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MEASURING SUSTAINABLE DEVELOPMENT: AN IN-DEPTH ANALYSIS OF ONE COMMUNITY'S SUSTAINABILITY INDICATORS

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Abstract

This thesis creates an evaluation framework for determining whether or not sustainability indicators actually measure sustainable development. This is important because sustainable development is such an amorphous concept that defining and measuring it are problematic. This thesis views sustainable development as a discourse, rather than a concept to be defined, and seven themes of this discourse are derived from the literature on sustainable development. These seven themes are then used in the Sustainability Indicator Evaluation Framework (SIEF), along with seven criteria for successful sustainability indicators drawn from the literature surrounding sustainability indicators. The SIEF consists of two content analyses that compare the themes and criteria pulled from the literature to the themes represented and criteria used in a sustainability indicator set. The Sustainable Pittsburgh sustainability indicator set is then used to test the SIEF, to help determine how well the framework functions and where it may need to be improved.

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Chapter 1: Introduction

The concept of sustainability is being used as a guiding principle for development all over the world. It is used by international organizations, such as the United Nations and the World Bank, by national governments, such as The Netherlands, and by individual communities, cities, and non-governmental organizations. Along with the use of this principle, there comes a need to monitor the progress towards sustainability and the effectiveness of certain policies and/or regulations. This measurement is difficult for many reasons, such as the lack of a universally agreed upon definition of sustainable development, and the lack of specific and transferable methodologies for the implementation of sustainable development.

Indicators have been chosen as the measurement tool of choice for many sustainability projects worldwide. Agenda 21, a document prepared at the United Nations Conference on Environment and Development in 1992, recommends the development of sustainability indicators both for "use in national and international accounting systems" and for "areas outside of national jurisdiction, such as the high seas, the upper atmosphere and outer space" (United Nations 1992, 302). In the book *Our Common Journey: A Transition Toward Sustainability* published by the Board on Sustainable Development at the National Research Council in the United States asserts that "Indicators are essential to inform society over the coming decades how, and to what extent, progress is being made in navigating a transition toward sustainability" (Board on Sustainable Development Policy Division National Research Council 1999, 8). The European Union has given the use of sustainability indicators a prominent role in its

sustainable cities campaign and has developed its own sustainability indicators (*European Union Summit in Barcelona* 2002).

Indicators have been defined both as "measurements selected to represent a larger phenomenon of interest" (Coles, Eyles, and Gibson 1998, 202) and as "an attributive characteristic of impact" (Belousova 2000, 1227). Implicit in both these definitions is the idea that indicators do not present the status of the full picture, but rather they present the status of a small part of the picture, intended to be representative of the full picture.

Sustainability indicators seek to represent the state of the selected study area in regards to its progress towards its sustainability goals. These can include environmental goals, social goals, economic goals, and everything in between. Sustainability indicator projects often make use of a democratic process in determining the goals and indicators to be used, involving community members and experts in an effort to better define the goals and base them more accurately on the needs and wants of the community. The indicator measurements are intended to be collected at specified intervals and then reported to the public and local decision makers.

The use of indicators to measure sustainable development is not without problems, however. There have been several arguments made as to why indicators are not suitable for measuring sustainable development. For example, Bell and Morse have argued that indicators are a reductionist measurement tool and are therefore inaccurate in their assessment of sustainable development, which is a holistic concept (1999).

Holden has argued that indicators are less effective as measurement tools and more effective as community engagement tools (2001, 218).

This does not mean that indicators should be thrown out the window and never used again for the measurement of sustainable development. It does, however, mean that an investigation of sustainability indicators is necessary in order to determine what the indicators are actually measuring and whether or not these measurements accurately represent the state of progress in sustainable development.

Problem Statement

Despite these difficulties, many of these organizations, nations, cities, and communities attempting to implement sustainable development have latched onto the idea of using indicators as a measurement tool. Indicators have been used to measure social, environmental, and economic change individually, so the decision to use indicators to measure sustainable development, which is ostensibly a combination of social, environmental, and economic issues, is a logical one. However, it is not clear how effective indicators are in measuring sustainable development specifically. For example, Bell and Morse have argued that indicators are not the best choice for measuring sustainability because sustainable development is a holistic concept, it involves consideration for whole systems, while indicators are reductionist, they involve the dissection of systems to find one simple measurement that will 'indicate' the condition of the whole system (Bell and Morse 1999).

I agree with Bell and Morse in that using a reductionist measurement tool to assess a holistic concept may not be the most effective choice. However, indicators do have redeeming qualities: they can be easily understood by the general public, many of the measurements suggested as indicators of sustainability are also being measured for other purposes (making the data collection process easier), and the development of sustainability indicators has in many cases proved to be a positive community building and educational experience (Gahin and Paterson 2001).

There are, then, several questions to be answered. The first is whether or not sustainability indicators do in fact measure sustainability. The second question is, if they are not measuring sustainability, then why not and how inaccurate are they? A third question could be whether it is more important that sustainability is more accurately measured or that the measurement tool be easily understood by the general public? It is not within the scope of this thesis to answer these questions completely, but rather to begin the process of answering them through the development of an indicator evaluation tool and the examination of one set of indicators.

In this thesis, I will complete an in depth examination of a set of sustainability indicators to determine what, exactly, these indicators are measuring and whether or not these measurements actually fit with the current discourse on sustainable development. This examination will be separated into two content analyses: the first comparing the criteria for sustainability indicators used by Sustainable Pittsburgh and criteria identified in the literature about sustainability indicators; the second being a detailed analysis of each indicator in the set to see whether or not it is compatible with a

set of themes defining the sustainable development discourse which are drawn from the literature.

Thesis Structure

I have several goals in writing this thesis. The first is to develop a framework for analyzing a sustainability indicator set with respect to its treatment of the topic of sustainable development. The second is to develop a list of key themes of sustainable development that can be used in this and other analyses. Third is to explore the idea of indicators and what makes a good indicator. Finally, I would like to test the framework on just one indicator set. While this may not produce any conclusive results, it will give me a better idea of where the framework needs to be improved as well as ideas for areas of future research.

The second chapter of my thesis will describe the methodology that I am proposing for this study. The Sustainability Indicator Evaluation Framework (SIEF), as I have named it, will, as previously noted, consist of two content analyses: one focused on sustainability indicator criteria and the other focused on the themes of sustainable development.

The third chapter will be about defining sustainable development. In preparation for this, I have compiled a list of definitions of sustainable development, both direct and indirect, that I have gathered from the literature. From this list, I have distilled a list of seven key themes in the sustainable development discourse. Each of these themes will

be discussed in this section in order to set up their use in the analysis of the indicator set. The full list of definitions pulled from the literature is attached as Appendix A.

The fourth chapter is about indicators. In this section I will briefly review the history of indicator use, different methods of developing sustainability indicators, different ways of organizing indicator sets, and problems with the use of indicators as identified in the literature. One of the most important parts of this section, however, is the list of criteria for good indicators. This list was also distilled from the literature in much the same way as the themes of sustainable development were. A full list of all the criteria found in the literature is included as Appendix B.

The fifth chapter is intended to give the reader some background information about Sustainable Pittsburgh and its indicators project. This chapter contains information about the organization's history, its other initiatives, and an outline of the indicator development process they utilized.

The sixth chapter is the actual analysis of the Sustainable Pittsburgh indicator set. It will begin with the criteria analysis and then move onto the themes analysis. At the end of the chapter I will present several conclusions on the indicator set based on the two content analyses.

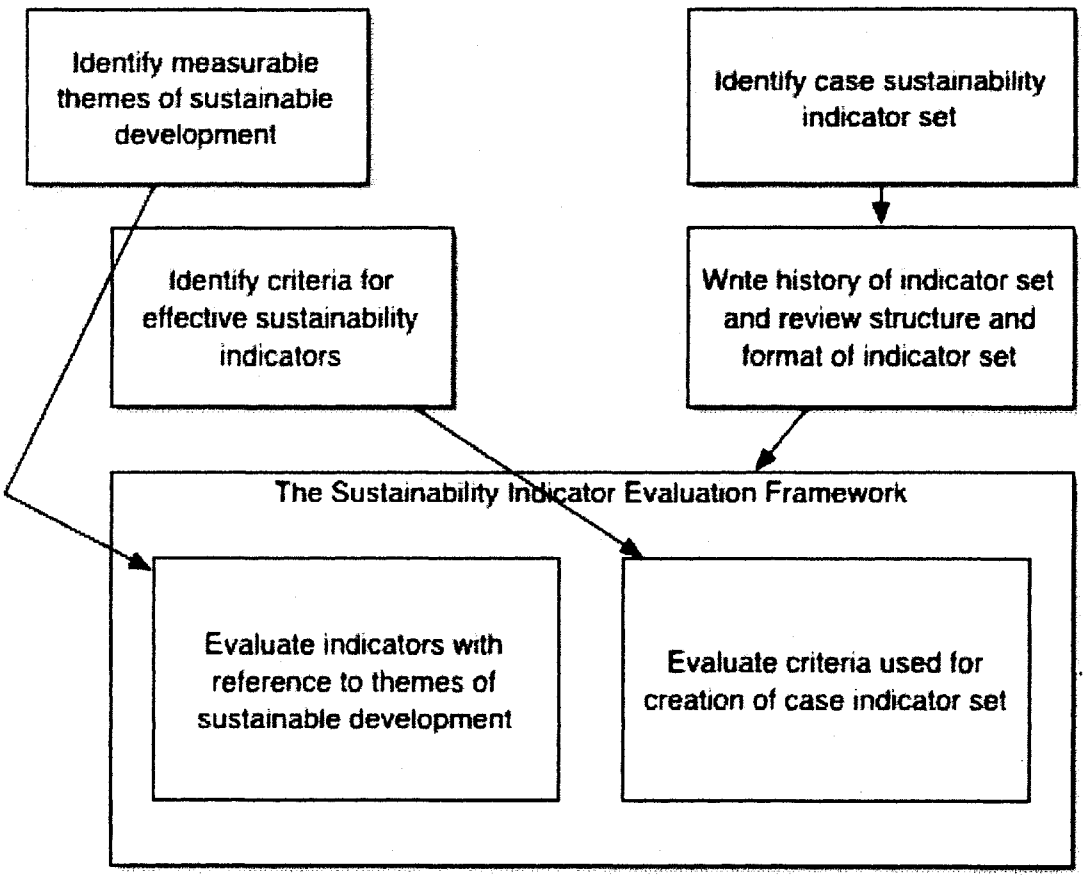
The seventh chapter contains any final thoughts on the study. These will consist of any conclusions that I can draw from the case study and the content analysis, observations

about the use of the framework I have developed, some notes about possible improvements to be made to the framework, and ideas for future research.

Chapter 2: The Sustainability Indicator Evaluation Framework

The purpose of the analysis of this indicator set is to determine whether or not the indicators are measuring sustainable development. The Sustainability Indicator Evaluation Framework (SIEF), which is described in this chapter, is based largely on the literature surrounding both sustainable development and sustainability indicators. Chapters of this thesis have been written which identify seven main themes of the sustainable development discourse and seven main criteria for successful sustainability indicators from the literature. The use of this information in the design of the SIEF will be discussed further in the rest of this chapter and is illustrated in Figure 2.1.

FIGURE 2.1: THE DEVELOPMENT OF THE SIEF



The SIEF consists of two content analyses. Babbie defines content analysis as, basically, "a coding operation" (Babbie 1998, 313). Coding consists of describing the chosen material in terms of certain predetermined characteristics (Leedy and Ormrod 1985, 156-157). The first stage of the SIEF is an analysis of the indicator set in terms of the criteria used in its creation. The purpose of this section is to answer the question of whether or not the indicators meet the criteria for good indicators as presented in the literature about sustainability indicators. The second stage is an analysis of the indicator set which divides the indicators into their fundamental elements and analyzes these elements in terms of their representation of the aforementioned seven themes of the sustainable development discourse. The purpose of this second stage is to determine whether or not the indicator set deals with the seven themes of sustainable development as derived from the literature.

Finally, an indicator set also had to be chosen in order to test this analysis methodology. This chapter also contains a detailed description of the process used when selecting the test indicator set.

Indicator Criteria

The first stage of the SIEF is based a list of sustainability indicator selection criteria presented in the literature surrounding sustainability indicators, which is identified and explained in Chapter 4. The purpose of this stage of the analysis is to ascertain whether or not the indicators fit the criteria described in the literature.

Instead of attempting to determine whether or not each individual indicator meets the criteria for sustainability indicators derived from the literature, which would be an almost impossible task, the SIEF is designed to use a proxy method. This method involves comparing two lists of criteria for sustainability indicators: one list derived from the literature (listed in Box 2.1 and explained in Chapter 4), and the list used for the creation of the indicator set being studied. It is assumed, in this analysis, that the criteria used for creating the indicators must at least include the criteria for sustainability indicators emphasized in the literature.

BOX 2.1: INDICATOR SELECTION CRITERIA DERIVED FROM THE LITERATURE

1. The indicator set must have a sound scientific basis
2. The indicator set must be measurable
3. The indicator set must be predictive
4. The indicator set must be sensitive/responsive to change
5. The indicator set must be integrative
6. The indicator set must be representative of/relevant to the topic under investigation
7. The indicator set must be easily understood and interpreted by non-experts.

The Themes of Sustainable Development

In this second stage of the SIEF the intent is to determine to what degree the indicator set reflects the seven themes of the sustainable development discourse, which are shown here in Box 2.2 and discussed further in Chapter 3. These themes were derived

through a detailed analysis of a collection of definitions of sustainable development, the complete list of which can be seen in Appendix A.

A matrix has been designed for this stage of the analysis that separates the indicators into three distinct elements (the columns of the matrix) and analyzes these elements for the presence of the seven themes of sustainable development (the rows of the matrix). The full matrix can be seen in Appendix C.

BOX 2.2: THEMES OF SUSTAINABLE DEVELOPMENT

1. A focus on temporal concerns
2. A focus on the maintenance of ecological integrity
3. A focus on anthropocentric concerns
4. The view of sustainable development as a process
5. A focus on systemic and holistic thinking
6. The notion of balance/harmony/integration
7. A focus on global concerns.

The four elements of an indicator represent the fundamental components of a basic indicator:

- The *phenomena* being measured ,
- The *reason for selecting* that phenomenon,
- The *actual measurement value* or number (not included in the matrix), and
- The *interpretation* of the measurement.

This division facilitated the development of the questions that appear in the cells of the matrix and will give a more accurate view of how each indicator embodies, or doesn't embody, the seven themes of sustainable development. Only three of the four elements

actually appear in the matrix. The SIEF does not consider the actual measurements taken, as the analysis lies more in the choice and interpretation of the indicators than in the numbers, consequently this element is not included in the matrix.

The phenomena being measured are the things that are measured by the indicator. For example, an indicator might measure the literacy rate of the community. The reason for choosing those phenomena should be found in the description of each indicator. Finally, the interpretation of the measurement is important because it gives some insight into how the indicators might be linked or how the phenomenon being measured affects the community.

The cells of the matrix contain one or more questions designed to determine the presence of a particular theme in each indicator. For example, when looking for a reference to "a focus on the maintenance of ecological integrity" in the interpretation element of an indicator, one question would be whether or not there is any analysis relating the results of the measurement to the wider ecosystem. A positive answer would provide evidence that the theme is addressed in that indicator. In order to be able to carry out this stage of the analysis using a content analysis the questions in each cell of the matrix had to be able to be answered with a positive or negative response or a response that identifies a characteristic that could be counted.

