ASSESSING THE ENVIRONMENTAL PRACTICES AND IMPACTS OF INTENTIONAL COMMUNITIES: AN ECOLOGICAL FOOTPRINT COMPARISON OF AN ECOVILLAGE AND COHOUSING COMMUNITY IN SOUTHWESTERN BRITISH COLUMBIA

by

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Abstract

The ecological footprint of the average Canadian is three times greater than the global per capita biocapacity of the planet. The purpose of this research is to gain insights from intentional communities on how to reduce household ecological footprints in Canada. Intentional community is an inclusive term for a variety of community types, including ecovillages and cohousing, where residents have come together to achieve a common purpose. Studies show that intentional communities have per capita ecological footprints that are less than those of conventional communities. I corroborate these findings through my own ecological footprint analyses of Quayside Village and OUR Ecovillage, in southwestern British Columbia. These communities have per capita ecological footprints that are smaller than some conventional averages. Overall, Quayside Village and OUR Ecovillage also have comparatively similar per capita ecological footprints, suggesting that residents of both urban and rural intentional communities may demonstrate similar environmental behaviours.

Intentional community living is currently confined to small-scale grassroots initiatives so even the aggregate environmental benefits are insignificant. Municipalities and land developers can help to advance the pro-environmental practices of intentional communities by increasing incentives for this community model and adapting intentional community practices to a conventional context.

Preface

This research was approved by the University of British Columbia Behavioural Research Ethics Board (Certificate #H09-01602). A copy of the Certificate of Approval can be found in Appendix A.

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List of Abbreviations

BC	British Columbia
Bed Zed	Beddington Zero Energy Development
CDC	Cohousing Development Consulting
CEEI	Community Energy and Emissions Inventory
CMHC	Canada Mortgage and Housing Corporation
CO_2	Carbon Dioxide
CO2-e	Carbon Dioxide Equivalent
CoNV	City of North Vancouver
DCC	Development Cost Charge
EF	Ecological Footprint
EFA	Ecological Footprint Analysis
ESRL	Earth System Research Laboratory
FCM	Federation of Canadian Municipalities
FSR	Floor Space Ratio
GEN	Global Ecovillage Network
GFN	Global Footprint Network
GHG	Greenhouse Gas
GJ	Gigajoule
gha	Global Hectares
ha	Hectares
IPCC	Intergovernmental Panel on Climate Change
kg	Kilogram
km	Kilometre
kWh	Kilowatt-hour
L	Liter
LCA	Life Cycle Analysis
OUR	One United Resource
sq.m	Square Metres
UK	United Kingdom
VKT	Vehicle-Kilometre Travelled
WWF	World Wildlife Fund

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1.0 Introduction

1.1 *Problem and Context*

The ecological footprint of the average Canadian is 7.1 global hectares per person (gha/person), more than three times the 2.1 gha/person biocapacity of the planet (WWF 2008). In the face of the environmental stress imposed by rich countries like Canada, many innovative lifestyle and housing models have emerged including intentional communities. Intentional community is an "inclusive term for ecovillages, cohousing, residential land trusts, urban housing cooperatives, and other projects where people strive together with a common vision (Intentional Communities 2009)." The residents of these communities have consciously or 'intentionally' chosen to live together for social, economic and/or environmental reasons. My research focuses on the environmental practices and impacts of an ecovillage and a cohousing community in southwestern British Columbia (BC).

A number of studies show that intentional communities have less environmental impact per capita than conventional communities (Haraldsson *et al*. 2001, Tinsley & George 2006, Moos *et al.* 2006). However, there are no studies to verify whether this is true of Canadian intentional communities. There are over 100 intentional communities, either in existence or forming, in Canada (Intentional Communities 2009).

Most research on intentional communities has focused on the relative environmental impacts of ecovillages and their conventional counterparts. There is limited research, both in quantity and scope, which compares the relative environmental impacts of different types of intentional community, including cohousing. There is also limited research that draws from the experiences of intentional communities to inform conventional policy and practice. My research is intended to address these limitations in the literature.

1.2 *Research Purpose and Questions*

The overall purpose of my research is to gain insights from a small sample of intentional communities on how to reduce household ecological footprints in Canada. My research questions are as follows:

1. How do the environmental practices and impacts of an urban intentional community differ from a rural intentional community, in southwestern BC?
2. How do the environmental practices and impacts of two intentional communities in southwestern BC differ from a conventional BC community?
3. What policies can be implemented to advance the pro-environmental practices of intentional communities in a conventional context?

I explore these questions, in part, by calculating the ecological footprint of two intentional communities in British Columbia: Quayside Village and One United Resource (OUR) Ecovillage. Further information about these communities can be found in Section 1.4 while information about research methods can be found in Section 3.

1.3 *Significance of Work*

This study is unique and significant for the following reasons:

1. This is the first ecological footprint assessment of intentional communities in Canada. This may also be the first study to compare the ecological footprints of an urban and rural intentional community, specifically an urban cohousing community and rural ecovillage.

2. This research is based on first-hand knowledge of living in an intentional community, OUR Ecovillage, where the author resided for 1-month in 2009.
3. This study recommends policy directions to advance the pro-environmental practices of intentional communities in a conventional context.

