or use public transit, and has no lawn to water or fertilize. Unfortunately, the American lifestyle norm has gone in exactly the opposite direction.

It is troubling how the modest progress we are making in energy efficiency cannot keep up with our appetite for bigger houses and cars. While energy codes adopted by states and municipalities over the last few years have increased building energy efficiency per square foot, the size of the average American house appears to be increasing more quickly, canceling out any efficiency savings.

Even worse, since 1968 the United States has experienced a steady 2.5 percent annual increase in miles driven that are not being offset by any energy efficiency gains. The Corporate Average Fuel Economy (CAFE) standards have been flat since 1972, a fact made worse by a loophole allowing SUVs (Figure 5-16) an exemption from the standards.

In addition to these adverse environmental impacts, the public infrastructure necessary to support this low-density development is expensive to build and maintain. Infrastructure is made up of the public facilities and services that are necessary—to support living in a community, including facilities—roads, pipes, and wires—as well as services education, police, and fire protection. The cost of building and maintaining infrastructure is divided among the number of people it serves, described as the cost per capita. National studies show that low-density development increases the cost of hard infrastructure, and with it the tax burden, in developed areas by an average of 11 percent. It should be clear now that the lifestyle choices we’ve made, our “rational” decisions to live in comfort and access jobs and stores by mechanical means, have inexorably altered our built environment. We are paying a terribly high price in individual health, a general sense of well-being, and happiness. We have alienated ourselves from nature, which we need to sustain us. Perhaps worst of all, we are jeopardizing our global climate and are confused as to the causes.

The conventional view in America is to think of cities as the source of the pollution that is causing climate change. Indeed, per unit of land area, cities generate a great deal of pollution (see the traditional view in Figure 5-17). However, on a per capita basis, city dwellers...
generate the least CO2 (see the emerging view in Figure 1-17). The American dream of a large house on a large lot in the suburbs is what’s most responsible for cooking the planet. To rectify these wrongs we need to take a cold, hard look at some of our most cherished assumptions and pet comforts. We need the courage to challenge the course we have chosen, whose symptoms have been so long in the making and may seem so resistant to change. But it is not an optional effort. Too much is at stake. And if we approach it right, if we allow ourselves to explore and confront this resistance to change, then the rewards can be incalculable. Our plan is not to focus on the wrongs of the past; it is to chart a compelling future.

**Comparison of Environmental Transect Performance in Sacramento, California**

<table>
<thead>
<tr>
<th>Design Option</th>
<th>Suburban</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Density (mid-point)</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Open Space (mid-point)</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Employment Poiut (mid-point)</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Street Density (mid-point)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Transit Promote (mid-point)</td>
<td>25.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Area Use (mid-point)</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Environmental Performance</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Vehicle Use (mid-point)</td>
<td>200.0</td>
<td>200.0</td>
</tr>
<tr>
<td>Energy Use (mid-point)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Water Use (mid-point)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Non-motorized (mid-point)</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Non-renewable Fuels (mid-point)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Onsite Air Pollutant Emissions</td>
<td>200.0</td>
<td>200.0</td>
</tr>
<tr>
<td>Downwind Air Pollutant Emissions</td>
<td>20.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>


Figure 1-16: This "right track" gets less than 10 miles per gallon.

**Two Views of Cities and CO2**

*CO2 Generated by Automobiles in the Chicago Region per Year*

*Traditional View*
- Cities produce large amounts of greenhouse gases

*Modern View*
- Cities produce relatively lesser amounts of greenhouse gases

**Tons of CO2 per Square Mile**

<table>
<thead>
<tr>
<th>County/Chicago</th>
<th>Tons of CO2/Square Mile per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>METRA Rail Line</td>
<td>81.100 Tons</td>
</tr>
<tr>
<td></td>
<td>7.450 Tons</td>
</tr>
<tr>
<td></td>
<td>1.695 Tons</td>
</tr>
<tr>
<td></td>
<td>290 Tons</td>
</tr>
<tr>
<td></td>
<td>35 Tons</td>
</tr>
</tbody>
</table>

**Tons of CO2 per Household**

<table>
<thead>
<tr>
<th>County/Chicago</th>
<th>Tons of CO2/Household per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11.5 Tons</td>
</tr>
<tr>
<td></td>
<td>10.5 Tons</td>
</tr>
<tr>
<td></td>
<td>10 Tons</td>
</tr>
<tr>
<td></td>
<td>9 Tons</td>
</tr>
<tr>
<td></td>
<td>2.5 Tons</td>
</tr>
</tbody>
</table>
Pioneering Reforms: Setting the Stage for Sustainable Urbanism

“America is ready to turn the page. American is ready for a new set of challenges.” Illinois Senator Barack Obama

Sustainable urbanism draws attention to the enormous opportunity to redesign the built environment in a manner that supports a higher quality of life and promotes a healthy and sustainable American lifestyle. The basis for this transformation of the built environment is a synthesis of urbanism—the millennia-old tradition of human settlements—with late 20th Century environmentalism that started with Rachel Carson’s Silent Spring. The synthesis of these two intellectual and practical histories requires a new consensus on the role of humans in nature. The best place to start this discussion is with the influential 1969 book Design with Nature by Scottish landscape architect Ian McHarg.

While unknown to many today, this influential book was the first to explain to a relatively wide audience geographic information systems (GIS), the natural transect (Figure 2-a), and other ecological principles. Design with Nature also tells the story of McHarg’s harsh reaction as a young man against the pollution, ugliness, and lack of vegetation in his native Glasgow, which instilled in him, and many of his generation, a lifelong link between cities and pathology. The subtitle of this book Urban Design with Nature was chosen both to credit McHarg for his influential work, but also to rebut his bias against cities, his distaste for human systems, and his focus on wilderness free of humans.

Given how critical McHarg was of the design of cities, it is ironic that Design with Nature ignored the task of trying to improve cities by better integrating their designs with natural systems. When asked why his book failed to address cities and “social systems,” McHarg replied: “I had experienced four graduate years at Harvard, dominantly in social science, and concluded that much of it, conspicuously economics, was antithetical to ecology, while the remainder, including sociology, history, government, and laws, was oblivious to the environment. As I could not reconcile social science with ecology, I had simply excluded the subject.” While not unique, McHarg’s self-imposed blinders are indicative of the long-running divide between nature-focused environmentalists and human-focused urbanists. This obliviousness to human systems carried over to McHarg’s built work—essentially well landscaped, auto-dependent suburbs—which are still mistakenly seen as sustainable development.

Sustainable urbanism grows out of three late 20th Century reform movements that have transcended McHarg’s anti-social environmentalism to highlight the benefits of integrating human and natural systems. The smart growth, new urbanism and green building movements provide the philosophical and practical bones of sustainable urbanism. While all three share an interest in comprehensive economic, social and environmental reform, they differ greatly in their history, constituencies, approach, and focus.

Each of these movements, highly worthy in and of itself, has suffered from a certain insularity, that has resulted in a myopia when it comes to searching for long-term solutions. Further, there has been an understandable but unfortunate tendency toward self-validation, resulting in an unwillingness to engage a larger, comprehensive agenda. For instance, a certified green building isn’t really a positive for the environment when it turns out to be surrounded by a massive paved parking lot; a walkable neighborhood is hard to sustain when its houses are wastefully constructed and energy inefficient.

Sustainable urbanism attempts to bring these three important movements together and knit them into a design philosophy to allow and create truly sustainable human environments.

Smart Growth: The Environmental Conscience of Sustainable Urbanism

Smart Growth has its roots in the environmental movement of the 1970s which was strengthened by President Richard Nixon’s environmentally focused legislative agenda. With bipartisan support, Nixon signed into law what serves as the backbone of United States environmental policy to this day (Figure 2-b). This includes the Clean Water Act, the Clean Air Act, the Endangered Species Act, the National Environmental Protection Act (NEPA), the Coastal Zone Management Act, as well as the creation of the Environmental Protection Agency.

Amidst this unique burst of federal environmentalism, Senator Henry “Scoop” Jackson introduced the National Land Use Policy Act in 1970. Designed as a bookend to NEPA, it was intended to encourage states to develop coordinated state land use plans and proposed a new federal agency and land-planning database. The legislation passed twice in the Senate but failed in the House, and was then dropped amidst the turbulence of Nixon’s second term. But while the proposed act failed, its proposal for state-by-state land use planning was adopted by several pioneering governors in the intervening years.

In Oregon, Governor Tom McCall proposed legislation to manage the state’s population growth and land development, responding to Oregon’s long tradition of land conservation and interest in preserving its scenic beauty. In 1973 Oregon’s legislature passed a law requiring all the state’s municipalities to designate Urban Growth Boundaries (UGBs), rings beyond which land development was not permitted. These boundaries were designed to expand in an orderly fashion as each ring of land was developed. However, they remain a subject of serious debate. UGB succeeded in controlling the scope of land development, thus preserving the state’s scenic treasures, but it did little to ensure the quality of development within the UGB, leading to well-located bad development, or what could be called “smart sprawl.”
Other states took different approaches to regulating land use. Judy Corbett of the Local Government Commission has explained that Colorado Governor Roy Romer first used the term in 1995 when, concerned about sprawl in the State of Colorado, he put forward a new vision for what he called ‘Smart Growth.’ Former Maryland Governor Parris Glendenning subsequently picked up and popularized the term. Maryland’s state land use law was rooted in good governance—the extension of state-financed infrastructure to those areas with the lowest cost of delivering municipal services. Maryland’s legislation, the Smart Growth and Neighborhood Conservation Program, was enacted in 1997 and designated urban growth areas that were eligible for state infrastructure. While the law remained in effect only until shortly after Glendenning stepped down in January 2003, this strategy influenced other states, notably New Jersey, to follow suit. These development location criteria helped to inform similar criteria in LEED for Neighborhood Development (see Chapter 2).

The Smart growth movement embraced a broader agenda in 1996 with the development of ten principles of smart growth (see sidebar), initiated by Harriet Tregunno, then Director of Development, Community, and Environment at the U.S. Environmental Protection Agency. At the time, many environmentalists were simply anti-growth and viewed all development, largely without distinction, as hostile to the environment. The principles were successful in uniting a decentralized grassroots movement of local and regional citizen activists and municipal leaders under the Smart Growth banner. However, the vagueness of the standards and the Smart Growth movement’s decision to lend its name to development projects of sometimes minimal incremental improvement worked to deviate the smart growth brand. Nonetheless, this national coalition of regional, not-for-profit organizations has a dedicated membership, promoting urban redevelopment and sound land conservation policies. The local, on-the-ground leaders who form the broad membership base of the smart growth movement are the foot soldiers of sustainable urbanism, and are essential to its success.

**Congress for the New Urbanism: Sustainability’s Urban Design Movement**

The Congress for the New Urbanism (CNU) was founded by six architects—Peter Calthorpe, Andrés Duany, Elizabeth Moule, Elizabeth Plater-Zyberk, Stephen Ross, and Daniel Solomon—and first met as an organization in Alexandria, Virginia, in 1993. Many of the six founders had ties to Princeton University and collaborated on the design of Playa Vista, a large mixed-use development in California, and participated in the writing of the Ahwahnee Principles for Resource-Efficient Communities in 1991. They united around a shared vision of promoting traditional urbanism as an antidote to conventional sprawl and created an ad hoc organization that convened four annual congresses. To best understand CNU, it helps to go back seventy-five years to the founding of the Congrès Internationale d’Architecture Moderne, or International Congress of Modern Architecture (CIAM), in 1928. Like CNU, CIAM was a design reform movement with a stated focus of bettering public health and design by improving cities and housing. At its core the CIAM movement was a humane and essential attempt to improve human health and sanitation; at the time large sections of the older cities of Europe were dangerous and unhealthy places to live, especially for the lower classes. CIAM’s analysis accurately captured the gravity of the problem, citing “a mortality rate reaching as high as twenty percent” in some city quarters.8

---

**The Ten Principles of Smart Growth**

1. **Create a range of housing opportunities and choices.**
2. **Create walkable neighborhoods.**
3. **Encourage community and stakeholder collaboration.**
4. **Foster distinctive, attractive places with a strong sense of place.**
5. **Make development decisions predictable, fair, and cost-effective.**
6. **Mix land uses.**
7. **Preserve open space, farmland, natural beauty, and critical environmental areas.**
8. **Provide a variety of transportation choices.**
9. **Strengthen and direct development toward existing communities.**
10. **Take advantage of compact building design.**

---

“You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete.” R. Buckminster Fuller

The CIAM reform movement brought together many of Europe’s leading modernist architects including Gropius, Le Corbusier, Sert, and Alito. Over nearly 30 years they conducted an ambitious program of annual retreats, design studies, and declarations, with the goal of establishing a comprehensive agenda for the reform of the built urban environment. The philosophy of CIAM combined three dissimilar intellectual strains: (1) humanistic reforms concerning the provision of dignified shelter, enhanced sanitation and health; (2) an enthusiastic embrace of the use of cars, the use of which required a redesign of the built environment; and (3) a preoccupation with modernist architectural styles and rational (“one size fits all”) solutions.

CIAM’s analysis of thirty-three cities became the basis for its Athens Charter published in 1943, “by which the destiny of cities will be set right.” A typical declaration reflecting the problems with cities read: “The nuclei of the old cities were generally filled with close-set structures and deprived of open space. But, in compensation, verdant spaces were directly accessible, just outside the city gates, making all of good quality available nearby.”

This idea that cities lacked “ lungs” would come to shape the CIAM approach to the design and site planning of individual buildings. In a pivotal turn in the history of CIAM at its third congress, held in Brussels in 1930, the participants prepared design studies of housing alternatives, concluding that high-rise dwellings solved almost all of the cities’ problems: “High structures respond to this purpose [the aeration of the city] since they permit a considerable increase in open spaces which can become reserves of trees and verdure...” These reserves closely encircling the dwelling-places will turn the jays of nature into a daily occurrence and not merely an optional Sunday pleasure.”

