Shades of Green

Modifying Sustainability Rating Systems for Transit Center Functionality

Courtney Crosson

Urban transit centers or hubs that expand walkability, increase transportation and neighborhood connectivity, and broaden infrastructure resilience are intrinsically sustainable. However, under the Leadership in Energy and Environmental Design Neighborhood Development (LEED ND) rating system, the infrastructure requirements of this built typology can preclude it from achieving sustainability certification. LEED ND is the most established certification system for projects at the district scale that seek economic development without the depletion of natural, cultural, and social surroundings. In 2015, Los Angeles Union Station, in California, through its master plan, LAUSMP, became the first transit hub to pursue LEED ND certification. Using evidence from LAUSMP, this paper outlines the inherent advantages, existing barriers, and needed expansions to achieve compatibility between transit center design and LEED ND. This paper also suggests updated metrics for connectivity and walkability to recognize linkages that occur above and below the ground plane, inclusion of incentives for carbon emissions reduction and air quality monitoring, and expanded exemptions for transit infrastructure from density and tree-lined street calculations. The paper proposes a revised version of the LEED ND rating system to create a standardized tool with which to measure sustainability across transit hubs.

Urban transit centers or hubs expand walkability, increase transportation and neighborhood connectivity, and broaden infrastructure resilience and thus significantly contribute to the sustainability of the urban areas in which they operate. Numerous urban transit centers in the United States are planning to increase efficiency and flexibility as part of a new focus on multimodal transit options and urban revitalization. In the past 5 years, ambitious plans have been announced to green the historic rail centers of New York City's Grand Central Station (*1*) and the Union Stations of Denver, Colorado (*2*); Chicago, Illinois (*3*); and Washington, D.C. (*4*). Rail centers currently under construction, such as the San Francisco, California, TransBay Terminal (*5*), are intended to meet high standards for energy, water, and waste efficiency and make positive ecological contributions to their urban surroundings. With this surge of planning efforts, there is a need for a standardized tool with which to measure, monitor, and document sustainability across the typology.

College of Architecture, Planning, and Landscape Architecture, University of Arizona, Room 314, 1040 North Olive Road, Tucson, AZ 85719. ccrosson@email.arizona.edu.

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Several green rating systems offer third-party certification to projects at the district scale. Of these systems, Leadership in Energy and Environmental Design Neighborhood Development (LEED ND) is the most established and is the best fit for urban transit centers, given the broad inclusion of credits spanning infrastructure efficiency, revenue generation, transportation demand management, and community inclusion (*6*). However, under the LEED ND rating system, the infrastructure requirements of transit hubs can preclude them from achieving sustainability certification.

In 2015, Los Angeles Union Station, in California, through its master plan, LAUSMP, became the first transit hub to pursue LEED ND certification. Using evidence from LAUSMP, this paper outlines the inherent advantages, existing barriers, and needed expansions to achieve compatibility between transit center design and LEED ND. This paper suggests updated metrics for connectivity and walkability to recognize linkages that occur above and below the ground plane, inclusion of incentives for carbon emissions reduction and air quality monitoring, and expanded exemptions for transit infrastructure (e.g., tunnels and Interstate ramps) from density and tree-lined street calculations. The paper proposes a revised version of the LEED ND rating system to create a standardized tool with which to measure sustainability across transit hubs and recognize design advances contributing to a more sustainable city.

SUSTAINABILITY BENCHMARKING FOR DISTRICTS

For projects larger than a building, the most prominent green rating systems are ecodistricts, 2030 Districts, LEED ND, Envision, Living Community Challenge, and Sustainable Sites. There is wide variation in these systems' approaches, from an open-ended community process (e.g., ecodistricts) to defined checklists (e.g., LEED ND) to a customizable checklist (e.g., Envision) to an all-or-nothing award (e.g., Living Community Challenge). The correct rating system depends on the scope of the project, the objectives of the owner, the status of the land entitlement, and the location. In most cases, LEED ND is the best fit for transit centers within urban neighborhoods because its checklist contains a broad range of credits that address sustainable infrastructure within environmental, social, and cultural consequences. LEED ND emphasizes site selection, design, and construction elements that bring buildings and infrastructure together into a neighborhood and relate the neighborhood to its landscape as well as its local and regional context.