1.4 *Study Sites*

This section provides a description of OUR Ecovillage and Quayside Village. Figure 1.1 shows the locations of both communities while Figures 1.2 and 1.3 show, at a more detailed level, OUR Ecovillage and Quayside Village, respectively.

1.4.1 OUR Ecovillage

OUR (One United Resource) Ecovillage, founded in 1998, is a 10 ha "sustainable learning community and demonstration site" located in the Cowichan Valley on Vancouver Island (OUR 2010). Under a unique zoning designation, R-4 Rural Community Residential, the ecovillage features a multitude of integrated land uses including educational and office facilities, an organic farm and housing. Furthermore, one-third of the property is being conserved under a protective covenant (OUR 2008). The community's buildings are clustered at the southeast corner of the property (see Figure 1.2) in close proximity to the farm and outdoor kitchen.

The number of community residents is continually evolving; however, as of February 2010, there were 7 full-time households (defined as living on-site for more than 3 consecutive months). During the summer season, the number of people on-site increases as the ecovillage hosts educational internships related to natural building and sustainable food production. The ecological footprint analysis focuses on the 7 full-time households. As of

February 2010, there were 15 adults and 4 children (under 15 years old) residing in these 7 households.

The community's mission is "to co-create accessible models of sustainable living…onsite and cooperatively within the wider world. We provide a nurturing space to support social, physical, cultural, spiritual and ecological well-being for ourselves, the land and our broader community (OUR 2009)." In accordance with their mission statement, OUR Ecovillage has undertaken a variety of ecological initiatives and projects including permaculture[1] gardening and natural building construction, involving materials such as cob and straw. The ecovillage has completed two natural buildings with plans to build nine more in the future. The Climate Change Demonstration Building (Figure 1.2), the larger of the two natural buildings, is approximately 150 sq.m.

1.4.2 Quayside Village

Quayside Village, completed in 1998, is a 19-unit cohousing community in North Vancouver, BC. As with most cohousing communities, Quayside features a common house (240 sq.m) in addition to individual dwelling units. The common house includes a kitchen and dining area, a lounge, playroom, laundry facilities, craft area, guestroom, and an office (Danziger 2004). Quayside also features a 60 sq.m ground-oriented commercial space, currently occupied by a convenience store (CDC 2010). The dwelling units range in size and layout, from a bachelor to 3-bedrooms, in both apartment and townhouse styles with an average dwelling size of 80 sq.m (Meltzer 2005, Quayside 2010). The site area is

[1] Permaculture, coined by Bill Mollison and David Holmgren, is an approach to food production that mimics the patterns and relationships found in nature.

approximately 0.1 ha, resulting in an overall floor-space-ratio (FSR) of 1.8. As of February 2010, there were 31 adults and 7 children (under 15 years old) residing at Quayside.

Quayside's mission statement is "to have a community which is diverse in age, background and family type that offers a safe, friendly, living environment which is affordable, accessible and environmentally conscious" (Meltzer 2005). In accordance with their mission statement, Quayside has incorporated many environmental initiatives including a greywater recycling plant and an extensive solid waste recycling program. The greywater recycling plant, funded by the Canada Mortgage and Housing Corporation (CMHC), was the first in a Canadian multi-unit complex. The greywater plant is maintained by Quayside residents. Residents also participate in an extensive recycling program that often results in 90-95% diversion of solid waste from the landfill (Burke Personal Communication 2010).