Indeed, this single CIAM congress served as the source for the “towers in the park” pattern of public housing development widely built in the United States following World War II (Figure 1.10), which, outside of New York City, has since been largely dismantled.

Particularly notable in the Athens Charter is the confident voice given to the needs—one might say rights—of drivers to travel at high speeds unimpeded by constraints. At the expense of pedestrians and a fine-grained street grid, this passage elevates the poor acceleration and braking of early cars as a fundamental basis for street design: “Before reaching their normal cruising speed, mechanized vehicles have to start up and gradually accelerate. Sudden braking can only cause rapid wear and tear on major parts. A reasonable unit of length between the starting up point and the point at which it becomes necessary to break must therefore be gauged. Street intersections today... are not suited to the proper operation of mechanized vehicles. They should be separated by intervals of from 200 to 400 yards.”
Two other new urbanist innovations, the urban-rural transect and the Smart Code, both developed by Andrés Duany, principal of Duany Plater-Zyberk, also have the capacity to shape regions. The natural transect (Figure 1.23), developed in nineteenth-century Germany and mentioned earlier in this chapter in connection with Ian McHarg, is a longitudinal drawing used in ecology to describe the unique ecological niches found across a landscape. The urban-rural transect (Figure 1.24) applies this ecological framework to describe human settlements or place types across a spectrum of intensity ranging from wilderness to dense urban centers.

The Smart Code is a transect-based, form-based code which seeks to replace existing zoning codes with new codes of breathtaking clarity and simplicity. It combines aspects of conventional zoning codes, subdivision codes, and overlay districts into one integrated document. The Smart Code is an open framework that establishes code criteria to be "calibrated" locally. After only a few years, the Smart Code has been adopted by numerous cities and counties as the basis for their land development controls.

The Charter of the New Urbanism

"The Congress for the New Urbanism was formed in 1993 to focus on planning and design in the areas of sustainability, livability, and vibrancy. It has become a powerful advocate for walkable, well-connected, and walkable communities. The New Urbanism is a philosophy, a set of principles, and a practical framework for creating communities that work.

Figure 1.23

New zoning defines a new urban form

New development is characteristically dense, walkable, and walkable.

New design guidelines define a new urban form

New urban design guidelines define a new urban form.

New form-based codes define a new urban form

New form-based codes define a new urban form.
Despite its many achievements, however, the CNU has proved only somewhat successful in reforming state or national practices. In large part this is because the CNU has focused on convincing local regulators to create exceptions to conventional practice and to allow the approval of individual projects. While effective on a case-by-case basis, this pragmatic approach has left intact a foundation of hostile single-issue standards as well as a built environment that remains dominated by climate-changing sprawl.

A larger perspective is needed, one that goes beyond reviewing and debating the dozens of exemplary projects that members design each year. At this time, no national organization has taken on the call to systematically dismantle the regulations and subsidies, known best to CNU members working on the front lines, that generate sprawl. Nor has the CNU gone beyond its self-identification as an "elite" organization of creatives, declining to agree on standards of any sort so as not to limit the creative process. However, because of its effectiveness at design, persuasion, and selling, the CNU membership will play a leading role in implementing sustainable urbanism.

**USGBC: Sustainability's Building Performance and Certification Movement**

The oil shocks of the 1970s jump-started a movement for building energy efficiency and solar heated and powered buildings. Unfortunately these movements were unable to attract much governmental policy support throughout the 1980s and gained little traction. In 1993, however, the American Institute of Architect's Committee on the Environment, inspired by the 1992 Rio Earth Summit, published *The Environmental Resource Guide*. This comprehensive catalogue on the theory, practice, and technology of "environmental" buildings drew heavily on the pioneering work that preceded it.

This same confluence inspired the creation of the third founding reform of sustainable urbanism, the United States Green Building Council (USGBC). The USGBC was founded in Washington D.C., in 1993 by three development industry professionals; David Golfray, Richard Fedrizzi, and Michael Italiano. They too were inspired by the Rio Earth Summit and were largely concerned with the same intellectual ground explored in *The Environmental Resource Guide*. The USGBC made two very smart moves to accelerate the adoption of environmental or green building practices: it expanded its audience outside the architecture profession, and it sought to mobilize the private sector.

Shortly after its founding the USGBC drafted pioneering standards for green building, completing a "final" version in 1995. The name Leadership in Energy and Environmental Design (LEED) was adopted in 1996. USGBC launched the pilot version in 1998 and its rating system in 2000. The LEED standard combines prerequisites, with optional credits that earn points toward an overall score. As a project's point score goes up it earns LEED certification at increasing levels of performance from Certified on the low end to Platinum on the high end. This flexibility works well in the marketplace, allowing a project to incorporate only well-suited green building strategies.

USGBC set an initial target of certifying 5 percent of the U.S. market for new construction buildings as green buildings under its LEED program. A helpful early breakthrough was the decision by the U.S. General Services Administration to adopt LEED standards as a requirement for all government-owned and -developed buildings. This single administrative act created a market for LEED-rated buildings and continues to deliver large square footages of LEED-certified projects every year. As a result, LEED has become an increasingly mainstream force that has reformed the entire building industry toward more sustainable practices.
By the end of 2006 there were more than forty thousand LEED Accredited Professionals—an almost a baseball stadium (see Figure 1.26)—and increasing numbers of municipalities, universities, and private developers adopting LEED as a standard for their building portfolios.

The backbone of the success of LEED has been the ability of the U.S. Green Building Council to increase its staff and certification operations at a geometric pace while maintaining quality and integrity. This success is based on USGBC’s ability to mobilize and harness a huge amount of volunteer effort from hundreds of professionals. So far LEED has found a middle ground between competing arguments that LEED documentation was too rigorous on one hand and no longer cutting edge on the other.

A second engine driving green building practice is the concept of integrated design: working in interdisciplinary teams to optimize overall building performance without adding construction cost. Integrated design teams have succeeded by reallocating existing budget monies to achieve a higher-performing building, largely by stressing the performance of systems over components. The classic illustration of design integration is increasing the energy performance of a building’s envelope, which in turn enables the installation of a smaller and more efficient mechanical system.

The LEED system currently has two significant unrelated drawbacks. The first relates to the number of buildings that have actually achieved certification under the LEED system. In 2006, six years after LEED was launched, fewer than a thousand buildings have reached any level of certification (see Figure 1.27). This falls far short of any of the USGBC’s ambitious market penetration goals and represents an insignificant number compared to the estimated 250,000 new buildings built each year in the United States. The low level of LEED certification poses a challenge for the USGBC, which wants to increase the number of certified projects while also raising the criteria for carbon reduction. USGBC will likely need to embrace municipal adopters of LEED as code to yield a significant number of highly energy-efficient buildings necessary to achieve its goal.

The second shortcoming is LEED’s building-centric focus and the low value it places on a project’s location and context, particularly concerning auto-dependency. The dominant unit of reform within the LEED system remains the stand-alone building. The prerequisites and credit weightings from the original draft of LEED, heavily weighted toward the building itself, are nearly unchanged since 2000. In the flagship LEED-NC (LEED for New Construction), there are no prerequisites for location or context, and only about 6 percent of all credits address these issues. This greatly limits the power of LEED certifications for individual buildings to have any effect on their surrounding context (see Figure 1.25). The original drafters of LEED can be forgiven for failing to adopt more rigorous land use and location criteria, since none existed at the time. Subsequent initiatives suggest a shift toward a more comprehensive view. In 2002, the USGBC Board of Directors inaugurated the LEED for Neighborhood Development rating system in partnership with the Congress for New Urbanism and the National Resource Defense Council. It is expected that this will begin to inform the remainder of LEED, presumably by increasing the weighting given to land use and transportation concerns. In 2005, in a significant signal of its intention to move beyond the stand-alone building, the USGBC board modified its mission to address both buildings and community. Because of its entrepreneurial outlook and enormous base of LEED Accredited Professionals, the USGBC is well positioned to be a virtual green army of sustainable urbanists.
Chapter 7
Sustainable Neighborhoods

Neighborhood Diagns
Illustrations by Regional Plan Association, Duany Plater-Zyberk & Company
and Farr Associates

Neighborhood Unit: Clarence Perry
Clarence Perry's diagram of the neighborhood unit, published as part of the 1929 Regional
Plan of New York and Environ, has influenced generations of plans. The enduring parts of the
diagram include its quarter-mile "pedestrian shed," its ideal size of 160 acres, a neighborhood
center surrounded by civic buildings, clearly delimited edges, commercial uses at the edge,
a network of narrow streets, small walk-to parks throughout, and the population needed to
support an elementary school. From the point of view of sustainable urbanism, the plan has a
number of shortcomings. For instance, it includes no reference to public transit or varied
housing types, neglects the river asset, misaligns streets with those in adjacent neighbor-
hoods, and is silent on buildings and infrastructure.

An Urban Neighborhood (Part of a Town): DPZ
The Duany Plater-Zyberk (DPZ) urban neighborhood diagram, based on Clarence Perry's
neighborhood unit, is an update that resolves most of the earlier plan's shortcomings.
The diagram sensibly substitutes boulevards for highways, aligns local streets, proposes
a bus stop in the neighborhood center, adds parking, and sites the school to allow it to

Figure 7-5
Neighborhood unit for the Regional
Plan of New York by Clarence Perry,
1929. Image © Regional Plan
Association.

Figure 7-12
Updated neighborhood unit.
Image © Duany Plater-Zyberk
& Company.
serve multiple neighborhoods. The DPZ diagram also establishes a rule of thumb for establishing neighborhood parks—one per quadrant. From the point of view of sustainable urbanism, the DPZ diagram, like Perry’s before it, remained silent on buildings and infrastructure and sees no role for nearby nonhuman habitat, going so far as to eliminate Perry’s hypothetical river altogether.

**Sustainable Urbanist Neighborhood**

The sustainable neighborhood diagram below builds on the previous two, adapting them to meet current needs. Five distinctions result: (1) the neighborhood is a building block of a transit corridor; (2) the central DPZ bus stop is replaced with a higher intensity transit mode (BRT, trolley, light rail); (3) it is fitted out with high-performance infrastructure: district power, dimmable streetlights, and a share car per block; (4) the mix and density support car-free housing and a third place; and (5) habitat and infrastructure greenways give the neighborhood distinct edges.

![Sustainable Neighborhood Diagram](image)

---

**Neighborhood Definition**

**Victor Dover and Jason King**

Dover Kohl & Partners

The traditional neighborhood is the basic increment of town planning. One neighborhood alone in the countryside is a village. Two or more neighborhoods grouped together sharing a specialized hub or main street is a town. The neighborhood concept remains in force even as the size increases to city scale; Paris, for example, is assembled from a series of many high-quality neighborhoods. Coupled with special districts and corridors, neighborhoods are the building blocks from which enduring settlements are formed. The dynamism and diversity that characterize attractive cities rely upon a solid foundation of vital and coherent neighborhoods.

In our time it’s become necessary to reassert the definition of the term. We don’t use the word neighborhood to refer to the disconnected, single-use developments that characterize sprawl, such as stand-alone apartment complexes, subdivision tracts, office parks, or shopping centers. Real traditional neighborhoods meet all those same needs—for housing, workplaces, shopping, civic functions, and more—but in formats that are compact, complete, and connected, and ultimately more sustainable and satisfying.

A genuine neighborhood is “compact, pedestrian-friendly, and mixed-use,” according to the charter of the Congress for the New Urbanism. That said, we are often pressed to specify the exact parameters of the ideal neighborhood—minimum and maximum acres, dimensions, densities, populations, commercial components, mix of dwelling types, and so on—but the metrics of neighborhoods should range widely to reflect regional customs, climates, and site conditions.

Although the numbers vary, there are five basic design conventions that provide a common thread linking great neighborhoods.

**Identifiable Center and Edge to the Neighborhood**

One should be able to tell when one has arrived in the neighborhood and when one has reached its heart.

There must be places where the public feels welcome and encouraged to congregate, recognizable as the heart of the community. A proper center has at least one outdoor public environment for this purpose, designed with pedestrians in mind; this is spatially the most well-defined “outdoor room” in the neighborhood. It is configured for gatherings both organized and spontaneous, for both ceremonies and day-to-day casual encounters. The size and formality of the central space vary from place to place, and while it most typically takes the form of a square or plaza, it is also possible to give shape to the neighborhood center with just a special “four corners” intersection of important streets. In most climates, shade or other protection from the elements is found at the center.
The best centers are within walking distance of the surrounding, primarily residential areas, and typically some gradient in density is discernable from center to edge. Centers possess a mix of uses and the potential for higher-density buildings at a pedestrian scale (four stories maximum for most circumstances, except at the metropolitan core).

Discernible centers are more important than discernible edges because of the center’s usefulness in day-to-day life. Paul Murrain has observed that average urban dwellers probably care far less about a well-defined edge for their neighborhood than a well-defined center because the center affects the quality of life by being the place for meeting daily needs and connecting socially. The center is also the place for coalescing of community in response to adversity; we gather at the commons in times of emergency.

Delineating the neighborhood edge by design is more a source of psychosocial comfort than the meeting of a physical need, so the adjustments that are made to the urban fabric at the edge are often subtle.

**Walkable Size**

The overall size of the neighborhood should be suitable for walking. Neighborhoods range from 400 to 200 acres.

Most people will walk a distance of approximately one-quarter mile (1,320 feet) before turning back or opting to drive or ride a bike rather than walk. This dimension is a constant in the way people have settled for centuries. Most neighborhoods built before World War II were one-quarter mile from center to edge.

Of course, neighborhoods are not circular in design, nor is that desirable. Neighborhoods tend to elongate along contours and ridges and compress at slopes because the walkability elongates across flat planes. The quarter-mile radius is a benchmark for creating a neighborhood unit that is manageable in size and feel and inherently walkable. We certainly should be willing to walk farther.

