AN EVALUATION OF NEIGHBOURHOOD SUSTAINABILITY ASSESSMENT FRAMEWORKS USING ECOSYSTEMS CHARACTERISTICS AND PRINCIPLES OF SYSTEMS RESILIENCE AS THE EVALUATION CRITERIA

by

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ABSTRACT

If human societies are to sustain over the long-term, we must manage human societies and our products, including settlements, to work within the context of a living environment. While conventional practice in neighbourhood planning has made advances in acknowledging the importance of sustainability in the built environment, it generally does not acknowledge fundamental ecological concepts such as the ecology of sites, global ecological productive carrying capacity or the dynamic nature of a living, rapidly eroding, biophysical environment.

This thesis articulates the need to acknowledge the ecological context as the basis of sustainable communities. A living ecological system is not only the context in which settlements operate; ecosystems may also be a viable model from which to form settlements. This thesis proposes incorporating the model of ecosystems, the characteristics they embody and principles by which they are governed into the planning and design of settlements as a method of informing a physical form that can support sustainable communities.

A case study of a local Vancouver neighbourhood, False Creek North, is used as a tangible reference point around which to frame the discussion of sustainable communities. Although not planned explicitly to be a "sustainable community" the neighbourhood embodies many of the characteristics of conventional thinking about sustainable neighbourhoods. Using sustainability assessment frameworks, the False Creek North development is evaluated for sustainability merits and weaknesses in order to understand how this model of development could be improved to better reflect concepts of sustainability. In order to ensure that the frameworks reflect a strong, ecologically bound concept of sustainability the assessment frameworks are also evaluated based on their ability to capture characteristics and principles of ecological systems using an evaluation matrix. An integrated discussion is presented on a) how well the frameworks reflect ecological principles and b) what elements of FCN display ecological sustainability characteristics.

Overall, the assessment frameworks are found to be limiting in their ability to capture fundamental ecological concepts. Indicators that reflect ecological principles and characteristics are therefore proposed and examples are given as to how they might be used to measure aspects of the case study site, False Creek North.

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PROLOGUE

For years I have heard residents, friends and visitors to Vancouver telling me that I live in one of the most livable and sustainable cities in the world. Writer Lance Berlowitz calls it "Dream City" and writes about how it has captured the "Global Imagination"; another author, John Punter refers to the planning and result "The Vancouver Achievement"; and Mike Harcourt, former Premier of British Columbia along with Sean Rossiter and Ken Cameron refer to Vancouver as "Paradise" with respect to city planning that has occurred there (Berlowitz, 2005; Harcourt, Rossiter & Cameron, 2007; Punter, 2003). People, and in particular planners, are taking notice of Vancouver because it is seen as being able to do some pretty special and unique things. One of those special things is the community of False Creek North, which in particular merits this recognition (Berlowitz, 2005).

For a novice planner, living in such a place is a treat, a living laboratory, a source of answers. As I become acquainted with the planning and development community in Vancouver I see that planners are eager to share their experiences. Working in such a place must be a distinction, given the sustainability imperative that is widely recognized in today's environment-conscious world. As I embarked on my thesis I eagerly anticipated the opportunity to understand the qualities and processes that have contributed to Vancouver having this "sustainability" reputation.

My motivation for this inquiry

I feel I must begin by stating my objectives in learning about planning and the inevitable expectations and biases I bring to my interpretation of planning and sustainability. Initially educated as an ecologist, I was taught to perceive the world as the living system that it is. Fortunately, this approach resonates with my personal affiliation with Nature and ecology.[1]

[1] The term "Nature" is one that is somewhat elusive and hard to define. For the purposes of this paper it will be used to refer to components and places which are not greatly modified, explicitly controlled or frequently manicured by humans. Prescott (as cited in Fjortoft & Sageie, 2000) also provides three qualities that typify Nature and which are relevant to this definition here: high diversity, not made by man and an impression of

That is why I chose to study ecology in the first place. I became interested in planning and community development when I realized that if we are to sustain life on Earth, we must learn to manage human societies and our products, including settlements, to function within this ecological context. I would consider myself a deep ecologist.[2] Because I see the world through this lens, I am unable to ignore the distress signals of a planet under strain. I am acutely aware that the human species has created a cultural and socio-economic system that threatens to implode on itself. We know that the future is uncertain. And I feel honest bewilderment about how we as a species will navigate the uncertain times ahead, what Howard Kunstler aptly terms, "converging catastrophes" in his book *The Long Emergency* (2005).

An opportunity

It is through this paradigm that I attempt to understand the community of False Creek North located in Vancouver, British Columbia. In 2007 Wendy Sarkissian, my advisor and mentor on this thesis, encouraged me to participate in a post-occupancy evaluation course, the task of which was to evaluate resident satisfaction with the False Creek North development. What a journey! I can think of no better way to understand the grand gestures and minutiae of physical planning. Nor can I think of a better way to be introduced to the needs and concerns of people's everyday living experiences. The learning experience rewarded me by exposing me to the breadth and depth of issues that concern a planner and the skills employed in the planning process. We not only discussed at length in class our research approach, methods, policies and questions we sought to evaluate, but we also became intimately acquainted with the community by walking the grounds of the neighbourhood with people who had planned,

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timelessness. "Nature" is capitalized throughout the text as a means of "assigning integrity" and "acknowledging the power" of the nonhuman world as is described by Sarkissian (1996).

[2] Norwegian philosopher Arne Naess is credited with introducing the phrase "deep ecology" to environmental literature in the early 1970s. The concept, and movement, represents an inherent value of all living beings and the use of this view in shaping environmental policies. Naess introduced the concept when he noticed two different approaches to environmental policy, "shallow" and "deep". "The word "deep" in part refers to the level of questioning of our purposes and values when arguing in environmental conflicts" (Deep Ecology Movement, n.d.).

designed and developed the area. We met and listened to people who lived, worked and patrolled in the community and we worked with kids who had lived there all their lives and attend the local school.

After eighteen months on the project, False Creek North was beginning to seep into my bones; it had begun to course through my veins. One element of my experience remained unsatisfied, however. The scope of our project had to be firmly controlled to respect our budgetary restraints, our responsibilities to our funders and the original proposal of the study: to explore dimensions of the lived experiences of the residents. Studying the site's ecological sustainability was not part of the scope of the project.

Yet I recognized in False Creek North a strategic opportunity to learn and talk about the sustainability of urban neighbourhoods and settlements more broadly. I wanted to engage in discussions on the deeply sustainable; a type of form and function that will not only not erode the Earth's ability to continue fulfilling its life support functions, but also that will see us through the "converging catastrophes" of peak oil and climate change, among others. Many questions arose as I delved more deeply into the research project.

> *Shouldn't all our planning and development models strive to be sustainable?*
>
> *What goal is more critically important than the ability for life to continue into the future?*
>
> *If sustainability is not the ultimate criterion against which we measure our settlements, I have to ask, what purpose are our models meant to serve?*

My interest was piqued and I could not abandon *m*y questions about the future of False Creek North and its ability to weather uncertain times. When the post-occupancy study was completed, my questions remained – even stronger than they were when the research began.

This experience – and this ecological paradigm – influenced my decision to undertake this ecologically based evaluation of False Creek North.

A quest for the deeply sustainable

In the common parlance of planners, False Creek North embodies many of the characteristics that are espoused by Smart Growth[3] and other best practices in planning today: central location near a major source of jobs in the Central Business District; compact and dense form; mix of uses; transit service; family-friendly orientation and provision of high-quality public amenities. All of these are worthy goals and – at first glance – consistent with the deeply sustainable. But they are not sufficient in achieving this ambitious goal. As Rees (2009, p.307) notes, these goals are more consistent with livability than with sustainability:

> "Many people see such cities [Melbourne and Vancouver] as icons of sustainability, but *in the modern global context*, this is simply wrong-headed – at best, it confuses 'sustainability' with 'liveability'. There is no question that Vancouver and Melbourne are highly liveable cities. However, they are also arguably among the least sustainable cities on Earth. The inhabitants of modern high-income cities enjoy their high-quality urban environments and material lifestyles at the cost of unconsciously imposing an enormous material burden on the rest of the Earth. Consumer cities are massive sinks for the world's resources and the ultimate sources of most of its industrial wastes."

Further, I wonder if the urban patterning and form that is desirable today will remain so in the future under changing circumstances such as post-peak oil and climate change. After all, as the influential environmentally minded urban planning consultancy firm the Sheltair

[3] Smart Growth is a settlement planning practice and theory of which the goals are to create compact, mixed-use and pedestrian oriented communities in response to sprawling suburbs that characterize much of North America's urban landscape. For more on Smart Growth, and how it's applied in British Columbia, visit: www.smartgrowth.bc.ca.

Group in Vancouver reported in 2002 (p.13), "today's sustainable community may be inappropriate tomorrow". We are now painfully aware that many well-intentioned plans of the past led to misguided decisions. It is entirely possible that the decisions we make about neighbourhood planning and design today could become problems in the future.

As I examined False Creek North through my "ecological" lens, I noticed a number of elements that appeared to contrast with my understanding of the deeply sustainable.

1. The buildings appear to be of a static form powered by much energy and require a significant degree of costly maintenance, none of which can easily be done by the building's inhabitants. I wondered: *will their structure accommodate changes in use over time?*

2. The automobile remains a dominant feature in the landscape. Once I discovered the amount of parking the site accommodates in underground structures, I wondered: *how is accommodating vehicle use to such an extent consistent with the deeply sustainable?*

3. The green space and permeability of the site, designed for humans, does not appear to accommodate native species or exhibit ecological processes. Although there is a relatively generous amount of park space for a downtown setting, I wondered: *how do the native species of Vancouver experience this place?*

4. There is little infrastructure or explicit emphasis on adopting more ecologically friendly behaviour such as recycling, composting, or Nature restoration activities. I wondered: *what options do residents have to adopt more "environmentally-friendly" behaviour?*

5. The community does not seem to display any degree of self-reliance in terms of food, water, recycling and waste management. Bill Rees's term "consumer city" applies

here. The concept of "complete community" is articulated, but pertains only to the mix of retail and commercial uses along with residential, schools and amenities; the means of production for the community are not internalized, even symbolically. I wondered: *in a downtown setting, can and should these functions be accommodated?*

6. But perhaps the greatest thing that I noticed was that nothing in the development reminds me of the living ecological context on which it depends. There is a distinct lack of emphasis on opportunities to interact and learn about the environment. As an experiential learner, I wondered, *wouldn't I know (or seek to know) if I were in a sustainable community?*

As I began the journey to evaluate and understand the deeply sustainable in urban development, more urgent questions emerged about the adequacy of the assessment frameworks available to evaluate sustainable neighbourhood development. Initially, I expected that the assessment frameworks would fulfill the function of awarding exemplary practice. If *exemplary* is defined solely as more efficient versions of conventional development, then they are successful. However, if exemplary is defined as the bold moves needed to achieve the deeply sustainable as is described in this thesis, clearly they are falling short. I therefore decided to shift the focus of my thesis from the specific False Creek North site to explore how sustainable neighbourhoods are defined more generally through these assessment frameworks. I still regard False Creek North as a case study of a model urban form but my focus is now less on what gains it specifically is making towards sustainability. In this thesis, False Creek North serves more generally as a tangible example for framing broader planning concepts and assumptions made in master planned neighbourhood developments.

CHAPTER 1: INTRODUCTION

Introduction

Achieving a truly sustainable society is arguably one of the greatest challenges humanity will ever face. The scale of the unsustainability problem, which affects not only ecosystems but necessarily also human societies and their economies, has reached global proportions and is unprecedented in human history. We know now that climate change is "unequivocal as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (Intergovernmental Panel on Climate Change (IPCC), 2007, p.30); species extinction rates over the past century are as high as 1000 times greater than background extinction rates (Millennium Ecosystem Assessment (MEA), 2005, p.15); extreme poverty at the global scale is more "pervasive than we thought" (World Bank Development Research Group, 2008, para.1); and the peak in oil production is fast approaching (Oil Depletion Analysis Centre and Post Carbon Institute, 2008). The Millennium Ecosystem Assessment (MEA) (2005, p.5) soberly sums up human impact on our global environments when they state "human activity is putting such a strain on the natural functions of the Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted".

These problems are not only indicators of a changing and eroding environment, but also, to borrow from the cliché, will affect life as we know it. These global macro-challenges synergistically work together to create a problem of unsustainability that is bigger and less predictable than the sum of each of these challenges. In a hard-hitting book entitled, *The Long Emergency*, Kunstler (2005) refers to these challenges as "converging catastrophes". For instance, the Center for Strategic and International Studies (CSIS) (2007) notes that massive non-linear events in the global environment give rise to massive non-linear societal events such as epidemics, armed conflicts over resources and massive migrations as some areas of the world become inhabitable thereby creating refuges. They conclude that "the social consequences range from increased religious fervour to outright chaos" (p.7).

Urban development is one of the contributors to local and global ecological crises and therefore also to sustainability. The United States Environmental Protection Agency (USEPA) (2001, p.i) concludes that "urban form directly affects habitat, ecosystems, endangered species, and water quality through land consumption, habitat fragmentation, and replacement of natural cover with impervious surfaces".[4] Further, the "form of urban development today will control resource use for generations to come" (McDonald, 2008, p.100). Urban development therefore clearly directly and indirectly affects resource use, ecosystem productivity and climate change.

In addition, urban form is affected *by* the consequences of some of its own effects on the ecosphere. For example, by drawing upon a groundwater resource at an unsustainable rate (such as in the case of an aquifer), large subsidence causing changes in surface gradients may occur, "leading to changes in flow paths for drainage and flood flows and even the development of wetlands on residential land" (Pereira, Cordery and Lacovides, 2002, p.231); this subsidence has already occurred in many cities throughout the world. Another example is the impact of urban development on formerly agriculturally productive land, the loss of which in aggregate, and certainly nearby, will affect food availability as travel costs become prohibitively expensive, fresh water becomes more scarce and soils become exhausted and/or inundated due to sea level rise (CSIS, 2007). Kunstler (2005) believes that large cities will not survive once oil becomes expensive enough to prohibit access to many of the goods we take for granted such as imported food. In conducting a comprehensive long-range plan for Metro Vancouver (then known as Greater Vancouver Regional District), The Sheltair Group, (2002, p.16) concluded that "it is prudent to assume that not all such efforts [to address sustainability] will be successful, and cities will collapse. Research institutes worldwide have repeatedly identified this threat".

[4] See Bridgman, Warner and Dodson (1995) for an example of a comprehensive review of the impacts of urban settlements on biophysical form and processes.

Such daunting projections necessitate a planning response that promotes urban communities that can respond and remain resilient in the face of these "converging catastrophes". To succeed, these responses will have to admit that even if every effort is taken to curb greenhouse gas emissions and reduce oil dependency, human societies, and the settlements in which we live, will be forced to face some very serious challenges. Because "human destiny is closely linked to the success or failure of the places we live" (Girardet, 1999, p.9), Sustainable Urban Development (SUD) must assert itself as a key and necessary approach in the broader pursuit of a sustainable human existence on this planet. Given the sustainability imperative and the contribution human settlements can make towards Nature protection and sustainable use of energy and resources, we need new models of enduring, sustainable neighbourhood development. We need, as Lynch (1981, p.289) argues in describing development models, "an arsenal of possibilities". He continues, "Indeed, we should be engaged in anticipatory design, creating prototypes which will be useful for those new situations and motives which are only unfolding today" (Lynch, 1981, p.289). After all, I would argue, *what is a forward thinking profession like planning good for?*

Emerging models of sustainable urban development

One such possibility is the community of False Creek North which is evaluated for its sustainability successes in this thesis. False Creek North has received awards of merit and international attention for its *Living First* focus, which aims to capitalize on the competitive advantages of the urban lifestyle over a suburban lifestyle.[5] Key to this model is the provision of public amenity, a mix of uses and the ability to accommodate residential density using slim point towers upon a "podium" of street-friendly town homes and storefronts. Boddy (2004, p.18) notes that this "Vancouver prototype is now spreading rapidly around the world.... A whole generation of Vancouver architects, planners and developers is exporting our expertise around the Pacific Rim and to such more distant locales as Tehran and Bombay".

[5] Awards of merit include: 2004 Special Achievement Award for Planning for the "Living First" Strategy Downtown, International Downtown Association, Washington, D.C.; 2006 Award of Excellence for the "Living First" Strategy Downtown, Congress for the New Urbanism, Chicago.

Although the planning and design False Creek North were not specifically guided by sustainability principles, it makes for a suitable case study as many of the development's core design principles are congruent with current thinking about sustainable communities today: central location near a major source of jobs in the Central Business District; compact and dense form; mix of uses; transit service; family-friendly orientation and provision of high-quality public amenities.

The intent of using False Creek North as a case study is not so much to discuss its specific contributions to sustainability and where it could be improved (although this is discussed), but rather more generally to serve as a physical example to ground discussion of sustainable urban development more broadly. This provides a contextual frame for discussing some broader planning concepts and assumptions made in master-planned neighbourhood developments. Further, the case study extends the evaluative line of inquiry of an extensive post-occupancy evaluation in 2007 and 2008 into resident satisfaction and livability in the development.

Questions around the emerging models

The models of sustainable urban development being proposed are not without question. For example, one of the most pervasive concepts in the current discourse on sustainable urban form is that of the compact and densely settled city. There is now wide agreement that a sprawling, poorly connected, car-dependent and single-use urban form (i.e. typical contemporary North American suburbia) does not contribute to sustainability goals. Kunstler (2005, p.248) has gone as far as to deem suburbia "the greatest misallocation of resources in the history of the world". Nevertheless, there is a lack of consensus on what degree of compact, and by association dense, communities, reduce ecological impact, are resilient and reflect sustainability thinking.[6] Skyscrapers or high-rise towers, a building form typified of

[6] For example, two major rationales for the compact form remain disputed. Simonds and Coombe (2000, p.121) and Jenks, Burton and Williams (1996, p.342) demonstrate that the connection between public transit and high

high-density settlements, are highly energy-intensive, leading Kunstler (2005, p.262) to describe them as "experimental" and anachronisms in a less energy-intensive future. Further, an inflexible highly developed and artificial environment experientially devoid of ecological functioning does not resonate with the concept of a sustainable, resilient, ecologically respectful neighbourhood form. In short, we lack consensus on the ideal compact form due to a lack of tangible evidence (Frey, 1999; Jabareen, 2006). Some authors, such as Jeffrey et al. (1997), believe that as a result instead of solely focusing on the form or state, we should also focus on those *attributes* of a system that lend themselves to sustainability and to a holistic sense of the concept. They believe that distinguishing between these two phenomena – states and attributes – "has particular relevance within the context of planning methodologies, where a focus on system states has been allied with a mechanistic approach to problem solving, whereas a focus on system attributes has been associated with an evolutionary approach" (p.49). Corner (2006, p.28) quotes cultural geographer David Harvey who states "new possibilities for future urbanisms must derive less from an understanding of form and more from an understanding of process – how things work in space and time". I argue in this thesis for an approach to planning and design that is informed by attributes of sustainable systems and ecosystems.

The proposed ecological lens

This thesis explores the potential for sustainable community models at the neighbourhood scale based on an ecological approach to planning and design. I argue that physical neighbourhood sustainability planning and design concepts should be oriented around those attributes of built form which capture the concepts of low ecological impact and community resilience.

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densities is not as straightforward as some proponents of the intensification assert. A study by Senbel and Kissinger (2009) on False Creek North's Green House Gas emissions as compared to those of lower density communities found exaggeration of the energy benefits of the higher density urban form compared to other neighbourhoods; the Green House Gas emissions are not much lower in the case study site, False Creek North. For a more detailed discussion of the merits and pitfalls of the compact city as a sustainable urban form, see Jenks et al. (1996) and Williams, Burton and Jenks (2000).

Specifically, I propose that basing the physical parameters of neighbourhoods on ecological characteristics by adopting a more systems-based approach to neighbourhood design may provide a template for conceptualizing sustainable community development. Because human societies must embed their systems within the living ecological context of this planet if they are to be sustainable, we need to relate development construction and operating impacts to ecological productive and assimilative capacity and adopt a biomimicry approach in which Nature and ecological processes are viewed as model, measure and mentor (Benyus, 1997; McLennan, 2004).[7] This requires locating urban fabrics in their regional and biotic contexts and designing healthy relationships between dynamic environmental processes and urban forms (Corner, 2006, p.24). I believe, with Corner (2006, p.28) that "in conceptualizing a more organic, fluid urbanity, ecology itself becomes an extremely useful lens through which to analyze and project alternative urban futures".

Problem statement

The neighbourhood models proposed to address sustainability are inadequate in lessening their ecological impact or preparing for an uncertain future as described in the previous section. In terms of impact, particularly in North America, they may achieve efficiency gains of water, energy and material use when compared to traditional development, but rarely reach levels of use that fit within the Earth's carrying capacity (Rees, 2009). Further, *resilience,* another key component of sustainability, and the ability to withstand potentially fundamental changes brought on by peak oil and climate change, is largely absent from the language of "sustainable communities". For example, Gill et al. (2007) highlight a concerning lack of serious preparation and adaptation to the effects of climate change. In her master's research, Larson (2006) found the same to be true for peak oil in Vancouver, B.C.

This problem is compounded when these neighbourhood models are erroneously recognized as embodying strong sustainability-related principles when they are in fact embodying only

[7] "Biomimicry is the science and art of emulating Nature's best biological ideas to solve human problems" (Why Biomimicry, n.d.).

weak sustainability principles or efficiency gains, thus potentially hindering learning and hampering progress towards authentic sustainable outcomes. It has been cogently argued that if actions towards sustainability are not based on ecological and sustainability science and sound judgement, well-intentioned interventions could result in further ecological impoverishment (Loucks, 1994).

Sustainability assessment frameworks may play a critical role in influencing development practice as well as evaluating a development's contribution towards sustainability. It is therefore critical that they do not reward ostensible sustainable practices and developments but rather attempt to promote a strong concept of sustainability by accurately linking human relationships to biophysical reality. By not capturing this reality, sustainability assessment frameworks are contributing to the compounded problem – erroneous recognition of exemplary developments – and thusly may be hampering progress towards true, strong sustainability.

Purpose

This research has three purposes. The first is to propose an ecological approach to planning in which Nature is regarded as model, measure and mentor. The second purpose is to ascertain the degree to which neighbourhood sustainability assessment frameworks reflect the three concepts of ecological impact, carrying capacity and community resilience. I have chosen to evaluate sustainability assessment frameworks because their criteria, indicators and targets reflect current trends in sustainable neighbourhood physical planning and development. Their well-articulated and focused list of indicators and targets offers a specific set of metrics of manageable scope to enable evaluation. Finally, I am to explore the sustainability merits of a high-profile residential community within Vancouver - False Creek North (hereafter FCN).

Some research assumptions

A number of assumptions underpin this research. Firstly, human settlements will be affected by macro-environmental, economic and social challenges precipitated by such phenomena as

peak oil, climate change, mass extinctions and persistent toxification of the environment. Planners, designers and developers of human settlements must therefore be aware of these challenges and prepare for them to the best of their abilities.

Secondly, efforts towards sustainability must respect ecological principles because a living biosphere is the context in which human societies operate and on which they depend. Humans cannot transcend or subdue ecological forces, and therefore must work, plan and design with Nature. Further, all species have the right to exist and evolve therefore SUD should be undertaken in such a way as to allow other species to co-exist with humans.

Thirdly, the sustainability of any action is clearly contextual. This means that even a community that is doing all that it can to reduce impacts and prepare for change cannot be sustainable so long as it exists in a greater system that is operating unsustainably. As Rees (2009, p.306) points out, "the best any sub-global system can attain in isolation is a state of *quasi*-sustainability. This describes a level of economic activity and energy/material consumption which, if extended to the entire system, would result in global sustainability".

Definitions and terms of reference

Because of the multi-disciplinary nature of this thesis, it is necessary to define several terms at the outset.

Sustainability

Weak and strong sustainability models

While the discourse around sustainability is expansive, with no single definition triumphing for the principles, criteria or vision of sustainability, one commonly used typology of perspectives includes that of "weak" versus "strong" sustainability. A defining characteristic of *strong* sustainability is the emphasis on preserving or even enhancing stocks of natural capital and ecological functions as the basis for all other forms of human-derived capital (Pearce, Atkinson & Dubourg, 1994). For *weak* sustainability, however, the *aggregate* of welfare potential of the Earth's overall capital must be maintained intact over time;

substituting natural resources and functions with human-made capital is permitted. In other words, the *welfare* or *utility* derived from the environment must be maintained over time where maintaining the natural capital stock is just the means to this end (Jacobs, 1995). Within this interpretation, environmental and economic goals are seen as conflicting and the need to "balance" and "trade-off" one against the other is required; "no aspect or 'level' of the environment is regarded as inviolable, at least until countervailing economic benefits have been assessed" (Jacobs, 1999, p.31). In contrast, by internalizing the true costs of human engineering, the *strong* perspective of sustainability does not accept the principle of substituting different forms of capital because it recognizes natural capital as the *source* of capital upon which all other capital and all life processes depend (Hediger, 1999; Pearce et al. 1994). Proponents of strong sustainability believe that prioritizing biophysical and ecological dimensions over human considerations can be considered an "empowerment tool and an optimistic challenge to our collective planning, decision and management efforts" (Doherty & Rydberg, 2002, p.15). In this thesis I am advocating for the strong perspective of sustainability.

In part due to these varying interpretations, sustainability and sustainable development have become buzzwords used by advocates of various and diverse interest groups. It would seem that, in the mainstream at least, sustainability can be flexibly defined based on different priorities and optimization criteria (Gatto, 1995). "Greenwashing" is a commonly used term to describe companies who disingenuously spin their products and policies as "environmentally friendly" or sustainable (Laufer, 2003). James and Lahti, authors of *The Natural Step*, describe this practice, which may also be applied to urban development, as a "minefield stemming from unclear or differing understandings of sustainability" (2004, p.16). From their, and my, perspective clear sustainability principles must be articulated if we are to avoid this "minefield".

Another less sinister, but perhaps even more dangerous form of green washing is that in which a product, action or policy is erroneously believed to be espousing sustainability principles. Strong sustainability proponents generally refer to these directions as "band-aid"

approaches because they fail to address the source of the unsustainability problem. Register (2002, p.132) believes that such approaches are not only erroneous but also dangerous because they may actually *prevent* truly sustainable communities from coming into being by strengthening systematic relations supporting unsustainability. He quotes architect Richard Levin: "such 'band-aid' solutions lead to instances where these deeper problems fall below the threshold of public attention and the political momentum for more fundamental change dissipates" (Register, 2002, p.131). Register, Levine and Rees believe that for sustainability principles and approaches to be helpful, they must identify the fundamental causes of why something is unsustainable in the first place.[8]

Of course other sustainability proponents are genuinely attempting to understand sustainability in all its complexity and subtleties. In a literature review conducted on the topic of sustainable urban development in 1995 Stephen Wheeler categorized a number of definitions into various reoccurring themes (p.13):

- Meeting the needs of future generations

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[8] One theory on the cause is, ironically, a lack of attention and reflection on the problem. Rees (2009, p.304) believes that *status quo* society does not meditate enough on this identification-of-the-problem stage in formulating solutions:

> "If we have not adequately thought through our sustainability conundrum, we should not be surprised that remedies to date are ill-conceived and largely ineffective. I argue that most mainstream approaches to sustainability today - hybrid cars, green buildings, smart growth, the new urbanism, green consumerism - do not, in fact, address the fundamental problem. Instead, they attempt to reproduce the status quo by other means. Consistent with our prevailing cultural illusion, today's global society essentially equates sustainability with maintaining growth through technological innovation and greater material and economic efficiency."

A number of hypotheses explain the root causes of society's collective unsustainability, many of which appear to complement each other: a detachment from Nature (man as outside of nature, not apart of it) (Glendinning, 1994), a mechanistic view of the world (Capra, 1982), limitations in sensory perception and thus understanding due to the subjective nature of interpretation of experiences (Regal, 1990), and the resulting creation, indoctrination and entrenchment of myths or cultural stories that do not accurately reflect our relationship to the rest of the living earth (Rees, 2009; Sarkissian et al., 2009). While it is unlikely that any one root cause can be identified, I believe that by embedding an explicit recognition of our inherent dependence on the living biosphere in our settlement planning we might begin to physically and psychologically re-integrate humans with Nature, experience the world as the living system that it is and reveal the incorrectness and failure of our cultural stories that lead us to believe otherwise.

- Carrying capacity of ecosystems
- Maintain natural capital
- Maintenance and improvement of systems
- Not making things worse
- Meeting both human and ecological needs
- Sustaining human livelihood
- Opposing exponential growth
- Protecting and restoring the environment

The fourteen years since Wheeler's categorization have seen no consensus on a single definitive term of the general concept of sustainability or more specifically of sustainable urban development (hereafter SUD) and sustainable neighbourhoods. Jepson (2001, p.502) notes that **"**for the most part, the tendency has been to keep definitions of sustainability and/or sustainable development imprecise and descriptive rather than prescriptive". In quoting Scruggs he states that this definitional variety and vagueness is neither good nor bad but it is inevitable because "every major concept which encompasses human ideals is subject to diverse interpretation" (2001, p.503; see also Jacobs, 1999).

To clarify the aim and operational principles of SUD in this work, I recognize the validity of all the concepts of sustainability identified by Wheeler (1995). A fundamental criteria is that critical thresholds of natural capital must be preserved and restored and human activities – individual and collective – must be aligned within ecological capacity constraints.[9] While some degree of localized ecological impact associated with settlement development is inevitable, it may be reduced, mitigated and/or compensated; while it is inevitable that

[9] A number of conceptions or metaphors are used to show how the broadly defined economic, social and ecological systems may work together to promote sustainability (Sarkissian et al., 2009): 1) the three interlocking circles concept in which sustainability occurs at the point where all systems coalesce; 2) the three-legged stool concept in which sustainability cannot be achieved without equal "length" or consideration to each of the legs of the stool; and 3) the nested hierarchies or concentric circles concept in which the sustainability of any one system depends on the sustainability of the system in which it is embedded. In this model, unlike the other two, each of the systems is not equal. The nested hierarchies concept acknowledges that a healthy (or sustainable) economy depends on a healthy society which depends on a healthy environment. Therefore, ecological sustainability is a prerequisite for the sustainability of all other systems. It is this concept of sustainability that is represented here.

human activity will have an impact on ecosystems, it can at least be managed within sustainable levels. Further, in order for a community to be sustainable, it must also be resilient by anticipating change and being prepared and able to adapt. In other words, for a system to sustain itself it must not only not infringe on its ability to continue to exist (i.e., not supersede its carrying capacity), but it must also maintain its ability to adapt to changing circumstances. For instance, even if the most robust application of targets based on ecological carrying capacity were applied to a low-lying coastal neighbourhood located in an area expected to be inundated due to rising sea levels, the development will not be sustainable despite it being "low-impact". Therefore, when discussing sustainability in this thesis, I am referring to these complementary characteristics of impact and resilience. When discussing the concept of sustainability throughout this paper, it will in most instances be referring to SUD or sustainable neighbourhoods and communities in particular.

Neighbourhood

Like the concepts of sustainability and SUD, the concept of the *neighbourhood* is a contested one with no one definitive definition (Downs, 1981). It may be described from a sociological perspective: a neighbourhood is defined by what its inhabitants think it is or as the locus of community. Or from a physical planning perspective: as a building block of a larger settlement pattern or a specific place as characterized by its specific aesthetic experience. Or the approach may be to us a multi-dimensional lens: the neighbourhood serves particular needs and functions, both physical and social such as providing a basis for home life and certain other activities (Barton, 2000, p.5). Just as sustainability proponents may feel that they are speaking at cross-purposes in the absence of a commonly articulated definition of sustainability, those involved with neighbourhood planning may also find this to be the case. For example, Barton (2000, p.5) notes that in England, functional qualities are most strongly emphasized as the basis for planning decisions, whereas in North American urban design has been very active in defining the neighbourhood. The following spatially oriented definition of neighbourhood is accepted for this thesis: "a walkable residential or mixed-use area, within which residents share basic facilities and have easy access on foot (400, or 800 metre

diameter) to basic facilities and services (e.g. school, shops, community centre, etc.)" (Kim, 2005, p.201).

This thesis examines SUD at the neighbourhood scale for a number of reasons. Firstly, neighbourhoods are an appropriate scale at which to illustrate these concepts because it is the scale at which detailed plans are made and with which residents identify. While sustainability must be addressed at all scales of planning, by all actors, industries, governments and citizens, the neighbourhood may serve as a microcosm of greater settlement dynamics. It is also a scale more conducive to design interventions, experimentation and evaluation. Thus, neighbourhoods may serve as "living laboratories" to test some of the applications advocated in this work. Borrowing from the metaphor of a healthy body made of numerous healthy cells, and echoing Rees' (2009) acknowledgement of the contextual nature of sustainability, a major assumption behind this work is that "sustainable solutions applied at the scale of the neighbourhood, if widely replicated, may be the crucial ingredient for a sustainable region" (Condon, 2006, p.3). The site or neighbourhood scale, therefore, is a justifiable level at which to address the concepts of SUD and the incorporation of ecological principles into neighbourhood planning. In terms of livability, neighbourhoods are also the scale at which communities identify and interact. Therefore, planning at this scale may have the ability to counteract the trends towards placelessness and car-oriented lifestyles and contribute to quality of life (Berg & Nycander, 1997).

Settlement scales and sustainability

Different sustainability-related planning concerns are present at different settlement scales. At one end of the spectrum – the regional scale – efficient placement of infrastructure and zoning for sustainable growth are paramount planning concerns. Therefore, issues of locational context, connectivity and, some would add, total ecological productivity and assimilative capacity (Rees, 2009) are best addressed at this scale. Regional plans are quite general in nature and provide a "skeleton" type of framework of development guidance to sub-plans at the city and neighbourhood scale (Adams, 1998, p.295). At the other end, the building scale, planning concerns are more of an architectural nature and involve the

specifics of the site, building design, materials and performance. Between these two extremes is the neighbourhood scale at which detailed land use plans are crafted, development controls and design guidelines articulated and servicing and transportation strategies addressed. At this scale, site planning and landscape design are implemented and a balance of mixed uses, housing and support facilities are provided to foster experiences of safety, identity, and sense of place (Kim, 2005). Central to best practice in neighbourhood planning today is a strong degree of community involvement through active engagement.

The neighbourhood scale will be the focus of the study. However, I will also discuss how the individual neighbourhood site fits within a larger region (through its street and transportation network and green spaces) as well as the necessity to extend ecological principles to the other end of the scale.

Research questions

Although this thesis raises a number of questions about sustainable community planning and design (some of which will remain unanswered in this work), the overarching line of inquiry attempts to address the following question: *How well do current best practices in spatial neighbourhood planning in North America reflect the concept of sustainability?* To answer this question with the conceptual tools planners have readily available to them today, I employ a number of sustainability evaluation frameworks. I hypothesize that the current planning principles and criteria of sustainable urban development and community design (as articulated in these frameworks) are not fully capturing the complexity of the unsustainability problem and therefore must be recognized as limiting.