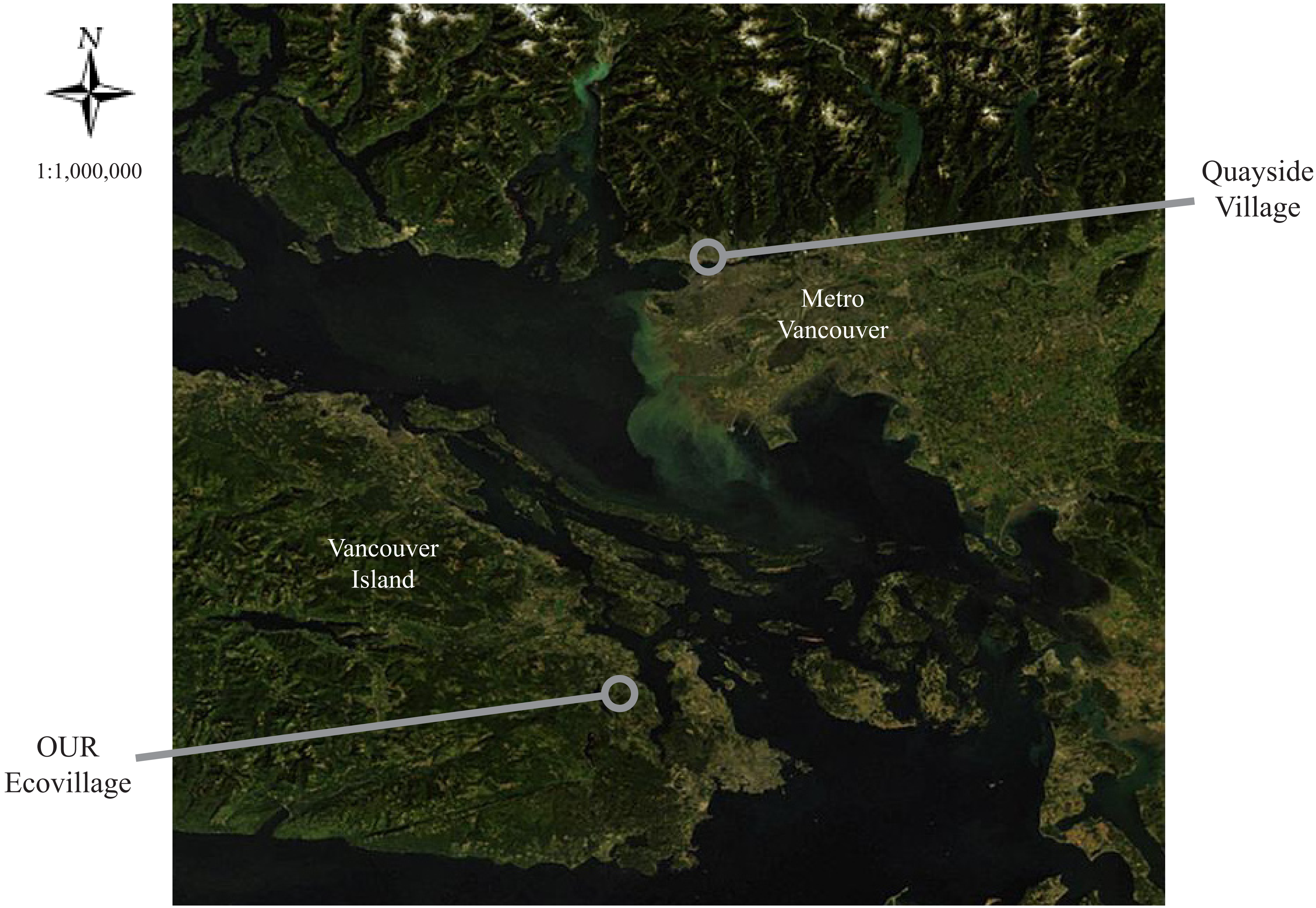


Figure 1.1: CONTEXT MAP

Aerial Photo of Site

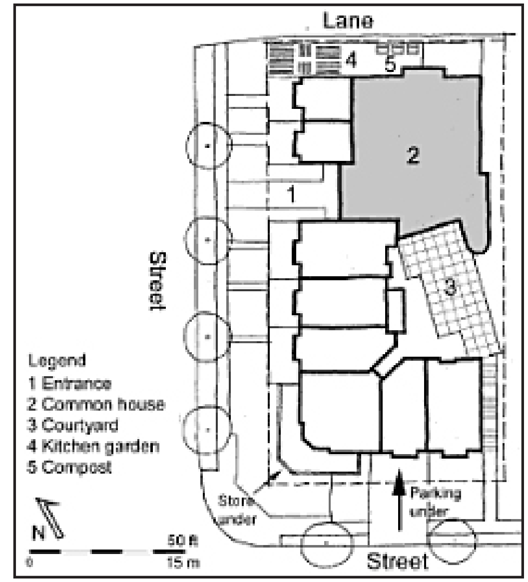

Fireplace inside Climate Change Demonstration Building


Climate Change Demonstration Building

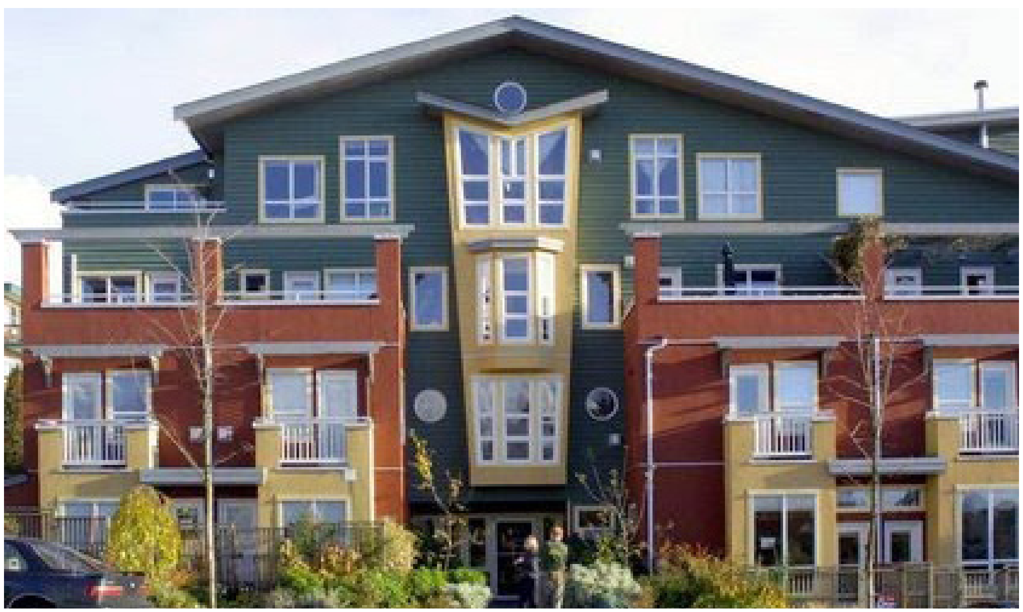

Permaculture Garden

Figure 1.2: OUR Ecovillage

Aerial Photo of Site



Site Plan


Main Entrance of Building Complex


Common Kitchen

Figure 1.3: Quayside Village

2.0 Sizing Up Intentional Communities

In this section, I review the literature. Section 2.1 defines intentional communities and discusses their origins, philosophies, motivations and challenges. Section 2.2 examines environmental impact assessment methods and metrics that are relevant to this research. Section 2.3 describes studies that have assessed the environmental impacts of intentional communities. Finally, Section 2.4 presents literature regarding the influence of intentional communities on environmental behavioural change.