The matrix is applied to each indicator individually, with every one of the questions in the matrix being asked of each indicator. The number of positive responses, then, determines which themes are more strongly represented in the indicator set.

Selecting A Test Project

Sustainable Pittsburgh's indicator set has been chosen for a test of the SIEF. This decision was made through the use of a systematic process designed to find the indicator set best suited for analysis using the SIEF.

From two lists of indicator sets, obtained from Sustainable Measures (*Sustainable Measures* 2000), a consulting agency specializing in the development of measurements of sustainability, and from the International Sustainability Indicators Network (*ISIN - International Sustainability Indicators Network* 2002), an organization that provides resources for groups establishing and using sustainability indicators, thirteen indicator sets were selected due to their self-identification as sustainability indicator projects and their location in the United States. This is important, as there are many community and quality of life indicator sets listed as well. I wanted to be positive that the goal of the indicator set was to measure progress towards sustainability and that that this concept has been discussed and defined within the group that developed the indicators.

The thirteen communities with the selected indicator sets are as follows:

- San Francisco, California
- Santa Monica, California
- Franklin County, Maine
- Boston, Massachusetts
- Cape Cod, Massachusetts
- Lansing, Michigan

- Ann Arbor, Michigan
- Pittsburgh, Pennsylvania
- Austin, Texas
- Seattle, Washington
- Orlando, Florida
- Sonoma County, California
- Tucson, Arizona

In order to determine which indicator set would best suit the evaluation framework, a list of necessary pieces of information, such as information about the development of the indicator set and information about the reports published using the indicator set, was drawn up and then each indicator set was examined to ascertain what pieces of information were missing. Most projects had a website, and so I consulted each project's website in order to take stock of the information available there. I then e-mailed each organization, informing them of my study and asking if they wouldn't mind providing me with some information, which consisted of the information I needed to know that was not to be found on their websites. The purpose of this step was to determine which of the organizations had the most and best quality information and was willing to work with me.

Only seven of the communities responded to the e-mail. From these, three were eliminated simply because, even though they were reported to have a sustainability indicator project, they did not in fact have one. Another two of communities were also removed because of the relatively small amount of information offered. Finally, the

search was narrowed to two communities: Orlando, Florida, and Pittsburgh, Pennsylvania.

Both of these indicator sets were developed through collaboration with AtKisson, Inc, a consulting firm specializing in sustainability issues. It was difficult to choose between them, as both had large amounts of information on their indicator sets available and both programs had people who were willing to answer my questions and help me with my study in any way possible. In the end I chose Sustainable Pittsburgh simply because their website provided more detailed information than Orlando's. Should I choose to continue with this study and try another indicator set, however, Orlando would be my first choice.

Chapter 3: Defining Sustainable Development

In order to complete the second stage of the Sustainability Indicator Evaluation Framework, it is necessary to identify several main themes that occur in the sustainable development discourse. The following discussion details the seven themes that have emerged from a detailed analysis of the literature on sustainable development. A full list of the definitions of sustainable development from which these themes were pulled can be found in Appendix A. These themes will later be searched for in the indicator set being analyzed.

The Seven Themes of Sustainable Development

Defining sustainable development is a complicated process. As Bell and Morse have noted, "sustainability is what we want it to be and can change as we change. It is an organic and evolving construct of our minds and not an inorganic and static entity that can be physically probed" (Bell and Morse 1999, 155). Many people have attempted to define this discourse and, even though their definitions sometimes differ in fundamental ways, they retain some incredibly similar elements. An examination of the literature on sustainable development has revealed seven themes central to the discourse of sustainable development:

1. A focus on temporal concerns
2. A focus on the maintenance of ecological integrity
3. A focus on anthropocentric concerns
4. The view of sustainable development as a process
5. A focus on systemic and holistic thinking

6. The notion of balance/harmony/integration
7. A focus on global concerns.

The following discussion will shed some light on each of these themes, which will later be used in the evaluation of the indicator set.

A Focus on Temporal Concerns

The very word 'sustainable' implies a temporal element. For something to be sustainable, it must be able to be sustained over time. A key element of sustainable development is to preserve natural resources so that future generations will be able to provide for themselves. Therefore, this is an important theme in the sustainable development discourse.

Some definitions assume that the temporal element is not limited in any way, that human development on earth can be sustained indefinitely (Costanza 1992, 111,112; Moffatt, Hanley, and Wilson 2001, 3; Munro 1995, 28). Still many others do not specify whether the future of human development is indefinite or limited, but rather simply refer to the 'future' as a vague, indefinable time period (Alberti 1996, 383; Cornelissen et al. 2001, 174; Desta 1999, 16; Kaufmann and Cleveland 1995, 109; Kline 2000, 2; Krizek and Power 1996, ; MacLaren 1996, 185; Morse et al. 2001, 1; Phillis and Andriantiatsaholiniaina 2001, 438; World Commission on Environment and Development 1987).

A few people, however, have stressed the importance of temporal limits. Costanza and Patten include a discussion of this topic, eventually concluding that "a system is

sustainable if and only if it persists in nominal behavioral states as long as or longer than its expected natural longevity or existence time" (Costanza and Patten 1995, 195). Carpenter and Atkinson et al both briefly mention the fact that systems are not sustainable forever, but only for a certain unspecified time period (Atkinson et al. 1997, 3; Carpenter 1995, 178).

The Maintenance of Ecological Integrity

Included in this theme are the notions of the maintenance of the earth's life-support systems and of limitations to natural resource use. The overarching concept of maintaining ecological integrity is significant to the discourse of sustainable development. Costanza defined this concept as not destroying "the diversity, complexity, and function of the ecological life-support system" (Costanza 1992, 111). Many authors include this concept in their definitions of sustainable development (Alberti 1996, 388, 413; Bell and Morse 1999, 61; Costanza 1992, 111, 112; Desta 1999, 16; Kaufmann and Cleveland 1995, 109; Kline 1996, 1, 2; Krizek and Power 1996, 7; Levett 1998, 295; MacLaren 1996, 185-186; Moffatt, Hanley, and Wilson 2001, 9, 12; O'Riordan and Voisey 1997, 2; Winograd 1995, 203). Bell and Morse, Goulet, Wheeler, and Gibbs have all included this concept in their lists of the core principles of sustainability (Bell and Morse 1999, 61; Gibbs 2002, 3; Goulet 1996, 189-190; Wheeler 1996, 13-14). The idea of preserving life-support systems simply narrows the focus of maintaining ecological integrity to maintaining those ecological systems that support life. The argument can be made, however, that all ecological systems support life, and, therefore, the only difference between the two concepts lie in the wording.

The idea of limits to natural resource use, however, while in this case it is classified under the maintenance of ecological integrity, is an important concept in and of itself. Arguments emphasizing these limitations can be traced all the way back to Malthus, who discerned that population growth could potentially exceed the earth's ability to produce food. More recently, the Club of Rome published *The Limits to Growth* in 1974, which sparked a fierce debate and was one of the main catalysts for the sustainable development movement.

This concept of limits is heavily ingrained into the discourse on sustainable development (Board on Sustainable Development Policy Division National Research Council 1999, 21; O'Riordan and Voisey 1997, 2; World Commission on Environment and Development 1987, 8, 43). One example of how this concept is used comes from Rennings and Wiggering. In their article entitled *Steps Towards Sustainable Development*, they identify three rules for managing resources;

- "Harvest rates of renewable resources should not exceed regenration rates.
- Waste emissions should not exceed the relevant assimilative capacities of ecosystems.
- Non-renewable resources should be exploited in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of renewable substitutes" (Rennings and Wiggering 1997, 25-26).

Embedded in the idea of limits is the idea of a natural system's carrying capacity. Carley and Christie referred to carrying capacities as "thresholds for sustainability" (Carley and Christie 2000, 5). They later define the term as "the number of people who,

sharing a given territory, can be supported at any time on a sustainable basis, taking into account known resources, as well as sociocultural factors" (Carley and Christie 2000, 28). This definition makes it quite evident that much of the discussion about sustainable development is based upon the concept of carrying capacities. One conception of the idea behind sustainable development is the notion of living within the carrying capacity of the earth (Alberti 1996, 384; Munro 1995, 30).

A Focus on Anthropocentric Concerns

Much of the discussion about sustainable development centers on human interests (Alberti 1996, 383, 388-389, 413; Atkinson et al. 1997, 3, 12; Bell and Morse 1999, 61; Berke and Conroy 2000, 23; Board on Sustainable Development Policy Division National Research Council 1999, 21; Caldwell 1998, 10, 11; Cornelissen et al. 2001, 173, 174; Costanza 1992, 111; Gibbs 2002, 3; Kaufmann and Cleveland 1995, 111; Kline 1996, 1, 2; Krizek and Power 1996, 7; Levett 1998, 295; MacLaren 1996, 185-186; Moffatt, Hanley, and Wilson 2001, 3, 103, 110, 153, 154, 182; Munro 1995, 28, 29, 32; O'Riordan and Voisey 1997, 2, 21; Winograd 1995, 203; World Commission on Environment and Development 1987, 8, 43, 44, 46). The idea is to preserve the earth for future generations of people. Three important components of these interests are the concepts of needs, equity, and quality of life.

Fulfilling basic human needs is an important part of the sustainable development movement. There are many definitions that use this as a criterion for sustainable development. The WCED considered this concept a fundamental concern for sustainable development, stressing its presence in their definition by listing it as one of

the two key concepts, stating that "overriding priority" should be given to fulfilling the "essential needs of the world's poor" (World Commission on Environment and Development 1987, 43).

Equity is a huge issue in the discourse surrounding sustainable development (Atkinson et al. 1997, 3; Gibbs 2002, 3; Krizek and Power 1996, 7; MacLaren 1996, 185-186; Moffatt, Hanley, and Wilson 2001, 110). The phrase "intra- and intergenerational equity" occurs throughout the literature. This, again, is a fundamental concept in the sustainable development discourse. As noted by Maclaren, equity includes "social equity, geographical equity, and equity in governance" (MacLaren 1996, 185).

Quality of life concerns have arisen in the literature as well, calling on sustainable development to improve the quality of life of the less fortunate and maintain it for the rest of the world into eternity (Caldwell 1998, 10; Gibbs 2002, 3; Kline 1996, 1). Caldwell has written that, in order for development to be sustainable it must focus on quality of life, rather than economically driven concerns (Caldwell 1998, 10). This is a complicated issue, however, as many would argue that the quality of life in some parts of the world exceeds the regenerative capacity of the earth, and therefore is not sustainable. Atkinson et al have argued that:

> Achieving a sustainable development path will imply a reduction in current wellbeing only if that flow of wellbeing cannot be reproduced for each successive generation. This will be the case where the current flow of wellbeing is being created by running down natural assets without saving or reinvesting for future consumption. (Atkinson et al. 1997, 12)

A View of Sustainable Development as a Process

The WCED noted that "sustainable development is not a fixed state of harmony, but rather a process of change" (World Commission on Environment and Development 1987, 9). The view of sustainable development as a process is very important indeed (Berke and Conroy 2000, 23; Caldwell 1998, 2; Krizek and Power 1996, 7; Spangenberg 2002, 299; Winograd 1995, 203; World Commission on Environment and Development 1987, 9, 46). It basically changes the whole conceptualization of the notion of sustainable development from something to be achieved to something that will never be achieved and will require constant adjustment. This idea that there is no pot of gold at the end of the rainbow, but rather the pot of gold is the rainbow, is one of the most challenging for champions of sustainable development. Natural systems are constantly adjusting themselves. This is the basic idea behind the theory of natural selection. As environments change, species adapt and therefore survive through the changes, rather than simply becoming extinct as soon as the changes make it impossible to survive.

The challenge comes because this means that there is no final, achievable goal. The world will never be able to say that it has accomplished sustainable development. It is an ongoing process that will require constant adjustment and adaptation to the situation of the world as it changes, both in the natural world and the developed world. It is a way of doing things and making decisions. Granted, as the world changes and moves towards a way of handling development more in line with the principles of sustainable development the process will become easier, but it will still be a process and will still require some level of fine-tuning.

A Focus on Systemic and Holistic Thinking

This theme has to do with conceptualizing the world as a huge system where everything that happens within it has an affect on everything within the system. The idea of interconnectedness and interdependability are central to the discourse on sustainable development (Bell and Morse 1999, 61; Berke and Conroy 2000, 23; Costanza and Patten 1995, 193; Krizek and Power 1996, 7; Levett 1998, 295; Moffatt, Hanley, and Wilson 2001, 3, 153; Morse et al. 2001, 1). This theme takes into account that while, for example, the depletion of a natural resource may not mean much on its own, it may be detrimental to the earth-system as a whole.

The main argument behind holistic and systemic thinking is that the whole is more than the sum of its parts and therefore needs to be examined as a whole. This is in contrast to reductionist thinking, which posits that in order to understand the whole it must be deconstructed into its various parts. Holistic theorists would argue that the relationships between the parts within a whole give the parts value that they would not retain once separated from one another. Therefore, in order to fully understand the whole it must be studied as such, not from a reductionist perspective. (Phillips 1976).

Holism is a difficult concept to represent in indicators, as indicators by nature are a reductionist measurement tool. Morse and Bell, however, in their book *Sustainability Indicators: Measuring the Immeasurable* attempted to design an sustainability indicator system that would address this issue (Bell and Morse 1999). The result was what they referred to as systemic sustainability analysis (SSA), which is a soft-systems approach,

rather than the hard-systems approach traditionally used in sustainability measurements (Bell and Morse 2001, 294).

A Focus On Balance, Harmony, and Integration

This section relates to the previous discussion of systemic thinking. 'Balance', 'harmony', and 'integration' are all words used in the literature to describe the idea of relationships between different systems on earth (Bell and Morse 1999, 61; Berke and Conroy 2000, 23; Kaufmann and Cleveland 1995, 109; Krizek and Power 1996, 7; Moffatt, Hanley, and Wilson 2001, 110, 182; World Commission on Environment and Development 1987, 9). The ultimate desire reflected in this theme is optimization – finding the levels of environmental protection, economic health, and social health that complement each other. The WCED provided a definition of sustainable development that highlights this desire:

> In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in *harmony* and enhance both current and future potential to meet human needs and aspirations. (World Commission on Environment and Development 1987, 46 emphasis added)

There are two arguments that complicate this vision, however. The first is made by Levett, who argues that "balance infects policy-making with defeatism" and that the better solution is to think about "reconciling" the different systems (Levett 1998, 298). In this way, we do not sacrifice, for example, economic prosperity for environmental benefits or vice versa. Rather, when we think about reconciling instead of balancing, we are more apt to find solutions that allow us to have both.

The second argument is also presented by Levett in the same article. He describes two conceptions of how the systems ought to fit together. The first is the most common and he refers to it as the "three-ring circus" model. Basically, in this model all three systems (environmental, economic, and social) are considered equal and there is an effort to determine how they should intersect. He contends that a better model is the "Russian doll" model, where the environment takes precedence and is a precondition for the social and economic systems. This model also includes the argument that the economic system falls within the social system, since it caters to social needs. (Levett 1998, 295).

A Focus on Global Concerns

Since the beginning of the sustainable development movement, the focus has been on global sustainability (Alberti 1996, 383; Berke and Conroy 2000, 23; Board on Sustainable Development Policy Division National Research Council 1999, 2; Moffatt, Hanley, and Wilson 2001, 9, 110, 154, 182; O'Riordan and Voisey 1997, 2). There is a growing dispute in the sustainable development literature concerning whether or not local sustainability is actually possible. The realization behind this focus is that things that are done in one area of the world, especially in this age of rampant globalization, ultimately affect other parts of the world as well. This is especially true with reference to environmental concerns, where pollution and resource use are quite obviously not simply local issues.