To lend some context to the discussion, the following secondary research question is posed: *What are the sustainability characteristics of False Creek North as a model of urban form?*

I hypothesize that FCN offers a valuable template that can be enhanced with our current understanding of sustainable urban development and design strategies. However, in its basic

patterns, massing and form, it avoids addressing the community's sustainability in terms of both its impact and resilience.

Issues which this work does not address

Because of space limitations, this work does not address:

- Sustainability from economic and social perspectives or the social or economic implications of proposed physical planning and design decisions. It does, however, build on the post-occupancy evaluation, which evaluated resident satisfaction and liveability, both essential qualities of social sustainability. Because biophysical reality is the ultimate constraint, I argue that we must understand firstly this context before we can make social and economic considerations fit these circumstance;
- Planning and designing for sustainability at other spatial planning scales beyond the neighbourhood, other than to reference how neighbourhood needs might be met within a larger regional planning framework;
- The consumption patterns and behaviour of individuals and residents, although this work does acknowledge these as critically essential components of achieving sustainability;
- A quantification of the energy and material expenditures and pathways associated with design decisions as described by the indicators. Indicators are evaluated for their ecological appropriateness, but in a qualitative, rather than quantitative sense; and
- Specific challenges to and their effects on Vancouver and the community of FCN. The purpose of the thesis is to discuss in a general sense how communities might be designed to anticipate uncertainty, broadly defined.

The organization of this thesis

The intent of this work is to provide for a platform from which to encourage further discussion and research in the area of ecologically based planning and design, given the strong advocacy of this approach by a number of academics, authors and practitioners (see

chapter 3). The strength of this analysis is that it begins to articulate the general systems-based characteristics of neighbourhood indicators that might begin to capture concepts of strong sustainability and thus proposes a direction for this discussion.

Chapter 2 describes the methods by outlining the steps in my methodological approach including the scope of my literature review, the construction of an ecologically based theoretical evaluation framework to assess a number of neighbourhood assessment frameworks and how I report on the results of my analysis.

Chapter 3 examines the current thinking of SUD from a range of perspectives, each pursuing the goal of sustainability communities from a different point of reference or area of focus. I do this to determine where we might find such new models and what they might encompass. Visionaries, natural scientists, those concerned with energy and metabolic processes, spatial planners and ecological designers each bring different, yet valuable, perspectives on how to operationalize sustainable communities. The focus of this thesis is on the last perspective, that of the ecological designer. This is because I believe that it is the appropriate foundational approach to address community sustainability.

Chapter 4 and 5 are the substantive results-based chapters. Chapter 4 lays out the results and discussion of how well the indicator frameworks capture the concept of strong sustainability. It concludes with critiques of individual frameworks and highlights an emerging framework with some promise. Chapter 5 lays out the results and discussion of how well FCN captures the concept of strong sustainability after a brief introduction to the site characteristics and planning process that guided the development.

Chapter 6 concludes the thesis by returning to the research questions and answering them as best I am able. Some questions emerge from the analysis which are stated here. The ecological approach is proposed as a normative theory that offers operationalizable criteria. To further this study, I highlight the need for experimentation, evaluation and strategic application of these concepts.

Finally, I conclude in my own voice on some my reflections and lessons I've learned along the way.

CHAPTER 2: RESEARCH METHODS

Introduction

This chapter outlines the steps in my methodological approach including the scope of my literature review, the construction of an ecologically based theoretical evaluation framework to assess a number of neighbourhood assessment frameworks and how I report on the results of my analysis.

In this work I identify characteristics of strong sustainability using the ecosystem as a model of a sustainable system. I use these ecosystem characteristics to develop a theoretical framework from which to evaluate neighbourhood sustainability assessment frameworks and the community of FCN. In the results and discussion I identify areas of improvement for the assessment frameworks, FCN and future developments that aim to be distinguished as "sustainable". This is achieved by demonstrating which elements of the development are consistent with concepts of ecological impact, carrying capacity and systems resilience.

My methodological approach follows the following sequence of steps:

1. Extensive literature review of SUD, ecological characteristics and principles of systems resilience;
2. Construction of a theoretical framework for selecting and critiquing neighbourhood assessment frameworks and their indicators;
3. Targeted literature review to select neighbourhood assessment frameworks;
4. Construction of an evaluation matrix using the theoretical framework and indicator categories (from the selected neighbourhood assessment frameworks);
5. Assessment of indicator categories based on the ecologically based theoretical framework;
6. Application of matrix analysis to FCN; and
7. Assessment of FCN using the selected assessment frameworks for comparison with my ecologically based framework.

These steps in the analysis are discussed sequentially below.

Step 1: Extensive literature review of sustainable urban development, ecological characteristics and principles of systems resilience

An extensive literature review of conventional thinking around SUD was conducted in order to capture the current discourse and situate the ecological perspective of sustainability within this discourse. This literature review is presented in chapter 3. A literature review was also conducted on ecosystem characteristics and principles of systems resilience in order to justify and populate the theoretical evaluation framework described in step 2. This literature review is presented in chapter 4.

Step 2: Construction of a theoretical framework for selecting and critiquing assessment frameworks and their indicators

The literature review reveals that the use of ecosystem characteristics as a basis of evaluating neighbourhood development concepts is not common. Applying ecosystem characteristics and principles to practice is common in agroforestry and permaculture contexts (Doherty & Rydberg, 2002), but is rarely applied to human settlements. Jabareen (2006) conducted a similar analysis to mine in which he compared characteristic urban forms to sustainability indices such as density, diversity, mixed use etc., but not ecological characteristics. Because I could not find an analysis framework that specifically contained ecosystem characteristics and principles of resilience I constructed an ecologically based theoretical framework based on the ecosystems characteristics literature review conducted in step 1. This framework, or lens, is discussed in chapter 4.

Step 3: Targeted literature review to select assessment frameworks

I examined a number of sustainability evaluation frameworks as contenders for the current analysis. To locate the frameworks, I conducted an Internet search on Google Scholar using a combination of the following terms: “sustainability”, “neighbourhood”, “evaluation”, “framework”, “assessment”, “indicators”. Tools which emphasized primarily aspects of

physical site and community design at the neighbourhood scale were sought. The frameworks also had to meet the following criteria:

- be professionally recognized: either formally adopted in practice or academically proposed through peer-reviewed research;
- allow for comparability with other sites (i.e. has been used before);
- the suite of selected frameworks had to complement one another to allow for the widest range of physical site and community design indicators and criteria to be used;
- where possible, it was desirable to capitalize on local innovation as such approaches would likely be most sensitive to the context;
- require data that could be easily obtained; and
- reflect ecological principles wherever possible.

For an annotated list of the frameworks examined, but not selected, see Appendix A.

Selected tools for analysis

The following three assessment frameworks were chosen for the analysis of this work: Leadership in Energy and Environmental Design for Neighbourhood Development (LEED ND), Sustainable Urban Landscapes Site Design Manual for B.C. Communities (SDMBC) and Sustainable Sites Initiative (SSI): Guidelines and Performance Benchmarks. A short discussion of each is provided below. Depending on the data required for the indicators in these frameworks, data were obtained from observation, direct measurement, indirect measurement using orthogonal maps, review of bylaws and other relevant policy documentation or informal interviews with planners at the City of Vancouver. Data are entered in tables, or scorecards, for each of the frameworks, all of which are included in Appendix D.

Evaluation Framework 1. LEED for Neighbourhood Development

Reference: United States Green Building Council. (2008). *LEED for neighbourhood development rating system: 1st public comment draft.* Washington, DC: USGBC.

The U.S. Green Building Council (USGBC), in partnership with the Congress for New Urbanism and the Natural Resources Defence Council, has developed the Leadership in Energy and Environmental Design for Neighborhood Development assessment framework (hereafter LEED ND). It "is a green neighborhood certification program that integrates the principles of smart growth, New Urbanism, and green building into the first U.S. national program for neighborhood design" (FAQ sheet for LEED ND, n.d.). The framework is designed to encourage "the creation of compact, walkable, vibrant, mixed-use neighborhoods with good connections to nearby communities", the benefits of which are to encourage healthy living, reduce urban sprawl and protect threatened species (LEED for Neighbourhood Development, n.d.). The LEED ND framework is based on a series of prerequisites and a number of optional credits which, if achieved, are used to rate the development's performance from "best" (platinum) to gold or silver. Prerequisites and credits are distributed across the following categories: smart location and linkage, neighbourhood pattern and design, green infrastructure and building and innovation and design process. See Appendix D for the assessment scorecard.

While LEED rating systems have been in operation for individual residential, commercial and industrial buildings for over ten years, the neighbourhood development suite of LEED is currently finalising the pilot program. Since 2007, 240 projects from around the world were involved in the testing of the framework, one of which was the local UniverCity project at Simon Fraser University, Burnaby, in suburban Vancouver. Two iterations of the framework were submitted for public comment, the second of which recently closed. The comments from this public review are now available on the USGBC website. It is projected that the post-pilot version of the rating system will be available late 2009.

Evaluation Framework 2. Sustainable Urban Landscapes Site Design Manual for B.C. Communities

Reference: Condon, P.M. (2003). *Sustainable urban landscapes: site design manual for British Columbia communities. Version 1.5*. Vancouver, BC: University of British Columbia, James Taylor Chair in Landscape and Liveable Environments.

This framework is informed by a number of overarching principles and more specific design guidelines for sustainable community design in British Columbia. These principles and guidelines emerged from a series of design charrette strategies that were conducted for existing communities in the Fraser Valley area of south western British Columbia, Canada. Reversing the "usual process of working from the particular design rule to the general plan" this approach "derived the specific design rules from the integrated whole of the completed charrette proposals" (Condon, 2003, p.79). Thus, the criteria are based on very practical considerations, opportunities and constraints common to all the projects reviewed.

More than simply an assessment tool, the Sustainable Urban Landscapes Site Design Manual for B.C. Communities (hereafter SDMBC) is comprised of a review of: development trends and their effects on local environments; documentation of the methodological approach used to develop the design guidelines and principles of sustainable design; as well as a sustainability checklist which can be used as a tool in evaluating neighbourhood developments. Employing a simple yes/no assessment, this checklist tool offers a less rigorous judgement of criteria than the LEED ND or SSI frameworks, but is also more comprehensive through its integration of a number of more district- and regional-level concerns, such as regional waste infrastructure capacity and integration with regional ecological networks. The checklist and design strategies proposed in the manual are not intended to serve as scientific or absolute measures of sustainable development, but rather to provide the basis of consistent comparison between options.

The overarching principles are as follows:

1. Capitalize on the site
2. Connect the flows
3. Layer the systems
4. Create a centre
5. Employ an economy of means
6. Make it home

Each principle is reflected in the 43 design guidelines across four scales: district, corridor, block and parcel. The sustainability checklist captures the full range of guidelines and principles proposed in the manual. See Appendix D for the assessment scorecard.

Evaluation Framework 3. Sustainable Sites Initiative: Guidelines and Performance Benchmarks

Reference: Sustainable Sites Initiative (SSI). (2008). *Guidelines and performance benchmarks draft 2008.* Washington, DC: Author.

The Sustainable Sites Initiative in the U.S. is an interdisciplinary effort spearheaded by the American Society of Landscape Architects that aims to "create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices" (SSI, n.d.). The Sustainable Sites Initiative: Guidelines and Performance Benchmarks (hereafter SSI) has been informed by an interdisciplinary team of experts in soils, hydrology, vegetation, materials and human health and well-being. The initiative "envisages that sustainable land practices will enable natural and built systems to work together to protect and enhance the ability of landscapes to provide services such as climate regulation, clean air and water, and improved quality of life" (SSI, 2008, p.10). The emphasis of the framework is explicitly ecological and it uses the criteria of restoring and preserving ecosystem services as the means through which to achieve sustainability of a site. The

orientation of the framework is towards sustainable practices in landscape design, although site location and some building elements are also incorporated.

In all, the Initiative uses 59 draft prerequisites, credits and their associated benchmarks to provide a comprehensive assessment of the ecosystem services present on a site. All these criteria are based on "comprehensive review of applicable science and best practices in the industries involved" (SSI, 2008, p.31). See Appendix D for the assessment scorecard using these prerequisites and credits.[10]

This framework is still being reviewed and the authors have recently concluded the online public comment period. The authors of the SSI plan to adopt the benchmarks by the end of 2009 and pilot and release a formal rating system by 2011. The USGBC has expressed interest in incorporating the benchmarks into future versions of the LEED Green Building Rating System once they've been adopted.

How the frameworks compare with each other

Each of the three evaluation frameworks offers somewhat different areas to focus their assessment of neighbourhoods, which are complementary when used together. For example, the SDMBC Checklist has an explicit physical design emphasis and advocates for a "design with Nature" approach. In addressing a range of considerations from the district to corridor to parcel scales, the neighbourhood is viewed within a greater regional context. This framework, however, is less oriented on resource throughputs than either the LEED ND or SSI.

LEED ND is the most professionally recognized framework of the three in North America and, in my view, offers a more rigorous evaluation and discerning application of credits than

[10] Please note that to simplify the analysis of this study, the SSI assessment framework is used as a yes/no checklist tool, rather than based on point allocations as it is intended.

either of the other frameworks, which serve as checklists in this analysis.[11] It articulates more site and building-specific treatments and resource use, particularly in the area of building performance, an area with which it has experience. In contrast, it has a less regional focus than the SDMBC and emphasizes designing with Nature less than either of the other two frameworks.

SSI is clearly oriented to landscape elements such as the size, quality and connectivity of open spaces on site and habitat needs of urban wildlife. Resource use and associated impacts are emphasized more than physical design parameters and there is less focus on human needs than on ecological.

Step 4: Construction of an ecologically based evaluation matrix using the theoretical framework and indicator categories

The evaluation matrix is comprised of elements to be evaluated as well as evaluation criteria. I distilled from the literature reviews and assessment frameworks the following respective thematic categories: sustainability indicators (elements to be evaluated) and ecosystem characteristics and principles of systems resilience (evaluation criteria).

The matrix is not meant to evaluate empirically how well the indicator captures the ecological principle, but rather to suggest which indicators might currently capture *some degree* of the principle. It therefore provides a framework around which these ideas of incorporating ecological characteristics into indicators can be more qualitatively discussed.

Sustainability indicators

The indicators from each of the assessment frameworks are grouped into a number of categories using a "lump-and-split" grouping method of simple categorizing (Sarkissian & Bunjamin-Mau, 2009). In this categorization method, reoccurring themes are first grouped

[11] The SSI framework does offer credits, but they are still being drafted.

together – lumped – and then names are given to the groups. Upon further revision, themes that may ostensibly have appeared to fit within one category may be moved to fit within a more closely related category – split. For example, indicators pertaining to site design, patterning, massing, form and connectivity all shared similar physical site design language. By contrast, indicators pertaining to the process that informed the design, as well as the ability to integrate within previous plans, shared a common language, and thus became its own category. All indicators within each category are listed in Appendix B.

Ecosystem characteristics and principles of systems resilience

The indicators are evaluated as to how well they capture the concepts of both ecological "impact" and "resilience". Firstly, "ecological impact" is divided into direct and indirect impact. Indirect impact includes such parameters of form that may encourage or at least provide the option for individuals to reduce their direct impact. For example, providing a mix of shops, services and facilities will likely require the same amount of materials and operating energy than a single use (i.e. they will have the same direct impact), but in providing a mix of uses in close proximity to residential, residents have the opportunity to choose a less impactful mobility option to the car to meet their shopping needs. Table 2.1 in step 5 illustrates the matrix format for this criterion.

The ecosystem is used as the model of resilient systems in this thesis. Therefore the "resilience" aspect of sustainability is demonstrated through the ecosystem characteristics which are grouped into categories using the "lump-and-split" method. The indicator categories are then evaluated against these criteria. Table 2.2 in step 5 provides an example of the matrix layout for this segment of the analysis.

Step 5: Assessment of indicator categories based on the theoretical framework

The indicator categories are evaluated using the ecologically based theoretical framework in order to answer the first research question: *How well do current best practices in spatial*

neighbourhood planning in North America reflect the concept of sustainability? The analysis for both "impact" and "resilience" dimensions of sustainability are achieved through the author's judgement, having been immersed in the literature of ecological principles and sustainability indicators, where qualified responses are given to justify the response; I refer to these as "rationale statements". Tables 5.1 and 5.2 below illustrate the matrix format for the "impact" and "resilience" dimensions of sustainability respectively, including how the rationale statements are presented.

Table 2.1: Example of how the impact dimension of sustainability is presented in the ecologically based evaluation framework.

Impact (across)/ Indicator categories (down)	**Direct**	**Indirect**
Design process, consistency with existing policy and setting of goals		
Specific siting process and constraints	X	
Site design: patterning, massing, form and connectivity	X	X
etc.		

Table 2.2: Example of how the resilience dimension of sustainability is presented in the ecologically based evaluation framework.

Ecosystem characteristic (across)/ Indicator (down)	Decentralized	Cyclical	Redundant	Renewable	Responsive	etc.
Design process, consistency with existing policy and setting of goals					X rationale statement	
Specific siting process and constraints	X rationale statement					
Site design: patterning, massing, form and connectivity			X rationale statement			
etc.						

Step 6: Application of matrix analysis to False Creek North

I evaluate FCN with the ecologically based theoretical framework in order to answer the second research question: *What are the sustainability characteristics of False Creek North as a model of urban form?*

Because the ecologically based theoretical framework evaluates indicator categories, and not individual indicators, FCN's rating on the indicator *categories* is given in the matrix. Personal judgement informed by the assessment process in step 7 is used to determine how well FCN reflects these categories of indicators.

Step 7: Assessment of False Creek North using the selected assessment frameworks

The purpose of evaluating FCN using the assessment frameworks is to provide a comparative analysis on a tangible development between the conventional and my theoretical assessment frameworks. Because the intent of the analysis is to be illustrative, it is not pertinent that the evaluations be conducted with the exact rigour that is intended in the assessment frameworks. For example, the SSI framework follows a similar format to the LEED ND framework where a series of points is allocated based on the degree to which a certain criterion is met. To simplify the analysis for the purposes of this thesis, however, the credits in the SSI framework are treated more like a "checklist" where a simple "yes/no" or "presence/absence" judgement is used to allocate merit. This approach clearly does not reflect the richness of the assessment frameworks. This must be taken into consideration when reading and/or referencing the data presented in the assessment scorecards. The LEED ND framework, however, is used in its original form and credit points are allocated because of the framework's wide recognition and the LEED precedence with developing the point-form evaluation method in other applications. Further, it is anticipated that the LEED ND analysis of FCN may, on its own, be of professional interest.

Because of data limitations and scope of the project, personal and professional judgement was used to assign a result in some instances. It has been noted where this is the case in the

respective assessment framework tables or scorecards. In other instances, where data could not be obtained and personal judgement could not be used to determine a response, no answer is allocated to those indicators. This is also noted in the assessment scorecards.

Conclusions

Now that the problem statement has been articulated and the methodological approach established, the next chapter will explore the theoretical and practical underpinnings of conventional perspectives of SUD.

CHAPTER 3: LITERATURE REVIEW ON CONVENTIONAL THEORY AND PRACTICE OF SUSTAINABLE URBAN DEVELOPMENT

Introduction

Chapter 1 outlined the problems associated with urban unsustainability, and societal unsustainability in general, as a great imperative of this time. It posited the inadequacy of current neighbourhood planning, design and development models. It argued for new models of neighbourhood development or a new look at old models, to counter the "converging catastrophes" of our time. This chapter examines the current thinking of SUD from a range of perspectives, each pursuing the goal of sustainable communities from a different point of reference or area of focus. I do this to determine where we might find such new models and what they might encompass. Visionaries, natural scientists, those concerned with energy and metabolic processes, spatial planners and ecological designers each bring different, yet valuable, perspectives on how to operationalize sustainable communities. The literature review reveals that perspectives lack a common language which may result in the proponents of respective perspectives feeling that they are not working together as a result. A "levels of approaches" analysis suggests that these various perspectives might benefit from recognizing their more specific foci within the greater pursuit of SUD. I propose the last perspective, that of the ecological designers as a unifying normative perspective. To begin, I address why planning is a suitable profession to be tackling the concept of sustainable communities.

The emergence of sustainability in the planning profession

In the broad sphere of planning, physical planning and design are increasingly being recognized and explored for their potential leverage in providing a structure for sustainable communities. However, we lack agreement about how well sustainability is being addressed through these means. Not everyone working in planning and design agrees about the seriousness and urgency of the situation or the root causes of the problem (Wheeler 1995, p.34). At one end of the spectrum are those who agree with Canadian sustainability specialist, William Rees, that even our best attempts at "sustainable community planning" are inherently flawed because they perpetuate status quo growth-bound thinking, which is

inherently unattainable and unsustainable on a finite planet (Rees, 2009). Those with this view tend to advocate for revolutionary whole-systems changes in how we view our relationships to the living biosphere (see Rees, 2009; Register, 2002; Sarkissian et al., 2009). At the other end of the spectrum are those who see recent progress in this field and affirm that we are on the right track (Newman, 1998). Regardless of how serious one regards the general societal trend of unsustainability, however, there appears to be a common understanding that settlement planning must assert itself as a major tool to address these challenges (Saunders, 1997).

In recent history, planning has earned a reputation of inadequately anticipating the challenges we face today. In many cases, planning solutions to problems of the day have led to unsuitable and unsustainable land-use patterns and built forms such as energy-intensive, sprawling, low-density development, now regarded as the anathema of sustainable design (McManus, 2005). As early as the 1960s, many planning interventions were seen as unsuccessful from a social perspective. For example, urban activist Jane Jacobs highlighted the disruptive and often terminal effects of neighbourhood "improvement" programs in which existing neighbourhoods were demolished and replaced. Most of these programs are now widely accepted as unsuccessful, demonstrated by their subsequent demolition. Another example, land-use zoning, has come full circle in the view of Australian critic Phil McManus, to promote diversity, vibrancy, cohesion and a degree of self-sufficiency in communities by departing from rigid separation of land uses to zoning for a "mix of uses" (McManus, 2005). A number of communities (such as New Orleans) have also experienced severe natural disasters, which raises the question of whether we should be settling in such vulnerable areas in the first place. The Government of the United Kingdom Housing Corporation may sum up planning's inadequacy at anticipating the challenges we face best when they contend that the increasing interest in planning *sustainable* communities "is born of a candid acknowledgement that much of the development undertaken in the second half of the 20th Century has already been shown not to withstand the test of time" (Housing Corporation, 2004, p.3).

Over the past couple of decades, settlement planning has increasingly been recognized as an essential profession and activity in addressing some key unsustainable practices related to land use and development. There are a number of reasons for this. Firstly, procedurally and in terms of policy formation, planning may play a strategic role in formulating contextually appropriate responses to local sustainability issues by managing and resolving conflict. Because progress with sustainability will be "loosely coordinated, flexible, based on common principles and a common goal rather than a common blueprint," (Housing Corporation, 2004, p.6) the contextually sensitive approach that planners can bring to problem solving is of immense value. Campbell (1996) believes that one of the planner's strategic strengths is her ability to act as mediator and translator in order to assist ostensibly dissimilar groups in understanding the priorities and reasonings of the other.

Secondly, the goal of sustainability and the process of planning are both inherently forward-thinking and require us to address integration of values, disciplines, actors and institutions as a central conceptual challenge (Jepson, 2001). Jepson (2001, p.507) points out that sustainability and planning are "complementary in the sense that sustainability has the potential of providing much, if not all, of the conceptual context (theories, goals, objectives, etc) for the activity of planning in the twenty-first century".

Thirdly, planners have substantive knowledge about the degree to which physical forms and patterns of our cities can influence economies, social phenomena and ecological impact (Campbell, 1996). Land use, and specifically the conversion of productive living land into ecologically unproductive urban communities, is widely believed to irreversibly change the natural ecology and processes of the site (USEPA, 2001). Urban forms, as aggregates of the housing forms, mobility options and distribution of commercial, industrial and amenity services they facilitate, also have immense indirect "enabling" impacts on individual behaviour. For example, if the services required to meet daily shopping needs are not in walking proximity or transit accessible, individuals will have few options other than to use private automobiles to meet such needs. Further, Rees (2009, p.309) notes that because "the building sector arguably has greater material leverage in reducing the human ecological

footprint than any other major industrial sector", it is in a strategic position to provide leadership in the quest for global sustainability which could influence other sectors. As de facto regulators of the building sector, planners clearly have a role to play in activating that leverage.

Perspectives on sustainable urban development: with an emphasis on urban pattern and form

Although sustainability has the potential to provide the entire conceptual context for planning, this has not occurred. There appears to be "difficulty in incorporating the full range of its dimensions into local planning policies and programs" (Jepson, 2004, p.3). In conducting this research, I discovered a broad range of perspectives on how best to approach SUD at the neighbourhood scale, each with their own language, theories, universal truths and leading thinkers in their respective fields. To narrow the focus of the discussion of SUD, I attempt to present primarily perspectives as they pertain to physical characteristics of urban form. I recognize that this is a somewhat restrictive attempt, given the interdisciplinary and complexity of the concept of SUD described thus far. In an attempt to capture a wide range of emphases, nuances, approaches and strategies, I provide a categorization below of substantive "broad perspectives and key priorities" to describe some of the current discourse on physical planning for sustainable neighbourhoods.

The broader perspectives and key priorities

SUD proponents tend to focus their discussion on a number of perspectives, key priorities and substantive content. This includes what they see as the origins of the unsustainability problem to be and the solutions they propose to the problem. To understand the validity of a proposed strategy, it is helpful to understand the broader framework of thinking in which the strategy is embedded. Stephen Wheeler (1995, p.41-43) offers the following typology for categorizing perspectives on SUD:[12]

[12] These points are direct excerpts from this source.

1. *Garden City Planners/ New Urbanists*: Essentially improved versions of suburbia, green and highly livable; large-scale communities, often designed around transit; some emphasis on regional planning.

2. *Environmentalists*: Focus on cleaning up the urban environment and using resources wisely; less on design and social issues; main tools are policy, law, regulation and organizing. Some writers take a more holistic approach than others.

3. *Ecological Designers*: Focus on "green" design of particular buildings and sites; often using innovative and holistic approaches; interested in environment-friendly materials, passive solar design, biological wastewater treatment, etc.

4. *Utopians/Visionaries*: Comprehensive visions of healthy community, which incorporate social and spiritual aspects as well as design; a complete rethinking of urban form and content.

The literature review for this thesis revealed a similar, yet slightly more expansive, typology to characterize approaches. Wheeler (1995) and I acknowledge that these categories are not discrete. While individual proponents generally focus on one perspective or area as their expertise, most recognize the necessity of elements from other perspectives for actions to be successful. To provide a basis for comparisons, three themes were identified in the literature review: cause of unsustainability at neighbourhood scale, universal truths and proposed solutions.

Perspective 1: Philosophical: comprehensive visions for communities

Visionary approaches offer redefinitions of societal aims and generally promote whole systems change in communities, considering the cause of unsustainability to be an emergence of a socio-economic system that simply does not work at meeting human needs equitably and/or respecting the environment. Rarely are visions confined to the neighbourhood scale;

many visionaries comment on the need for national and international initiatives, as well as those at every other societal scale. Comprehensive in approach, they touch more broadly on all complex political and economic enterprises (Lynch, 1981). They generally paint a picture of an alterative to the current dominant Western growth-based socio-economic system and relationships to the natural environment and urge others to consider their alternative. Callenbach (1999, p.17), for example, lists a number of rules and the Earth's "ten commandments".

Because of their holistic approach to problem solving, SUD visionaries generally expand beyond an alternative physical settlement form to include the need for change in social norms and values, power and governance, education and sharing of information, behaviour, consumption, laws, economies including tax reform, pricing and trade as well as distribution of wealth (Birkeland, 2008; Girardet, 1999; Hester, 2006; McManus, 2005; Register, 2002). Common themes that emerge form this perspective are: spirituality, relations of humans to other living things, the individual's role as citizen (as opposed to consumer), gender, age and cultural equality, and an ethical framework that extends beyond the personal to encompass an ethic of care to all living things. The need for leadership, individual actions in the pursuit of social change and reason for hope are frequently evoked.

Writers of the philosophical and visionary persuasion generally explore the purpose of settlements (and cities in particular), beyond nodes of shelter and trade to include pinnacles of human achievement, culture, civility and conviviality. In this light, cities not only reflect the values of a culture, but are also seen as critical to nurturing human creativity, potential and evolution of culture. Girardet (1992, p.118), for example, advocates for civilization, not mobilization when he claims that cities can be centres of excellence and civilization, rather than "temporary camps for the mobilization of people in a motorized, ever-restless quest for the unobtainable". Many ecological designers, such as Hough (2004) and Todd and Tukel (1981), share the philosophy that alienation of urban society from ecological values is the root cause of a society out of balance with its ecological context. They emphasize a need to re-instil eco-literacy by making those connections explicit within our cities. The need for

more environmental, sustainability and eco-literacy education in general is a commonly cited leverage to amplify whole-systems change within the philosophical perspective (Capra, 1982, 2002; Orr, 1992, 2002, 2004; Sarkissian et al., 2009).

Even those authors who propose more radical or "utopian" visions are commonly bound by a comprehensive and complementary set of goals for society or for individual communities. While sustainability is likely to be the core goal of their vision, they may only gesture to the ecological impact and resilience dimensions of the concept, rather than clearly articulating or empirically investigating those impacts or dimensions. In recognizing the elusiveness of the concept of sustainability and the absence of a prescriptive approach, authors such as Wheeler believe that the strength of a visionary approach is its ability "express a coherent and meaningful philosophy that points in clear directions and has coherent applications" (Wheeler, 1995, p.iv). Wheeler and Beatley (2004, p.278) expand on this thought by stating that visionaries and even utopian thinkers "help expand the framework of permissible ideas".

Perspective 2: Natural sciences: protection of biodiversity and landscape dynamics

A number of academics and practitioners in the more traditional natural sciences such as forestry, landscape ecology and wildlife biology advocate for the needs of other organisms beyond humans and our domesticates within urban neighbourhoods (Breuste, Niemelä & Snep, 2008; Colding, 2007; Cook, 2000; Dale et al., 2000; Flores et al., 1998; Niemelä, 1999; Pickett & Cadenasso, 2007). They remind us that sustainable urban development must conserve biodiversity and natural ecological processes, such as wildlife migration patterns, hydrology, temperature regulation, nutrient cycling, natural disturbances, ecosystem succession and evolution. They are often concerned with the development impacts on local ecology, such as invasive species, habitat fragmentation or elimination, use of pesticides and herbicides to native species and the consequences of bioaccumulation. As the majority of these proponents are scientists, a utilitarian (or consequentialist ethical) case for conserving natural processes and other species as providing "ecosystem services" is often evoked, more so than moral imperatives (Bolund & Hunhammar, 1999). Their strength is in pointing out

ecological requirements but they do not generally make specific recommendations about planning and design strategies beyond recommending habitat patches of adequate size, connectivity, composition and quality and using native species in landscaping to provide habitat for local species. These initiatives form the bases of their "universal truths". They generally attempt to understand the dynamics of urban green spaces as their spatial focus (Breuste et al., 2008). My literature review does, however, indicate a trend in increasing interest in working more collaboratively with neighbourhood planners by attempting to understand urban systems as a socio-ecologic dynamic.

In an effort to better understand how urban planning can incorporate ecological knowledge, Niemelä (1999) believes that three broad questions need to be addressed:

1. Knowledge of what kind of Nature in urban areas exists;
2. Knowledge about processes affecting urban Nature in comparison to rural Nature, such as human-induced disturbances and the consequent effects on succession;
3. Ecosystem-specific management schemes designed for urban Nature based on ecological knowledge.

Ecological impact and the resilience dimensions of sustainability are frequently recognized by the naturalists, with the emphasis clearly being on impact to the organisms of study, or ecosystems at large, and, in turn, specifically their resilience in face of change. Beyond advocating for understanding how Nature might exist in our urban settings, and in contrast to the "philosophical thinkers", proponents with this perspective rarely question underlying assumptions about settlement patterns, or challenge existing institutional structure and concepts of sustainable economic growth itself (Wheeler, 1995, p.21).

Perspective 3: Extended Metabolism of Settlements model:[13] Flows of energy, materials and waste

One definition of sustainability provided by the United Nations emphasizes the importance of regulating energy and material throughput where sustainability is defined as a "global

[13] This term borrowed from Sheurer, 2001.

process of development that minimizes *environments resources* and reduces the impact on *environmental sinks* using processes that simultaneously improve the economy and the quality of life" (World Commission on Environment and Development, 1987, p.67).[14] This perspective attempts to understand the pathways along which energy and materials within settlements move in order to propose strategies of how energy and material use can be as efficient as possible and then recycled into the system. Proponents of this perspective recognize that because the Earth is finite, use of renewable energy and materials must be balanced with the ecosphere's ability to provide resources and energy (sources) and absorb wastes (sinks). Laws of thermodynamics, particularly related to the second law pertaining to how human activity consumes Nature-produced "ordered energy", thus resulting in increasing entropy, are frequently explicitly discussed within this perspective.

The *metabolism model* is a popular concept used to describe resource flows – inputs and outputs – of energy, materials and waste within a specific community, industrial and economic processes and human activity in general (Girardet, 1999; McManus 2005; Newman, 1999). Industrial ecology, in particular, is an emerging field which recognizes that "the physical and biological processes of converting "natural resources" into useful products and wastes is like the human body's metabolic processes or that of an ecosystem"(Newman 1999; see also Kibert, Sendzimir & Guy, 2000). These authors may acknowledge the broader concept of the "city as organism" in which analogies are made between city form and function and those of organisms or Nature in general (Kibert, et al., 2000). Generally, however, the focus is on the energy assimilation functions of the settlement. While those from this perspective may evoke the biological metaphor of city as organism, they generally do not extend this living system-focused thinking to address the broader concept of settlements as habitats for the human species as much as the ecological designers or philosophers do. Nor do they dwell on the needs of other organisms as much as the landscape ecologists.

[14] Italics added by the author.

The concept of the "ecological footprint" and a "fair share" of the Earth's resources for every human on the planet is predicated on these fundamental concepts of a finite carrying capacity and critical availability of usable (i.e., highly ordered forms of) energy (Wackernagel & Rees, 1996). The ecological impact dimension of sustainability is therefore clearly acknowledged where impact is measured in energy and material use. Many who operate from this perspective also recognize the need to base not simply human settlements, but all human activity (including the economy) on these fundamental thermodynamic concepts (Rees 2003).