2.1 *Intentional Communities*

2.1.1 Definitions

Intentional community is an "inclusive term for ecovillages, cohousing, residential land trusts, urban housing cooperatives, and other projects where people strive together with a common vision (Intentional Communities 2009)." Below are definitions of an ecovillage and cohousing community.

Dawson (2006) describes an ecovillage as a "settlement in which human activities are harmlessly integrated into the natural world in a way that is supportive of healthy human development and that can be successfully continued into the indefinite future." According to Bang (2005), an ecovillage typically has fewer than 500 members and includes the means to produce needs for life (food, water, shelter, leisure, commerce, etc.). What sets an ecovillage apart from other intentional communities is its explicit emphasis on ecology (Kasper 2008).

Cohousing emerged in the Netherlands, in the 1960s, through a desire to realize the social advantages of communal neighbourhoods while retaining the privacy of individual dwellings (Hanson 1996). McCamant and Durrett (1988) identify four characteristics of cohousing:

1) Participatory process: residents organize and participate in the planning and design of the housing development.
2) Intentional neighbourhood design: the physical design encourages a strong sense of community.
3) Extensive common facilities: common areas are designed for daily use and supplement private living areas. This often includes a common house and kitchen.
4) Complete resident management: residents manage the site and make decisions of common concern at community meetings.

In cohousing, there is also a strong focus on limiting material possessions by sharing resources such as laundry facilities, play areas, vehicles and computers & electronics.

2.1.2 Origins, Motivations and Philosophies

Intentional communities have different origins around the world. In America, intentional community building began as early as pioneer settlement. The levels of activity and motivations for building intentional communities have changed over time; however, the most recent increase in activity coincided with the paradigmatic shift of the 1960s (Kanter 1972). Since that time, people have been commonly motivated by intentional community living as a result of ecological concern and a desire for meaningful community.

The ecovillage movement, in particular, has arisen in response to the effects of modern living on the natural world (Kirby 2003). Kasper (2008) describes the ecovillage model as encompassing a new worldview that recognizes human-ecosystem interdependence. On the other hand, the cohousing model can be described as embracing a paradigm that recognizes human-human interdependence. Increasingly, however, ecologically-oriented cohousing communities are becoming the norm (Kirby 2003). The Global Ecovillage Network (GEN) was created in 1995 to serve as an umbrella organization for ecovillages and other ecologically-oriented intentional communities from around the world (Kasper 2008, GEN 2010).

2.1.3 Challenges

Intentional communities, including ecovillage and cohousing models, are faced with a variety of challenges to forming and sustaining their settlements. The greatest initial challenge is often finding the land, money and people to realize a vision. Commonly, groups spend years searching for an appropriate location to build a community (Kasper 2008). Once a location is found, there are often legal barriers including zoning bylaws, design standards and codes. Due to the array of challenges in forming an intentional community, ninety percent of groups do not succeed in building their envisioned communities (Christian 2003). Groups who succeed in building their communities still face other challenges including developing viable economies, achieving ethnic and socioeconomic diversity and maintaining internal and external relationships. The Findhorn Ecovillage, for example, faced numerous challenges with their conservative neighbours during the community's initial years. These tensions not only challenged the community's existence but also challenged the ideologies of its residents (Metcalf 2001).

2.2 *Relevant Methods*

This section examines relevant methods and metrics for environmental impact assessment including ecological footprint analysis, carbon dioxide emissions and life cycle analysis.

2.2.1 Ecological Footprint Analysis

The ecological footprint (EF) of a specific population represents the "area of land and water ecosystems required on a continuous basis to produce the resources that the population consumes, and to assimilate (some of) the wastes that the population produces, wherever on Earth the relevant land/water may be located (Rees 2001)." The EF aggregates some of the major ecological demands of a population or economy into a single value corresponding to an area of productive land and water, typically expressed in hectares (ha) or global hectares (gha)[2]. The footprint includes land area for the extraction of resources and land or marine area required for sequestering carbon emissions associated with production and waste. The ecological footprint is the aggregate of different land categories, typically including: energy (sequestration), arable (crop), grazing (pasture), degraded (built-up), forest and productive marine areas.

There are two main calculation methods for ecological footprint analysis: compound and component. The compound method, a 'top down' approach, often estimates consumption based on large-scale trade statistics (Simmons & Lewan 2001). The compound method is more established than the component method and is most applicable at the national scale where the full range of consumption data is available (Kissinger & Haim 2008).