A project that does not pursue certification is not inherently less sustainable. However, a master plan project that does not pursue certification may have a harder time reaching a coordinated sustainable

TABLE 1 Pros and Cons of Green Rating Certification Systems at Master Plan Scale

Rating System	Focus	Strengths	Weaknesses
Ecodistrict	Community decision-making process	Targets the process of a community creating bespoke sustainability goals	Process is not a clear-cut rating system with a certification outcome
Envision	Infrastructure	Compatibility with infrastructure, incorporates carbon monitoring	Newer and less recognized by constituents, underrecognizes buildings and neighborhood linkages
LEED ND	Neighborhoods and master plans	Well-recognized, well-rounded approach targeting whole neighborhood and all project components	Does not take large infrastructural coordination into consideration
Living community challenge	Net zero energy and water community scale developments	High aspirations that target net zero; most stringent rating system currently available	Difficult to execute within a restrained budget; all-or-nothing certification
Sustainable sites	Landscape	Emphasizes site design and infrastructure, successfully engages landscape architecture	Does not apply to buildings and community and economic development issues on a large scale

outcome given a lengthy time line and myriad actors. This paper argues that certification empowers sustainable design because property owners and developers are held to standards that define the best practices of sustainable urban design. The paper improves the best practices offered to transit centers through LEED ND certification.

Table 1 compares the leading sustainability rating systems for projects on a master plan scale.

The LEED ND rating system was developed through collaboration of the U.S. Green Building Council, the Congress for the New Urbanism, and the Natural Resources Defense Council as a sustainability certification tool for projects larger than a building (*7*). The system was launched in 2009 and is administered by the Green Building Certification Institute. LEED ND offers certification under the Version 4 rating system, which is the version used in the analysis in this paper.

LEED ND offers 110 possible points, distributed across five main categories: smart location and linkages (five prerequisites, 27 points), neighborhood pattern and design (three prerequisites, 44 points), green infrastructure and buildings (four prerequisites, 29 points), regional priority credit (four points), and innovation and design process (six points). Table 2 provides the full scorecard. The scoring system is heavily based on principles of New Urbanism (*8*). LEED ND is the most prominent and widely used and recognized system, with more than 100 projects certified and more than 160 registered (*9*).

LEED ND certification is a long process because master plans are complex design and construction projects involving multiple buildings and sometimes multiple owners and entitlements. Figure 1 diagrams the process of the LAUSMP through the three stages that lead to final certification.

TABLE 2 Evaluation of LEED ND Scorecard

Credit Number	Credit Name	Points	Inherent Advantage	Current Barrier	Needs Expansion
Smart Location and Linkage		27 Points			
Prereq 1	Smart location	Required	●		
Prereq 2	Imperiled species and ecological communities	Required			
Prereq 3	Wetland and water body conservation	Required			
Prereq 4	Agricultural land conservation	Required			
Prereq 5	Floodplain avoidance	Required			
Credit 1	Preferred locations	10	●		
Credit 2	Brownfield redevelopment	2			
Credit 3	Locations with reduced automobile dependence	7	●		
Credit 4	Bicycle network and storage	1			
Credit 5	Housing and jobs proximity	3			
Credit 6	Steep slope protection	1			
Credit 7	Site design for habitat or wetland and water body conservation	1			
Credit 8	Restoration of habitat or wetlands and water body	1			
Credit 9	Long-term conservation management of habitat or wetlands and water bodies	1			

(continued on next page)

TABLE 2 *(continued)* **Evaluation of LEED ND Scorecard**

Credit Number	Credit Name	Points	Inherent Advantage	Current Barrier	Needs Expansion
Neighborhood Pattern and Design		44 Points			
Prereq 1	Walkable streets	Required		●	●
Prereq 2	Compact development	Required			
Prereq 3	Connected and open community	Required		●	●
Credit 1	Walkable streets	12		●	●
Credit 2	Compact development	6			
Credit 3	Mixed-use neighborhood centers	4			
Credit 4	Mixed-income diverse communities	7			
Credit 5	Reduced parking footprint	1		●	
Credit 6	Street network	2		●	●
Credit 7	Transit facilities	1	●		
Credit 8	Transportation demand management	2	●		
Credit 9	Access to civic and public spaces	1	●		
Credit 10	Access to recreation facilities	1			
Credit 11	Visitability and universal design	1			
Credit 12	Community outreach and involvement	2			
Credit 13	Local food production	1			
Credit 14	Tree-lined and shaded streets	2		●	●
Credit 15	Neighborhood schools	1			
Green Infrastructure and Buildings		29 Points			
Prereq 1	Certified green building	Required			
Prereq 2	Minimum building energy efficiency	Required			
Prereq 3	Minimum building water efficiency	Required			
Prereq 4	Construction activity pollution prevention	Required			
Credit 1	Certified green buildings	5			
Credit 2	Building energy efficiency	2			
Credit 3	Building water efficiency	1			
Credit 4	Water-efficient landscaping	1			
Credit 5	Existing building reuse	1			
Credit 6	Historic resource preservation and adaptive reuse	1			
Credit 7	Minimized site disturbance in design and construction	1			
Credit 8	Stormwater management	4			
Credit 9	Heat island reduction	1			
Credit 10	Solar orientation	1		●	
Credit 11	On-site renewable energy sources	3			
Credit 12	District heating and cooling	2			
Credit 13	Infrastructure energy efficiency	1			
Credit 14	Wastewater management	2			
Credit 15	Recycled content for infrastructure	1			
Credit 16	Solid waste management infrastructure	1			
Credit 17	Light pollution reduction	1		●	
Innovation and Design Process		6 Points			
Credit 1	Innovation and exemplary performance	1			
Credit 1	Innovation and exemplary performance	1			
Credit 1	Innovation and exemplary performance	1			
Credit 1	Innovation and exemplary performance	1			
Credit 1	Innovation and exemplary performance	1			
Credit 2	LEED accredited professional	1			
Regional Priority Credit		4 Points			
Credit 1	To be decided by project team	1			
Credit 2	To be decided by project team	1			
Credit 3	To be decided by project team	1			
Credit 4	To be decided by project team	1			
Project totals (precertification estimates)		110 Points			