Setting sustainability targets and monitoring progress of defined goals have emerged as a logical and necessary approach to addressing sustainability within this perspective; quantitative targets are generally set for resource throughputs such as energy and waste. Other perspectives, such as visionary and spatial, may include indicators for less tangible and quality-based concepts such as equity or sense of place. Target-based approaches generally imply some recognition of ecological constraints (although, interestingly, they are not always based on absolute ecological constraints) and attempt first to quantify and then to minimize ecological impacts more so than other perspectives. For example, spatial planners do not always explicitly reference how urban form and pattern impact on resource flows other than to identify correlations between form and flow. This may be because, as McDonald reminds us, studies on how urban form affects resource use "vary substantially, depending on the resource in question and the socioeconomic context of the city" (McDonald, 2008, p.100).

When setting a comprehensive set of targets for a community, a pattern of familiar themes emerges in which one or a number of targets may be set. The Sustainable Urban Neighbourhoods (SUN) framework as applied to the Emerald Hills Urban Village in Edmonton, Alberta, identifies 12 themes for evaluating sustainable development, seven of which are directly related to resource throughputs, as shown in italics below (Campbell & Mayhew, 2007):

- *land*
- *carbon*
- *materials*
- natural habitat
- *transport*
- *waste*
- *water*
- *food*
- economy
- culture
- equity
- well-being

The One Planet Community movement is an effort to demonstrate that neighbourhoods can fit within the Earth's finite carrying capacity (One Planet Communities, n.d.). They have set an ambitious target of creating neighbourhoods internationally that can exist with an 80% reduction in ecological impact compared to today's standards (as measured by ecological footprint analysis) by 2020. Expected outcomes of this target are communities that emit zero carbon emissions and zero waste. In doing, so they believe that these neighbourhoods will "strengthen community, provide a healthier quality of life, and restore nature" (One Planet Communities, n.d.). Although this is a relatively new movement, and generally applied to newly built communities, a number of communities are attempting to embody the movement's 10 Principles of Sustainability around the themes identified above.

Perspective 4: Spatial planners: land use, pattern and form

Along with resource flows, the physical spatial dimensions of settlements are emerging as some of the more studied and evaluated sets of categories in sustainable urban development. This is not surprising, given the tangible, development-orientated focus of this perspective and the fact that spatial planning is the traditional domain of community planners. Spatial parameters are also somewhat simpler to measure in comparison to the other categories, although how they explicitly relate to ecologically bound resource use, as in the case with the previous perspective, continues to be researched. While it is acknowledged that form can influence resource flows, more substantive research is still required about how form affects total ecological impact (Ellis, 2002). Within this perspective, sustainability gains are purported to be achieved through the following measures: compact and contained development; higher density in infill areas – yet scaled to the pedestrian; mix of uses; greater range of alternative forms of transportation to the private automobile; revitalization of

existing urban form; and greater preservation and provision of open space and public amenities. Many of these approaches could be called the "universal truths" of good urban design, as described by Lynch (1981).

New Urbanism

New Urbanism is an example of a neotraditionalist theory and movement of neighbourhood planning and architecture that has "captured the imagination of the American public like no other urban planning movement in decades" (Fulton, 1996, p.2). Born out of a reaction to sprawling, "faceless", suburban development, this category of approaches relies heavily on so-called "proven" forms, many of which are a return to older, nostalgic forms of settlement patterning. It also attempts to fit those ideas into a variety of urban and suburban settings. Physical infrastructure is the focus of this group, with the belief that community design, such as walkability, and architectural design, such as front porches, can create or influence particular social patterns such as community cohesiveness. Some proponents of this view believe that one of its greatest merits is its practical hands-on approach to tackling physical planning issues (Moudon, 2000). Within this perspective, the language is generally focused more heavily on livability and quality of life than on ecological goals. Although sustainability and livability goals are increasingly seen as intertwined and necessarily complementary within this movement, they are sometimes conflated, thus distracting from the strong orientation of sustainability.

Smart Growth

Smart Growth is a planning approach that addresses many of the concerns raised by New Urbanists, with the added distinction of explicitly aiming to reduce impacts on the environment. Here, the ecological impact dimension of sustainability is acknowledged, while the explicit goal of community resilience is generally absent. Although there remains a lack of agreement about the most desirable urban form to promote sustainability, a number of commonly accepted planning directives of good practice emerge (Jabareen, 2006). Smart Growth B.C. offers a comprehensive range of such planning, design and development

principles to promote sustainable use of land and public resources (Ten Smart Growth Priniciples, n.d.):

1. Mix land uses
2. Build well-designed compact neighbourhoods
3. Provide a variety of transportation choices
4. Create diverse housing opportunities
5. Encourage growth in existing communities
6. Preserve open spaces, natural beauty, and environmentally sensitive areas
7. Protect and enhance agricultural lands
8. Utilize smarter, and cheaper infrastructure and green buildings
9. Foster a unique neighbourhood identity
10. Nurture engaged citizens

While many of these principles are nearly unanimously regarded as sound physical planning, some believe that the movement doesn't go far enough in addressing the human behavioural element. For instance, Scheurer (2001, p.202) gives examples of Smart Growth developments which may provide energy-efficient building design, while allowing "every opportunity for the user to maintain energy-intensive behaviour patterns". For example, they may make available non-car transport modes, but continue to supply generous parking and roads. She believes that such movements attempt to achieve sustainability by offering "carrots" of attractive alternatives, while not actually using any "sticks" to ensure that people change behaviour.

Perspective 5: Ecological designers

A growing category of perspectives on neighbourhood sustainability is that of the ecological designers (Girardet, 1992, 1999; Hough, 2004; Koh, 1982; Lyle, 1985, 1994; McHarg, 1992; McManus, 2005; Orr, 2002; Register, 2002; Wheeler, 1995; Todd & Tukel, 1981; Van der Ryn & Cowan, 1996; Wann, 1996). In his 1995 literature review, Wheeler categorized this group of proponents as focusing on "green" design of particular buildings and sites by using

innovative and holistic approaches, including the use of environment-friendly materials, passive solar design and biological wastewater treatment. This category of proponents is alive and well today and has grown to consider a wider scope of applications for the ecological design approach, such as whole community and neighbourhood design.

Landscape urbanism is a term used by ecological designers who recognize urbanization as a dynamic process characterized more by "fluidity, spontaneous feedback, and non-linearity, than stability, predictability, or rationality" (Corner, 2006, p.19). From their point of view, settlements may therefore be better conceived as adaptable "systems" rather than rigid "structures". Koh (1982, p.80) points out that for the ecological designer,

> "Provision for the necessary continuity to inevitable, and often rapid, change in the Post-Industrial world becomes one of his/her central concerns in design process, because continuity through change, and the synthesis of tradition and innovation are necessary evolutionary strategies in the face of the rapidity of change of Post-Industrial society."

The ecological designers therefore seem to inherently take the concept of resilience more seriously than any of the other perspectives.

In general, these thinkers explicitly advocate for designing with natural systems and ecological principles as the basis of community planning. Where the other perspectives, with the exception of philosophical, tend to focus on one strategy while recognizing a need for an integrated approach to community development, integration is the specialty of the ecological designers. Similar to ecological designers, philosophers may provide a normative framework in their concept of SUD, but they do not generally offer the operating principles that the ecological designers explicitly attempt to uncover. Because they recognize ecological constraints to be the most fundamental to all of humanity's activities, ecological designers approach sustainable urban development in a broader land use context by emphasizing that urban systems rely on the sustainable use of land bases beyond their boundaries (similar to

some who take the extended metabolism perspective). In taking a systems-based approach to solving unsustainability related problems, they attempt to identify systemic or root causes of the problems. Ecological designers generally note our disconnection from Nature and lack of ecological principles informing our planning and design as the root causes of our sustainability-related problems. "Learn from and design with Nature" is the underlying message of those espousing this perspective. Ecological design may be used to describe both the environment that is designed as well as the integrative and holistic process used to achieve the result (Koh, 1982). As a whole, ecological designers explicitly aim to reduce ecological impact and promote resilience to a greater degree than other perspectives.

Ecological regenerative design

For some ecological designers, the concept of creating human-nature environments that are not simply integrated and ecologically benign but ecologically and spiritually regenerative is the ultimate aim of community design. Birkeland (2008) and Mang (2001) further articulate the concept of regenerative design as not only an approach to design but also an explicit aim to nurture the creative spirit of human consciousness and thusly nurture our own evolution:

> "Regenerative design is grounded in ... the belief that, as part of a larger order, we humans must act in harmony with those larger patterns. When we do so, our designs become instruments for enabling the whole of the place to move to a richer and healthier expression of life. And in turn, a healthier whole grows the viability and vitality of the part. By seeing the ultimate aim of all our work as the regeneration and evolution of increasingly vital, viable and inspiriting places, we not only create extraordinary designs, we become more fully human" (Mang, 2001, para.7).

Koh (1982) describes this ecological-regenerative design as a post-modern design paradigm of holistic philosophy and evolutionary ethic. He describes those of this perspective as having a holistic expansionistic view of the world that orients their morality and intellectual pursuits. Barton (2000, p.87) points out that the ecological design approach and its

underpinning theories have both explanatory and normative power and contain "an inherent value structure missing from the more conventional approach to planning". Thus, while the other perspectives – the naturalists, the resource flow and spatial planners – recognize the value of human creativity in proposing solutions to current settlement problems, many ecological designers would agree that the very process, form, content, context and quality of the design strategy are themselves critical to contributing to that creativity and the development of human evolution in general: healthy physical, cognitive, affective and social development, as well as influencing nurturing and sustainability-oriented value systems (Orr, 1992). There is the common understanding amongst ecological designers that settlements should help nurture us to become the best we can be. The human being is therefore viewed as a critically active agent in the manifested design where he is iteratively both shaping his environment, which in turn shapes him. They therefore conclude that "the very act of designing and building is a legitimate specimen for the study of the nature of order and ordering, of reality and creativity" (Koh, 1982, p.81).

Recognizing that this ecological perspective is still in its infancy, the approach of designing with Nature, or *like* Nature through methods of biomimicry, has not gained traction in conventional planning practice. It is certainly not represented throughout conventional patterning and land-use and target-based approaches or even landscape dynamics and natural sciences in either literature or practice. Yet, from my perspective, this category offers the most promising approach to sustainable neighbourhood planning and design. It is explicitly oriented to the ecological context in which all human activity operates and acknowledges the biological and evolutionary foundation for a healthy supportive habitat for the human species. One possible reason for this lack of presence in current western planning practice is that the principles advocated are not necessarily "operational". They are typically general in nature and take the form of principles more than directives. McLennan (2004) offers an example of such principles organized around the theme of *respect*. Given the degree to which similar principles are cited in the literature, they may be thought of as the ecological designers' "universal truths":

1. Respect for the wisdom of natural systems – the biomimicry principle;
2. Respect for people – the human vitality principle;
3. Respect for place – the ecosystem/bioregion principle;
4. Respect for cycle of life – the "seven generations" principle;
5. Respect for energy and natural resources – the conservation and renewable resources principle; and
6. Respect for process – the holistic thinking principle.

To operationalize any of the first of these five principles requires the last – holistic thinking. And yet holistic, systems-based thinking is not an encouraged thinking pattern in western culture and is somewhat difficult for some to imagine (Orr, 2004). This thesis will discuss this perspective in more detail by proposing a set of operational ecological characteristics and principles that could be used to inform community planning and design.

Summary of perspectives

This short review of an expansive body of interdisciplinary literature has uncovered a number of themes that are relevant to this inquiry:

- There are a number of perspectives from which proponents of sustainable communities tend to focus and prioritize: philosophy, natural sciences, resource flows, spatial planning and ecological design. These categories are clearly not discrete; proponents may advance the theory and practice of SUD in a variety of categories.
- While these perspectives are generally united in their goal of the nebulously defined "sustainable community", they offer different ideas around focus and identification of root cause of problems and, therefore, different strategies.
- All perspectives acknowledge to some degree the need for integrated design solutions. Some even articulate the need to work with natural systems. The ecological designers are the most advanced in this thinking.

While not doing justice to the multi-dimensional nature of settlements, this simple conceptual classification of sustainability perspectives is meant to highlight how the strengths from each perspective may complement the other perspectives. For example, settlements can be thought of as the following: systems characterized by resource throughputs akin to metabolic flows, which are influenced by static and dynamic components enmeshed in a matrix of pattern and form, all of which is informed by the visions, goals, cultural norms and expectations of a community. Given this systems complexity, it is understandable that proponents create their niche within the SUD discourse, lack a common language around sustainability and may at times feel that they are at cross-purposes to other proponents.

James and Lahti (2004, p.18) believe that one of the reasons we as a society may have trouble forming a common language around sustainability is because of the many different levels of approaches to problems and solutions. Proponents may be able to locate themselves in one of the following levels of approaches if they concern themselves primarily with the following:

1. The ecosphere and the ecological laws by which it operates (e.g. laws of thermodynamics, species interdependence, etc.);
2. Philosophical visions of a sustainable society;
3. Context-specific strategies for achieving sustainability objectives (e.g. green building design or using waste as a resource);
4. Actions (e.g. density incentives for green buildings); and
5. Results and impacts of actions.

Table 3.1 below compares the various SUD perspectives that I encountered with Wheeler's categorization of perspectives and the "level of approaches" on which these various perspectives are attempting to address the problem.

Table 3.1: Perspectives of SUD and their respective "level of approach".

SUD foci	Wheeler's typology of perspectives	Level of approach
1. Philosophical – comprehensive vision for humanity	Utopians and Visionaries	Philosophical vision
2. Natural processes – protection of biodiversity and landscape	Environmentalists	Ecosphere and ecological laws
3. Resource flows – of materials, energy and waste	Not explicitly discussed	Ecosphere and ecological laws, results and impacts of actions
4. Spatial – land use, pattern and form	Garden City Planners and New Urbanists	Context-specific strategies and actions
5. Ecological paradigm – broad guiding principles and directives informed by ecological sciences	Ecological designers	Ecosphere and ecological laws, context-specific strategies and actions

When they are integrated, these perspectives may contribute to a coherent understanding of the potential strategies of SUD. I see the perspectives as complementing each other in the following way: Visionaries expand the realm of what is permissible; they serve to help articulate goals and aspirations of what we, as a society, might want and provide a broad framework of our values. They offer the "grand gestures" towards sustainability oriented thinking in settlement planning in beyond. Those concerned with the metabolism of communities recognize primary productivity and, ultimately, energy as the critical element that fuels life and thus, sustainability. Therefore, they work to reduce total direct and indirect energy, material and waste impact on global ecological systems. Spatial planners and urban designers ask how our settlements should be patterned and moulded to reflect these realities. Natural scientists and landscape preservationists provide the scientific evidence of the needs of other species and natural processes and provide a valuable complementary set of Nature-oriented knowledge to the more human focus in urban planning.

While each of these perspectives offers tools, strategies and perspectives on how to contribute to community sustainability, it is the ecological designers who offer and advocate for Nature and the ecological sciences to provide a normative basis and template to inform our planning and design strategies. My theory of using ecologically informed principles to

inform settlement patterning and land-use is firmly aligned within this perspective of ecological designers. It is this theoretical basis out of which I propose my articulation of an "ecological approach" to planning and design, described below.

Proposal: Ecological principles model, or the "ecological approach", as a conceptual tool for planning sustainable neighbourhoods

Given the complexity of settlement planning within a context of a compromised environment and increasing population pressure, it is not surprising that few, if any, models of sustainable community development emerge with any degree of confidence. This does not mean, however, that planners and communities are helpless in addressing the sustainability of our communities.

The central argument in this thesis is that natural ecosystems, whose components and processes are designed through natural selection and are scaled to renewable resources are of proven sustainability (Benyus, 1997), and therefore are the most appropriate models for planning and designing sustainable settlement systems. They function in such a way to promote their continuity over the long run, where pieces that do not fit with the system are selected out. Thus, all pieces therefore are congruent and appropriate and promote the further continuation of the system. The intent in adopting an ecological approach is explicitly to link community and broader planning approaches to ecosystems and to view human settlements as the living habitats that they are: a "complexity of open systems with living and non-living elements, cyclic processes and a complicated network of relationships" (Barton, 2000, p.87). David Orr describes this approach as the "ongoing negotiation between community and the ecology of a particular place" (2002, p.28).

Because ecosystems are the living frameworks within which all human activity is conducted we must, therefore, learn to design *with* Nature, to acknowledge this context, as well as *like* Nature, in order to create settlements that fit within their context. Benyus (1997), author of the book *Biomimicry*, refers to this as adopting an attitude of regarding Nature as *Model, Measure* and *Mentor*. Key to adopting this attitude and seeing through this lens is to focus on

the components the – the organisms, streams and soil, etc. – as well as the relational attributes aspect of ecology – how elements are organized within the system, how flows are regulated, how they respond to stress. This dual concept of designing with *and* like Nature will be referred to as the *ecological approach* throughout the remainder of this thesis.

Nature as model

An ecological approach attempts to achieve in the human realm "the complex efficiencies, yet simple elegance recognizable in design of natural systems." (Thayer Jr., 2008, p.xiii). This entails learning and adopting the "new language" of the ecological approach (Tjallingii 1995). As Brown (2009, p.4) points out,

> "Vitally, we need to use the landscape of towns and cities – trees, parks, rivers and lakes – to mimic natural processes, like water flow and cooling air flow. This green infrastructure should be as much a priority for a successful place as grey infrastructure – like the road network, or the sewage system."

Six of the 23 authors reviewed mentioned designing *with* Nature, with seven explicitly stating designing *like* Nature.

Nature as measure

Adopting Nature as the measure entails tying planning goals and setting targets based on biophysical reality, such as ecological footprint analysis. Condon (2003, p.142) contends that "understanding the human, aquatic, riparian, and terrestrial features, conditions, processes and interactions of watersheds (and their component parts) in their "natural" state provides a basis for developing performance targets for maintaining the optimum post-development health of natural systems".

The concept of the "prime footprints" approach attempts to operationalize ecological footprint analysis in planning decisions by locating what Forman calls "the specific footprint

locations, the amounts and routes of inputs and outputs linking key locations to the urban region, and the importance of planning each footprint and the urban region together as an integrated system" (Forman, 2008, p.319).

Nature as mentor

By "Nature as mentor", McLennan (2004, p.39) means "valuing what we can learn versus what we can extract". This approach implies a shift from hubris (or pride) to humility in how we approach planning and design decisions. As Wann (1996, p.15) aptly points out, "the only thing primitive about nature is our understanding of it". In looking to and learning from Nature, some believe that we can move beyond simply sustainable and resilient versions of the communities we have today to regenerative communities that actually "build soils, cultivate biodiversity, restore lands and waters, and make a net gain for the ecological health of the Earth" (Register, 2002, p.15). The concept of settlements as net providers to the Earth remains largely theoretical. Given the damage that has already been done to the environment, however, some argue that it is necessary and worthy of in-depth study. Surely if we are to gain any understanding of how to do this, it will be through learning *from* Nature.

A need for directives to promote the ecological approach

Numerous authors and practitioners voice the need for broad guiding principles based on ecology to inform settlement development. They note the difficulty in articulating specific design strategies that can be generalized to a variety of settings because each settlement is unique, the theory and application around the approach is still in its infancy and because the ecological approach is "more an instrument in a strategy which indicates the direction of activities" than certain designs, lifestyles or ways of management (Tjallingii, 1995, p.152). The following quotations, taken from leading theorists in this field, emphasize the need for such principles:

- Progress with sustainability will be "loosely coordinated, flexible, based on common principles and a common goal rather than a common blueprint" (Housing Corporation, 2004, p.6).

- "Find fundamental principles of indisputable relevance, and thereafter ask the advice of others on how to apply them" (The Natural Step Framework, n.d.).[15]

- "We need a clear, specific focus on basic principles – a scientific approach that may not be a popular preoccupation, but that simply looks for the truth about the relationship of the physical community to ecology and evolution" (Register, 2002, p.257).

- In response to the fact that experts don't always know best and that their models are only as good as their assumptions, "A better alternative may be to draw basic principles from sustainable ecological methods, and use such principles to help planners cope with uncertainty and surprise…. A risk assessment process for cities must use such principles as a basis for evaluating the long-term security, whenever choices are being made about urban development" (The Sheltair Group, 2002, p.10).

- "To link human and ecological activity, the ecological approach adopts principles of planning and design that respect Nature as model, measure and mentor" (McLennan, 2004, p.39).

This work attempts to answer the call for such principles by articulating an ecosystem-based model of settlement development. As chapter 2 discussed, ecological characteristics and principles of systems resilience are proposed as model properties for human communities. The following chapter 4 uncovers these principles, translates what these might look like in urban form, and evaluates conventional concepts of SUD based on these criteria.

[15] Quote originally from Dr. Karl-Henrik Robèrt, founder of The Natural Step, who coined the motto.

CHAPTER 4: RESULTS AND DISCUSSION OF THE ASSESSMENT FRAMEWORKS

Introduction

Thus far, we have discussed the need for new neighbourhood development models that are based on ecological principles. The theoretical basis has been established in the field of the ecological designers and it is with this lens that I conduct the analysis portion of my thesis. This chapter begins by preparing the material for the matrix analysis. This is achieved first by stating the results of the ecosystems characteristics literature review and secondly, conducting an inventory on the various sustainability indicators present in the frameworks. Ecosystem characteristics and principles of systems resilience are described through a framework of essential ecosystem qualities: Structure, function, temporality and emergent properties. Sustainability indicators are described through a framework of categories that emerged from the inventory; a discussion of the theoretical and practical basis of various indicators are presented in the following nine categories:

1. Design process, consistency with existing policy and setting of goals;
2. Specific siting process and considerations;
3. Site design: pattern, massing, form, grain and connectivity;
4. Promoting natural and cultural features of the site;
5. Promoting lower-impact development;
6. Promoting long-term use and self-sufficiency of basic requirements;
7. Promoting livability through enjoyable environment;
8. Promoting a sustainability ethic; and
9. Maintenance to the site.

To begin to envision how ecological characteristics and principles of resilience could be applied to settlement development, I employ the use of a creative narrative. The story that emerges is of a neighbourhood that embodies the following characteristics: it regulates its ecological impact, adapts to change and engages the individual through its physical design.

This narrative provides the substrate out of which a number of planning criteria based on the ecological approach emerge.

The chapter then discusses the results of the matrix analysis by highlighting which indicators from the frameworks capture some degree of the ecological approach and where there are gaps in the indicators available in the three frameworks. Finally, I offer a critique of the individual sustainability assessment frameworks and conclude with an indicator framework that may hold some promise, the Living Building Challenge.

Results of the ecosystem characteristics literature review

This thesis argues that ecosystem principles form a valid template upon which to base some settlement patterning and design considerations. Thus, this section discusses ecosystem characteristics and principles systems resilience in more depth. A number of categories emerge using the lump-and-split method of sorting the data. In total, 48 categories emerged, based on the literature by 23 authors. Not all of the categories, however, could be characterized as ecosystem characteristics. For instance, affordability and sacredness were mentioned a number of times. These are human requirements and therefore are not included in the broader discussion of ecosystem characteristics below.

Ecosystem characteristics and principles of ecology

As this literature review reveals, ecosystems are dynamic and complex entities; arguably more dynamic and complex than any other system on the planet. They are comprised of a myriad of biotic actors and abiotic components which are simultaneously a result and shaper of the energy and materials that flow through the system of which they are a part. Over time, the actors and components adapt to reflect the changing circumstances and, therefore, are always appropriate; anachronisms are weeded out. From this interplay of incalculable relationships and nearly infinite interactions emerges a system that has been able to support the continued evolution of a vast array of life on Earth. Ecology teaches us that while the lives of individuals and even whole species and communities are fragile, the property of life is also generative and tenacious. The ecological approach to planning and design would

therefore respect the fragility of the living systems on which it depends, as well as aim to mimic these tenacious qualities.

Costanza and Mageau (1999, p.106) state that three main components are critical to ecosystem health or integrity:

1. Vigour, as defined by its function, productivity and throughputs. Lyle (1985, p.194) refers to this as *function*;
2. Organization, as characterized by its structure of abiotic and biotic components and how they relate to one another. Lyle (1985, p.194) refers to this as *structure*; and
3. *Resilience*, which is a system's ability to provide critical functions and maintain its structure under variable, uncertain and extreme conditions (Evaluating Transportation Resilience, 2008).

To organize the thinking around ecosystem characteristics, I use a similar, yet modified, version of this framework to describe the key qualities of ecosystems: structure, function (primarily of energy flow), temporality and emergent properties (one of which is resilience). Each quality contains ecosystem characteristics which are listed and discussed below.

Ecosystem quality 1: Structure

Key characteristics:

- organized as nested hierarchies of self-organizing systems,
- diverse, redundant and connected interdependent components, and
- decentralized according to resource availability.

Ecosystems are comprised of systems within systems, wholes within wholes. Thus, the general pattern of organization is generally of *nested hierarchies of self-organizing systems*. Details are congruent with larger patterns where cycles of resource availability and renewability are nested within this larger pattern. Because the essential foundations of life, such as soil, sunlight and water, are influenced by geology, climate and past disturbances,

communities of organisms are *decentralized* according to presence of necessary resources and habitat (McHarg, 1992, p.125). Individual components within the system, such as individual species, or communities of species, are *diverse and connected*. "This diversity is present at several levels: within each population of a species, across all populations of a species, and across all species in communities" (Begon, Harper & Townsend 1990, p.237). Diversity serves a purpose and is appropriate to place. It is generally highest at the intersection of differing ecosystems. There is a great degree of *integration, interdependence and redundancy* among the parts and functions to the point where it becomes unclear which elements are dependent on which ones. As Lyle (1985, p.195) points out, "virtually ever species has an important interaction with at least one or two other species, and most have more". With the exception of keystone species,[16] the loss of individual species generally does not affect the total function, integrity or resilience of the entire system until a critical threshold is met after which it may flip into a radically different state and behave according to a different set of rules (Folke et al., 2004).

Ecosystem quality 2: Function

Key characteristics:

- process-oriented,
- renewable,
- cyclical,
- optimized,
- diverse,
- redundant,
- connected and decentralized, and
- open yet largely autonomous.

[16] Mills, Soulé and Doak (1993, p.219) define keystone species as being characterized by two hallmarks: "First, their presence is crucial in maintaining the organization and diversity of their ecological communities. Second, it is implicitly that these species are exceptional, relative to the rest of the community, in their importance."

The function and vigour of a system is determined by the energy and material flows that sustain it; these energy and material flows serve to maintain the structural order described above (Kibert, Sendzimer & Guy, 2000; Lyle 1985). The whole system operates to promote the continuation of the system and all its parts. Therefore, ecosystems are *process-oriented* in that gross production is allocated to networks, not single products. Lyle (1985 p.196) notes, "While interactions are limited for any one species, the aggregated network of interactions is essential to community cohesion".

Energy and material flows within the system are *open yet largely autonomous due to a stable and strong foundation of autotrophic components*, which form the basis for most food energy, and are based on *renewable* solar energy. Natural systems, for the most part, use solar or stored solar energy in the form of biomass for their functioning (Kibert, Sendzimer, & Guy, 2000). Ecosystems, therefore, are thermodynamically open and dissipative, yet components organize themselves into greater hierarchies of complexity to restructure energy into usable forms (Reed, 2007). Ecosystems generally rely on energy or material subsidies from other systems outside their "boundaries" (Brand, 2005; Marczak & Richardson, 2007), but this is constrained by global availability. The concept of "waste" does not exist and persistent toxic by-products are also not commonly produced because all materials and nutrients are continuously *cycled*, becoming a source of energy and sustenance for other components within the system. Systems with a great *diversity* of components have many parts that can capitalize on the "waste" of another and/or create niches of specialization so as not to have to compete with other components. Conversion of energy sources is generally *optimized* by being *efficient*, unless there is no selection pressure to be efficient (i.e., there is an abundance). This cycling of materials creates a complex and intricate flow of energy characterized by the food web. This complexity mitigates dependency upon any one energy source for a species, but especially for the entire system, by providing a *redundancy* of energy sources and material pathways.

Ecosystem quality 3: Temporality

Key characteristics:

- dynamic and constantly changing,
- responsive, and
- oscillatory.

As a result of the dynamic nature of energy flow and inevitable natural disasters caused by wind, fire, land movement, volcanoes and climate (precipitation and temperature), over time the system is *dynamic and constantly changing*. Succession and evolution are outcomes of inevitable change: slow and fast, short-term and long-term disturbances. In the absence of major disturbances, the structure of an ecosystem tends to become more diverse and complex. Lyle borrows from systems ecologist Howard Odum's research when he notes that the gross production of growth and energy flow of such systems decreases while the biomass supported per unit of energy flow actually increases (Lyle 1985). The reverse is true in younger, frequently disturbed systems.

In order to persist, ecosystems must have the ability to *respond* to a change, such as resource availability, through corrective feedback mechanisms (e.g., associated change in fertility rate). However, there are generally lag times in responsiveness, thus creating scenarios in which energy and productivity pulse or *oscillate* within the system. Pulsing systems are more resilient to change because they adapt to ebbs and flows of resources and energy by creating large margins or thresholds in which they may continue to operate under the "same rules" (Holling, 1978). While ecosystems are constantly experiencing some degree of flux, over time systems self regulate to maintain a degree of equilibrium within a threshold of what the system historically could sustain. *Storage* of resources and energy is a commonly used critical strategy to weather times of anticipated resource/energy scarcity. As Lyle (1994, p.39) puts it, "since rates of productivity, assimilation and use all vary, storage is the essential, ever-varying maintainer of equilibrium". Storage may be in the form of soil nutrients or aquifers or in the fat and nutrient reserves of flora and fauna.

Ecosystem quality 4: Emergent characteristics

Key characteristics:

- resilient,
- cooperative,
- contextual, and
- evolutionary.

Emergent characteristics, put simply, are totals that are greater than the sum of a set of interacting parts. Ecology and other complex systems theories are full of examples of emergence and synergies in which outcomes, such as energy flow through the system, are a result of a multitude of components interacting. Depending on the unique organizational components, vigour of the system and how it changes over time, a number of unique assemblages of ecological expressions will present themselves in a given location. All naturally occurring ecosystems are therefore *locally appropriate, contextual and unique* where all components and energy flows display appropriate fitness to other elements in the system. Components may display *cooperation between the parts* in order to capitalize on limited resources and compliment the other elements within the system. Mutualism, for example, increases as resources become limiting. In order for biodiversity to increase, individuals must find a way to fit within the system without having to compete directly for resources. Those that cannot fit within the system are selected out; species extinction is an inevitable consequence of the inability to adapt. This pressure to conform to local context results in an *evolutionary* loop in which components modify and are modified by the system in which they are embedded (McHarg, 1992, p.120). An ecosystem's *resilience* is a complex concept, but is described here as a system's ability to be flexible and adapt and regenerate in face of change (Brand, 2005).

Categories of indicators from the three sustainability neighbourhood assessment frameworks

To facilitate discussion of the assessment frameworks and the indicators of which they are comprised, a lump-and-split categorization method was used to highlight a number of themes under which indicators could be grouped (see chapter 2). These categories are described below and used in the matrix evaluation.

Categories of indicators

The following nine categories emerged out of an inventory of the indicators available in the assessment frameworks. Not all are indicators are of physical design, such as integrated process informed by public participation. Nevertheless, all categories of indicators included in the analysis are essential to successful and sustainable design strategies. For the list of indicators within each category, see Appendix B. The following passages offer a brief discussion on the theoretical and practical rationale behind the indicators.

1. Design process, consistency with existing policy and setting of goals

This category includes process-oriented and broader policy considerations essential to informing thoughtful and appropriate design decisions. Best or leading practices in this area suggest that sustainable outcomes are more likely in planning and design processes that integrate a wide variety of perspectives and include professionals from a range of social policy, land and engineering fields and the broader community. Sarkissian et al. (2009) point out that community engagement can be rationalized for two primary reasons: it is ethical in that "those whose livelihoods, environments and lives are at stake should be consulted and involved in the decisions that affect them," and it is pragmatic: "support for programs and policies often depends on people's willingness to assist the process" (Sarkissian et al., 2009, p.47). In the pursuit of sustainability, community engagement is critical as it "provides opportunities for developing a holistic sense of sustainability, where people make decisions using local wisdom, information and knowledge" (Sarkissian et al., 2009, p.49).

Broader policy considerations include the macro-context siting of development, informed by the Livable Regional Strategic Plan (LRSP) for Metro Vancouver, Canada. The LRSP guides growth under the following four broad strategies: protect the green zone, build complete communities, achieve a compact metropolitan region and increase transportation choice (Greater Vancouver Regional District, 1996, p.9). Protecting and connecting green and blue (aquatic) areas of ecological importance is also taken into consideration at this scale. Ideally, the areas of ecological importance at the site scale will be integrated with the regional network. Other policy directives at this level include compliance with the liquid waste management, pollution and watershed plans (Condon, 2003).

Setting performance goals, such as systems performance goals on the "health" of community systems, including grey and green infrastructure systems, policy and program goals, is another essential strategy in the pursuit of sustainable communities; it helps to articulate a community vision and encourages the monitoring of the goal's attainment and success (Innes & Booher, 2000). Clearly, however, evaluation of the effectiveness of achieving those goals must be conducted, the lessons from which must be integrated into planning decisions. In doing so the act of measuring performance becomes a responsive component of strategic decision making and planning (Ho, 2006; Houghton, 1997). (The concept of assessing the appropriateness of the goals in the first place is not addressed in any of the frameworks evaluated, however.)

2. Specific siting process and considerations

While activities under the previous category help to determine what areas development is appropriate within the general region, this category contains actions that relate to identifying the appropriate parcel of land within a chosen area. Siting considerations should respect the specific constraints, opportunities and sensitivities of the site, including (and importantly) natural hazards. Ian McHarg's work (1992) is seminal in articulating these considerations. He

adopted a “layering” approach in analysing the various ecological considerations such as climate geology, hydrology, soils, plant associations and history/culture, asked if it had unique or rare attributes and inquired into its “intrinsic suitabilities”. These analyses can be used to identify site opportunities, constraints, and the site’s overall development potential. Site assessments are therefore necessary to inventory pre-development conditions, with the intent of minimizing impact to the site, protecting features of value and restoring ecological functions where appropriate. Specific siting considerations may also include, as much as possible, reuse of existing sites and infrastructure through brownfield and infill development.

3. Site design: pattern, massing, form, grain and connectivity

Where the first two categories of indicators involve choosing the appropriate area and then the site for development, site design concerns the patterning and built form of the development. Depending on the ability to use existing building infrastructure, the site may be a relatively “clean slate” (i.e., with no existing development) or it may require an infill approach. Issues of site design pertain to the block size; orientation and form of buildings and street network; compactness and density of the development; the mix of land uses, including public amenity; and promotion of access to services by proximity and internal circulation as well as connection to and integration with the surrounding urban fabric. Best practice recognizes the value in prioritizing the pedestrian and other non-motorized or public forms of transportation in the transportation hierarchy. It also includes using knowledge of the unique characteristics of the site to employ vernacular, passive and climatically appropriate design; such design strategies can also add to the comfort and delight of residents and visitors.