Chapter 4: Indicators

This chapter presents a comprehensive look at sustainability indicators. It will begin with a definition of indicators in general. It will then go on to describe the history and evolution of sustainability indicators. The chapter will then end with a section on sustainability indicator design and selection, which will include a discussion of the various frameworks used for sustainability indicator sets, a description of the main criteria for effective sustainability indicators as derived from the literature, and finally a discussion of the problems with the use of indicators.

This chapter not only provides necessary background information on indicators and how they work, but the list of criteria for effective sustainability indicators will be used in the first stage of the Sustainability Indicator Evaluation Framework. Other information contained within this chapter will be referred to in the history and description of the indicator set used for the test of the SIEF.

Defining Indicators

Indicators, generally, provide a simplified, easily understandable vision of the state of a complex system. In the case of sustainability indicators, the focus is on "linkages among social, economic, and environmental factors" (Gahin and Paterson 2001, 353). They are a measurement tool that can be used for a variety of purposes because of their flexibility and their ability to facilitate community dialogue and action.

Definitions of indicators usually center around the fact that indicators are meant to be representative of larger systems. Cole, Ayles and Gibson provided a succinct

description of sustainability indicators when they wrote: "Indicators are measurements selected to represent a larger phenomenon of interest, in our case the relationships between ecosystems or environments and human health" (1998, 202).

History of Indicators

Community indicators were first used in 1914 for a study of industrial conditions in Pittsburgh by the Russell Sage Foundation (Gahin and Paterson 2001, 348). Indicators for economic purposes, such as the GDP and the GNP, had been in use for some time before this, but this was the first time that an indicator set had been used for a non-economic purpose.

The use of community indicators did not really surge, however, until the early 1970s (Gahin and Paterson 2001, 349). It was during this decade that the journal *Social Indicators Research* was first published and the social indicators movement was born. This sparked a substantial amount of research in the field of indicators and led to a multitude of advances in the field. (Gahin and Paterson 2001, 349).

During the 1980s, various environmental trend reports were published. Most of these used indicators in some form or another to monitor global environmental trends. Examples include the Council on Environmental Quality's *Environmental Trends*, Worldwatch Institute's *State of the World*, and the World Resources Institute's *World Resources* reports. Several of these continue to be published annually. (Gahin and Paterson 2001, 350).

Then, in 1992, the United Nations held the first Earth Summit in Rio de Janeiro, Brazil. At this meeting, Agenda 21, a document outlining the goals of sustainability and offering a blueprint of how to achieve it, was drafted. Included in Agenda 21 is the suggestion that organizations, local, national, and international, create sustainability indicator sets (United Nations 1992, 302). This, according to Holden, was the main impetus for sustainability indicator studies (Holden 2001, 218).

In the United States, the President's Council on Sustainable Development in 1996 suggested that the federal government along with other governmental and nongovernmental groups create a set of national-level sustainability indicators. In 1998, an experimental list of 40 indicators was published along with a progress report by the U.S. Interagency Working Group on Sustainability Indicators. (Gahin and Paterson 2001, 351).

Since then, a variety of localized groups have taken the initiative and created their own sets of local sustainability indicators. Examples include Sustainable Pittsburgh, Sustainable Seattle, Orlando's Healthy Community Initiative, and Sustainable Boston.

Indicator Design and Selection

Indicator Frameworks

Indicator frameworks are basically different methods for organizing and developing indicator studies. MacLaren, in her article *Urban Sustainability Reporting*, described six different types of sustainability indicator frameworks: domain-based, causal, goal-based, issue-based, sectoral, and combination frameworks (MacLaren 1996, 190).

Domain-based frameworks focus on the different domains, or areas of focus, of sustainable development, namely the environment, social issues, and the economy. The indicators are developed so that they deal with each of these focal areas explicitly. Categories can also be added for indicators that deal with a combination of the different domains. (MacLaren 1996, 190).

Causal frameworks are developed with the intention of using the indicators to derive cause-effect relationships (MacLaren 1996, 193). One example is the Pressure-State-Response framework developed by the OECD. In this framework, the indicators are divided into three categories: pressure indicators monitor the cause of pressure, or stress, on the environment; state indicators are simply 'state-of-the-environment' indicators, they are purely descriptive; response indicators measure the effectiveness of social responses to problem areas (Alberti 1996, 404).

Goal-based frameworks are simply that: goal-based. Rather than focus on the different domains of sustainability or on the cause-effect relationships between various social actions and their environmental repercussions, this approach requires the setting of various sustainability goals for a community. The indicators are then designed to assist the community in moving towards these goals. (MacLaren 1996, 190).

With issue-based frameworks, the focus is on key sustainability issues for a particular community. This is similar to the goal-based framework, however this framework does not require the setting of particular goals, but rather the identification of important

issues. Examples of issues include waste management, air and water quality, and poverty reduction. (MacLaren 1996, 193).

Sectoral frameworks are based around the organization of local government. Indicators are developed for each sector which municipal governments normally have jurisdiction over, such as "housing, transportation, waste management, land use, and police services" (MacLaren 1996, 193).

Combination frameworks are simply frameworks that make use of more than one of the above frameworks (MacLaren 1996, 194). These types of frameworks have an advantage over the others in that by combining the different types of frameworks it is possible to mix their strengths while also alleviating some of their weaknesses (MacLaren 1996, 194).

Indicator Use

There are a variety of uses for sustainability indicators. The three basic goals of sustainability indicator studies are to increase awareness related to sustainability issues, to monitor progress towards sustainability goals, and to inform policy decisions. As Holden has written, "urban sustainability indicators aim to monitor progress in the city toward the broad and varied goals of environmental, economic, and social sustainability, in order to improve policy and public awareness" (2001, 218).

Although informing policy decisions seems to be the most directly influential of the three uses, it has been observed that often the most influential use tends to be increasing

awareness related to sustainability issues, especially with respect to community indicator projects. Community sustainability indicator projects tend to be community-wide efforts, involving many local leaders and citizens, some with knowledge of sustainability issues and some without. The process of indicator development can, in many cases, prove to be the most useful aspect of the whole project (Holden 2001, 218). As Gahin and Paterson have noted,

> "Practitioners have discovered that the process of developing indicators yields many benefits as well. It brings people together from many sectors of the community, fosters new alliances and relationships, and creates shared understanding of community problems and goals. Deciding which indicators to include helps to define abstract and complex concepts such as sustainability in ways that have meaning for the community." (2001, 353).

Criteria for Sustainability Indicators

The following list of criteria for sustainability indicators is derived from the literature reviewed in Appendix B. This is important in that there are many different types of indicators that measure many different things and it was necessary to ensure that the criteria used for the Sustainability Indicator Evaluation Framework was designed to specifically handle sustainability indicators. The criteria focused upon in the literature are as follows:

- The indicator set must have a sound scientific basis
- The indicator set must be measurable
- The indicator set must be predictive
- The indicator set must be integrative
- The indicator set must be representative of/relevant to the topic under investigation
- The indicator set must be sensitive and/or responsive to change

- The indicator set must be easily understood and interpreted for non-experts.

The following subsections give short descriptions of each of these criteria, which will be helpful in the first stage of the Sustainability Indicator Evaluation Framework.

The Indicator Set Must Have a Sound Scientific Basis

Scientific soundness of an indicator is included as a criterion for indicator selection in many resources on the subject (Alberti 1996, 416, 417, 418; Holden 2001, 220; Levett 1998, 291; Spangenberg, Pfahl, and Deller 2002, 67). It is one of the three selection criteria employed by the OECD (Alberti 1996, 417). This criterion means, basically, that the indicator must have at its origin reliable scientific knowledge. For example, if an indicator is to measure water quality, the specific methods used and the interpretation of the results of those measurements should be based on scientific knowledge about measuring water quality.

According to Alberti, there are three conditions for determining whether an indicator meets this criterion. The indicator must be:

- "theoretically well-founded in technical and scientific terms
- based on international standards and international consensus about its validity
- capable of linkage with economic models, forecasting, and information systems" (Alberti 1996, 418)

These conditions are geared towards national and international indicators. As far as local indicators are concerned, the most important condition is that it is "theoretically well-founded in technical and scientific terms".

The Indicator Set Must be Measurable

While this criterion seems quite obvious, it is still an important criterion to mention (Alberti 1996, 417-418; Dale and Beyeler 2001, 6; Holden 2001, 220; Levett 1998, 292; Moffatt, Hanley, and Wilson 2001, 36; Nilsson and Bergström 1995, 181; Spangenberg, Pfahl, and Deller 2002, 64, 67). For an indicator to be measurable means several things. The first is that the indicator must deal with something that can, in fact, be measured with relative ease (Moffatt, Hanley, and Wilson 2001, 36). The second is that the necessary data must be available (Levett 1998, 292) and, third, it must be of known quality (Alberti 1996, 418). The fourth is that the data must be able to be updated at regular intervals, simply for the reason that if the data is not updated at regular intervals any significant trends will be difficult to discern (Alberti 1996, 418).

The Indicator Set Must Be Predictive

The indicator must be able to provide some sort of early warning signals that a bigger change is about to happen in the larger system it is attempting to approximate (Cole, Eyles, and Gibson 1998, 7; Nilsson and Bergström 1995, 181; Winograd 1995, 205). In order to accomplish this, the indicator must be sensitive to changes in the larger system. Dale and Beyeler wrote that "the most useful indicator is one that displays a high sensitivity to a particular and, perhaps, subtle stress, thereby serving as an early indicator of reduced system integrity" (2001, 6). This characteristic may be difficult to discern in an indicator until it has been measured several times.

The Indicator Set Must Be Integrative

This criterion takes on the idea that sustainable development deals with the linkages between economic, environmental, and social systems (Dale and Beyeler 2001, 7; MacLaren 1996, 186). An effective indicator, in this sense, would also attempt to link these systems, either outright through the indicator itself or through some sort of analysis.

The Indicator Set Must Be Representative Of/Relevant To The Topic Under Investigation

While this also may seem to be an obvious requirement of any indicator set, measuring sustainable development is not an easy task (Alberti 1996, 416-418; Holden 2001, 220; Levett 1998, 292; Nilsson and Bergström 1995, 181; Spangenberg, Pfahl, and Deller 2002, 64, 67). This is complicated in that sustainable development is such an amorphous idea that different communities may determine that different concepts are relevant to, or representative of, it. For example, a community located near a sensitive ecological system may choose to focus on ecological issues and consider those most relevant to the sustainability of its community. However, another community located in an urban area may choose to focus on social or economic issues. Therefore, the topic under investigation, while contained under the broad umbrella of sustainable development, may be quite different for different communities.

The Indicator Set Must Be Sensitive and/or Responsive to Change

This criterion has to do with how well the indicator set tracks changes in the phenomena being measured (Alberti 1996, 417-418; Cole, Eyles, and Gibson 1998, 204;

Dale and Beyeler 2001, 6; Holden 2001, 220; Spangenberg, Pfahl, and Deller 2002, 68). Spangenberg, Pfahl, and Deller wrote that indicators "have to react early and sensibly in what they are monitoring, in order to permit monitoring of trends or the successes of policies" (2002, 68). This is important because the whole purpose of indicators is to serve monitoring tools, and if they do not adequately monitor the phenomena they are measuring they are not of much use.

The Indicator Set Must Be Easily Understood and Interpreted for Non-Experts

In order for the general public and policy-makers to make use of the indicator set, they must be able to make sense of it (Alberti 1996, 417-418; Holden 2001, 220; Moffatt, Hanley, and Wilson 2001, 36). Indicator sets, as previously noted, are used largely as community-building tools. If the community is unable to understand what is being measured, than this potential use for indicator studies is lost. Also, it is important that people understand the measurements because oftentimes the organization producing the indicator reports is relying on the public to take action based on the results of the measurements.

Problems With Indicators

A number of problems with indicators have been noted in the literature. In fact, this is the reason for embarking on this study in the first place. Arguments have been made that indicators do not, in fact, measure sustainability. However, this is not the only argument presented. The next two subsections will discuss these problems further. The first will consider problems with the actual development of the sustainability indicator set and the second with consider more general concerns about sustainability indicators.

Developing the Indicator Set

There are many decisions made in the development of the indicator set that can ultimately affect how the indicators are interpreted. First, the correct framework must be chosen. Then the appropriate number of indicators must be decided upon and selected, keeping in mind that most community indicator projects are rather low-budget and must rely on data already being collected. Finally, a decision must be made as to how to report the data, whether the indicators will be presented separately or aggregated in some fashion. These are all difficult issues and warrant some consideration.

Choosing the correct framework for an indicator set is a difficult process. The framework must represent the goals of the community in creating an indicator set. For example, if the idea is for the community to be able to track changes in their natural, social, and economic resources over time, it does not make sense for them to choose a causal framework for designing their indicator set.

Each framework also has its particular limitations, which can be deterring factors in some cases. One of the most popular criticisms is of the Pressure-State-Response (PSR) framework, in which the community attempts to establish causal relationships. Bell and Morse refer to the process of classifying indicators as 'causes' and 'effects' as "shoe horning" (2001, 295). Spangenberg, Pfahl, and Deller note that the linear format of the PSR framework can easily lead to misinterpretations of the results, especially in the

context of "complex, non-linear self-organizing systems, like society, the environment or the economy" (2002, 64).

Choosing the appropriate number of indicators is a delicate matter. First, it depends on the framework being used, some frameworks allow for more indicators than others. It also depends on the goals of the indicator set. If the goal is simply that of increased public awareness, fewer indicators may be necessary to provide a 'snapshot' of the sustainability of the community that can easily be presented to the public. However, if the goal is policy guidance, a more complex set of indicators is necessary, which means more indicators. (Spangenberg, Pfahl, and Deller 2002, 68).

Data quality and availability is also a concern in determining how many indicators to use. Most indicator projects have limited funding and the cost of obtaining original data is prohibitive. Therefore, indicator projects must often rely on data that is already collected, such as census information, water quality information measured by the local water authority, and air quality information measured by other organizations. This means that, in some communities where such information is not readily available at a reasonable cost, fewer indicators may be necessary, simply for economic reasons. (Alberti 1996, 418).

The decision of how to present the data in its final form is an issue that is argued quite extensively in the literature. Most of the arguments center on whether or not to aggregate the data somehow into one number, or to present each indicator separately (Bell and Morse 2001, 295; Holden 2001, 225-226; MacLaren 1996, 186; Spangenberg,

Pfahl, and Deller 2002, 64, 68). The main issue here is that sustainability is a complex concept and to say that sustainability can be indicated by one aggregated measure is seriously misleading. As the saying goes, 'the devil is in the details', which are lost in an aggregated measure.

The benefit of an aggregated measure is that it is easily interpretable by the general public without having any scientific knowledge. However, if the decision is made to aggregate the indicators several more complicated issues must be considered. First, different weighting schemes must be considered. Are some indicators more important than others? How should this be represented in the final aggregate measure? Second, how are the different measurements taken for each indicator to be standardized so that they can be aggregated? Third, how should the indicators be aggregated? Should they simply be added up, or should a more complicated system be developed? Finally, what happens when the movement of one indicator towards sustainability is balanced or canceled out by the movement of another indicator away from sustainability? How should, or simply should, an aggregate measure reflect this? (MacLaren 1996, 186).

