PENN INSTITUTE *for* URBAN RESEARCH

PENN IUR WHITE PAPER SERIES ON SUSTAINABLE URBAN DEVELOPMENT

SUSTAINABLE URBAN DEVELOPMENT INDICATORS

FOR THE

UNITED STATES

Report to the Office of International and Philanthropic Innovation,
Office of Policy Development and Research, U.S. Department of Housing and Urban Development

September 2011

Amy J. Lynch (Lead Author), Stuart Andreason, Theodore Eisenman, John Robinson, Kenneth Steif, and Eugenie L. Birch

Contact information:
Amy J. Lynch, Doctoral Candidate
University of Pennsylvania
Department of City & Regional Planning
127 Meyerson Hall
Philadelphia, PA 19104
amyly@design.upenn.edu

Executive Summary

In August 2010, the Sustainable Urban Development Working Group engaged researchers from the University of Pennsylvania's Institute of Urban Research to provide research in support of a standard system of sustainable urban development indicators for the United States. Selected indicators were to demonstrate the progress that American cities are making toward sustainable urban development, inform supportive policy, planning and investment, and cover two conceptual frameworks including the Partnership for Sustainable Communities' Livability Principles. As the first step in that research, the objective of this study was to explore the characteristics of existing indicator systems, examine whether a standard set of sustainable urban development indicators could be drawn or adapted from existing systems, and identify challenges and recommendations in moving forward. Researchers reviewed of 22 systems with 377 indicators and identified a database of 145 candidate indicators. Following this analysis, the research team concluded that coverage of social wellbeing and economic indicators is insufficient, and the number of indicator systems in the review must be expanded. Additionally, separation of the dimensions of sustainable urban development (i.e. environmental quality, economic opportunity, and social wellbeing) hinders the ability of most systems to accurately understand broad movements toward sustainability. As the project moves forward, efforts should be made to include mainly indicators that emphasize and incentivize coordination between these dimensions.

Table of Contents

I. Introduction

In a rapidly urbanizing world with high levels of economic, environmental, and social instability, decision makers are increasingly turning to programs and policies that seek to enhance the sustainability of systems and settlements. While sustainable development remains a complicated endeavor, and is "not readily captured in precise definition," a variety or organizations, including municipalities, states, advocacy groups, and private corporations have accepted the challenge, examining their actions and assessing progress towards sustainability (Bell and Morse 2008). In setting sustainability objectives, and steering policy to meet them, many of these organizations recognize the importance of evidence-driven tools for measuring success and understanding progress. Although evaluation may employ many techniques (e.g. quasi-randomized studies, case studies, benchmarks, surveys, and questionnaires), in assessing sustainable development, the use of indicators has become the commonly accepted approach (Hak 2007,1; Morse and Bell 2008).

But as the number of organizations recognizing the importance of sustainable urban development grows, so does the number of indicator systems. In the United States, many local, regional, and national governments have developed their own indicator systems, as have numerous private and non-profit organizations. While the trend toward awareness of sustainable development is encouraging, the proliferation of indicator systems presents a challenge. With enumerable indicator systems in use, each with different goals, objectives, and definitions of 'sustainability,' understanding broad, national trends is difficult.

The ability of federal agencies and other organizations to understand progress toward sustainable urban development is hampered by the absence of standard evidence-driven tools. For bodies involved in developing national sustainability policies and programs, such as the U.S. Department of Housing and Urban Development (HUD), assessing needs and results is a particular challenge. In order for public and private organizations involved in understanding and developing urban areas to craft and deploy programs that foster sustainability, they need clear, consistent, and robust measures of sustainability. Without a standardized system, they must rely on individual cities' monitoring systems to understand policy results, which may or may not be comparable or include robust measures of movement toward sustainability. A standard system of evidence-driven measures would highlight areas important in enhancing the sustainability of urban development and allow HUD and other agencies to understand trends in

those key areas and where cities may be excelling or falling behind. Given the standard of the field, what is needed is an indicator system.

The current lack of measurement standardization also creates challenges for local governments. Since land use decision-making is inherently local, municipalities have a high degree of agency in the move toward sustainability. But, particularly given the current economic climate, they also face resource challenges. While larger municipalities have the resources to develop assessment strategies, smaller cities may lack the knowledge, staff, and resources needed to create comprehensive measurement systems. More critically, it is these small and mid-sized municipalities, with their large suburban, fringe, and rural areas that could have the greatest impact on the sustainability of urban development in the United States. The standardization of a recognized indicator system would further clarify the federal government's operational interpretation of sustainability and provide a point of departure for communities interested in tracking progress, participating in federal programs, or simply expanding their base of sustainability knowledge.

While the number and variety of sustainability indicator systems currently in use presents challenges, these existing systems may also provide the solution. With so many indicator systems in use or development, there are many measures from which to draw, and many examples to follow. Consequently, in this study, researchers explore how a standard set of sustainable urban development indicators could be drawn or adapted from existing systems and identify the challenges to be faced in doing so, the first steps towards creating the standardized system needed to understand national sustainable urban development trends.

II. Background

At the World Urban Forum in Rio de Janeiro, Brazil in March 2010, public, private, and non-profit entities from the U.S. and abroad convened to share ideas and reflect on urban development policies. U.S. Department of Housing and Urban Development Secretary Shaun Donavan represented the United States at the Forum, offering a keynote speech that attested to the importance of evidence-based research in developing and executing urban policy. At the World Urban Forum, UN-HABITAT also launched the World Urban Campaign (WUC), an activity designed to bring attention to the many facets of sustainable urban development, including tools for measurement. HUD Deputy Assistant Secretary Ana Marie Argilagos, Director, Office of

International and Philanthropic Affairs, attended WUC steering committee meetings and became interested in its work on evaluation.

In July 2010, as a follow-up to the Forum, the White House Office of Urban Affairs and U.S. Department of Housing and Urban Development, with support from the Ford Foundation, convened a meeting of a diverse group of stakeholders, representing government departments, and the private and non-profit sectors in the United States and Canada. The objective was to gauge interest in refining North American-oriented approaches to evaluating sustainable urban development. In particular, the group, that would later become the Sustainable Urban Development Working Group (SUD Working Group), set three goals (Lynch 2010):

1. To scan North American indicators and outcomes which evaluate successful sustainable urban development and revitalization strategies.
2. To map these metrics in the context of global best practices.
3. To submit suggestions on potential common language, normative principles, and universal benchmarks around sustainability to the World Urban Campaign.

At the July meeting, the Working Group agreed that working towards a common language, principles, and indicators is important, but that it is also critical to draw upon the substantial existing research and not 'reinvent the wheel.' The group identified next steps as scanning and compiling the "best indicators and outcomes around urban sustainable development currently employed in the U.S. and Canada" and bringing even more stakeholders to the table (ibid).

In August 2010, the Working Group reconvened in Washington, DC to further solidify the purpose of the project, agree upon a definition of sustainable urban development, and set a framework to guide the scan of existing indicators. The group agreed upon a purpose, "to develop indicators that demonstrate the progress that American cities are making toward sustainable urban development and inform supportive policy, planning and investment" (Lynch 2010) and adopted a definition of sustainability adapted from the 1997 President's Council on Sustainable Development:

Sustainable communities are those that flourish because they are governed in a responsible and responsive manner and build a mutually supportive, dynamic balance between social wellbeing, economic opportunity, and environmental quality" within a larger global framework of sustainable development.

At the meeting, representatives from the University of Pennsylvania's Institute of Urban Research agreed to do background research on indicators, existing indicator systems (with assistance from the American Planning Association), and to help the Working Group identify and test the 'best' indicators of sustainable urban development.

Development of a Framework

A major result of the August meeting was agreement upon a framework for sustainable urban development. The Working Group endorsed three dimensions of sustainable urban development: Social Wellbeing, Economic Opportunity, and Environmental Quality and agreed upon the elements necessary to ensure each. The result is the Working Group's Sustainable Urban Development Framework:

Dimension of Sustainable Urban Development	**Elements Necessary for Sustainable Urban Development:**
Social Wellbeing	Health Safety Local or civic identity/sense of place Access to decent – affordable – housing and services Access to public recreation and open space Access to a variety of transportation options
Economic Opportunity	A diversified and competitive local and regional economy Transportation and other infrastructure coordinated with land use Growth plans that leverage existing assets Access to capital and credit Access to education, jobs, and training
Environmental Quality	Efficient land use Efficient resource use Waste/pollution minimization and management Climate change and natural disaster mitigation, adaptation, and resilience Carbon efficient, environmentally sound, transportation A diverse natural environment and functional ecological systems

Partnership with APA

To support the SUD Working Group's goals, representatives from the American Planning Association (APA) agreed to assist Penn IUR in preliminary research on indicators and indicator systems. With guidance from the Working Group and input from Penn IUR, APA assembled an annotated a list of 22 existing indicator systems (see Appendix A) that provides the foundation for the research discussed in this report.

III. Research Objectives, Approach, and Methods

The SUD Working Group's goal is "to develop indicators that demonstrate the progress that American cities are making toward sustainable urban development and inform supportive policy, planning and investment." The Group also agreed that a standard set of North American indicators should be rooted in existing systems. This preliminary study is the first step in that process. It explores the characteristics of existing indicator systems, examines whether a standard set of sustainable urban development indicators could be drawn or adapted from existing systems, and identifies the challenges that might arise in doing so. Implicit in this research is an assumption that the movement toward sustainable urban development is mature enough to warrant a standard set of indicators, and has a robust enough body of literature and experts that a useful consensus can be reached.

This study has three aspects: expert guidance, literature review, and analysis of existing systems. Expert guidance comes from the SUD Working Group, which requested the study and set the parameters and frameworks that guide it. Existing literature is also important. There is a significant body of work surrounding indicators, particularly those related to sustainability and sustainable development, and it informs researchers' understandings of evidence-driven measurement systems. Finally, the SUD Working Group requested that a standard indicator system be based upon not only established research, but existing indicators. As such, the bulk of this study consists of examining and organizing existing indicators and testing their fit against proffered conceptual frameworks.

Researchers began with a review of academic and practice-oriented literature, undertaken to discern current understandings of indicators and indicator systems. The results provided a number of lenses through which to view and assess the merits and coverage of existing indicators. The research team then pulled indicators from existing systems to populate a database of existing indicators before applying the tests and organization tools identified in the literature review. By applying these tests, and examining the ability of existing indicators to comprehensively cover two conceptual frameworks identified by the SUD Working Group, researchers were able to understand the possibilities and challenges in developing a standard set of North American indicators from existing metrics.

IV. Literature Review

The first task facing the Penn IUR research team (the research team) was to understand how previous researchers had defined, tested, and used indicators in the context of social and physical sciences. This research had three objectives: 1) to adopt or develop and operational definition of 'indicator' and differentiate it from other metrics such as 'benchmarks,' 2) to understand the qualities of indicator systems, and 3) to understand what makes a 'good' indicator.

To address these questions, the research team performed a large-scale literature review, finding more than 30 relevant books and articles (bibliography in Appendix B). The breath of the inquiry required pulling from a variety of fields, including, but not limited to, urban planning, environmental management, economics, and social justice. Major findings are outlined below.

Key Definitions

Addressing the first objective necessitated minimizing terminological ambiguity, including the difference between 'indicator' and 'benchmark'. Based upon the literature review, the research team adopted a definition of an indicator as, "statistics, statistical series, and all other forms of evidence…that enable us to assess where we stand and are going with respect to our values and goals (Bauer 1966)." There are three notable aspects of this definition, which guided the research team's thinking. First, an indicator can be a statistic – a quantitative measure – but also encompasses other forms of evidence, including more qualitative assessments. Indicators are usually expressed in numerical terms, yet a number of researchers note that heavy reliance on quantitative results ignores other important information (Hak 2007, 11). Second, an indicator provides information on where we stand *and* where we are going. Finally, indicators are related to values or goals, or, as one of the SUD Working Group members noted, all indicators are subjective to the purpose of the group creating them. Due to their subjectivity, indicator systems are always guided by conceptual frameworks. The framework outlines, or defines, the value-judgments embodied in the paradigm under scrutiny (Bell and Morse 2008). Some indicator systems include composite indicators or indices created through aggregation of data while others introduce social science results through survey research, sometimes employing Likert scales that offer more qualitative information.

The research team also examined the term 'benchmark' which literature largely defines as, "a reference point in determining the current situation or position relative to the stated objective

(University of Missouri Extension, 2000). A benchmark is a reference point, where an indicator is an assessment of status or progress. Indicators and benchmarks may share a scale, but one shows where you are (or are going) while the other identifies some important value for the sake of comparison.

Qualities of Indicator Systems

Literature on the second objective was very broad, with at least six typologies to help organize and characterize indicators (United Nations 2007):

- **Pressure/state/response:** presenting descriptors related to the type of indicator
- **Issue or theme-based:** grouping indicators under various issues
- **Capital:** attributing monetary figures to indicators
- **Accounting:** drawing indicators from a single database
- **Aggregated:** integrating data into an index
- **Headline:** providing visible signals or messages via few dramatic indicators

Of these, the pressure/state/response categorization stands out as comprehensive, carefully developed, and supported by several prominent articles and initiatives. The categorization is based upon an understanding that there are different formats of indicators. Indicators of different types may measure the same issue, but they do so at different points in the chain of cause and effect. Based upon the point at which an indicator provides information, it can be classified as 'pressure,' 'state,' or 'response.' A pressure indicator measures a pressure on the system, an action that is threatening sustainability. Pressures are usually actions that would best be minimized to enhance the sustainability of urban development. A state indicator measures the state of the system, the current, on-the-ground condition. A response indicator measures actions that have been taken, reactions to undesirable states or pressures, or solutions to perceived problems. Unique among indicator typologies, pressure/state/response categorizations recognize the importance of considering not only *what* an indicator measures but *how* and *at what point* it does so. The pressure/state/response categorization is discussed further in section IX.

Qualities of a 'Good' Indicator and Indicator System

The third objective requires an understanding of what makes a good indicator. The literature provides many different scales, but a recent article by Shen and colleagues (2010) identifies the SMART framework, put forth by the Statistical Institute for Asia and Pacific (2007) and European Sustainable Development Network (Hametner and Steurer 2007). The SMART

framework suggests that indicators should be Specific, Measureable, Achievable, Relevant, and Time-Related. The SMART criteria is discussed further in section VI.

Distinct from discussion of what makes an *individual* indicator 'good,' substantial debate revolves around the question of the appropriate number of indicators to include in a system. Researchers cite trade-offs between ease of use and data-availability vs. comprehensiveness and depth (UN 2007, Hak, 2007, Bell and Morse 2008). Notably, the SUD Working Group urged the researchers to suggest only a few indicators, creating a system as 'lean and mean' as possible.

Additionally, at the August 2010 meeting, the SUD Working Group provided researchers with guidance in selecting indicators. In many ways concurring with findings from the literature, attendant experts agreed the newly formed set should:

- Adhere largely to political jurisdictions, i.e. cities.
- Be informed by international research and understandings, but tailored to domestic needs.
- Apply broadly, to American cities of all sizes and locales.
- Relate primarily to data that cities already collect and/or are interested in and motivated to collect over the long term.
- Be simple, few, and succinct, but supplemented with contextual information.

V. Broad Analysis of Indicator Systems

Following an exploration of the literature on indicators and indicator systems, the research team began a broad analysis of the 22 identified indicator systems. While the list of 22 is not comprehensive, it was compiled by the APA based upon the recommendation of SUD Working Group and other experts, and can be considered representative of the types of organizations that are active in the area. The 22 systems, shown below, fall into four broad categories, Institutional, NGO, Private, and Governmental.