NOTE: prereq. = prerequisite; certified = 40–49 points; silver = 50–59 points; gold = 60–79 points; platinum = 80–106 points.

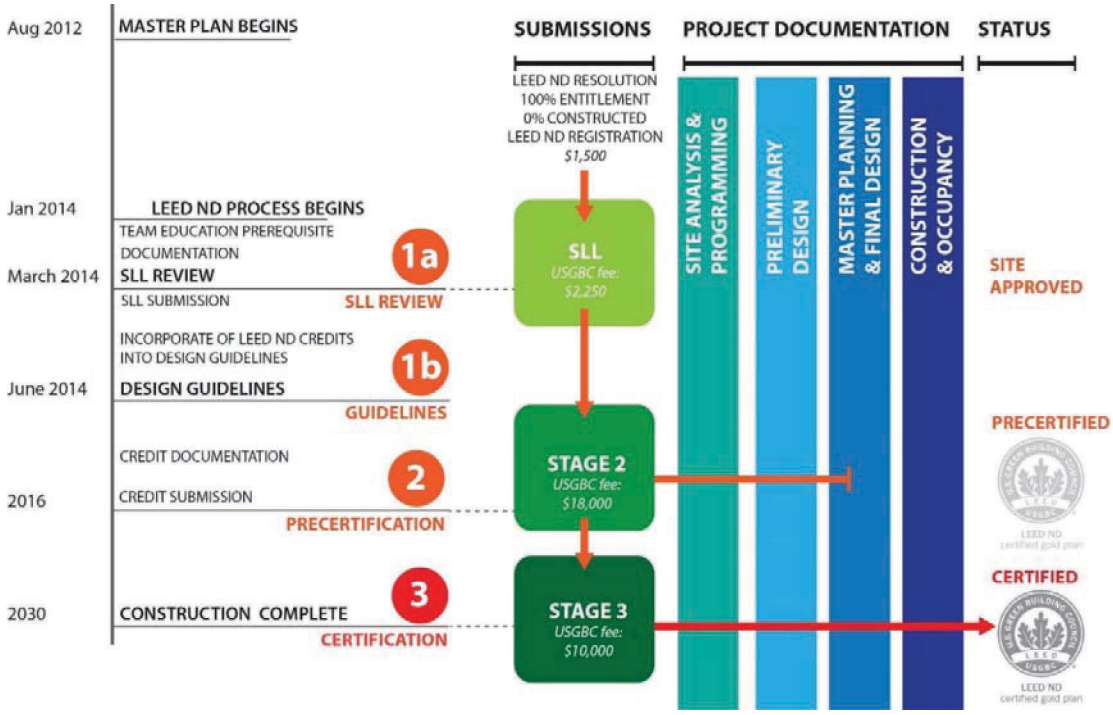

FIGURE 1 LEED ND time line for LAUSMP certification (SLL = Smart Location and Linkage; USGBC = U.S. Green Building Council).

PROCESS AND METHODS

Prominent district-scale sustainability programs were gathered and evaluated for identification of the system with the greatest compatibility with transit centers. LEED ND was the best fit (Table 1). Next, the LEED ND Version 4 manual was examined for affinity with the unique characteristics of the transit hub typology. Prerequisites were investigated for any mandates that would preclude transit centers from participating in the certification process. Then, all 110 points of the LEED ND system were analyzed for synergies and conflicts. Finally, LAUSMP was engaged as a case study, and the findings from the review were solidified through diagramming real examples. A critique of the design was included to underscore where the LEED ND could go beyond inclusivity of transit centers and actively propel better design in this typology.