4. Promoting natural and cultural features of the site

This category is specifically about respecting, promoting and reinforcing the local heritage of the site, both natural and cultural to create a sense of place and allowing the natural capital on the site to function as much as possible. Although not articulated in all indicator frameworks, green spaces that are congruent within a larger regional green network should be used to inform the site patterning considerations above. This means not only protecting the site’s features and mitigating construction impact such as earthworks to the site and containment of

construction pollution, but also actively restoring ecological function such as soil productivity, hydrologic patterns, biomass and native biodiversity supported by appropriate quality habitat of the site. Permaculture approaches support this objective.

Patterning and form, such as street orientation and framing, may also be used to highlight features of significance, such as views and landmarks. Vernacular design, discussed in the previous category, may in addition to contributing to lower impact design, also be used to celebrate local architectural heritage further contributing to a sense of place.

5. Promotion of lower-impact development

This category includes using fewer resources that have high impacts in the construction and operation of the community, promoting reduction and recycling of waste products, as well as allowing the site to absorb stormwater events by providing pervious (or permeable) surfaces and/or swales and other stormwater features to mitigate the effects of the event. Indicators in this category therefore pertain to energy efficiency and use (carbon neutrality being an ambitious target); integrated water management approaches; water efficiency and (re)use; air quality; stormwater management; waste management such as providing appropriate recycling receptacles and diverting waste from the landfill; and material use such as reuse of existing buildings and materials, recycled and recyclable non-toxic materials and certified forest products.

6. Promoting long-term use and self-sufficiency of basic requirements

While elements within a community that promote long-term use and self-sufficiency may also have lower impacts than those that do not, the concept of self-sufficiency and long-term use through decentralized and adaptive strategies deserves its own category; not all indicators of impact support these increasingly valued aims. Indicators within this category include provision of basic community requirements such as water, energy, food and waste management as well as adaptability of buildings, infrastructure and public spaces. These indicators are currently not as comprehensive or well articulated as some of the other categories. Water purification, renewable energy production including district

heating/cooling systems, opportunities for composting locally generated organic waste and providing spaces that can be used for different purposes are common indicators of this category.

7. Promoting livability through enjoyable environment

Promoting livability is an essential step in creating places that people can love and care for. It is argued that if community members are empowered and have opportunities to contribute to their communities, they will take care of what they love and thus work towards its sustainability over the long term (McLennan, 2006). This category has a wide number of categories pertaining to quality of life: site accessibility; community safety and wayfinding; opportunities for physical activity, on-site socialising, unforced social encounters and community congregation; pronounced local identity; and creating comfortable restorative environments through the use of vegetation to provide connection and mental stimulation as well as regulate shade, ventilation, humidity and temperature. While some of these attributes may not be lower impact, providing them may enable and encourage individuals to engage in less impactful behaviour. For instance, if streets are pedestrian-friendly, people may choose to walk to meet local needs rather than use private automobiles. Many of these attributes, particularly those pertaining to comfort and leisure provided by green spaces, are also congruent with goals related to providing green spaces for more ecologically utilitarian purposes. For example, trees can contribute to reducing pollution and heat islands in cities as well as reduce heating and cooling costs (Stevens, 1994).

8. Promoting a sustainability ethic

It is well recognized amongst strong sustainability proponents that while providing low-impact, resilient infrastructure is an essential component of achieving sustainability, individual consumption behaviour and political values will determine whether or not sustainability is embraced as a more comprehensive societal goal. The built environment is viewed by many as a powerful pedagogical medium through which individuals and cultures derive meaning and form values (Hester, 2006; Lynch, 1981). A lack of reference to Nature and ecology in settlements, as entrenched by the ostensible city vs. Nature dichotomy, is

blamed for a physical and spiritual disconnect from the life processes that sustain all life on this planet (Orr, 2002). Such critics advocate for more opportunities in communities to interact with those ecological processes though restoration, gardening and stewardship opportunities and explicit reference though educational mediums of natural heritage.[17] Eco-revelatory design, in which ecological processes, building operations and resource use are explicitly highlighted to encourage learning, is another design strategy that promotes this sustainability ethic (Hester, 2006). Travel Demand Management is an example of an explicit program and set of supporting actions to promote behaviour change.[18] A number of indicators attempt to measure how well a development contributes to the sustainability ethic of its inhabitants.

9. Maintenance to the site

This final category acknowledges the wise adage of not procuring what cannot be maintained. Thus, the maintenance and management of the design decisions must in and of themselves be sustainable. This category of indicators pertains to the creation of long-term plans for elements of the environment, such as soil health, habitat and conservation of species, as well as safe, low-impact maintenance strategies such as non-toxic and water-efficient landscape maintenance. These strategies, however, must be cost-effective and well funded otherwise the plans will not be implemented.

Applying the ecological characteristics and principles of resilience to settlement development: a narration

Before I discuss how well the assessment frameworks capture ecological impact, ecosystem characteristics and principles of system's resilience, it may be helpful to first conceptualize

[17] The concept of stewardship is ethically loaded in that it stems from the religious concept that the natural world has been entrusted by God to humans to maintain and care for (Palmer, 2006). This suggests separation from and domination over the natural world. The term may, however, be used in a more egalitarian sense in which management through participation, not separation and dominance, of natural systems may occur. It is this latter use of the word that I employ in this thesis.

[18] The VPTI (2009) describe Transport Demand Management (TDM) as a "general term for strategies that result in more efficient use of transportation resources". Examples of commonly used strategies include: improved transport options, incentives to use alternative modes and reduce driving, parking and land use management and policy and institutional reforms.

how a settlement could encompass the ecosystem characteristics and properties outlined in the sections above. As Ahern (2005, p.316) notes "explicitly integrating ecology principles with architecture and planning for achieving urban sustainability is still in the early stages". There is clearly a need to experiment with these ideas and determine which hold promise. In the absence of such evidence, the following discussion paints a creative and coherent qualitative, if not utopian, picture of how these ideas might be applied to settlement planning. It does not attempt to judge which elements are feasible or appropriate but simply to provide a model upon which to imagine a more expansive vision of urban futures, as informed by the ecological approach. Other authors, such as Richard Register and the the Sheltair Group, paint similar pictures of their interpretations of a sustainable community. Kevin Lynch (1981) may be one of the most well cited authors to do this when he painted his own "Place Utopia". Interestingly, some of his characteristics are similar to those espoused in the ecological approach. Throughout the following narrative the analogous ecological principles and ecosystem characteristics are italicized throughout the text. This discussion is followed by a discussion of how well the frameworks, and finally FCN in chapter 5, capture these concepts.

Urban development that regulates its ecological impact

Firstly, a neighbourhood informed by the ecological approach would regulate its *ecological impact* to fit within the Earth's carrying capacity by exhibiting an ecological footprint equal to its fair share of resources based on the number of residents.[19] This means minimizing adverse impacts on the environment and using only materials that are renewable or are drawn sustainably from an extensive resource base. Energy and resource use would become *optimized* through efficient use (i.e., there would be a "positive ratio of energy supplied to energy delivered" (Godschalk, 2003, p.139)). To minimize impact further and retain embodied energy, infrastructure would not be procured if it could not be maintained sustainably over the long-term. Foster's (1997) criteria of resilience require that there be no

[19] These concepts are continuously being refined and the figure of each person's "fair share" is changing as ecosystem productivity rates and human population change.

esoteric components and that unique skills are not necessary for maintenance. Wann (1996) further stipulates that infrastructure be durable, yet reversible, adaptable, reusable and ultimately recyclable.

The neighbourhood would aim to localize its resource use, and thus exercise greater *autonomy* and regulation of resources. Recognizing that relying on critical resources such as water, energy and food from "somewhere else" is no longer a viable option, even economically, in a post-oil-plentiful world, it would be planed to meet the resource and energy needs of its inhabitants locally (Lynch, 1981, p.307) in lock step with the physical form and infrastructure (Forman, 2008). In cases where autonomy is not feasible (which likely will be many), provisions would be made at another scale, such as the city-state "hinterlands" as discussed by Rees (2009), Forman (2008) and Frey (1999). Maintaining functions or *processes* within the neighbourhood would therefore be as important as providing the organizing structures.

The architecture and urban design[20], source of energy and availability of food would reflect the *local, contextual* resource base, unique climate conditions and productivity of the site. Design for flexibility, convertibility, expandability, durability and disassembly would be common design principles in all infrastructure systems, including public spaces, in order to retain embodied energy and promote *adaptability* and continued *evolution* to fit the community's needs, and thus *resilience* (The Sheltair Group, 2002).

To reduce physical impact on existing local natural areas so that they could continue to evolve and remain resilient to stress, land use would be *optimized* and development constrained to strategically located brownfield areas. Clustering of nodes of development would allow networks of green spaces to permeate the city and connect within a regional greenway. These would be designed to allow for ecological processes and species migration

[20] Particularly through retrofits and interventions as the neighbourhood of the future will have to exist within some degree of the current built form.

through the settlement and natural areas beyond (Beatley, 2008; The Sheltair Group, 2002). Stormwater, for example, would be retained and *stored* in order to recharge groundwater resources rather than being discharged into rivers and oceans. (Scheurer, 2001, p.67). Some degree of ecological restoration, depending on the site characteristics, would be part of every neighbourhood plan even it if is only creating soil from compostable materials.

The current "transportation hierarchy" in which the automobile is prioritized would be actively reversed and plenty of options would be provided for *connecting* the *decentralized nodes* of development through walking, cycling and public transit. Infrastructure would be designed to make the least ecologically impactful choice the easiest and most enjoyable (i.e., walking as opposed to driving) choice. "Access by proximity" would also be critical to ensuring needs are met without the use of a car. Many of these concepts are currently well articulated in planning literature today. Some are even being practiced.

Urban development that adapts to change

Secondly, to support the neighbourhood's ability to remain *resilient* to a dynamic and sometimes violent environment, efforts would be made to ensure that the community is not located in an area particularly prone to natural disasters, including rising sea levels. Efforts would also be made to ensure that the infrastructure could structurally sustain anticipated shocks (such as earthquake disturbances in Vancouver) (Godschalk, 2003). The community would be designed as a semi-autonomous, maintainable cell capable of sustaining critical functions should disaster affect the region or critical resources, such as food, become unavailable (Godschalk, 2003). The Sheltair Group (2002, p.14) notes the value in using design concepts such as compartmentalization, modularization and clustering to "help reduce the vulnerability of systems to the failure of any single part". The concept of "complete community" would therefore take on a new meaning beyond the provision of retail outlets for commonly used goods and services to include also the productive, storage and assimilative capacity of energy, food, water and waste of the neighbourhood. This would result in a *decentralized* regional system characterized by *nested subsystems* or hierarchies, each of

them reflecting the unique capacity and constraints of that neighbourhood. The benefit of a decentralized approach to heating, for example, is that the neighbourhood cluster "can quickly switch fuels, or install pollution control equipment, or upgrade to more efficient technology, or otherwise adapt" thus enhancing the flexibility and opportunity for small-scale interventions over the entire region (The Sheltair Group, 2002, p.13).

A resultant *diversity* of options in approaches, responses, physical structures and material pathways within each neighbourhood would result in a number of *redundancies* of these critical functions across a regional scale (Godschalk, 2003). In discussing transportation systems, the Victoria Transportation Policy Institute (VTPI) notes that "resilience tends to increase if a system has diversity, redundancy, efficiency, autonomy and strength in its critical components. This allows the system to continue functioning if a link is broken, if a particular resource becomes scarce, if a particular decision-maker is unavailable, etc. It allows the system to accommodate a wide range of user needs and conditions" (Evaluating Transportation Resilience, 2008, para.3). The Sheltair Group (2002, p.13) provides another perspective on the importance of diversity as an essential requisite of adaptability in that "diverse buildings and systems provide a modicum of local expertise and acceptance should less favoured technologies and designs prove more appropriate over time". Encouraging innovation as requisite fodder for natural selection promotes learning and expands the realm of what's possible, similar to genetic mutations in Nature which are often responsible for jumps in adaptation and evolution (Orr, 2005).

Because communities (neighbourhoods and regions) would to some degree be responsible for the basic means of their survival, only those strategies that promote their continuance and those that are sustainable, would be promoted. *Renewable* forms of energy would become the dominant form of energy and the *recycling* of water and nutrients to enhance soil productivity the dominant form of waste disposal (Swilling, 2006). A neighbourhood focused on using renewable forms of energy and recycling matter may identify cooperative synergies in integrated design solutions in which system components support each other (Godschalk, 2003) and accomplish a number of functions at once. Decentralizing energy and heat

production in temperate Europe, for example, has resulted in the "proliferation of co-generation, or combined heat and power production, which lends itself to application on a municipal or community scale" (Scheurer, 2001, p.56). Conversely, water treatment of grey and black would be separate "with the prospect of gaining valuable resources such as recycled water, natural fertilizer and biogas" (Scheurer, 2001, p.67).

Further, storage of critically important resources would be accommodated to reflect the inherently *oscillatory* nature of climatic variability and ecosystem productivity. Doherty and Rydberg (2002, p.42) note that "if oscillation is the normal state, then sustainability is about managing and adapting society to the oscillation frequencies of the natural capital.... Adapting to pulsing means that an activity that is sustainable in growth phase when nonrenewables are abundant can be unsustainable in declining phase: the nonrenewable resource needed is no longer available". A close reading of the literature on sustainable communities, discussed in chapter 3, reveals that currently these resilience-oriented concepts are considerably less articulated by authors and practitioners than those pertaining to ecological impact in planning literature and practice today.

Urban development that engages the individual through physical design

Thirdly, in an ecologically conscious neighbourhood every effort would be made to support the resident as a critical active and evolutionary agent of sustainability. Human observation would be prized for its ability to provide *responsive feedback* mechanisms in order to promote self-regulation of the entire system (Jepson, 2001). As the VTPI (Evaluating Transportation Resilience, 2008, para.4) notes,

> "Resilience is affected by a system's ability to collect and distribute critical information under extreme conditions. Resilience tends to increase if a system has effective ways to identify potential problems, communicate with affected people and organizations, and prioritize resources."

The information provided by residents, however, will depend entirely on the levels of their knowledge about sustainability and their community (Sarkissian et al., 2009). Design strategies would therefore be eco-revelatory and include educative dimensions in order to promote understanding of the natural ecology of the site, the human relationships to the natural environment in general and biomimicry approaches to harmonize human activity within this context. In short, people would be "aware of the living process around them and feel themselves a part of that process" (Lynch, 1981, p.308). The community would *cooperate* in acting on this collective knowledge, in effect acting as a form of "early-fault detection". An open and inclusionary form of community engagement and decision-making would therefore be necessary to account for the diversity of observations and perspectives as well as create support for the continued evolution of the ecological approach (Sarkissian et al., 2009). Setting performance goals based on biophysical reality, among other social goals, evaluating their achievement and success and feeding this information back into the decision making process would promote a learning-based, *evolutionary* approach to decision making. Similarly to what Lynch (1981, p.309) envisaged, "change is expected.... there [would be] strategies for decline as well as strategies for growth".

Residents would be encouraged to and have the ability to be involved in the stewardship of their community (Lynch, 1981, p.308); such opportunities would provide the medium in which ecological literacy and social capital could grow (Orr, 1992). The experiential dimension of place would receive recognition because a place that is enjoyed will be well loved and cared for more than one that is not (McLennan, 2006). In turn, communities would become more socially *cohesive* and therefore *resilient,* as individuals would invest in their communities and have their neighbours to turn to for support in times of stress.

A number of criteria for a sustainable and resilient neighbourhood

By applying the ecosystems characteristics to neighbourhood form, as is demonstrated in the hypothetical exercise above, the following criteria of a sustainable and resilient neighbourhood emerge:

Criteria of urban development that regulates its ecological impact

1. **Ecological carrying capacity**: Targets pertaining to all resource use (e.g., water, energy, material throughput and food) are tied to ecological carrying capacity
2. **Efficient use**: Energy and material use are optimized through efficient use.
3. **Maintenance**: Infrastructure can be easily maintained. That is, esoteric components that require unique skills for maintenance are minimized.
4. **Durability**: The infrastructure is durable, yet reversible, adaptable, reusable and ultimately recyclable.
5. **Local**: The architecture and urban design are reflective of the unique climatic and material conditions (i.e., resource availability) of the area. Buildings are designed using passive design techniques to reduce energy requirements for lighting and ventilation, heating and cooling.
6. **Land-use optimization**: Land use is optimized by constraining development to strategically located brownfield areas. No greenfield development is permitted.
7. **Green infrastructure**: Green spaces provide the backbone of development and are designed to permeate the city and connect with a regional greenway, thus allowing ecological processes and species migration through the settlement and natural areas beyond.
8. **Restoration**: The site is ecologically restored as is appropriate for the site. This includes preserving habitat.
9. **Non-motorized transit**: The "transportation hierarchy" is reversed to prioritize non-motorized forms of transportation as well as public transit.
10. **Reduced automobile dependence**: Automobile use is actively discouraged.

Criteria of urban development that adapts to change by: fulfilling critical neighbourhood functions

11. **Autonomy**: The development strives for levels of autonomy in critical life supporting functions such as food provision, water, energy and waste management. If not, these

functions and resources are planned for at another scale, preferably local, to meet the needs of the development's inhabitants.

12. **Renewability**: Only renewable forms of energy are used and emphasis is placed on using renewable materials.
13. **Integration**: Integrated design solutions are used to accomplish a number of functions at once.
14. **Storage**: Reserves of critically important resources are integrated into the development.
15. **Collaboration**: Residents have the opportunity and are encouraged to get involved in stewardship activities in their communities to promote social resilience.

Criteria of urban development that adapts to change through: resilient infrastructure

16. **Site selection**: The community is not located in an area particularly prone to natural disasters, including sea-levels rising.
17. **Disaster resistant infrastructure**: The infrastructure is designed to withstand anticipated physical shocks common to the area, such as earthquakes in Vancouver.
18. **Dynamic buildings**: Buildings are designed to be flexible, convertible and expandable.
19. **Connected nodes**: Nodes of development are well connected both internally and externally.
20. **Nested hierarchies**: Neighbourhoods are clustered as self-maintainable cells capable of fulfilling basic functions in times of resource unavailability.
21. **Diverse, redundant and decentralized**: At the regional scale, critical resources and functions are diverse, redundant and decentralized.

Criteria of urban development that engages the individual to encourage: systems response

22. **Education**: Residents are educated about sustainability and ecology.

23. **Participation**: Decision-making processes for the community are cooperative and include the perspectives of the residents.

Results of the matrix analysis

The previous sections have been concerned with populating the matrix with elements to be evaluated (indicator categories) and evaluation criteria (ecological characteristics). The following section will discuss which indicators available in the three assessment frameworks suggest ecosystem characteristics and principles of systems resilience.

Indicators that contain ecosystem characteristics and principles of systems resilience

The forgoing discussion identifies the basis for a number of criteria to assess the function and appearance of a sustainable, low-impact and resilient community. The discussion is broadly split into the two dimensions of sustainability articulated throughout this thesis: impact and resilience. These dimensions and the criteria they are characterized by will be used to firstly evaluate the assessment frameworks and then the FCN development (chapter 5). A summary of the results is presented in Table 4.1 below.

In considering these broad dimensions of impact and resilience to evaluate the indicators, it becomes apparent that, while limiting, the concept of reducing ecological impact is becoming accepted in planning practice while the concept of resilience has yet to achieve even this degree of recognition. Ecological characteristics in neighbourhood development are not explicitly promoted in any of the frameworks and are only implicitly referenced in some of the indicators. The results show that that fundamental concepts pertaining to strong sustainability are still largely absent both in language and content across all frameworks.

Sustainability dimension 1: indicators of ecological impact

Indicators to indicate ecological impact would include the following criteria:[21]

1. **Ecological carrying capacity**: Targets pertaining to all resource use (e.g., water, energy, material throughput and food) are tied to ecological carrying capacity
2. **Efficient use**: Energy and material use are optimized through efficient use.
3. **Maintenance**: Infrastructure can be easily maintained. That is, esoteric components that require unique skills for maintenance are minimized.
4. **Durability**: The infrastructure is durable, yet reversible, adaptable, reusable and ultimately recyclable.
5. **Local**: The architecture and urban design are reflective of the unique climatic and material conditions (i.e., resource availability) of the area. Buildings are designed using passive design techniques to reduce energy requirements for lighting and ventilation, heating and cooling.
6. **Land-use optimization**: Land use is optimized by constraining development to strategically located brownfield areas. No greenfield development is permitted.
7. **Green infrastructure**: Green spaces provide the backbone of development and are designed to permeate the city and connect with a regional greenway, thus allowing ecological processes and species migration through the settlement and natural areas beyond.
8. **Restoration**: The site is ecologically restored as is appropriate for the site.
9. **Non-motorized transit**: The "transportation hierarchy" is reversed to prioritize non-motorized forms of transportation as well as public transit.
10. **Reduced automobile dependence**: Automobile use is actively discouraged.

The ecological assessment of the frameworks reveals that few of these criteria are clearly articulated. The three most commonly referenced indicators in the frameworks pertaining to ecological impact include:

[21] Restated from the previous section.

a. *Site placement*: the physical location of the development (greenfield versus brownfield);
b. *Site protection and restoration*: the protection and/or restoration of ecological site functions through construction and operations; and
c. *Lower energy, resource and material use*: the promotion of lower consumption and more efficient use of materials in the construction of the development, management of waste, energy and water use throughout its operations.

A number of indicators also capture the concept of lowering ecological impact indirectly by offering less impactful choices:

d. Providing choices for less impactful behaviour such as alternative mobility options to driving; and
e. Encouraging a sustainability ethic through education.

Because these are the indicator categories that suggest some measure of the ecological approach, the following discussion will occur under these headings.

A. Indicators of site placement

All three assessment frameworks recognize the value of developing on strategically located brownfield sites because of their ability to reuse municipal infrastructure such as water, wastewater, electrical and road infrastructure, buildings and materials and avoid conversion of land, especially of unique or sensitive ecological value.[22] Greenfield development is therefore discouraged in all frameworks. For example, the LEED ND prohibits a development to contain more than 25 percent of prime agricultural land. A more rigorous target may mandate that no new developments be located on greenfield sites, a criteria that is not articulated in any of the three frameworks.

[22] Interestingly, despite the SDMBC's orientation towards respecting natural features and processes, it is the only framework that did not specify avoiding imperilled species habitat.

Borrowing from the ecosystem analogy, the modified use of existing sites and infrastructure is also a *responsive* characteristic, in that it responds to changing demographic and economic circumstances to make the "best use" of land. This is not to say, however, that the current form will be particularly responsive to changes in the future. Due to the intensity of development in FCN, for instance, it remains to be seen how well its form and spaces will adapt to future demographic and economic circumstances. Housing advocate Howard Rotberg echos urban designer Andres Duany's view on high rises when he acknowledges that high rises are inflexible, unlike brownstone apartment buildings of New York, row housing of Victorian London or inner-ring suburbs of Toronto, because of their "custom-design" (Rotberg, 2009). Referring specifically to the high-rise phenomenon in downtown Vancouver, Boddy (2005) believes that the fact that nearly all new development is residential may result in it losing its function as the Central Business District, an outcome which may result in residents emigrating out of the downtown core for work.

B. Indicators of site protection and restoration

All three frameworks require that natural features be identified and protected, disturbances in general be minimized and that landscapes not be modified or be subject to major "earthworks" or site engineering, such as extensive levelling of on-site topographical variations. This requirement also includes allowing interception and mitigation of on-site precipitation events. The LEED ND framework provides the option to compensate for negative impacts to on-site ecological communities by preserving an area off-site. SSI offers a detailed set of indicators pertaining to the restoration of soils and site productivity, including the formulation of long-term plans to achieve such goals. LEED ND also offers credit for long-term conservation plans. The SDMBC framework suggests that development can simulate pre-development hydrological and watershed processes. Indicators for site protection and restoration are commonly available, if not always rigorously applied.

C. Indicators of lower energy, resource and material use

More efficient use of energy, water and materials and elimination of noxious chemicals in materials such as low Volatile Organic Compound (VOC) paints are common requisites

across all frameworks. It should be noted, however, that many of the targets associated with these goals are increasingly becoming part of mandatory British Columbia Provincial and Vancouver municipal policy and therefore lose their "exemplary" status. For instance, as of last year, the British Columbia Building Code has been amended to improve energy and water efficiency requirements for all new construction in that Canadian province. The Provincial Government website states that further "areas under exploration include greywater recycling, the use of lighting sensors and the reuse of existing buildings" (Greening the B.C. Building Code, n.d.). Vancouver is also in the process of formulating green building strategies, which cover additional topics as rainwater management, heat island effect mitigation, landscape and ecology, energy, passive design, waste diversion and Travel Demand Management (Green Building, n.d.). While this is a sign that ideas related to sustainable planning, design and construction are becoming mainstream, it raises the question of how assessment frameworks can evolve to continue to promote the cutting edge in sustainable practices.

For example, none of the frameworks, nor the British Columbia Building code and Vancouver Green Building Strategy, explicitly tie energy or resource targets to ecological carrying capacity with one exception. The SSI framework does award credit for obtaining carbon emission neutrality throughout the life of the site, including construction, operations and maintenance. It further notes that the offsetting of embodied energy in materials may become a requisite to achieving the credit in the future. Along with LEED ND, it also does promote use of renewable energy, which conceivably could fit within the Earth's capacity, if it were based on solar income (and assuming all the infrastructure to procure the energy would be sustainably created and maintained). The SSI framework is also exemplary in that it emphasizes the life cycle considerations of construction materials used, such as their sourcing (i.e., no use of unsustainably procured materials), their recycled content and recyclability. Despite these few areas, however, the fact that most of the targets across all frameworks are not tied to ecological capacity is a serious omission that must be corrected if projects are to be promoted as "exemplary" and meet the requisites of strong sustainability.

D. Indicators of mobility options

Paramount in the literature on sustainable communities that all perspectives (see chapter 3) and frameworks agree on is the importance of coordinating land and transportation planning to provide mobility options beyond the private automobile. However, only LEED ND and the SDMBC frameworks recognize the need for *transit*-oriented development (TOD).[23] Other indicators promote regionally well-connected and safe bike paths and greenways both on-site and to off-site destinations. The hope is that by providing these options, they will influence travel behaviour. Authors such as Scheurer (2001, p.202) would argue, however, that this does not go far enough in discouraging a behaviour that so clearly is unsustainable. Indicators of activities that actively discourage automobile use by reducing or eliminating parking, make driving more expensive and promote educational campaigns against driving may have a better chance of influencing behaviour than only providing the option not to drive (Travel Demand Management (TDM), 2009). Within the assessment frameworks, LEED ND is the only framework to actively discourage car use by providing credit for Travel Demand Management programs. It also is the only one to recognize the importance of providing infrastructure beyond road dedication to support alternative mobility options, such as bike storage to promote cycling.

Coordinated land and transportation generally means not only providing mobility infrastructure such as transit and bikeways, but also providing access to essential goods and services, schools and jobs by proximity, generally within walking distance. Zoning for a "mix of use" is at the core of the concept of the "complete community" and is espoused in the SDMBC and LEED ND frameworks. Many of the indicators that promote an enjoyable environment do so to promote walkability. Treed streets, ample (well connected) sidewalks, articulated building facades, short blocks, and pedestrian scaled massing are examples of

[23] Recognizing that mobility is an essential aspect of land use and that automobile infrastructure is expensive, ecologically impactful and perpetuates automobile dependency and sprawl, transit-oriented development (TOD) has emerged as a planning concept in which land use planning is coordinated with transit. Common characteristics of TODs include: "mixed-use, walkable, location-efficient development that balances the need for sufficient density to support convenient transit service with the scale of the adjacent community. The project strives to develop techniques to assure that transit-oriented development incorporates a range of income levels" (Belzer & Autler, 2002, p.7).

design strategies to encourage walking and are common in the LEED ND and SDMBC frameworks.

E. Indicators of sustainability oriented education

Perhaps one of the most promising sources of influencing travel and consumer behaviour more broadly is through sustainability or ecology-focused education. Both the SDMBC and SSI frameworks recognize this by promoting sustainability educational features in the landscaping. In addition, SSI recognizes that vegetation can be used to educate and create a sense of bioregionalism.

Sustainability dimension 2: indicators of community resilience

A central argument of this work is that in order for settlements to be resilient they must be designed like Nature. They must also be designed within Nature's limits in order not to erode its life sustaining properties. The discussion below reveals that the assessment frameworks are generally lacking in their ability to capture concepts of structural and functional resilience and as such, essential emergent properties such as the ability to form locally appropriate solutions, respond to change through adaptation and evolve over the long term are likely not going to be achieved. The following three sustainability dimensions are discussed:

a) critical neighbourhood functions,
b) resilient (infra)structure, and
c) systems response.

A. Indicators of critical neighbourhood functions

Based on ecosystem characteristics, indicators to indicate functional neighbourhood resilience would include the following criteria:[24]

11. **Autonomy**: The development strives for levels of autonomy in critical life supporting functions such as food provision, water, energy and waste management. If not, these

[24] Criteria are re-stated from page 85-86. The number of the list continues from the previous list to indicate that these criteria are part of a larger list.

functions and resources are planned for at another scale, preferably local, to meet the needs of the development's inhabitants.

12. **Renewability**: Only renewable forms of energy are used and emphasis is placed on using renewable materials.
13. **Integration**: Integrated design solutions are used to accomplish a number of functions at once.
14. **Storage**: Reserves of critically important resources are integrated into the development.
15. **Collaboration**: Residents have the opportunity and are encouraged to get involved in stewardship activities in their communities to promote social resilience.

One of the many functions of ecosystems is to sustain processes, which keeps components within the system alive, and in turn further contributes to the continuation of the processes. To ensure that the system remains functional, ecosystems are process-oriented, renewable, cyclical, optimized, diverse, redundant, connected, decentralized, open, and yet largely autonomous. Human settlements are designed to keep humans alive and therefore critical functions such as ensuring that the residents receive water, food, energy, are able to manage their wastes and can freely move throughout the system should be the orienting focus in any neighbourhood plan. It is likely that very few if any neighbourhoods can provide for all their energy, material and waste management needs and therefore provisions for such functions would need to be made at a broader scale, such as the regional "hinterlands". The ecological assessment of the frameworks reveals that few of these resilience-oriented criteria are being captured. As the discussion below reveals, the frameworks are more focused on the structure of the settlement than its life sustaining functions and processes.

For example, while the LEED ND and SDMBC frameworks award points for on-site food production, targets do not reflect the nutritional requirements of the community; the requirements appear to be tokenistic or appeal more strongly to the social sustainability

function of community gardens.[25] None of the frameworks provide indicators of potable water provision. All three, however, do discuss how wastewater will be treated and reused for *irrigation* on site. In terms of energy, the LEED ND and SDMBC models award points for either providing district heating/cooling system (LEED ND) or having the ability to be connected to one in the future (SDMBC). Solid waste management is not discussed in any significant sense other than to offer credit for providing recycling receptacles, a now common requirement for all developments in Vancouver. SSI requires that all landscaping waste be composted, but this can be off site.

Other, more commercially oriented, neighbourhood functions are identified in the SDMBC and LEED ND frameworks, such as providing a range of shops, services, jobs and amenities near by. One might hope that the somewhat recent resurgence in moving away from rigid zoning to mixing these types of land uses at the neighbourhood scale may expand to encompass basic life-sustaining functions such as water, food, energy and waste management in the not too distant future. I certainly challenge the authors of the frameworks to consider a more expansive concept of "complete community".

B. Indicators of resilient (infra)structure

Based on ecosystem characteristics, indicators to indicate infrastructural resilience would include the following six criteria:[26]

16. **Site selection**: The community is not located in an area particularly prone to natural disasters, including sea-levels rising.
17. **Disaster resistant infrastructure**: The infrastructure is designed to withstand anticipated physical shocks common to the area, such as earthquakes in Vancouver.
18. **Dynamic buildings**: Buildings are designed to be flexible, convertible and expandable.

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[25] Community gardens have been found to be an invaluable venue for social interaction (Shinew, Glover & Parry, 2004).

[26] Criteria are re-stated from page 86. The number of the list continues from the previous list to indicate that these criteria are part of a larger list.

19. **Connected nodes:** Nodes of development are well connected both internally and externally.
20. **Nested hierarchies**: Neighbourhoods are clustered as self-maintainable cells capable of fulfilling basic functions in times of resource unavailability.
21. **Diverse, redundant and decentralized**: At the regional scale, critical resources and functions are diverse, redundant and decentralized.

Once the key functions described in the previous section have been identified, the structure of a settlement may emerge to fulfill these functions. The ecological assessment of the frameworks reveals that few of these criteria are being captured.

The most obvious effort towards promoting structural sustainability is to ensure that it is not unnecessarily vulnerable to expected natural disturbances such as floods, fire, and landslides. While all indicator frameworks require that a development not be located in an area prone to these more traditional types of natural hazards, none of the frameworks recognize sea-level rise as a consequence of climate change to be a natural hazard. It is not clear whether the authors of the frameworks do not think sea-level rise is imminent or if they believe it can be mitigated. Given the strength of evidence behind sea-level rise projections, assessment frameworks should include it as a legitimate site vulnerability.

Ecosystems are comprised of diverse parts connected in a decentralized system. Similarly, Vancouver's regional plan (LRSP) promotes decentralized yet connected nodes of development across the region. The LEED ND and SDMBC frameworks reward mixing uses, including a range of housing types, within any neighbourhood so that critical goods and services are scattered throughout the region rather than rigidly zoned into discrete areas. All three frameworks recognize that critical ecological functions such as stormwater management, as well as commercial needs such as shops and services, should be accommodated on site; without explicitly acknowledging it, all three frameworks promote to some degree the concept of designing in redundancy in these functions across the region. None of the frameworks, however, acknowledge in any significant sense the need to scatter

and create redundancies in other functions such as energy, water and waste treatment throughout the region.

A resilient structure, while autonomous, is also open and connected to the broader resource base on which it depends. It is therefore essential that the structure promote a good range of connectivity, through the use of benign or low-impact mobility options, to meet the needs of a diverse population, including of its non-human inhabitants. Both the LEED ND and SDMBC promote on and off site connectivity; the SDMBC framework explicitly references the need to link on-site green spaces to the regional ecological network. Connectivity for humans seems to have firmly established itself in the discourse on good neighbourhood design; naturalists in particular would argue there is a need to extend that concept to non-human species as well (Dramstad, Olson & Forman, 1996).

C. Indicators of systems response

Based on ecosystem characteristics, indicators to indicate systems response at the community scale would include the following two criteria:[27]

22. **Education**: Residents are educated about sustainability and ecology.
23. **Participation**: Decision-making processes for the community are cooperative and include the perspectives of the residents.