[2] A global hectare is one hectare of biologically productive space with world average productivity

The component method, a ‘bottom up’ approach, estimates consumption of particular activities at the local level. The component method involves compilation of the material flows that support different activities using data specific to the region under consideration (Chambers *et al.* 2000, Simmons *et al.* 2000, Kissinger & Haim 2008). For example, the footprint associated with electricity consumption in British Columbia would be based on an estimate of GHG emissions associated with electricity generation by the local utility company, BC Hydro, plus the area occupied by dams and other physical infrastructure. The full component method includes 24 variables as presented in Table 2.1 (Simmons *et al.* 2000). The component method most often uses solid waste as an indicator of the impacts of both goods consumption and waste generation but the method could also rely on local sales data (Barrett 2001, Barrett *et al.* 2002, Chambers *et al.* 2000, Kissinger & Haim 2008).

Like other indices, ecological footprint analysis cannot measure every kind of impact. Ecological impacts that are not readily associated with productive area or biocapacity are not accounted for by EF analysis e.g., the assimilation or neutralization of heavy metals, radioactive substances and persistent materials (Holden 2004).

Table 2.1: Variables of the Ecological Footprint Component Method

Components	Variable
Transportation	Travel by Private Vehicles
	Travel by Airplane
	Travel by Bus
	Travel by Train
	Road Haulage
	Rail Freight
	Sea Freight
	Air Freight
Energy	Electricity - domestic
	Natural Gas - domestic
	Electricity - other
	Gas - other
Waste	Household Waste (Landfill)
	Recycled Paper
	Recycled Metal
	Recycled Glass
	Recycled - Other
	Compost
	Inert Waste
	Commercial Waste
Food	Food consumption
Other	Water consumption
	Forest products
	Built land

2.2.2 Carbon Dioxide Emissions

There is a high level of certainty in the scientific community concerning the realities of climate change and the role that humans are playing in this change. Research shows that CO_2 levels in the atmosphere, which had remained relatively stable for 10,000 years, have increased by 38% since the Industrial Revolution in the 1800s (ESRL 2010). Human activity is strongly correlated with this increase in CO_2 levels and, consequently, a changing climate (Vitousek *et al.* 1997, IPCC 2007). In light of this, increasing attention is being directed towards carbon dioxide, and other greenhouse gas, emissions. For example, in British Columbia, community-level GHG inventories were produced through the Community Energy and Emissions Inventory (CEEI) Program, including for the City of North Vancouver. The reports allow comparisons to be made between communities and provide baseline values so that future GHG reductions can be monitored.

2.2.3 Life Cycle Analysis

Life Cycle Analysis (LCA) is a systematic tool used to assess the environmental impacts associated with a specific product or service during its life cycle from raw materials and manufacturing through distribution, use, and ultimately reuse or disposal (Ciambrone 1997). The strengths of LCA derive from its roots in traditional engineering and process analysis (Field & Ehrenfeld 1999). A full LCA requires extensive data collection, even for one product, which is often time-consuming and cost-prohibitive. Other innovative LCA methods are emerging including economic input-output life cycle assessment (Hendrickson, Lave & Matthews 2006).

2.3 *Environmental Impacts of Intentional Communities Worldwide*

Various metrics have been used to assess the environmental impacts of intentional communities. This section considers studies that have used the ecological footprint and carbon dioxide emissions.

2.3.1 Ecological Footprint

Several authors have used the ecological footprint to quantify the environmental impacts of intentional communities (Haraldsson 2001, Tinsley & George 2006, Moos *et al.* 2006). Haraldsson (2001) attempts to determine whether a 37-unit Swedish ecovillage, Toarp, is less environmentally impactful than its conventional counterpart, Oxie. The per capita EF of each community was derived from random surveys that asked households to report on their monthly consumption. Ten households from each community participated in the study. Survey results were entered into a calculation matrix to derive the ecological footprints. In addition, Haraldsson calculated the embodied energy of constructing one representative house in each community. The embodied energy calculations focused on ten main building materials.

The total ecological footprints for Toarp and Oxie are 2.8 and 3.7 ha/person, respectively. In other words, the ecological footprint of the ecovillage is 25% lower than that of the conventional neighbourhood. Haraldsson indicates, however, that this is not a statistically significant difference by using the Mann-Whitney non-parametric test.

Haraldsson highlights the significance of housing and food, which combined account for approximately 75% of the total ecological footprint for both communities. Housing includes energy use for heating and electricity. Tinsley & George (2006) also highlight the significance of housing and food in their study of Findhorn's ecological footprint. Findhorn is an ecovillage in Scotland that features eco-houses, wind turbines and a biological sewage treatment plant (Living Machine®[3]). Their study quantifies the ecological footprint of Findhorn's residents and guests to determine how the ecovillage compares with other communities including the Beddington Zero Energy Development (Bed Zed) in the UK. Of the 181 households at Findhorn, 48 participated in the study by completing the necessary

[3] The Living Machine uses plants and microorganisms to treat wastewater for onsite re-use including irrigation and toilet flushing. The system is typically regarded as less environmentally impactful than conventional systems as it requires less energy and chemicals.

surveys. Unlike Haraldsson's 2001 study, building materials were not included in Findhorn's footprint calculations. However, according to Haraldsson, building materials represent less than 5% of the communities' ecological footprints.

The total ecological footprint per person at Findhorn is 2.7 hectares. This is lower than averages in the UK (5.4 ha), Scotland (5.4 ha), and Bed Zed (3.2 ha). Findhorn residents have significantly smaller ecological footprints in comparison to the UK and Scotland averages for home & energy, food, travel and consumables. Furthermore, Findhorn residents have significantly smaller ecological footprints in comparison to Bed Zed with respect to food consumption. Findhorn's low food footprint can be attributed mainly to its vegetarian diet.