Neighborhoods of many sizes and shapes can satisfy the quarter-mile radius test. Large civic spaces such as modern schools with play fields require a great deal of acreage and can be situated where they are shared by more than one neighborhood. When the territory to be settled encompasses more acreage, larger planned communities can satisfy the quarter-mile radius by establishing several distinct neighborhoods or quarters within the community. Significant centers should be spaced about one-half mile apart or less.
“Design speed” is the crucial number engineers officially use to configure streets for orderly traffic movement. The chosen design speed must be a low figure, usually less than 25 mph, for a highly walkable environment. The slow design speeds that characterize walkable streets result from the conscious choice of features such as narrow curb-to-curb cross sections, street trees, architecture close to the street edge, on-street parking, and relatively tight radii at the street corners.

The highest quotient of walkability will result when the buildings that shape the street space are set close enough to the front property line to spatially define the streets as public spaces, with a minimum degree of enclosure formed by a building-height-to-street-width proportion of 1:3 or closer.

**Special Sites Are Reserved for Civic Purposes**

In complete neighborhoods, it is always true that some of the best real estate is set aside for community purposes. These locations are made significant by the geometry of the town plan. Prominent locations, such as a terminated vista seen down a street or at the top of a hill, should be reserved for landmark buildings. These locations are deliberately selected for building sites that will conclude the long view down a street or for anchoring a prominent street corner or neighborhood square. These unique settings within the neighborhoods are the permanent anchors for community pride. Civic buildings, because they serve the entire community, should be accessible and located in areas with greater activity.

Similarly, special sites should be set aside for parks, greens, squares, plazas, and playgrounds. Each neighborhood should have one special gathering space at its center, such as a village green.

Parks are the largest of the open spaces, and contain natural preserves, paths, and trails. Greens are smaller but should ideally be large enough for a person to be away from the noise and movement of the street. Squares are often used for civic purposes. They are at least one acre in size, located at the intersection of major streets, and shaped by surrounding building frontages. Squares contain landscaping and trees that are deliberately arranged. Plazas are used for civic and commercial purposes (such as outdoor cafes) and are primarily hard-surfaced (stone, brick, pavement, etc.). They are smaller than a square and spatially defined by surrounding frontages. Playgrounds can be any size, are designed primarily for children, and may be part of larger parks or greens.

**Note**


---

**Table 7-1 Neighborhood Definition**

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Size (Acres)</th>
<th>Area Devoted to Center (Acres)</th>
<th>% of Size to Center</th>
<th>Number of Primary Dwellings</th>
<th>Number of Accessory Dwellings</th>
<th>Net Residential Density (Dw/acre)</th>
<th>S.F. of Commercial Space</th>
<th>Net Commercial Area (B.F. of Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic city of Charleston</td>
<td>Charleston, SC</td>
<td>3,015</td>
<td>300</td>
<td>9%</td>
<td>1,948</td>
<td>Unknown</td>
<td>3.6</td>
<td>1,480</td>
<td>3,804</td>
</tr>
<tr>
<td>Four levels in Historic Savannah</td>
<td>Savannah, GA</td>
<td>94</td>
<td>30</td>
<td>32%</td>
<td>120</td>
<td>Unknown</td>
<td>3.1</td>
<td>85,200</td>
<td>2,304</td>
</tr>
<tr>
<td>Seaside (original 80 acres)</td>
<td>Seaside, FL</td>
<td>80</td>
<td>5%</td>
<td>15.5 acres</td>
<td>350</td>
<td>Unknown</td>
<td>8.2</td>
<td>153,934</td>
<td>1,092</td>
</tr>
<tr>
<td>The North End Neighborhood</td>
<td>Braintree, MA</td>
<td>141</td>
<td>7%</td>
<td>10.9 acres</td>
<td>9,500</td>
<td>Unknown</td>
<td>82.6</td>
<td>7,063,397</td>
<td>4,785</td>
</tr>
<tr>
<td>Queen’s Gardens</td>
<td>Queens, NY</td>
<td>324</td>
<td>7.2%</td>
<td>4.0 acres</td>
<td>300</td>
<td>Unknown</td>
<td>2.2</td>
<td>7,500</td>
<td>52</td>
</tr>
<tr>
<td>Charity/Churches</td>
<td>Palm Beach County, FL</td>
<td>89</td>
<td>5%</td>
<td>2.7 acres</td>
<td>460</td>
<td>3.7</td>
<td>9.06</td>
<td>18,000</td>
<td>370</td>
</tr>
<tr>
<td>Kure Beach</td>
<td>Miami Beach, FL</td>
<td>918</td>
<td>4.5%</td>
<td>6.5 acres</td>
<td>428</td>
<td>301</td>
<td>11</td>
<td>62,768</td>
<td>1,586</td>
</tr>
<tr>
<td>Jupiter Ranch</td>
<td>Jupiter, FL</td>
<td>351</td>
<td>9.5%</td>
<td>10.4 acres</td>
<td>377</td>
<td>329</td>
<td>8</td>
<td>116,200</td>
<td>1,407</td>
</tr>
<tr>
<td>Great Barrier</td>
<td>Great Barrier</td>
<td>490</td>
<td>3.4%</td>
<td>1.7 acres</td>
<td>490</td>
<td>149</td>
<td>6.06</td>
<td>109,000</td>
<td>209,000</td>
</tr>
</tbody>
</table>

2. Residential Density = Dwelling Units / Acres (which do not include rooths, parks, and public areas); Source: ArcGIS 9.3 Data and Maps
3. Source: ArcGIS Business Analyst
4. Data unavailable
5. The four levels shown are bounded to the north by RL 25, to the east by Lincoln Street, to the west by Willowbrook Street, and to the south by Ogden Avenue.
6. Source: Western Redevelopment Authority
7. Potential number of units once property built
8. This estimate is based on 2010 assumptions about conventional retail channels of distribution and per-household purchasing.
9. The number will change as sustainable urbanism advances.
Neighborhood Completeness

Emerging public health research is revealing an ever-clearer understanding of the relationship between neighborhood design and the length and share of all trips that people will willingly make on foot. One central idea that has become very clear is that meeting one’s daily needs on foot in a neighborhood is made much more convenient and more likely when many walk-to destinations are clustered close together. The questions raised by this idea are how many destinations are needed and how close together do they need to be to get people to consistently walk?

Criterion Partners has developed a pioneering methodology that can serve as the basis for developing metrics to begin to answer this question. While the criteria in this threshold were developed to assess auto-dependent study areas as large as 500 acres, far larger than a neighborhood or viable pedestrian shed, the tools and methods are immensely useful. The hope is that this tool will be used for research purposes and the number of destinations and clustering distance be refined to apply to a 40 to 200 acre neighborhood. Once refined, the tool can be used in existing and new communities to identify opportunities for densification and economic development.

The first step is to list all pedestrian destinations that may occur in the neighborhood. The list below, taken from the draft of LEED for Neighborhood Development and amended with sustainable urbanist destinations, serves as the basis for the following examples.

<table>
<thead>
<tr>
<th>Potential Pedestrian Destinations/Developed Land Uses</th>
<th>Number of pedestrian destinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank</td>
<td>Post office</td>
</tr>
<tr>
<td>Child care facility</td>
<td>Laundry/dry cleaner</td>
</tr>
<tr>
<td>Community/civic center</td>
<td>Library</td>
</tr>
<tr>
<td>Convenience store</td>
<td>Live-work housing</td>
</tr>
<tr>
<td>Hair care</td>
<td>Medical/dental office</td>
</tr>
<tr>
<td>Hardware store</td>
<td>Park</td>
</tr>
<tr>
<td>Health club or indoor recreation facility</td>
<td>Place of worship</td>
</tr>
<tr>
<td></td>
<td>Police/fire station</td>
</tr>
</tbody>
</table>

Proportional area balance of all pedestrian destinations in pedestrian shed
(Refer to Table 7.2 to determine completeness level).

<table>
<thead>
<tr>
<th>Level of Neighborhood Completeness</th>
<th>Percentage of Identified Uses Present in Neighborhood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>70% or greater</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>50-70%</td>
</tr>
<tr>
<td>Minimal</td>
<td>10-30%</td>
</tr>
<tr>
<td>Poor</td>
<td>Less than 10%</td>
</tr>
</tbody>
</table>

From the list of amenities that has been put together, identify those in the vicinity and their respective walking catchment areas—for example, walking distances of one-quarter mile. Delinate pedestrian sheds for each amenity (see Figure 7.5).

Identify a critical mass of pedestrian destinations by mapping clusters where destinations are no further apart than one-quarter mile (see Figure 7.6). The number of destinations that meet this proximity threshold is called the critical mass and is the first value in the neighborhood completeness equation.

Use balance is the proportional balance of developed uses in the critical mass pedestrian shed, by land area, expressed on a scale of 0 (low) to 1 (high). This is calculated as follows:

\[ P_1 = \text{proportion of developed land uses in the critical mass pedestrian shed (1 to N)} \]

\[ N = \text{number of unique developed land uses in the study area} \]

The resulting use balance score is the second value in the neighborhood completeness equation.

Sample Completeness Calculations
7 amenities (of 20 possible) in a consolidated pedestrian shed x 0.2 use balance = 1.4 neighborhood completeness
20 amenities (of 20 possible) in a consolidated pedestrian shed x 0.75 use balance = 15.0 neighborhood completeness

<table>
<thead>
<tr>
<th>Neighborhood Completeness Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>10-20</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>5-10</td>
</tr>
<tr>
<td>Minimal</td>
<td>3-5</td>
</tr>
<tr>
<td>Poor</td>
<td>Less than 3</td>
</tr>
</tbody>
</table>

Figure 7.5 Neighborhood plan showing one-quarter mile catchment areas for each destination. Image © Elliot Allen.

Figure 7.6 Critical mass of four pedestrian destinations clustered and no more than one-quarter mile apart. Image © Elliot Allen.
Apologists for the status quo persist in declaring that the automobile-dominated, low-density, single-use pattern of the postwar suburbs is the inevitable manifestation of the niggardly independent American character. However, the relentless dispersion of housing, shopping, and workplaces across the American landscape is far from inevitable.

Purely from a market perspective, if there is any inevitable destiny for American settlement patterns, it will be the reurbanization of our cities and towns rather than the continuation of the slow march toward economic, fiscal, and social entropy. Remaking, reforming, and rebuilding American settlement patterns will be the major real estate story of the first half of the twenty-first century.

The housing market that will drive this urban renaissance is no mystery. We don’t have to wait for these urban citizens to be born or to arrive from abroad; they already live here. The market is simply the convergence of the two largest generations in the history of America: the 82 million baby boomers, born between 1946 and 1964, and the 78 million millennials, who were born from 1977 to 1996.

Boomer households have been moving from the full-nest to the empty-nest life stage at an accelerating pace that will peak sometime in the next decade and continue beyond 2020. In our work in cities across the country, large and small, we have found that since the first boomer turned fifty in 1996, empty nesters have had a substantial impact on urban housing, particularly in downtown areas. After fueling the dramatic diffusion of the population into ever lower-density exurbs for nearly three decades, boomers, particularly affluent boomers, are rediscovering the merits and pleasures of downtown living.

Meanwhile, millennials are just leaving the nest. The millennials are the first generation to have been largely raised in the post-1970s world of the cul-de-sac as neighborhood, the mall as village center, and the driver’s license as the main means of liberation. We have found that, as has been the case with predecessor generations, many millennials are heading for the city. They are not just moving to New York, Chicago, San Francisco, and other large American cities; often priced out of these larger cities, millennials are discovering second,-third, and fourth-tier urban centers.

In contrast to previous generations, the millennials are much more aware of environmental issues and are more actively involved in organizations and activities that promote sustainability. The millennials recycle whenever possible, buy organic products when available, and are very interested in green building and construction.

Boomers and millennials are already the primary purchasers of condominiums; in 2003, for the first time, the national median price of a new condominium exceeded that of a new single-family house. In response, it is the rare regional or national building company that hasn’t established an infill housing division. During the mid-decade housing slump, those urban/infill housing divisions generally accounted for a significantly increased percentage of the parent company’s revenue.

The convergence of two generations of this size—each reaching a point when urban housing matches their life stage—is unprecedented. For example, in 2006, there were an estimated 44 million Americans between the ages of twenty and twenty-nine, forecast to grow to 54 million by 2015. In that same year, the population between fifty and fifty-nine also will have reached 44 million, from 38.6 million today. The synchronization of these two demographic waves will mean that there will be 8 million potential urban housing consumers in these age groups eight years from now.

Compared with the postwar flood of households to the new exurban suburbs, the current rediscovery of urban environments is still a mere trickle. But the sheer numbers of urban-oriented households will shift this paradigm.

Over the next several decades, this “demographic imperative” represents the potential for millions of additional urban dwellings, not only in urban infill and downtown locations but also in mixed-use, walkable locations at every scale, from existing urban neighborhoods to new suburban centers.

Zimmerman/Volk Associates groups American households into three general categories: young singles and couples, traditional and nontraditional families, and empty nesters and retirees. These three categories correspond roughly to the major life stages of an individual household. A neighborhood that includes housing types matching the preferences of the potential market, then, could potentially accommodate an individual’s housing needs and desires over a lifetime; by extension, that mix of housing types could potentially accommodate several generations of residents over time.

The charts on the accompanying page aggregate sixty recent market studies from among the hundreds prepared by Zimmerman/Volk Associates for public and private sector clients across the country (see Tables 7-3, 7-4, 7-5). They document the range of market potential by household and dwelling types along with the optimal distribution of dwelling types. The averages outline broad national trends, while the ranges demonstrate that housing must reflect local context, site conditions, climate, culture, and tradition, yielding significant variations in the optimal housing mix from location to location.
Car-Free Housing

Car-free housing is the emerging practice of developing residential buildings that do not provide off-street parking. This practice is the norm in Manhattan and in mixed-use transit-served locations in other large cities. Zoning regulations across the United States adopted over the last fifty to sixty years have required developers to provide one or more off-street parking spaces per dwelling. These parking requirements are well suited to the reality of automobile-dominated suburban locations. However, in pedestrian-friendly transit-served locations, they require parking spaces for residents who may not own cars. This requirement can unnecessarily increase the cost of housing by as much as $30,000 to $40,000 per required off-street space and become a self-fulfilling prophecy, inducing car ownership with the "free" parking space the dwelling owner bought. The common practice of selling dwelling units with dedicated parking spaces results in an oversupply of parking.