LAUSMP CASE STUDY BACKGROUND

The LAUSMP process was initiated when Los Angeles Metro purchased the historic station and 40-acre property in 2011. Los Angeles Union Station is the primary regional transit center of Southern California, connecting more than 600,000 travelers and commuters with light rail, commuter rail, long-distance trains, buses, shuttles, and bike share (*10*). The LAUSMP site exists within a quickly transforming urban fabric and links the station to the adjacent downtown commercial center, the historic neighborhoods of El Pueblo and Chinatown, and reemerging assets of the Los Angeles River and Arts District. LAUSMP includes a newly integrated bus terminal, updated and expanded rail services, three metro lines, a proposed high-speed rail station terminal, and more than 3 million ft^2 of transit-oriented development.

LAUSMP is a good match for certification under the LEED ND rating system given the points awarded for transit-oriented development, mixed use, and historic reuse. Figure 1 outlines the necessary steps and time line for LAUSMP to achieve LEED ND certification.

RESULTS

Results were broken into three categories: inherent advantages, existing barriers, and areas that need modifications. This analysis concluded that a modified LEED ND can be an effective standardized tool for measuring sustainability of transit hubs. Table 2 displays the results.

Inherent Advantages

The inherently sustainable attributes of transit centers are recognized in several areas of LEED ND, creating a strong compatibility between the third-party rating and the typology. In the site location and linkages category, the credits called smart location, preferred location, and locations with reduced automobile dependence highlight transit center compatibility with LEED ND criteria (totaling 17 points of 110). In the neighborhood pattern and design category, the credits called transit facilities, transportation demand management, and access to civic and public space fit well with transit centers (totaling four points of 110). In the third category, green infrastructure and building, there are no credits that are implicit to transit center functioning, but there are several that are beneficial to the needs of such a facility. Energy-efficient infrastructure, district heating and cooling, and stormwater management are credits that are advantageous for transit facilities to pursue.

In the case of LAUSMP, there are several additional synergies in the LEED ND point structure, including historic resource preservation and adaptive reuse, heat island reduction, and certified green buildings. The LAUSMP site fits well within the expectations of the LEED ND category called smart location and linkages. Under the smart location prerequisite, the project easily accomplishes the infill site classification (*9*).

Existing Barriers

The analysis of LEED ND proved there were two prerequisites and several credits in the LEED ND system that need modification to create compatibility between LEED ND and transit centers. These prerequisites, credits, and modifications are explained below.

Connected and Open Community Prerequisite

LEED ND uses the metric of intersections per square mile to evaluate projects' connectivity. According to the manual, "connectivity is measured in intersection density because this metric is most closely correlated with increasing multimodal travel, particularly walking and bicycling. Projects designed with short blocks and frequent intersections make walking and bicycling more attractive and reduce carbon emissions from cars and vehicles" (*9*). The connected and open community prerequisite in the neighborhood pattern and design category requires

- 140 intersections per square mile and
- A project design with at least one through street every 800 ft (nonmotorized rights-of-way may count for only 20% of intersections) (*9*).

Access to a transit center has been proved to greatly increase an area's connectivity (*11*). In transit centers, connectivity is often accomplished through dedicated transit rights-of-way with intersections above, below, and at the ground plane and inside and outside buildings. Pedestrian bridges, under-street connections, metro station entrances inside buildings, and protected lanes for foot traffic can all allow for smooth connectivity despite a complex ground plane. Transit centers and transfer facilities typically are superblocks in their site configuration and have their own network internal to the superblock that is outside of the LEED ND current metric of number of ground plane intersections. The LEED ND prerequisite for dense ground plane intersections and a through street every 800 ft is challenging in this logistical choreography of multiple modes of high-volume transit in a dense urban core.

Because a prerequisite is connected and open community, the current limited definition of connectivity can exclude transit hubs from pursuing LEED ND certification. This exclusion can be addressed by expanding the metrics by which connectivity is quantified. By broadening eligible intersections to include connections that happen above and below the ground plane and inside as well as outside buildings, a more efficacious measure of connectivity can be mandated. Good urban design maximizes connectivity while ensuring safety for pedestrians and bicyclists and efficient movement for motorized vehicles. Widening the definition of connectivity to activity above and below the ground plane will promote better design for dense urban spaces.

LAUSMP Case Study: Connectivity

In the case study of LAUSMP, the site straddles the downtown urban fabric (downtown Los Angeles), historic industrial fabric (Piper Technical Center, Bail Bonds, County Jail), and cultural districts (Chinatown, El Pueblo, Arts Districts). While offering many possibilities for connecting these fabrics to a more integrated whole, solid boundaries such as Interstate 101 and the rail yard also offer challenges to computing satisfactory urban density of gross square feet and density of intersections on the ground plane. The bicycle flyovers and pedestrian connections offered by LAUSMP positively address the current pedestrian and bicycle safety issues and work to link El Pueblo, Chinatown, and the Arts District. If LEED ND expands eligible intersections, the connectively that LAUSMP offers would be better recorded. For efficacious urban design in LAUSMP, neighborhood connectivity needs to be viewed not only as a single plane of internal walkability but as a multilayered system.