Haraldsson and Tinsley & George both highlight intentional communities that have per capita ecological footprints lower than that of their conventional counterparts. They also describe reasons for differences in ecological footprints such as dietary choices and energy sources. These studies, however, do not attempt to discern the aspects of each community's environmental impact that are attributable to design decisions rather than personal behavioural choices. These issues are explored by Moos *et al.* (2006), who compare the EF of an existing intentional community, Ecovillage at Ithaca, with two other unrealized designs for the same 71 ha site. Ecovillage at Ithaca, located in New York State, is currently comprised of 60 dwellings with plans to expand to 150 dwellings. The community features a 3.5 ha organic farm and 22 ha conservation easement. The ecovillage follows Scandinavian cohousing principles with common facilities and tightly clustered homes arranged along pedestrian pathways. The second subdivision design is a hypothetical 150-unit new-urbanist community called New Uxbridge. The design follows principles outlined in the Charter of The New Urbanism and features a variety of housing types, narrow streets and pedestrian accessible services & amenities. The third subdivision follows an earlier design for this site that was never realized. A previous developer had proposed an estate style suburban neighbourhood, “Rose Hill”, featuring 50 townhouses and 100 single-family homes on one-acre (0.4 ha) lots. Of the three communities, Ecovillage at Ithaca demonstrated the lowest per capita EF of 4.25 ha in comparison to 6.88 and 7.53 ha at New Uxbridge and Rose Hill, respectively.

Moos *et al.* (2006) also compare that part of the EF attributable to physical infrastructure with the part of the EF attributable to personal consumption choices. Physical infrastructure includes roads, buildings, parking, open space, paths and private yards while personal consumption includes food, transportation and utility use. Personal consumption choices are shown to contribute more to one’s ecological footprint than physical infrastructure. This suggests that behavioural patterns are possibly more important than physical infrastructure from an ecological perspective. However, this does not account for behavioural changes that are influenced by physical infrastructure through design. For example, utility consumption is a function of building design; water consumption is linked to landscape design; transportation is linked to pedestrian-oriented design. Based on interview results, the authors suggest that “physical design may be a catalyst or facilitator of some changes in consumption”. These design-induced behavioural changes are not studied in Moos’ analysis.

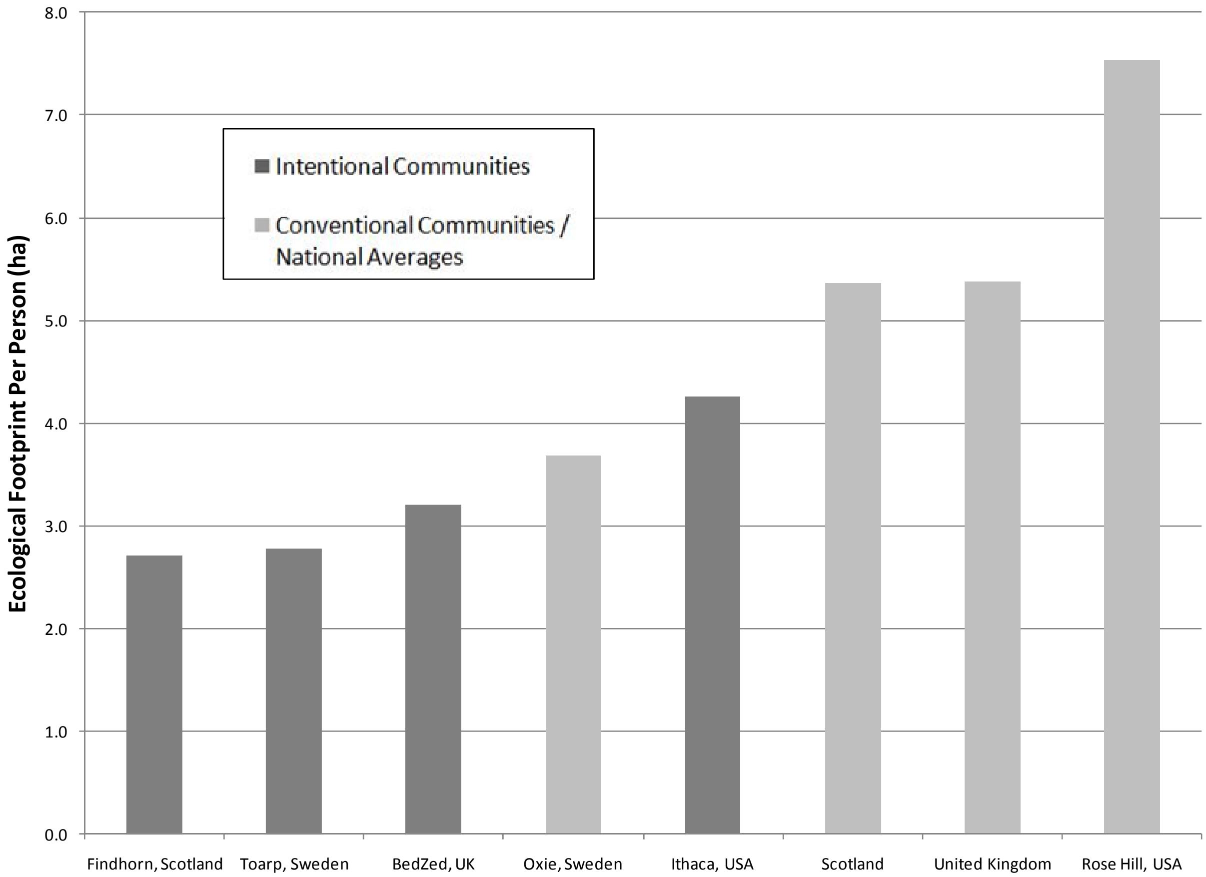
The studies above suggest that intentional communities have lower environmental impacts per capita than conventional communities. Table 2.2 outlines the per capita ecological footprints for the communities and nations discussed above. The ecological footprints are disaggregated into major categories of housing & energy, food, transportation, consumables and other. The category 'other' includes a variety of elements such as government services and capital investment. It is important to note that EF calculation methods may vary from study to study; however, the overall methodological frameworks are consistent.