Sustainable urbanism requires that any parking be sold separately from the dwelling unit. Car-free housing is a viable strategy to reduce the cost of housing and to increase development density, walking, biking, and transit use. It requires coordination and integration between the location of a development, the municipal regulations that guide the development, and the willingness of banks and developers to bring forward car-free projects. In order to test the market demand and viability of such a concept, a number of projects have set aside a portion of residential units as car-free. The tenancy can be either rental or ownership.

Car-free housing should be developed in concert with either public or developer-provided shared cars (see Car Sharing). Each shared car is thought capable of replacing five to eight private cars. Municipalities have tended to adopt very conservative off-street parking reductions—less than half of the predicted rate of replacement. Car-free housing also requires contractual assurances that residents will not own cars.

The car-free housing criteria on the next page provide guidance regarding the location of potential car-free housing districts and related project requirements (See Table 7.6). The thresholds for regulation of municipal residential parking provide guidance on how to modify existing parking requirements to extend the benefits of reduced residential parking requirements citywide (see Table 7.7).
Table 7-6: Criteria for Car-Free Housing Districts

<table>
<thead>
<tr>
<th>Location Criteria</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed use</td>
<td>High percentage of neighborhood completeness</td>
</tr>
<tr>
<td>Transit service</td>
<td>Connector with high level of transit service</td>
</tr>
<tr>
<td>Connected location</td>
<td>Five-grained network of pedestrian and bike facilities</td>
</tr>
<tr>
<td>Local demographics</td>
<td>See Table 7-5: minimal thresholds for car shares</td>
</tr>
</tbody>
</table>

Table 7-7: Sustainable Urbanism Thresholds for Residential Parking Regulations

<table>
<thead>
<tr>
<th>Policy</th>
<th>Conventional Practice</th>
<th>Sustainable Urbanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-street parking spaces</td>
<td>Minimum number required per dwelling</td>
<td>Maximum number allowed per dwelling</td>
</tr>
<tr>
<td>Reduced parking requirements</td>
<td>Not permitted</td>
<td>Permitted for shared car with shared car replaces up to five off-street parking spaces</td>
</tr>
<tr>
<td>For-sale parking spaces</td>
<td>Sold with dwelling</td>
<td>Sold separately</td>
</tr>
<tr>
<td>Shared-car parking and car</td>
<td>None required</td>
<td>Minimum one per every ten dwellings</td>
</tr>
<tr>
<td>On-street parking in front of development</td>
<td>Cannot be used to meet requirements</td>
<td>Can be used to meet off-street or shared car requirements</td>
</tr>
</tbody>
</table>

Neighborhood Retail

Robert J. Gibbs, ASLA
Gibbs Planning Group, Inc.

One of the primary advantages of traditional neighborhood designed (TND) communities over conventional suburbs is the opportunity to walk to shopping and entertainment venues. However, few communities based on new urbanism have successfully implemented retail centers. In many cases, a TND community’s retail is not developed until years after the last residential phase is completed.

Often, TND communities’ retail centers fail to meet minimal sales necessary for its business owners to earn a reasonable income. The underperforming centers result in businesses that offer limited goods and poor service and thus cannot compete with market-driven retail centers. Many TND developers choose not to build the commercial phase of their community because land values are much higher for residential than retail.

Developing and managing retail centers remains one of the riskiest of all real estate categories. Retailers must respond to ever-changing consumer trends and demands while constantly fending off new competition. As a result, the retail industry relies upon proven methods and techniques to minimize the risk and to earn a market rate of return on their investment. Many of the most desirable historic neighborhoods and TND communities have clusters of successful retailers.

Unlike suburban development, where various commercial land uses are segregated from residential, in a TND community retail and residential are closely intertwined. As a result, the vitality of the TND community’s retail can directly impact the surrounding residential areas. In extreme cases, boarded-up storefronts and undesirable tenants such as tattoo parlors and pawn shops can cause the values of adjacent homes to nosedive. Conversely, popular and useful retailers such as coffee shops, cafes, and food markets contribute to the quality of life in the neighborhood. It is in the best interests of the community that the retailers meet or exceed industry sales standards.

Corner Stores

The smallest and most useful retail type, the corner store, ranges from 1,500 to 3,000 square feet. Corner stores are ideally located along major local roads at the busiest entry to the neighborhood. However, in densely populated TND communities, the corner store can be sustainable within the neighborhood when located along its primary street. The store also benefits if it is located adjacent to community buildings, parks, and schools, although schools often dislike corner stores being near their campus because of their appeal as student hangouts (refer to Chapter 7: Neighborhood Completeness).
Approximately one thousand households are necessary to support the average corner store. This represents one corner store per each TND neighborhood, based upon a five-minute walk. However, this number can be reduced significantly if the store is located along a major road with 15,000 cars per day or more. Corner stores that also sell gasoline are supportable with virtually no adjacent homes. Sales from construction trades prior to the completion of an entire neighborhood can potentially support a corner store.

The average corner store will yield approximately $210 in sales per square foot per year, or $300,000 to $600,000. Gross sales will be significantly higher if the store sells packaged liquor or gasoline. Annual rents for the typical corner store will average $14 to $16 per square foot. Rents and sales are significantly higher in dense urban areas. Rent represents only 8–10 percent of most retailers’ total operating expenses. Developers will often offer the store owner a significant rental discount in order to have the amenity for the neighborhood. Such a discount is not advised, since if the store is not sustainable from the onset, the business owner will often fail or quit (see Table 7-8).

**Convenience Centers**

Typically between 10,000 and 30,000 square feet, these centers offer an array of goods and services geared toward the daily needs of the surrounding neighborhoods. These centers are often anchored with a small specialty food market or pharmacy. The balance of the center usually includes five to eight small businesses ranging from 1,500 to 3,000 square feet each.

Each of these small businesses would have a difficult time if located on a stand-alone site. However, by being grouped into a walkable cluster, each business helps to generate impulse traffic and sales for the others.

Convenience centers need about two thousand households, or two TND neighborhoods, to be supportable. These centers must be located along a major road and ideally at the primary entry to both neighborhoods. Their average trade area typically extends up to a one-mile radius. Average sales for convenience center retailers are $225 per square foot per year. Annual rents in centers average $15 per square foot per year, with a range of $12 to $18 (see Table 7-8).

**Neighborhood Centers**

Typically anchored with a supermarket, pharmacy, and video store, neighborhood centers offer a full range of goods and services not available at corner stores or convenience centers. Neighborhood centers generally range from 60,000 to 80,000 square feet in total size (including the supermarket) and typically require 6 to 10 acres of property. Site planning using TND principles can potentially reduce the center’s size by up to 20 percent. These centers are often less than the overall blended parking ratio of 4.4 cars per 1,000 square feet of gross building area. Supermarkets and restaurants will demand higher parking ratios around their business.

These neighborhood centers require 6,000 to 8,000 households to be located within their primary trade area. The typical suburban trade area is 5 to 2 miles. However, in very rural areas it’s not unusual for residents to drive over fifty miles weekly to visit a neighborhood center. By contrast, dense urban centers can support a supermarket every few blocks.

Neighborhood centers vary widely depending on business type. On average, the centers average $245 per square foot per year in sales. Rents range from $7.25 for supermarkets to up to $40 for coffee shops.

Many TND developers and new urbanist planners often try to limit the size of the supermarket to between 20,000 and 30,000 square feet. However, small supermarkets are impractical due to the large variety of goods demanded by the average American household. Today’s supermarket must carry a much greater variety of products than it did in the 1960s, when a 25,000-square-foot A&P was considered full-size.

The neighborhood center is a favorite for lending institutions and investment houses. They earn a proven income stream, and it is assumed that families will always need to purchase groceries. Recently the neighborhood center has been threatened by the discount supercenter, estimated to be able to put up to two supermarkets out of business when entering a market. In addition, the popular “green” grocery stores and warehouse clubs are attracting well-educated, higher-end consumers away from the standard supermarket. Retail development is forever reinventing itself (see Table 7-8 below).

<table>
<thead>
<tr>
<th>Gross Retail Area (S.F.)</th>
<th>Dwelling Necessary to Support Retail?</th>
<th>TND Necessary to Support Retail? (5 DU/Gross Acre)</th>
<th>Sales per S.F.</th>
<th>Average Annual Rent per S.F.</th>
<th>Avg Trade Area</th>
<th>Parking?</th>
<th>Urban Form</th>
<th>Anchor Store</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Store</td>
<td>1,500-3,000</td>
<td>1,200</td>
<td>$10</td>
<td>$14-16</td>
<td>Neighborhood story building</td>
<td>On-street</td>
<td>Mixed-use</td>
<td>Anchor retail</td>
</tr>
<tr>
<td>Convenience Centers</td>
<td>10,000-30,000</td>
<td>2,000</td>
<td>$125</td>
<td>$15-20</td>
<td>1-mile radius</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighborhood Center</td>
<td>60,000-80,000</td>
<td>6,000</td>
<td>$145</td>
<td>Highly varied from $7.25 - $16.00</td>
<td>1.5-mile radius</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. This number can be reduced significantly if the store is located along a major road with 15,000 cars per day, and reduced nearly to zero if gasoline is sold.
2. Combines on-street and off-street parking
Convenience-oriented neighborhood businesses must offer a sufficiently high level of amenities in order to be competitive with major shopping centers and big-box stores. The center should be planned to allow for most of the retailers to face the primary road and neighborhood entry street. Ideally, most neighborhood residents will walk or drive through a section of the retail area on their way to and from home. Given that the average household produces ten trips per day, a dwelling neighborhood could produce up to ten thousand daily trips along the storefronts. Because local businesses mostly rely on the impulse visit and have limited advertising budgets, this exposure is a must.

The corner store or neighborhood center should also be oriented to allow for easy pedestrian access from the surrounding neighborhoods. Surface parking lots should be hidden behind small line retailers or oriented toward the primary highway. As much as possible, a seamless transition from residential to commercial should be maintained.

Parking remains one of the most critical issues facing any retailer, and this is especially true for neighborhood retailers. Easy-to-use parking is essential. Ample free parking near a store's entry is vital. That being said, parking should not dominate the site plan, and walkable, store-lined streets should be maintained to the greatest extent possible.

In contrast, shoppers will demand parking directly in front of the destination store in a small town or convenience center. Should such a space not be available, the typical shopper will believe that parking is problematic and less convenient compared with the modern shopping center. As a result, this shopper will tend to avoid the location for shopping in the future.

### Business Practices

A major weakness of many TND commercial centers is the lack of modern business practices and management. In some cases, retailers have been left to fend for themselves, with little or no required management participation and organization. These practices can result in low sales, high turnover and, eventually, a failed center.

One of the most common mistakes in TND neighborhood retail is the lack of required minimum store hours. It’s impractical for small independent retailers to maintain extended hours. However, one of the top complaints of many shoppers is the limited hours of small retailers and centers. Approximately 70 percent of all retail sales occur either after 5:30 P.M. or on Sundays. A center that does not keep these hours is limiting itself to one-third of the market share. In addition, good lighting, clean walkways, and well-maintained street furniture are essential for a competitive commercial center. Limited hours and poor maintenance convey a sense of subpar service and lack of value to time-stressed families. Following is a summary of basic recommended guidelines for TND neighborhood center management (see Table 7-9).

### Table 7-9: Guidelines for Traditional Neighborhood Business Practices

<table>
<thead>
<tr>
<th>Guidelines for Traditional Neighborhood Business Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management</strong></td>
</tr>
<tr>
<td>• Establish a required Common Area Management (CAM) fee as a part of the tenant base rent. This fee is to be used by the shopping center management for maintenance and marketing of the center’s common area.</td>
</tr>
<tr>
<td>• Develop a business mix plan that limits overlapping goods and services, while still maintaining healthy competition.</td>
</tr>
<tr>
<td>• Maintain control over interior store plans, merchandising, lighting, and displays.</td>
</tr>
<tr>
<td>• Implement a common marketing campaign for the center and its merchants.</td>
</tr>
<tr>
<td><strong>Design</strong></td>
</tr>
<tr>
<td>• Require high design standards for storefronts and signage. Adjust a 20 percent minimum clear glass frontage (as measured between 3 and 8 feet from finished walk) at the first floor for all new construction. Avoid civilian shopping center-type signage and storefronts.</td>
</tr>
<tr>
<td>• Businesses should be encouraged to differentiate themselves with signage, color, and façade alterations. Allowing them to reinforce their brand also emphasizes the downtown’s wider selection of goods and services. Avoid an overemphasis on continuity of color and form.</td>
</tr>
<tr>
<td>• Reduce the front wall face height to 8 inches maximum. Only permit canvas-type fabrics; plastic fabrics should be prohibited. Permit two colors for awnings. Small logos or business names on awnings should be permitted.</td>
</tr>
<tr>
<td>• Keep all storefront lights on a central timer to remain illuminated until 2:00 A.M. Large common TND can should be located in alleys or at the rear of buildings. These containers should be enclosed if possible, and kept clean and free of pets and odors. Restaurant containers should be cooled during warm weather.</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
</tr>
<tr>
<td>• Maintain minimal hours to 7:00 P.M. weekdays and to 9:00 P.M. at least one evening per week. Suggest 9:00 A.M. to 5:00 P.M. Saturday hours.</td>
</tr>
<tr>
<td>• Cross-merchandise with other downtown merchants by sharing window and interior display props.</td>
</tr>
<tr>
<td>• Highlight holidays and seasons with prominent displays located at the front and center the stores.</td>
</tr>
<tr>
<td>• Require storefront window displays to be updated monthly.</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
</tr>
<tr>
<td>• Paint storefronts and interiors on a regular (one to two year) basis. Clean and paint front doors and windows three to four times per year. Wash store doors 4-5 times daily.</td>
</tr>
</tbody>
</table>
Economic Benefits of Locally Owned Stores

Matt Cunningham
Civic Economics

Many people have strong emotional arguments for supporting locally owned businesses. They list such reasons as better service, unique atmosphere, and a wider choice of goods as reasons to promote local businesses. Recent research has also shown that there is a strong economic reason to shop locally. Money spent at a locally owned business is more likely to stay in the region and have a greater economic impact than money spent at a national chain. This threshold will highlight this new way of thinking about local businesses and show how they help to create a more sustainable economy than national chains.