Problems With Indicators in General

Several more general problems with sustainability indicators have also been discussed in the literature. By far the most prominent issue is the fact that sustainable development is a complex issue involving complex processes, systems, and linkages, while indicators are a simplified measurement tool. The question is whether or not indicators can, and/or to what degree indicators can, approximate an accurate measure of the sustainability of a particular area. Bell and Morse, in their book on the subject, noted

that "for all their attempt at holism and a desire to incorporate the richness of humankind's complex interrelationships with nature, (Afgan, Caravalho, and Hovanov 2000) are still a classic reductionist set of tools based on quantification" (1999, 31).

Chapter 5: Sustainable Pittsburgh's Southwestern Pennsylvania Indicators Project

> *"The mission of Sustainable Pittsburgh is to affect decision-making in the Pittsburgh region so that it integrates economic prosperity, social equity, and environmental quality. We do so by building diverse coalitions, developing measurable new indicators as a compass, and undertaking key initiatives. In all of our work we emphasize long term and sustained quality of life for all citizens."* (Sustainable Pittsburgh)

This chapter is intended to present an in-depth portrait of the Sustainable Pittsburgh indicators project. It will begin with an introduction to Sustainable Pittsburgh and its goals as an organization, which includes developing an indicators project. It will then move on to a discussion of the indicators project itself, describing (a) the history of the indicators project, (b) the process employed in developing the indicator set, (c) the framework of the indicator set, (d) the indicators themselves, and (e) the use of the indicator study, both potential and actual.

Four different resources are used to complete this study. The first is the *Goals and Indicators Project Public Report*, which more or less depicts the beginning of the indicator development process in Pittsburgh (Sustainable Pittsburgh 1999). Second is the *SWPA Community Indicators Handbook*, a document prepared by Sustainable Pittsburgh in an effort to help other communities develop their own sustainability indicator set (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002). The *Southwestern Pennsylvania Regional Indicators Report* is the next resource that will be included in the case study (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002). This is the report completed using the indicator set developed by Sustainable Pittsburgh.

Finally, I will fill in the information missing from the previously listed sources through an interview with Court Gould, the director of Sustainable Pittsburgh. In order to determine what information was missing, I made a list of the questions I had about the indicator set and went about attempting to answer them with the information provided in the reports and the website. I then took those questions that could not be answered and put them into an interview format. The full list of interview questions can be seen in Appendix D.

Sustainable Pittsburgh

Sustainable Pittsburgh is an organization that began in 1998 with the purpose of furthering the cause of sustainability in the Pittsburgh metropolitan area. The indicators report itself covers the entire six-county southwestern Pennsylvania region. The organization is funded principally through the Heinz Endowments, a funding organization devoted to improving the quality of life in the southwestern Pennsylvania region (*The Heinz Endowments*). Sustainable Pittsburgh has also been working with AtKisson, Inc., a consulting firm specializing in sustainable development, for the development of the indicator set and the collection of data.

While this group does produce an indicators report, this is not the only focal point of the organization. In Sustainable Pittsburgh's Strategic Plan several objectives and goals are listed, of which an indicators project is only one. The group has also been successful in establishing "a network of affiliates - individuals, businesses, and organizations that are committed to working more closely together to advocate and advance sustainability" (Sustainable Pittsburgh). However, the indicators project is

important in identifying the areas most in need of improvement for the region and giving the organization important data that can be used for improvement projects and future research. (Sustainable Pittsburgh).

A History of Sustainable Pittsburgh's Indicators Project

The Sustainable Pittsburgh project began in 1998, in part a reaction to a visit from the members of the President's Council on Sustainable Development. During early 1999, about 250 community leaders worked together to lay the groundwork for the Sustainable Pittsburgh Goals and Indicators Project.

BOX 5.1: OBJECTIVES AGENDA FOR THE SUSTAINABLE PITTSBURGH GOALS AND INDICATORS PROJECT

- Suggest a long-range regional development agenda and establish guiding principles and benchmarks for pursuit of regional prosperity that balances Economy, Equity, and Environmental interests
- Citizen Participation: Model a process that can be replicated by communities throughout the region in building a consensus agenda.
- Indicators: Develop, implement, and track new measures/indicators of regional prosperity that ensure balance between she three E's.
- Integrate: Link the agenda and adoption of the indicators to the region's mainstream development strategies and create a regional vision which establishes sustainability as a key criterion in policy, planning, design, and decision-making.
- Education: Increase appreciation for sustainability issues that leads to cooperation on specific and measurable strategies to address regional goals.
- Natural Capital: Increase recognition of material contributions to economy, quality of life and human capital made by natural resources and amenities.
- Stewardship: Encourage key institutions to adopt sustainable development principles and practices.
- Public Policy: Offer substantive, long-range issues around which to frame the public policy debate
- Constituency: Grow an ever-widening circle of persons and organizations ready to promote recommendations of the project and integrate sustainable development in their work.

(Sustainable Pittsburgh 1999)

This group put together an objectives agenda for the project, including encouraging citizen

participation and suggesting a "long-range regional development agenda" (Sustainable Pittsburgh 1999) (A complete listing of the objectives can be seen in Box 5.1). Ten teams were then created, based on the ten categories, shown in Box 5.2, indicated by the President's Council on Sustainable Development to be "a reasonable set of issues on which to examine sustainable development and look at its component parts" (Sustainable Pittsburgh 1999). The objectives were meant to serve as guiding principles for the teams as they developed their suggested goals, indicators, and strategies.

BOX 5.2: CATEGORIES FROM THE PRESIDENT'S COUNCIL ON SUSTAINABLE DEVELOPMENT

- Equity
- Women, Children and Regional Demographics
- International Relations
- Health and the Environment
- Education
- Economic Prosperity
- Stewardship
- Conservation of Nature
- Sustainable Communities
- Civic Engagement

(Sustainable Pittsburgh 1999)

Each of the teams consisted of an average of a little over 20 community members, some of which served on more than one team. The teams met on four occasions during a two-month period. In the end, each team produced a set of goals for their assigned category, each with their own set of suggested indicators and strategies. Some also included examples, called models in the report, of initiatives with a similar goal. For example, under the category of Equity, the strategies include conducting a public attitude survey and forming "an umbrella advocacy group that unites groups focusing on equity issues". Indicator suggestions for this category include "representation and diversity" and "number of grassroots groups that are working to raise awareness on equity issues". Models (examples) include the Alliance for Progressive Action and the Hill Consensus Group. (Sustainable Pittsburgh 1999).

The results of these team meetings and discussions were published in May of 1998 as the *Goals and Indicators Project Public Report* (Sustainable Pittsburgh 1999). Following this effort, a few years were spent actually identifying the final indicators. Because the organization chose to focus their efforts on a larger six-county region, rather than simply the city of Pittsburgh, the indicator development process was quite complex and difficult. The group consulted with many citizens, experts, regional organizations, and local leaders, gaining their insights on the important issues in the region and the best ways to measure these issues. (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002).

Finally, in the year 2002, Sustainable Pittsburgh produced its first indicators report, measuring 21 indicators in total. In 2002 Sustainable Pittsburgh also produced the *SWPA Community Indicators Handbook,* which is a workbook designed to assist other regions in developing their own sustainability indicators using AtKisson, Inc.'s Compass Index of Sustainability (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002)

The Indicator Development Process

Once the goals for the project had been identified, Sustainable Pittsburgh took three more years to select the final indicators and produce the report. The group wanted to ensure that they were as comprehensive as possible and that the indicators were meaningful to the southwestern Pennsylvania community. In order to accomplish this,

the organization undertook a time-consuming process of community involvement and intensive research. (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 8).

One of the biggest concerns for Sustainable Pittsburgh in creating this indicator set was to make certain that the set would be comprehensible and meaningful to nearly everyone in the region. As can be gathered from the history of the indicator set, the process used in order to develop the indicator set was very participatory in nature. In the literature surrounding this project, Sustainable Pittsburgh has emphasized the point that this is a community-oriented project, and therefore the organization wanted to make sure that the project contained strong ties to the community and that the indicators were representative of the concerns of the citizens. Community participation in this project began with the birth of the organization in 1998, with community meetings preceding the meeting of the President's Council on Sustainable Development, held in Pittsburgh in 1998. In terms of the indicator project, community input was crucial in developing the project itself as a goal of the organization. Sustainable Pittsburgh also consulted with community leaders and citizens from each of the six counties in determining what was important for the indicators to try and measure and what these potential indicators would mean to the community. (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 8).

The southwestern Pennsylvania region is home to 29 colleges and universities, including Carnegie-Mellon University and the University of Pittsburgh (*Pittsburgh Information and Statistics* 2003). This makes for a rich collection of research projects and

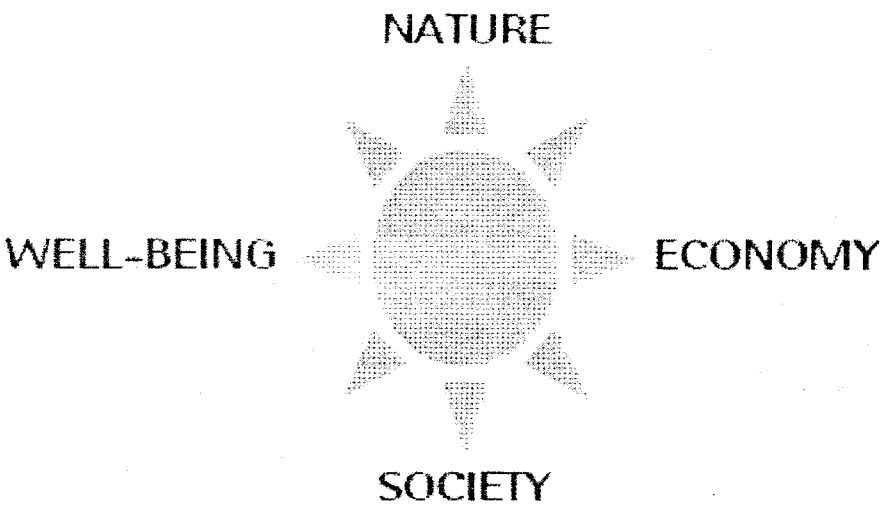
indicator studies focused on the southwestern Pennsylvania region (Gould 2003). Sustainable Pittsburgh made an effort to review as many of these studies as possible in order to determine what kind of data was available for the region and to become familiar with the "ins and outs" of local research. (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 8).

Besides looking into local research and interacting with community members, the organization also consulted with experts on the selection of the final indicator set and then again when the measurements were collected and interpreted. (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 8).

The Indicator Framework

The framework utilized to organize the indicators was originally developed by AtKisson, Inc., the consulting firm which facilitated this project. The focal point of the framework is the Sustainability Compass, a concept which visualizes the sustainability

FIGURE 5.1: THE SUSTAINABILITY COMPASS



(Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 11)

discourse as having four major "points": Nature, Economy, Society, and Wellbeing (see Figure 5.1). The indicators are then placed into one of these four categories. After the measurements are taken, then, an aggregation tool is used to come up with a final sustainability index number. (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002).

The Sustainable Pittsburgh sustainability indicator set can be said to have a combination framework, in that it is both issue-based and domain-based. The indicator set is issue-based due to the choice to focus on several important issues within the community. The most obvious example is the choice to complete an equity analysis for each indicator. Through community discussions it was determined that equity is a major issue for the southwestern Pennsylvania region and that it was so important that it warranted its own special analysis related to each indicator.

The indicator set is also domain-based. In fact, of the two frameworks combined in this set I would argue that the domain-based framework is the dominant framework. The four points of the sustainability compass determine the four domains into which the different indicators are organized.

The Indicators

In the indicators report a total of 21 indicators are presented in four categories. Each indicator is listed under a generalized title, such as "Air Quality" and is connected to a specific goal, such as "Clear Healthy Air, Every Day" (Sustainable Pittsburgh

Southwestern Pennsylvania Regional Indicators Report 2002, 17). A full listing of the indicators can be seen in Box 5.3.

BOX 5.3: THE INDICATORS

Nature
- The EPA's Air Quality Index
- The health of regional indicator species (both flora and fauna)
- Electrical energy use
- Random phone survey of adult residents' environmental knowledge, attitude, and behavior
- Percent change in land consumed
- Percent of solid waste recycled
- Miles of stream meeting state "recreational standards"

Economy
- The difference between cost of basic needs and annual incomes
- Home ownership and rental affordability for low-income people
- Hours per year of driving delays
- Percentage of people living in poverty
- Unemployment rate
- Average and median wages, adjusted for inflation

Society
- Rate of adult violent and property crime
- Percent of high school seniors graduating from high school
- The number of students per computer
- Social Capital Index (for the state of Pennsylvania)
- Voting rates in annual elections

Well-Being
- Age-adjusted death rates for heart disease
- Infant mortality rate and rate of low birth-weight babies
- Suicide rates

(Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002)

The analysis of every indicator is divided into seven subsections for the report: (1) "Indicator", which is the name of the actual indicator; (2) "Trend", which describes the trend that can be discerned from the measurement, if any; (3) "What We Measure", which is a description of the indicator and how it is measured; (4) "What It Means", which is a sketch of the actual measurement; (5) "What It Connects To", which is a narrative about what other facets of the community this particular indicator could have an effect on; (6) "What We Need To Know", which is a section that

details how this particular measurement could be enhanced or improved in the future and also a listing of the understanding needed in order to fully comprehend the meaning of the indicator measurement; and finally (7) "Equity Analysis", which is a section that connects each indicator to the idea of equity and describes how the indicator could have an impact on this issue (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002).

The Use of the Indicator Study

The last, but certainly not the least important, element of an indicator set to be discussed here is the use of the indicator study. This section will not only include a discussion of the present use of this indicator study but also its intended use and hopes for its future use.

According to the preface of the 2002 *Regional Indicators Report* the indicator study is intended to be a "catalyst for assessment, education, and advocacy of our region's progress toward a sustainable future" (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 5). In other words, this is only the beginning. The indicator study is intended to provide a stepping-off point for other sustainability-related initiatives. It is also intended to be a tool that will help to create a regional discussion about sustainability issues and move regional decision-making into a broader realm (Gould 2003).

As of yet only one report has been published, and therefore the indicator study has not yet been able to fully accomplish the goals outlined in the previous paragraph.

However, it has been of some use to Sustainable Pittsburgh in that it has given them some legitimacy as an organization truly trying to do some good for the region (Gould 2003). According to Court Gould, the organization's director, they are "not just seen as an anti-sprawl group anymore" (Gould 2003). It has also given the group the ability to "play ball" with other organizations in the region (Gould 2003).

As for the future use of this indicator set, Court Gould would like to see it being used as a mainstream policy guide (Gould 2003). He would also like to see the information collected through the indicators being used as a platform for politicians and, in an interview, referred to the Sustainable Community Initiative of the City of Austin, Texas, as an example of what Pittsburgh would like to accomplish (Gould 2003). Eventually, the vision is for the indicator reports to become integrated with public policy-making and regional decision-making.

Chapter 6: Testing the SIEF – Analyzing Sustainable Pittsburgh's *Southwestern Pennsylvania Indicators Report*

The purpose of this thesis has been to develop a framework for determining whether or not sustainability indicators measure sustainable development. However, in order to find out whether or not the framework will prove useful, it is necessary to test it and find the problems and decide what improvements need to be made. The indicator set created by Sustainable Pittsburgh, as described in the previous chapter, will be used for a test of the Sustainability Indicator Evaluation Framework, as outlined in Chapter 2.