Institutional (1)
Columbia Univ. + Yale Univ. –
2010 Environmental Performance Index

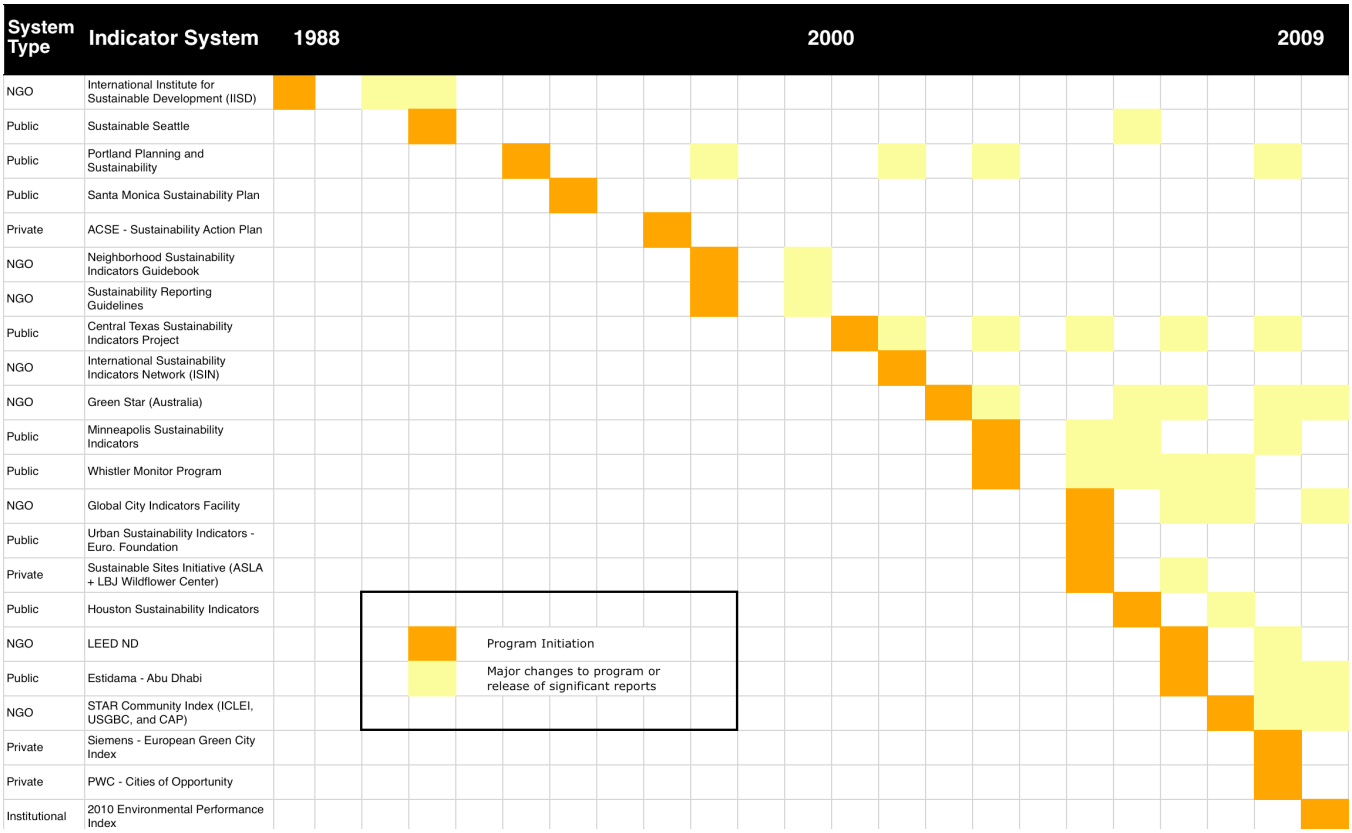
Non-Profits / NGO (9)
CAP, ICLEI + USGBC – STAR Community Index
GBCA (Australia) – Green Star
Global Reporting Initiative – Sustainability Reporting Guidelines
International Institute for Sustainable Development
Urban Ecology Coalition – Neighborhood Sustainability Indicators Guidebook
USGBC – LEED ND
The World Bank – Global City Indicators Facility
ACSE – Sustainability Action Plan*
International Sustainability Indicators Network*
The World Bank – Sustainable Development*

Private Organizations (3)
ASLA + Lady Bird Johnson Wildflower Center – Sustainable Sites Initiative
PricewaterhouseCoopers – Cities of Opportunity
Siemens – European Green City Index

National / Municipal Governments (9)
Abu Dhabi – Estidama
European Foundation – Urban Sustainability Indicators
Central Texas Sustainability Indicators Project
Houston Sustainability Indicators
Minneapolis Sustainability Indicators
Portland Planning and Sustainability
Santa Monica Sustainability Plan
Whistler Monitor Program
Sustainable Seattle

The systems were instituted over a period of 22 years, beginning with the International Institute of Sustainable Development in 1988, and concluding with the 2010 Environmental Performance Index (Columbia and Yale University). Suggesting that the development of sustainable development indicators is gaining momentum, the number of indicator programs and their activity, even within this small sample, increases dramatically over time (Figure 1).

Figure 1. Timeline showing initiation and activity of 22 sustainability indicator programs (Diagram by John Robinson 2010)

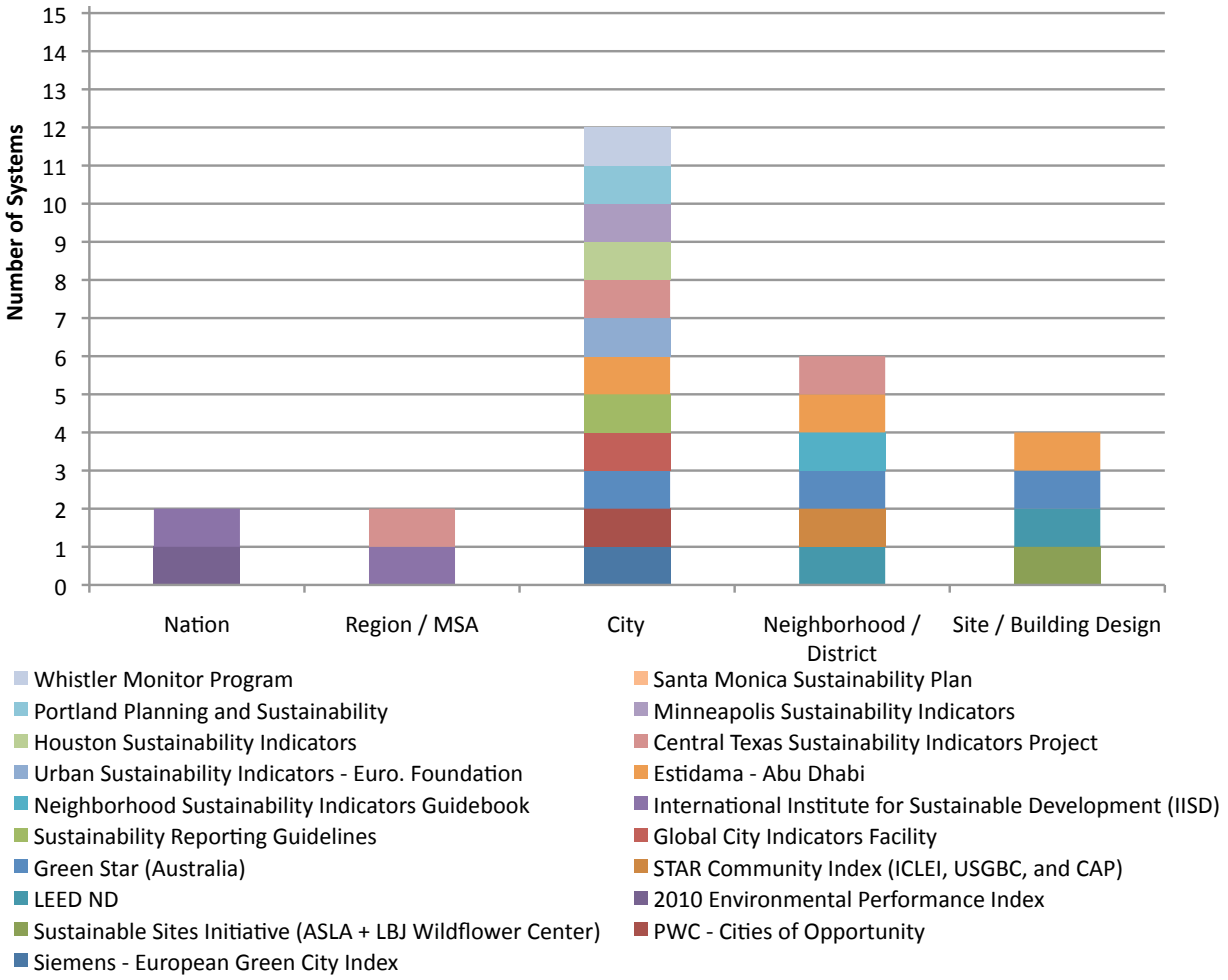


However, as of September 2010, three of the 22 indicator systems on the list, ACSE – Sustainability Action Plan, International Sustainability Indicators Network (ISIN), and The World Bank – Sustainable Development did not have concrete indicators and could not be considered further in the analysis. ISIN, for example, is an information-sharing network for individuals and organizations involved in indicator work rather than a set of discrete indicators.

Following from the literature review, the research team identified three main points of analysis: scale, interpretation of sustainability, and goals. Understanding the scales of identified systems is particularly important as scale influences the indicators contained in each system. As we know from the literature, indicators are linked to goals. Systems with different scales (e.g. site-level, municipal) emphasize different aspects of sustainability, those most appropriate to the goals of the organization creating the system.

The SUD Working Group suggested that final indicators adhere to political jurisdictions, but given the wide variety of system scales, limiting analysis to municipal indicators would be overly narrow. Broadening the search prevents potentially useful – and adaptable – national or site-level indicators from being eliminated. However, given the urban emphasis of many members of the SUD Working Group and of the project more broadly, more municipal indicator systems were identified than those of other scales (figure 2).

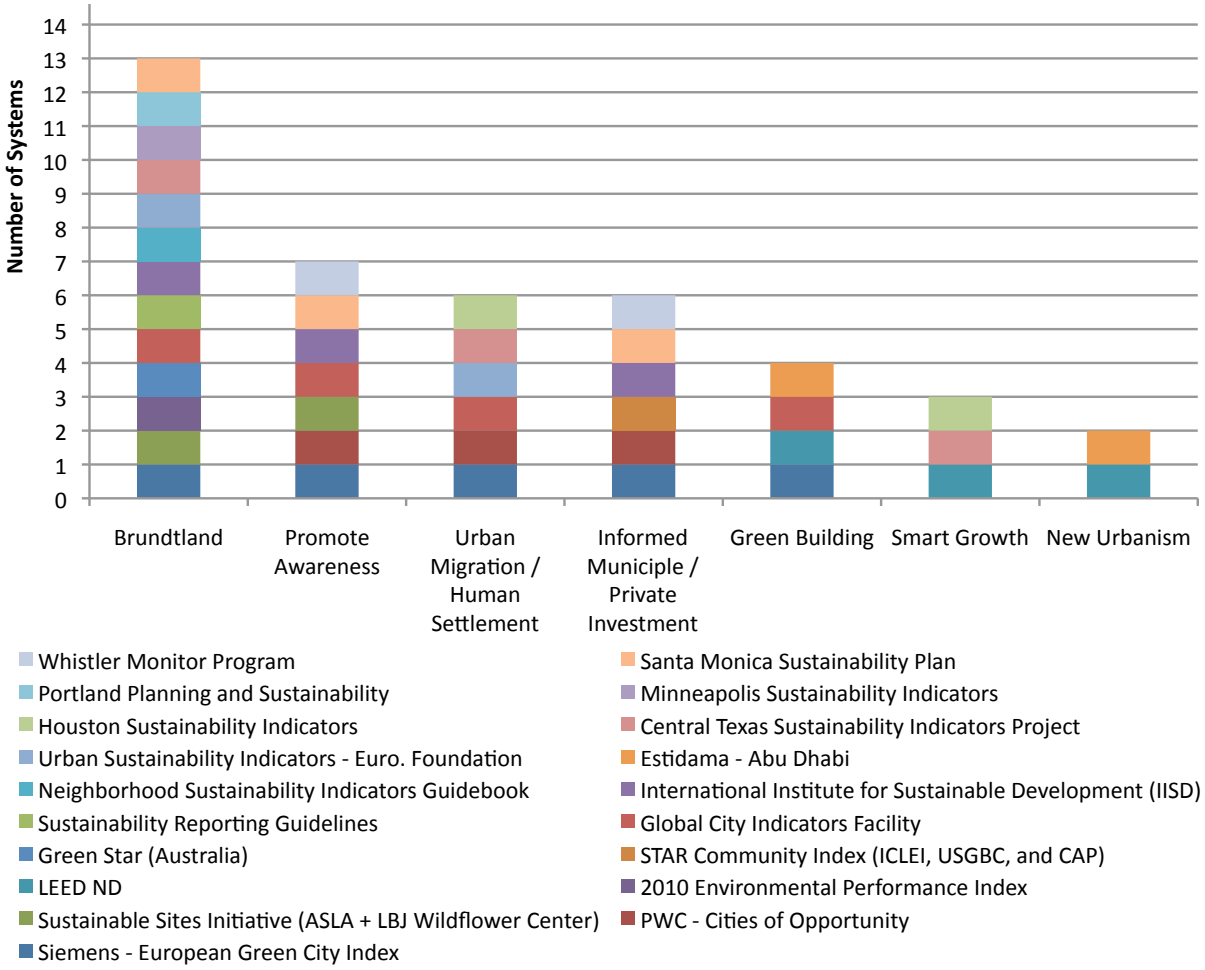
Figure 2. Scale of 19 Sustainability Indicator Systems.



Each of the indicator systems identified measures sustainability or sustainable development, but since sustainability has a variety of definitions it is important to understand the principles or actions that each organization ascribes it. The most commonly cited interpretation, noted by 13 of the groups, is that of the Brundtland Commission, which emphasizes intergenerational equity.

Promoting civic awareness, responding to urban migration pressures, and informing municipal investments were also cited by six or seven systems each (figure 3).

Figure 3. Facets of Sustainability Supported by 19 Sustainability Indicator Systems



Note: Number of systems does not add up to 19 as most systems support multiple facets/interpretations of sustainability.

Since goals are the major drivers of indicator selection, understanding their trends provides insight into possible consensus as to what sustainability indicators should be measuring. In this area, there is significant difference among the three dimensions of sustainability (environmental quality, economic opportunity, and social wellbeing). The environmental quality dimension has the most consensus, while the social wellbeing dimension has the least. Three categories of environmental goals – air pollution, environmental stewardship, and water quality/quantity – appear in at least 17 of the 19 systems (Figure 4). Contrarily, no social goal appears in more than nine systems, with the majority noted by fewer than five (Figure 5). The other area of

divergence is breadth. Both the environmental quality and social wellbeing aspects have more goals than the economic opportunity dimension, which – among all 19 systems – has only seven (Figure 6). But even with only seven categories of goals, there is little consensus within the economic dimension. Like the social dimension, no goal appears in more than nine systems. Some of the difference is due to the prevalence of environmental goals overall. While all identified systems have several environmental goals, fewer have multiple social goals, and even fewer more than one economic goal.