Table 2.2: Ecological Footprints of Various Intentional and Conventional Communities/Nations

	Ecological Footprint (ha/person)					
Community	**Housing & Energy**	**Food**	**Transportation**	**Consumables**	**Other**	**Total**
Intentional Communities						
Toarp, Sweden	1.15	0.93	0.42	0.15	0.13	**2.78**
Findhorn, Scotland	0.29	0.42	0.37	0.3	1.33	**2.71**
BedZed, UK	0.36	0.99	0.26	0.37	1.22	**3.20**
Ithaca, USA	1.58	1.38	1.30	0.00	0.00	**4.25**
Average	**0.84**	**0.93**	**0.59**	**0.21**	**0.67**	**3.24**
Conventional Communities / National Averages						
Oxie, Sweden	1.41	1.36	0.49	0.28	0.15	**3.69**
Scotland	1.33	1.06	0.99	0.67	1.31	**5.36**
United Kingdom	1.35	1.14	0.85	0.65	1.39	**5.38**
Rose Hill, USA	2.51	2.51	2.51	0.00	0.00	**7.53**
Average	**1.65**	**1.52**	**1.21**	**0.40**	**0.71**	**5.49**

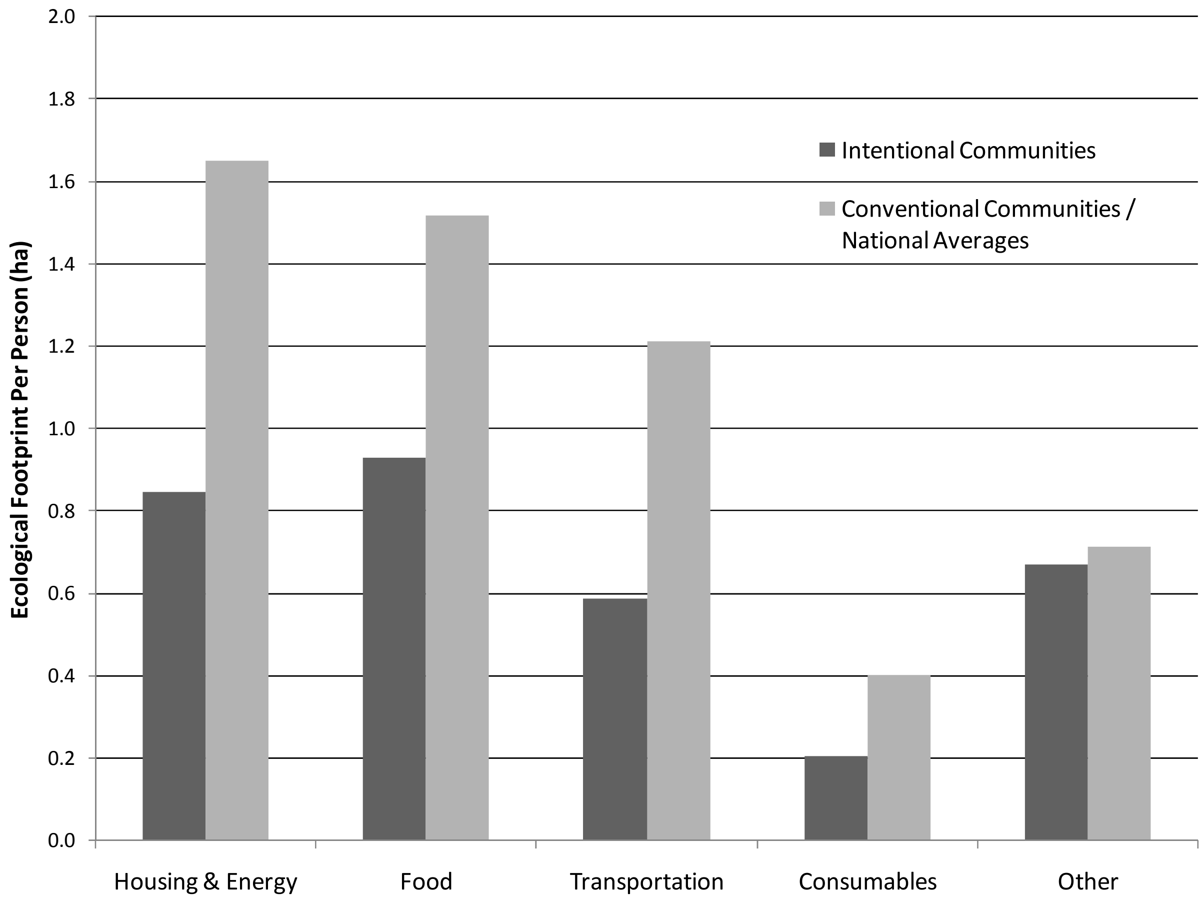
The ecological footprint for intentional communities ranges from 2.7 to 4.3 ha/person while the footprint for conventional communities ranges from 3.7 to 7.5 ha/person. Figure 2.1 shows the total per capita ecological footprint of each community or nation.