In new versions, LEED ND could go a step further and create criteria that would promote better connectivity in dense urban areas. For example, criteria for way finding and multimodal transition times would offer qualitative and quantitative assurance that efficient and safe connections are made. In the case of LAUSMP, way finding and connection times were important design criteria.

Walkable Streets Prerequisite

The neighborhood pattern and design category includes a prerequisite called walkable streets, which focuses on maintaining rights-of-way. The metric for walkable streets is building frontages facing public spaces, ratios of building to streets, continuous sidewalks, and density. The manual explains that "walkable streets are the foundation of projects that reduce carbon emissions and air pollution by creating a multimodal travel environment, with the pedestrian at the center" (*9*). The walkable streets prerequisites include the following:

- 90% of new building frontage faces a public space,
- The building-to-streets ratio is 1:3 for 15% of the master plan,
- Continuous sidewalks are provided along both sides of 90% of streets or frontages within the project, and
- There is a density of seven dwelling units per acre for residential space and a 0.5 floor area ratio for nonresidential space (excluding parking) for the entire master plan (*9*).

Two complications exist for transit centers fulfilling this prerequisite. First, regional transit centers have complex logistical coordination. The need for wide road or rail line entrances to the site can preclude sidewalks from surrounding all frontages on the site. Pedestrian bridges, underground tunnels, and protected separate lanes all provide access and exist outside the sidewalk paradigm on which LEED ND relies.

Another condition common to regional transit centers is internal entrances that function as frontages (Figure 2). The public entrance to a popular restaurant could be located two levels below the main street entrance. The public entrance and exit to the metro could be within a shopping center. From the LEED ND language, it is unclear whether these internal civic frontages are included as building frontages.

Despite the intention for LEED ND to create a multimodal travel environment, the current metric greatly limits compliance by transit hubs. Since walkable streets is a prerequisite, the LEED ND

FIGURE 2 Current site conditions for incompatible credits.

walkability definition can keep transit centers from participating in certification. Walkability can be ensured without traditional sidewalks through use of pedestrian and bicycle elements above and below the ground plane. Dedicated rights-of-way for bicycles and pedestrians provide longer stretches of travel than street sidewalks that are repeatedly interrupted by car traffic and thus create better walkability (*12*).

LAUSMP Case Study: Walkable Streets Prerequisite

The external street frontage entrances in LAUSMP all open to parking lots and automobile drop-off areas (Figure 3). Although this setup is largely a result of the Los Angeles dependence on automobiles, it is common for transit centers to incorporate bus plazas and taxi areas. LAUSMP is designed to turn these parking lots into public plazas and green space. LEED ND must address the need for automobile access in these high-traffic conditions.

LAUSMP has a series of internal thresholds that could be interpreted as frontages (Figure 2). The master plan is detailed with multilevel retail and residential areas to promote the financial viability of expanding the station. In the master plan, many areas that are inside the station function as main streets (*10*). A significant fraction of visitors to LAUSMP will never leave the site and navigate through the project as a neighborhood. LEED ND must expand the definition of street frontages and thoroughfares to include these conditions that capture the essence of building entrances.