Figure 4. Environmental Quality Goals Identified by 19 Sustainability Indicator Systems (Diagram by John Robinson 2010)

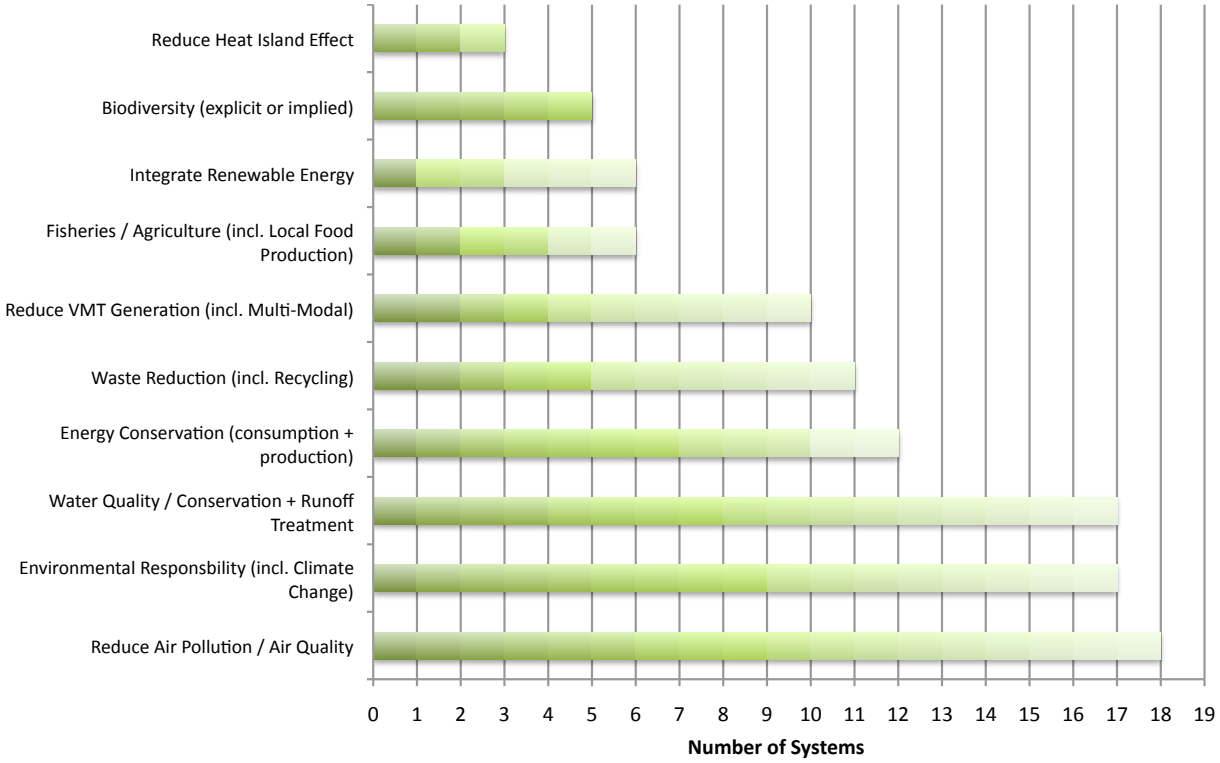


Figure 5. Social Wellbeing Goals Identified by 19 Sustainability Indicator Systems (Diagram by John Robinson 2010)

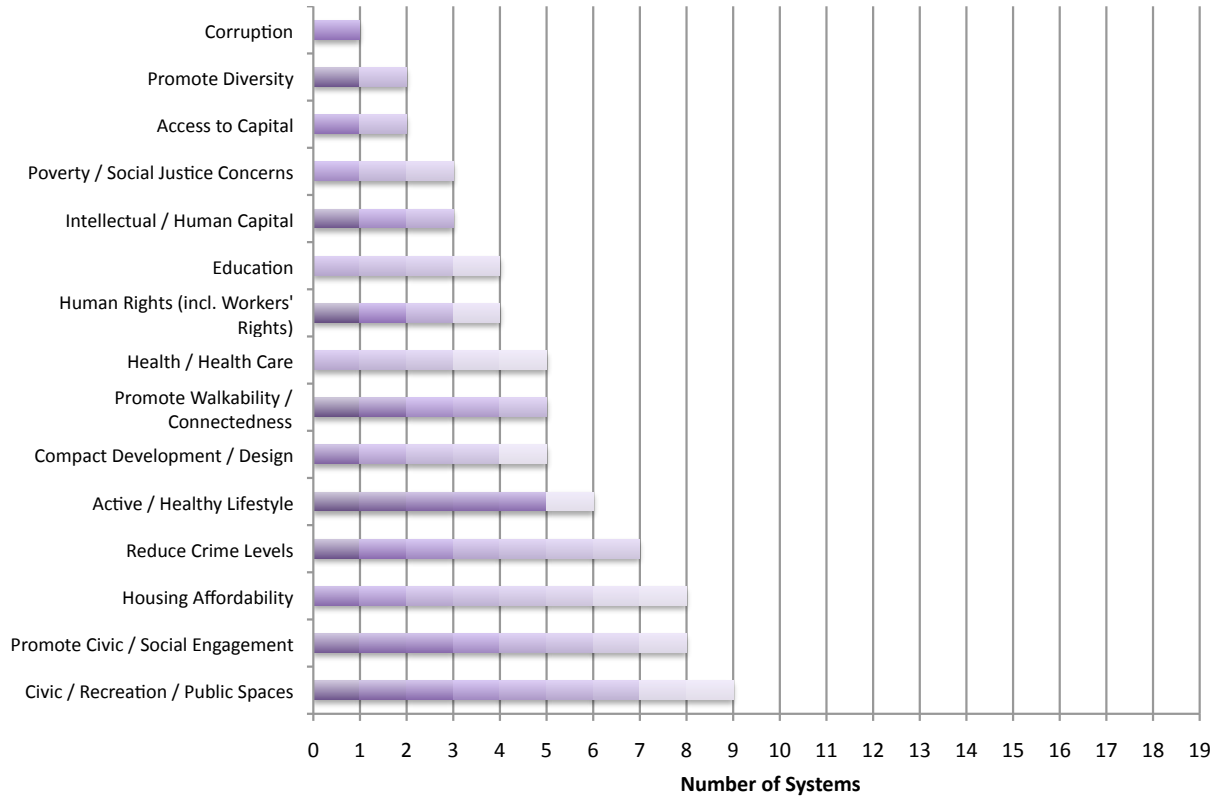
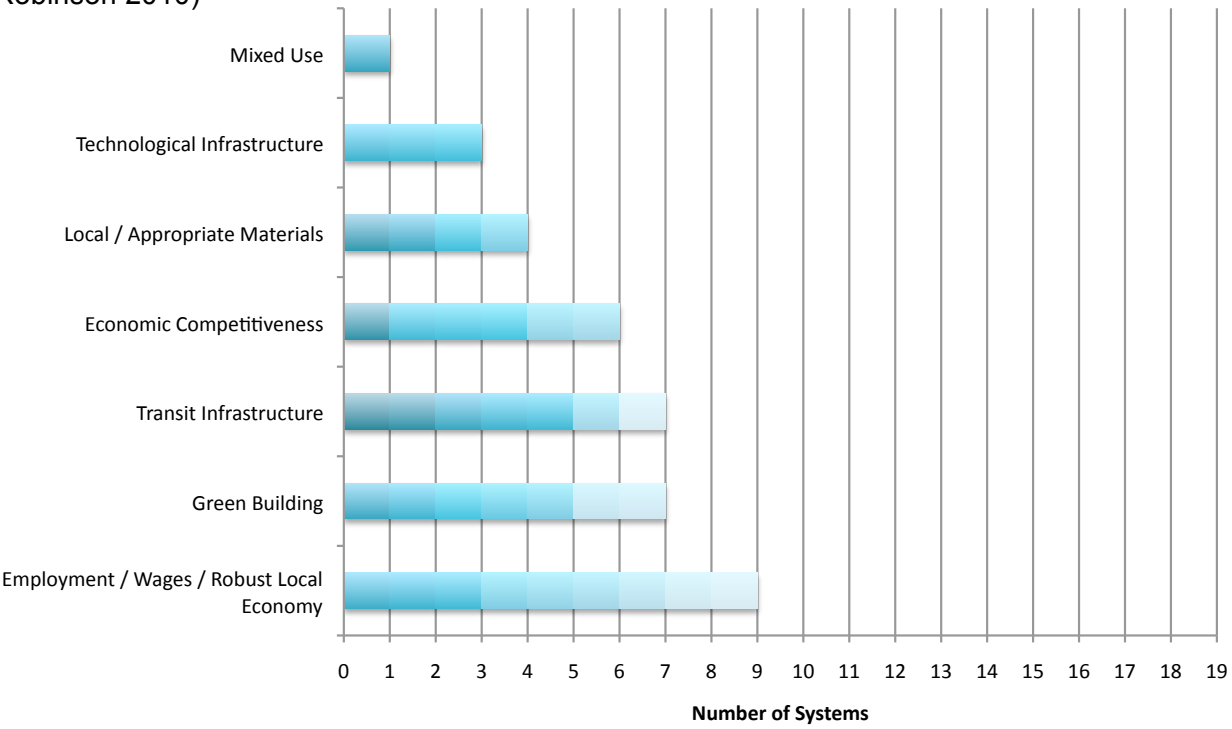


Figure 6. Economic Goals Identified by 19 Sustainability Indicator Systems (Diagram by John Robinson 2010)



In addition to environmental, economic, and social goals, a number of indicator systems identified cultural goals, a category not included in the SUD Working Group framework. The most common cultural goals among the 19 indicator systems relate to 'place making and the public realm,' 'cultural employment opportunities,' and 'connection to nature.'

VI. Compiling a Database of Existing Indicators

In August 2010, the SUD Working Group set a goal of "scan[ning] North American indicators and outcomes which evaluate successful sustainable urban development and revitalization strategies" and noted the importance of 'not reinventing the wheel' in creating a new indicator system. Consequently, the next step for the research team was to examine the indicator systems that the American Planning Association had identified, and compile a database of their composite indicators. The process had three steps: 1) compile a list of all indicators used in the 19 systems, 2) remove or combine duplicate indicators, and 3) apply the SMART framework.

Compiling the List

With the rich amount of information that could be drawn from the APA list, a key challenge was determining how to properly organize specific indicators so as to understand the trends and relationship to the framework identified by the SUD Working Group. The Working Group had given the previously mentioned specifications: adhere largely to political jurisdictions, (i.e. cities); be informed by international research and understandings, but tailored to North American needs; and apply broadly, to American cities and metropolitan areas of all sizes and locales, but many other considerations were also important. As such, the first step was to determine how many different sustainable development indicators are encompassed in the APA list and examine their qualities. In this first cut, researchers asked key screening questions: Does the system have actual indicators? (Or just goals/objectives? Just benchmarks?) At what scale does the indicator system operate? To what degree has the system been implemented? (Is it merely theoretical or has it been applied, if so, how much and where?)

The initial scan yielded a list of 377 indicators, which when subjected to the questions noted above was further reduced. Excluded 'indicators' were those reexamined and found to be overly broad (i.e. goals) or very specific (i.e. benchmarks) and not appropriate for the purposes of this project. In total, the research team identified 304 indicators, including 137 environmental indicators, 116 social indicators, and 51 economic indicators. But significant duplication

remained in the list, and a number of indicators which did not meet criteria identified in the literature, most critically the SMART framework.

Removing Duplication

As a second cut, the researchers created a database of indicators without duplication. Removing duplication was not always straightforward, so researchers erred on the side of inclusion. For example, a metric in common use is homelessness. While several indicator systems use this convention as a means of understanding the needs of the local population, the research team included a single instance of this indicator – rather than adding each separate instance of the indicator to the database. However, where measurement or orientation of the indicator was different, variations were included. Returning to the homelessness example, while an indicator measuring the number of homeless persons per 100,000 population and one measuring the percentage of the population that is homeless would be combined, if a third indicator measured the number of homeless persons receiving city services, it would be retained as a separate indicator. While there was little duplication within indicators in the economic dimension, there was a significant amount in the environmental and social dimensions, particularly relating the air and water quality, and health and education.

Finding the SMARTest Indicators

The acronym SMART, put forth by the European Union and Statistical Institute for Asia and Pacific (2007) describes the qualities of a 'good' indicator. Identified during the literature review, the qualities (Specific, Measurable, Achievable, Relevant, and Time-related) were endorsed by the SUD Working Group at its August 2010 meeting. Ultimately the most dramatic cut of the database process, researchers applied the SMART criteria to the 304 database indicators. While most of the indicators were specific and measurable, achievability, relevance, and time-relatedness were common issues. A number of indicators were measurable, but not achievable, meaning they asked for information that could be collected, but to do so would be prohibitively expensive or difficult. In the economic and social dimensions, in particular, many indicators were removed for referencing resource- intensive one-time surveys. Some indicators were also irrelevant, given the goals of the project. Interpreting the time-related criterion proved more of a challenge, but researchers liken it to timely, that is whether an indicator is based upon current, continuous data that can be tracked over time, as opposed to old surveys or databases. Several indicators were based upon surveys in magazines such as Fortune or Readers' Digest,

which are released periodically, but rarely up to date. Examples of indicators that were removed, and the reasoning are:

Indicator	Description	SMART?	Rationale
Local Consumption	Percentage of residents consuming food produced within 150 miles	No	Not Achievable
Green Cities Ranking	City's score/rank in Reader's Digest's 2007 Green Cities Index	No	Not Time-Related
Fire Services	Number of Firefighters per 100,000 population	No	Not Relevant

Applying the SMART criteria reduced the number of indicators in the database by more than 50%, for a total of 145. Of the 145 indicators remaining, 36 were economic, 49 environmental, and 60 social. Notably, the SMART criteria were the final cut performed on the database of indicators. Remaining actions – discussed below – organize and analyze the indicator list, but do not further reduce it. The database of indicators resulting from this work has 145 indicators (See Appendix C).

VII. Organizing and Analyzing the Database: Single vs. Multi-element Indicators

As noted in the literature, and by members of the SUD Working Group, indicators are subjective to their purpose, and must be linked to goals or, as in this case, a framework. The conceptual frame for this project, the SUD Framework, encompasses the SUD Working Group's interpretation of sustainable urban development and includes three dimensions of sustainability (environmental quality, economic opportunity, and social wellbeing). Each of the dimensions has six or seven associated elements (figure 7). If a core set of indicators is to meet the goals of the SUD Working Group, it must provide information on all elements of the framework.

Figure 7. Sustainable Urban Development Framework (SUD Working Group 2010).

Dimension of Sustainable Urban Development	Elements Necessary for Sustainable Urban Development:
Social Wellbeing	Health Safety Local or civic identity/sense of place Access to decent – affordable – housing and services Access to public recreation and open space Access to a variety of transportation options
Economic Opportunity	A diversified and competitive local and regional economy Transportation and other infrastructure coordinated with land use Growth plans that leverage existing assets Access to capital and credit Access to education, jobs, and training
Environmental Quality	Efficient land use Efficient resource use Waste/pollution minimization and management Climate change and natural disaster mitigation, adaptation, and resilience Carbon efficient, environmentally sound, transportation A diverse natural environment and functional ecological systems

Having created a database of 145 indicators, the next step for researchers was to understand how well the list covered the framework. The big questions for this analysis were, 1) is there at least one indicator related to each of the 20 elements? and 2) how much selection/variety is there within the indicators that cover each element?.

However, the SUD Working Group also requested a small number of indicators, and supported the idea of a 'lean and mean' set. A 'lean and mean' set of indicators is one that provides the most information with the fewest measures. One way to do this, while comprehensively covering the SUD Framework, is to select indicators that relate to multiple elements. The strategy raises a third question for this portion of the analysis: which indicators cover multiple elements and which relate to only one?

To answer the three questions, and further understand which of the database indicators has the greatest potential for inclusion in a standard set of sustainable urban development indicators, researchers identified the elements to which each indicator is related and whether each indicator is "single element" or "multi-element." The following sections describe those results, by dimension.

Environmental Quality

Indicators focusing on environmental quality represent the largest set of the three dimensions of sustainability, 49 individual indicators (See Figure 5). More than half of all environmental indicators in the database provide information on 'waste/pollution minimization and management' (31), 'efficient land use' (27), and 'climate change and natural disaster mitigation, adaptation, and resilience' elements, but only slightly fewer relate to 'efficient resource use' (23), 'carbon efficient, environmentally sound transportation' (22), and 'a diverse natural environment and functional ecological systems' (21) (Figure 8). Coverage of the environmental quality dimension of the SUD Framework is comprehensive; the element with the least coverage relates to 21 individual indicators. The main reason coverage is complete is the large number of multi-element indicators. Of the 49 environmental quality indicators, only five are single-element. The remaining 44 provide information on two to four elements of the SUD Framework. Likely due to interrelationships between environmental systems and between elements identified by the SUD Working Group, there are far more multi-element indicators in the environmental quality dimension than the other two dimensions of sustainability.

Figure 8. Coverage of Environmental Quality SUD Framework Elements by Single- and Multi-Element Indicators.

	Environmental Quality Framework Element					
	Efficient Land Use	Efficient Resource Use	Waste/ Pollution Minimization	Climate Change	Efficient Transportation	Diverse Natural Environment
Single Element Indicators	0	1	2	0	0	2
Multi-Element Indicators	27	22	29	25	22	19
Total Number of Indicators	**27**	**23**	**31**	**25**	**22**	**21**

Note: Figures show the number of indicators that provide information on each of the framework elements. Multi-element indicators – those that relate to several elements – are counted multiple times, once for each related element.