Local Advantages
A local business has economic advantages over national chains in four main categories: labor, profit, procurement, and charity.

Labor: Spending on local labor accounts for a larger share of operating costs for a locally owned establishment than for an outlet of a national chain. While chains are able to consolidate administrative functions such as bookkeeping and marketing at national headquarters, independents carry out these functions in-house or outsource them within the community. Additionally, economies of scale and carefully engineered store layouts may allow national chains to employ fewer on-site staff than locally based firms.

Profits: A larger portion of profits earned by locally owned stores will remain in the local economy. Purchases of goods, services, and meals at chain outlets generate profits for the corporation, which then either reinvests in global operations or distributes a portion of profits to shareholders. In either case, chain store profits circulating in the local economy are nominal.

Procurement: Locally owned businesses procure a wider array of goods and services in the local marketplace. These include goods for resale, business supplies, and professional services.

Charity: A smaller yet significant share of the local advantage is charitable giving. The owners and employees of local firms generally live in and around their business locations and are more likely to give back to their own communities. National firms may be more likely to donate to charities near corporate headquarters or other large corporate facilities.

Civic Economics knows that in order for cities to create policies to help level the playing field for local businesses against their national competitors, a solid economic rationale would need to be added to the prevailing emotional argument. To date, three major studies have been completed to add economic data to the argument.

The first study was conducted in Austin, Texas, during the fall of 2002. Due to a legislative quirk, the city government was to give an incentive package to a new nationally based retailer, to be located directly across the street from BookPeople and Waterloo Records, two longtime local landmarks.

Civic Economics spearheaded a study that demonstrated the economic advantages the two locally owned retailers had over nationally based competitors. After reviewing the finances of the locally owned businesses and comparing them to benchmarks for their national competitors, it was determined that for every $100 spent at the local businesses, $45 stayed in the local economy. When the same methodology was applied to the national businesses, only $33 remained local.

The results in Austin demonstrated the economic advantages of supporting local businesses, but it was done on a small scale with just two local merchants. In the fall of 2004, a follow-up study was conducted in the Andersonville neighborhood of Chicago, Illinois. The same basic methodology was applied as in Austin, but for this study the number of local businesses analyzed jumped to ten and the results were categorized as retail, services, and restaurants. The phrase “local premium” was used to label the percentage difference in impact between local and national chain businesses.

The results in Andersonville validated the results from two years earlier in Austin. The overall local premium was 58 percent, meaning that 58 percent more money was left in the local economy after shopping at a locally based business than national chains. Additionally, locally owned stores in our survey actually had higher revenues per square foot of sales than national chains, meaning their local premiums were even higher when calculated on a square-foot basis.
Third Places: Where People Meet, Develop, Trust, and form Associations

Based on the work of Ray Oldenburg

"Third places" is a term coined by Robert Oldenburg, author of The Great Good Place. He defined these locations as those outside of home and work and open to the general public where people informally gather on a regular basis. Third places become established by people informally designating them as places to go to see and be seen. Third places need to be easily accessible for a lot of people, comfortable, and open for a minimum of sixteen hours a day, five or six days a week, for people to drop by. Many, but not all, serve food and/or beverages, encouraging people to hang around longer to converse. Coffee shops, tot lots, bus stops, dog parks, pubs, alleys, libraries, laundries, and churches are all examples. Third places are a must-have for a complete neighborhood and a key component of sustainable urbanism.

Oldenburg succinctly describes the social interaction in third places as "meet, trust, and form associations" (from author interview with Ray Oldenburg, September 15, 2006). Third places help to expand people's social networks, facilitating meaningful or happenstance meetings with others they would not normally meet at work or home. Economically speaking, third places can serve as informal markets for services, employment, and entrepreneurship—indeed, the international insurance behemoth Lloyd's of London started in a coffee shop. If your babysitter just quit or you need your kitchen painted, talking it up in a third place might get you a word-of-mouth referral. Socially, the recurring informal contact typical of third places can result in new acquaintances, friends, and even romances.

According to Oldenburg, "The best third places are family-owned and run, ideally by the type of person Jane Jacobs described as a social character—someone who knows everyone in the neighborhood." He believes that locally owned independents know the community and "take an interest" and by contrast, "chain stores don't get involved in the community," often even banning kiosks for posting community flyers and announcements. Traditional third places such as the neighborhood pub are located in walkable urban settings and are much less viable in automobile-dependent locations. In the suburbs, spontaneous meetings are being replaced by scheduled visits arranged by cell phone or text messaging. The criteria set forth in Table 7-10 are meant to aid in both the enhancement of existing third places and the creation of new ones.

Table 7-10

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog owners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People with children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seniors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working parents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7-10

Intelligensia Cafe in Chicago is a third place. Image © Faris Associates.
Healthy Neighborhoods
Melanie Simmons, PhD, Kathy Baughman McLeod, MS, and Jason Hight, MS
Healthy Development Inc.

According to the Centers for Disease Control and Prevention's Task Force on Community Preventive Services, an estimated 200,000 to 300,000 premature deaths occur each year in the United States due to physical inactivity. Regular physical activity is associated with enhanced health and reduced risk of mortality. Beyond the effects on mortality, physical activity has other benefits and cost savings. The benefits include reduced risk of cardiovascular disease, stroke, type 2 diabetes, colon cancer, osteoporosis, depression, and fall-related injuries. The direct health care costs of physical inactivity are conservatively estimated to be 2.4 percent of U.S. health care expenditures. Indirect costs of physical inactivity are difficult to estimate. However, indirect costs are believed to be higher because of the costs to employers and insurers from missed work days and disability.

The recommended amount of physical activity is thirty minutes of moderate-intensity physical activity five or more days per week. Walking is the most commonly promoted moderate-intensity physical activity; other types can include biking, swimming, mowing the lawn using a push or walk-behind mower, and dancing.

In this example, the built environment's influences on health go beyond individual lifestyle choices. The urban form impacts active transportation and work-related and leisure-time activity (see Table 7-1). Within this context, built environment interventions promote physical activity rather than try to change lifestyle behavior.

The table shows street-scale urban redesigns that are proven effective in promoting physical activity. The studies were conducted on small geographic areas of a few city blocks. The math in this table should be easy to follow and reproduce. The population affected by the redesigned streets was set at 5,000 people. Projects wishing to use these calculations must adjust the population figures and the level of moderate-intensity physical activity accordingly (use the Behavioral Risk Factor Surveillance System). Then, proposed street-scale urban redesign projects can forecast impacts on physical activity for different populations and locations.

These interventions meet the criteria for being effective physical activity interventions, and so implementing these practices at the community level should be a priority. Community developers should be educated about the value-added aspect of design that promotes healthy communities.

An important way to attract attention and funding from policy makers to support street-scale urban redesign is to highlight the potential health care cost savings. The table demonstrates the potential direct health care cost savings. With effective street-scale urban redesigns, health care cost savings due to greater physical activity would average $92,795 (ranging between $42,192 and $163,494) annually for 1,000 people in a small geographic area of a few blocks. The indirect cost savings are not estimated but are probably much higher.

<table>
<thead>
<tr>
<th>Table 7-1: Street-Scale Urban Redesign and Physical Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Street-Scale Urban Redesign</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Greenway</strong></td>
</tr>
<tr>
<td><strong>Walkability</strong></td>
</tr>
<tr>
<td><strong>Connectivity</strong></td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
</tr>
<tr>
<td><strong>Density</strong></td>
</tr>
<tr>
<td><strong>Attractiveness</strong></td>
</tr>
<tr>
<td><strong>Convenience</strong></td>
</tr>
</tbody>
</table>

*Note: Interventions listed under lighting, walkability, aesthetics, and convenience used similar measures of physical activity and a summary estimate was calculated. The average effect of these street-scale urban redesigns is associated with an average 35 percent increase in physical activity.* The interventions should on average increase the walking rate of moderate-intensity physical activity from 65 percent to 61 percent. For a population of 50,000, the number of people active would increase from 40,000 to 46,000. Therefore, the number of people engaged in moderate-intensity activity after the street-scale urban redesign would increase by a median of 145 people, with a range from 72 to 217 people.

**Medical Cost Savings Calculations**
Moderate-intensity physical activity saves $556 per person per year in direct medical costs ($227 savings in direct medical care costs annually)

**Summary**
With effective street-scale urban redesigns, health care cost savings due to greater physical activity would be about $92,795 (ranging between $42,192 and $163,494) annually for 1,000 people in a small geographic area of a few blocks.
Walkable Streets and Networks

Dan Burden
Walkable Communities, Inc.

How to Score the Walkability of a Place

The walkability of a place is shaped by the physical characteristics of both the public right-of-way and the adjacent private development. The spectrum of walkability can be classified in two ways: by the components that make up a place and by its overall look and feel. The following two charts are classified by a list of materials expanded from those found in LEED.

Streets, neighborhoods, and guidelines are flexible. As long as the spirit of a concept is met, quality level designations are met. A weak showing in a row reduces the ability to meet that quality level. A week showing in one row is offset when other factors indicate high walkability, such as schools or mixed use within one quarter mile of most homes, easy access to nature and open space, the presence of a great park, or a low-automobile-speed environment. Street dimensions are measured curb face to curb face.

LEED Platinum and Diamond levels are intentionally very difficult to achieve. Stone and Bronze levels are of moderate distinction and indicate that the area is somewhat walkable. Criteria for the Platinum level are met only if many pedestrians are seen in most locations twelve to fourteen hours a day (that is, an observer sitting in one place sees a dozen or more people walk by every ten minutes). These levels are marked by population spread in age, ability, and diversity.
Walkable Neighborhoods
Street Block and Building Forms that Complete the Street-Design Criteria

Walkable Neighborhoods
Street, Blocks and Building Forms that Complete the Street-Visual Criteria
Street design as a professional practice has developed over the last ninety years to address safety and mobility for the motoring public. The profession is based as much on the physics of moving vehicles as it is on the characteristics of driver behavior. The safety goals of street design have attempted to engineer driver error out of the equation by improving vehicles, the driver-vehicle interface, and the road and roadside environment to remove obstacles and reduce the effects of curvatures. These efforts have led to successively wider roadways—wider lanes, wider clear zones, larger curve radii—which have the effect of promoting faster operating speeds. The mobility goals for street design, originally focused on connecting places, have evolved to focus on minimizing delay while traveling. The results of these joint approaches have been to create a philosophy of wider and faster being better, which separates streets from the land uses adjacent to them and marginalizes pedestrians, bicycles, and transit, modes that are necessary for sustainable urbanism.

Transportation systems that support sustainable communities of compact, walkable neighborhoods and urban centers require multimodal and context-sensitive planning and street design. The idea of context-sensitive solutions (CSS) has developed recently as a process for bringing a collaborative, multidisciplinary design approach to streets that balances the competing needs of the community, the road user, and the environment. CSS requires addressing a wide range of objectives for streets, which include:

- Support for compact neighborhood-oriented development
- Walkability in neighborhoods and mixed-use areas
- Multimodal (transit, bicycle, walking, driving) choices
- Improved compatibility with adjacent land uses
- Provision of high-quality public space for activity and aesthetic values
- Enhanced quality of life
- Protection of environmental quality

The process of sustainable street design integrates the street with the form and function of the surrounding land uses and provides for all travel. The policy approach to this goal is embodied in the Complete Streets movement (www.completestreets.org), which advocates for providing for all travel modes when a street is constructed or rebuilt. The design approach uses a framework that pairs a street typology (modes accommodated, purpose) with a place typology of urban context (levels of activity, location of access, relation to street). This context-based design framework, similar to that used in form-based coding, is the basis for street design that is described in the 2006 ITE volume Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities.

The context-based guidance is intended for use primarily in low-speed (under 35 mph) urban environments through the use of a context-sensitive solutions approach. The selection of design controls and design values must follow a rational process that includes consideration of published standards and guidance, particularly that found in the current version of A Policy on Geometric Design of Highways and Streets (American Association of State Highway and Transportation Officials, 2003), otherwise known as The Green Book.

The CSS approach employs a level of flexibility that is consistent with the policies expressed by the Federal Highway Administration and the American Association of State Highway and Transportation Officials. Policies, guides, and standards used by state and local governments control the design process, and sustainable design must operate within the bounds of those agencies. CSS gives design engineers flexibility to propose alternative ways/strategies for achieving safe designs. Older adopted standards may be inconsistent with some CSS designs. In lieu of updating such standard variances or design exceptions may be obtained to allow the CSS designs to be constructed. The CSS process is designed to provide the technical support necessary to such activities.
Table 7-13  Street Types Appropriate for Low Speed Urban Contexts

<table>
<thead>
<tr>
<th>Street Types</th>
<th>Maximum</th>
<th>Target</th>
<th>Lane</th>
<th>Transit</th>
<th>Bicycle</th>
<th>Freight</th>
<th>Median</th>
<th>Parking</th>
<th>Access</th>
<th>Pedestrian</th>
<th>Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through</td>
<td>Operating</td>
<td>Width</td>
<td></td>
<td>Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spacing</td>
</tr>
<tr>
<td>Boulevard</td>
<td>6</td>
<td>30-35 mph</td>
<td>11-13 ft</td>
<td>Paralel</td>
<td>Regional</td>
<td>Yes</td>
<td>Optional</td>
<td>Limited</td>
<td>Sidewalk</td>
<td>460-510 ft</td>
<td></td>
</tr>
<tr>
<td>Avenue</td>
<td>4</td>
<td>25-30 mph</td>
<td>10-11 ft</td>
<td>Local</td>
<td>Local</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Sidewalk</td>
<td>300-400 ft</td>
<td></td>
</tr>
<tr>
<td>Street</td>
<td>2</td>
<td>25 mph</td>
<td>10-11 ft</td>
<td>Local</td>
<td>Local</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sidewalk</td>
<td>300-400 ft</td>
<td></td>
</tr>
</tbody>
</table>

*Note: On-street parking lanes are 7-8 feet in width.