The ecological assessment of the frameworks reveals that these criteria are being captured to a degree. A critical component to a system's resilience is its ability to respond to information about the system, "correct problems and perform repairs, even under extreme conditions". (Evaluating Transportation Resilience, 2008, para.3). In addition to hardwiring these "fail-safe" devices and warning detections in infrastructure, the planning process itself may be viewed as another avenue in which to display this responsive characteristic. On this point, all three frameworks agree as to the importance of open, participatory and deliberative planning

[27] Criteria are re-stated from page 86-87. The number of the list continues from the previous list to indicate that these criteria are part of a larger list.

processes. However, it should be acknowledged that the outcomes of the planning will only be as good as the values and knowledge of the community. If, for instance, the community is ignorant of sustainability and appropriate measures to promote it, their contributions may be counterproductive to the goal. This highlights the importance of education in community planning processes. The SDMBC and SSI frameworks award points for providing educational features on site to promote environmental learning, but none of the frameworks emphasize the importance of educating about sustainability within a decision-making context. Sarkissian et al. (2009) remind us that this point cannot be overlooked and therefore should form part of the assessment frameworks.

Another key characteristic of resilient structures is their ability to act on that information and incorporate it into the structure and function of the settlement. Setting performance measures that can be evaluated and fed back into the decision-making system are an example of a responsive planning measure that can be incorporated into further decision-making. The SSI is the only framework to include such a measure.

Physical adaptability is another precursor to responsiveness. However, the SDMBC framework is the only one to suggest adaptable form through shared uses and a diversity of block (or lot) sizes. Because the case for flexible blocks is discussed in the context of suburban neighbourhoods, the applicability to denser neighbourhoods such as FCN is not clear. The concept of adaptability of built form and infrastructure, as well as public open spaces, is in need of further development across all assessment frameworks.

Table 4.1 summarizes which of my ecologically based criteria are being captured through the indicators. I indicate in the table how many and which frameworks contain the ecologically based criteria. Omissions in the indicators are also indicated where appropriate.

Table 4.1: Number of assessment frameworks that reflect specific ecological based criteria.

Criteria No.	Ecologically based indicator criteria	No. of frameworks that contain the criteria	Discussion
1.	**Indicators of ecological impact**		
1.1	Targets pertaining to all resource use (water, energy, material throughput and food) are tied to ecological carrying capacity.	0	
1.2	Energy and material use is optimized through efficient use.	3	Efficiency is not based on rigorous standards.
1.3	Infrastructure can be easily maintained. That is, esoteric components that require unique skills for maintenance are minimized.	0	
1.4	The infrastructure is durable, yet reversible, adaptable, reusable and ultimately recyclable.	1	SSI awards credit for life cycle assessment of materials.
1.5	The architecture and urban design are reflective of the unique climatic and material conditions (i.e. resource availability) of the area. Buildings are designed using passive design techniques to reduce energy requirements for lighting and ventilation, heating and cooling.	2	SSI and LEED ND discuss elements passive design, but not in a significant way.
1.6	Land use is optimized by constraining development to strategically located brownfield areas. No greenfield development is allowed.	0	All 3 frameworks encourage brownfield, but none prohibit greenfield development.
1.7	Green spaces provide the backbone of development and are designed to permeate the city and connect with a regional greenway, thus allowing ecological processes and species migration through the settlement and natural areas beyond.	1	SDMBC
1.8	The site is ecologically restored as is appropriate for the site. This includes preserving habitat.	3	
1.9	The “transportation hierarchy” is reversed to prioritize non-motorized forms of transportation as well as public transit.	2	LEED ND and SDMBC
1.10	Automobile use is actively discouraged.	1	LEED ND

Criteria No.	Ecologically based indicator criteria	No. of frameworks that contain the criteria	Discussion
2.	**Indicators of critical neighbourhood functions**		
2.1	The development strives for levels of autonomy in critical life supporting functions such as food provision, water, energy and waste management. If not, these functions and resources planned for at another scale, preferably local, to meet the needs of the development's inhabitants.	2	LEED ND and SDMBC promote the use of district heating systems and food production, but not in a significant way.
2.2	Only renewable forms of energy are used and an emphasis is placed on using renewable materials.	0	
2.3	Integrated design solutions are used to accomplish a number of functions at once.	0	
2.4	Storage (i.e. backup) of critically important resources is integrated into the development.	0	
2.5	Residents have the opportunity and are encouraged to get involved in stewardship activities in their communities to promote social resilience.	2	SSI and SDMBC. Social resilience is not explicitly articulated as a goal of social interaction.
3.	**Indicators of resilient infrastructure**		
3.1	The community is not located in an area particularly prone to natural disasters, including sea levels rising.	3	Sea-level rise is omitted as a possible natural disaster.
3.2	The infrastructure is designed to withstand anticipated physical shocks, such as earthquakes.	0	
3.3	Buildings are designed to be flexible, convertible and expandable.	0	
3.4	Nodes of development are well connected both internally and externally.	2	LEED ND and SDMBC
3.5	Neighbourhoods are clustered as self-maintainable cells capable of fulfill basic functions in times of resource unavailability.	0	
3.6	At the regional scale, critical resources and functions are redundant and decentralized.	0	
4.	**Indicators of systems response**		
4.1	Residents are educated about sustainability and ecology.	2	SDMBC and SSI
4.2	Decisions making processes for the community are cooperative and include the perspectives of all the residents.	3	

Gaps in the neighbourhood sustainability assessment frameworks

The discussion in the above sections and Table 5.1 reveals a number of serious omissions in conventional sustainability assessment frameworks for urban neighbourhoods. All sorts of sustainability assessment tools balance the challenge and trade-offs between providing a rigorous evaluation that reflects accurately the sustainability of an action and making their tool user-friendly (by making the criteria clear, easily measurable or data easily obtained) so that it will be used and influence practice. Some, like Kim (2002, p.422), note that, "it is impossible to produce a 'perfect' set of sustainability indicators that can be applied to all situations because of structural variations between countries and initiatives." Further, *prioritizing* criteria and their contribution to sustainability can be challenging. Failure to do so is one of the major criticisms of the LEED ND framework (Thomas, 2008). Inevitably, there will be limitations in sustainability assessment tools because of these trade offs, the requirements of a specific site or specific context and/or our nascent understanding of the root causes of unsustainability and the strategic actions required to implement it.

However, it is possible to remedy at least one of the glaring omissions. In general, the indicators reviewed that pertain to resource use (energy, water, materials and waste) are appropriate and useful for tracking resource throughput in a system. However, these indicators are weak in establishing best or exemplary practice if their targets are not based on ecological productive and assimilative capacity. Abiding by these indicators and their associated targets may reduce the *speed* at which we are using resources unsustainably. However, a word of caution is necessary: slowing down resource use cannot be equated with sustainable use. As Rees (pers. comm., 2007) reminds us, *being more efficiently unsustainable is not the same as being sustainable*. To address this weakness, we can choose to include concepts such as ecological carrying capacity when setting targets.

Despite the limitations of the frameworks in capturing or reflecting the concept of ecological impact in a meaningful way, this clustering of indicators does have value. A more optimistic view might consider that at least people are taking into account the concept of ecological

impact to *some* degree. This is a valuable first step. Once it has been taken, others may see the need for improvement within the frameworks and begin to strengthen and expand them.

Whether building on the weaker sustainability components of the frameworks will yield strong sustainability also remains to be seen for the *resilience* dimension of sustainability. Resilience systems are defined by their diverse, connected, decentralized and redundant components organized within nested hierarchies as well as by their renewability, recycling, optimizing, diverse, redundant and autonomous processes. Conceptually, these concepts pertaining to systems resilience are explicitly and implicitly lacking from all three frameworks.

Indicators of emergent properties such as adaptability and evolution are also omitted. Perhaps even more striking is that the language of the frameworks (both in their use of indicators and in the preambles) largely overlooks our embeddedness in a dynamic world. They fail to challenge our assumptions of the world, which, I believe, may no longer be taken for granted (MEA, 2005). Many of these challenges, such as demographic shifts and natural disasters, are situational and contextual. Therefore, a general framework may be unable to capture these local nuances. Other challenges, however, such as climate change and peak oil, are expected to have impacts on all the Earth's communities to some degree. (Although how each community will experience these challenges will be unique.)

As an example, none of the frameworks acknowledges projected sea-level rise as a potential natural disaster similar to floods, fire or landslides. Yet the scientific data are clear that sea levels internationally will rise over the next century (IPCC, 2007). The frameworks also include very little explicit emphasis on our decreasing dependency on finite and diminishing materials such as fossil fuels. Use of renewable energies is acknowledged by SSI and LEED ND and a general promotion of alternative forms of transportation to gas-guzzling automobiles is acknowledged by LEED and SSI. But fossil-fuel dependence is not appropriately highlighted. The reader is left without any sense that these frameworks reflect

an understanding of the fundamental effect of fossil fuels on our settlements, as well as on how we meet our needs and, ultimately, how we live our lives.

One set of neighbourhood actions that reflects characteristics of resilient systems is the planning for a degree of autonomy within a community, for example, for water, energy, food and waste management. The appropriate scale for each of these activities is a question that cannot be answered in the scope of this thesis. Certainly, not all communities can, or even should, become fully autonomous. In such cases, autonomy might be considered from a broader scale such as the region. Rees (2009), Forman (2008) and even Lynch (1981) to a degree promote the concept of planning for local use of resources at this scale in tandem with community growth. Such thinking (were it embedded in the frameworks reviewed) would expand the popular planning concept of "complete community" to include the biophysical base from which all goods and services are derived.

At least one functional ecosystem characteristic appears to be entirely missing from the indicator frameworks: oscillatory flows in throughput. The concept of being able to adapt to pulses in energy and resources is not a common policy goal for human societies where the norm tends to be to maintain a stable or increasing level of energy and resources. A framework that promotes anticipatory planning, however, would consider these realities.

Another key area for improvement in the indicator frameworks is their promotion of flexibility, responsiveness and adaptability in all infrastructure as a means to accommodating unexpected changes. This concept is almost entirely lacking from the language of all assessment frameworks. Questions pertaining to how well a form or infrastructure can be replaced, maintained, expanded, disassembled, reused and recycled would help to identify adaptability. Yet the structure must have enough integrity that its basic components are durable enough so as not to require repeated maintenance and/or replacement.

Critique of the individual sustainability assessment frameworks

Up until this point the emphasis of the discussion has been on individual indicators and their ability to reference the ecological concepts highlighted above. The following section offers a critique on how well each of the frameworks in their entirety capture these ecological concepts. The purpose of the critique is not to highlight specifically what elements are present or lacking, but to provide a discussion of the frameworks' *approach* to sustainability and sustainable neighbourhood planning and design, what its strengths and omissions are, and how it might be improved to reflect the ecological approach.

Each of the frameworks is unique in that each emphasizes different components of development; each offers contributions in their own approach that can be augmented with the ecological approach.

Evaluation framework 1: LEED for Neighbourhood Development

The LEED ND assessment framework is likely the most well known framework of the three. The LEED standard for buildings, for example, has been adopted by a number of municipalities. Between the other two frameworks in terms of scale, the LEED ND offers a range of indicators from the building specific to the regional. Through the use of both spatially and resource oriented indicators, it largely reflects the perspectives of the spatial planners and elements of the *traditional* environmental-designers, described in chapter 3.

Consistencies with the ecological approach

One of the most significant strengths of the LEED ND framework is its recognition in planning and development practice. By setting targets that are better than conventional, yet still achievable, they have asserted themselves as a planner and developer friendly framework that has put more environmentally conscious development on the map (Thomas, 2008). Further, LEED professional certification is now commonly sought among planners as a valuable designation.

The framework also offers a number of indicators that are consistent with the ecological approach such as optimizing land use, restoring the ecology of the site, actively discouraging the use of automobiles (something that the other frameworks do not explicitly reward) and using water, energy and materials efficiently.

Omissions

Seen in a different light, however, many of these targets are increasingly being seen as best practice and no longer "exemplary". Further, there are a number of omissions within the LEED ND framework. Concepts pertaining to the life cycle of materials are not explicitly addressed. For example, the longevity, durability, flexibility, adaptability, reusability and ultimately recyclability of materials and infrastructural components is not discussed. Habitat preservation and restoration of the site is discussed but there is a lack of attention to how these green areas connect with the regional green network to promote species migration and ecological processes that require extensive ranges. Finally, like the general consensus on the other frameworks, the concepts of community resilience and carrying capacity with respect to resource throughputs are not present in any of the indicators. The concept of designing to anticipate future changes is also absent from this framework.

In her own evaluation of an earlier version of the LEED ND framework Thomas (2008, p.25) points out in her masters research:

> "The pilot LEED ND treats itself more as a list of 'best practices' than as a rating system for awarding truly sustainable neighborhood developments.... While it is necessary to keep the minimum targets and strategies attainable, LEED ND must still push the boundaries of conventional thinking in a way that will challenge the development community to go beyond current notions of what is considered 'high density' or 'endangered species conservation' or even what true 'floodplain avoidance' might entail. To reward environmental sustainability, a rating system must incorporate cutting edge research done by environmental

> engineers, planners and green building experts in a manner that challenges accepted practices while at the same time encourages innovation."

The latest version of the LEED ND framework has recently concluded its consultation phase and is prepared to make changes to reflect progress in research and assert itself as a more rigorous framework. McLennan (2006, p.3) for instance notes that the LEED system in general is in the process of restructuring is requirements to take into account such concepts as potential life cycle impact and regionalization. I eagerly anticipate the evolution of this framework and hope that it will contain elements of the ecological approach.

Evaluation framework : Sustainable Urban Landscapes Site Design Manual for B.C. Communities

The SDMBC framework offers indicators or criteria for the widest range of spatial scales out of any of the frameworks: district, corridor, block and parcel. As such, the framework allows the regional *context* of the neighbourhood to be captured; this is valuable as clearly no neighbourhood operates in isolation. This framework is more exclusively design and urban pattern oriented than either of the two and therefore offers spatial planning ideas, but these are not always clearly linked to resource throughputs. Operation and maintenance considerations are also not emphasized, in contrast to the SSI framework. This framework tends to primarily reflect the perspective of the spatial planners and the naturalists described in chapter 3.

Consistencies with the ecological approach

This framework has two major strengths that stand out when compared to the other frameworks. Firstly, the framework promotes contextual and regional systems based thinking. Secondly, and similar to Ian McHarg, it uses the natural regional landscape as the basis of regional systems based design strategies. For example, there are a number of indicators that describe the notion of allowing natural features to design the block and permitting "green fingers" within the development. Another example is ecological function-

oriented design strategies such as designing streets and streams as one system to assist in site drainage.

One of the strengths in a regional focus is the ability to capture concepts of planning for resource self-sufficiency through the use of urban "hinterlands". This framework touches on this concept lightly with the following indicator: maximizing regional food production through the preservation of land with high agricultural value. I would encourage the authors to push this concept further by providing indicators that measure the matching of resource demand to resource production to capture Forman's (2008) concept of "prime footprints". Such an inclusion would be a major contribution to regional sustainability and resilience planning.

In addition to these general foci, there are a number of individual indicators that are somewhat consistent with the ecological approach and are unique to the framework. The concept of flexibility and adaptability, while still quite limiting, are articulated more in this framework than in the other two. Designing spaces, particularly open spaces, to serve multiple functions is discussed as is the idea of the "flexible block". This refers to the idea of providing a patterning of lots (primarily small lots) that can accommodate a range of housing types. Townhomes and single-family homes may fit on a single lot; lots can be consolidated to accommodate a higher density structure such as an apartment building. While the concept of flexibility is a distinction of this framework, the "flexible block" concept is somewhat less dynamic than I had hoped; it seems to emphasize more the concept of how a range of housing types can be accommodated in an area as opposed to how lots may respond to changing circumstances, such as peak oil and climate change. The "flexible block" concept is also not well suited to high-density built out areas and therefore I had difficulty in imagining how it could be applied to FCN.

Omissions

One of the primary weaknesses from my perspective is its "comparative" function. The framework notes "While not intended as a scientific or absolute measure of sustainable

development, this checklist does provide a consistent basis for comparison between options" (Condon, 2003, p.143). The framework is clear of this role, which may be seen as practical value. I would argue, however, that without a stronger hold on these absolute measures, the development this framework promotes may be "better" than conventional standards, but this does not mean it will be sustainable. I discuss the distinction between "better" as a relative measure and "good" as an absolute measure of development in my conclusions, chapter 6.

The checklist also uses the measure of being consistent with existing policies at a higher scale (i.e., the region). This criteria assumes that regional policies are consistent with sustainability. While the LRSP is a revolutionary document with many ideas consistent with sustainability, it does not pursue the concepts of resilience and self-sufficiency to the degrees that this thesis proposes it should. Therefore, being consistent with regional policies such as the LRSP may not necessarily be a suitable criteria.

While not necessarily an absolute weakness, many of the design principles proposed are more suitable to suburban contexts of low density and low rise buildings; this made it difficult to apply some of the concepts to the high-density neighbourhood of FCN. I would urge the authors of this framework to consider the regional implications of nodes of high-density urban development, since it is a convincing form that is being put forth in planning practice. For instance, the SDMBC might consider the area of food growing potential for a community of FCN's size, roughly 10,000 people.

Finally, the concepts of carrying capacity and community resilience with respect to resource throughputs are not present in any of the indicators. Similar to the SSI framework, designing like Nature is recognized, but designing within Nature's limits is not. Nor is designing to anticipate future changes.

The explicit use of patterning and design strategies to address issues of regional concern in this framework position it with the opportunity to experiment with physical patterning concepts that mimic natural systems' structure and function. Concepts such as redundancy,

diversity, nested-hierarchies, etc. are all concepts that I could envision being encapsulated in this framework more so than the other two frameworks. I would urge the authors of this framework to consider experimenting with these ideas to further the evolution of their sustainability, principles, guidelines and checklist tool.

Evaluation framework 3: Sustainable Sites Initiative: Guidelines and Performance Benchmarks

The SSI framework is the most specific in scale and scope of all the frameworks examined in this thesis; it provides guidance and criteria for design and practices pertaining to site *landscapes*. The sustainability nuance is on a site's ecosystem services such as climate regulation, air and water cleansing, erosion and sediment control, hazard mitigation, waste decomposition, food products and human well-being through contact with Nature. As such, the orientation of the indicators is primarily on biophysical attributes of the site such as soils and vegetation. The philosophical approach espoused in the framework is to align with natural forces to fulfill the continued functioning of these ecosystem services on site. Similar to the SDMBC framework, this framework tends to reflect primarily the naturalist perspective described in chapter 3 with some elements consistent with the perspective of the ecological designers. Unlike the SDMBC framework, however, the planning emphasis is much more on resource throughputs used through restoration, operations and maintenance than physical design.

Consistencies with the ecological approach

Despite the site specificity of the framework, it is the only one that begins to capture absolute measures of resource use. The goal of achieving a degree of carbon neutrality throughout the life of the site (including construction, operations and maintenance) through sequestration, or providing carbon sinks to offset the balance, is one such example. Even if it is only for the landscape components of the development, the direct reference to ecological sources, sinks and the need to balance human activity is unique to this framework. This goal may be seen as achievable to this framework given the fact that landscape features such as vegetation and soils are major sequesters of carbon. There is also some indication that the indicator on

carbon neutrality may be expanded in further iterations of the framework to include the embodied energy of site landscape materials, again unique to the this framework. The exclusive use of renewable energy is also distinct, but again is applied only to the landscape components. Finally, the emphasis on adopting a life cycle approach when selecting materials is consistent with the ecological approach, and unique to this framework.

Aside from some specific indicators, some of the greatest strengths of the framework are in their ability to articulate a set of guiding principles, aligned with Nature, from which to inform the indicators. These principles are very similar to those I encountered in my SUD and ecosystems literature review:

1. Do no harm
2. Precautionary principle
3. Design with nature and culture
4. Use a decision-making hierarchy of preservation, conservation and regeneration
5. Provide regenerative systems as intergenerational equity
6. Support a living process
7. Use a systems thinking approach
8. Use a collaborative and ethical approach
9. Maintain integrity in leadership and research
10. Foster environmental stewardship

Another strength of the framework is that it points out which ecosystem services each indicator contains. For example, achieving a carbon-neutral site supports the ecosystem services of global and climate regulation, air and water cleansing and human health and well-being. Conducting a life-cycle assessment of materials used supports global climate regulation, air and water cleansing, habitat functions and waste decomposition and treatment.

Omissions

The SSI framework is meant to evaluate sustainable landscapes and therefore does not contain some of the common neighbourhood planning elements found in the other

frameworks such as mix of uses, compact and transit oriented development. This scope is valuable for a beginning iteration of a framework organized around the science of ecosystem services as it gives the opportunity to explore the specific functions of landscapes in built environments with more depth than either of the other two frameworks. Because open areas are key components of communities that have the potential to fulfill certain critical neighbourhood functions such as producing food or managing waste, I would challenge the authors of the framework to consider how these concepts of community autonomy could be captured in community landscape dynamics.

Further, because green spaces, the key element in "green infrastructure", are largely comprised of living components, they may be expected to experience climate change more acutely than grey infrastructure particularly due to water availability. Gill et al. (2007) point out the need to both plan for the changes this infrastructure may experience and also use it creatively to contribute to urban climate control. Overall, concepts of a landscape's resilience and adaptability to changing circumstances are not addressed; this is a critical omission in my estimation.

Finally, despite laudable efforts to capture some degree of ecological carrying capacity, this fundamental concept is not enshrined in their guiding principles. Similar to the SDMBC framework, designing like Nature is recognized, but designing within Nature's limits is not. In creating the framework, the authors recognize that there are questions left unanswered as to "how much is enough" in the pursuit of sustainable landscapes. I would encourage them to continue to pursue that question and recognize that they are not quite there.

The quest for an assessment framework that aims for the truly sustainable: the Living Building Challenge

I am not the first to search for a perfect set of indicators. Nearly all authors of existing assessment frameworks recognize the limitations and continuous learning process behind developing an indicator framework. The efforts behind developing assessment frameworks is laudable as the work is complex, but authors of such frameworks must remain vigilant in

attempting to encourage SUD practices that are consistent with strong concepts of sustainability.

One framework that I came across that is more consistent with the ecological approach than any of the others in this research is the Living Building Challenge (McLennan, 2006). This assessment framework is limited to buildings, but efforts are underway to scale these concepts to neighbourhoods as well.

The purpose of the Living Building Challenge is to define "the highest measure of sustainability attainable in the built environment based on the best current thinking – recognizing that 'true sustainability' is not yet possible" (McLennan, 2006, p.4). Certification is attainable when a building (either new or refurbished) has met a number of mandatory prerequisites; only prerequisites, not credits, are used in this framework. Further, the Living Building designation is based on actual, rather than modeled or anticipated, performance (McLennan, 2006).

The second iteration of the Living Building Challenge is currently being developed and will be relevant for projects at multiple scales including: community, neighbourhood and campus design. This scalable framework is expected to be released at the end of 2009. Noting that the most rigorous applications of the LEED framework (Platinum) have been achieved in numerous buildings in North America, "some with zero or small first-cost premiums", the authors of the Living Building Challenge believe that industry is ready for the next iteration in sustainable built form (McLennan, 2006, p.4). They claim that the time for baby steps is over, that what is needed are giant leaps, such as the shift to decentralized, self-sustaining carbon neutral buildings.

Consistencies with the ecological approach

The most striking distinction of this framework is its biomimetic orientation, which is consistent with the ecological approach. Firstly, the name of the framework itself clearly

references the qualities it aims to promote: life. The framework document opens with the following passages:

> "Imagine a building designed and constructed to function as elegantly and efficiently as a flower.... Imagine a building informed by its eco-region's characteristics, and that generates all of its own energy and renewable resources, captures and treats all of its water, and operates efficiently and for maximum beauty" (McLennan, 2006, p.2).

Later in the document they note that each building will be different to reflect its eco-region's characteristics. Therefore "becoming water-independent in the desert demands "evolving" building design to be more like a cactus and less like a tree" (McLennan, 2006, p.7). Overall, the authors advocate for an approach to building that not only does "less harm" to the Earth, but actually does no harm and even restores the environment. The authors of the framework recognize that their goals are ambitious but affirm that their expectations are based on "pragmatic experience with what has been built in the marketplace" (McLennan, 2006, p.7). They conclude that "The standard is difficult – but not impossible – to fulfill" (McLennan, 2006, p.7).

In its current iteration the framework is comprised of sixteen prerequisites within six performance areas, each of which is complimented by a principle that guides the performance area:[28]

1. Site: Humanity has co-opted enough land; it is time to draw boundaries and declare it enough.
2. Energy: A living building relies solely on current solar income.
3. Materials: Safe, healthy and responsible for all species.
4. Water: A Living Building is water independent.
5. Indoor Quality: Maximize health, minimize impact.

[28] The following points are taken directly from the framework document.

6. Beauty and Inspiration: A Living Building tells a story.

Further, the prerequisites pertaining to site, energy, materials and water are based on ecologically based targets such as using solar income, achieving net-zero carbon sites, harvesting and treating 100% of water used on site and using only materials that are sustainably procured. The three other frameworks examined in this thesis each promote some of these goals, but the Living Building framework is the first one I have encountered that so confidently put these ideas forth. For example, the Challenge states on the energy requirements of the building: "The project must account for the embodied carbon footprint of its construction through a one-time carbon offset tied to the building's square footage and general construction type. It should be recognized that buildings continue to accrue embodied energy as systems are replaced and repaired over time. It is recommended that additional offsets be purchased at 7-10 year intervals" (McLennan, 2006, p.12). Further, one of the most unique attributes of this framework is its concept of inspiring a story and encouraging occupants of the building to engage with the environmental qualities of their Living Building.

Another strength of this framework is that it awards points to buildings that have achieved their intentions, not simply what they plan to do; assessment occurs after the building has been built. Also, every criteria is mandatory, so there is no chance of the performance objectives being diluted such as in the LEED ND framework (Thomas, 2008).

Omissions

One omission that remains throughout all the frameworks, including the Living Building Challenge, is the concept as resiliency as an essential characteristic of sustainability. While many of the ideas they put forth may contribute to resiliency through self-sufficiency (e.g., water independence), I believe that this concept of resilience planning and building needs to be more explicitly and strongly articulated. I am deeply curious to what principles and strategies the authors will propose for Living Communities. I encourage them to consider my ecologically based criteria.

Conclusions

This chapter has taken us through the long journey of reporting on the material used to set up the matrix evaluation, critiquing the individual indicators as well as the assessment frameworks in their entirety and concluding with what I hope is an inspirational example of ecologically based thinking in this field. The chapter is dotted with a myriad of specific findings throughout which, when woven together, reveal one clear message: much thought has been put into how to inform and evaluate built forms we hope will be consistent with a sustainable future, but that this work is an evolving process. The approaches I think hold the most promise are those that respect the context of a living Earth most explicitly. I therefore challenge the authors of all assessment frameworks to acknowledge this context by explicitly incorporating strong sustainability concepts of impact and resilience.

Now that we've thought through how the assessment frameworks can be improved, let us now turn to our tangible case study example, False Creek North, to see how it measures up to the ecological approach.

CHAPTER 5: RESULTS AND DISCUSSION OF FALSE CREEK NORTH

Introduction

This chapter begins by briefly describing the False Creek North site, its planning goals, its physical dimensions and demographic characteristics. I then present the key results from a post-occupancy evaluation of resident satisfaction with the development. The ecologically based theoretical framework, developed above in chapter 4, is applied to the False Creek North site and the results are discussed, as are the results from the three assessment frameworks. This chapter concludes by discussing the merits of False Creek North as a sustainable neighbourhood development model and as a site of continued study.

Description of the site

False Creek North was planned in the late 1980s and 1990s and broke ground in the early 1990s. Over two decades the 67ha industrial site was transformed to a mixed-use, primarily residential neighbourhood. It is currently nearly completely built out. The site, also known as Concord Pacific Place, was developed by a single developer, Concord Pacific. John Punter in his book *The Vancouver Achievement* (2003) gives a description of the history and planning process of the site. For more information on the site, consult the False Creek North Post-Occupancy Evaluation Summary and Compilation reports (Hofer, 2008; Wenman et al., 2008).

Planning objectives of the site

From the conception of the development, the City of Vancouver committed to making the False Creek North project an example by revitalizing the concept of urban living through the Living First strategy; this strategy placed emphasis on accommodating families in the city's downtown core, a concept that remains somewhat revolutionary in North America today. Ambitious social policies directed specifically at families, residents in social housing and the necessary amenities were conceived to address the goals of high amenity living in a down town setting. These are outlined in the following guiding documents: *False Creek Policy Broadsheets* (City of Vancouver, 1988), *False Creek North Official Development Plan* (City

of Vancouver, 1990), *CityPlan Central Area Plan* (City of Vancouver, 1991), *High-Density Housing Guidelines for Families with Children* (City of Vancouver, 1992a), and *Plaza Design Guidelines* (City of Vancouver, 1992b).

To shift the use of the site from commercial and industrial to commercial and residential required a "major stroke of rezoning" in which "some eight million square feet were converted from excess commercial (office) capacity to allow residential development" (Beasley, 2000, para.2). Larry Beasley, the co-director of Vancouver Central Area Planning for a majority of the duration of the planning of the site, attributes the ability to transition from industrial to residential on vibrant markets as well as the following planning efforts: a comprehensive integrated strategy that pushed for housing intensity; insisting on housing diversity; structuring the development into for coherent, identifiable, and supportive neighbourhoods; and fostering suitably domestic urban design and architecture.

The clear emphasis in all the documentation of the site and the intensive and coordinated planning efforts is on promoting livability. The project literature contains few references to sustainability.[29] However, although the planning and design of False Creek North were not specifically guided by sustainability principles, many of the development's core design principles are congruent with thinking about sustainable communities today: central location near a major source of jobs in the Central Business District; compact and dense form; mix of uses; transit service; family-friendly orientation and provision of high-quality public amenities. As this thesis argues, however, these concepts, while valuable, may not be sufficient actions towards strong sustainability.

Physical description of the site

False Creek North is situated on a peninsula that makes up downtown Vancouver as is shown in Maps 5.1 and 5.2.

[29] For a discussion on the evolution of False Creek's emphasis on livability to sustainability, see the following website prepared by a group of SCARP graduate students: http://vancouvergroup.wordpress.com/

Map 5.1: Contextual map of False Creek North (City of Vancouver, 2007).

The primary physical design principles centre on:

- limiting commuter access into the downtown and prioritizing walking, biking and transit options;
- extending the fabric, patterns and character of the existing city to the new developments at the waters edge;
- developing complete neighbourhood units at the pedestrian scale;
- insisting on a housing mix for different familial compositions and financial means; and
- reflecting beauty and community identity as well as promoting social life in the public realm.

The Living First approach has also necessitated examination of potential negative externalities such as noise, danger, invasion of privacy and insensitivity to the needs of children in creating high-density downtown living. Balancing an urban design aesthetic, one that welcomes residents and gives a feeling of domesticity, and urban functionality also received focused attention; design strategies depend on the traditional relationships between the street, the sidewalk, and the building wall to solve many of the problems in making high densities work. For example, building facades are articulated with doors, porches, stoops, windows, terraces and vegetation. Design guidelines, enabled by the zoning, set the form which is of small floor plates out of which a tower sits upon a pedestrian scaled "podium", many of which are comprised of now popular row housing.

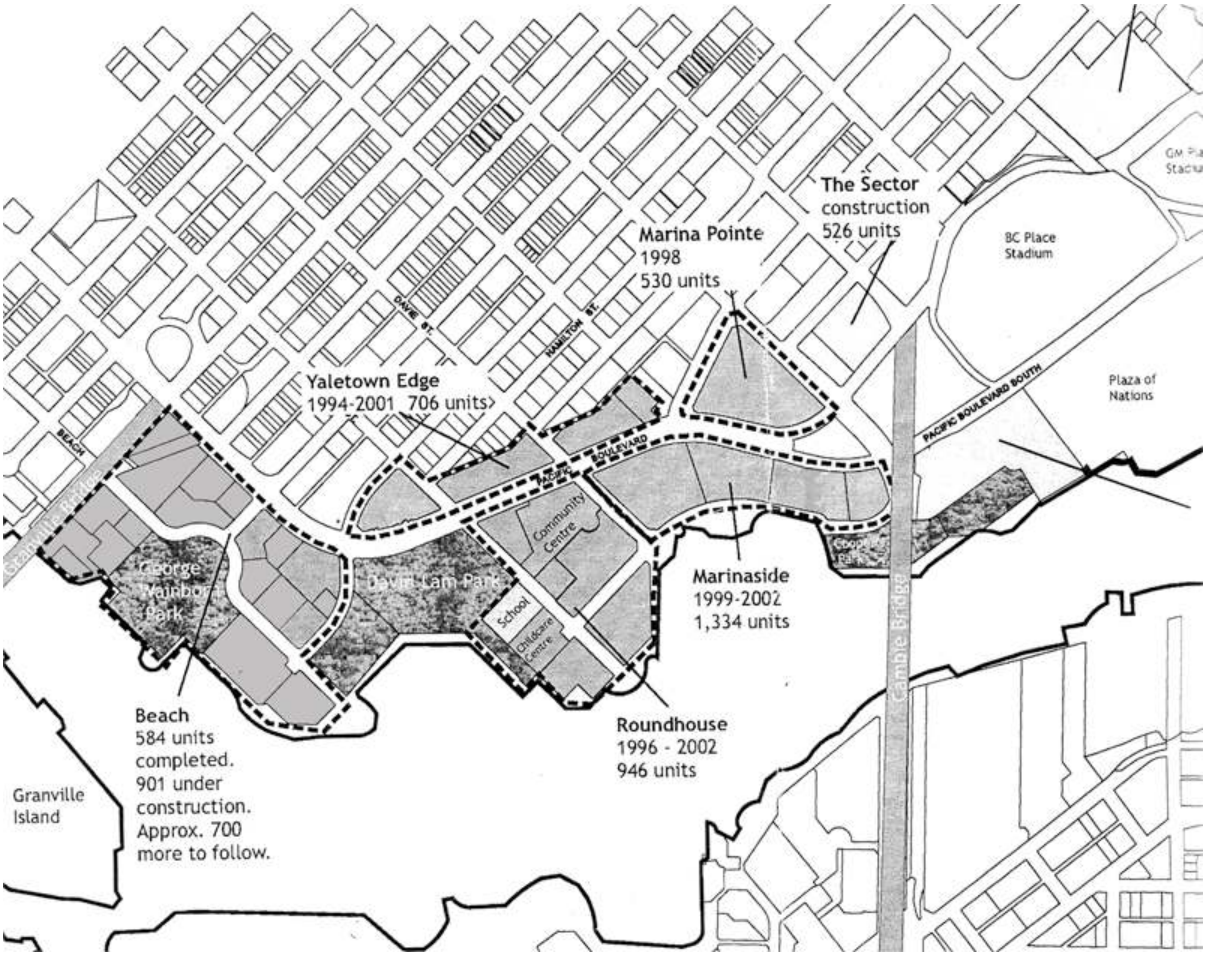
The Official Development Plan outlines the following organizing principles for False Creek North (City of Vancouver, 1990, p.4-6):

- Integrate with the city;
- Build on the setting;
- Maintain the sense of a substantial water basin;
- Use streets as an organizing device;
- Create lively places having strong imageability;
- Create neighbourhoods; and
- Plan for all age groups with a particular emphasis on children.