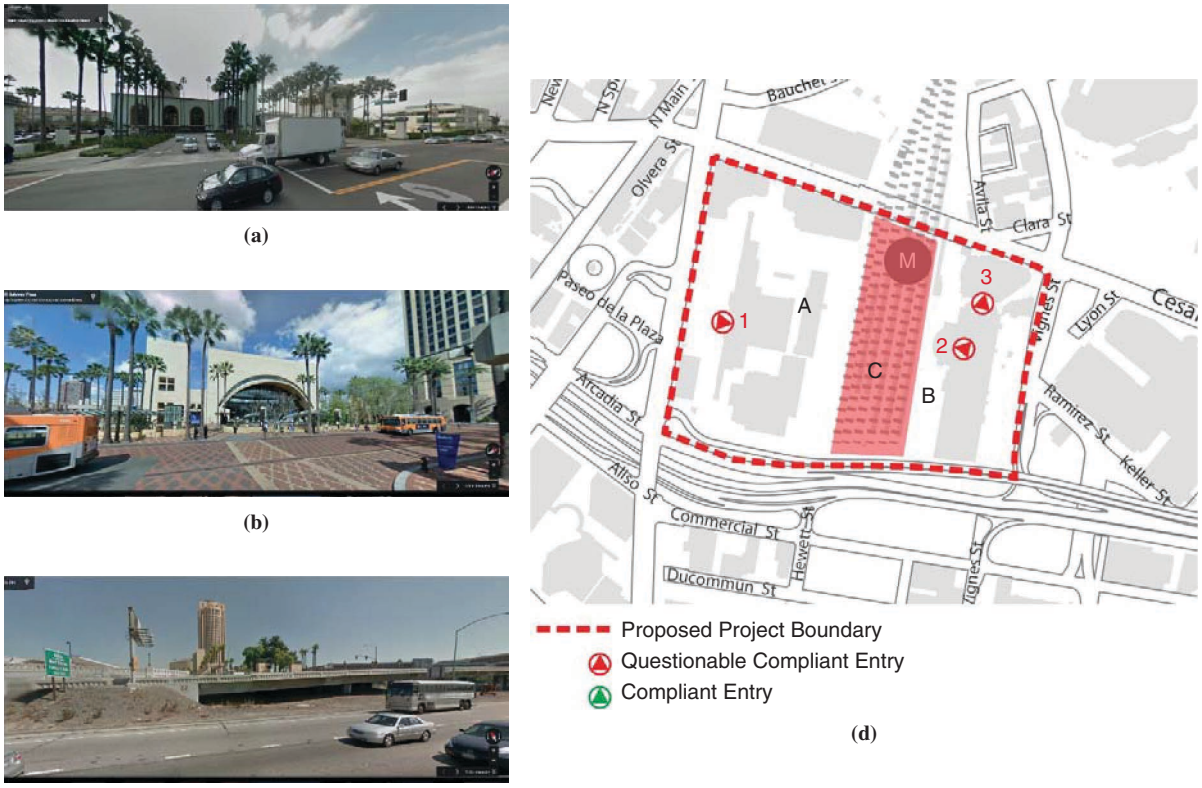

FIGURE 3 LAUSMP and walkable streets conflicts: (*a*) entrance on Alameda Street, (*b*) entrance on Vignes Street, (*c*) entrance on Vignes Street, and (*d*) map of site.

Los Angeles Union Station narrowly qualifies for the LEED ND prerequisite for connected and open community for projects without internal streets (it has 144 intersections per square mile and needed 140). In Figure 4, qualifying intersections per square mile are marked by a green dot.

Incompatible Credits

Several credits within the LEED ND scorecard are incompatible with transit center operations. These credits total 25 points, or 23% of the points available under LEED ND. Not all points in any rating system will fit perfectly to every typology; however, the walkable streets and tree-lined streets credits should be modified. If adapted, the total credits that could be ill suited for a transit hub project are only 11 points, or 10% of the total possible points.

Walkable Streets Credit, 12 Points

The neighborhood pattern and design category includes a credit (12 points) called walkable streets, representing 11% of the possible points awarded by the rating system. For this credit, a point is awarded for meeting each of the 16 characteristics listed within the topics facades and entries, ground-level use and parking, design speeds for safe pedestrian and bicycle travel, and sidewalk intrusions. Many of the 16 items are difficult for transit centers to achieve because of how the centers function. For example, servicing of trains