Economic Opportunity

There are fewer indicators relating to the economic opportunity dimension of sustainable development than to environmental quality or social wellbeing, a total of 36. Perhaps because of the small number, coverage is uneven. While 15 indicators cover 'a diversified and competitive local and regional economy' and 13 relate to 'access to education, jobs, and training,' coverage of the remaining three is poor (Figure 9). No indicator covers 'growth plans

that leverage existing assets,' and 'access to capital and credit' and 'transportation and other infrastructure coordinated with land use' have six and two indicators, respectively.

Additionally, economic indicators tend to be narrow, targeting specific outcomes. Of the 36 total indicators, only one – performance of banks and thrifts meeting community credit needs according to Community Reinvestment Act ratings – covers multiple elements (i.e. *diversified competitive local and regional economy* and *access to credit and capital*). With almost every indicator focusing on a single element, and only 36 unique, SMART indicators available, this dimension of sustainability will be a challenge, and the list may need to be expanded further before it is narrowed down. Of particular concern is the SUD Framework element 'growth plans that leverage existing assets,' which has no indicators in the database. Following the initial determination that none of the 19 reviewed indicators systems provided an indicator for it, the result was taken to the SUD Working Group. They determined that the element was important part of the SUD Framework, and every effort should be made to cover it. Such an action should be a major objective in further research efforts.

Figure 9. Coverage of Economic Opportunity SUD Framework Elements by Single- and Multi-Element Indicators.

	Economic Opportunity Framework Element				
	Diversified Economy	Coordinated Infrastructure	Growth Plans that Leverage Assets	Access to Capital and Credit	Access to Jobs Education and Training
Single Element Indicators	14	2	0	5	13
Multi-Element Indicators	1	0	0	1	0
Total Number of Indicators	**15**	**2**	**0**	**6**	**13**

Note: Figures show the number of indicators that provide information on each of the framework elements. Multi-element indicators – those that relate to several elements – are counted multiple times, once for each related element.

Social Wellbeing

With 60 indicators, the social wellbeing dimension has the largest number of indicators in the database. Coverage of SUD Framework elements is more even than the economic opportunity dimension, but not as even as the environmental quality dimension. Two elements, 'health' (24 indicators) and 'access to decent – affordable – housing and services' (25) have significant coverage, two others 'safety' (13) and 'local or civic identity/sense of place' (11) have a moderate amount, and two more 'access to a variety of transportation options' (5) and 'access

to public recreation and open space' (7) very little (Figure 10). Unlike the environmental quality dimension, 40 of the 60 social wellbeing dimension indicators are single-element. The difference means that indicators are narrower (i.e. more specific), and even distribution more of a challenge. The two elements with the least coverage, 'access to a variety of transportation options' and 'access to public recreation and open space' have fewer single-element indicators than the other elements, with two and zero, respectively, compared to eight or more. An objective moving forward in the social wellbeing dimension will in deciding whether to fill the transportation and public space gaps with new single-element indicators or to increase the overall number of multi-element indicators to raise overall coverage. Since only two elements have more than 15 indicators, the latter may be most sensible, and a good way to increase information on a variety of elements without significantly increasing the number indicators.

Figure 10. Coverage of Social Wellbeing SUD Framework Elements by Single- and Multi-Element Indicators.

	Social Wellbeing Framework Element					
	Health	Safety	Local Identity or Sense of Place	Access to Affordable Housing and Services	Access to Recreation and Open Space	Access to a Variety of Transportation Options
Single Element Indicators	9	8	8	13	0	2
Multi-Element Indicators	15	5	3	12	7	3
Total Number of Indicators	**24**	**13**	**11**	**25**	**7**	**5**

Note: Figures show the number of indicators that provide information on each of the framework elements. Multi-element indicators – those that relate to several elements – are counted multiple times, once for each related element.

Takeaways from Dimension/Element Analysis

Understanding the degree to which indicators in the database cover the SUD Framework is critical in creating a comprehensive indicator system. This analysis, which included indentifying which of the 145 indicators are single-element and which are multi-element, shows significant variation between dimensions. While the 49 environmental quality indicators comprehensively cover associated elements of the SUD Framework, the 60 social wellbeing indicators do not. The difference is the number of multi-element indicators. The majority (90%) of environmental quality indicators relate to more than one element, while only one-third of social wellbeing indicators do. In short, if indicators are narrow, and provide information on only one element, more indicators are needed to cover the framework. When there are mostly single-element

indicators, even distribution over the elements is critical. In the social wellbeing and economic opportunity dimensions, the uneven distribution over elements (i.e. some elements have many indicators, others have one or none) causes gaps in coverage. In the social wellbeing dimension, two elements have fewer than seven indicators, while others have more than 20. Economic opportunity coverage disparities are even greater; two elements have zero and two indicators, respectively, while others have 13 and 15.

Based upon this analysis, the existing database of indicators does *not* sufficiently cover the SUD Framework. The most obvious gap is in 'growth plans that leverage existing assets,' an economic element for which the research team could identify no indicators. Researchers suggest two possible reasons for this deficit, a lack of clarity in the element – which could be corrected with further guidance from the SUD Working Group – or a lack of consideration by organizations/governments creating the surveyed indicator systems. In addition, there are four more elements that have seven indicators or fewer. The small numbers raise concerns about the breadth of the sample and the likelihood of having a large enough group from which to select. The elements with questionable coverage are: 'access to a variety of transportation options,' 'access to public recreation and open space,' 'access to capital and credit,' and 'transportation and other infrastructure coordinated with land use.'

VIII. Organizing and Analyzing the Database: Sub-elements

Due to the necessary breadth of the SUD Framework elements, there is a significant amount of variation within them. To better understand this intra-element diversity, researchers created a supplemental third tier for the SUD Framework, called sub-elements. Sub-elements (shown below) emerged organically, from natural groupings within the list of existing indicators. The research team returned to the list of 145 indicators, categorized by element, and examined each indicator to understand, qualitatively, the actual facet of each element that the indicator spoke to. Using the different facets, they developed a number of common thematic categories. In a few cases, the team identified several important, but underrepresented or non-represented, sub-elements.

Environmental Quality

1. Efficient land use
- 1.1 Inside Game Actions (e.g. mixed use, high density, pedestrian friendly)
- 1.2 Outside Game Actions (e.g. conservation, rural development restrictions)

2. Efficient resource use
- 2.1 Reduce
- 2.2 Reuse
- 2.3 Renewables

3. Waste/pollution minimization and management
- 3.1 Production
- 3.2 Treatment
- 3.3 Prevention

4. Climate change and natural disaster mitigation, adaptation, and resilience
- 4.1 Mitigation
- 4.2 Adaptation and Resilience

5. Carbon efficient, environmentally sound, transportation
- 5.1 Ratio of Public to Private
- 5.2 Emissions
- 5.3 Non-Motorized Vehicles

6. A diverse natural environment and functional ecological systems
- 6.1 Quality and Diversity of the Natural Environment
- 6.2 Extent/Coverage of Natural Area.

Social Wellbeing

1. Health
- 1.1 Individual Health – Adult Population
- 1.2 Individual Health - Children
- 1.3 Social Justice / Equity
- 1.4 Public Health Measures (e.g., hospitals, insurance)

2. Safety
- 2.1 Property and/or Violent Crime
- 2.2 Crime Factors (e.g. gangs, juvenile data)
- 2.3 Crime Protection Services
- 2.4 Resident Accidents (e.g. vehicular)

3. Local or Civic Identity / Sense of Place
- 3.1 Social Capital*
- 3.2 Civic Engagement
- 3.3 Community Programs
- 3.4 Place Culture*

4. Access to Affordable Housing and Services
- 4.1 Rent Gap / Housing Overhang
- 4.2 Subsidies for Affordable Housing
- 4.3 Access to Affordable Housing
- 4.4 Location Choice / Proximity to Work
- 4.5 Unit Size / Overcrowding

5. Access to Public Recreation and Open Space
- 5.1 Proximity to Public Recreation and Open Space
- 5.2 Condition/Services of Public Recreation and Open Space*

6. Access to a Variety of Transportation Options*
- 6.1 Mode Choice
- 6.2 Proximity to Different Modes
- 6.3 Cost of Choices Relative to Disposable Income
- 6.4 Travel Time to Work

Economic Opportunity

1. A diversified and competitive local and regional economy
- 1.1 Healthy Business and Industry Mix
- 1.2 Growing Community and Individual Wealth
- 1.3 Equal Opportunity and Mobility*
- 1.4 Reasonable Tax and Regulation Costs

2. Transportation and other infrastructure coordinated with land use*
- 2.1 Density and Agglomeration
- 2.2 Infrastructure Assessment and Investment
- 2.3 Travel Times and Time to Move Goods

3. Growth plans that leverage existing assets*

4. Access to capital and credit*
- 4.1 Capital and Credit Flows to Industries
- 4.2 Entrepreneurial Support and New Business Starts
- 4.3 Protection of Assets, Stable Prices, and Stable Economy

5. Access to education, jobs, and training
- 5.1 Access to and Completion of Quality Education and Training
- 5.2 Jobs and Unemployment

* Indicates elements/sub-elements with few or no indicators

The objective of this analysis/categorization was to understand the breadth of each element and ensure that any selected indicators would cover not only each element, but each facet of each element. For example, twenty indicators covering the element 'efficient resource use' are not enough if they all relate to the same sub-element. But if those twenty are spread across the three sub-element categories of 'reduce,' 'reuse,' and 'renewables,' coverage is more comprehensive.

Sub-element categorization helped the team to understand what groups of indicators existed in each element and how well indicators spoke to the elements provided by the Working Group. Where the number of indicators was sufficient, such as most of the environmental dimension, sub-elements developed from natural groupings of indicators within each element. When the number of indicators was not sufficient, as was the case in parts of the social and economic dimensions, sub-elements were inferred from indicators that *did* exist and researchers' knowledge of the field. But, since the character of existing indicators within each element were the main factor in designating sub-elements, where there were no indicators, as was the case with 'growth plans that leverage existing assets,' sub-elements could not be determined.

Results from Sub-element Analysis

Sub-elements show the breadth and diversity of indicators within elements and provide a better understanding of the types of indicators within each element. They allowed researchers to identify the types of indicators missing from inadequately-addressed elements and were particularly useful for the economic and social dimensions, where coverage of elements is uneven.

In the economic dimension, in addition to the lack of indicators under 'growth plans that leverage existing assets,' many indicators are intended to analyze business climate, but do not describe economic diversity. Additionally, existing indicators emphasize human capital and average business climate (GDP, median earnings, etc.) and are not fine grained enough to provide sufficient coverage of SUD Framework elements, much less sub-elements.

Categorization into sub-elements was most useful for the social dimension where there are many indicators, but coverage of elements is uneven. Researchers identified three elements with uneven or insufficient indicators, 'local or civic Identity/sense of place,' ' access to public

recreation and open space,' and 'access to a variety of transportation options.' In 'local or civic identify/sense of place' few indicators spoke to how people interact with each other and their environment. The major sub-element gaps were in social capital / social cohesion and sense of place. For the 'access to public recreation and open space' element, indicators were all one-sided, none relates to the quality and condition of open space, which is also an important aspect of access. The 'access to variety of transportation options' element contains only four indicators, not enough to confidently group into sub-elements. Probable sub-elements are mode choice, proximity to different modes, cost of choices, and travel time to work.

Takeaways from Sub-element Analysis

Identifying and examining sub-elements emphasized results from previous sections of analysis, but with a greater degree of specificity. Within the economic dimension, more indicators are needed for equal opportunity and mobility, density and agglomeration, infrastructure assessment and investment, travel times and time to move goods, capital and credit flows to industries, entrepreneurial support and new business starts, and protection of assets, stable prices, and stable economy. There are fewer inadequately covered sub-elements within the social dimension, but significant gaps do remain. The clearest needs are in social capital / social cohesion and sense of place, which are notoriously difficult to measure. But results also suggest transportation-related indicator deficiencies, in categories such as mode choice, proximity to different modes, cost of choices relative to disposable income, and travel time to work. These economic and social dimension categories can provide guidance in expanding the list of indicators and ensuring that it comprehensively covers the SUD Framework.

IX. Organizing and Analyzing the Database: Pressure/State/Response

With the final organization/analysis tool, the research team moved from the *subject* of indicators, to their *type.* As discussed in the preceding sections, indicators provide information on the dimensions, elements, and sub-elements that comprise the Working Group's SUD Framework. Those areas are their subjects. But there are different formats of indicators; that is, different types of indicators that measure the same dimension, element, and sub-element, just at different points in the chain of cause and effect.

An indicator provides information at one of three different points and can accordingly be classified as 'pressure,' 'state,' or a 'response' (Figure 11). A pressure indicator measures something that is happening, an action that that may threaten sustainability. Pressures are

usually activities that would best be minimized to enhance the sustainability of development. They are pressures on a system. A state indicator measures the current, on-the-ground condition. State indicators are most often numeric, and show the state of the aspects of a community that relate to sustainability. A response indicator measures actions that have been taken. Plans and programs *respond* to undesirable *states* or *pressures*. Response indicators measure those actions.

Figure 11. Pressure/State/Response Typology

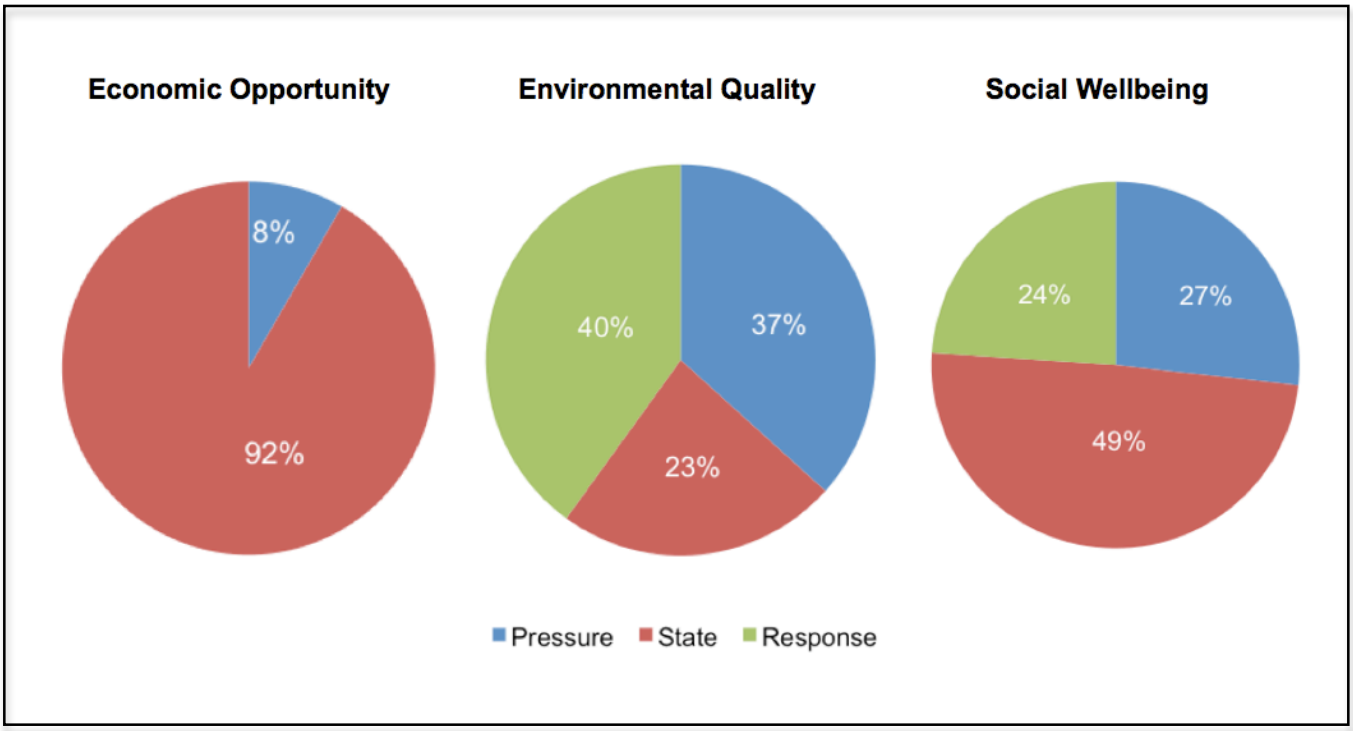
Source: Adapted from the Statistical Institute for Asia and Pacific (2007).