Table 5.1 gives some summary statistics of the site. Map 5.2 shows the site in more detail. See Appendix E for photos of the site.

Table 5.1: Some descriptive statistics of the False Creek North site.

Site area	67 ha
Population	10,570 in 2006
Density	390 units per hectare in 2006
Built form height	No building, except one, shall exceed 91 metres. The exception shall not exceed 110 metres.
Affordable housing	361 out of 1380 projected units have been built.
Dwelling mix	Tenure mix (ownership, rental, social housing and co-operative housing) and specific proportions of housing allocated to households with children.
Open Space	1.0 hectares per 1,000 residents, or 25% of the total site.



Map 5.2: Site map of False Creek North. Parks are shown in contrasting texture. Data for number of units of housing are valid for 2004 (City of Vancouver, 2004).

Transportation

False Creek North has recently attained the status of a transit-oriented development (TOD) with the recent opening of a rapid public transportation station (Skytrain) within close proximity. Until this time, there were few direct public transit connections to False Creek North despite the area being dense enough to justify well-serviced transit. Bike routes are available on most streets and along the shared bike and pedestrian seawall (described below).

Land uses

The site contains a mix of uses including a grocery store, cafés, restaurants and high-end retail shops. The onsite Roundhouse Community Centre is located in the refurbished original train roundhouse and offers a wide range of programs and facilities. A number of childcare services and an elementary school are also located on site.

Amenities

The wider False Creek area is a great amenity for the City and a regional destination for residents and tourists (Brownell, 2006; City of Vancouver, 1988). In addition to the 17 ha of park space distributed across three large parks (George Wainborn, David Lam and Cooper's parks), the Seawall is a much loved and well-used regional public amenity (City of Vancouver, 1988). The approximately 10 m wide Seawall was 8.8 km long at the time of the research study and connects all of False Creek to Stanley Park and the Coal Harbour area on the north side of the downtown peninsula.

Demographic description of the site

The median age for residents in False Creek North is 38 years, which is consistent with the rest of the Vancouver Census Metropolitan Area (CMA) (Statistics Canada, 2007). Of a total of 10,570 residents, 1,355 (13%) are nineteen years of age and under and 830 (8%) are ten years of age and under. This is significantly lower than the rest of Vancouver and the province which both average close to 23% of their population under the age of 19. Only 685 residents (4%) are seventy and older. Almost one-third of the population is between 20 to 34 years of age.

The top ethnic origins (the cultural and/or ethnic roots with which residents self identify) of False Creek North residents are English, East/Southeast Asian (primarily Chinese), Eastern/Western European and Canadian. These are generally the same top five for Vancouver and the rest of the Metro Vancouver region. However, there are significantly fewer residents of Asian descent in False Creek North than for the rest of Vancouver. There

are more residents of European and British descent in False Creek North than for the rest of Vancouver.

Fifty percent of False Creek North residents speak English as their primary language. This is similar to residents living in Vancouver and Metro Vancouver. Of the less dominant languages spoken, Chinese is the next most popular spoken language. False Creek North has more Spanish, Farsi and Serbian speakers than the rest of Vancouver or Metro Vancouver.

False Creek North residents show significantly higher income levels than the rest of Vancouver or the region. Over a third of the population has a household income over $80,000. The average household income is $82,744. For residents living alone, the average income is $63,249 while the average income of a two-person household is $95,091. Households in False Creek North make almost $20,000 more than their counterparts in the larger Metro Vancouver.

Results from the post-occupancy evaluation

In 2007/2008 a comprehensive post-occupancy evaluation (POE) of False Creek North was conducted by a class of graduate students from the School of Community and Regional Planning.[30] The aims of the False Creek North POE case study were primarily to: a) evaluate policies developed to guide the development, specifically those pertaining to the creation of housing, community services and amenities; and b) determine how the residents felt about their neighbourhood.[31] One reason for conducting the POE study was to determine if this development truly can act as a valuable guide for livable neighbourhoods for future developments.

This POE research addresses the planning approach to housing residents from a comprehensive perspective by looking beyond just the individual residential units and

[30] I was involved throughout the entire duration of the study as both a researcher and project manager.
[31] An early assessment of the project's resources led to the decision to limit the evaluation solely to FCN residents.

housing component of the development to the entire range of support services and amenities that make a community a "home". Eight primary research topic areas were therefore identified for exploration:

- Parks and public open spaces
- Shops, services and community amenities
- Mobility and transportation
- Community safety
- The residential building
- The housing unit
- Sense of community
- Perceived sustainability of the neighbourhood

A mixed-method research design was employed to reinforce the credibility of the data and interpretation and to construct a more complete picture of the state of the neighbourhood. Quantitative responses were analysed using statistical software and written comments were compiled for qualitative content analysis. The following methods were used to explore the above topic areas:

- Mail-out survey questionnaire
- Community SpeakOut event: "Have YOUR Say!" day
- In-depth interviews
- World Café focus group discussion
- Photo-collage exercise with elementary students

The study revealed overall high levels of satisfaction with nearly every aspect of the community evaluated, from parks and open spaces to unit design. However, a number of important policy areas were identified as in need of improvement. The findings from the study found that when planning neighbourhood community developments it is important to:

- Articulate more strongly policy guidelines framing implementation of social infrastructure, such as schools, to ensure that sufficient facilities are available before

the first families move in. Ensure that these facilities are available within growing neighbourhoods as the number and concentration of families increases;

- Guide the allocation of space for daycare facilities with a realistic sense of demand and projected growth. Identify and address any loopholes that might weaken such a framework;
- Design more diverse public spaces catering to the specific recreation and play needs of older children, as well as to younger children, rather than simply treating children as a homogenous group with common play and recreation needs;
- Aggressively foster affordable housing schemes targeting middle and modest incomes to ensure a diverse socio-economic mix, an environment appropriate for families and a strong sense of community; and
- Target the incorporation of more appropriate and affordable retail outlets from the early stages of the development to meet the needs of residents from a variety of socio-economic grounds. Focus on families, in particular.

While the results of the POE are detailed and expansive, I will only highlight the key results of the residents' perception of their neighbourhood's sustainability as it is directly relevant to this thesis topic:

- Sustainability was considered as being important or very important to half of the interview participants;[32]
- Most of the children in the study have an awareness of the natural environment and raised concerns on the water pollution and litter in the neighbourhood. They appreciate transit and recycling programs offered in the neighbourhood;
- Most participants support increased energy efficiency of appliances and building systems;
- Many residents don't want to use energy intensive air conditioning to cool their units. Several residents believe that more could have been done to mitigate temperature variability when the units were constructed, rather than installing air conditioning;

[32] Residents were permitted to use their own definition of sustainability.

- Some energy-efficient systems are not effective such as energy-efficient heating systems and water saving toilets;
- Most residents recycle, although it has been noted that there is some tension in this regard with those in the building who do not understand how to separate materials. Some suggested providing information and/or training to incoming residents, particularly those from other cultures that may be unfamiliar with recycling or have different methods;
- A mix of stores that better reflects the range of incomes and needs in the community would add to the social and economic sustainability of False Creek North; and
- Many residents are also concerned that False Creek North may be approaching the limits to how many people it can accommodate and that more people will infringe on the qualities that make False Creek North what it is — a safe and livable community.

Evaluation of False Creek North using the three assessment frameworks

The False Creek North development rated reasonably highly using the assessment frameworks especially when it is considered that the site was not explicitly planned to be a "sustainable community". It achieved 72% of the checklist requirements on the SDMBC framework that were applicable and data were available for (i.e. if the indicator was not applicable to the site or data was not available, it was not considered part of the total number of achievable credits). 55% of the prerequisites and 42% of the credits were achieved in the SSI framework on indicators that were applicable to the site and data were available for. The site does not achieve a LEED ND rating due to it not meeting all of the prerequisites. However, it does meet 77% of the prerequisites and achieved 62 out of the possible 100 points. See Appendix D for detailed information on how FCN scored on each of the frameworks.

As discussed in chapter 2, the purpose of conducting the assessment of False Creek North is to serve as a reference and provide an illustrative point for general discussion of the ecological approach. Because of this specific intention, the three individual frameworks were not applied in the rigorous way that they were intended to be used. As noted earlier, the SSI

framework was simplified from a point-allocation method to a simple checklist to simplify analysis. While the LEED ND framework was used in its original form, the site could not be assessed against all available indicators due to data limitations. Thus, in some instances personal judgment was used. It is necessary to take into accounts the liberties used in the assessment process when reading and/or referencing the data presented in the assessment scorecards in Appendix D and in the discussion below. Appendix D also provides a detailed list of the major areas in which False Creek North is successful, as well as a list of the areas in need of improvement (according to the frameworks, not my ecological evaluation).

Evaluation of False Creek North using the ecological approach

I use a Likert scale (a semantic-differential rating scale) to rate my own assessment of the degree to which False Creek North contains ecosystem characteristics and principles of systems resilience as described through my criteria established in chapter 4. The scale is rated on a five-point scale. The possible ratings are used to determine the degree to which I believe False Creek North agrees with the indicator criteria statement, the results of which are presented in Table 5.2.

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Table 5.2: Evaluation of False Creek North using the ecologically based indicator criteria.

Indicators No.	Indicator criteria	Rating of False Creek North
1	**Indicators of ecological impact**	
1.1	Ecological carrying capacity: Targets pertaining to all resource use (e.g., water, energy, material throughput and food) are tied to ecological carrying capacity.	Strongly disagree
1.2	Efficient use: Energy and material use are optimized through efficient use.	Agree
1.3	Maintenance: Infrastructure can be easily maintained. That is, esoteric components that require unique skills for maintenance are minimized.	Strongly disagree
1.4	Durability: The infrastructure is durable, yet reversible, adaptable, reusable and ultimately recyclable.	Disagree
1.5	Local: The architecture and urban design are reflective of the unique climatic and material conditions (i.e., resource availability) of the area. Buildings are designed using passive design techniques to reduce energy requirements for lighting and ventilation, heating and cooling.	Strongly disagree
1.6	Land-use optimization: Land use is optimized by constraining development to strategically located brownfield areas. No greenfield development is permitted.	Strongly agree
1.7	Green infrastructure: Green spaces provide the backbone of development and are designed to permeate the city and connect with a regional greenway, thus allowing ecological processes and species migration through the settlement and natural areas beyond.	Disagree
1.8	Restoration: The site is ecologically restored as is appropriate for the site.	Neutral
1.9	Non-motorized transport: The "transportation hierarchy" is reversed to prioritize non-motorized forms of transportation as well as public transit.	Neutral
1.10	Reduced automobile dependence: Automobile use is actively discouraged.	Strongly disagree
2.	**Indicators of critical neighbourhood functions**	
2.1	Autonomy: The development strives for levels of autonomy in critical life supporting functions such as food provision, water, energy and waste management. If not, these functions and resources are planned for at another scale, preferably local, to meet the needs of the development's inhabitants.	Strongly disagree
2.2	Renewability: Only renewable forms of energy are used and emphasis is placed on using renewable materials.	Disagree
2.3	Integration: Integrated design solutions are used to accomplish a number of functions at once.	Strongly disagree
2.4	Storage: Reserves of critically important resources are integrated into the development.	Strongly disagree
2.5	Collaboration: Residents have the opportunity and are encouraged to get involved in stewardship activities in their communities to promote social resilience.	Disagree
3.	**Indicators of resilient infrastructure**	
3.1	Site selection: The community is not located in an area particularly prone to natural disasters, including sea-levels rising.	Disagree

Indicators No.	Indicator criteria	Rating of False Creek North
3.	**Indicators of resilient infrastructure**	
3.2	Disaster resistant infrastructure: The infrastructure is designed to withstand anticipated physical shocks common to the area, such as earthquakes in Vancouver.	Agree
3.3	Dynamic buildings: Buildings are designed to be flexible, convertible and expandable.	Strongly disagree
3.4	Connected nodes: Nodes of development are well connected both internally and externally.	Strongly agree
3.5	Nested hierarchies: Neighbourhoods are clustered as self-maintainable cells capable of fulfilling basic functions in times of resource unavailability.	Strongly disagree
3.6	Diverse, redundant and decentralized: At the regional scale, critical resources and functions are diverse, redundant and decentralized.	Disagree
4.	**Indicators of systems response**	
4.1	Education: Residents are educated about sustainability and ecology.	Strongly disagree
4.2	Participation: Decision-making processes for the community are cooperative and include the perspectives of all the residents.	Agree

Discussion of False Creek North's performance using the assessment frameworks and the ecological criteria

The site and land-use fundamentals of False Creek North reflect the practical discourse around sustainable community development. Its location is consistent with the Livable Region Strategic Plan (LRSP), which promotes concentrated development in nodes across the region. False Creek North is located on a brownfield site next to the most significant employment and commercial node in the region, the Vancouver Central Business District or downtown core. Its physical form is compact and is able to accommodate a high level of residential density. As the post-occupancy evaluation revealed, this density does not detract from the residents' living experience (Hofer, 2008; Lancaster, 2008; Wenman et al., 2008), making the site a cause for much acclaim in planning circles around the world. A mix of uses is accommodated, although residents do note a lack of variability and affordability in many shops and services. Nevertheless, the shops and services are appreciated, as are the open space and community centre amenities – another important reason for False Creek North 's

acclaim. The community displays good connectivity both internally and to the existing urban fabric and provides opportunity for mobility beyond the automobile. At the time of the POE study, residents acknowledged that the transit service was not as frequent or well connected to other routes as it could be, but this is expected to change now that Skytrain line is complete.

The assessment frameworks did, however, point out a number of areas in which False Creek North is deficient in sustainability terms. Firstly, the parks and greenways, while ample, are not well integrated into the regional greenway. This planning weakness affects their ability to undertake the dual function of serving ecological functions such as hydrology or habitat requirements as well as social requirements. The parks also have a distinctive human focus and poorly accommodate natural process or species habitats. Secondly, while options to reduce car use are available, the car continues to be well accommodated especially in terms of the quantity of residential parking. This infrastructure not only detracts from the "alterative mobility" focus, but also imposes a cost burden on the resident, who may pay tens of thousands of dollars for a parking space. Given the housing affordability challenge in Vancouver (Hofer & Gurstein, 2009), this approach to car use can hardly be considered socially sustainable. Thirdly, while some degree of water and energy efficiency is accommodated in a number of the buildings on site, not one achieves the designation of a "green building". Fourthly, some critical neighbourhood functions are also poorly accommodated on site: for example, there are no opportunities for food production and at a minimum one would hope to find recycling receptacles in the public realm, which are not present. Finally, education about the ecological process related to the site has not been promoted, to my knowledge.

Thus, when False Creek North is assessed against my sustainability criteria based on the ecological approach several areas for improvement emerge (see Table 5.2). Some of these are matters that now occupy contemporary site-planning and design discourse and decision-making while others remain largely absent as is apparent in the ecological evaluation of the assessment frameworks themselves (see chapter 4).

Suggested improvements

This analysis reveals that False Creek North, while an interesting case study and a trendsetter, does not adequately embody characteristics of ecological sustainability and systems resilience, as demonstrated in Table 5.2. We clearly cannot turn back time to change the guiding parameters of this development. It could be argued that, for its time, its ability to "push the envelope" for neighbourhood development is noteworthy. And it does offer inspiration today. However, times have changed and much more pressing imperatives must now guide site planning and design for neighbourhoods. If we are to recognize our urgent need for neighbourhood models capable of responding to the "converging catastrophes" and other unforeseeable challenges that society will continue to face, the False Creek North model must be regarded for what it is: a good beginning. To compete with developments that can live up to their sustainability credentials today, this development would require the improvements described below. If False Creek North model is to be improved upon, it must be modified to include the following important characteristics:

1. In order to reduce ecological impact, energy and material use must be optimized through efficient use, including embodied energy in the construction phases. Throughputs of materials and energy used to construct the development and operate it must be tied to ecological carrying capacity.
2. Infrastructure should be designed to be easily maintained. Durability, reversibility, adaptability, reusability and ultimately recyclability are additional necessary characteristics of a sustainable infrastructure.
3. The architecture and urban design should reflect the unique climatic and material conditions (i.e., resource availability) of the area. Buildings should be designed using passive design techniques to reduce energy requirements for lighting and ventilation, heating and cooling.
4. Green spaces should be designed to permeate the city and connect with a regional greenway, thus allowing ecological processes and species migration through the settlement and natural areas beyond. Those ecological processes that can be restored on site should be restored wherever possible. In general, all landscape efforts should be oriented towards a soft and restorative approach to the ecology of the site.

5. The transportation hierarchy must accommodate a wide range of low impact mobility options, which allow for good connectivity both internally and to off-site locations. The use of private automobiles must actively be discouraged.
6. The site should be planned to fulfill certain critical neighbourhood functions by striving for levels of autonomy in critical life supporting functions such as food provision, water, energy and waste management. If this is not possible, these functions and resources must be planned for at another scale, preferably local, to meet the needs of the development's inhabitants.
7. Only renewable forms of energy should be used. Integrated design solutions should be used where ever possible to support one another and accomplish a number of functions at once.
8. Storage (i.e., backup) of critically important resources should be integrated into the development or provided for somewhere off site.
9. In terms of resilient infrastructure, firstly, the site should not be located in an area particularly prone to natural disasters, including sea-levels rise. Secondly, the infrastructure should be designed to withstand anticipated physical shocks common to the area, such as earthquakes in Vancouver.
10. Buildings, like the site's infrastructure should be designed to be flexible, convertible, expandable and ultimately adaptable. Neighbourhoods should be clustered as self-maintainable cells capable of fulfilling basic functions in times of resource unavailability. At the regional scale, critical resources and functions should be redundant and decentralized.
11. Residents should have the opportunity and be encouraged to get involved in site remediation, repair, and other activities in their communities to promote social resilience.

Conclusions: Why False Creek North serves as a good site for further study

The False Creek North development, along with others such as Coal Harbour, has lent to Vancouver's distinction as a trendsetter in master planning, policy, design and implementation of attractive and livable density in a downtown setting. As Marshall (2001,

p.19) states, “other cities look to it [Vancouver] as a model and seek to understand how it has been able to implement innovative high-quality, high-density housing, streetscapes and public spaces along its waterfront” and re-establish “the idea of community in an urban setting” (p.26). There is, therefore, strategic value in continuing to study it because all eyes are on it – Vancouver, and the poster child of False Creek North, are already models to other cities.

The planning process that resulted in the False Creek North development also received attention for promoting a collaborative and discretionary approach and working with the developer to extract maximum public amenity from the site. The lessons learned from planning False Creek North contributed heavily to the “cooperative planning model”, comprising a set of established and emerging leading practices that continue to inform Vancouver’s master planned developments (Beasley, 2007, pers. comm.). This planning model further insisted that amenity contributions be borne by the development. In addition, a highly discretionary regulatory framework, which emphasizes guidance and incentives over hard regulations was used to pursue a more flexible approach to the planning and design of the development (Marshall, 2001). Finally, the general public in the City of Vancouver was invited to contribute to the creation of *CityPlan*.

These characteristics further lend themselves to False Creek North and Vancouver’s ability to re-imagine what is permissible and achievable in urban form. As a class of graduate planning students note (Vancouver Group, n.d.), the evolution from an emphasis on livability to an emphasis on sustainability (that encompasses livability) is well documented in Vancouver through the progression of the False Creek sites. The question remains, however, as to whether efforts towards neighbourhood sustainability are accurately reflecting strong sustainability or are merely promoting slightly better versions of the status quo. Clearly, more substantive research on SUD is needed to address this important question, which is discussed in the following, concluding chapter.

CHAPTER 6: CONCLUSIONS

In answer to the research questions

This thesis affirms that if human societies are to sustain over the long-term, we must manage human societies and our products, including settlements, to work within the context of a living environment. We therefore need models of neighbourhood development that can respond to this imperative. Such models would reflect strong concepts of sustainability, which includes maintaining natural capital and managing human activity to fit within the Earth's productive capacity. Conventional sustainable physical planning and design concepts have made advances in acknowledging the importance of sustainability in the built environment but they generally do not acknowledge fundamental ecological concepts such as the ecology of sites, their opportunities and constraints, global ecological productive and thus carrying capacity or the dynamic nature of a living, rapidly eroding, biophysical environment. Nor are they adequately preparing us for the "converging catastrophes" such as peak oil and climate change that human (and other) communities internationally are expected to experience in the next century. It would appear that these concepts are not transferring quickly into planning practice or even planning education.[33] These omissions are revealed in the neighbourhood sustainability assessment frameworks currently available to planners. In failing to reflect such concepts, they are potentially hindering learning and hampering progress towards authentic sustainable outcomes by steering SUD in directions that, while more efficient, livable and "green", are not necessarily ultimately sustainable.

This thesis concludes that three such frameworks do not currently adequately fulfil the critical function of identifying truly exemplary neighbourhood development and that there is clearly room for cutting-edge research and innovation pertaining to concepts of strong sustainability in the assessment frameworks. This thesis proposes adoption of the ecological approach to provide guidance in neighbourhood assessment development.

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[33] In my own school, which distinguishes itself as having an explicit "sustainability" mandate, the ecological context in which we plan is given little more than a token acknowledgement. The School of Community and Regional Planning is making laudable efforts to reflect a more coherent concept of sustainability, but as with all things institutional, it will take time for this to translate into the education of planners.

As I outlined in chapter 1, this research has three purposes:

a) to propose an ecological approach to planning in which Nature is regarded as model, measure and mentor;
b) to ascertain the degree to which neighbourhood sustainability assessment frameworks reflect the three concepts of ecological impact, carrying capacity and community resilience; and
c) to explore the sustainability merits of a high-profile community within Vancouver, British Columbia – False Creek North.

Responses to each question are discussed below. I begin by answering the foremost critical question in this thesis, *How well do the neighbourhood assessment frameworks reflect the ecological approach?* The merits of FCN are then discussed. I conclude my answers to these questions by identifying the need for a normative theory to situate the range of sustainability directives emerging in literature and practice; I propose the ecological approach as this normative theory.

Question 1: The ability of neighbourhood sustainability assessment frameworks to reflect the ecological approach

In chapter 1, I hypothesized that current planning principles and criteria of sustainable urban development (SUD) and community design (as articulated in the three neighbourhood sustainability assessment frameworks) are not fully capturing the complexity of the unsustainability problem. They must therefore be recognized as limiting. The research undertaken for this thesis confirms this hypothesis.

The common fundamental weakness of all three frameworks is that they poorly reference the concept of *strong* sustainability, both in terms of ecological impact and resilience. The results demonstrate that ecological impact as a *concept* is recognized across a clustering of indicators. Ecological impact as a *constraint*, as defined by a finite carrying capacity,

however, is not. Nearly none of the indicators and their associated targets, especially in terms of resource use, acknowledge a concept of "Earth fair share" or absolute limits to resource throughput. While grossly liming, the concept of reducing ecological impact is at least present in all assessment frameworks in three aspects: (1) indicators pertaining to the physical land footprint of the development, (2) resource use (energy, water, materials and waste) and (3) indirect impact as defined in this thesis. Integrating concepts such as ecological carrying capacity and ecological footprint analysis can ameliorate these indicators. The discussion in chapter 4 concludes that a more optimistic view of what this means for the influence on mainstream development might conclude that merely referencing the concept of ecological impact offers hope for improvement within the frameworks.

The concept of community resilience, however, does not emerge from the frameworks either in their language or their metrics. Ecological systems characteristics in neighbourhood development are not explicitly promoted in any of the frameworks and are only implicitly referenced in some of the indicators. The discussion in chapter 4 reveals the assessment frameworks to be generally lacking in their ability to capture concepts of structural and functional resilience. Thus, essential emergent qualities such as the ability to respond to change through adaptation and evolve over the long term are less to emerge than if these concepts were explicitly embedded in the development.

The authors of the frameworks might remedy their weaknesses by adopting the following two strategies. Firstly, to reflect accurately biophysical limitations, resource use indicators and targets must be tied to ecological carrying capacity. Secondly, to promote developments that will not only be low-impact but will also weather change, systems and sustainability science thinking must be incorporated into the physical patterning indicators. The ecological approach offers a number of systems attributes that may be helpful in guiding research on the operationalization of these concepts.

In addition to reflecting these biophysical limitations and opportunities, assessment frameworks must also attempt to capture the individual human behaviour element. That is,

they need to measure, as Rowe and Robbins (2000) suggest, how features that "enable" less impactful behaviour are used. Rowe and Robbins (2000, p.175) argue that individuals must be empowered in the communities to which they belong "so that responsibility – and indeed accountability – are apportioned appropriately, and contributions of every kind may be recognized" (Rowe & Robbins, 2000, p.174). One of the striking weaknesses of the three frameworks examined is that they primarily address physical design and do not capture this behavioural element. While this limitation provided methodological benefits for this thesis (as the scope was to focus on *physical* neighbourhood dimensions of sustainability), it nevertheless highlights another omission in sustainability assessment frameworks more broadly. It is surprising that the behavioural component has been lacking to date. Post-occupancy evaluation, termed a "dead duck" by POE expert Wendy Sarkissian (pers. comm., 2007) may be a useful evaluation framework through which to address human interaction with the built environment.

Further, a neighbourhood or community is clearly more than the physical dimensions of which it is comprised. Much more contributes to quality and joy of life than having one's needs met sustainably or being able to withstand disturbances. Truly exemplary SUD meets the various multiplicity of aspects of the needs of the human species. Humans are, as influential humanist psychologist Abraham Maslow argued in the 1950s and 1960s, complex, interactive, interdependent, thoughtful, emotional and spiritual creatures, seeking self actualization and meeting their higher needs. To guide development towards these human aspirations, sustainability assessment frameworks must also capture the qualitative elements that make a community worth living in and maintaining.

Question 2: The sustainability characteristics of False Creek North as a model of urban form

In chapter 1, I hypothesized that FCN does not adequately reflect concepts of strong sustainability, measured either through impact or resilience characteristics. This research confirms my hypothesis.

Seen through the lens of the ecological approach, the FCN community is evaluated for its claimed sustainability merits. Not surprisingly, FCN receives a higher sustainability rating using the assessment frameworks than it does when I apply my ecological impact and ecosystem characteristics assessment measures. My analysis of the ecological evaluation concludes that, aside from optimizing land use through concentrated development and siting development in a strategically located brownfield area, FCN displays few of the ecological characteristics proposed in this thesis. Some key areas for improvement include enhancing autonomy of critical functions such as food, water, energy and waste management; adopting a life-cycle perspective in the use of materials and adaptive building design to ensure that embodied energy is retained; and promoting more ecological functions in the sites "green infrastructure" such as parks, greenways and streets.

We must not, however, overlook the fact that some planners and analysts have argued that FCN "pushed the envelope" for what was permissible and achievable, especially for its time. It may be meritorious even today. In the current practical discourse of planners, the physical fundamentals that underpin FCN *are* sustainable urban development, or at least something very close to it. It would be safe to assume that you could ask any planner to cite off the top of his head characteristics of sustainable neighbourhoods and the physical and social elements that characterize FCN would be mentioned: mixed use, central location, proximity to jobs, transit oriented, dense, high amenity, family housing, mixed tenure and income households and ethnically diverse. This is not surprising, as this is a common and pervasive discourse. These key concepts in sustainable neighbourhood practice are being espoused by advocates of some of the leading planning movements in North America, including New Urbanism and Smart Growth, as described in chapter 3. Together, these planning characteristics offer a valuable set of directives to becoming a "better", "more efficient" version of conventional neighbourhoods. But as noted in chapter 1, more efficient versions of what we have may not lead us to the strong concept of sustainability. For example, Lynch (1981 p.371) aptly points out that the term "efficiency" is meaningless "until basic values are defined". The critical distinction here is that relatively "less bad" development is not necessarily absolutely "good" or appropriate development; more efficiently unsustainable use

of the Earth is not sustainable. As Rees (2009) would argue, we are not successfully pushing the boundary on what that "good" development as an absolute measure might be.

To attempt to remedy conflation of less harmful with desirable, and to begin to develop and share a common language about sustainability, we need to identify implicit values of what we as a society want and assumptions on how to achieve that aim. This is no small task. The next section promotes the ecological approach as such a normative theory, the explicit values of which are to protect and promote the integrity of the Earth.

The proposal: the ecological approach as a normative theory

The ecological approach can serve as a philosophical basis and ultimately a normative theory, thereby underpinning and nourishing the wide range of sustainability directives currently flourishing in the literature from practice and research. A number of authors have identified the need for such philosophical grounding in sustainability planning. For example,, Kibert, Sendzimir and Guy (2000, p.915) state the following in describing the tremendous progress of the green building movements:

> "To continue their momentum and their transformation of the built environment, these efforts badly need to establish a strong philosophical basis to create a consistent approach for handling the wide variety of resource and environmental issues being addressed.... Without turning to nature for its compass, the sustainable building movements are no more than a set of disconnected efforts with nothing to tie them together."

Clearly the tools we use to determine our trajectory in this pursuit must also reflect this philosophy. Doherty and Rydberg (2002, p.3) point out that this is currently not the case:

> "Assessment indicators and criteria, however, are generally limited, lacking integration, and at times in conflict with one another. A result is that certification criteria, indicators, and assessment

> methods are not based on a consistent, underlying conceptual framework and often lack a management focus."

I propose the ecological approach as this underlying conceptual focus.

Biomimicry and the ecological approach

The ecological approach is about biomimicry or learning from Nature to help understand and manage our collective problems. It is about adopting Nature as model, measure and mentor in planning and design decisions. First and foremost, it is about reducing the ecological impact of development. It respects the constraints of a given locality, and ultimately the Earth's ecological constraints as the basis upon which human activity must operate. It encourages us to live within these limits by minimizing disturbances to the site ecologies when developing as well as minimizing resource and energy use to build and operate a neighbourhood (measure).

Secondly, the ecological approach is about modeling communities based on how ecosystems function as a means not only to reduce their impact, but also to enhance their resiliency in face of change (model). Thirdly, this approach adopts a humble attitude about our inevitable conceptual limitations, and thus our ignorance. It recognizes that we may have much to learn from the great web of life that supports and exists alongside humanity's existence (mentor).

As a normative theory, biomimicry and the ecological approach may provide the necessary alternative sustainability story to guide the goals and aspirations of the human species. Chapter 3 discussed the numerous perspectives that we can use when addressing sustainable urban development (SUD). A critical finding from this literature review that emerged is that while the diversity in various perspectives is valuable in lending richness to understanding our challenges, to be effective they must be oriented toward a common goal. Because of its holism and normative power, the ecological approach has the potential to provide the model, substantive basis and common ground upon which all other SUD perspectives can relate.

From the simple, yet powerful, axiom that something is good if it protects the integrity of the Earth and is not if it does otherwise, other concerns such as equity and justice may flow. As Leopold states (1949, p.17), "A thing is right only when it tends to preserve the integrity, stability, and beauty of the community, and the community includes the soil, waters, fauna, and flora, as well as people".

Questions emerging from this analysis

This analysis aimed to identify sustainable urban development indicators that reference ecological impact, ecosystem characteristics and ecological principles. The information that can be extrapolated from the matrix analysis is diverse, yet limited. A number of critical questions emerge as I attempt to understand how well indicator frameworks (and the developments they are meant to influence) capture the concept of sustainability as espoused in this work.

Methodological questions emerge about to how to determine how well an indicator captures ecological concepts when it has not been explicitly designed to do so. As described above in chapter 2, the analytical approach reflected the author's judgement following months of immersion in the literature of ecological principles and sustainability indicators. To avoid bias, qualified responses are indicated in the matrix to justify the response. Nevertheless like all research undertaken within an interpretive research paradigm this approach is clearly subjective. Empirical study of these ecosystem characteristics and how they can be applied to human settlements is necessary to complement and extend this work.

A number of theoretical questions also emerge about how to redesign settlements to behave like Nature. They parallel the questions asked by Kibert, Sendzimir and Guy (2000, p.914) about redesigning industry to behave like Nature:

- "Do natural systems in fact use resources optimally or can technology actually improve on the energy and matter utilization of nature, perhaps through observing nature itself?

- Are there limits to using the natural system metaphor for industrial systems and, if there are, what are they?
- Can mankind really live off current solar income as has been suggested or is this impossible if quality of life for present and future populations is to be maintained?
- What is the human-carrying capacity of the Earth if adequate natural systems functions are to be maintained?
- Can natural systems perform many critical functions required by humankind and in effect substitute for the work of industry in some cases?"

I agree that these questions are as relevant to the ecological approach of settlement planning as they are to industrial practices. My research also suggests a wider application of the ecological approach beyond settlements to all design efforts, including those of industrial ecology, thus affirming its power as a normative theory.

Substantive and logistical questions also emerge about the appropriateness of rigidly applying the ecological approach to neighbourhood developments. For example, there are clearly sustainability tradeoffs in some of the characteristics that may work for ecosystems, but may not work for human communities, especially at fine-grained scales. For example, Barton and Kleiner (2000, p.115) note that,

> "It is not normally appropriate or possible to create cosy self-sufficient neighbourhoods or villages.... The significant scale for dispersed concentration, i.e. areas with the capacity to achieve a fair degree of autonomy when the friction between distance is high, is not the pedestrian-scaled neighbourhood but the town or urban township."

Thus, while this analysis may suggest that a diversified and decentralized approach to energy production or waste management may emulate ecological principles and promote ecosystems resilience, I am unable to suggest the scale at which such interventions are appropriate for

human communities through this research. Here are some additional questions that arose from this research:

- *Is it possible to build high density development alongside or atop sensitive habitat areas and avoid the typical perilous, impacts of development?*[34]
- *Is it ecologically feasible and desirable for each neighbourhood to have its own source of renewable energy and treatment of waste*? The form of renewable energy and its infrastructure will depend on the community's context; different forms will clearly require different infrastructure, all of which will be more appropriate and efficient and different scales.
- *What forms of waste can reasonably be treated at the neighbourhood scale*? The spatial requirements and resources required for such interventions will clearly determine their impact. It may be determined that spatial and infrastructure efficiency gains are realized in some degree of centralization, not decentralization. Small might not always necessarily be better (Jeffrey et al., 1997).
- *Is it possible to design public open spaces that can serve both diverse recreational and leisure as well as ecological functions*? Public open spaces, particularly in inner city high-density neighbourhoods such as FCN, already experience competing human interests. Rigorous study of the tradeoffs between these objectives and optimum scales of intervention are therefore required to further the ecological approach and understand how it might be applied more broadly. More detailed analysis, investigation of these principles and how to implement them offers a way forward on SUD.