For this test evaluation, the two stages of the analysis have been completed. The first is a comparison of the two lists of criteria for sustainability indicators, one from the literature and one from Sustainable Pittsburgh. The second stage of the analysis is a content analysis of the indicator report itself in which the questions listed in the matrix in Appendix C are asked of each indicator in order to determine whether or not the indicator set measures sustainable development.

Indicator Selection Criteria

This section of the analysis is based on a comparison of a list of criteria for sustainability indicators to the list of criteria for sustainability indicators presented by Sustainable Pittsburgh. Both lists can be seen side by side in Boxes 6.1 and 6.2.

The criteria derived from the literature have been defined in Chapter 4. The definitions for the criteria from Sustainable Pittsburgh, however, have not yet been discussed in this document. A brief description will be provided in the analysis, however the full

section of Sustainable Pittsburgh's *Indicators Handbook* describing these criteria can be found in Appendix F.

As is shown in Table 5.1, the analysis of these two lists has revealed three different categories for the criteria. Either they matched completely, possibly could match, or did not match at all. Four of the criteria on each list belong in the first category. Both argue that a good indicator must be relevant, understandable, sensitive (or responsive) to change, and systemic (labeled integrative in the table of criteria pulled from the literature).

Table 6.1: Comparison of the Criteria From the Literature and the Criteria From Sustainable Pittsburgh

Sustainability Indicator Criteria From the Literature	Sustainability Indicator Criteria From Sustainable Pittsburgh
Match	
Sensitive and/or Responsive to Change	Responsive
Integrative	Systemic
Representative of/Relevant to Topic Under Investigation	Relevant
Easily Understood and Interpreted for Non-Experts	Understandable
Possible Match	
Sound Scientific Basis	Reliable
No Match	
Measurable	Clear in Direction
Predictive	Reflective of Change Over Time

(Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002, 10-11)

The second category contains one set of criteria that have meanings that are close enough to each other that they could match, but there is not enough information to determine whether or not there is actually a match. The criteria that an indicator set must have a sound scientific basis requires that the set be founded on scientific principles and that the measurements be scientifically valid. Sustainable Pittsburgh includes the criteria that the indicator set must be reliable. According to their definition, this means that the data must be "trustworthy" (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002, 10). There is also reference in this description to being assured that the data can and will be collected at regular intervals (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002, 10). Whether the data being "trustworthy" refers to being able to trust the measurements or the availability of the measurements is not clear. Therefore I determine that it is a likely match, but at this point an uncertain one.

Two criteria in each list did not match up. The criteria from the literature requiring the indicators to be measurable and predictive had no counterparts. This does not mean that these criteria are not met by the indicator set, but rather that, when making the list of criteria, Sustainable Pittsburgh, for any number of reasons, chose not to list these two criteria. For example, the criterion that an indicator be measurable was obviously employed, even though it was not listed. This is implied simply through the fact that all of the indicators were measured.

In terms of the ability of an indicator to be predictive, as noted in Chapter 4, this may not be able to be determined until a particular indicator has been measured and analyzed

several times. The Sustainable Pittsburgh indicator set has only been measured and analyzed once thus far, and therefore it is impossible to determine whether or not the indicators display a predictive nature.

The two criteria from the Sustainable Pittsburgh list that are not included in the list derived from the literature are that the indicators must be clear in direction and reflective of change over time. For an indicator to be clear in direction means that the data must be displayed in a way that is obvious to the reader which direction the status of the phenomenon being measured is moving (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002, 10). That an indicator be reflective of change over time means that the indicator must be able to show slow-moving, subtle, long-term trends as well as short-term, dynamic trends (Sustainable Pittsburgh *SWPA Community Indicators Handbook* 2002, 10). Neither of these criteria were found in the literature presented in Appendix B, which could possibly indicate a gap in the literature. It could also be a possibility that these points were not emphasized in the literature on sustainability indicators, but may have been emphasized in literature on other types of indicators or indicators in general.

What Are Sustainability Indicators Measuring?

Appendix E contains a matrix that shows which indicators from Sustainable Pittsburgh's *Southwestern Pennsylvania Indicators Report* give positive answers for the questions in each cell in the matrix presented in Appendix C. This section is organized around these two matrices, with each subsection below describing a different cell of the matrices.

Only two of the three columns of the first matrix were possible to be used for this analysis. The two columns not used represent the indicator elements of how the indicators were selected and the actual measurements taken. Unfortunately, not much information was available about how each indicator was selected. In fact, it would be almost impossible to know this exactly unless one was present at the meetings in which the indicators were selected. Otherwise, the only information available would be people's stories about the meetings, which may or may not be reliable. The actual measurements are not relevant to this analysis, and so no questions were devised for that column to begin with.

In the sections below is a discussion of the results of this study in detail. However, as can be seen in Chart 6.1 below, the strongest themes represented by the indicators were A Focus on Balance/Harmony/Integration, A Focus on Temporal Concerns, and A Focus on Anthropocentric Concerns, with 16, 21, 21 indicators respectively. No indicators represented the themes A Focus on Global Concerns or A Focus on Holistic and Systemic Thinking.

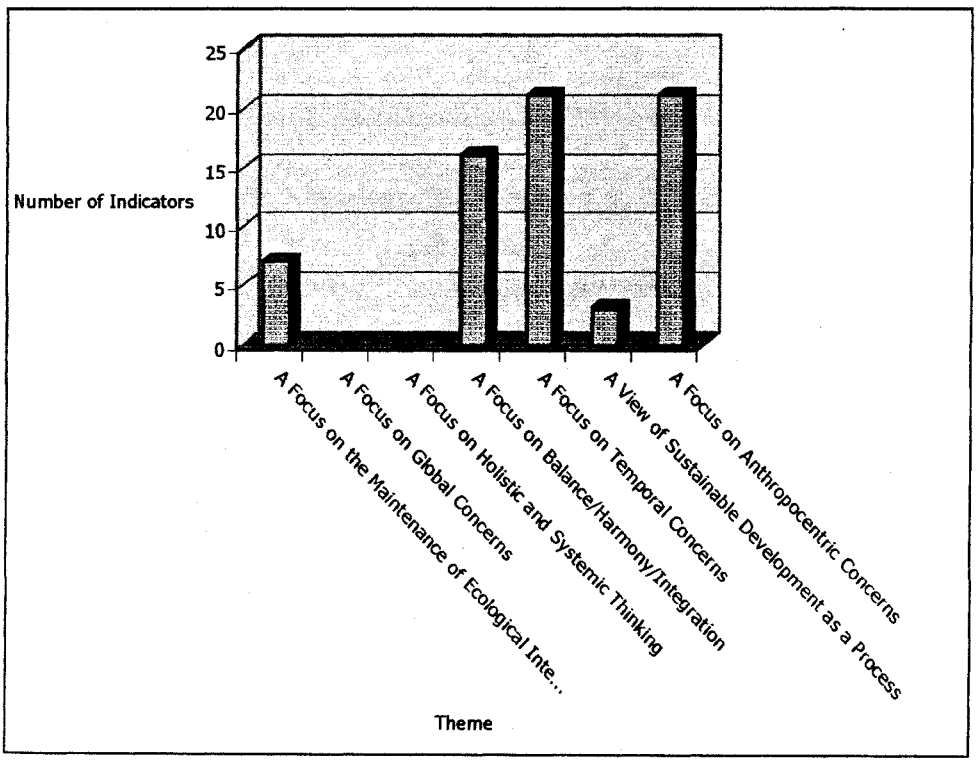
A Focus on the Maintenance of Ecological Integrity – Components

How many indicators deal directly with environmental issues?

Seven indicators showed a focus on the maintenance of ecological integrity in terms of the components measured. Basically, these were the indicators that fell under the "Nature" section of the indicator report. These were all indicators that dealt primarily with environmental issues, or were at least categorized as environmental issues by

Sustainable Pittsburgh. Examples of indicators in this Cell include The EPA's Air Quality Index and a random phone survey of adult residents' environmental knowledge, attitude, and behavior.

CHART 6.1: THEMES REPRESENTED BY THE INDICATORS



A Focus on the Maintenance of Ecological Integrity – Interpretation

In how many indicators does the analysis discuss an environmental threshold limit or value for the indicator?

Only three indicators fit into this cell. The question asked here was whether or not there was any analysis that indicated an environmental threshold limit or value for the indicator. Only the EPA's Air Quality Index, the health of regional indicator species, and the miles of streams meeting state "recreational use standards" could answer this question in the affirmative. In fact, in the case of the health of the regional indicator

species, there is no actual threshold limit, but the statement is made that "we need to determine the appropriate population levels at which these five species[1] signal an ecological balance within their natural ecosystem" (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 20). So, in reality, actual threshold limits are provided for only two of the indicators, with the third identifying a need for threshold limits to be established.

A Focus on Balance/Harmony/Integration – Components

How many indicators deal with more than one sector (environment, economy, social)?

As previously mentioned, this theme was in the top three themes represented by this indicator set. Fifteen indicators fit into this Cell, meaning that fifteen of the 27 indicators measured dealt with more than one sector. Indicators from each of the four classifications (Nature, Economy, Society, Well-Being) are found here, everything from the percent change in land consumed to infant mortality rates and the rate of low birth-weight babies.

A Focus on Balance/Harmony/Integration – Interpretation

In how many indicators does the analysis discuss a linkage between an indicator representing one sector to an indicator representing another sector?

Four indicators fit into this cell, compared to the fifteen represented in the other cell for this theme. These are the indicators that are linked in the analysis to another indicator or other indicators in different classifications. In each of these cases, the indicators are

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[1] The five species measured are mussels, Great Blue Herons, Pileated Woodpeckers, Blue-Eyed Mary's, and trillium.

not linked to specific indicators in other classifications, but rather the general statement is made that the indicator is connected to other indicators.

A Focus on Temporal Concerns – Components

How many indicators lend themselves to being measured over time?

Most of the indicators had been tracked for several years before being included in Sustainable Pittsburgh's report. These are the indicators that have been included in the count for this particular cell in the matrix. All of the indicators, however, are things that, even if they have not been measured in the past, have the potential to be measured over time.

A Focus on Temporal Concerns – Interpretation

In how many indicators does the analysis include plans to continue measuring this indicator in the future?

Court Gould, in the interview conducted for this study, mentioned that Sustainable Pittsburgh intends to collect and report on the data on the indicators annually, and therefore this implies that there are plans to measure all of the indicators in this set in the future. Therefore, while in only the analysis of six indicators were future plans for measurement were mentioned directly, there were no indicators where the analysis mentioned that the measurement would be discontinued.

A View of Sustainable Development as a Process – Interpretation

Are there any plans to revise the indicator set in the future? Are there any feedback mechanisms in place to determine the usefulness of the indicators?

Only three indicators specifically mentioned how they would be improved in the future. However, a couple of things in the indicator report show that Sustainable Pittsburgh is committed to revising and updating the indicator set as needed. The first is that, while most of the indicators did not include information on how specifically the measurements would be improved in the future, they did all include a section entitled "What We Need To Know". It is in this section of the analysis that Sustainable Pittsburgh has listed the different things that might be included in the measurement in the future in order to better understand the situation being measured. Also, at the end of the indicators report a section is included about future indicators, with a list of indicators that did not make it into the 2002 report due to a lack of meaningful data, which will hopefully be rectified in the future (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 66).

A Focus on Anthropocentric Concerns – Components

How many indicators deal with issues that have a direct effect on human health and wellbeing? How many indicators deal with issues of equity?

It can be argued that all of the indicators deal with issues that have a direct effect on human health and wellbeing simply because the idea behind sustainability is that the earth is one big system in which all elements are important for the health and wellbeing for all other elements. Fitting with this argument is the finding that all 21 indicators are represented in this cell. As far as equity concerns go, Sustainable Pittsburgh made the decision to focus on equity issues in the indicator report, and so the analysis of each indicator includes a section entitled "Equity Analysis." While in some cases it was

noted that there was not information to complete an equity analysis, there was a genuine effort to determine each indicator's relationship with equity issues.

A Focus on Anthropocentric Concerns – Interpretation

Is there any analysis indicating how improvement in the condition of a situation measured by an indicator might help improve the quality of life of people in the region?

While it is assumed that improvement in the condition of the situation measured by any indicator would mean an improvement in the quality of life of people affected by the situation, in this cell the focus is on whether or not there is any mention of what this improvement in the indicator situation will mean to the quality of life of people in the region. This is why only seven indicators are included in this cell. For example, the analysis of the indicator "the difference between cost of basic needs and annual incomes" included a sentence discussing the need "to be able to afford to plan for the long-term, to invest in education, to protect our lands, and to help our neighbors" (Sustainable Pittsburgh *Southwestern Pennsylvania Regional Indicators Report* 2002, 33). It then went on to say that without improvement in this indicator, it would be more difficult to meet these goals.

So What Do These Indicators Measure?

As is quite evident from this analysis, there are themes that are represented quite strongly, and then there are themes that are not represented at all. As previously noted, the themes A Focus on Balance/Harmony/Integration, A Focus on Temporal Concerns, and A Focus on Anthropocentric Concerns are represented quite heavily, with the latter two being present in all 21 indicators. A Focus On the Maintenance of

Ecological Integrity had moderate representation with seven indicators and A View of Sustainable Development as a Process could only be found in three of the 21 indicators.

However, A Focus on Global Concerns and A Focus on Holistic and Systemic Thinking were not represented at all. There are explanations for these omissions, however. The first concerns the theme of A Focus on Holistic and Systemic Thinking. As noted in Chapter 3, this theme is negated by the use of indicators as a measurement tool. The purpose of indicators is to break a large concept into smaller, more easily measurable chunks. The idea of holistic and systemic thinking is to keep all of the chunks together and measure them as a whole. Therefore, the best the indicator set could do, in this regard, would be to provide some sort of analysis connecting all of the indicators, which is measured under the theme of A Focus on Balance/Harmony/Integration.

The second explanation deals with the lack of A Focus on Global Concerns. This is a difficult theme to cover, especially in a set of regional indicators which not only need to present important information but also to hold people's interest. People are interested in reading about issues that affect them directly, not issues that affect people half a world away, even if the situation originates in their region. Therefore, it follows logically that the information presented in the indicator report would show how these issues affect the local situation, rather than the global situation. However, while the focus can be maintained on the local scale, it is important for people to realize the far-reaching effects of their choices. Therefore, this indicator set could be enhanced by including some sort of information about how the situation measured by a particular indicator affects people outside of the Southwestern Pennsylvania region.

Final Thoughts

The effort put forth to create the *Southwestern Pennsylvania Indicators Report* has been a good start. The indicators are quite strong in certain aspects of sustainability, but also very weak in others. Included in this section is a discussion of the two analyses of the Sustainable Pittsburgh indicators and a discussion of the strengths and weaknesses of the indicator set in terms of its ability to measure sustainable development.

In terms of meeting the criteria for indicators of sustainable development, there were two criteria focused on in the literature that were not focused on by Sustainable Pittsburgh: that the indicators be measurable and predictive. As previously noted, however, due to the limitations of the analysis it is not possible to say that these elements do not exist in the indicator set, it is only possible to say that they were not included in the list of criteria for indicators provided by Sustainable Pittsburgh.