Paying attention to which types of indicators are included in a system is important, since different types of indicator systems are sensitive to different actions. For example, a state-oriented system is sensitive to any action that moves the needle in the areas of interest (air quality, jobless rate, etc) while a response-oriented system responds only to actions specifically identified in indicators (green buildings constructed, job trainings performed), missing anything not previously specified and overlooking the benefits of the innovative or unexpected. Response-oriented systems may also be of limited duration and must be updated frequently with new programs to remain relevant.

In this portion of the analysis, the research team assessed whether each existing indicator could be categorized as pressure, state, or response. Some straddled two different classifications and were difficult to determine. In such cases, researchers used their best judgment, and as much consistency as possible, to determine which was most appropriate. The final determination was usually related to the objectives of this research and to the time-frame in which the indicator is important. For example, 'student math scores' is an indicator in the economic dimension. As it measures the status of students' math comprehension, it could be considered a state indicator. In an education study, it probably would be. But in thinking about long term sustainable urban development and communities' ability to be competitive, low math

and reading scores is a pressure, a threat to economic success that could have significant consequences in the years to come. Additionally, knowing the reading and math scores of students does not indicate the current economic success of a community, it indicates how it might be in the future. As such, researchers classified 'student math scores' as a pressure rather than a state indicator.

Figure 12. Pressure, State, and Response Variables by Dimension



Takeaways from Pressure/State/Response Analysis

Breakdown of the indicator database by pressure, state, and response variables shows significant differences between dimensions (Figure 12). The economic dimension had no response variables, perhaps due to a reluctance to prescribe economic solutions. The social dimension saw a high number of response indicators, which may be due to the challenges associated with measuring the pressures on, or state of, socially sustainable development. The environmental dimension saw the most even coverage, but – due to a large number of program and intervention indicators – was skewed slightly toward response.

In looking forward to selecting between indictor types, a main consideration is the level of objectivity. State indicators, which measure the status of key systems, appear to have the most promise. Pressure indicators may also be useful, but since there is often no way to link a pressure to a certain sustainability outcome, they are most useful in well-known areas of sustainability where there is a robust body of literature that identifies key pressures and their impacts. Response indicators provide programmatic guidance, and could be particularly useful for small municipalities, but are problematic for other reasons. Most critically, they are highly prescriptive. While actions may be effective in one city, transferability is always questionable. Response indicators, in measuring programs, also encourage communities to follow standard responses rather than innovate. As a result, this analysis suggests that an indicator system should be comprised primarily from state indicators, with any supplemental pressure and response indicators chosen very carefully to address key issues and incentivize effective and well-understood response strategies.

The indicator database includes a large number of state indicators, suggesting that organizations developing sustainable development metrics also see the merit in state indicators and that creating a state-oriented system would not be difficult. Challenges are more likely to come in supplementing the system with key pressure or response indicators. While state indicators are most useful for objectively measuring progress, response indicators are important in guiding the actions of local governments. If an indicator measures the number of green buildings in the municipality, that municipality understands that green buildings are an important component of the government's interpretation of sustainable urban development. A few response variables underscore the importance of key programs. But, in the social and economic dimensions there are few response variables. Given the economic climate, it is unsurprising that no organizations chose to make economic prescriptions, but without those types of variables, the system lacks guidance.

X. A Second Conceptual Framework: HUD/EPA/DOT Livability Principles

This research began with one conceptual frame, the SUD Framework, created in August 2010 by the SUD Working Group. But given that the work has a dual objective of providing communities a way to track their progress toward sustainable urban development *and* providing a tool for governments to assess policy and grant results, by January 2011, a second framework emerged. The Partnership for Sustainable Communities, a group comprised of representatives from the Department of Housing and Urban Development, Department of Transportation, and

Environmental Protection Agency, crafted the Livability Principles in 2009 as part of the group's initial work. The six principles articulate the federal government's view of US sustainable development, making them a useful expression of the operationalized sustainable development paradigm currently in use in the United States. The principles are particularly appropriate for this project as they are community-oriented. They are designed to bring sustainable development down to the local level and to make it more accessible.

Fulfilling the original purpose of the Working Group (to demonstrate the progress that American cities are making toward sustainable urban development and inform supportive policy, planning and investment) requires reducing the database of 145 indicators to a manageable number while ensuring coverage of the project's goals and conceptual frame. Through dialog with experts on indicator systems, some of whom are participants in the SUD Working Group, researchers have come to understand that all indicator systems are subjective to their purpose. So, in expanding the conceptual framework to include the Livability Principles, a value set established by the federal government for use in local programs, researchers were merely recognizing that an intended audience for the recommended list of indicators is federal agencies evaluating community progress. While the SUD Framework and HUD/EPA/DOT Livability Principles both describe key facets of sustainable urban development, the two have different approaches. The Working Group Framework is comprised of a list of elements necessary for sustainable urban development and is divided into three dimensions: environmental quality, economic opportunity, and social wellbeing. The Livability Principles, however, are six, descriptive, action-oriented statements.

With the understanding that creating an indicator system that speaks to the two conceptual frameworks requires bridging the systems, researchers began by identifying thematic connections (Figure 13). Themes from the Livability Principles were connected with SUD Framework elements (see below). Since a new indicator system must comprehensively address *both* frameworks, researchers then matched database indicators with the themes and elements to assess synergy and coverage.

Figure 13. HUD/EPA/DOT Livability Principles and themes identified by researchers.

Livability Principle 1: Provide more transportation choices.
Develop safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health.

Themes Identified by the Research Team:
1) Commute mode/mode share
2) Commute time/VMT
3) Carbon emissions

Livability Principle 2: Promote equitable, affordable housing.
Expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.

Themes Identified by the Research Team:
1) Housing affordability
2) Equity in housing
3) Housing energy efficiency

Livability Principle 3: Enhance economic competitiveness.
Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well as expanded business access to markets.

Themes Identified by the Research Team:
1) Educational attainment
2) Agglomeration
3) Access to credit and capital

Livability Principle 4: Support existing communities.
Target federal funding toward existing communities—through strategies like transit oriented, mixed-use development, and land recycling—to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes.

Themes Identified by the Research Team:
1) Supporting/revitalizing exiting urban areas
2) Promote compact development
3) Conserve and wisely use our natural resources
4) Ensure a clean, healthy, and functional natural environment.

Livability Principle 5: Coordinate and leverage federal policies and investment.
Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy

Themes Identified by the Research Team:
1) Renewable/locally generated energy
2) State and federal support for local planning efforts

Livability Principle 6: Value communities and neighborhoods.
Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods—rural, urban, or suburban.

Themes Identified by the Research Team:
1) Health
2) Safety
3) Sense of place

Researchers connected Livability Principle themes and SUD Framework elements with indicators from the database to create the Sustainable Urban Development Indicators Matrix (SUDI Matrix). As shown in Appendix D, the first column of the SUDI Matrix includes the Livability Principle Theme and the second shows related SUD Framework elements. Organized in this way, the diagram displays a strategy for narrowing down the number of indicators to a more manageable number while ensuring coverage of both conceptual frameworks. There are 18 Livability Principle themes, if each has one or - if absolutely necessary - two indicators, a final set would have 18 to 20 indicators.

Results and Takeaways from Connection with Livability Principles

The result of this analysis is that there is enough connection between the two conceptual frameworks that a new US indicator system *can* address both. But the work also indicates an area which may be problematic and requires further research: Livability Principle 5, "Coordinate and leverage federal policies and investment." The Principle notes the importance of "align[ing] federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth…" The major themes of this Principle do not clearly align with SUD Framework elements. It is possible the Principle could be adapted to relate to local planning practices, such as comprehensive or strategic planning, but not without deviating from the original intent of the Principle.

XI. Organizing and Analyzing the Database: Multi-Dimensional Indicators

In early versions of the SUDI Matrix, researchers emphasized coverage of SUDI elements and Livability Principle themes. But knowing the degree to which existing indicators cover elements and principles does not speak to the information they provide on broader movement toward sustainability. Literature indicates that true sustainability requires coordination of environmental, economic, and social systems. Consequently, to measure progress toward sustainable urban development, an indicator system should be comprised of multi-dimensional indicators. That is, indicators that relate to - and provide information on - at least two of the SUD Working Group dimensions (environmental quality, social wellbeing, and economic opportunity). Multi-element indicators, the focus of earlier analyses, are not nearly as robust, because the two to four elements on which they provide information could be in the same dimension and unrelated to the broader goal of sustainability, which ultimately involves the balanced *combination* of the

three dimensions. With this in mind, researchers reexamined the indicator database, identifying whether each relates to a single or multiple dimensions of sustainability. Notably, many of the dimension identifications are debatable and can only be considered preliminary, pending SUD Working group confirmation.

Results and Takeaways from Multi-dimensional Indicator Analysis

Literature suggests that the best indicators for measuring progress toward sustainable urban development are those that relate to at least two of the three dimensions, but such indicators – particularly outside the environmental dimension – are far less common than single-dimension indicators (See Appendix D). In all, 50% (72) indicators have some degree of multi-dimensionality with 11 of 36 economic opportunity indicators, 39 of 49 environmental quality indicators, and 22 of 60 social wellbeing indicators relating to multiple dimensions of sustainability. As discussed throughout this research, the database of indicators covers environmental quality more robustly than social wellbeing and economic opportunity, so it is unsurprising that there should be more multi-dimensional indicators in the environmental quality dimension than the other two. If health is considered a facet of 'social wellbeing,' many existing indicators span environmental quality and social wellbeing, but far fewer connect environmental quality & economic opportunity or economic opportunity & social wellbeing. This dearth of bi-dimensional indicators, and the general lack of economic and social indicators, suggests that creating a set of core indicators of sustainable urban development requires going beyond existing systems.

XII. Conclusions and Recommendations

In August 2010, the Sustainable Urban Development Working Group engaged researchers from the University of Pennsylvania's Institute of Urban Research to provide research in support of a standard system of sustainable urban development indicators for the United States. As the first step in that research, the objective of this study is to explore the characteristics of existing indicator systems, examine whether a standard set of sustainable urban development indicators could be drawn or adapted from existing systems, and identify challenges and recommendations in moving forward. Given the small sample of 22 indicator systems and 145 indicators, this work can only be considered preliminary, but results provide guidance for an expanded study. A larger number of indicator systems – and expanded indicator database - in conjunction with the recommendations noted later in this section, and guidance from the SUD Working Group, should move the project toward an appropriate and useful set of indicators.

In keeping with common characteristics of sustainability indicator systems, much of this research was conducted with the three dimensions of sustainable development (environmental quality, social wellbeing, and economic opportunity) separated. As such, each is discussed here, in turn, followed by broader recommendations.

The sustainability movement is rooted in environmentalism, so it is unsurprising that environmental quality indicators are more developed than those of the other two dimensions. While there are more social wellbeing indicators in the final database of 145, existing environmental quality indicators provide better coverage of both the SUD Framework and Livability Principles. Furthermore, multi-dimensional analyses show that coverage environmental-social and environmental-economic connections are more complete than social-economic. However, there are several challenges related to existing environmental indicators and their use in this project. First of all, since the environmental aspect of sustainability is so well developed, there is a long list of indicators from which to choose. With more indicators supported by the literature than can be included in a final, standard system, narrowing the list to a carefully selected few will be a challenge. A second, related, concern is that environmental systems are interconnected and transboundary. Crafting a set of indicators that provide information on environmental systems, but within political-boundaries, and without over-emphasizing commonly measured aspects of environmental quality will be a challenge. And, finally, the Livability Principles do not provide extensive coverage of the environmental aspects of sustainable development. In this work, researchers have inferred that 'communities' mean both natural and manmade, but such interpretations will need to be confirmed and expanded upon to balance coverage of economic, social, and environmental dimensions.

The social wellbeing dimension has the largest number of indicators in the existing indicators database, but coverage of the SUD Framework and Livability Principles is not complete. The vast majority of indicators relate to health, safety, and housing, an emphasis that is unsurprising, since these categories are clearly important and data is easy to obtain. A significant aspect of sustainable urban development that indicators largely fail to address is civic identity and sense of place. Few existing metrics speak to how people interact with each other and their environment. Researchers identified several existing measures in the review for this study, but the majority came from periodic local surveys and were removed as not meeting achievability or time-related criteria. Integrating or crafting metrics that clearly and simply speak to social capital and sense of place, without resource-intensive surveys, and at the municipal –

rather than community – scale will be a challenge. Also in the social wellbeing dimension, existing indicators are weak on accessibility, both through transportation options and to public and open spaces. Accessibility is an important aspect of sustainable urban development, particularly in the social wellbeing dimension, but given the diversity and geographic implications it could prove difficult to find simple metrics. Geographic Information Systems may be necessary to understand accessibility, but not all communities have such capabilities.

With the fewest indicators in the existing indicator database, and slimmest coverage of the SUD Framework and Livability Principles, the economic opportunity dimension of sustainable development poses the greatest challenge moving forward. There is one element in the SUD Framework, 'growth plans that leverage existing assets' for which there are no indicators in the database. The SUD Working Group has confirmed that the element is important but, as yet, there are no related indicators. A similar issue exists with the Livability Principles, where few indicators provide information on agglomeration. A second challenge in the economic dimension is that many existing indicators are intended to analyze business climate and are not sufficient for describing economic diversity. Scale is also an issue. A number of metrics, many of them well-known, emphasize human capital and average business climate (e.g. GDP, median income), but may not be fine-grained enough to capture municipal activities and progress. And finally, the economic data sources that exist are underrepresented in the existing indicator database. For example, well-known sources of occupational data (Bureau of Labor Statistics), firm data (US Census), business/industry data (US Census), and travel time and mode data (US Census) are rarely referenced.

Based upon these challenges, and this study more broadly, the research team has two major recommendations. They are action-oriented and intended to guide the next steps toward a standard set of sustainable urban development indictors for the United States.

Recommendation 1: Expand the survey with a special emphasis on municipal and community metrics

Results show that a large number of indicators are out there, and that a useful indicator system can likely be created from them. But, with only 22 measurement systems under review, only 19 of which have indicators, there is not enough information to discern whether a standard indicator system can be created from existing indicators alone. What is clear is that the 145 indicators

that result from this study are insufficient, particularly in the areas of economic opportunity and social wellbeing. Consequently, the research team's first recommendation is that the survey of existing indicator systems be expanded. With more indicators in the database, researchers can better understand how far existing indicators will carry us and whether supplementary indicators – newly created or pulled from literature – will be necessary. The way in which the scan of indicator systems is expanded will be important. Since the SUD Working Group recommended that indicators adhere to municipal boundaries, city sustainability indicator systems should be the main focus. Community indicator systems could also be useful, since they may be combined or expanded to function at a larger scale and are more likely to include the missing social wellbeing metrics.

Recommendation 2: Focus upon multi-dimensional indicators

An important finding of this study is that multi-dimensionality is critical. The majority of indicator systems separate metrics by dimension (i.e. environmental, economic, social), a characteristic symptomatic of broader issues in the movement toward sustainability. While compartmentalization of dimensions is the norm, literature shows that true sustainability requires coordination of environmental, economic, and social systems. Separation of program areas may be a reason that movement toward sustainable development proceeds slowly. A standard indicator system should be based in recognition that actions that improve environmental, social, *and* economic systems are the most beneficial and that the best indicators for measuring progress toward sustainable urban development are multi-dimensional, meaning they relate to at least two of the three dimensions. However, such indicators are less common than single-dimension indicators, representing only 50% of the 145 indicators in this study. The dearth of multi-dimensional indicators further suggests that creating a set of standard indicators of sustainable urban development requires expanding the scan, as discussed in recommendation 1. But orienting the system around multi-dimensional indicators may also require a new conceptual framework, one that is based upon the SUD Framework and Livability Principles, but oriented toward dimensional coordination.