Towards operationalizing the ecological approach

In addition to substantive and empirical research, a number of other strategic efforts are required to operationalize and "ground" the ecological approach in reality: experimentation, evaluation and strategic investment.

[34] This question taken from take directly from Girling, 2008, p.67.

The need for experimentation and evaluation

A starting premise of this thesis is that the neighbourhood models promoted to address urban sustainability challenges are not adequate. We need new models – genuinely new models, not simply more efficient versions of the *status quo*. This innovation will occur only through experimentation. Experimentation in and of itself may be considered an ecological characteristic similar to the continuous mutations or "models" that organisms are constantly generating. A diversity of models allows the act of selection pressure to determine the most appropriate model or "best fit". Human settlements could benefit from this process of generating a number of ideas from which to select, rather than blindly clinging only to what we know.

Experimentation with new ideas will help to remove barriers to more widespread application of such concepts. Further, Australian sustainability specialist Peter Newman (1998) demonstrates that symbolic gestures offered through experimentation can influence practice over the long term. Kellert, Heerwagen and Mador (2008) offer the example of Universal Design, now widely applied as a design approach that did not used to be conventional.[35] They ask if this could happen for ecological design. Neighbourhoods may be the scale that is most appropriate to design interventions, experimentation and evaluation. Thus, neighbourhoods may serve as "living laboratories" in which to test some of the applications advocated for in this work. A number of authors cite the need for experimentation and the establishment of "living laboratories" in the urban field (Felson & Pickett, 2005; Frey 1999).

In addition, fostering *learning* about this approach will require evidence-based evaluation, the lessons from which can be used to inform subsequent practice. As McDonald (2008, p.103) notes, "Sustainability is currently a policy goal and a platitude – it needs to be transformed into an evidence-based and empirically grounded science, with close links to ecology and the study of ecosystem services". Without this "the complex issues of a

[35] Universal Design is design that is accessible and appropriate to all users regardless of physical impairment or age.

sustainable city region will not become more tangible and we will continue to rely on assumptions" (Frey, 1999, p.69). Evaluation in and of itself may also be considered as an ecological characteristic similar to feedback responses exhibited in Nature. This process can help us determine how appropriate a mutation or strategy is in a changing context. Evaluation, like feedback mechanisms, helps to promote adaptive management and ultimately evolution of the system. Koh (1982) also points out that evaluation is an essential ingredient in the creative process.

The need for strategic application

Finally, we need to identify strategic applications of the approach so that it can be implemented at a wide and effective scale. Currently, we see an eco-city movement informed to some degree by ecological imperatives in developing countries such as China and the United Arab Emirates. The low carbon Masdar development in the emirate of Abu Dhabi is one such opportunity to practice these ideas (Masdar Sustainability Case Study, n.d.). While questions remain about the appropriateness of establishing large sedentary communities in areas of low ecological productivity and water availability, the Masdar development offers a much needed platform for experimentation with innovative SUD ideas.

In contrast to such well-funded efforts such as Masdar, developing countries with relatively low investment capacity may offer another settlement context for experimentation with low-impact, simple and human-scaled technologies and strategies to reduce ecological impact and enhance community resilience. In fact, a relative paucity of rigid and expensive physical infrastructure in these contexts offers opportunities for more strategic application of the ecological approach than in developed contexts. Implementation of the ecological approach in the developed world will require reconciliation with an urban pattern and matrix of infrastructure that are not designed for autonomy, redundancy, diversity, integration and adaptation. Developing contexts, on the other hand, can leapfrog over the infrastructure mistakes of the developed world and design in planning concepts such as precaution and additional systems characteristics such as durability, reversibility, stability, reusability,

recyclability of infrastructure and built form investment. The massive migration of traditionally rural populations to urban centres across the globe further provides the impetus for this application.

Concluding words

This thesis has reaffirmed the view that the transition to a sustainable built environment cannot occur without the transition to a truly sustainable society. Although the sustainability of any endeavour will ultimately be judged upon its ability to reflect ecological context, the initiation of an endeavour will depend on how socially and economically palatable and viable the option is in the first place. In many ways, if sustainability were simply an ecological issue, it would be much easier than it is. As a result, widespread societal change is needed. Writing about ecological neighbourhoods, Barton (2000, p.63) notes the critical ingredients that are required for successful regeneration of neighbourhoods, of which if one is missing the whole will fail: "an interested and knowledgeable citizenry, ecosystem technology, public will, political leadership, and appropriate financial support". This thesis cannot address all these issues; it does however address an *approach* to planning for uncertain times – an ecological approach.

EPILOGUE

I chose to conduct my thesis on an ecological approach to planning because I wanted to study it throughout my years in graduate school and never had the opportunity. I was amazed to find that these ideas are not commonly discussed in the general planning discourse, not even in planning schools. Coming from an ecology background, I am admittedly biased in favour of the ecological perspective. However, I was honestly shocked and disappointed to discover how little really serious attention is paid to the strong concepts of sustainability. There is certainly a healthy and lively debate on the subject in some niches of planning, but this occurs mainly with academics and possibly a few extremely progressive planners in Europe. I have been told that these ideas are not "practical" enough to make them legitimate alternatives to conventional development. Given the magnitude of the threats we now face, I find planning's lack of interest in experimentation with current and established sustainability and systems science to be an ignorant response to an urgent problem. To paraphrase Albert Einstein, "the same level of thinking that has gotten us in the mess will not help us get out of it". I am convinced that we need a new type of thinking; we need a new paradigm.

I know now how fine a balance a planner must walk between listening and responding to the needs of the community and providing substantive expertise in sound land management. The task of sustainable urban development and sustainable land uses of all kinds does not rest solely on the shoulders of planners; sustainability is a goal that will require the efforts of us all. A new paradigm can only be collectively forged.

I'm going to stop talking about indicators and frameworks and even neighbourhoods and planning for a moment because this thesis fits within a much larger and more all-encompassing message; one that is very dear to me.

At the root of the sustainability conundrum, as Bill Rees refers to it, is the need for honest dialogue among community members, planners and politicians about the future we want and the actions needed to get there. Environmental philosopher and educator David Orr has

argued convincingly that because the ecological crisis is about what it means to be human, we need a distinctively human approach characterized by intelligence, critical thinking, creativity, enlightened rationality, learning, sharing and an ethic of care to all things living and sacred. Alone, our individual contributions to a sustainable future may seem inadequate and meaningless, *so why bother?* The wonderfully elegant solution and paradox to a paradigm shift, however, is that it requires the participation of everyone. This is particularly the case with the sustainability paradigm. To realize it, it requires the intelligence, critical thinking, creativity, enlightened rationality, lessons, and care of everyone. An individual's contribution may be meaningless on its own, but this shift towards sustainability ultimately cannot occur without it.

I am a dreamer and an optimist; I envision that such dialogue could help to piece together that new paradigm of the deeply sustainable, one story at a time. I cannot know where the dialogue will lead, or what directions we collectively might propose to address our solutions, but I am convinced that when people get talking and taking these things seriously, I mean really seriously, when they realize that that they have a role to play, that it is important, and when they are equipped with the confidence and skills to play that part, they will rise to the occasion.

Is this naive? Perhaps. But as a planner I have come to appreciate the value in the act of visioning and the power of a vision to uncover and create cohesiveness in a community. As philosopher and educational reformist John Dewey (1938, p.304) says of visions:

> "A vision is not a scene but it can enable us to construct scenes which would not exist without it.... To ignore or depreciate the ideal because it cannot be literally translated into existence is to acquiesce not only to things 'as they are' – as is some thing said – but also to things 'as they are not' because all things that are have potential."

To this I would add the importance of *striving* for our visions. Author of *The Land Ethic* (1949, p.209), Aldo Leopold, sagely observes: "We shall never achieve harmony with the land, any more than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve, but to strive". We may not be able to control what we will achieve, but we can control what we strive for. I hope that human communities around the world will come together to strive for this common sustainable future.

I strongly believe that built form has a strategic role to play in this pursuit. I agree with other thinkers before me who have stated that our built form is a reflection of our values and reciprocally, informs our values. The theory of "Environmental Generational Amnesia" states that a child who is raised in a Nature deprived setting will not value Nature.[36] Further, their baseline reference for a "clean" environment will be that what they were brought into; a child raised in a slum will not see their home as a slum. Over generations, such children experience and perpetuate the collective amnesia of a once pristine environment, thereby further diminishing the chances that it will be cherished and protected.

This theory makes me wonder:

What values does our built environment reflect of us?

What values does it promote?

Can the built environment be designed to reflect the living context in which all human activity operates?

Can the built environment be designed to encourage the valuation of Nature and this life context?

[36] Put forth by Kahn and Kellert (2002). See also Louv (2005) for his theory of "nature deficit disorder".

Viewed in this light, the ecological approach can be much more than a solution to the challenge of creating habitable form that fits within the confines of the Earth; it can be design manifesto that reclaims humanity's ecological heritage and promotes nurturing, educative and inspirational forms. In nurturing these qualities, the ecological approach is a strategic tool to both turn the trajectory of our development and help us anticipate and respond to inevitably uncertain futures.

Reflections on my journey

During the year of this journey on my thesis topic, I discovered that I spent much less time thinking specifically about False Creek North than I had originally planned. As a result, the thesis remains largely theoretical and visionary. It could be said that it lacks "grounding" and immediately implementable solutions. I would disagree, as I have discovered a greater confidence that the ecological approach is legitimate, appropriate and possible. Its goal is to literately ground *us* in our ecological realities. This research has provided a valuable lens through which to view False Creek North and other neighbourhood developments that might seek to be regarded as "sustainable".

I found myself walking around False Creek North the other day, just as I was completing this thesis. It was a beautiful warm late summer day. The trees are filling out nicely, although some appear to be beginning to change colour, there were small flocks of chirpy birds flitting in and out of them. Children, parents and plenty of dogs were out using the parks and the seawall was, as usual on a fine day, an endless conveyor belt of people enjoying the sights and sounds. But as I looked around with my ecological lens I realized I was no closer to understanding the ideal sustainable neighbourhood. I was no closer to envisioning some future version of False Creek North fifty, one hundred or one thousand years hence. Things seem so good right now, the place so pleasant and people clearly enjoy it. But what about the future? Will this place be inundated by sea levels rising? How will people get their food when fuel costs prohibit importing food from half way around the world?

This lack of an answer frustrated me. The purpose of conducting research is to uncover something, some form of an answer, to know something I did not know before. *What could I share with the world about what I had learned from False Creek North and how suitable it is as a model of sustainable urban development?*

I took a deep breath and tried clear my mind; I realized I had learned at least one valuable lesson that is not so much about the physical development of False Creek North, but rather the confidence through which it emerged. As I've mentioned earlier, False Creek North embodies some of the best practices in physical planning theory today; its successes do deserve recognition. But I am concerned that in the search for answers, we may too quickly latch on to ideas without taking the time to uncover the assumptions, beliefs and values behind those ideas. Because the only quality we may know about the future with any certainty is that it is uncertain, we need a precautionary, anticipatory, flexible and adaptive approach for all settlement planning efforts. Continued evaluation, critical discourse and vigilance are required to uncover the suitability of our development decisions over time.

I sat in George Wainborn Park and listened to the din of a lively neighbourhood. I let my eyes focus, blur and re-focus on the dappled light that played across False Creek and reflected on the values I interpreted from the site. The area is pleasant, well used by people, the air smells clean and there are natural elements dotted in the landscape. I like to spend time here. But it feels like only a partial answer to a much bigger question. I do not feel a conscious orientation towards sustainable living, I do not feel that Nature and ecological processes have been "invited in", I find it hard to reconnect to the living Earth in this artificial place. While I do feel inspired at the great feats humans can accomplish in looking at False Creek North, I do not sense nurturing or educative qualities in its landscape. I looked across the water, to the newly partially developed community of South East False Creek, the site of the 2010 Winter Olympics, and I do not sense those qualities there either, despite laudable efforts to make it a model sustainable neighbourhood.

While we may not know all the answers to the best form, I believe the ecological approach offers promise. At the very least, while better models are being developed, we can include Nature in our settlements so that we might learn from her, tap into the creative potential and nurture our human qualities.

Taking off my glasses, I look around at a grand experiment. I value its contribution. And I look forward to making my own contribution to planning by keeping the ecological perspective firmly in my mind – and my heart – as I venture out into the planning field. I believe will still have a way to go.

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APPENDICES

Appendix A : List of neighbourhood scale sustainability assessment tools that were reviewed, but not chosen for the analysis.

1.Residential Landscape Sustainability: A checklist tool [37]

The aim of the book is to provide a resource and rating tool that will assist those involved in residential housing design create more sustainable residential environments. The emphasis is on landscape sustainability as they identified this as a major omission in the existing sustainability evaluative frameworks they reviewed. The setting of criteria and allocation of credits is informed by extensive literature review of existing best practice in landscape architecture and a pilot testing on developments that have been promoted as 'sustainable' by some recognized measure.

This framework was not used in this research as the focus was too detailed and site-specific the purpose of this work. Further, because many of the criteria and targets pertained to specific plant species, the framework could not easily be transferred from the English biogeographic context to Vancouver's.

2. Formal Indicators of Social Urban Sustainability[38]

This framework was constructed in order to "measure the formal components of a neighbourhood and street that theorists have stated important promoting sustainability." Urban fabric indicators such as accessibility, land use diversity, public/private realm, natural surveillance, permeability, employment density, number of buildings, sedibility and number of lots were used.

While this framework measures explicitly spatial elements of the urban environment, it was not used because it did not capture the more ecological focus of this research.

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[37] Smith, C., Clayden, A. & Dunnett, N. (2008). *Residential landscape sustainability: a checklist tool*. Oxford: Blackwell Publishing.

[38] Porta, S. & Renne, J.L. (2005). Linking urban design to sustainability: formal indicators of social urban sustainability field research in Perth, Western Australia. *Urban Design International*, 10, 51-64

3. Sustainability Indicators for Computer-based Tools in Community Design[39]

This draft framework focused on the following spatial attribute indices: diversity, intensity, connectivity, distribution and proximity for nine performance areas including land, transport, etc. 34 indicators using 50 different metrics are proposed for a range of planning scales: neighbourhood, district and region.

Although a very strong contender due to its explicit spatial orientation and local innovation, this framework was not used in this research as it was still under development, had not yet achieved professional recognition and did not provide any form of target.

4. Sustainable Community Rating tool

This tool is from New Zealand and provides criteria in the following categories: environmental leadership, urban design, community well-being, housing affordability and commercial success

This framework was not used in this research because the majority of the data requirements were too detailed for the purposes of this work, the application was not explicitly spatial with many other sustainability tenets such as affordability and commercial success being evaluated.

5. Complex Proportional Assessment (COPRAS)[40]

The COPRAS method allows one to establish the rank of priorities of residential areas in respect of their sustainability. Residential areas are largely evaluated for their facilities, residential and business environment, quality of life and infrastructure.

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[39] Kellett, R. (2008). *Sustainability indicators for computer-based tools in community design* [Class handout]. Vancouver, BC: Design Centre for Sustainability, School of Architecture + Landscape Architecture, University of British Columbia.

[40] Zavadskas, E, Viteikienė, M. & Šaparauskas, J. (2007). Sustainable development assessment of cities and their residential districts. *Ekologija*, 53, 49-54.

This framework was not used in this research because it did not capture the more ecological focus of this research.

6. ***Sustainable neighbourhood evaluation framework: Kim, 2005***[41]

In his PhD dissertation, Kim puts forth a sustainability evaluation framework to further and assist sustainable neighbourhood design and to propose transferable lessons for future neighbourhoods. Four international projects, one of them being South East False Creek, Vancouver, that promote sustainable neighbourhood design are used to develop and test the framework (Kim, 2002). Although not used in the current analysis, the framework adopts "performance indicators" for assessing levels of progress towards sustainability so that interpretation of performance can be easily understood.[42]

This framework was not used in this research because the criteria were too detailed and onerous for the purpose of this work.

[41] Kim, K. (2005). Towards sustainable neighbourhood design: a sustainability evaluation framework and a case study of the Greenwich Millennium Village project. *Journal of Architectural and Planning Research,* 22(3), 181-203.

[42] The percentage indicator is not relevant to this study as no sustainability-related targets were set for the FCN development.

Appendix B : List of indicators in each indicator category

All of the indicators from each of the assessment frameworks are listed in this appendix. Metrics and targets for each of the indicators are not listed. To access metrics and targets, visit the respective assessment frameworks. The nine indicator categories that emerged from the analysis of the assessment frameworks are used to organize the indicators. Within each category are a number of sub-categories to which the indicators are assigned. Due to inconsistency in the wording across the three assessment frameworks, most indicators have been shortened and paraphrased for consistency here. Each assessment framework that uses the indicator is identified in parentheses. The following acronyms are used:

- LEED ND: LEED for Neighbourhood Development;
- SDMBC: Sustainable Urban Landscapes Site Design Manual for B.C. Communities;
- SSI: Sustainable Sites Initiative: Guidelines and Performance Benchmarks

Indicator category 1: Design process, consistency with existing policy and setting of goals

a. Integrated process informed by public participation
   - Community outreach/ public participation occurred (LEED ND, SSI, SDMBC)
   - Integrated design process occurred (SSI)
   - Accredited professionals were on the job (LEED ND)

b. Performance goals
   - Site performance goals were established (SSI)
   - Innovation and exemplary performance was achieved (LEED ND)

c. Macro-context siting considerations
   - Supports and links to regional ecological network (SDMBC)
   - Reflects OCP principles (SDMBC)
   - Reflects goals of liquid waste management, pollution and watershed plans (SDMBC)
   - Reflects purpose and goals of Regional Growth Strategy (SDMBC)
   - Is situated in regionally preferred locations (LEED ND)

Indicator category 2: Specific siting considerations

a. Site assessments of site constraints and sensitivities including natural hazards
   - Pre-design site assessment occurred (SSI)
   - Threatened or endangered species habitat are protected (SSI, LEED ND)
   - Site is located outside areas identified as environmentally sensitive and/or hazardous (SDMBC)
   - Wild fire risk is mitigated (SSI)
   - Steep slopes are protected (LEED ND)
   - Floodplains are protected (SSI)
   - Reflects understanding of watersheds (SDMBC)

b. Reuse of existing sites and infrastructure
   - Connects site to existing features (SSI)
   - Reuses existing infrastructure (SDMBC)
   - Is brownfield redevelopment (LEED ND)
   - A degree of infill intensity is achieved (SSI)

c. Land and transport coordinated though planning
   - Land use is coordinated with transportation planning (SDMBC)

Indicator category 3: Protecting ecology of site through mitigating development impact and enhancing natural features and processes of the site

a. Anthropogenic works to site protect and promote natural features
   - Minimizes site disturbance as measured by protection of existing ecology of site (LEED ND)
   - Natural features are promoted (SDMBC)
   - Stream crossing impacts are minimized (SDMBC)
   - Existing topography is preserved (SSI)
   - Earth works and site engineering are minimized (SDMBC)
   - Construction activity pollution is prevented (LEED ND, SSI)
   - Windows are oriented to views (SSI and SDMBC)
   - Streets are used to frame important views (SDMBC)

b. On site stormwater management (infiltration, etc.)
   - Stormwater management is included (LEED ND, SDMBC)
   - Water is infiltrated and stored on site including in streets (SSI, SDMBC)
   - Floor plates are minimized to allow for infiltration (SDMBC)

c. Restoration of site productivity and ecological functions including habitat
   - Preserves or restore site biomass (SSI)
   - Protects and restores riparian and wetland areas including buffers (SSI and SDMBC)
   - Protects healthy soils (SSI)

- Restores soils (during and after construction) (SSI)
- Preserves and restores native wildlife habitat (LEED ND and SSI)
- Enhances habitat in streets and corridors (SDMBC)
- Fish survival is promoted (SDMBC)
- Pre-development hydrology is achieved (SDMBC)

Indicator category 4: Site design: pattern, massing, form and connectivity

a. Compact development
   - Development is compact (LEED ND)
   - Compact development is concentrated around transportation and commercial uses (SDMBC)
   - Commercial uses are centred on a "main" street (SDMBC)

b. Block size
   - Blocks are short (SDMBC)
   - Mid-block connections occur on large blocks (SDMBC)
   - A range of lot sizes are present (SDMBC)
   - Blocks are flexible (SDMBC)
   - Blocks protect important environmental features (SDMBC)

c. Diversity of uses and services, including for different income ranges (I.e. "complete communities")
   - Mixed income diverse communities are accommodated (LEED ND)
   - Multiple housing types are present (SDMBC)
   - Land uses are diverse and mixed (LEED ND, SDMBC)
   - All residents in the development are located within a 400m (5 minute) walk of neighbourhood stores, parks and transit (SDMBC)

d. Enabling (non-auto) on site movement
   - Bike network and storage is accommodated (LEED ND)
   - Streets are walkable defined by a wide range of factors such as shade, sidewalk width, block length, facades, etc. (LEED ND)
   - Parking is located such that it does not detract from the pedestrian environment (SDMBC)
   - Streets are safe and comfortable (SDMBC)
   - Sidewalks are present on both sides (SDMBC)
   - Interruptions to sidewalks are minimized (SDMBC)
   - Setbacks are used to frame streets (SDMBC)
   - Buildings are used to create a sense of enclosure (SDMBC)
   - Design encourages a "friendly face" to the streets (SDMBC)
   - Garages are located around back (SDMBC)
   - Street network is well connected (LEED ND and SDMBC)

e. Enabling (non-auto) off site movement
   - The community is connected and open community (LEED ND)
   - Green and bikeways are integrated into the transportation system (SDMBC)
   - Transit is provided (SDMBC)

f. Discouraging automobile use
   - Parking requirements are reduced (LEED ND)
   - On-site parking is minimized while on-street parking is maximized (SDMBC)
   - Transit facilities are provided (LEED ND)
   - Residential and commercial density supports transit (SDMBC)

g. Vernacular design (e.g. design passively)
   - Buildings are oriented to maximize solar gain and ventilation (LEED ND)
   - Vegetation is used to cool buildings and sites (SSI)

Indicator category 5: Promoting less energy and resource intensive development

a. Energy use
   - Buildings are energy efficient (LEED ND)
   - Infrastructure is energy efficient (LEED ND)
   - Renewable forms of energy are used (LEED ND and SSI)
   - Energy use is minimized (SDMBC)
   - Carbon neutral site is achieved (SSI)

b. Water use
   - Buildings are water efficient (LEED ND)
   - Landscaping is water efficient (LEED ND, SSI)
   - No potable water is used in water features or in irrigation (SSI)

c. Use of materials
   - Material use is minimized (SDMBC)
   - Recycled/salvaged materials are used in infrastructure (LEED ND and SSI)
   - Low VOC emission paints, etc. are used (SSI)
   - Products designed for reuse and recycling are used (SSI)
   - Sustainable practices in material production are supported (SSI)
   - No endangered tree species are used for construction (SSI)
   - Certified wood is used (SSI)
   - Life cycle assessments of materials used are conducted (SSI)

d. Waste diversion
   - Provides storage and collection and recyclables (SSI)
   - Provides waste management infrastructure (LEED ND)

- Diverts construction materials from disposal (SSI)

e. Quality of air
   - Exposure to local air pollutants is minimized (SSI)

f. Reuse of existing buildings, materials, etc.
   - Buildings are reused (LEED ND)
   - Existing structures are reused (including landscaping structures and excess landscaping materials) (SSI)

Indicator category 6: Promoting long-term use and self-sufficiency of basic requirements

a. Energy
   - District heating/cooling system are used (LEED ND and SDMBC)

b. Food
   - Food production is accommodated (LEED ND)
   - Food production is maximized (SDMBC)

c. Water
   - Wastewater is reused on site (LEED ND)
   - Wastewater is cleaned and reused on site (SSI and SDMBC)

d. Waste management
   - No indicators

e. Adaptable and flexible built form
   - No indicators

f. Adaptable and flexible public spaces
   - Ecological and recreational functions are layered on site (SDMBC)
   - Spaces are shared between uses (SDMBC)

Indicator category 7: Promoting livability through enjoyable environment

a. Enjoyable experience of public place
   - Site accessibility, safety and wayfinding are optimized (SSI)
   - Outdoor physical activity is promoted (SSI)
   - Streets are tree-lined (LEED ND)
   - Special trees are preserved (SSI)
   - Local identity and culture are enhanced (SDMBC)

- Buildings with unique and historical attributes are preserved (LEED ND and SSI)
- Organic unity and identity of development is promoted (SDMBC)
- Outdoor areas for mental restoration are provided (SSI)
- Water features that allow for human contact are provided (SSI)
- Urban heat island effect is reduced/mitigated (LEED ND, SSI)

b. Ability to interact with and contribute to community
- Public gathering and stewardship opportunities are available (SDMBC)
- Outdoor spaces for social interaction are provided (SSI and SDMBC)

Indicator category 8: Promoting sustainable behaviour of residents and visitors

a. Education of residents and visitors
- Vegetation is used to provide a sense of local ecology and place (SSI)
- Stormwater features are designed as a landscape amenity (SSI)
- Sustainability awareness and education is promoted(SSI)
- Public areas are designed to maximize environmental learning (SDMBC)

b. Influencing behaviour (e.g. Travel Demand Management)
- Travel Demand Management is implemented (LEED ND)

Indicator category 9: Maintenance to the site

a. Long-term plans
- A soils management plan is created (SSI)
- Conservation management plans for on-site habitat are created (for new or existing habitat) (LEED ND)
- Sustainable landscape maintenance plans are created (SSI)

b. Sustainable, low-impact maintenance
- Oganic matter generated during landscape operations and maintenance is recycled (SSI)
- Invasive species are managed (SSI)
- Non-invasive plants are used in landscaping (SSI)
- Sustainable practices in plant production are supported (SSI)

Appendix C : Evaluation of the assessment frameworks using the ecologically based criteria of impact and resilience measures

The information presented below is extracted from the matrix analysis that was conducted in an Microsoft Excel file. Table C.1 and C.2 demonstrate the matrix set up that I described in chapter 2, methodology. I have broken the analysis data into two pieces based on the impact and resilience dimensions discussed throughout this thesis. Table C.1 captures the impact part of the matrix; Table C.2 captures the resilience part of the matrix.

Table C.1: Example of how the impact dimension of sustainability is presented in the ecologically based evaluation framework.

Impact (across)/ Indicator categories (down)	**Direct**	**Indirect**
Design process, consistency with existing policy and setting of goals		
Specific siting process and constraints	X	
Site design: patterning, massing, form and connectivity	X	X
etc.		

Table C.2: Example of how the resilience dimension of sustainability is presented in the ecologically based evaluation framework.

Ecosystem characteristic (across)/ Indicator (down)	Decentralized	Cyclical	Redundant	Renewable	Responsive	etc.
Design process, consistency with existing policy and setting of goals					X response:	
Specific siting process and constraints	X response:					
Site design: patterning, massing, form and connectivity			X response:			

In this appendix the above information cannot be presented effectively in such tabular format therefore I have chosen to present the data in list form. The indicator categories derived in chapter 4, results, provide the structure of the information. Within each of the nine indicator categories are a number of subcategories. For each of these I have assigned a response or rationale statement for why a given indicatory category captures concepts of impact and/or resilience. In addition to capturing the concept of indirect and/or direct impact (if at all), an indicator may demonstrate any of the following ecosystem characteristics shown in Table C.3.

Table C.3: Key characteristics within each ecosystem quality.

Ecosystem quality	**Key characteristics of that quality**
Structure	- organized as nested hierarchies of self-organizing systems - diverse - redundant and connected components - decentralized according to resource availability
Function	- process-oriented - renewable - cyclical - optimized - diverse - redundant - connected and decentralized - open yet largely autonomous
Temporality	- dynamic and constantly changing - responsive - oscillatory
Emergence	- resilient - cooperative - contextual - evolutionary

See chapter 2 for a discussion on the rationale and the methodology used to derive the ecosystem characteristics and principles of systems resilience categories and assign results. See Appendix B for a full list of the indicators associated within each indicator category.

Matrix results

Category A. Design process, consistency with existing policy and setting of goals

a. ***Integrated process informed by public participation***. This indicator subcategory captures the following ecosystem characteristics:
   - **Structure** – *process oriented* by encouraging collective deliberation over policy responses and design decisions.
   - **Function** – *diverse* by ensuring that a diversity of perspectives and considerations are taken into account in formulating an appropriate policy response.
   - **Temporality** – *responsive* by giving the opportunity for a diversity of perspectives be taken into account in responding to challenges and decision making.
   - **Emergent property** – *cooperative* by providing for cooperative and collective decision making which may capitalize on the diverse knowledge base of a region's constituents.
   - **Emergent property** – *contextual* by allowing for the representation of local views, knowledge and concerns in the formulation of policy and design strategies.

b. ***Setting of performance goals.*** This indicator subcategory captures the following ecosystem characteristics:
   - **Temporality** – *responsive* by setting goals that respond to the challenges of the day.
   - **Emergent property** – *evolutionary* by encouraging evaluation of site performance and modifying policy responses based on this learning. Note - this will only be achieved if the achievement of performance goals are actually evaluated and results are fed back into planning processes.

c. ***Includes macro-context siting*** such as being consistent with regional level plans. This indicator subcategory captures the following ecosystem characteristics:

- **Direct impact** assuming that regional level plans promote wise and strategic use of existing sites to create an overall settlement pattern that is integrated, cohesive and minimizes use of greenfield sites. In the case of Vancouver's regional plan, the LRSP, this is the case and therefore the indicator is appropriate at capturing the concept of a development's direct impact.
- **Structure** – *decentralized* by being consistent with a regional plan (LRSP) which promotes decentralized yet connected nodes of development across the region (note - this characteristic will only be achieved if that is the policy direction stated in the regional plan).

Category B. Specific siting considerations

a. ***Site assessments of site constraints and sensitivities including natural hazards***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by avoiding areas of sensitive local ecology and attempting to avoid costly and resource intensive mitigation and repairs due to natural disasters.
   - **Emergent property** – *resilience* by ensuring that neighbourhoods will not be subject to natural disasters.
   - **Emergent property** – *contextual* by responding to the unique challenges and opportunities of the site.

b. ***Reuse of existing sites and infrastructure***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** because brownfield development is less impactful to ecology than greenfield development. Reuse of municipal infrastructure retains use of embodied energy of the infrastructure and is generally more cost effective.
   - **Function** – *optimized* by retaining some embodied energy in the original infrastructure.
   - **Temporality**- *responsive* by responding to demographic and economic shifts and making current uses of the site compatible with these trends - not sure how well the current site will respond to changing needs in the future however.

- **Emergent property** – *contextual* by responding to the existing unique characteristics of the region and site.
- **Emergent property** – *evolutionary* by allowing a site to achieve its "best use" over time as determined by the goals of the community (including natural community).

c. ***Land and transport coordinated though planning***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by encouraging alternative transportation choices to the private automobile.
   - **Structure** – *connected* by promoting connectivity over an area.
   - **Structure** – *diverse* by promoting a diversity of movement modes and pathways.

Category C. Protecting ecology of site through mitigating development impact and enhancing natural features and processes of the site

a. ***Anthropogenic works to site protect and promote natural features.*** This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by minimizing disturbance to existing ecology of site and energy required to modify landscapes.

b. ***On site stormwater management*** (infiltration, etc.). This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by allowing precipitation events to be intercepted and mitigated on site with minimal ecological impact such as erosion of soils.
   - **Structure** – *decentralized* by providing the natural and artificial infrastructure to intercept and mitigate precipitation events throughout the region rather than channelling all excess rainfall into stormdrains to be treated centrally.

c. ***Restoration of site productivity and ecological functions including habitat***. This indicator subcategory captures the following ecosystem characteristics:

- **Function** – *renewable* by promoting renewability of ecological functions, habitat and species.
- **Emergent property** – *resilience* by promoting ecological resilience of the site.
- **Emergent property** – *evolutionary* by promoting natural processes and life histories of organisms to continue to evolve.

Category D. Site design: pattern, massing, form and connectivity

a. ***Compact development***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by promoting protection of natural areas by reducing the development, associated transportation infrastructure footprint and heating/cooling requirements due to thermal gains from shared walls.
   - **Function** – *optimized* by maximizing use of land and in many cases materials and energy for thermal comfort.

b. ***Block size***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting connectivity, and therefore accessibility, through permeable block patterning.
   - **Structure** – *connected* by promoting connectivity within the neighbourhood.
   - **Structure** – *diverse* by promoting a diversity of block structures to meet different building typology and functional needs.
   - **Temporality** – *dynamic* by providing a diversity of block sizes which have a better change of adapting to changing land use patterns than a single form.

a. ***Diversity of uses and services, including for different income ranges*** (I.e. "complete communities"). This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting accessibility by proximity - I.e. reduced trip length and alternative modes of travel to trip destination to the private automobile.

- **Structure** – *diversity* by promoting a diversity of needs that can be met within a close proximity.
- **Structure** – *decentralized* by providing a diversity of uses mixed throughout a region rather than rigidly zoning uses to one or a few specific locations in a region.
- **Structure** – *redundant* by providing for alternative modes and venues for providing goods throughout a region. Therefore if one becomes unviable or has to close down, there are others to take its place.
- **Emergent property** – *resilience* by providing alternative modes and venues to provide goods and services throughout the region.

b. ***Enabling (non-auto) on site movement***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting alternative transportation modes to the private automobile on site.
   - **Structure** – *diverse* by promoting a diversity of mobility options.
   - **Structure** – *connected* by promoting connectivity within the neighbourhood.

c. ***Enabling (non-auto) off site movement***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting alternative transportation modes to the private automobile to off site destinations.
   - **Structure** – *diverse* by promoting a diversity of mobility options.
   - **Structure** – *connected* by promoting connectivity to greater region.

d. ***Discouraging automobile use***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by diverting fewer land and resources to automobile infrastructure such as parking facilities and roads.
   - **Indirect impact** by discouraging use of private automobile.
   - **Structure** – *diverse* by promoting a diversity of mobility options.

e. ***Vernacular design*** (e.g. design passively). This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** because passive design minimizes or eliminates the need to use artificial light and/or temperature control. Vernacular design generally encourages use of locally available materials. While FCN is recognized as having its own aesthetic, it is not appropriate to the climate and does not use locally appropriate materials.
   - **Structure** – *diverse* by promoting a diversity of architectural responses to meet local climatic and topographical conditions.
   - **Temporality** – *responsive* by responding to the specific climatic and topographical conditions of the site.
   - **Emergent property** – *contextual* by responding to the unique local climatic and topographical conditions.
   - **Emergent property** – *evolutionary* by promoting experimentation, understanding and opportunity for selection of appropriate architectural responses.