This result is promising. It shows that, at least according to the literature, this indicator set should be relatively effective, an important goal for any indicator set. The lack of a specific reference to scientific soundness is troubling, as it is a very important criterion indeed. It is noted in the text describing the development of the indicator set that "experts" were consulted when they made the final indicator selections, and this could imply that the "experts" determined that the indicators were scientifically sound. I do not mean to imply that the indicators used by Sustainable Pittsburgh are not scientifically sound or that it concerns me that they may not be, rather I am concerned because this list of criteria was pulled from a handbook for other communities in the

southwestern Pennsylvania area on creating their own sets of sustainability indicators. Again, not to imply that they definitely would use indicators that are not scientifically sound, but without specific mention of this criterion, it is possible that one or two indicators might slip in that have no basis in scientific measurement.

As far as the measuring of sustainable development is concerned, the results of the analysis are encouraging, but I am not yet ready to say that this indicator set does indeed measure sustainable development. They are encouraging because of the high levels of representation in three of the themes. There is reservation, however, because of the complete lack of representation for global or holistic thought. The fact that the indicator set is regional, rather than city-based, is a step forward in considering the effects of the indicators outside the local area, however including some reference to areas outside the region is a way of providing some context for the region, locating it and its strengths and weaknesses in the world.

The lack of representation for holistic thought does not surprise me. In the beginning of this thesis the point was made that indicators are essentially reductionist measures and therefore not suited to measuring holistic concepts. This is essentially what troubles me about the use of indicators to measure sustainable development in general. They provide good measurements of all of the pieces, but the whole is not represented. If a way can be found to include the whole in indicator measurements it would be ideal. However, I fear that this ideal may be unattainable and another form of measurement may need to be developed.

Chapter 7: Conclusions

This final chapter will review this study and draw some conclusions about the methodology and, generally, about sustainability indicators and sustainable development. It will begin with some general lessons learned through this study about indicators and sustainable development. It will then move on to an examination of what didn't work as planned in the test evaluation. The next section will review what, based on the test evaluation, should be changed in the methodology. Finally, it will finish up with a section on how this study could be continued in the future.

What Didn't Work As Planned

For the most part, the evaluation of Sustainable Pittsburgh's indicator set was completed without a problem. A couple of small issues did arise, however. These mainly concerned the questions in the matrix under the heading of "How They Were Picked". The questions in this column were asked of three of the themes of sustainable development and basically all dealt with the reasons why the particular indicators had been chosen.

After reviewing the information available about the Sustainable Pittsburgh indicator set, it became obvious that none of this information was included, at least not at the level of specificity required in order to answer these questions. These are also questions that need to be asked of each indicator, there is no general answer that would apply to all of them. Therefore it would have been too time consuming to ask about in the interview with Court Gould. Nevertheless, the actual indicator selection had occurred some time ago, and in order to get a good picture of how the decision was made and

why it would be necessary to speak with a number of people who had been involved in the indicator development process. Even then, the description of the events may not be entirely accurate. The only way to be able to answer these questions fully would be to have been there when the decisions were being made.

Suggested Changes to the Methodology

There are just a couple of changes I would suggest in order to improve the methodology. The first is to eliminate the questions mentioned in the previous section. However, it would be good idea to speak to several people involved in the indicator development process, simply to get an idea of how the final decisions were made.

The second would be to find a way to look for questions that would indicate "A Focus on Holistic and Systemic Thinking". In Chapter 3 it is noted that indicator sets are inherently reductionist and therefore not holistic. However, there could be elements of holistic thought, or even a measurable inclination towards a more holistic measurement tool. In future incarnations of this study it would be useful to study this aspect further and figure out a way to determine whether or not these elements are present in the indicator set.

General Lessons About Indicators and Sustainable Development

In terms of sustainable development, I have developed a better grasp of the complexity of the concept and how difficult it would be to implement a project based on its principles. Measuring sustainable development is an especially difficult task, in particular because of its lack of an agreed upon definition. Every group attempting to

develop a measurement tool is therefore left on its own to decide upon its own interpretation of the concept. As previously noted, this is one of the strengths of the idea, as well as a weakness. It is a strength in that it allows the groups to develop a definition that fits their particular situation better than a standardized definition might. It is a weakness, however, because it opens up the concept to a lot of misinterpretation and does not allow for comparisons between groups who might choose slightly different definitions.

As far as indicators are concerned, I have learned that are not necessarily solely measurement tools. They can be used as community building and educational tools as well. It was impressive that at least 250 people were involved in the creation of Sustainable Pittsburgh's indicator set and that they are still being asked to give presentations on the set and the results presented in their first indicator report. However, it will be important to maintain the interest in this project as the years go on. Getting people interested in the indicator development process is not too difficult, since it can be, and often is, a participatory activity. People can get involved and contribute something to the process. In the data collection and reporting phase, however, it is more difficult to hold the public's interest. If a way could be found to involve the public in this stage as well it would assist in preserving interest in the project.

I have also learned that indicators, while they may not be the optimal method of measuring sustainable development, they can be an acceptable way of tackling the daunting task of measuring sustainable development. As noted in Chapter 6, the

Sustainable Pittsburgh indicator set did include most of the themes of sustainable development.

To Continue This Study

Overall I was pleased with the results of this study and I believe that there is potential to use the Sustainability Indicator Evaluation Framework in order to evaluate other sustainability indicator sets. In the future, however, there are several changes I would make to the process that would improve upon the information gathered about the indicator set and in the understanding of the purpose it serves within the community.

One of the biggest changes I would recommend would be to conduct more interviews. I would interview other staff members working on the project, members of organizations that have supported the project, and members of the local media who have covered the project in newspapers and on television. I would also recommend conducting a random survey of the general public in the region simply to gauge their level of knowledge about, and possibly involvement with, the indicators project. This would reveal the extent of the knowledge about the project in the community and the effectiveness of any efforts by the organization that created the indicator set to publicize the project.

Other than that, other adjustments may need to be made as the tool is used more and in varying circumstances. The Sustainable Pittsburgh project was chosen because of the wealth of information available about the project and the willingness of the director of the organization to work with me. However, this will not be the case with every

indicator set one might want to study, and therefore in some cases this tool may not produce the information needed to give an informed assessment of the project.

As with sustainability indicators, the SIEF is a tool that will most likely need constant updating and modification, especially since it is based on the discourse of sustainable development and the main themes may change as the discussion continues. However, the use of indicators to measure sustainable development is still a controversial issue and deserves further attention.

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Appendix A: Definitions of Sustainable Development

(Spangenberg 2002)

- Sustainability comprises four dimensions – environmental, social, economic and institutional. 296
- Sustainable development as a multidimensional optimization process by its very nature cannot have one unambiguously optimal solution, but can be characterized as an internally pluralistic opportunity space surrounded by the domain of unsustainability. 299
- Although normative through its ethical fundament, the concept of sustainability is not dogmatic but open to be shaped by political decisions and citizens' as well as customers' preferences. 306

(Kaufmann and Cleveland 1995)

- Sustainability is based on the balance between the ever-changing types and quantities of environmental life support used by society, and the long-run ability of natural ecosystems to provide life support. 109
- To learn about sustainability, we must identify non-sustainable aspects of society, quantify impacts of non-sustainable activities on natural and social systems, and quantify the impacts of corrective actions. 111

(Kline 1996)

- By analyzing different configurations of community, four characteristics of a sustainable community emerge: economic security, ecological integrity, quality of life, and empowerment with responsibility. 1
- A more sustainable community includes a variety of businesses, industries, and institutions which are environmentally sound (in all aspects), financially viable, provide training, education, and other forms of assistance to adjust to future needs, provide jobs and spend money within a community, and enable employees to have a voice in decisions which affect them. 2
- A more sustainable community is in harmony with natural systems by reducing and converting waste into non-harmful and beneficial purposes, and by utilizing the natural ability of environmental resources for human needs without undermining their ability to function over time. 2
- A more sustainable community recognizes and supports people's evolving sense of well-being which includes a sense of belonging, a sense of place, a sense of self-worth, a sense of safety, a sense of connection with nature, and provision of goods and services which meet their needs, both as they define them and as can be accommodated within the ecological integrity of natural systems. 2
- A more sustainable community enables people to feel empowered and to take responsibility based on a shared vision, equal opportunity, ability to access expertise and knowledge for their own needs, and a capacity to affect positively the outcome of decisions which affect them. 2

(Costanza and Patten 1995)

- The basic idea of sustainability is quite straight forward: a sustainable system is one which survives or persists. But there are three additional complicating

questions: (1) what system or subsystem or characteristics of systems persist? (2) for how long? (3) When do we assess whether the system or subsystem or characteristic has persisted? 193

- Biologically, sustainability means avoiding extinction and living to survive and reproduce. Economically, it means avoiding major disruptions and collapses, hedging against instabilities and discontinuities. Sustainability, at its base, always concerns temporality, and in particular, longevity. 193, 194
- But nothing lasts forever, not even the universe as a whole. Sustainability thus cannot mean an infinite life span or nothing would be sustainable. Instead, we argue it means a life span that is consistent with the system's time and space scale. 195
- A system is sustainable if and only if it persists in nominal behavioral states as long as or longer than its expected natural longevity or existence time; and neither component- nor system-level sustainability, as assessed by the longevity criterion, confers sustainability to the other level. 195

(Munro 1995)

- For development to be sustainable, it must continue, or its benefits must be maintained, indefinitely. This means that there must be nothing inherent in the process or activity concerned, or in the circumstances in which it takes place, that would limit the time it can endure. It also means that it must be worthwhile: it must meet the social and economic objectives just noted. 28
- To summarize then, sustainable development is the complex of activities that can be expected to improve the human condition in such a manner that the improvement can be maintained. 29
- Caring for the Earth attributes a new and broader meaning to carrying capacity in considering it to be the capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability for renewal. 30
- Activity is socially sustainable if it conforms with social norms or does not stretch them beyond the community's tolerance for change. 32
- Economic sustainability depends upon the relationship between benefits and costs; more precisely, it requires that benefits exceed or balance costs. 33
- Economic sustainability is conditioned mainly by the availability and cost of inputs, the cost of extraction and/or processing, and the demand for the product. 33
- Economic sustainability is constrained by anything that upsets a viable balance between benefits and costs. 34

(Carpenter 1995)

- Sustainability is whether (not the extent to which) the productive potential of a certain natural system will continue (for a long time, at least several decades) under a particular management practice (intensity and type of technical and social activities, e.g. inputs of energy, nutrients, genetic variety, harvesting procedures, and cyclic variations over time). 178
- Thus sustainability is inherently uncertain and even its probability is uncertain. Sustainability may be only relative, not absolute; a given management practice is

more or less sustainable at a certain location over a certain time with a certain mix of products. 184

(Winograd 1995)

- Sustainable development should be a process which allows for the satisfaction of human necessities without compromising the basis of that development, which is to say, the environment. 203

(MacLaren 1996)

- Some of the key characteristics of urban sustainability that are often mentioned in the literature and in policy documents are: intergenerational equity, intragenerational equity (including social equity, geographical equity, and equity in governance), protection of the natural environment (and living within its carrying capacity), minimal use of nonrenewable resources, economic vitality and diversity, community self-reliance, individual well-being, and satisfaction of basic human needs. 185-6

(Alberti 1996)

- There is agreement that for human activities to be sustainable, there must be a constant capital stock. There is also considerable consensus within the scientific community that humanity has altered important aspects of the natural resource base and that imprudent use may irreversibly reduce its capacity to support the human population in the future. 383
- When applied to cities, sustainability requires that inhabitants' needs be met without imposing unsustainable demand on local and global resources. The interdependence between cities and the global environment implies that even if cities reach sustainability at the local level, they will not necessarily be sustainable at the global level. 383
- Developing the arguments of White and Whitney, three conditions need to be met for a city to be sustainable: First, by adopting the best available technology, it must minimize its impact on natural resources. Second, assuming that a city has exceeded the carrying capacity of its hinterland and is importing carrying capacity from other regions, it must be based on an ecological surplus in these regions. Third, this same city should compensate the exporting regions for the value of ecological productive capacity it has subtracted. 384
- Building upon Kevin Lynch's performance dimensions, proposed in *Good City Form*, I suggest seven criteria of urban quality crucial to sustainability. First, urban life requires good environmental quality – clear air, water, and soil – but also adequate food supplies, housing, and infrastructure, as well as green areas and open space. 388
- Furthermore, to be sustainable, resource allocation must be both efficient – maximize the economic output per unit of resource input – and equitable – maximize social benefit per unit of economic output – across social groups, regions, and generations. 388-9
- Sustainability implies that essential life-support systems be maintained over time without degrading their quality. These systems provide essential services,

ranging from nutrient recycling, to water purification, to the maintenance of biodiversity. 413

(Atkinson et al. 1997)

- The context of sustainable development has always been that of intergenerational equity, as well as intragenerational equity, but the length of any particular sustainability time horizon is of course open to debate. It must be a few generations at least, but it will not be infinity. 3
- To spell it out, achieving a sustainable development path will imply a reduction in current wellbeing only if that flow of wellbeing cannot be reproduced for each successive generation. This will be the case where the current flow of wellbeing is being created by running down natural assets without saving or reinvesting for future consumption. 12

(Cornelissen et al. 2001)

- Rather than referring to continuity per se, sustainability associates continuity to *context-dependent* economimc, ecological and society (EES) issues. 173
- Sustainability implies an ongoing dynamic *development*, driven by human expectations about future opportunities, and is based on present EES issues and information. Sustainability *is* "sustainable development". 174

(Moffatt, Hanley, and Wilson 2001)

- At the risk of oversimplifying the complex concept of sustainable development, Elkins and Max-Neef (1992) have suggested that it can be thought of as a regular tetrahedron in which ethical, economic, social and ecological aspects are represented at the vertices. No priority is given to any one of these factors; thus sustainable development is an attempt to integrate all four sects into one coherent view of the world so that current and future generations of people and other living organisms can continue indefinitely. 3
- The base of sustainable development is the need to ensure that the Earth's support systems are maintained and, if damaged, repaired. 9
- One rule for the sustainability of the ecosphere must be to ensure that the largest possible number of species survive, and that also requires that the habitats for these species have to be maintained. 12
- Whilst most definitions of sustainable development acknowledge the need to integrate economic and ecological systems (Costanza 1997), some definitions require that attention be devoted to the social implications of the concept. 103
- Whilst there are many definitions of sustainable development (Pearce et al., 1989 illustrate this well from page 17 onwards), Jacobs (1991) suggests that there are there key elements that remain, no matter how it is interpreted. These are, briefly: (1) the integration, in both theory and practice, of environmental and economic policy making; (2) a commitment to global equity i.e. the fair distribution of resources both intra- and iner-generational; and (3) the notion that non-financial components be acknowledged when measuring economic welfare. 110
- Sustainable development is a broad, multidisciplinary topic that incorporates ethical, economic, social and environmental/ecological aspects of the real world.