---

Universal Basic Home Access

Eleanor Smith
Concrete Change

Several relatively recent changes drive the need for universal home features that welcome guests and support residents with disabilities:

- The increased number of older people, both in absolute terms and as a percentage of the national population. Average life span in the United States has increased by thirty years in the past century, and in spite of improvements in general health, mobility impairment rises dramatically with each decade after age sixty.
- The greatly increased survival rate of younger disabled people. For example, in the early 1940s, life expectancy following a spinal cord injury averaged only about one and a half years, while today people with spinal cord injuries typically live for many decades.
- The emergence of a historically unprecedented disability rights movement, raising the expectations of people with disabilities, young and old, to live rich lives and participate fully in community.

Access came first to government buildings, then to commercial buildings such as offices and stores and to public transportation via the ADA of 1990, then to multifamily residences via the federal Fair Housing Amendments Act of 1988 that entitles single-family houses as the last new buildings lacking any element of basic access.

With the increase in older people has come a steep increase in the number of nursing home residents, at an average cost of more than $60,000 per person per year. Sixty-four percent of these costs are borne by the public coffers. Almost 60 percent of people who move to nursing homes enter directly from hospitals or rehabilitation centers. Although to date no research has been done documenting the extent to which architectural barriers prevent people from returning to their own homes, common sense and anecdotal reports suggest that barriers in homes often force people from their homes and communities into institutions.

Incorporating three designated visibility features upfront improves personal social life and community inclusion. It saves money by decreasing institutionalization and minimizing retrofits, and at the same time costs little at the time of construction — $100 for homes on concrete slabs and $500 for homes with basements or crawl spaces are typical costs when preplanned for design, siting, and grading.

Single-family houses are the only buildings largely untouched by the principle of including people with disabilities. Inaccessible houses exclude people from visiting friends and extended family, waste materials and money through retrofits, and force people out of their neighborhoods and into institutions.
Widely incorporating these three specific access features greatly increases the ability to visit others and to remain in one's home after experiencing mobility impairment. These features improve the physical and emotional health of individuals, enhance community diversity, and reduce public financial costs for institutionalization.

Whether termed "visible," "inclusive," or "universal basic access," three design criteria applied to virtually every new house will create enormous positive change for individuals, diverse communities, and the national fiscal health. Of the many access features one could in corporate, these three are by far the most crucial for visiting, and they provide the basic shell for residing in a house if disability occurs.

- One zero-step entrance on an accessible route
- Passage space of at least 36 inches when the door is open at 90 degrees for all interior main-floor passage doors
- A usable half bath (or preferably a full bath) on the main floor.

The practicality of incorporating these features has already been demonstrated in several U.S. cities where Inclusive houses have been built by the thousands, from affordable to high-end. Rather than applying the features to a percentage of houses, the inclusive home standard dictates that the features will be incorporated whenever feasible, which in practice has been more than 95 percent of the time. The 10 or 20 percent approach is impractical because it is not possible to predict in which homes a person will develop a disability. Nor do percentages take into account that eight or more families are likely to occupy any one house over its lifetime, greatly increasing the likelihood that every home will at one time have a resident with a severe long-term or permanent disability. Further, inclusive homes permit disabled people to visit others, a social fluidity taken for granted by nondisabled people.

One Zero-Step Entrance

The zero-step entrance can be located at the front, side, or back of the home, in accordance with the topography. There should be no step from the sidewalk to the porch and no step from the porch to the interior. The grade of the route to the designated entrance should not be steeper than 1:12, and less steep when possible. If a ramp (i.e., a structure with 90-degree drop-offs at the edges) is used, it must be constructed to code. However, the entrance can often be accomplished with a sloping sidewalk rather than a ramp.

On a steep lot where the driveway cannot be graded to a slope less than 1:12, a usable zero-step entrance can proceed from the driveway to the house. A zero-step entrance is nearly always feasible unless all three of the following conditions exist: a steep lot, no driveway, and no back entrance such as an alley. In that and a few other situations, zero-step entrances are impractical.

Preferably, the entry door should have a low threshold of one-half inch. Residential doors with low thresholds are available at low cost and in many attractive styles.

Passable Interior Doors

Thirty-one inches of clear passage space can be achieved with a door measuring 3 feet 10 inches in width. Doors of such size, while not yet available from home improvement stores, are readily available from wholesale suppliers where builders purchase, at nearly same cost as doors two inches narrower. Three-foot doors are also excellent where space permits. Pocket doors are another option.

Usable Bathrooms

In a small bathroom, the door can be hinged out to provide room for the user to shut it. Rectangles of open space at least 30 inches by 48 inches, which can overlap, should be adjacent to each fixture. The FHA offers useful diagrams for usable small bathrooms.

Resources

- Concrete Change: www.concretechange.org
- IDEA Center: www.up.buffalo.edu/idea

For additional residential universal design features beyond the essential visibility basics, see the Practical Guide to Universal Home Design: www.uiowa.edu/infotech/universalthomedesign.htm
Managing Travel Demand

Jeffrey Tumlin
Nelson\Nygaard Consulting Associates

Transportation demand management (TDM) is a broad term to describe strategies to change travel behavior. TDM recognizes that there are physical capacity limits to any transportation system, and it seeks to make the most efficient use possible of limited transportation resources.

The need for TDM grew in North America due to the rapid expansion of automobile ownership in the post-World War II era. Throughout the mid-twentieth century, planners' response to increased auto use was primarily to accommodate and encourage demand by providing abundant supplies of automobile infrastructure. This meant creating new and wider highways and adding parking spaces, often by demolishing prewar portions of cities. Minimum parking requirements were invented and spread by a partnership between the American Planning Association and the American Automobile Association.

In response to these concerns, modern transportation demand management became formalized in the United States first during the oil crises in the 1970s, then later under air quality rules in the 1990s. Most programs focus on the 20 percent of total trips that are between home and work, since these trips tend to coincide with peak traffic congestion periods and since they tend to be most amenable to mode shift. The most effective programs, however, cover all types of trips.

TDM is useful in all development contexts, but its effectiveness increases as density increases. Even where transit service is not available, TDM can still achieve 25 percent reductions in traffic by promoting carpooling and "internalizing" some utility trips, for example, by providing concierge services and retail at the workplace. In transit-oriented development (TOD) projects, even at a suburban scale, traffic reductions of 30-40 percent are readily achievable.

There are a variety of tools to calculate the effectiveness of TDM programs, including various traffic models named "3D," "4D," "5D," based on the number of trip generation factors they apply to. The models apply different mathematical formulas to adjust trip generation according to some or all of the following factors:

- **Residential and employment density.** As density increases, trip generation rates decline significantly, since more uses are available within walking distance and transit's market potential increases to the point where frequent service is possible.

- **Diversity of land use types/mix of uses.** Where jobs, housing, and services are within walking distance of one another, auto use declines, particularly for the 80 percent of trips that are non-commute-related.

- **Walkable design.** Where walking is a pleasure, travelers will walk greater distances to reach their destinations.

### Programs to Reduce Travel Demand

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>Henry Ford first markets the Model T</td>
</tr>
<tr>
<td>1975</td>
<td>First parking meters installed (downtown Oklahoma City)</td>
</tr>
<tr>
<td>1989</td>
<td>American Planning Association and American Automobie Association partner to urge municipalities to adopt minimum parking requirements</td>
</tr>
<tr>
<td>2000</td>
<td>Washington State passes its Congestion Reduction Program</td>
</tr>
<tr>
<td>2005</td>
<td>Transportation is the second largest source of U.S. carbon dioxide emissions after electricity generation</td>
</tr>
</tbody>
</table>

#### Access to Regional Destinations
- The intensity of local transit service and the regional destinations it serves influence travel behavior.

#### Transportation Demand Management
- Parking pricing has greater travel impact than all other TDM measures combined.

<table>
<thead>
<tr>
<th>Physical Measures</th>
<th>Residential (%)</th>
<th>Non-Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Residential Density</td>
<td>Up to 55%</td>
<td>N/A</td>
</tr>
<tr>
<td>Mix of Uses</td>
<td>Up to 9%</td>
<td>Up to 9%</td>
</tr>
<tr>
<td>Local-Serving Retail</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Pedestrian/Bicycle Friendliness</td>
<td>Up to 9%</td>
<td>Up to 9%</td>
</tr>
<tr>
<td>Physical Measures subtotal</td>
<td>Up to 90%</td>
<td>Up to 92%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand Management and Similar Measures</th>
<th>Residential (%)</th>
<th>Non-Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordable Housing</td>
<td>Up to 4%</td>
<td>N/A</td>
</tr>
<tr>
<td>Parking Supply (Q)</td>
<td>N/A</td>
<td>No limit</td>
</tr>
<tr>
<td>Parking Pricing/Cash Out</td>
<td>N/A</td>
<td>Up to 25%</td>
</tr>
<tr>
<td>Free Transit Passes</td>
<td>25%* reduction for transit service</td>
<td>25%* reduction for transit service</td>
</tr>
<tr>
<td>Telecommuting (p)</td>
<td>N/A</td>
<td>No limit</td>
</tr>
<tr>
<td>Other TDM Programs</td>
<td>N/A</td>
<td>Up to 5%, plus 10% of the credit for transit and pedestrian friendliness</td>
</tr>
<tr>
<td>Demand Management subtotal (q)</td>
<td>Up to 7.25%</td>
<td>Up to 7.35%</td>
</tr>
</tbody>
</table>

*Notes:
1. For residential uses, the percentage reductions shown apply to the ITE average trip generation rate for single-family detached housing. For other residential land use types, some level of these mitigation measures is implicit in ITE average trip generation rates, and the percentage reduction will be lower.
2. (q) Only if greater than sum of other trip reduction measures.
3. (p) Not additive with other trip reduction measures.
4. (q) Excluding credits for parking supply and telecommuting, which have no limit.
The Institute of Transportation Engineers’ report Trip Generation and the companion Trip Generation Handbook are the most definitive available sources for estimating the automobile traffic that different land uses will generate in North America. As noted in the handbook’s introduction, however, data for these publications were collected almost entirely at isolated, single-use facilities, where access was primarily limited to automobiles. To address the deficiencies in using Trip Generation for TOD and TND projects, URBEMIS (a simplified program for determining trips generated) starts with the ITE standard trip generation rates and offers credits depending upon how far a project deviates from a typical sprawl development. The potential credits for the various measures are summarized in Figure 7.23.

The following sections discuss the most significant TOD measures.

Density
Residential density provides one of the strongest correlations of any variable with automobile use, but only some of this effect is due to the inherent effect of density alone, as opposed to the other factors for which density serves as a common proxy: parking price, local retail, transit intensity, pedestrian quality, and so on. URBEMIS uses net residential density and applies the formula developed by John Holtzclaw and colleagues.¹

According to this formula, an apartment building of sixteen units per residential acre would generate 26 percent fewer auto trips than a three-unit-per-acre product. In the densest neighborhoods, density alone can cut trip generation in half.

Parking Supply and Pricing
On the employment side, travel behavior is less strongly correlated with density but very strongly correlated with parking policies. ITE’s Parking Generation manual assumes that all travelers to an employment site will drive. Accommodating them with parking becomes a self-fulfilling prophecy: abundant parking ensures that parking will be free, that adjacent uses will be further away, and that transit’s market potential will decline. Provided that parking spillover can be managed, reducing the parking supply reduces incentives to drive and produces cost savings that can be invested in transportation alternatives.

Directly related to the supply of parking is the price of parking. Even in locations with little or no transit service, parking charges result in significant changes in motorists’ behavior, if only to promote carpooling. In locations where direct parking charges are not politically acceptable, parking cash-out programs can achieve similar results. In cash-out programs, employees who do not drive are offered the cash value of the parking spaces given free to employees who do drive. Parking price elasticities vary according to context but generally range from -0.1 to -0.3, that is, every 1 percent increase in parking price results in a 0.1–0.3 percent decrease in parking demand. Parking cash-out programs are somewhat less effective than direct charges. Still, Don Shoup found that solo driving declined by 15 percent on average across several employment sites in the Los Angeles region that introduced parking cash-out.²

Source: Holtzman et al. (2002).

Transit Service
As transit service intensity and quality increase, driving rates decline. This is especially true where transit is fast, frequent, reliable, and runs all day and into the evening. URBEMIS calculates transit service credits first by calculating a transit service index as follows:

\[
\text{Transit Service} = \frac{\text{Number of average daily buses stopping within a quarter mile of the project site}}{\text{Number of daily rail or bus rapid transit trips stopping within a half mile of the site}} \times \text{Number of dedicated shuttle trips}
\]

The benefits of transit service can double in a pedestrian-friendly environment, so the trip reduction benefits of transit are calculated in URBEMIS as follows:

\[
\text{Transit trip reduction} = (\text{Transit service index}) \times 0.075 + (\text{Pedestrian/bike score}) \times 0.075
\]
### Table 7-1: 4D Elasticities

<table>
<thead>
<tr>
<th>Density</th>
<th>Daily Vehicle Trips</th>
<th>Daily Vehicle Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;0.04</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Diversity</td>
<td>&lt;0.06</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Design</td>
<td>&lt;0.02</td>
<td>&lt;0.04</td>
</tr>
<tr>
<td>Destinations</td>
<td>&lt;0.03</td>
<td>&lt;0.20</td>
</tr>
</tbody>
</table>

\[ \text{Density} = \frac{\text{Percent Change in } (\text{Population} + \text{Employment}) \text{ per Square Mile}}{\text{Population} + \text{Employment}} \]

\[ \text{Diversity} = \frac{\text{Percent Change in } (1 - \text{ABS}(b \times \text{population} - \text{employment})/(b \times \text{population} + \text{employment}))}{\text{population}} \]

Where: b = regional population / regional employment

\[ \text{Design} = \frac{\text{Percent Change in Design Index}}{\text{Design Index}} \]

\[ \text{Design Index} = 0.1995 \times \text{street network density} + 1.18 \times \text{sidewalk completeness} + 3.63 \times \text{route directness} \]

Where:

- 0.1995 = coefficient applied to street network density, expressing the relative weighting of this variable relative to the other variables in the Design Index formula
- street network density = length of street in miles/area of neighborhood in square miles
- 1.18 = coefficient applied to sidewalk completeness, expressing the relative weighting of this variable relative to the other variables in the Design Index formula
- sidewalk completeness = total sidewalk centerline distance/total street centerline distance
- 3.63 = coefficient applied to route directness, expressing the relative weighting of this variable relative to the other variables in the Design Index formula
- route directness = average airline distance to center/average road distance to center

### Free Transit Passes

After parking pricing, the operational TDM programs with the greatest effectiveness are free transit pass programs. Where employers provide free transit passes to all employees, or developers or home owners’ associations provide free passes to all residents, the trip reduction effectiveness of transit service can be multiplied by 25 percent.