Category E. Promoting less energy and resource intensive development

a. ***Energy use***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by encourages wise and efficient use of energy.
   - **Function** – *optimized* by promoting efficient use of energy.

b. ***Water use***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by encouraging wise and efficient use of water.
   - **Function** – *optimized* by promoting efficient use of water.

c. ***Use of materials***. This indicator subcategory captures the following ecosystem characteristics:

- **Direct impact** by encouraging wise and efficient use of materials.
- **Function** – *optimized* by promoting efficient use of materials including retaining embodied energy of existing buildings and materials.
- **Emergent property** – *contextual* by using materials that are locally appropriate and available, including reuse of existing materials.

d. ***Waste diversion***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by encouraging reuse and recycling of solid waste materials.
   - **Function** – *cyclical* by promoting the reuse and recycling of materials within the system rather than direct disposal which makes the materials unusable.

e. ***Quality of air.*** This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by encouraging reduction of air pollution.

Category F. Promoting long-term use and self-sufficiency of basic requirements

a. ***Energy***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by promoting energy self-sufficiency using forms of renewable energy.
   - **Structure** - *nested systems* by promoting self-contained subsystems of energy production within the greater city/regional system.
   - **Structure** – *diverse* by promoting locally appropriate responses to energy provision - which will be unique to each neighbourhood.
   - **Structure** – *decentralized* by promoting decentralization of energy production across a region.
   - **Structure** – *redundant* by providing for alternative modes and venues for energy production throughout a region. Therefore if one becomes unviable or breaks down, there are others to take its place.
   - **Function** – *renewable* by promoting renewable energy sources.

- **Function** – *diverse* by promoting locally appropriate, diverse, redundant and decentralized methods to energy production.
- **Function** – *autonomous* by promotes energy autonomy.
- **Emergent property** – *resilience* by providing alternative sources of energy throughout the region therefore if one breaks down there are others to take its place. Also, if energy systems are organized as discrete modular cells, then the failure of one will not affect the functioning of the whole system.
- **Emergent property** – *cooperation* by combining energy generation with waste management, in the case of co-generation technologies.
- **Emergent property** – *contextual* by providing locally appropriate energy strategies.

b. ***Food***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by promoting food self-sufficiency and reducing the energy required for transporting and preserving food.
   - **Structure** – *nested systems* by promoting self-contained subsystems of food production within the greater city/regional system.
   - **Structure** – *diverse* by promoting locally appropriate responses to food provision - will be unique to each neighbourhood.
   - **Structure** – *decentralized* by promoting decentralization of food production across a region.
   - **Structure** – *redundant* by providing for alternative modes and venues for food production throughout a region. Therefore if one source becomes unviable or suffers disease, there are others to take its place.
   - **Function** – *renewable* by promoting renewable food production methods and sources.
   - **Function** – *diverse* by promoting locally appropriate, diverse, redundant and decentralized methods to food production.
   - **Function** – *autonomous* by promoting food security/ autonomy.

- **Emergent property** – *resilience* by providing alternative sources of food throughout the region therefore if one becomes unviable there are others to take its place.
- **Emergent property** – *cooperative*, for example by combining food production with water treatment and waste management (of organic materials).
- **Emergent property** – *contextual* by providing locally appropriate food security strategies.

c. ***Water***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by promoting self-sufficiency of (generally non-potable) water and reuse of greywater without resource intensive treatment (note though – treatment plants for each NH may be more resource intensive than centralized system).
   - **Structure** – *nested systems* by promoting self-contained sub-systems of water treatment and provision within the greater city/region system.
   - **Structure** – *diverse* by promoting locally appropriate responses to provision and treatment of fresh water - will be unique to each neighbourhood.
   - **Structure** – *decentralized* by promoting decentralization of water procurement and treatment throughout a region.
   - **Structure** – *redundant* by providing for alternative modes and venues for water production and treatment throughout a region. Therefore if one becomes unviable or breaks down, there are others to take its place.
   - **Structure** – *renewable* by promoting renewable water use.
   - **Function** – *cyclical* by promoting the recycling of water resources.
   - **Function** – *diverse* by promoting locally appropriate, diverse, redundant and decentralized methods to fresh water production and treatment.
   - **Function** – *autonomous* by promoting fresh water autonomy.
   - **Emergent property** – *resilience* by providing alternative sources of water and water treatment throughout the region therefore if one becomes unviable there are others to take its place.

- **Emergent property** – *cooperative*, for example, by combining water treatment with habitat by using natural features such as wetlands to help purify water.
- **Emergent property** – *contextual* by providing locally appropriate water capture and purification strategies.

d. ***Waste management*** (no indicators present in any of the frameworks). This indicator subcategory would capture the following ecosystem characteristics:
   - **Direct impact** by promoting self-sufficiency in management of waste produced on site and reduces energy required for transporting of waste.
   - **Indirect impact** by having to manage waste on site may reduce the acceptability of a "throw away culture".
   - **Structure** – *nested systems* by promoting self-contained sub-systems of waste treatment within the greater city/region.
   - **Structure** – *diverse* by promoting locally appropriate responses to waste management - will be unique to each neighbourhood.
   - **Structure** – *decentralized* by promoting decentralization of waste management throughout a region.
   - **Structure** – *redundant* by providing for alternative modes and venues for waste treatment throughout a region. Therefore if one becomes unviable, breaks down or becomes full, there are others to take its place.
   - **Function** – *renewable* by promoting renewability of soil through composting.
   - **Function** – *cyclical* by promoting the recycling of waste resources.
   - **Function** – *diverse* by promoting locally appropriate, diverse, redundant and decentralized methods to waste management.
   - **Function** – *autonomous* by promoting waste management autonomy.
   - **Emergent property** – *resilience* by providing alternative means and venues to manage waste therefore if one becomes unviable, or full, there are others to take its place.

- **Emergent property** – *cooperative*, for example, by combining waste management with food production and restoration of degraded soils (with use of composted materials).
- **Emergent property** – *contextual* by providing locally appropriate waste management strategies.

e. ***Adaptable and flexible built form*** (no indicators present in any of the frameworks): This indicator subcategory would capture the following ecosystem characteristics:
   - **Structure** – *diverse* by promoting the potential for multiple and diverse uses of buildings and infrastructure provided.
   - **Temporality** – *dynamic* by providing ability to change over time.
   - **Temporality** – *responsive* by being able to respond to changing needs over time.
   - **Emergent property** – *resilience* by providing a built form that has a chance to adapting to change.
   - **Emergent property** – *cooperative* by accommodating shared uses of spaces.
   - **Emergent property** – *contextual* by creating built forms that will adapt to changes, with an emphasis on those expected for the region/site.
   - **Emergent property** – *evolutionary* by providing a built form that has the ability to become what it needs to be over time to meet the needs of the community (including natural community) - I.e. those forms that meet changing needs will be selected for.

f. ***Adaptable and flexible public spaces***. This indicator subcategory captures the following ecosystem characteristics:
   - **Direct impact** by promoting flexible and adaptable use of public spaces over time thereby increasing their longevity.
   - **Structure** – *diverse* by promoting the potential for multiple and diverse uses of public spaces provided.
   - **Temporality** – *dynamic* by providing ability to change over time.
   - **Temporality** – *responsive* by being able to respond to changing needs over time.

- **Emergent property** – *resilience* by providing public spaces that have the ability to adapt to change.
- **Emergent property** – *cooperative* by accommodating shared uses of spaces.
- **Emergent property** – *contextual* by creating built forms that will adapt to changes, with an emphasis on those expected for the region/site.
- **Emergent property** – *evolutionary* by providing public spaces that has the ability to become what they need to be over time to meet the needs of the community (including natural community) - I.e. those forms that meet changing needs will be selected for.

Category G. Promoting livability through enjoyable environment

a. ***Enjoyable experience of public place***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by nurturing attachment to place which may encourage stewardship and investment in community.

b. ***Ability to interact with and contribute to community***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by nurturing of social capital (I.e. human resources) which is essential to realization and continuation of any intervention or program.
   - **Function** – *renewability* by fostering an on-going, renewable, source of social capital
   - **Function** – *autonomous* by promoting solidarity, autonomy and ownership over local community.
   - **Temporality** – *dynamic* by promoting a living source of social capital with the ability to galvanize to change as needed.
   - **Temporality** – *responsive* by promoting a living source of social capital with the ability to respond to changes as needed.
   - **Emergent property** – *resilience* by promoting social capital which is a proven source of a community's resilience to disturbances.

- **Emergent property** – *cooperation* by promoting cooperation in activities pertaining to the site's maintenance.
- **Emergent property** – *contextual* by fostering a base of social capital which will inherently be unique to its place.
- **Emergent property** – *evolutionary* by fostering the capacity in a community to continue to work together and continue to evolve to meet changes as they arise.

Category H. Promoting sustainable behaviour of residents and visitors

a. ***Education of residents and visitors***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by aiming to encourage a sustainability ethic in order to modify individual consumer behaviour more broadly.
   - **Temporality** – *responsive* by promoting education that reflects the needs of the community.
   - **Emergent property** – *contextual* by providing education strategies that are appropriate to the community.
   - **Emergent property** – *evolutionary* by fostering collective learning which is the key to adaptation.

b. ***Influencing behaviour*** (e.g. Travel Demand Management). This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by providing incentives and deterrents to non-environmentally friendly behaviour such as driving.
   - **Temporality** – *responsive* by promoting travel incentives and deterrents that reflects the needs and capacity of the community.
   - **Emergent property** – *contextual* by providing travel incentives and deterrents that are appropriate to the community.

Category I. Maintenance to the site

a. ***Long-term plans***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting on-going investments to ensure long-term ecological viability of the site.
   - **Temporality** – *responsive* by encouraging a degree of equilibrium of ecosystem functions - note, it is essential that the plans allow for flexibility and adaptability and do not inappropriately "freeze" ecological processes in time.
   - **Emergent property** – *resilience* by promoting long-term attention to the site to ensure it is able to adapt to changes.
   - **Emergent property** – *contextual* by creating plans that respect the unique needs, opportunities and challenges of the site.
   - **Emergent property** – *evolutionary* by promoting evaluation of past plans - note, evaluation is a critical step in successful planning, but is not widely adopted or rigorously applied.

b. ***Sustainable, low-impact maintenance***. This indicator subcategory captures the following ecosystem characteristics:
   - **Indirect impact** by promoting foresight in site maintenance to ensure that that what has been procured can be maintained sustainably over time.
   - **Temporality** – *responsive* by encouraging self-regulation of the maintenance of the system.
   - **Emergent property** – *contextual* by adopting maintenance strategies that are appropriate to the site.

Appendix D : False Creek North's performance using the three neighbourhood sustainability assessment frameworks

False Creek North's (FCN) performance on each of the indicators for all three of the neighbourhood sustainability assessment frameworks is presented before in tabular form as a "score card". Due to inconsistency in the wording across the three assessment frameworks, most indicators have been shortened and paraphrased for consistency here. Metrics and targets for each of the indicators are not listed. To access metrics and targets, visit the respective assessment frameworks.

Depending on the data required for the indicators in these frameworks, data were obtained from observation, direct measurement, indirect measurement using orthogonal maps, review of bylaws and other relevant policy documentation or informal interviews with planners at the City of Vancouver. Because the intent of the analysis is to be indicative and qualitative rather than rigorous and empirical, it is not pertinent that the evaluations be conducted with the exact rigour that is intended in the frameworks. For example, the SSI framework follows a similar format to LEED ND where a series of points is allocated based on the degree to which a certain criterion is met. To simplify the analysis for the purposes of this thesis, however, the credits in the SSI framework are treated more like a "checklist" where a simple "yes/no" or "presence/absence" judgement is used to allocate merit. This approach clearly does not reflect the richness of the assessment frameworks. This must be taken into consideration when reading and/or referencing the data presented in the assessment scorecards. The LEED ND framework does follow its original point allocation format. The total yes/no responses or point value for each of the frameworks is provided.

Because of data limitations in some instances and scope of the project, personal and professional judgement was used to assign a result. It has been noted where this is the case in the respective assessment framework tables or scorecards. In other instances, where data could not be obtained and personal judgement could not be used to determine a response, no

answer is allocated to those indicators. This is also noted in the assessment scorecards. Where judgement has been used in the place of empirical evidence, the assumptions behind that judgement are articulated.

These scorecards are followed by a summary of the total range of FCN elements that are consistent with the frameworks and those that are in need of improvement. See chapter 2 for a further discussion of the assessment frameworks and the methodology.

The following acronyms are used:

- LEED ND: LEED for Neighbourhood Development;
- SDMBC: Sustainable Urban Landscapes Site Design Manual for B.C. Communities;
- SSI: Sustainable Sites Initiative: Guidelines and Performance Benchmarks

1. Sustainable Urban Landscapes Site Design Manual for BC Communities Sustainability Checklist

Table D.1: Scorecard for FCN using the SDMBC assessment framework.

No.	Criteria	Response
1	Do site development, engineering and subdivision requirements reflect the purpose and goals of the regional growth strategy?	Yes
2	Do site development, engineering and subdivision requirements reflect Official Community Plan principles?	Yes
3	Does the development reflect the goals/objectives of regional Liquid Waste Management, pollution management, and/or watershed plans and strategies?	Yes[43]
4	Does the development utilize existing infrastructure networks?	Yes
5	Does the development support a coordination between land-use and transportation?	Yes
6	Are residents and community stakeholders involved in the planning and design process?	Yes
7	Does the development reflect and understanding of watershed forms and processes?	No
8	Is the development located outside areas identified as environmentally sensitive and/or hazardous?	Yes
9	Does the development support and link to a regional ecological network?	No
10	Are alternative stormwater management design standards incorporated to reduce downstream impacts on development?	No
11	Does development maintain pre-development hydrological conditions?	No
12	Are riparian zones sufficient to protect the aquatic and terrestrial features necessary for fish survival?	n/a[44]
13	Do riparian zones layer ecological protection and passive recreational access in mutually supportive ways?	n/a[45]
14	Are public parks, school sites, and wetlands integrated to maximize recreational, environmental learning, and community development opportunities?	No
15	Is the development concentrated around commercial and transportation nodes?	Yes
16	Do residential and employment densities support the regional transit system?	Yes
17	Does the development incorporate a mix of uses?	Yes
18	Is the street system interconnected to allow multiple paths for movement through the community?	Yes
19	Are all residences in the development located within a 400m (5min walk) of neighbourhood stores, parks and transit?	Yes
20	Are greenways and bikeways integrated into the transportation network?	Yes
21	Does the development enhance local identity and character?	Yes[46]

[43] Because the planning of the FCN occurred after these initiatives were put in place, it is assumed that FCN complies to these standards.
[44] The site has coastal, but not riparian areas.
[45] The site has coastal, but not riparian areas.
[46] While I might argue that the development does not reference it's natural history enough, explicit guidelines were set in place to ensure that each neighbourhood precinct within FCN had a unique character.

No.	Criteria	Response
22	Are public facilities shared to accommodate different uses at different times of the day?	Yes[47]
23	Are homes oriented towards open space and/or views to the maximum extent possible?	Yes
24	Are opportunities for regional food production maximized?	No
25	Has the incorporation of district-scale energy and servicing infrastructure been considered?	Yes[48]
26	Does the development meet requirements for riparian protection?	n/a
27	Are streets designed to infiltrate and treat storm water?	No
28	Are stream crossings designed to minimize impact on aquatic habitat?	n/a
29	Are opportunities for habitat enhancement incorporated into streets and corridors?	No
30	Does the street network respond to existing topography and minimize earth works and engineering?	Yes
31	Are commercial activities centred on a pedestrian oriented 'Main Street'?	Yes
32	Are on-site parking requirements minimized while on-street parking is maximized?	No
33	Is parking located such that it does not detract from the pedestrian environment?	Yes
34	Are streets designed to be safe and comfortable for pedestrians and cyclists?	Yes
35	Are streets designed to frame important views?	Yes
36	Are blocks designed to maximize the infiltration and storage of ground water?	No
37	Are blocks designed to embrace and protect important environmental features?	Yes
38	Do sidewalks connect blocks on both sides of the street?	Yes
39	Are interruptions to the sidewalk minimized?	Yes
40	Are blocks short enough to provide easy movement for pedestrians?	Yes
41	On longer blocks are there mid-block connections to greenways or trails?	Yes
42	Are there multiple lot sizes within each block to accommodate many housing and tenure types?	n/a
43	Are setbacks minimized to create a sense of enclosure on the street?	Yes
44	Do blocks incorporate space for public gatherings?	Yes
45	Are building footprints reduced to maximize infiltration of rainwater?	No
46	Does building and site design minimize energy and material inputs?	No
47	Are buildings articulated in response to natural features and phenomena?	Yes
48	Are opportunities for water reuse and recycling incorporated into the building and site design?	No
49	Are a variety of living spaces layered within the parcel to accommodate different family and income types?	Yes
50	Do homes present a friendly face to the street?	Yes
51	Are garages placed behind or recessed back from a house?	Yes
52	Are opportunities for social interaction within each parcel maximized?	Yes

[47] The David Lam Park is shared with the school grounds of the Elsie Roy Elementary School. Also, the Roundhouse Community Centre is used for a variety of purposes.
[48] It is currently being considered with the planning of the North East False Creek development immediately to the east of FCN.

No.	Criteria	Response
Total results		
5 n/a 34 Yes 13 No		

2. Sustainable Sites Initiative

Table D.2: Scorecard for FCN using the SSI assessment framework.

No.	Prerequisite or credit?	Criteria	Response
1.0	***Criteria for site selection***		
1.1	Prerequisite	Preserve threatened or endangered species habitat	n/a
1.2	Prerequisite	Protect and restore floodplain functions of riparian and coastal zones	No
1.3	Prerequisite	Limit disturbance of prime farmland soils, unique soils, and soils of state-wide importance	n/a
1.4	Credit	Select brownfields or greyfields for redevelopment	Yes
2.0	***Criteria for pre-design assessment and planning***		
2.1	Prerequisite	Conduct a pre-design site assessment	Yes
2.2	Prerequisite	Use and integrated design process	Yes
2.3	Prerequisite	Develop a program plan with site performance goals	Yes[49]
2.4	Credit	Engage users and other stakeholders in meaningful participation in site design	Yes
3.0	***Criteria for site design – ecological components***		
3.1	Prerequisite	Control and manage invasive species	Data not available
3.2	Prerequisite	Use appropriate, non-invasive plants	Yes
3.3	Prerequisite	Preserve special status trees	n/a
3.4	Prerequisite	Reduce potable water consumption for irrigation	Yes[50]
3.5	Credit	Minimize or eliminate potable water consumption for irrigation	No
3.6	Credit	Preserve and restore plant biomass on-site	Yes[51]
3.7	Credit	Minimize building heating and cooling requirements with vegetation	No
3.8	Credit	Reduce urban heat island effects	Data not available
3.9	Credit	Promote a sense of place with vegetation	No
3.10	Credit	Preserve and restore native wildlife habitat	No
3.11	Credit	Protect and restore riparian and wetland buffers	n/a
3.12	Credit	Repair or restore damaged or lost streams, wetlands, and coastal habitats	No
3.13	Credit	Preserve existing healthy soils	n/a
3.14	Credit	Preserve existing topography	No[52]

[49] Site performance goals were set pertaining to housing mix and livability.
[50] The Parks Board is progressively increasing water efficiency practices in all their activities across Vancouver, not just FCN.
[51] But not to pre-industry levels.

No.	Prerequisite or credit?	Criteria	Response
3.15	Credit	Restore soils disturbed by previous development	Yes
3.16	Credit	Manage water on-site	No
3.17	Credit	Cleanse water on-site	No
3.18	Credit	Eliminate potable water use in ornamental or stormwater features	No
3.19	Credit	Minimize use of potable water in water features designed for full human contact	No
3.20	Credit	Mitigate potential wildfire risk	n/a
4.0	***Criteria for site design – human health components***		
4.1	Credit	Promote equitable site design, construction, and use	Data not available
4.2	Credit	Promote sustainability awareness and education	No
4.3	Credit	Provide for optimum site accessibility, safety and wayfinding	Yes[53]
4.4	Credit	Provide views of the natural environment to building occupants	Yes
4.5	Credit	Provide opportunities for outdoor physical activity	Yes
4.6	Credit	Connect site to surrounding resources, amenities and services	Yes
4.7	Credit	Provide outdoor spaces for mental restoration	Yes[54]
4.8	Credit	Provide outdoor spaces for social interaction	Yes
4.9	Credit	Design stormwater management features to be a landscape amenity	No
4.10	Credit	Prevent and abate sensory stress	Yes
4.11	Credit	Protect and promote unique cultural and historical site attributes	Yes
5.0	***Criteria for site design – materials selection***		
5.1	Prerequisite	Eliminate use of lumber from threatened tree species	No
5.2	Credit	Support sustainable practices in plant production	Yes
5.3	Credit	Support sustainable practices in materials manufacturing	No
5.4	Credit	Reuse on-site structures, hardscape, and landscape amenities	No
5.5	Credit	Use salvaged and recycled content materials	No
5.6	Credit	Use certified wood	No
5.7	Credit	Use products designed for reuse and recycling	No[55]
5.8	Credit	Use adhesives, sealants, paints, and coatings with reduced VOC emissions	No
5.9	Credit	Conduct a life-cycle assessment	No

[52] Parts of the shoreline of the stream were physically modified through major earth works.
[53] Wayfinding is somewhat limited.
[54] The Parks Board attempted this with the creation of an "area of tranquility" in part of David Lam Park. Due to homeless people using the area to sleep, however, the benches have subsequently been removed. The planners of FCN therefore tried to provide such areas, but were unsuccessful. Nevertheless, a point is rewarded for attempting in this case.
[55] The Parks Board does, however, prioritize durability in their landscape elements.

No.	Prerequisite or credit?	Criteria	Response
6.0	***Criteria for construction***		
6.1	Prerequisite	Create a soils management plan	No
6.2	Prerequisite	Restore soils disturbed during construction	n/a
6.3	Credit	Achieve a carbon-neutral site	No
6.4	Credit	Divert construction and demolition materials from disposal	Data not available
6.5	Credit	Control and retain construction pollutants	Yes
6.6	Credit	Use excess vegetation, rocks, and soil generated during construction	No
7.0	***Criteria for operations and maintenance***		
7.1	Prerequisite	Plan for sustainable landscape maintenance	No[56]
7.2	Credit	Minimize exposure to localized air pollutants	Data not available
7.3	Credit	Recycle organic matter generated during site operations and maintenance	Yes
7.4	Credit	Provide for storage and collection of recyclables	Yes
7.5	Credit	Use renewable sources for site outdoor electricity	No
Total Results			
Prerequisites: 14 4 n/a 1 Data not available 5 prerequisites achieved 4 prerequisites not achieved that were applicable and data were available for		Credits: 45 3 n/a 4 Data not available 16 Credits achieved 22 Credits not achieved that were applicable and data were available for	

[56] The Parks Board does, however, generally plan for minimal landscape maintenance.

3. LEED for Neighbourhood Development

Table D.3: Scorecard for FCN using the SSI assessment framework.

No.	Prerequisite or credit?	Criteria	Response
Criteria for smart location and linkage			
1	Prerequisite	Smart location	Yes
2	Prerequisite	Proximity to water and wastewater infrastructure	Yes
3	Prerequisite	Imperilled species and ecological communities	Yes
4	Prerequisite	Wetland and water body conservation	Yes
5	Prerequisite	Agriculture land conservation	Yes
6	Prerequisite	Floodplain avoidance	Yes
1	Credit	Preferred locations	10/10
2	Credit	Brownfield redevelopment	2/2
3	Credit	Reduced automobile dependence	7/7
4	Credit	Bicycle network and storage	1/1[57]
5	Credit	Housing and jobs proximity	2/3[58]
6	Credit	Steep slope protection	1/1
7	Credit	Site design for habitat or wetlands	1/1
8	Credit	Restoration of habitat or wetlands	0/1
9	Credit	Conservation management of habitats or wetlands	0/1
Criteria for neighbourhood pattern and design			
1	Prerequisite	Walkable streets	Yes
2	Prerequisite	Compact development	Yes
3	Prerequisite	Connected and open community	Yes
1	Credit	Walkable streets	11/12[59]
2	Credit	Compact development	6/6
3	Credit	Diversity of uses	4/4
4	Credit	Mixed-income diverse communities	3/7
5	Credit	Reduced parking footprint	1/1[60]
6	Credit	Street network	2/2
7	Credit	Transit facilities	0/1[61]
8	Credit	Transportation demand management	0/2
9	Credit	Access to public spaces	1/1

[57] Data was not available for bike storage figures. I judged the point allocation based on my familiarity with the site including bike storage I had seen in the public realm and from discussing with the residents their experience with bike storage in their buildings.
[58] Although FCN provides plenty of housing near a major jobs centre, it does not receive full points because the affordable housing component is not sufficient.
[59] Better street calming measures are required to be awarded full points.
[60] Although plenty of parking is provided, it is accommodated largely through underground structures which do not expand the spatial "footprint" of the parking requirements.
[61] The frequency of transit is adequate but facilities not.

No.	Prerequisite or credit?	Criteria	Response
10	Credit	Access to active public spaces	1/1
11	Credit	Universal accessibility	1/1
12	Credit	Community outreach and involvement	2/2
13	Credit	Local food production	0/1
14	Credit	Tree-lined and shaded streets	2/2[62]
15	Credit	Neighbourhood schools	1/1
Criteria for green infrastructure and buildings			
1	Prerequisite	Certified green building	No
2	Prerequisite	Minimum building energy efficiency	No
3	Prerequisite	Minimum building water efficiency	No
4	Prerequisite	Construction activity pollution prevention	Yes
1	Credit	Certified green buildings	0/5
2	Credit	Building energy efficiency	0/2
3	Credit	Water efficient landscaping	0/1
4	Credit	Existing building reuse	0/1
5	Credit	Historic building preservation and adaptive use	1/1
6	Credit	Minimize site disturbance in design and construction	1/1
7	Credit	Stormwater management	0/4
8	Credit	Heat island reduction	Data not available
9	Credit	Solar orientation	0/1
10	Credit	On-site renewable energy sources	0/3
11	Credit	District heating and cooling	0/2
12	Credit	Infrastructure energy efficiency	1/1[63]
13	Credit	Wastewater management	0/3
14	Credit	Recycled content in infrastructure	Data not available
15	Credit	Waste management infrastructure	0/1
16	Credit	Light pollution reduction	Data not available
Criteria for innovation and design process category			
1	Credit	Innovation and exemplary performance	0/5
2	Credit	LEED accredited professional	n/a
3	Credit	Regional priority credit	n/a
Total results			

[62] It should be noted, however, that the Parks Board stated that the trees along Aquarius Mews appear to be dying.
[63] Data was not available for infrastructure other than streetlights which use light-emitting diode (LED) lights. I generously awarded this point in the absence of the other data.

No.	Prerequisite or credit?	Criteria	Response
Prerequisites: 13 0 n/a 0 Data not available 10 prerequisites achieved 3 prerequisites not achieved that were applicable and data were available for			Credits: 62 out of a total of 100 available points that are applicable and data were available for were achieved Certification estimate: No LEED certification because some prerequisites were not achieved

Summary of Results on FCN's performance using the assessment frameworks

The lists below provide summary points on what elements in FCN are consistent with the assessment frameworks, which are in need of improvement to comply with the frameworks and which are not applicable to the site. These are amalgamated for the set of the three frameworks.

Indicators and criteria not applicable to the FCN site

A number of indicators were not appropriate to the FCN site for the following reasons:

- Protecting imperilled species and ecological communities – none were on site prior to current development.
- Mitigating against fire risk – fire disturbance not common in this part of B.C.
- Protecting stream crossings and restoring riparian and wetland buffers, including fish – there are no streams/riparian areas on site. However, if we were to take into account coastal ecology, it could be argued that more could be done to improve site conditions.
- Protecting, preserving and restoring healthy soils and habitat, including mature landscaping – there were no natural habitat or vegetation on site prior to current development and soils were heavily polluted.
- Different lot sizes for a range of housing types – not appropriate in this downtown context as there are no single-family dwellings on site. A range of housing types were accommodated, but were not a function of lot size.
- Reusing building structures – most previous buildings were industrial and therefore may not have been suitable for conversion to largely residential. The site did at least use and restore the Roundhouse which promotes its heritage value as well.

- Using excess vegetation, rocks and soils generated during construction – no vegetation was present and rocks and soil were polluted and therefore should not be reused.

Indicators and criteria that FCN achieves

FCN achieves a number of sustainability-oriented goals as defined by the assessment frameworks. Overall FCN is successful in the following:

- Integrated design process with professionals familiar with New Urbanism concepts (LEED did not exist at the time).
- Community participation – the CityPlan process for entire downtown core, in which FCN was apart, involved an extensive community engagement strategy.
- Site assessment – standard site assessment procedures were conducted prior to development.
- Setting some site performance goals – around livability, promoting family friendly living and accommodating households of lower income.
- Is consistent with broader policy goals – FCN Official Development Plan (ODP), waste management, and Livable Region Strategic Plan (LRSP).
- Not locating in an environmentally sensitive or hazardous location such as steep slopes or prone to flooding – the site however is in a site that is subject to sea level rising, although this natural hazard was not included in any of the assessment frameworks.
- Locating in a regionally appropriate location – central location of lands for housing on brownfield site is consistent with LRSP.
- Protecting important environmental features - in this case these are views and public access to water both from units and from streets and public spaces. Studies of view corridors were conducted. Public doesn't have direct access to water in all areas but lands along the coast are public.
- Connected to existing features and infrastructure – consistent with being located in a brownfield site.
- Restoring soils – they are in better condition now than post industry although they are not restored to pre-industry conditions.
- Safe, walkable, comfortable streets – adequate sidewalks, street trees, articulated facades and storefronts are all present in mixed-use areas.
- Connected and open community – bike/walkways (Seawall, Central Area Greenway) are integrated into transportation system, the site is serviced by transit, streets are well connected both within and external to development. Site is accessible and safe but wayfinding is in need of improvement.

- Blocks have good connectivity between them complete with bike and walkways.
- Compact and mixed-use development, concentrated around transit and commercial – although there is enough density to support transit, the frequency and reliability of service is not as strong as it could be and there is a lack of transit facilities such as shelters, seating and service information.
- Access by proximity to a mix of land uses/services including open spaces and amenities - however, the site has not achieved its intent on accommodating the range of household incomes due to a lack of senior government funding. Nor does it provide an affordable range of shops and services to accommodate this segment of the population.
- Promotion of physical activity and social interaction – the Seawall is a well-used recreational amenity and different recreational uses are accommodated in different parks. There could, however, be more community gardens and options for residents to participate in stewardship activities.
- Creating a pedestrian scaled environment by framing the streets with setbacks and appropriate enclosure – tower-podium building typology created to accommodate towers while providing a "friendly face" to the street through the use of front doors on town homes, porches and no parking garages.
- Universal accessibility – promoted in public realm and in many buildings.
- Accommodating some shared uses in spaces – Elsie Roy Elementary School playground is in David Lam Park. Improvements in this respect would include incorporating more sharing of spaces.
- Using non-invasive plants and supporting sustainable practices in plant production – non-native non-invasive plants are used in the landscaping of public spaces. Parks Board also has its own plant nursery and is steadily accommodating more sustainable practices in their plant production.
- Attempting to create local identity with use of neighbourhood concepts – site was developed in sub-neighbourhood precincts each with their own character, organized around open spaces and distinguished with the use of different materials and slightly different design aesthetic.
- Recycling organic waste generated from landscape operations – materials are composted at an off site citywide location. Personal organic material, however, is not accommodated on site.
- Providing places for mental restoration – an area of the David Lam Park was designed specifically to provide a place of tranquility, but had to be modified later due to safety concerns relating to homeless people sleeping in the space.
- Retaining and reusing some existing buildings – the Roundhouse was retained which has heritage value as well, although it is a unique example of building reuse on site.

Needs improvement

FCN is also lacking in a number of sustainability-oriented goals as defined by the assessment frameworks:

- Explicitly linking parks and greenways to regional ecological network – while the Seawall does link the FCN open spaces with other open spaces in Vancouver, including Stanley park, little attempt was made to use this linkage as a habitat corridor. Parks were not planned explicitly to accommodate habitat and mobility needs of urban wildlife or other ecological processes.
- Fostering sustainability awareness and environmental learning – education is not explicitly promoted.
- Preserving existing topography/ minimizing earth works and site engineering – while topography was not modified, some of the shorelines were modified.
- Creating a soils and habitat management plans with minimum 10 year time lines – no long term plans were conducted for either.
- Enhancing habitat on site – although the site offers better habitat than when it was in industrial use, landscaping in FCN has not been explicitly used to provide habitat to urban wildlife, which could be significant given the provision of open space and green roofs.
- Retaining pre-development hydrological conditions and managing water on site including stormwater management, infiltration of water in streets and wastewater management – not achieved in any significant sense.
- Layered ecological and recreational functions in outdoor areas – this was not an explicit goal and is not accommodated in any significant sense.
- Food production – is lacking as measured by intensity and distribution of garden plots, and other opportunities such as farmers markets.
- Using native plants, to serve as habitat and also to enhance sense of place with vegetation, and using sustainable practices in maintenance of such landscapes in both public and private landscapes – the Parks Board does not dictate landscaping requirements on private land. Priority is not given to native plants. Pesticides are not used and water conservation methods in irrigation are beginning to be used. The informant at the Parks Board, however, mentioned that they plan for minimum maintenance which is consistent as a form of sustainable "inputs".
- Green building concept as measured primarily by energy and water efficiency, use of passive techniques for lighting and thermal comfort and use of non-toxic and sustainably managed materials – this was not achieved in any significant sense. Heat gain is a major problem in the summer months which has necessitated the use of air conditioners in some units.
- Providing storage and collection of recyclables – some frameworks emphasize recyclable facilities on site in general and others specify facilities in the public realm.

All buildings have such facilities but the public realm doesn't have any recycling infrastructure.

- Using renewable energy and heating sources such as district heating or co-generation – was not a priority although FCN is currently being assessed for its ability to be connected to the neighbouring North East False Creek site.
- Aiming for reducing greenhouse gas emissions (GHGs) and achieving a carbon neutral site – not given great consideration other than residents do have the option to use alternative mobility options to the car, which is potentially significant.
- Travel demand management – was not conducted. Further, the generous provision of car parking is inconsistent with its concept of being transit oriented. FCN does not provide surface parking, and makes good use of street parking, but has provided more than adequate underground parking (which is very expensive) especially given the site's other mobility options.

Appendix E: Photographs of False Creek North

Figure 1: False Creek North is situated on False Creek.

Figure 2: False Creek North is characterized by very high density set amongst generous provisions of open space for a down-town setting.

Figure 3: The “tower-podium” is a commonly used building typology in False Creek North used to accommodate density while maintaining a “friendly face” to the street. Here, townhomes are used in the podium.

Figure 4: Townhomes line many of the streets in False Creek North.

Figure 5: The seawall is a much loved amenity that extends along the shoreline of False Creek.