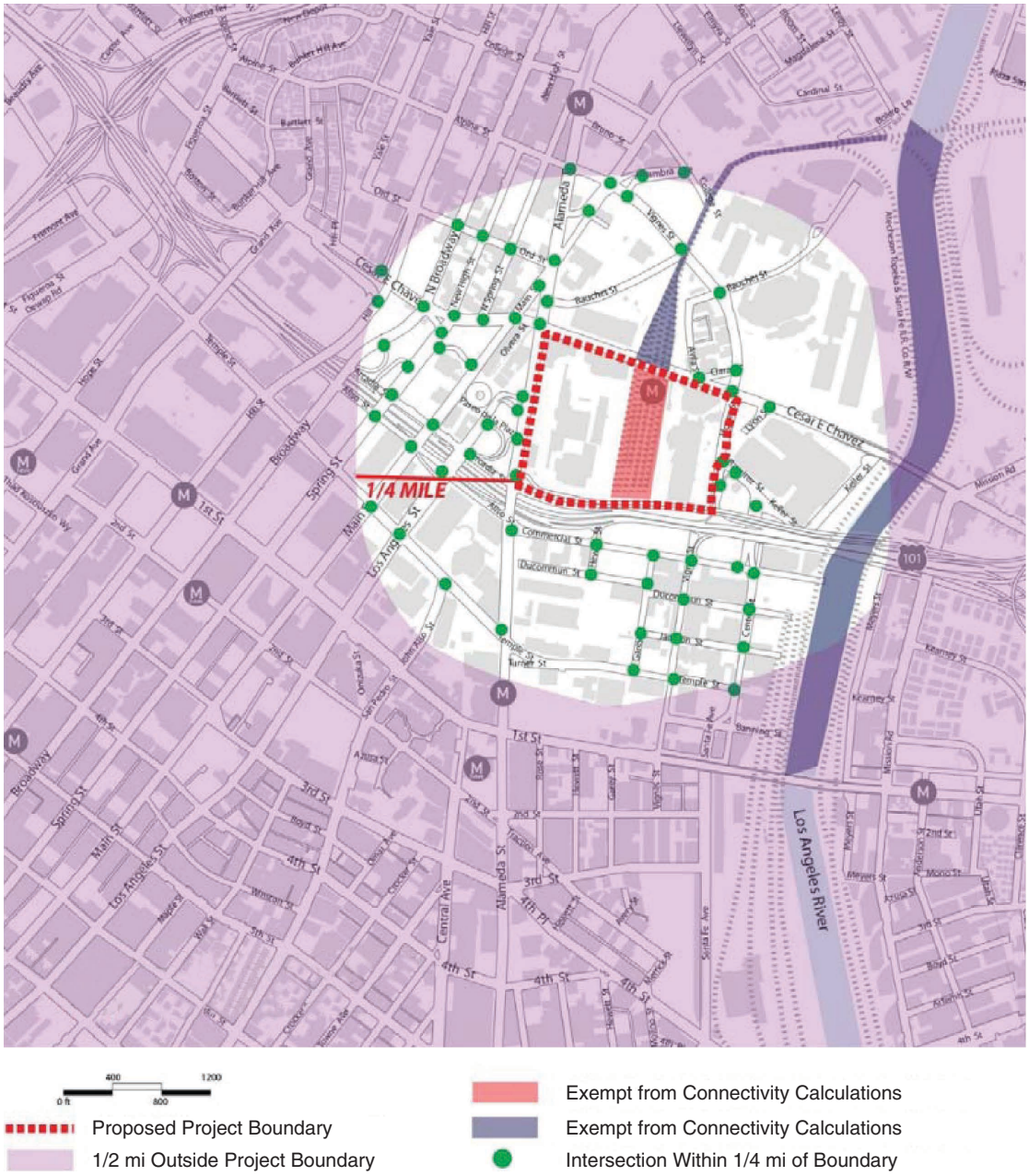

FIGURE 4 LAUSMP and connectivity conflicts (62 intersections per 0.435 mi^2, 144 intersections per square mile).

and buses requires access to larger back-of-house and servicing areas. These infrastructural realities can lead to a ground plane that is chopped up and cannot qualify for this 11% group of points, although walkability above and below the ground plane is addressed.

Los Angeles Union Station has three main entrances: one on Alameda Street and two on Vignes Street, shown in Figure 3. All entrances front onto parking lots, making Union Station in its current configuration ineligible for LEED ND certification. (Photos were taken from Google Maps in May 2015.)

Compact Development Credit, One to Six Points

LEED ND defines compact development through the metric of a weighted average of residential dwelling units per acre and non-residential floor area ratio (*9*). Through several credits, LEED ND is biased toward inclusion of a strong residential component in the project. Transit centers can be prime for residential development for people who want easy access to transit. Residential development creates an embedded customer group for on-site commercial development and a citizen group invested in the maintenance and sense of place of the project. However, transit centers face challenges in offering density. To achieve density, it is structurally very expensive to build over rail yards, where the foundation must bridge long spans. Additionally, for an existing transit center, a complex layering of the infrastructure for metro lines and underground parking may make building more expensive than in a typical urban condition. Furthermore, if the transit hub includes a historic asset, sight lines may be protected and the density called for by LEED ND may not be possible.

Tree-Lined and Shaded Streets Credit, Two Points

The tree-lined and shaded streets credit (two points) seeks to ameliorate heat islands, contribute to localized carbon mitigation, and beautify and create a sense of place. The credit outlines these requirements:

- Design and build the project to provide street trees on both sides of at least 60% of new and existing streets within the project and
- Obtain a registered landscape architect's determination that planting details are appropriate for growing healthy trees (*9*).

In the case of regional transit centers, there are many unique conditions in which tree-lined streets are not possible. For example, tree growth is impractical for bridges and impossible for tunnels. LEED ND needs to create an exemption for these exceptional conditions rather than strictly mandating trees on every street.

Furthermore, LEED ND could promote better design. Tunnels could become an alternate criterion to tree-lined streets, and the design specification for health and safety could include safe lighting and air quality measures. In the case of LAUSMP, there would have been an incentive to address the current health and safety issues in Cesar Chavez Tunnel.