The basic ethical dimension of sustainable development states that people and many other living organisms have the right to a fulfilled life. 153

- Central to the sustainable development debate is the realisation that ultimately all human life depends on careful use of the world's resources. 154
- The principal conclusion from this chapter is that the primary condition for sustainable development on this planet is the maintenance of a balance between human and many other forms of life and their habitats. 182

(Bell and Morse 1999)

- To begin with, the juxtaposition of the words sustainable and city may appear to be a gross contradiction – can any urban centre be regarded as sustainable when it clearly depends on goods and services created from outside? However, sustainability in this context has quite a distinctive meaning. For example, at a seminar held in California in 1991, the following definition was adopted: Sustainability may be defined as a dynamic balance among three mutually interdependent elements: (1) protection and enhancement of natural ecosystems and resources; (2) economic productivity; and (3) provision of social infrastructure such as jobs, housing, education, medical care and cultural opportunities. 61
- Sustainability is not an absolute quantity to be measured. Sustainability changes as an idea (or as a system) in terms of the perception of the onlookers. According to this approach, the view of sustainability must be developed so that it takes inboard the legitimacy of different views of sustainability. 100
- Like the term environment but far more so, sustainability is what we want it to be and can change as we change. It is an organic and evolving construct of our minds and not an inorganic and static entity that can be physically probed. 155

(Rennings and Wiggering 1997)

- Although the general definition of sustainability touches upon nearly all areas of economic, ecological, and social development, three main management rules of resource use have been derived from it:
    - Harvest rates of renewable resources should not exceed regeneration rates
    - Waste emissions should not exceed the relevant assimilative capacities of ecosystems.
    - Non-renewable resources should be exploited in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of renewable substitutes. 25-26

(Phillis and Andriantiatsaholiniaina 2001)

- Sustainability is difficult to define or measure because it is an inherently vague and complex concept. 436
- Sustainability measures the degree of the consistency of present and future needs in an economy, which is a dynamic process. Tietenberg (1984) suggested that sustainability means, "Future generations remain, at least, as well off as current generations". 438

(Morse et al. 2001)

- Sustainability seen as a system property seeks to define the ability of the system to exist in some preferred state and continue to deliver its products over time. 1

(Levett 1998)

- Many discussions of sustainability – including Custance and Hillier (1998) – invoke the idea that sustainable development is about the intersection of social, environmental and economic goals. This model – we could call it the 'three ring circus' – is a great advance on treating social goals as dependent on or identical with economic goals, and environmental outcomes as residuals – or simply ignoring these two realms altogether. But it does not go sufficiently far, for two reasons. First, the environment is a *precondition* for the other two. Without the planet's basic environmental life-support systems there can be no economy or society. Secondly, 'the economy' is not an end in itself or a force of nature. It is a *social* construct. It only works as it does because human societies have created the institutions and inculcated the assumptions, expectations and behaviours which *make* it so. The only reason for keeping it thus and not otherwise is if we think that it will be good at meeting our needs. So the picture really is 'Russian dolls'. This says that sustainability is about ensuring that human society lives within the environment's limits – and that the economy meets society's needs. 295
- In the Russian doll model, development is sustainable if it provides a good quality of life *and* stays within environmental limits. 298

(Board on Sustainable Development Policy Division 1999)

- The reconciliation of society's developmental goals with the planet's environmental limits over the long term is the foundation of an idea known as *sustainable development.* 2
- Ours is a normative vision of sustainability, which in our view is defined by the joint objectives of meeting human needs while preserving life support systems and reducing hunger and poverty. 21

(Desta 1999)

- Environmentally sustainable economic development may be defined as a long-term objective that ensures continuous economic development in which the quality of the environment is not negatively affected by the use mankind makes of it for economic growth. Thus a sustainable future depends o taking precautionary action now. 16

(Mitcham 1997)

- Sustainability is an ideal, not unlike love or patriotism that points toward something necessary and even noble, but that can also readily become an ideological rationalization misleading to all who use it. 359

(World Commission on Environment and Development 1987)

- Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future

generations to meet their own needs. The concept of sustainable development does imply limits – not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. 8

- Yet in the end, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. 9
- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:
    - The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
    - The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs. 43
- Hence sustainable development requires that societies meet human needs both by increasing productive potential and by ensuring equitable opportunities for all. 44
- In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. 46

(Caldwell 1998)

- Donella Meadows (1992) defines "a sustainable society as one that ccan persist over generations, one that is far-seeing enough, flexible enough, and wise enough not to undermine either its physical or its social systems of support." 2
- It appears, therefore, that sustainable development means sustaining a process, not a condition. 2
- Because of circumstantial differences among societies, no operational theories or formulas for sustainability are uniformly generalizable. 4
- Development, to be sustainable, must serve the quality of life, rather than social and ecological values being preempted primarily to serve the imperatives of economistic development plans. 10
- For development to be sustainable, ways must be found to direct perceived self-interest at the societal level of development away from unsustainable short-term expediency. 11

(O'Riordan and Voisey 1997)

- Sustainable development ought to mean the creation of a society and an economy that can come to terms with the life-support limits of the planet. That in turn suggests that sustainable development can only be maintained by a global society that fully recognises that it cannot expand its population numbers and its economy indefinitely, and that collective self-interest lies in co-operating towards a more socially just economy, as well as competing within it. 2

- Sustainable development is a deliberately ambiguous concept that means conservatism and liberalism in proportions commensurate with the general drift of social and political change. This is its staying power. Its organising focus emphasises more ecological and human-sensitive accounting, the application of a precautionary duty of care, and the scope for civic activism at local level. 21

(Goulet 1996)

- The term *sustainable development* can have at least six different meanings: (1) "maintenance, replacement and growth of capital assets, both physical and human"; (2) "maintaining the physical environmental conditions for the constituents of well-being"; (3) the "resilience" of a system, enabling it to adjust to shocks and crises; (4) "avoiding burdening future generations with internal and external debts"; (5) "fiscal, administrative and political sustainability. A policy must be credible and accept able to the citizens, so that there is sufficient consent to carry it out"; and (6) "the ability to hand over projects to the management by citizens of the developing country in which they are carried out, so that foreign experts can withdraw without jeopardizing their success".

(Berke and Conroy 2000)

- Sustainable development is a dynamic process in which communities anticipate and accommodate the needs of current and future generations in ways that reproduce and balance local social, economic, and ecological systems, and link all local actions to global concerns. 23

(Krizek and Power 1996)

- Given the diversity of lifestyles and preferences that are present in this country and abroad, no single definition suffices to meet the needs and expectations of all. Even if we were to succeed in creating a mutually agreed upon definition, it might be so vague as to be meaningless. 7
- In reality, sustainability seems to b e more a process than a set of concrete ideas, one whose basic precepts evolve as conditions, ideals, and technological capabilities change. 7
- Key Characteristics of Sustainability
    - Inter- and intragenerational equity
    - Protecting and living within the natural carrying capacity of the natural environment
    - Minimization of natural resource use
    - Satisfaction of basic human needs. 7
- Most experts agree that a sustainable society mjust balance social equity, economic prosperity, environmental integrity, and attempt to reconcile the often competing interests in these three areas. It must also consider both inter- and intragenerational equity, satisfaction of basic human needs, and protection of the natural systems that sustain us. 7

(Dryzek 1997)

- Sustainable development refers not to any accomplishment, still less a precise set of structures and measures to achieve collectively desirable outcomes. Rather it

is a discourse. And it is not just any discourse. Since the publication of the report of the Brundtland Commission in 1987 it is arguably the dominant global discourse of ecological concern. 123

- ...sustainable development, like democracy, is a discourse rather than a concept which can or should be defined with any precision. 125

(Gibbs 2002)

- While definitions of sustainable development vary, most allude to the following core principles:
  - Quality of life (including and linking social, economic and environmental aspects);
  - Care for the environment;
  - Thought for the future and the precautionary principle;
  - Fairness and equity;
  - Participation and partnership. 3

(Costanza 1992)

- Sustainability is a relationship between dynamic human economic systems and larger dynamic, but normally slower-changing, ecological systems in which: (1) human life can continue indefinitely; (2) human individuals can flourish; (3) human cultures can develop; but in which (4) the effects of human activities remain within bounds, so as not to destroy the diversity, complexity, and function of the ecological life-support system. 111
- Sustainability has been variously construed, but a useful definition is the amount of consumption that can be continued indefinitely without degrading capital stocks – including natural capital stocks. 112

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Appendix B: Literature on the Criteria for Sustainability Indicators

(Nilsson and Bergström 1995)

- An important criterion is that key indicators should be practical devices and designed and evaluated as such. Key indicators should extract relevant information from the available data base, and adjust the information to the format of reports and information load of decision makers. 177
- There are five leading principles for the choice of SDR key indicators.
- *The "non-violence" principle* states that using less resources is better or preferred...
- *The "theory" principle* states that all questions and answers should be rigorously formulated in theoretical terms before looking for empirical indicators...
- *The "hit-the-board" principle* states that rough and relevant is preferable to precise and inexpedient...
- *The "cluster" principle* is a derivative of the hit-the-board principle. If you need very reliable information and the available indicators are perceived as too rough, it is better to design a cluster of rough indicators than a single perfect one...
- A fifth strategy in SDR analysis is to follow *the "salami" principle* which says it is wise to distinguish among the effectiveness, thrift, and margin aspects of the means-ends spectrum. 177
- The key indicators used in the SDR method represent three general types of performance criteria, namely:
- *Effectiveness.* How effective or appropriate are the services provided by the system?
- *Thrift.* Does the system require a modest input of material resources and energy?...
- *Margin.* Can the inflows and outflows be sustainably maintained without impairing the resource base and essential ecological functions? 177-178
- Gilbert and Feenstra (1994) list four desirable features of indicators found in previous documentation.
- The indicator jmust be representative for the chosen system and have a scientific basis
- Indicators must be quantifiable
- Part of the cause-effect chain should be clearly represented by the indicator
- Indicators should offer implications of policy. 181
- Another model has been proposed by Holmberg and Karlsson (1992). According to this model, socio-ecological indicators should:
- Focus on factors of crucial importance for maintaining a sustainable relationship to nature,
- Provide early warning signals,
- contribute to (a) an enlightened discussion among decision-makers as well as among the general public (b) environmental impact analysis of various projects (c) the formulation of local or regional environmental goals. 181

(Spangenberg, Pfahl, and Deller 2002)

- In its Work Program, the CSD has listed a number of criteria for the selection of indicators, which have been the basis for preliminary set presented. According to this decision, indicators should be
    - Primarily national in scale or scope;
    - Relevant to the main objective of assessing progress towards sustainability;
    - Understandable, that is to say, clear, simple and unambiguous;
    - Realisable within the capacities of national governments, given logistics, time, technical and other constrains;
    - Conceptually well founded;
    - Limited in number, remaining open ended and adaptable to future developments;
    - Broad in coverage of Agenda 21 and all aspects of sustainable development;
    - Representative of an international consensus, to the extent possible; and
    - Dependent on the data, that are readily available or available at a reasonable cost to benefit ratio, are adequately documented, of known quality and updated at regular intervals. 64
- This list of criteria causes two problems: on the one hand, it does not specify which kind of indicators should be preferably chosen. On the other, it restricts the selection of indicators to already well founded, consensus based ones for which data are already available and which can be realised within the currently given constraints in national administrations. 64
- In some more detail, and according to the selection criteria pointed out by the CSD, in general they should be (although not all of these recommendations can be met at all times):
    - Based on a sound scientific basis, widely acknowledged by the scientific community;
    - Relevant, i.e. they have to cover crucial aspects of sustainable development;
    - Transparent, i.e. their selection, calculation and meaning must be obvious even to non-experts;
    - Quantifiable, i.e. they should be based as far as possible – but not exclusively – on existing data and/or on data that is easy to gather and to update;
    - Limited in number according to the purposes they are being used for. In particular, communication needs just a handful of indicators, policy monitoring some more, expert scrutiny a lot of them. 67
- Indicators, according to these criteria should furthermore be:
    - Independent, i.e. each indicator must be meaningful in itself;
    - Indicative, i.e. an indicator must be truly representative of the phenomenon it is intended to characterise;
    - General, i.e. not dependent on a specific situation, culture or society, but be meaningful for different perceptions of reality, whether dominant for society or not;
    - Robust, i.e. directionally safe with no significant changes in case of minor changes in the methodology or improvements in the data base; 67

- Sensistive, i.e. they have to react early and sensibly changes in what they are monitoring, in order to permit monitoring of trends or the successes of policies. 68

(Holden 2001)

- Urban sustainability indicators simultaneously simplify complex urban phenomena and integrate environmental, economic and social dimensions of urban policy issues. Urban sustainability indicators also are adaptable to change over time, whether against historical trends or against established reference points, such as targets and thresholds. In addition to this emphasis on change over time, sustainability indicators are concerned with the spatial distribution of urban conditions and the equitability of conditions among different demographic groups, and as compared to other people and places in different regions. A final important characteristic of this type of indicator project is that of a democratic development process, involving input from many policy actors throughout the city. 219-220
- Good sustainability indicators, according to a survey of the literature conducted by Maclaren (1996: 192), are: "scientifically valid, representative of a broad range of conditions, responsive to change, relevant to the needs of potential users, comparable with indicators developed in other jurisdictions, cost-effective to collect and use, attractive to the media, and unambiguous." 220

(Winograd 1995)

- The creation of environmental indicators requires a conceptual framework that will enable the user to understand what he or she wants to monitor and what should be monitored. The indicators should be selected based on the levels and scales to be monitored and should be a function of the components and the steps of the process to be monitored. Furthermore, to analyze and monitor processes of development and the use of land and natural resources, it is necessary to classify the region from a wide perspective. 201
- In general terms, environmental indicators should perform the following functions: simplify, quantify, analyze, and communicate. That is to say that the indicators should facilitate understanding by depicting issues in less complex terms and should make them quantifiable so that they can be analyzed in a given context and communicated to the different levels of society. 205
- In addition, the indicators should be useful in predicting and anticipating aspects of non-sustainable development, as well as the limitations and opportunities for applying sustainable development. 205

(MacLaren 1996)

- Urban sustainability indicators can be distinguished from simple environmental, economic, and social indicators by the fact that they are:
  - Integrating
  - Forward-looking
  - Distributional
  - Developed with input from multiple stakeholders in the community. 186

- Sustainability indicators are integrating in the sense that they attempt to portray linkages among the economic, environmental, and social dimensions of sustainability. 186
- A second important characteristic of sustainability indicators is that they must be forward-looking if they are to be used in measuring progress towards achieving intergenerational equity. 186
- Sustainability indicators must be able to measure not only intergenerational equity but also intragenerational equity. They should be able to take into account the distribution of conditions (social, economic, environmental) within a population or across geographic regions. 187
- Sustainability indicators should also be able to distinguish between local and nonlocal sources of environmental degradation, and between local and nonlocal environmental effects. 188
- Similarly, sustainability indicators should also measure the extent to which a local community contributes to environmental degradation in other communities, regions, or the world at large. 188
- However, a sustainability report should not be simply a descriptive tool. It should also evaluate whether the indicator resoults are showing progress towards or away from sustainability and suggest how or whether the indicators could be improved. It may also present recommendations about the kinds of policies or programs that are needed to improve progress towards the community's sustainability goals. 188

(Alberti 1996)

- A systematic analysis of urban sustainability should consider the following aspects:
    - Direct transformation of the physical structure and habitat;
    - Use of natural resources (renewable and non-renewable);
    - Release of emissions and wastes; and
    - Human health and well-being. 386
- A useful set of indicators should be able to tell us both (1) whether urban quality and performance in cities is improving or deteriorating in relation to certain sustainability criteria or desirable targets, and (2) how these trends in urban quality and performance are linked to trends in spatial structures, urban organization, and lifestyles. 388
- I have identified three dimensions that need to be considered in measuring urban sustainability: (1) urban quality; (2) urban flows; and (3) urban patterns. While each of these dimensions would require extensive elaboration, here I limit my focus on the linkages between these dimensions and the natural resource base. For each of these dimensions, indicators can be specified as symptoms or causal factors affecting sustainability. 388
- To monitor sustainability we need to redefine the urban ecological space and carefully choose signals that can link urban patterns to the state of the resource base. 394
- Most urban indicator programs refer to four key characteristics of successful indicators:
    - Policy relevance