### Bicycle and Pedestrian Friendliness

The Florida Department of Transportation, Federal Highway Administration, and other organizations have produced excellent models for estimating how changes to the built environment impact rates of walking and bicycling. Data collection for these formulas can be onerous, however, so URBEMIS uses three of the most important variables:

- **Intersection density**: Small blocks result in significantly higher rates of walking than neighborhoods of superblocks and cul-de-sacs. A grid of 1,300 intersection legs per square mile is ideal, equating roughly to 300-foot-square blocks.
- **Sidewalk completeness**: This refers to the percentage of streets with sidewalks on both sides. However, this measure unfortunately ignores pedestrian quality of service, which examines factors such as the separation between the sidewalk and fast-moving vehicle traffic.
- **Bike lane completeness**: Or, where suitable, adjacent parallel routes.

Together, these factors work equally to allow up to a 9 percent trip reduction credit.

### Parking

Eliminate minimum parking requirements, since they serve only to require developers to overbuild parking, resulting in underpriced parking and excessive rates of driving. For employment sites, municipalities should consider parking maximums as a tool for managing congestion.

### Development Approvals

Adopt TDM ordinances citywide or as part of TOD or TND overlays. These can require specific TDM measures or simply require projects to meet certain trip reduction targets.

### Analysis Tools

Do not use ITE's Parking Generation or Trip Generation figures without adjusting them for TOD and TND projects.

### Leadership

States and municipalities should ensure that their environmental compliance guidelines, impact fee programs, congestion management programs, transportation funding allocations, and other formulas reward rather than penalize infill development.
Car sharing is a short-term, membership-based auto rental program. Car-share members typically reserve a car over the phone or online, then walk to a car in their neighborhood and open the door with an electronic key card. Members are billed each month according to how much they drive, much as they would be billed for other utilities such as electric service. Gas, maintenance, parking, and insurance costs are included in the fee.

Shared cars are parked in reserved spaces on the street, in public garages, and in private facilities; such spaces are typically scattered throughout transit-oriented neighborhoods and downtowns or are found at major nodes such as rail stations. Most programs rely on technologies that permit members to identify and reserve the nearest available car, then allow the reserved car to identify and open for the member’s unique electronic key. The car reports usage and mileage back to the central office via satellite, automating the entire reservation, use, and billing process.

Car sharing works in locations with sufficient density, transit service, and mix of uses to allow many residents and employees the ability to meet most of their daily needs without the use of a car. It allows members to forgo the costs and hassles of owning, parking, and insuring a car while still maintaining all the mobility benefits of access to a car.

For most motorists, the primary costs of driving, including buying, real estate, and insuring a car, are fixed; they vary little based upon how much they drive. As a result, motorists have every incentive to drive as much as possible in order to maximize the value of their car. Car sharing shifts all of the costs of driving to variable costs, changing the economic incentives. As a result, car-share programs produce significant transportation and environmental benefits. Each car-share vehicle typically eliminates between six and fifteen privately owned vehicles. Members report an average 39 percent reduction in vehicle miles traveled—even factoring in members who did not previously own a car.

Car shares differ from rental cars in that the former are aimed primarily at short-term rentals from self-accessed, scattered locations. Car-share programs also have the express purpose of reducing vehicle ownership and driving rates.

Locations that meet all of the thresholds in the rightmost column (Large Car-Share Program) of the following table can generally support at least ten car-share vehicles within a half-mile radius of any household or business, offering members a high level of car-share service (see Table 7.13). A modest car-share program with a few vehicles generally requires meeting all of the factors in the middle column (Small Car-Share Program).
Among the most neglected realms in town planning are walk-to neighborhood parks and plazas. Because of their prime location—a short walking distance from a large population—they greatly enhance the quality of neighborhood life. Walk-to parks outfitted with benches, playground equipment, and dog runs can serve as intergenerational third places, allowing recurring casual social encounters and the building of social capital. Parks and plazas with a high degree of landscaping, a naturalized stormwater feature, or a view of the night sky play a key role in supporting biophilia. Parks also increase the price home buyers are willing to pay to live close by, providing a very good return on investment for either government or private developers (see Table 8.1). In master-planned developments, a network of new smaller parks is relatively easy to plan and can be built over time, phased in with the surrounding development. Small parks can be amazingly difficult to develop in existing cities, despite their important contribution to livability. Land prices are often quite high and publicly owned land is rarely located exactly where parks are needed. Many municipal park district policies set a five-acre minimum requirement, which is larger than most vacant land parcels and essentially bars new parks. Because of these policies, municipal planning often fails to detect and redress the deficiency of walk-to parks (see Figure 8-1). Parks and open space are no less important in commercial and industrial districts. New arrangements for park maintenance and upkeep are also emerging. Neighborhood association volunteers, backstopped with revenue from special taxing districts, can perform upkeep and maintenance. Filtering stormwater, even in high-density urban locations, is an important aim of sustainable urbanism (see Figure 8-2). In new developments, best management practices

---

**Chapter 8 Biophilia**

---

**Open Space**

---

Figure 8-1 Despite a great system of large legacy parks, much of Toledo is underserved by walk-to parks. Shaded areas on the map indicate land more than a 9-minute walk from a park. Image © Farr Associates, data source: Lucas County Auditor, One Government Center Suite 600, Toledo OH 43660.

Figure 8-2 This landscaped plaza serves as a stormwater park, filtering runoff water from adjacent streets. Image © 2002 Bruce Randy.
can be designed at the site, block, and neighborhood scales. In existing built-out areas, stormwater parks are emerging as a promising approach to retrofit the capacity for stormwater filtration. The runoff from city streets combines toxic automotive drippings and concentrates them in stormwater. Such parks can be designed to filter water running off public streets, a widespread municipal discharge currently exempted from regulation under the Clean Water Act.

Consider the following standards:
1. Parks or high quality open spaces should be within a three-minute walk of every dwelling.
2. The minimum park area should be 1/6 acre.
3. The minimum average size of all neighborhood parks should be 1/2 acre.
4. All parks shall be bounded on at least two sides by public rights-of-way.
5. Parks may be fenced and locked at night, if necessary, for security.

**Park Types**
The Lexicon of the New Urbanism defines various aspects of open space within the neighborhood:

**Sports field**: an open area specifically designed and equipped for large-scale recreation. Such fields should be confined to the edges of neighborhoods, as their size is disruptive to the fine-grained network required for pedestrian travel.1

---

<table>
<thead>
<tr>
<th>Table 8-1: Park Proximity Sales Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Park In Feet</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>400</td>
</tr>
<tr>
<td>500</td>
</tr>
</tbody>
</table>


---

Green: a medium-sized public space available for unstructured recreation, circumscribed by building façades, its landscape consisting of grassy areas and trees, naturally disposed, and requiring substantial maintenance.

Square: a public space, seldom larger than a block at the intersection of important streets. A square is circumscribed spatially by frontages; its streetscape consists of paved walks, lawns, trees, and civic buildings all formally disposed and requiring substantial maintenance.

Plaza: a public space at the intersection of important streets set aside for civic purposes and commercial activities. A plaza is circumscribed by frontages; its landscape consists of durable pavement for parking and trees requiring little maintenance. All parking lots of frontages should be designed as plazas with the paving not marked or detailed as parking lots.

Community garden: a grouping of garden plots available for small-scale cultivation, generally to residents of apartments and other dwelling types without private gardens. Community gardens should accommodate individual storage sheds. They are valuable for their recreational and communal role, similar to that of a club.

Public lighting began as a way to provide some level of safety along rights-of-way for pedestrians and to encourage nighttime activities and commerce. While exterior and right-of-way lighting is required for commerce and public safety, conventional designs often result in extensive, continuous overlighted areas. This can result in glare and light pollution—wasted light from exterior lighting that is directed upward or away from where it is needed. All of this wasted light increases the sky glow effect easily seen in urban areas, reduces the view of stars for citizens as well as astronomers, and wastes energy. Research is now finding that exterior lighting has a harmful effect on flora and fauna and can cause disturbances of human circadian rhythms that have been associated with insomnia and other sleep disorders.

A better approach to lighting design in a neighborhood uses light where it is most useful—at potential vehicle/pedestrian conflict zones, to accent building façades, and to light wayfinding elements. Lighting can be designed to eliminate glare, overlighting, and light trespass. The level of brightness should be based on the type of place being lit, ranging from rural to urban. Rural places will tend to be dark, while higher levels of outdoor lighting are better suited to more vital urban neighborhoods and districts.

Table 8-1: Descriptions and General Lighting Allowances for Lighting Zones

<table>
<thead>
<tr>
<th>Transient Zone</th>
<th>L2a Rural and Remote</th>
<th>L2b Reserve and Suburban</th>
<th>L2c General Neighborhood</th>
<th>L2d Urban Center</th>
<th>L2e Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Illuminance (lux)</td>
<td>1.25 x 10^6</td>
<td>2.5 x 10^6</td>
<td>5.1 x 10^6</td>
<td>7.5 x 10^6</td>
<td>10 x 10^6</td>
</tr>
<tr>
<td>Base Allowance (lux)</td>
<td>0</td>
<td>17,000</td>
<td>26,000</td>
<td>46,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Lighting Design Criteria</td>
<td>No ambient light</td>
<td>Very low ambient light</td>
<td>Low ambient light</td>
<td>Medium ambient light</td>
<td>High ambient light</td>
</tr>
</tbody>
</table>

*T his minimal lighting should be turned off most of the time.

Chart data compiled from: Model Lighting Disturbance Graph, Illuminating Engineering Society of North America (IESNA) and International Dark Skies Association (IDA).

Figure 8-3: Los Angeles, 1956. Image courtesy of International Dark-Sky Association.

Figure 8-4: Los Angeles, 1988. Image courtesy of International Dark-Sky Association.

Figure 8-5: Pedestrian-related lighting. Image © Clanton & Associates.

Figure 8-6: Automobile-oriented lighting. Image © Clanton & Associates.
Stormwater Systems

Jean Patchett and Tom Price
Conservation Design Forum
Contributions from Jamie Simone, Farr Associates

Most contemporary urban, suburban, and rural agricultural land use practices across North America generate substantial amounts of surface water runoff that are directly associated with increased erosion, sedimentation, and flooding, water quality degradation, loss of biodiversity, aquifer depletion, and climate change.

The historic patterns of hydrology that supported the diverse and complex ecology of our lakes, rivers, and streams across North America were predominately groundwater driven. Most of the continent's historical wetlands and aquatic systems, including lakes, streams, and rivers, were sustained from a combination of groundwater discharge and direct precipitation. Nearly all of the continent's endemic wetland and aquatic species, both flora and fauna, are adapted to such stable patterns of groundwater-dominated hydrology and consistent water quality.

Contemporary urban, suburban, and rural land uses have drastically altered the historical patterns of stable hydrology and water quality. Today's environments are dominated by erratic forms of polluted surface water runoff.

Conventional water resource engineering practices directed at the collection, conveyance, and temporary storage of stormwater runoff generally exacerbate downstream flooding, water quality degradation, habitat loss, and system stability due to the cumulative volume and velocity of discharged flows. The collective runoff acts to carve out existing streams and rivers, resulting in deeply incised stream banks subject to constant erosion and sedimentation. The loss of infiltration and groundwater recharge in the surrounding watershed combines with the depression of normal water levels in the stream system to lower the regional water table and starve the stream during periods of drought. At the opposite extreme, intense periods of rainfall, once mediated by landscapes highly capable of absorbing and using the water as a resource, now regularly result in flash floods in areas that were not historically subject to flooding. The economic, environmental, and cultural impacts of flooding are significant, and often catastrophic.

In contrast to traditional stormwater engineering practices, which are designed to direct water away from where it falls, sustainable approaches to site and regional water resource management strive to treat water as a resource, not a waste product. Such measures revolve around the restoration of stable groundwater hydrology on a site-by-site basis through the incorporation of techniques that effectively cleanse, diffuse, and absorb water where it falls, thus restoring the historical patterns of groundwater-dominated hydrology and water quality. This should be the fundamental design and engineering goal of every type and scale of development project, regardless of whether the environment is urban, suburban, or rural. Simply put, the degree to which water leaves land in the form of surface water runoff is the degree to which the area where it fell in the form of precipitation will be in deficit and downstream environments will be surfeited (and generally adversely impacted).

2030 Targets for Public Lighting
The following targets are proposed to reduce energy consumption and the adverse impact of light on the nighttime environment.