Figure 2 is a view of LAUSMP from the west, taken July 15, 2016. Transit infrastructure largely prohibits the project from gaining points under the walkable streets credit. However, the entrances to the Metro system function as street entrances through which visitors enter and exit the site. These unique conditions need to be considered under the walkable streets intent.

FIGURE 5 Current site conditions for incompatible credits.

Figure 5 is a view of the Cesar Chavez tunnel that flanks the eastern boundary of the site (*13*). This tunnel keeps LAUSMP from gaining points under the tree-lined streets credit.

Stormwater Management Credit, Four Points

LEED ND rewards stormwater management "to reduce pollution and hydrologic instability from stormwater, reduce flooding, promote aquifer recharge, and improve water quality by emulating hydrological conditions" (9). The metric for fulfilling this intent is percentile of rainwater event volume retained on site.

These stated objectives can be difficult for transit hubs to meet because of few opportunities for infiltration. The infiltration challenge for transit hubs has two causes: (*a*) large expanses of impervious pavement that are necessary for transportation functions and (2) previous ground pollution by oils and other machine by-products. With a narrow area in which to manage stormwater through natural methods, transit hubs may have to rely on more expensive, engineered means such as dry wells or stormwater reuse for process or building-water needs.

Solar Orientation Credit, One Point

LEED ND offers two methods for documenting a project's solar orientation to gain credit for passive energy savings. Projects can provide proof through either (*a*) block orientation when a threshold is achieved under compact development or (*b*) building orientation. In both cases, the requirement is that

- 75% or more of blocks or buildings must be oriented in plus or minus 15° of the east–west axis and
- The east–west lengths of those blocks or buildings must be as long as the north–south lengths of the blocks or buildings (9).

For transit centers, orientation is often dictated by large connecting pieces of infrastructure. Interstates, rail lines, and metro lines can fix building and block orientation. Solar orientation considerations are trumped by a need to logistically meet turning radii of large pieces of infrastructure and successful coordination of multiple transit needs

to access the site. This credit can be a difficult for transit centers to obtain because of complex functionality demands.

LAUSMP Case Study: Incompatible Credits

A handful of LEED ND credits are incompatible with LAUSMP. With respect to the solar orientation credit, the existing station platforms and tracks are not oriented in a way that is conducive to development with a dominant east–west axis. With respect to the stormwater management credit, the current LAUSMP site only allows for infiltration in the forecourt along Alameda Street. For the tree-lined streets credit, a rail yard that spans Cesar Chavez Boulevard creates a long tunnel. An exemption is necessary for LAUSMP to be awarded the credit for tree-lined streets through the rest of the project.

CONCLUSION

The analysis concluded that LEED ND could be used as a standardized tool for measuring sustainability of transit hubs if a series of necessary modifications were completed. This paper suggests updated metrics for connectivity and walkability to recognize linkages that occur above and below the ground plane, inclusion of incentives for carbon emissions reduction and air quality monitoring, and expanded exemptions for transit infrastructure from density and tree-lined street calculations.

Through these modifications, LEED ND can empower good urban design for transit centers and urban cores with new metrics for connectivity and walkability to include dedicated rights-of-way, way finding and multimodal transition times, and the health and safety of tunnels and overpasses.

LEED ND does not include any explicit requirement for projects to monitor carbon reduction, the most important metric for climate change amelioration. Although carbon is addressed through secondary indicators such as vehicle miles traveled, energy efficiency, and bicycle network and storage, points must be directly awarded for carbon management. To address this lack, LEED ND should first require transit authorities to sign on to a third-party carbon reporting system. Second, transit authorities should pledge to report Scope 1, 2, and 3 emission categories for their facilities as part of annual sustainability benchmarking. Unlike other requirements under LEED ND, this credit requires annual action.

LEED ND should reward monitoring health and well-being indicators. Communities seeking environmental justice need the information to prove the quality of their environment and its influence on the local community. Specifically, LEED ND could include FTA's emphasis on ladders of opportunity in awarding funds for transit facilities as a criterion. In the case of transit centers, air quality is a key environmental indicator that must be monitored for impact on the community and its neighbors. Depending on the form of transit accessing the transit hub, this monitoring could be an advantage or a disadvantage toward certification.

To make LEED ND inclusive of transit centers, a broadened understanding of types of pedestrian and bicycle connections is needed for the connected and open community and walkable streets prerequisites. Rather than treating a project as fixed to two dimensions, the rating systems must expand definitions and metrics of walkability and connectivity so that more complex designs can be measured. Rather than a single ground plane on which all interventions must register, LEED ND must create methods for accounting for layered uses, multiple types of streets and frontages, and blurred inside and outside spaces. Expanding past its roots in New Urbanism (*8*), the rating system should fit the definition of contemporary sustainability that urban areas are embracing through multimodal transit.

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