Bibliography*

Bauer, Raymond (1967). Social indicators. Cambridge, MA: M.I.T. Press.

Bell, Simon & Morse, Stephen (2008). *Sustainability Indicators: Measuring the Immeasurable?* 2nd ed. Earthscan Publishing. London.

Birch, Eugenie. and Amy Lynch (2011). Sustainable Development Indicators, State of the Art and Congruence with U.S. Department of Housing and Partnership for Sustainable Communities, Draft Progress Report to U.S. Department of Housing and Urban Development Office of International and Philanthropic Innovation and the Sustainable Urban Development Indicators Working Group, July.

Hak, T. and B. Moldan, A.Dahl, Eds. (2007). Sustainability Indicators: A Scientific Assessment. Washington, DC: Island Press.

Hametner, Markus and Reinhard Steurer (2007). Objectives and Indicators of Sustainable Development in Europe: A Comparative Analysis of European Coherence. ESDN Quarterly Report, December 2007.

Lynch, Amy (2010). Sustainable Urban Development Indicators: Purpose and Framework Summary, August 26 Meeting. Washington, DC.

Lynch, Autumn (2010). Global Sustainable Urban Development and Revitalization Initiative Working Group Meeting Minutes, July 16. Ford Foundation Headquarters, New York.

United Nations (2007). Indicators of Sustainable Development: Guidelines and Methodologies. Third Edition. New York: Division for Sustainable Development.

University of Missouri Extension (2000). Benchmarks & Indicators. July 7. Retrieved September 25, 2010, from http://extension.missouri.edu/about/fy00-03/Benchmark.htm

*Literature review bibliography in Appendix B.

Appendix A. Sustainable Urban Development Indicators Scan

Prepared by the American Planning Association
September 2010

Introduction

In July 2010, the White House Office of Urban Affairs, Department of Housing and Urban Development, and the Ford Foundation convened a meeting of sustainability and urban development experts at the Ford Foundation headquarters in New York City. A follow up meeting was held at HUD headquarters in August. Following the two meetings, the University of Pennsylvania and the American Planning Association agreed to collaborate on a scan of sustainability indicator programs. The University of Pennsylvania focused on characteristics of good indicators, while the American Planning Association researched how indicators are used in professional practice.

Survey Methods

The researchers at the American Planning Association reviewed several characteristics of professional indicators including:

Structure

Is the indicator system developed and promoted by government, private, domestic, or international interests?

Design

Who administers the system, how is data collected, and what is the focus (environment or broader)

Time

When was the indicator system started? How long does it take to rate? What have the results been?

Scope

What is the geographic area that the indicators look at? Do publications/ratings come out of the indicator? What is the size of audience?

Starting points:

The working group that met in New York and Washington started with several common definitions of sustainable urban development, including that of the Brundtland Commission of the United Nations. In 1987, the Brundtland Commission of the United Nations proposed now common definition of sustainable development: “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

In Washington, the working group updated this definition based on what it deemed important in 2010. The working group definition read:

> Sustainable communities are those that flourish because they are governed in a responsible and responsive manner and build a mutually supportive, dynamic balance between social wellbeing, economic opportunity, and environmental quality” within a larger global framework of sustainable development.

This definition was adapted from The President's Council on Sustainable Development, 1997).

Background Information on Indicator Systems

Indicators from Organizations
American Society of Civil Engineers
http://www.asce.org/ProgramProductLine.aspx?id=7085

The American Society of Civil Engineers defines sustainable development as "the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development."

Sustainability is defined by ASCE as "a set of economic, environmental and social conditions in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely, without degrading the quantity, quality or the availability of natural resources and ecosystems." Since 1996, the ASCE Code of Ethics has guided members to work in concert with the "principles of sustainable development." Although, ASCE has adopted a 2006 policy of supporting the UN Millennium Declaration goals as they apply to improving the quality of life through science and engineering, a July 2010 policy outlining the role of the civil engineer in sustainable development views sustainable development solely as environmentally-conscious development as opposed to the broader definition.

European Foundation for the Improvement of Living and Working Conditions (Eurofound)-
http://www.eurofound.europa.eu/pubdocs/1998/07/en/1/ef9807en.pdf

In 1998, Eurofound developed a set of categories and indicators that could be employed in developing an index for European cities. The indicators proposed are grouped by themes of indicators: environmental indicators; local quality of life linked to global considerations; "key elements of sustainability" (such as social justice, housing, urban safety and citizen participation); quality of spaces promoting public health, social life, and cultural identity; and a unique sustainability indicator to each locality. Each indicator is scaled dependent on its nature being relevant at a territorial level, a city level, or a neighborhood level. Despite creating a collection of indicators, Eurofound stopped short of creating that index for various reasons related to scaling the various indicators based on ambiguities of sustainability as well as because of differences in ways in which the public scales the various indicators. Additionally, Eurofound cites the limited amount of local data on information on city-generated problems linked to the global environment, such as emissions outside of CO_2, which affects the comprehensiveness of certain measured indicators.

Global City Indicators Facility
http://www.cityindicators.org/

The Global City Indicators Facility was initially funded by The World Bank and allows for cross-comparison of over 100 participating cities across the globe based on 22 themes. These themes are grouped under two broad categories, and each theme represents a measure of various indicators. The categories and corresponding themes are: city services (education, energy, finance, fire and emergency response, governance, health, recreation, safety, solid waste,

transportation, urban planning, wastewater, and water) and quality of life (civic engagement, culture, environment, shelter, social equity, and technology). Participating cities agree to submit data to be compiled in the database, which is centralized on the Global City Indicators website. There are currently plans to broaden indices on themes of economy, energy, environment, governance, recreation and culture, social equity, subjective well-being, transportation, technology, and water. The program is managed by the University of Toronto.

LEED-ND
http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148

This rating system is an extension of the US Green Building Council's Leadership in Energy and Environmental Design. Where the LEED certified buildings were at a smaller scale, LEED-ND is a more holistic approach to neighborhood design. Measures take into account smart locations, walkability, and compact design. It was designed in collaboration with the Congress for the New Urbanism, and Natural Resource Defense Council.

This rating system seems a little too micro in scale and looking at how to make planned developments more "sustainable." Even though it is looking it neighborhoods, the other indicator indexes here are more helpful since they are focused on city and municipality scales.

Price Waterhouse Cooper – Cities of Opportunity
http://www.pwc.com/us/en/cities-of-opportunity

The Cities of Opportunity report examines 21 cities worldwide based on 58 variables, each weighed equally, used to measure area categories such as finance, commerce, sustainability, culture, etc.. Cities were chosen once identified as capital market centers, as being distributed over a broad geographic sampling, and as balanced between mature and emerging economies. For the overall ranking as well as for the rankings within each category, cities were scored on each indicator 1 (lowest) through 21 (highest). The resultant high score across all indicators or only those in a category allowed for the cities to be ranked. In measuring sustainability, the report aggregated scores based on the "green cities" composite index, air quality, recycled waste, green space as a percent of city area, and city carbon footprint. Based on these measures, the 2009 report identifies the top five cities for sustainability as Stockholm, Sydney, Frankfurt, Toronto, Paris, and London.

STAR Community Index
http://www.icleiusa.org/programs/sustainability/star-community-index

The STAR Community Index, which is scheduled to be launched in 2010, seeks to be a universal evaluation of sustainability and livability in U.S. communities that will be measured through economic vitality, environmental stewardship, and social responsibility. The index, which is modeled after the U.S. Green Building Council's LEED system, is being developed through a partnership between ICLEI –Local Governments for Sustainability, the Center for American Progress, and USGBC. Because of its anticipated universality and scalability, the index is anticipated to allow communities to identify success model programs and innovations with the overall goal of improving sustainability.

The World Bank (Independent Evaluation Group
http://www.worldbank.org/oed/

Sustainable Development
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSDNET/0,,menuPK:4812133~pagePK:64885066~piPK:4812134~theSitePK:5929282,00.html

The World Bank views sustainable urban development in the context of and in line with its mission of poverty amelioration and reduction. The November 2009 Urban and Local Government Strategy, which declares this decade the "Decade of the City," seeks to leverage urban development as a means of improving the lives of the urban poor as well as a means of addressing the root sources of inefficiency and pollution that are causes of climate change. The strategy proposed five business lines around which to build this strategy:

- Focusing on the core elements of the city system: City management, finance, and governance
- Making pro-poor policies a city priority: Reducing urban poverty and upgrading slums
- Supporting city economies: Cities and economic growth
- Encouraging progressive urban land and housing markets: Urban land, housing, and planning
- Promoting a safe and sustainable urban environment: Urban environment, climate change, and disaster management

Indicators from Individual Cities
Houston Sustainability Indicators
http://www.houston-indicators.org/

Houston Sustainability Indicators is an online resource to compare different communities in Houston. The (private?) consulting group, Blueprint Houston, has compiled "citizens' goals," which guided the creation of the indicators. Smart Growth, New Urbanism, and Transit Oriented Development also influence the structure of the indicators. There are three sections (Social, Economic, and Environmental) inform urban planning efforts for the city to undertake. The indicators are measured by a conducting a Delphi with experts and surveying the population (e.g. for safety). There are currently 22 indicators.

The study will move into the Data collection and analysis steps, culminating in a robust website and printing of 1000 pamphlets. The indicators will also be measured annually in order to track the progress the city is making.

Minneapolis, MN
http://www.ci.minneapolis.mn.us/sustainability/indicators.asp

Started in 2003, the Sustainability Initiatives are high level measurements, using a three groups of interrelated groups of indicators (A Healthy Life, Greenprint, and Vital Community). More varied indicators than Houston, and have specific targets of where the city wants to move. There are a total of 25 indicators and targets, of which not all are completely formulated.

Two annual reports (since 2005) are conducted measuring these indicators. The Sustainability Report is focuses on the progress the city is making to reach their 25 targets, while the GreenPrint Report is a subset, more narrowly focused on the physical environment.

Four city policies guide municipal actions in order to reach the intended targets, and incorporate other standards such as LEED certification of all new municipal buildings.

The website is very detailed with the results, but are not specific about how the actual reports are administered. The website is also a great resource for learning about how the city views sustainability and how individuals can be involved, benefit from, and support these efforts.

Portland, OR
http://www.portlandonline.com/bps/index.cfm?a=155834&c=41630#Indicators

The Planning and Sustainability Commission will hold its first meeting in October 2010, which will act as an advisor to the city to further the area's ability to become more sustainable. The existing bureau of Planning and Sustainability is implementing many land use changes, planning, initiatives, and actions to promote sustainable practices. Although these programs are efficient and successful, there doesn't seem to be many specific targets and indicators that they are working towards.

Santa Monica, CA
http://www.smgov.net/departments/ose/

In September 1994, the city adopted the Santa Monica Sustainable City Plan, which addressed needs of the community through different goals and strategies. Numerical indicators are rated annually divided into four sets: Resource Conservation, Transportation, Pollution Prevention and Public Health Protection, and Community and Economic Development. The progress report is issued annually and lists the goals, specific indicators and targets and how the city is performing in relation to these issues. There are 8 groups of indicators (each of which have 8-10 indicators), more specific than the broader sets

Annual Report Card (last in 2008) administers different grades for each area of the Sustainable City Plan. The grades are for progress and effort, reflecting the "aggressive targets" set by the city. The grades are based on indicator data and evaluation of progress moving towards each goal.

Seattle, WA
http://sustainableseattle.org/

Started in 1993, Seattle's Regional Sustainability Indicators are a set of 40 indicators (work in progress) that span a wide variety fit into 5 groups (Environment, Population & Resources, Economy, Youth & Education, and Health & Community). Each indicator is well explained on how the information is compiled, depending on the indicator. There is data analysis as well as surveying by outside firms. The problem is that the report has not been updated since 1998.

There is also the B-Sustainable, which tackles sustainability on a regional level with four environments: built, natural, personal, and social. Each environment has four goals, evaluated through 10-12 indicators. The framework was formulated through public participation with the inclusion of many stakeholders and the public. The reports are very detailed and somewhat hard to digest, questions of accessibility to public.

The entire Sustainable Seattle Program is a robust resource of various training, information, and indicator analysis.

Whistler, BC
http://www.whistler2020.ca/whistler/site/allIndicators.acds?context=1967970&instanceid=1967971

The Whistler2020 Monitor Program is a vision that the community of Whistler, BC is moving towards. They have outlined two set of indicators (Core and Strategy), collected by various sources (government databases, surveys, economic information, etc). The organization of the indicators is broken into indicators by priority, strategy, and sustainability objective. There is an abundance of information, data, and charts for the reader. The system seems overly complex and interrelated, for example: Energy Use works into three sustainability objectives, but also links into one strategy, and moving towards a vision. The number of indicators is unclear as it is quite large and overlapping.

International Examples
Green Star Communities (Australia)
http://www.gbca.org.au/green-star/green-star-communities/

The Green Building Council of Australia is a national not-for-profit organization that has compiled this system. The Green Star Communities has compiled a national framework for sustainable communities to establish five national best practice principles for the communities in Australia to follow. Also, there is now a Green Start Communities rating tool that assesses the sustainable communities against the standards. The five principles are:

- Enhance Livability
- Create Opportunities for Economic Prosperity
- Foster Environmental Responsibility
- Embrace Design Excellence
- Demonstrate Visionary Leadership and Strong Governance.

The intent of the initiative is one to institute a common national language and inspire communities to work together to the same trends. The idea of place is also flux in that each community needs to acknowledge their own individuality, but realize the common interest in reaching the same goals.

This system is the first that is highlighting design excellence as an important part of the vision, promoting desirable places with integrated design, as well an increased accessibility. The visionary leadership and strong governance is also a great addition to the overall group of principles.

The rating tool kit is not entirely finalized, but is working to not create an entirely new set of indicators, but look at examples in Australia as well as around the world to compile a list of indicators and ideas of how to rate them.

Broad Sustainable Institutes
International Sustainability Indicators Network –
http://www.sustainabilityindicators.org/about/AboutISIN.html

The ISIN is a large database of various sustainability indicators and bodies that administer rating systems. The network sets to connect sustainability practitioners and increase the visibility of sustainable measurements and indicators. They also convene hold conferences and meetings for the exchange of ideas.

International Institute for Sustainable Development -- http://www.iisd.org/

IISD is a Canadian-based, policy research institute exploring sustainable development. Mostly produce papers and provide a platform for network of sustainability indicators (Canadian sustainability Indicators Network).

Summary

Although many different indicators exist to rate how cities are sustainable, they all focus on similar issues. The major lens these systems look at sustainability tend to group themselves into categories of **environmental, social, economic sustainability**. Each will label these groups differently, and perhaps be more specific, but in essence the consensus is looking at these three factors.

At this point, databases such as the International Sustainability Indicators Network are evidence to the large amount of independent rating systems that exist throughout the world. The Australian Green Star Communities is a good model for a national systems. They act as a higher vision and goals that each community can create their own rating systems. Instead of imposing a blanket system, these broader goals can be adapted and become specific to each individual place. The document even explains that the creation of a “place” or community must be made at the local level.

The US can work towards a national rating system for sustainability, but a national system should not be rigid, but flexible for easy implementation in the various localities this country has. The federal government can lead with visionary goals that at the local scale will be reached through different avenues.

Appendix B. Indicator Literature Review Bibliography

Primary Resources

Bauer, Raymond. 1967. Social indicators. Cambridge, MA: M.I.T. Press.

Bell, Simon & Morse, Stephen. *Sustainability Indicators: Measuring the Immeasurable?* 2nd ed. Earthscan Publishing. London: 2008

Berman, Yitzhak and Phillips, David. (2000). Indicators of Social Quality and Social Exclusion at National and Community Level. *Social Indicators Research* 50: 329-350.

Briassoulis, Helen (2001). Sustainable Development and its Indicators: Through a (Planner's) Glass Darkly. *Journal of Environmental Planning and Management.* 44(3): 409-427.

Green, Maria (2001). What We Talk about When We Talk about Indicators: Current Approaches to Human Rights Measurement. *Human Rights Quarterly*. 23: 1062-1097.