<table>
<thead>
<tr>
<th>Current Practice</th>
<th>2030 Sustainable Urbanist ideals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Exposition</td>
<td>Outdoor brightness</td>
</tr>
<tr>
<td>Light Level Regulations</td>
<td>Minimums</td>
</tr>
<tr>
<td>Control Technology</td>
<td>On-off</td>
</tr>
<tr>
<td>Control</td>
<td>Manually controlled</td>
</tr>
<tr>
<td>Roadway Lighting</td>
<td>Pole-mounted</td>
</tr>
<tr>
<td>Human Links to Nature</td>
<td>Glare obscures all but a handful of stars</td>
</tr>
</tbody>
</table>

According to the International Energy Agency, North America leads the world in consumption of light. Per capita, North Americans used 101 megalumen-hours of light in 2005, compared with 62 in Australia and New Zealand and 43 in Europe. Throughout the world, outdoor lighting consumes approximately 250 terawatt-hours (so7 watt-hours) of electricity each year. This accounts for roughly 10 percent of the annual energy used for all lighting.
There are many practical, cost-effective design and development innovations that are directed at the restoration of hydrological stability and enhanced water quality in urban, suburban, and rural environments. Innovative design and development techniques that bring water's positive properties to bear, often replicating historical patterns of hydrology, may include one or any combination of technologies that effectively capture, cleanse, recycle, and infiltrate water on-site. Integrated building and site design techniques such as greenroofs, porous paving systems, bioswales and other bioretention measures, rainfall collection and recirculation measures such as storage cisterns, and the incorporation of deep-rooted, highly absorbent native landscape systems are but a few of the multifunction, cost-effective urban water resource management strategies that may be applied. Such measures are important elements for groundwater recharge, flood reduction, site and regional water-quality enhancement, and the restoration of terrestrial and aquatic ecosystem viability.

The tools and thresholds presented in this section are multidimensional practices that meet traditional water quality and quantity standards as well as achieving planning, urban design, and landscaping objectives (see Figures B-7 through B-13 and Table B-4). The practices address both the quantity and quality of runoff and can be designed and implemented in new developments as well as retrofitted into existing developments in cost-effective ways. The practices discussed here include bioretention, greenroofs, porous pavement, rainwater harvesting and reuse, and native landscaping. It is essential that each practice be designed and engineered based on specific local conditions and land use characteristics. These measures are often most effective when integrated with other building and site development strategies that manage water effectively. Sustainable water management elements can be integrated into roofs, parking lots, streets, driveways, alleys, sidewalks, lawns and landscaped areas, parks and other open spaces, and agricultural fields.

Rainwater is often treated as a waste product in urban and suburban environments, to be eliminated from where it falls as quickly and efficiently as the local jurisdiction allows. Stormwater runoff is typically routed through gutters and storm sewers into detention basins for temporary storage prior to discharge, or directly into local aquatic systems including wetlands, streams, rivers, and lakes. While necessary for some applications, conventional stormwater management measures often contribute to flooding, water quality degradation, habitat loss, and aquifer depletion. Rainwater that flows across driveways, streets, sidewalks, parking lots, turf grass lawns, and other impervious surfaces picks up urban and agricultural pollutants and carries them into our waterways, where they can damage habitat for aquatic organisms as well as render the waterways unsuitable for recreational activities such as swimming, boating, and fishing.

In contrast to conventional collection and conveyance systems, runoff can be directed into bioretention systems that are designed to reduce flow energy and cleanse, convey, and infiltrate water generated from nearby impervious surfaces. Bioretention systems suited for urban contexts include rain gardens, bioswales, dry wells, naturalized detention or retention, and other bioretention structures such as specialty designed tree wells, planter boxes, and median strips. For rain gardens and bioswales, porous materials such as sand or gravel are often installed under 18 to 24 inches of amended topsoil to facilitate temporary storage and percolation into the ground. Filtration and water absorption can be enhanced through the incorporation of dense, deep-rooted native vegetation that aids in pollutant removal and infiltration. The resultant reduction in stormwater runoff volume promotes the protection and enhancement of areawide aquatic systems.
Food Production

Lynn Peeneo and Jim Slama, with Cathy Morgan
Contributions from James Gwinjer and April Hughes

In the past century, food production has become industrialized and globalized and in effect unsustainable. This is symbolized by the fact that fresh produce travels on average 1,500 miles from field to table in America. That's a lot of fuel consumption! To feed the needs of our ever-expanding communities, family farms have been taken over by big business, sprawl, and agricultural monoculture. Sadly, the farm-as-corporation economic model has become the paradigm for modern food production, with a bottom line of volume and efficiency. This low-cost food is of questionable quality, taste, and safety. Fruits and vegetables from the conventional system harbor residues of multiple pesticides that are toxic to the environment and the body.

It's no mystery that a myriad of health problems can be traced back to diet and the current food system, including cancer, diabetes, hypertension, and America's biggest battle, obesity.

Luckily, sustainable solutions are within reach. New economic models for food production are emerging that can feed the world more nutritiously. Organic food is the fastest-growing sector in food production, while sustainable food production and increased food access are being integrated into neighborhoods. Due to the popularity of this movement, the time to act is now. Planners and architects have the opportunity to bring back what years of irresponsible practices have taken away. They can achieve this by integrating food systems in two basic ways: through food production and through food access. Proper zoning regulations will allow for communities and individuals to produce their own food. In communities, points of food access can be created with minimal economic investment and infrastructure. Many towns and villages have begun to strategically plan by conducting a comprehensive needs assessment of the local food system.

Good-quality food is vital to the public health of a population. The economic benefits of community-based food systems include the creation of jobs and self-sustaining markets. Environmental benefits include less energy use, cleaner air and water, and remediated soil. Community benefits include food security, better health, neighborhood beautification, and greater connections between people and the Earth.
Food Production

Communities thrive when people are empowered to grow their own food, whether they do it individually or as a community. The number one rule of growing food is clean soil. Clean, nutrient-rich soil will yield safe, high-quality produce. If the site is on a brownfield, the soil must be tested for contaminants such as lead before food can be grown safely. Access to water, sunlight, and good drainage are other important aspects of food production in the urban environment.

Individual
- Rooftop gardens
- Household gardens
- Household greenhouses

Neighborhood-Based
- Community garden
- Community orchard
- Community greenhouse
- Community farms

Both public and private land in a neighborhood can be used to grow food. Permanent and accessible community gardens, orchards, and greenhouses can be planned for communities, an approach gaining popularity in sustainably designed communities. Individuals and families can produce food through rooftop gardens, household gardens, and greenhouses. Local food production also offers the potential for recycling food waste—removing organic materials from the waste stream and using it to make soil.

Food Access

It is difficult to access healthy food produced locally. In order to have a steady supply of year-round produce, many retailers buy from national distribution companies instead of local farms. Some of this food is neither fresh nor nutritious. Farmers’ markets directly link farmers with consumers, while neighborhood and corner grocery stores can provide increasing access to more nutritious food.

Notable case studies of food production and production are summarized in Table B-5.
Wastewater treatment is a complex interplay of environment, politics, culture, and science. The purpose of this threshold is to provide a clearer vision of how to think about wastewater treatment for a sustainable future. It is not intended to be comprehensive; rather, the intention is to give the decision maker enough information to interact with wastewater design professionals in order to work toward a sustainable, site-appropriate design that integrates the reuse of wastes and water in a way that is beneficial to humankind without harming the environment. The field of wastewater treatment design is so broad that often design professionals and even entire consulting firms focus on certain niches of the market.

Society has progressed in the way it manages human wastes (see timeline). Early on, wastes were by and large ignored. As urbanization increased and the source of disease was recognized, sewage treatment began. By the early twentieth century, waterborne diseases were in check and the objective of wastewater treatment was to minimize nuisance conditions noticeable by sight or smell. Primarily the systems were for the disposal of wastes only.

In the latter portion of the twentieth century, systems emerged that viewed the nutrients and the water as resources, rather than waste products. Constituents of treated wastewater effluent, such as nitrogen, phosphorus, and potassium, began to be used for a variety of purposes, including the irrigation of golf courses, green spaces, forests, and farmland; the creation of wetlands and estuaries; and utilization in hydroponics systems. Our understanding of the problems caused by harmful bacteria and viruses increased and enabled science-based designs for beneficial reuse of the nutrients in the sewage. At the same time, knowledge of synthetic contaminants and their effects on humans and the environment continue to challenge designers.

These advances were made with little consideration of the offsetting impact of energy consumption, greenhouse gases, and societal costs. The only limitations were the ability of the society to pay for the construction and operating costs.

Today there are many alternatives for the wastewater planner, but a successful, sustainable project requires a balance of science, site, economics, and regulations.

A critical requirement of a wastewater treatment system is to do no harm to the receiving waters. Our understanding of this will change with time, increasing knowledge, and location. Some areas may be sensitive to thermal discharges, others to nutrients, still others to disinfection by-products. A prerequisite for meeting this standard is to obtain a letter from a local environmental group stating that it has no objections to the project as it relates to a potential change in the receiving stream or groundwater quality.

Sustainable Urban Wastewater System Performance Targets
Three additional goals should be pursued in wastewater system design.

1. Reuse of 75 percent of nutrient energy in the waste stream into beneficial uses. This should be calculated on an annual basis.
2. The energy consumption of operation and maintenance, included sludge hauling and disposal, will not exceed 80 kilowatt hours per year per capita.
3. Reuse of 75 percent of water in the waste stream into beneficial uses. This should be calculated on an annual basis.
Indoor Wastewater Treatment

John Todd Ecological Design

Eco Machines are ecologically-based wastewater treatment facilities, typically built inside greenhouses, that create clean and reusable water from local wastewater what would otherwise be a monetary and environmental expense for the community, can be turned into resource and an asset.

In a conventional design, wastewater treatment imposes high capital and lifetime operating costs on a community while requiring significant investments in infrastructure and energy for long-distance transport. In this scenario, the wastewater is pumped to a large treatment plant that uses significant amounts of energy and chemicals for treatment and disposal (see Table 8-7).

With Eco Machine technologies, a neighborhood can use its own wastewater to create local green space for varied usage, to grow plants and ecologies that sequester carbon, and to produce clean, chemical-free water for reuse within the community. This can be done in a greenhouse facility requiring very small above-ground footprint, with sub-surface constructed wetlands serving a dual use as a park or orchard (see Table 8-8).

Designed to use wastewater as a local asset, Eco Machines create a variety of positive opportunities for the urban neighborhood. These can include education, flower and fish production, clean water for landscape irrigation, water features, and harvested nutrients for specific purposes.

At the heart of Eco Machines are three principles: ecology, economy, and design. While urban environments are dependent on continuous inputs of energy, food, and materials, they are also great creators of a wide variety of wastes. The Eco Machine is designed to use a substantial portion of the waste created by the urban environment and create opportunities and inputs for various nutrient intensive enterprises within that same environment.

Eco Machines are built for various scales and environments. While this essay concentrates on the sustainable urban neighborhood, Eco Machines are also designed for industrial wastewater, various organic wastes, and crude oils.

The Eco Machine systems built for urban neighborhood wastewater contain the following elements:

- **Collection and distribution.** Small-diameter collection systems with interceptor tanks at each input location minimize pumps, energy, and infrastructure.
- **Pretreatment and equalization.** Underground tanks with biofilters reduce organic loading and ensure that subsequent treatment elements are not overloaded with suspended solids.
- Constructed wetlands. Passive, two-foot-deep gravel recirculating beds are planted with functional and aesthetic flora. The treated water flows subsurface, making constructed wetlands an aesthetic green landscape with variable use possibilities. Where space is limited, Advanced Wetland Treatment Systems, which use forced bed aeration to provide oxygen to the root zones, often result in a reduced footprint. Eco Machine Aquatic Cells also further reduce the footprint requirements.

- Eco Machine Aquatic Cells. After the constructed wetland or Advanced Wetland Treatment System, secondary treated effluent flows into Aquatic Cells, open, aerobic tank-based systems most often housed in a greenhouse or other light-filled buildings but with possibilities for being outside in warm climates. Each tank is designed through a balance of engineering and ecology to perform a different but critical step in the treatment process. Within each tank is a variety of organisms, each with essential and unique roles in the ecological cycles of water treatment, including microscopic algae, fungi and bacteria, protozoa, snails, clams, fishes, and phyto- and zooplankton; higher plants are grown on suspended racks within each tank. An ideal demonstration of the benefits of ecological diversity, the system is uniquely capable of handling various forms of shock from the waste stream, such as chemical or oil spills. The plants also create a beautiful tropical environment, and the system can be designed for use in flower production or for reseeding local water bodies. Ornamental or native fishes, which perform final polishing, can also be grown for retail or for release into local water bodies.

The tertiary-quality water that emerges from the Eco Machine treatment process can be used for the irrigation of grounds or tree crops, for water features, or for toilet flushing. Narrative signs throughout the system—from toilets to flowers—can provide space for living art, public discourse, and community participation. Eco Machines offer opportunities to use wastewater within the footprint of our neighborhoods and watersheds while creating local value. It is our hope that this local approach will replace the conventional high-energy pump-and-treat paradigm.

<table>
<thead>
<tr>
<th>Table 8-7: A Comparison of Alternate Waste Water Treatment Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Use</td>
</tr>
<tr>
<td>Summary System</td>
</tr>
<tr>
<td>Sequencing Batch Reactor</td>
</tr>
<tr>
<td>Vertical BioReactor</td>
</tr>
</tbody>
</table>

*Note: 5,000 gnd drying bed for sludge management

<table>
<thead>
<tr>
<th>Table 8-8: Rules of Thumb for Sizing Eco Machine Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Room</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>Neighborhood</td>
</tr>
<tr>
<td>1,000</td>
</tr>
<tr>
<td>3,000</td>
</tr>
<tr>
<td>5,000</td>
</tr>
</tbody>
</table>

*Note: All sizing based on the secondary treatment assumption (as mg/L BOD and TSS)

1. Conventional subsurface-flow constructed wetlands do not utilize any mechanical components such as pumps. Systems may be oxygen-limited and therefore not capable of nitrogen reduction. However, constructed wetlands can be designed with either biological or natural components to reduce footprints and increase the ability to remove nitrogen.

2. The Advanced Wetland Treatment System utilizes the patented Forced Bed Aeration System and uses a modest amount of energy. The horizontal flow is a single pool, and wastewater is recirculated to the vertical flow configuration.

---

Figure 8-20: Eco-Machine. Image © John Todd Ecological Design.

Figure 8-21: Water quality monitoring in an Eco Machine. Image © John Todd Ecological Design.