- Scientifically founded
- Readily implemented
- Usable for decision-making. 416

- There is wide agreement that indicators must be both scientifically sound and relevant to policy. UNCHS stresses that indicators should be policy-oriented, guiding policy during the three crucial stages of developing a strategy, monitoring implementation, and evaluating its success. 417
- The OECD approach uses three selection criteria: political relevance, scientific soundness, and measurability. The political relevance of an indicator refers both to its usefulness and its pertinence to the issue under consideration. Indicators are expected to meet the following requirements:
  - Provide a representative picture of environmental conditions, pressure on the environment, or society's response;
  - Be simple, easy to interpret, and able to show trends over time;
  - Be responsive to change in the environment and related to human activities;
  - Provide a basis for international comparisons; and
  - Have a target or threshold against which to compare environmental quality and performance. 417-8
- The scientific soundness of indicators can be measured by the following criteria:
  - Theoretically well-founded in technical and scientific terms;
  - Based on international standards and international consensus about its validity; and
  - Capable of linkage with economic models, forecasting, and information systems. 418
- The measurability of indicators requires that data be:
  - Readily available at a reasonable cost/benefit ratio;
  - Adequately documented and of known quality; and
  - Updated at regular intervals. 418

(Cole, Eyles, and Gibson 1998)

- Availability of appropriate data is the first scientific criterion for indicator selection, as set out in Table 3. The second criterion refers to the closely related concepts of validity and reliability. Questions based on the types of validity include: after evaluating the rationale behind indicator selection, is it a reasonable measure? (face validity); does the measure behave as expected in relation to other related variables? (construct validity); does the measure correctly predict a situation which would be caused by the phenomenon being measured? (predictive validity); and do several measures collected or structured in different ways all move similarly over time? (convergent validity). 204
- The third criterion is responsiveness or the ability to avoid ceiling or floor effects which inhibit documentation of change over time. 204
- To be informative, indicators should also be able to be broken down by key variables. 205
- Similarly, indicators should be able to be compared across communities and jurisdictions to satisfy the human desire for ranking and to permit studies to link human health outcomes with environmental conditions in different places. 205

(Dale and Beyeler 2001)

- Ideally the suite of indicators should represent key information about structure, function and composition. 4
- Although few scientists deny the benefits that indicators provide to research and management efforts, three concerns hamper the use of ecological indicators as a resource management tool. 4
    - Monitoring programs often depend on a small number of indicators and, as a consequence, fail to consider the full complexity of the ecological system. 5
        - Indicators should be selected from multiple levels in the ecological hierarchy in order to effectively monitor the multiple levels of complexity within an ecological system. Thus, a key challenge is to find a mix of measures which give interpretable signals, can be used to track the ecological conditions at reasonable cost, and cover the spectrum of ecological variation. 5
    - Choice of ecological indicators is often confounded in management programs that have vague long-term goals and objectives. 5
        - Primary goals and objectives should be determined early in the process in order to focus monitoring on current and future management issues. Ecological indicators can then be selected to measure system characteristics that most closely relate to those management concerns. 5-6
    - Management and monitoring programs often lack scientific rigor because of their failure to use a defined protocol for identifying ecological indicators. 6
        - Lack of robust procedures for selecting ecological indicators makes it difficult to validate the information provided by those indicators. Until standard methods are established for selecting and using indicators, interpretation of their change through space and time remains speculative. 6
- In general, ecological indicators need to capture the complexities of the ecosystem yet remain simple enough to be easily and routinely monitored. 6
- Building on discussions by Landres et al. (1988), Kelly and Harwell (1990), Cairns et al. (1993), and Lorenz et al. (1999), we suggest that ecological indicators should meet the following criteria:
    - Be easily measured: The indicator should be straightforward and relatively inexpensive to measure. The metric needs to be easy to understand, simple to apply, and provide information to managers and policymakers that is relevant, scientifically sound, easily documented, and cost-effective. 6
    - Be sensitive to stresses on the system: The ideal ecological indicator is responsive to stresses placed on the system by human actions while also having limited and documented sensitivity to natural variation. While some indicators may respond to all dramatic changes in the system, the most useful indicator is one that displays high sensitivity to a particular

and, perhaps, subtle stress, thereby serving as an early indicator of reduced system integrity. 6

- Respond to stress in a predictable manner: The indicator response should be unambiguous and predictable even if the indicator responds to the stress by a gradual change. 7
- Be anticipatory, i.e. signify an impending change in key characteristics of the ecological system: Change in the indicator should be measurable before substantial change in ecological system integrity occurs. 7
- Predict changes that can be averted by management actions: The value of the indicator depends on its relationship to possible changes in management actions. 7
- Are integrative: The full suite of indicators provides a measure of coverage of the key gradients across the ecological systems (e.g. gradients across soils, vegetation types, temperature, space, time, etc.): The full suite of indicators for a site should integrate across key environmental gradients. 7
- Have a known response to disturbances, anthropogenic stresses, and changes over time: The indicator should have a well-documented reaction to both natural disturbance and to anthropogenic stresses in the system. This criterion would pertain to conditions that have been extensively studied and have a clearly established pattern of response. 7
- Have a low variability in response: Indicators that have a small range in response to particular stresses allow for changes in the response value to be better distinguished from background variability. 8

- Ecological indicators are used to monitor, assess, and manage natural resources. A difficulty in selecting appropriate indicators is dealing with the complexity of ecological systems. Thus, it is necessary to use a suite of indicators representative of the structure, function, and composition of ecological systems. 8

(Moffatt, Hanley, and Wilson 2001)

- Anderson (1991) has suggested seven criteria that may determine a good indicator: (1) the indicator or the information from which it is calculated should be readily available; (2) the indicator should be relatively easy to understand; (3) the indicator must be about something that can be measured; (4) the indicator should measure something believed to be important in its own right; there should only be a short time lag between the state of affairs referred to and the indicator becoming available; (6) the indicator should be based on information that can be used to compare different geographical areas; and (7) international comparability is desirable. 36
- Sustainable development indicators need to connect with the ways in which the environment is being altered so that its ability to support human and other forms of life might not be compromised. To achieve this aim we have to make an assumption that, at one extreme, all life is worthy of support, or, from a less egocentric perspective, that human life at least is worthy of support. 46

(Levett 1998)

- Everyone agrees that indicators should be
  - Policy relevant,
  - Resonant,
  - Scientifically valid and
  - Measurable (i.e. the necessary data are available). 291
- Meaning comes from the patterns that indicators make with each other, just as a single word or chord has little meaning without the rest of the sentence or musical passage. 292

(Riley 2001)

- Indicators must be easily understood by all concerned. 253

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Appendix C: The Sustainability Indicator Evaluation Framework Matrix

Themes	Components	How they were selected	Interpretation
A focus on the maintenance of ecological integrity	How many indicators deal with environmental issues?	Were these indicators selected because they are representative of the wider area ecosystem?	In how many indicators does the analysis discuss an environmental threshold limit or value for the indicator?
A focus on global concerns	How many indicators deal with issues that transcend the physical boundaries of the study region	Were there any considerations/adjustments made because the indicator covers an area wider than the study region? Were these indicators picked because of their ability to look beyond the political boundaries?	
A focus on holistic and systemic thinking			
A focus on balance/ harmony/integration	How many indicators deal with more than one sector (environment, economy, social)?	Were these indicators chosen because they are multi-sectoral?	In how many indicators does the analysis discuss a linkage between an indicator representing one sector to an indicator representing another sector?
A focus on temporal concerns	Are the components of the indicator things that lend themselves to being measured over time?		In how many indicators does the analysis include plans to continue measuring this indicator in the future?
A view of sustainable development as a process			Are there any plans to revise the indicator set in the future? Are there any feedback mechanisms in place to determine the usefulness of the indicators?
A focus on anthropocentric concerns	How many indicators deal with issues that have a direct effect on human health and wellbeing? How many indicators deal with issues of equity?		Is there any analysis indicating how improvement in the condition of a situation measured by an indicator might help improve the quality of life of people in the region?

Appendix D: Questions for Interview With Court Gould

1. Why did you choose to use the entire six-county region rather than just the city of Pittsburgh?
    a. In your reports you have identified more general reasons for the importance of studying regions, but I am interested in why this was the approach taken in SWPA.
        i. Data?
        ii. Agency?
        iii. Statistical Region?
        iv. Planning activities?
        v. Watershed?
        vi. Bioregion?
2. Can you please tell me again exactly how the report has been distributed?
    a. Do you have any knowledge of this report being used for policy decisions?
    b. What about funding the publication of the reports?
        i. Does this have any say in how the reports are distributed and/or who receives them?
3. About how often do you foresee the reports being published?
    a. Is there a plan for future development and publication of the reports?
4. Why did you choose to focus more on equity issues, including an equity analysis for each indicator?
    a. Did you consider doing this for other issues, social, environmental, economic, or otherwise?
5. How did you make the decision to use the sustainability compass approach?
    a. Did you consider other methods of organization and/or aggregation before you made a final decision?
6. How would you go about classifying an indicator that could potentially fit into more than one of your compass points?
    a. Example: pollution. Would it go under environment (nature), or wellbeing?
7. When you began with the idea of developing this indicator set, what was the purpose?
    a. Were you trying to create a policy tool?
        i. A public awareness tool?
        ii. A benchmarking tool?
        iii. A monitoring tool?
8. What has this indicator set done thus far (I realize that this is the first report and it may not have fully caught on yet)?
    a. Have there been any measurable or perceivable benefits to having it?
9. What would you ultimately like to do with this indicator set?
    a. In what direction(s) do you see your efforts heading?

Appendix E: Sustainable Pittsburgh's SIEF Matrix

Themes	Components	Interpretation
A focus on the maintenance of ecological integrity	• The EPA's Air Quality Index • The health of regional indicator species • Electrical energy use • Random phone survey of adult residents' environmental knowledge, attitude, and behavior • Percent change in land consumed • Percent of solid waste recycled • Miles of streams meeting state "recreational use standards"	• The EPA's Air Quality Index • The health of regional indicator species • Miles of streams meeting state "recreational use standards"
A focus on global concerns		
A focus on holistic and systemic thinking		
A focus on balance/ harmony/integration	• The EPA's Air Quality Index • Random phone survey of adult residents' environmental knowledge, attitude, and behavior • Percent change in land consumed • Percent of solid waste recycled • Miles of streams meeting state "recreational use standards" • Home ownership and rental affordability for low-income people • Hours per year of driving delays • Percentage of people living in poverty • Unemployment rate • Average and median wages, adjusted for inflation • Percent of high school seniors graduating from high school	• The health of regional indicator species • Home ownership and rental affordability for low-income people • Percentage of people living in poverty • Unemployment rate

	• Social Capital Index (for the state of Pennsylvania) • Voting rates in annual elections • Age adjusted death rates for heart disease • Infant mortality rate and rate of low birth-weight babies	
A focus on temporal concerns	• The EPA's Air Quality Index • The health of regional indicator species • Electrical energy use • Percent change in land consumed • Percent of solid waste recycled • The difference between cost of basic needs and annual incomes • Home ownership and rental affordability for low-income people • Hours per year of driving delays • Percentage of people living in poverty • Unemployment rate • Average and median wages, adjusted for inflation • Rate of adult violent and property crime • Percent of high school seniors graduating from high school • Number of students per computer • Voting rates in annual elections • Age adjusted death rates for heart disease • Infant mortality rate and rate of low birth-weight babies • Suicide rates	• The EPA's Air Quality Index • Random phone survey of adult residents' environmental knowledge, attitude, and behavior • Miles of streams meeting state "recreational use standards" • The difference between cost of basic needs and annual incomes • Percentage of people living in poverty • Social Capital Index (for the state of Pennsylvania)
A view of sustainable development as a process		• The health of regional indicator species • Electrical energy use • Random phone survey of adult residents' environmental knowledge, attitude, and behavior

A focus on anthropocentric concerns	• The EPA's Air Quality Index • The health of regional indicator species • Electrical energy use • Random phone survey of adult residents' environmental knowledge, attitude, and behavior • Percent change in land consumed • Percent of solid waste recycled • Miles of streams meeting state "recreational use standards" • The difference between cost of basic needs and annual incomes • Home ownership and rental affordability for low-income people • Hours per year of driving delays • Percentage of people living in poverty • Unemployment rate • Average and median wages, adjusted for inflation • Rate of adult violent and property crime • Percent of high school seniors graduating from high school • Number of students per computer • Social Capital Index (for the state of Pennsylvania) • Voting rates in annual elections • Age adjusted death rates for heart disease • Infant mortality rate and rate of low birth-weight babies • Suicide rates	• The EPA's Air Quality Index • The health of regional indicator species • Electrical energy use • Random phone survey of adult residents' environmental knowledge, attitude, and behavior • Percent of solid waste recycled • The difference between cost of basic needs and annual incomes • Rate of adult violent and property crime

Appendix F: Sustainable Pittsburgh's Criteria for Sustainable Development Indicators

(Taken from Sustainable Pittsburgh's *SWPA Community Indicators Handbook*, page 10)

WHAT MAKES A GOOD INDICATOR?

In recent times, there has been an enormous amount of work to refine the practice of doing sustainability indicators. International experts on the subject, as well as project leaders in many local communities, have come together in many different forums to define criteria and set standards. References to some of their work is noted at the end of this section.

But for introduction purposes we offer just a few tried-and-true guidelines to help you think about choosing good indicators, combined from a number of sources. Good measures of sustainability are ...

Relevant. An indicator set needs to relate to the community — to its successes and concerns, its assets and problems, its worries today and its vision of a better future tomorrow.

Reliable. There needs to be good, trustworthy data available, and some assurance that the data will be collected regularly over time. Often a community doing indicators for the first time will discover things that should be measured but that are not yet being measured. In those cases, the community must make a commitment to make such measures itself.

Understandable. If an indicator is not understandable to the average person, it is generally not useful except to specialists and experts. Sometimes more complicated measures can be converted or combined into something simpler (the way that thousands of economic measurements are combined into the Gross Domestic Product); but it is generally best to choose a simpler alternative whenever one is available.

Clear in Direction. Since an indicator must help us steer our course, it should be obvious, when you look at the graph and other information, which direction constitutes "improvement" and which direction "decline." Whenever possible, it's good to frame the indicator in positive terms — for example, "Percentage of Solid Waste Recycled" rather than "Percentage of Solid Waste Discarded."

Reflective of Change over Time. Part of an indicator's purpose is to expand our sense of time, and help us understand processes that happen slowly, over years. The human mind is biologically programmed to notice immediate threats and sudden changes. Indicators need to show us clearly those slower, long-term trends that are "sneaking up on us" because they happen more slowly and escape our attention.

Systemic. This word simply means that the indicator helps us understand something

about the whole system. For example, it is impossible to measure the entire performance of a school system, or an ecosystem, or a governmental system. We have to choose one measurement (or a few measures) that gives us a sense of the whole, such as how well our children perform on standardized tests, or how well certain key animal species are doing, or what voting rates say about people's perception of government. One indicator never tells us everything — but a well-chosen indicator alerts us when something is going wrong, so we can dig deeper into the details.

Responsive. An indicator should go up when things are getting better, and go down when things are getting worse. It should register change with as small a time-delay as possible, to ensure that the actions we take will be reflected quickly so we can know whether our strategies for sustainability are working.