Hammond et. al. *Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development*. World Resources Institute: 1995.

Hoornwet, Daniel, Fernanda Ruiz Nunes, Mila Freire, Natalie Palugyai, Maria Villaveces, and Eduardo Wills Herrera (2007). *City Indcators: Now to Nanjing.* World Bank Policy Research Working Paper 4114.

Kuik, Onno and Harmen Verbruggen (1991). *In Search of Indicators of Sustainable Development*. Boston and London: Kluwer Academic Publishers.

Milman, Anita and Anne Short. (2008). Incorporating Resilience into Sustainability Indicators: An Example for the Urban Water Sector. *Global Environmental Change.* 18 (4). 758-767.

Reed et al. *An adaptive learning process for developing and applying sustainability indicators with local communities*. Ecological Economics (2006): 406-418.

Rodenburg, Caroline and. Tuzin Baycan-Levent, Eveline van Leeuwen and Peter Nijkamp. (2001). Urban Economic Indicators for Green Development in Cities. *GMI 35*, 105-119.

Sahely, R. Hall, Christopher A. Kennedy, and Barry J. Adams. (2005). Developing Sustainability Criteria for Urban Infrastructure Systems. *Canadian Journal of Civil Engineering.* 32. 72-85.

Sawicki, D. S., & Flynn, P. (1996). Neighborhood indicators. *Journal of the American Planning Association*, *62*(2), 165.

Shen, Li-Yin, J. Jorge Ochoa, Mona N. Shah, and Xiaoling Zhang (2010). The Application of Urban Sustainability Indicators: A Comparison between Various Practices. *Habitat International*. 1-13.

Sirgy, Joseph H. (2010). "Theoretical Perspectives Guiding QOL Indicator Projects. *Social Indicators Research.* Online edition - DOI:10.1007/s11205-010-9692-6

Sirgy, M. J., Rahtz, D., & Lee, D. (2004). *Community Quality-of-Life Indicators: Best Cases* (1st ed.). Springer.

Sirgy, M. J., Rahtz, D., & Swain, D. (2006). *Community Quality-of-Life Indicators: Best Cases II* (1st ed.). Springer.

Smeets, Edith and Rob Weterings (1999*). Environmental Indicators: Typology and Overview*. European Environment Agency – Technical Report No 25. TNO Centre for Strategy, Technology and Policy, The Netherlands.

Spangenberg, Joachim H. and Bonnoit, Odile. (1998). *Sustainability Indicators - A Compass on the Road Towards Sustainability*. Wuppertal Paper No. 81. Sustainable Societies Program, Division for Material Flows and Structural Change, Wuppertal Institute for Climate, Environment, Energy.

Westfall, M. S., & Villa, V. A. D. (2001). *Urban Indicators for Managing Cities: Cities Data Book*. Asian Development Bank.

Van den Bergh, Jeroen & Verbruggen, Harmen. *Spatial Sustainability, Trade and Indicators: an Evaluation of the 'Ecological Footprint*. Ecological Economics. 29 (1999): 61-72.

Additional Resources

Black et. al. *Sustainable Urban Transportation: Performance Indicators and Some Analytical Approaches*. Journal of Urban Planning and Development: 2002 (184-192)

Bossel, Hartmut (2001). Assessing Viability and Sustainability: a Systems-based Approach for Deriving Comprehensive Indicator Sets. *Ecology and Society.* 5(2): 12.

Custance, John & Hillier, Hilary. *Statistical Issues in Developing Indicators of Sustainable Development*. Journal of the Royal Statistical Society Series A (1998): 281-290.

Donegan, M., Drucker, J., Goldstein, H., Lowe, N., & Malizia, E. (2008). Which Indicators Explain Metropolitan Economic Performance Best? Traditional or Creative Class. *Journal of the American Planning Association*, *74*(2), 180.

Hart, Maureen. (1998). Sustainable Community Indicators Trainer's Workshop. US EPA Office of Sustainable Ecosystems and Communities (OSEC) under a cooperative agreement with Lowell Center for Sustainable Production at the University of Massachusetts, Lowell, MA.

Hodge, Tony. "Toward a Conceptual Framework for Assessing Progress Toward Sustainability." *Social Indicators Research* 40 (1997): 5-98.

Hunt, Sonja M. and McEwen, James. "The Development of a Subjective Health Indicator." *Sociology of Health and Illness* 2 (2008): 231-246.

Mega, Voula and Jørn Pedersen. (1998). Urban Sustainability Indicators. European Foundation for the Improvement of Working and Living Conditions. Dublin, Ireland.

Myers, D. (1992). *Analysis with Local Census Data: Portraits of Change*. Academic Press.

Talen, Emily. (1998). Visualizing fairness. *Journal of the American Planning Association*, *64*(1), 22.

Appendix C. Existing Indicator Database

Primary Dimension	Indicator	Primary Source (Others)
Environmental	Total CO2 Emissions in metric tons per year	Central Texas
Environmental	Total # of passenger miles by private car per inhabitant per year	Euro Found
Environmental	Percent of miles traveled (or trips) taken by sustainable modes (walking, biking, public transportation) as a fraction of miles traveled by private auto	Euro Found, Houston
Environmental	Number of automobiles per capita	GCIF
Environmental	Number of two-wheeled vehicles per capita	GCIF
Environmental	Ghg emissions in tons per capita	Global City, Whistler
Environmental	Percentage of persons entering downtown by transit	Minneapolis
Environmental	Linear distance of bike lanes in roadways	Minneapolis
Environmental	Percent of population commuting via bus	Portland
Environmental	Average ridership per vehicle	Santa Monica
Environmental	Percent of vehicles, buses, etc with hybrid or alternative fuel	Santa Monica, Whistler
Environmental	Percentage of households within 1/4 mile of a transit stop	Seattle, Santa Monica
Environmental	Residential, Industrial, and Agricultural water use as a percentage of total water availability	2010 Environmental Performance Index (EPI)
Environmental	Co2 emissions by the energy sector divided by the the total electricity output.	2010 Environmental Performance Index (EPI)
Environmental	Percent forest cover change per annum (including urban greening/forestry)	2010 Environmental Performance Index (EPI)
Environmental	Percentage of EPA/IUCN/State designated critical habitat protected (if applicable)	2010 Environmental Performance Index (EPI)
Environmental	Percentage of water bodies that are classified as 'impaired' by the US EPA.	2010 Environmental Performance Index (Seattle)
Environmental	Percentage of wetlands permanently protected	Adapted from Seattle, Whistler.
Environmental	Total solid waste production (pounds per person per day)	Central Texas (Adapted from Whistler)
Environmental	Toxic Release Inventory - On and Off Site Releases	Central Texas (Seattle)
Environmental	Residential, Industrial, and Agricultural water demand in ten years	Central Texas Sustainability Indicator Project
Environmental	Water Use (Residential, Industrial, and Agricultural) use per capita (gallons per capita per day)	Central Texas Sustainability Indicator Project
Environmental	Average Well Depth	Central Texas Sustainability Indicator Project
Environmental	Megawatt-Hours of renewable energy consumed (per capita)	Central Texas Sustainability Indicator Project
Environmental	Percentage of the population served by a public water provider while the provider was in violation of EPA water quality rules.	Central Texas Sustainability Indicator Project
Environmental	Vulnerability of a city to natural disasters (hurricanes, droughts, earthquakes, floods, landslides and volcanic)	Cities of Opportunity - PWC
Environmental	The percent of municipal solid waste recycled	Cities of Opportunity - PWC

Environmental	The proportion of a city's land area designated as recreational and green spaces to the total land area	Cities of Opportunity - PWC
Environmental	Annual Average pH of rainfalll	Euro Found
Environmental	Energy consumption per capita	Euro Found (Central Texas, Adapted from Whistler)
Environmental	Ratio of road to transit expenditures per capita	GCIF
Environmental	Percent of water lost in conveyence	GCIF (Euro Found)
Environmental	Percent of persons commuting via transit	Houston Sustainability Indicators
Environmental	Percentage of renewable energy used municipal operations	Minneapolis Sustainability Indicators
Environmental	Users of Bikeways - Number of cyclists at key locations as measured in bike counts.	Minneapolis Sustainability Indicators
Environmental	Urban tree canopy coverage (as percentage of total urbanized area).	Minneapolis Sustainability Indicators
Environmental	The annual amount of carbon dioxide emissions in metric tons divided by the city population	PWC (Adapted from Central Texas and Minneapolis)
Environmental	Average number of households within ¼ mile of transit nodes	Santa Monica
Environmental	Farmers markets within the city (per 1000 population)	Santa Monica
Environmental	Percent of households and population within ½ mile of a park	Santa Monica
Environmental	Number of days waterways are posted with health warnings or closed.	Santa Monica (Seattle, Minneapolis)
Environmental	Health based upon the benthic index of biotic integrity (average over all assessed streams normalized by the length of the waterway)	Seattle
Environmental	Acres zoned for mixed-use development.	Seattle
Environmental	Median Flashiness of streams within the jurisdiction.	Seattle
Environmental	Average weekday vehicle miles traveled	Seattle
Environmental	Percentage of brownfield/infill development as a percentage of total development	Seattle
Environmental	Change in acres of impervious surface and forest cover over the past year.	Seattle
Environmental	Acres in forestry and farm production	Seattle
Environmental	Walkscore	Walkscore
Social	Total percentage of the population participating in local elections or as active members in associations for urban improvement and quality of life.	Euro Found
Social	Total percentage of the population affected seriously by crime or traffic accidents.	Euro Found
Social	Percentage of people affected by poor housing environments.	Euro Found
Social	Percentage of people affected by poverty, unemployment, lack of access to education, information, training and leisure.	Euro Found
Social	Number of Firefighters Per 100K pop	GCIF
Social	Percentage of population receiving government financial assistance	Global City
Social	Percentage of city population living in poverty	Global City
Social	Housing rent/income ratio	Global City
Social	Number of homeless people per 100,000 population	Global City

Social	Number of health care professionals per 100,000 (physicians, nurses, other)	Global City
Social	Under age five mortality per 1,000 live births	Global City
Social	Number of police officers per 100,000	Global City
Social	Juvenile crime	Global City
Social	Number of homicides per 100,000 population	Global City
Social	Citizen's representation	Global City
Social	Housing price/income ratio	Global City
Social	Voter participation	Global City (Santa Monica)
Social	% of population with access or using recreation space	Global City Indicators Facility
Social	Number of square feet of indoor recreation space available	Global City Indicators Facility
Social	Number of square feet of outdoor recreation space	Global City Indicators Facility
Social	Violent crime rate per 100,000 population	Global City, Santa Monica
Social	Relative change in value of properties in the city as compared to metro area	Houston
Social	Access to health care	Houston
Social	Income of health care workers	Houston
Social	Percent of population with health insurance	Houston (Seattle)
Social	Affordable Housing	Minneapolis
Social	Cost of the longest transit trip	PWC
Social	Ratio of registered taxis to total city population	PWC
Social	Air Craft Movement - including cargo, commercial, and non-revenue flights	PWC
Social	Number of Hospitals	PWC
Social	Community participation in comprehensive plan updates	Santa Monica
Social	Rent-controlled housing stock affordable to low and very-low income residents	Santa Monica
Social	Funds supporting local family, disability, employment and homeless services	Santa Monica
Social	Number of homeless receiving services.	Santa Monica
Social	Gang crime rate	Santa Monica
Social	Number of active neighborhood organizations	Santa Monica
Social	Percent of residents which attended an art of cultural event.	Santa Monica
Social	Percent of residents which contacted a city department.	Santa Monica
Social	Homelessness	Santa Monica (Global City, Minneapolis)
Social	Acres of land zoned for farming	Seattle
Social	Number of Certified Organic Farms in a Region	Seattle
Social	Median house size of new residential construction	Seattle
Social	Households within ¼ mile of neighborhood center (accessibility to a neighborhood center).	Seattle
Social	Percent of houses affordable to buyers at specified income levels.	Seattle
Social	Public dollars spent on low income housing	Seattle
Social	Percent of Households Paying More than 30% of Income for Homeownership or Rent.	Seattle
Social	Housing affordability gap	Seattle

Social	Percent of units affordable to renters at specified income levels.	Seattle
Social	Ratio of housing units to population	Seattle
Social	Percent of annual household income spent on housing and transportation costs (esp. working class families)	Seattle
Social	Percent of Adults Age 18+ Who Are Overweight or Obese.	Seattle
Social	Percent of children under age 18 Who Are Overweight or Obese.	Seattle
Social	Children living in poverty	Seattle
Social	Percent of students eligible for the Free and Reduced Lunch Programs	Seattle
Social	Mortality by race, ethnicity, income.	Seattle
Social	Under age one mortality per 1,000 live births	Seattle (PWC)
Social	Proportion of permanent residents with incomes below the cost of living	Whistler
Social	Unlawful Incidents per capita	Whistler
Social	Number of Highway Accidents	Whistler
Social	Voter Turnout as percentage of the local population	Whistler (Santa Monica, GCIF, Houston)
Economic	Venture Capital Investment	GCIF
Economic	Number of Internet Connections per 100K Population	GCIF
Economic	Number of Cell Phones per 100K population	GCIF
Economic	Average time to get a business license	GCIF
Economic	Number of Patents per 100K pop	GCIF
Economic	Jobs-Housing Ratio	GCIF
Economic	Student/teacher ratio	Global City
Economic	Performance on standardized tests	Global City
Economic	Number of institutions of higher learning within 500km	Global City
Economic	Gini co-efficient/ income distribution	Global City
Economic	Percentage of city population enrolled in institutions of higher learning	Global City
Economic	Survey of Infrastructure Conditions	Houston
Economic	Share of Top 500 Universities	PWC
Economic	% penetration of mobile phones (phones/city pop)	PWC
Economic	Consumer Price Index	PWC
Economic	Number of Hotel Rooms	PWC
Economic	Percent of Population with Higher Education	PWC (GCIF)
Economic	Proportion of employees in the financial and business sector services to the total city workforce	PWC Cities of Opportunity
Economic	Number of "Global 500" corporations per city (defined as top 500 global corporate headquarters)	PWC Cities of Opportunity
Economic	Domestic Market Capitalization (Total number of issued shares of domestic companies listed at the city's stock exchange(s) multiplied by their respective prices at a given time)	PWC Cities of Opportunity
Economic	Cost of Living	PWC Cities of Opportunity
Economic	Strength of Currency	PWC Cities of Opportunity
Economic	Total Business Tax Take	PWC Cities of Opportunity
Economic	Inflation	PWC Cities of Opportunity

Economic	Purchasing Power (Net hourly income is divided by the cost of a basket of commodities, including rent.)	PWC Cities of Opportunity
Economic	High school students attending college	Santa Monica
Economic	Literacy Rate	Seattle
Economic	Bank and Thrift Performance at Meeting CRA Guidelines	Seattle
Economic	Educational Attainment	Seattle
Economic	High school graduation rate	Seattle (GCIF, Santa Monica)
Economic	This indicator tracks the performance of banks and thrifts in meeting the credit needs of the community by using Community Reinvestment Act lender ratings	Sustainable Seattle
Economic	Housing Units per acre	Whistler 2020
Economic	Median income	Whistler 2020
Economic	Unemployment Rate	Whistler 2020
Economic	Total funds transferred to residents from other levels of government, divided by total tax filer income multiplied by 100.	Whistler 2020

Source Indicator System Key

Central Texas:	Central Texas Sustainability Indicators Project
EPI:	Columbia University & Yale University - Environmental Performance Index
Euro Found:	European Foundation – Urban Sustainability Indicators
GCIF:	The World Bank – Global City Indicators Facility
Houston:	City of Houston, Texas - Houston Sustainability Indicators
Minneapolis:	City of Minneapolis, Minnesota - Minneapolis Sustainability Indicators
Portland:	City of Portland, Oregon – Portland Planning and Sustainability
PWC:	PricewaterhouseCoopers – Cities of Opportunity
Santa Monica:	City of Santa Monica, California – Santa Monica Sustainability Plan
Seattle:	City of Seattle, Washington – Sustainable Seattle
Whistler:	City of Whistler, British Columbia – Whistler Monitor Program

Appendix D: Sustainable Urban Development Indicator Matrix (14 July 2011)

Livability Principle 1: Provide more transportation choices.
Develop safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health.

Principle Themes	Framework Elements	Single-Dimension Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
1.1. Commute Mode/Mode Share	- Access to a variety of transportation options - Carbon efficient, environmentally sound, transportation - Efficient resource use	- Ratio of registered taxis to total city population (PWC) - Air Miles Traveled (Seattle, Adapted from PWC) - Number of automobiles per capita (GCIF) - Number of two wheeled vehicles per capita (GCIF)	**- Linear distance of dedicated public transit and bike routes per capita (Adapted from GCIF, Minneapolis, Seattle)** **- Percent of miles traveled (or trips) taken by sustainable modes (walking, biking, public transportation) as a fraction of miles traveled by private auto (Eurofound, Houston)** **- Linear distance of bike lanes in roadways (Minneapolis, Seattle)** - Ratio of road to transit expenditures per capita (GCIF) - Annual number of transit trips per capita (GCIF) - Percent of persons commuting via transit (Houston) - Percent of population commuting via bus (Portland) - Percent of people entering downtown by transit (Minneapolis) - Number of users of bikeways (Minneapolis) - Average number of households within ¼ mile of transit nodes (Santa Monica)	TBD
1.2. Commute Time/ VMT	- Transportation and other infrastructure coordinated with land use - Efficient land use - Access to a variety of transportation options - Efficient resource use	- Average ridership per vehicle (Santa Monica)	- Average weekday vehicle miles traveled (Seattle) - Total # of passenger miles by private car per inhabitant per year (Eurofound)	TBD
1.3. Carbon Emissions	- Access to a variety of transportation options - Transportation and other infrastructure coordinated with land use - Carbon efficient, environmentally sound, transportation - Waste/pollution minimization and management - Climate change and natural disaster mitigation, adaptation, and resilience - Efficient land use	**- Percent of vehicles, buses, etc with hybrid or alternative fuel (Santa Monica, Whistler)**	**- Greenhouse gas emissions in tons per capita (Global Cities, Whistler)** - CO2 emitted per capita (PWC) - Total CO2 emissions in metric tons per year (Central Texas)	TBD

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Livability Principle 2: Promote equitable, affordable housing.
Expand location- and energy-efficient housing choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.

Principle Themes	Framework Elements	Single-Dimension Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
2.1. Housing Affordability	- Access to decent – affordable – housing and services. - Access to capital and credit - A diversified and competitive local and regional economy	- Number of homeless per 100,000 population (GCIF) - Percent change in homelessness since last measure (Seattle) - Number of homeless receiving services (Seattle) - Percentage of people affected by poor housing environments - those registering demands for good housing (Euro Found)	**- Gap between price of affordability for a typical household and median price of market-rate housing (Seattle, GCIF)** **- Gap between price of affordability for a typical rental household and median price of market-rate rental housing (adapted from Seattle, GCIF)** - Ratio of housing units to population (Seattle) - Percent of houses affordable to buyers at 30%, 30 – 49%, and 50 – 79% of median income (Seattle) - Percent of units affordable to renters at 30%, 30 – 49%, and 50 – 79% of median income (Seattle) - Public dollars spent on low income housing (Seattle) - Percent of households paying more than 30% of income for homeownership or rent (Seattle) - Percent of annual working class income spent on housing (Seattle) - Percent of rent-controlled housing stock affordable to low and very-low income residents (Santa Monica)	TBD
2.2. Equity in Housing (esp. as relates to mobility and location)	- Access to decent – affordable – housing and services. - Access to a variety of transportation options - Access to recreation and open space - Transportation and other infrastructure coordinated with land use - Access to education, jobs, and training		- Median house size of new construction (Seattle) - Households within ¼ mile of a neighborhood center (Seattle) - Percentage of low-income households within ¼ mile of a neighborhood center (Adapted from Seattle) - Percentage of households within ¼ mile of a transit stop (Seattle, Santa Monica) - Percentage of low-income households within ¼ mile of a transit stop (Adapted from Seattle) - Percentage of new low-income residential new construction within ¼ mile of a transit stop (Adapted from Seattle).	TBD
2.3. Housing Energy Efficiency	- Transportation and other infrastructure coordinated with land use - Carbon efficient, environmentally sound, transportation - Waste/pollution minimization and management - Climate change and natural disaster mitigation, adaptation, and resilience	- Number of houses certified as energy efficient by certification organizations, e.g. LEED (Adapted from Portland)	**- Median energy consumption per household (adapted from Eurofound, Whistler)** - Median house size of new construction (Seattle)	TBD

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Livability Principle 3: Enhance economic competitiveness.
Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well as expanded business access to markets.

Principle Themes	Framework Elements	Single-Dimension Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
3.1. Educational Resources and Investment	- Access to decent – affordable – housing and services. - A diversified and competitive local and regional economy - Access to education, jobs, and training	- Student/teacher ratio (GCIF) - Performance on standardized tests (GCIF) - Literacy Rate (Seattle) - Number of institutions of higher learning within 500km (GCIF) - Share of top 100 universities in the country (adapted from PWIC)	**- High school graduation rate (GCIF, Seattle, Santa Monica)** **- Percent of population with a university-level education or higher (PWIC, adapted from GCIF)** - Percentage of city population enrolled in institutions of higher learning (GCIF) - Percent of Population with a high school-level education or higher (Seattle) - Percentage of high school graduates attending college (Santa Monica)	TBD
3.2. Agglomeration	- Access to decent – affordable – housing and services. - Access to a variety of transportation options - Transportation and other infrastructure coordinated with land use - A diversified and competitive local and regional economy - Access to education, jobs, and training - Efficient land use	- Number of "Global 500" corporations per city defined as top 500 global corporate headquarters (PWC) - Proportion of employees in the financial and business sector services to the total city workforce (PWC)	- Jobs housing ratio (GCIF)	TBD
3.3. Access to Capital, Credit, and Markets	- Access to decent – affordable – housing and services. - Access to credit and capital - A diversified and competitive local and regional economy	- Number of Internet Connections per 100K Population (GCIF) - Number of Cell Phones per 100K population (GCIF) -Number of Patents per 100K pop (GCIF) - Venture Capital Investment (GCIF) - Percentage of penetration of mobile phones (PWC) - Market Capitalization of Stock issued for Local Companies (PWC) - Bank and Thrift Performance at Meeting CRA Guidelines (Seattle)	- Consumer Price Index (PWC)	TBD

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Livability Principle 4: Support existing communities.
Target federal funding toward existing communities—through strategies like transit oriented, mixed-use development, and land recycling—to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes.

Principle Themes	Framework Elements	Single-Dimension Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
4.1. Compact, Transit-Oriented Development	- Access to decent – affordable – housing and services. - Access to a variety of transportation options - Transportation and other infrastructure coordinated with land use - Efficient land use - Efficient resource use - Carbon efficient, environmentally sound transportation	- Cost of the longest transit trip (PWC) - Ratio of road to transit expenditures per capita (GCIF)	**- Linear distance of high capacity public transit per 100K population (GCIF, PWC)** **- Linear distance of light transit per 100K population (GCIF, PWC)** **- Linear distance of bike lanes in roadways (Minneapolis, Seattle)** - Average number of housing units per acre (Whistler) - Average number of households within ¼ mile of transit nodes (Santa Monica) - Residential density within the CBD - or 1 mile of the 100% corner of the city or a proportional distance to the edge (Adapted from Santa Monica) - Percent of persons commuting via transit (Houston) - Linear distance of dedicated public transit and bike routes per capita (Adapted from Minneapolis) - Walkscore (walkscore)	TBD
4.2. Efficient Land and Resource Use	- Access to decent – affordable – housing and services. - Access to public recreation and open space - A diversified and competitive local and regional economy - Transportation and other infrastructure coordinated with land use - Efficient land use - Efficient resource use - Waste/pollution minimization and management - A diverse natural environment and functional ecological systems	**- Percentage of water lost in conveyance (GCIF, Eurofound)** **- Percentage of municipal solid waste recycled (PWC, Adapted from Portland)** - Percentage of renewable energy in municipal operations (Minneapolis) - The annual amount of carbon dioxide emissions in metric tons divided by the city population (PWC)	**- Energy consumption per capita (Eurofound, Central Texas, Adapted from Whistler)** **- Water use (Residential, Industrial, and Agricultural) use per capita in gallons per capita per day (Central Texas, Whistler)** **- Total solid waste production in pounds per person per day (Central Texas, Adapted from Whistler)** **- Co2 emissions per capita (PWC, Adapted from Central Texas and Minneapolis)** - Percentage of brownfield/infill development as a percentage of total development (Seattle) - Acres of vacant or brownfield coverage (as a percentage of total urbanized area) (Adapted from Seattle) - Acres zoned for mixed-use development (Seattle) - Change in acres of impervious surface and forest cover over the past year (Seattle) - Acres converted to 'developed' uses per population change (Adapted from Seattle) - Average well depth (Central Texas) - Residential, Industrial, and Agricultural water use as a percentage of total water availability (EPI) - Co2 emissions by the energy sector divided by the total electricity output (EPI)	TBD
4.3. Clean, Healthy, and Functional Natural	- Health - Safety - Local or civic identity/sense of place	- Acres in forestry or farm production (Seattle) - Percentage of EPA/IUCN/State designated critical habitat protected (EPI)	**- Percentage of water bodies that are classified as 'impaired' by the US EPA (EPI, Seattle)** **- Percentage of wetlands permanently protected (Adapted from Seattle and Whistler)**	

Communities	- A diversified and competitive local and regional economy - Efficient land use - Efficient resource use - Waste/pollution minimization and management - Climate change and natural disaster mitigation, adaptation, and resilience - Carbon efficient, environmentally sound, transportation - A diverse natural environment and functional ecological systems	- Annual Average pH of rainfall (Adapted from Eurofound) - Stream health based upon the benthic index of biotic integrity (Seattle)	- Mean flashiness of streams within the jurisdiction (Seattle) - Protected farmland, forest land, and natural areas (including wetlands) as percentage of total land area (Adapted from Seattle) - Percent of forest cover change per annum (EPI) - The proportion of a city's land area designated as recreational and green spaces to the total land area (PWC) - Acres of open space per 100,000 population (GCIF) - Urban tree canopy coverage as percentage of total urbanized area (Minneapolis) - Percent of households and population within ½ mile of a park (Santa Monica)	

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Livability Principle 5: Coordinate and leverage federal policies and investment.
Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy

Principle Themes	Framework Elements	Single-Dimension Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
5.1. Renewable and Locally Generated Energy	- Access to decent – affordable – housing and services - A diversified and competitive local and regional economy - Efficient resource use - Waste/pollution minimization and management	- Percentage of renewable energy used in municipal operations (Minneapolis) - Total renewable energy used in municipal operations (Minneapolis)	- Megawatt-Hours of renewable energy consumed per capita (Central Texas) - Number of renewable energy providers supplying local consumers (Adapted from EPI)	TBD
5.2. State and Federal Support for Local Planning Efforts	- Transportation and other infrastructure coordinated with land use - Growth plans that leverage existing assets - Access to capital and credit	None	None	TBD

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Livability Principle 6: Value communities and neighborhoods.
Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods—rural, urban, or suburban.

Principle Themes	Framework Elements	Single-Dimensional Indicators*	Multi-Dimensional Indicators**	Rec. Indicator
6.1. Public Health	- Health - Access to decent – affordable – housing and services - Access to public recreation and open space - Access to a variety of transportation options - A diversified and competitive local and regional economy - Waste/pollution minimization and management - A diverse natural environment and functional ecological systems	**- Percent of population with health insurance (Houston, Seattle)** **- Under age one mortality per 1,000 live birth (Seattle, PWC)** **- Under age five mortality per 1,000 live births (PWC, Global Cities)** - Number of Hospitals (PWC) - Income of health care workers (Houston) - Average number of health centers per neighborhood (Houston) - Number of health care professionals per 100,000 (GCIF) - Percent of students eligible for the Free and Reduced Lunch Programs (Seattle) - Children living in poverty (Seattle) - Proportion of permanent residents with incomes below the cost of living (Whistler) - Percentage of population receiving government financial assistance (GCIF) - Percentage of city population living in poverty (GCIF) - Percent of adults age 18+ who are overweight or obese (Seattle) - Percent of children under age 18 who are overweight or obese (Seattle)	**- Number of air quality non-attainment days in the last year (Adapted from Minneapolis, PWC, Eurofound)** **- Number of days waterways are posted with health warnings or closed (Santa Monica, Adapted from Seattle and Minneapolis)** **- Toxins released by industrial firms (Central Texas, Seattle)** - Number of Certified Organic Farms in a Region (Seattle) - Number of ozone danger (or 'Ozone Action' or 'Air Quality Alert') days in the last year (Adapted from PWC) - Percentage of the population served by a public water provider while the provider was in violation of EPA water quality rules (Central Texas)	TBD
6.2. Public Safety	- Safety - Access to decent – affordable – housing and services - A diversified and competitive local and regional economy - Climate change and natural disaster mitigation, adaptation, and resilience. - A diverse natural environment and functional ecological sys.	**- Violent crimes per 100,000 population (Santa Monica, GCIF)** - Number of police officers per 100,000 (GCIF) - Juvenile crime rate (GCIF) - Gang crime rate (Santa Monica) - Unlawful Incidents per capita (Whistler)	- Total percentage of the population affected seriously by crime or traffic accidents (Euro Found) - Vulnerability of a city to natural disasters - hurricanes, droughts, earthquakes, floods, landslides and volcanic (PWC) - Percentage of the 100-year floodplain that is covered by impervious surface (Adapted from PWC)	TBD
6.3. Sense of Place	- Local or civic identity/sense of place - Access to public recreation and open space - A diversified and competitive local and regional economy - A diverse natural environment and functional ecological systems	**- Voter participation as a percentage of the population (Santa Monica, GCIF, Whistler, Houston)** - Percent of residents which contacted a city department (Santa Monica) - Percent of residents which attended an art of cultural event (Santa Monica) - Number of active neighborhood organizations (Santa Monica) - Local officials per 100,000 population (GCIF)	- Households within ¼ mile of neighborhood center (Seattle) - Community participation in comprehensive plan updates (Santa Monica) - Total percentage of the population participating in local elections or as active members in associations for urban improvement and quality of life (Eurofound)	TBD

* Single-Dimension Indicators – Relate to the theme, elements and only ONE dimension of sustainability.
** Multi-Dimensional Indicators – Relate to the theme, elements and more than one dimension of sustainability.
Indicators used in more than one reviewed system are in **bold**.

Color indicates dimension of sustainability: (From Working Group Framework)
Social Wellbeing
Economic Opportunity
Environmental Quality

Source Indicator System Key

Central Texas:	Central Texas Sustainability Indicators Project
EPI:	Columbia University & Yale University - Environmental Performance Index
Euro Found:	European Foundation – Urban Sustainability Indicators
GCIF:	The World Bank – Global City Indicators Facility
Houston:	City of Houston, Texas - Houston Sustainability Indicators
Minneapolis:	City of Minneapolis, Minnesota - Minneapolis Sustainability Indicators
Portland:	City of Portland, Oregon – Portland Planning and Sustainability
PWC:	PricewaterhouseCoopers – Cities of Opportunity
Santa Monica:	City of Santa Monica, California – Santa Monica Sustainability Plan
Seattle:	City of Seattle, Washington – Sustainable Seattle
Whistler:	City of Whistler, British Columbia – Whistler Monitor Program

Others Systems Consulted

Abu Dhabi – Estidama
ACSE – Sustainability Action Plan
ASLA + Lady Bird Johnson Wildflower Center – Sustainable Sites Initiative
CAP, ICLEI + USGBC – STAR Community Index
GBCA (Australia) – Green Star
Global Reporting Initiative – Sustainability Reporting Guidelines
International Institute for Sustainable Development
International Sustainability Indicators Network
Siemens – European Green City Index
Urban Ecology Coalition – Neighborhood Sustainability Indicators Guidebook
USGBC – LEED ND
The World Bank – Sustainable Development