Figure 2.1: Per Capita Ecological Footprint by Community or Nation



The Findhorn ecovillage has the lowest per capita ecological footprint while the 1-acre lot subdivision, Rose Hill, has the highest footprint. Figure 2.2 shows the average per capita ecological footprint for both intentional and conventional communities based on category. Housing & energy account for the largest portion of the conventional ecological footprint while food accounts for the largest portion of the intentional communities' footprint.

Figure 2.2: Average per Capita Ecological Footprint by Category and Community Type



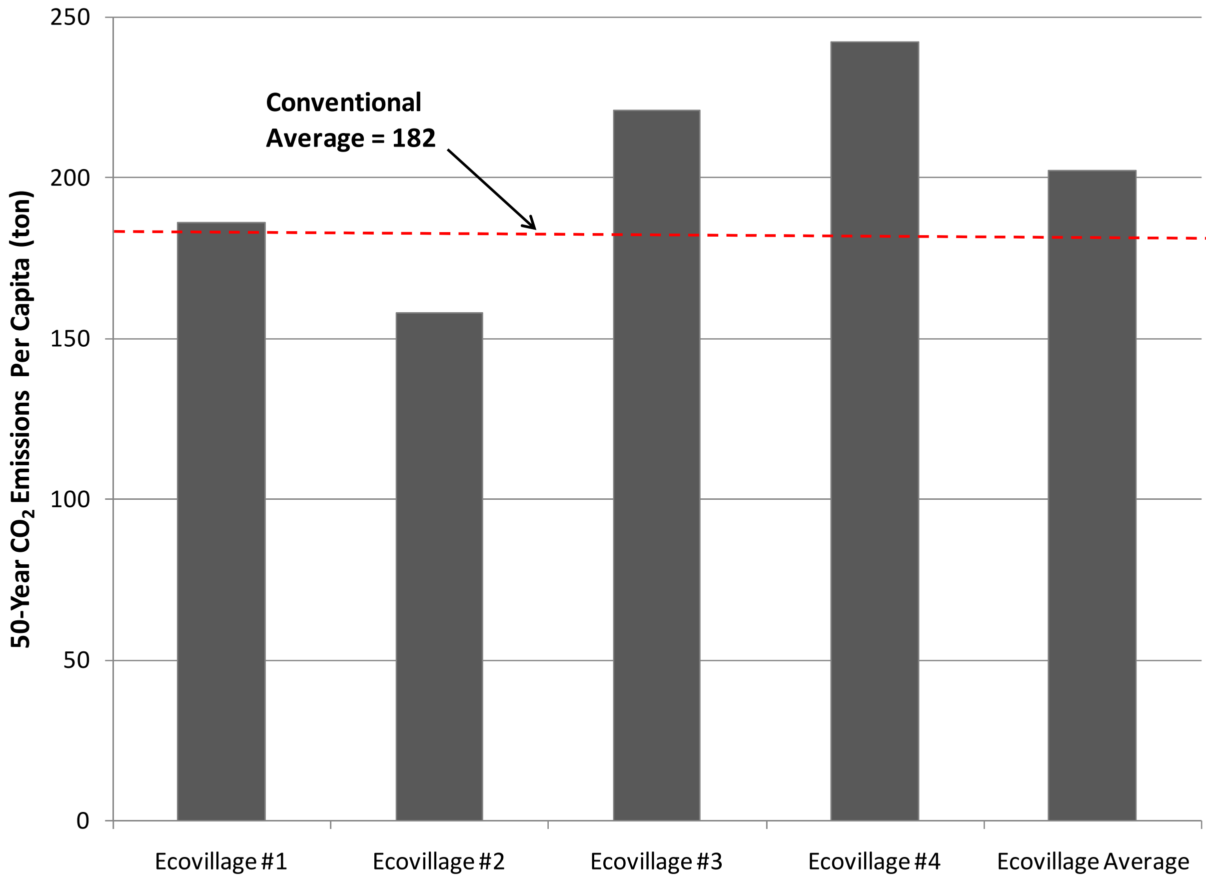
2.3.2 Carbon Dioxide Emissions

Carbon dioxide (CO_2) emissions is another metric used to measure environmental performance. Harmaajarvi (2000) developed the EcoBalance Model in Finland as a tool to estimate the life-cycle environmental impacts of residential development, including production of carbon dioxide emissions. Model inputs include details of building materials and transportation networks while model exports include total energy consumption and production of emissions. Four ecovillages and two conventional detached home developments were assessed using the EcoBalance model. Figure 2.3 shows the average per capita 50-year life-cycle carbon dioxide (CO_2) emissions for the four ecovillages as well as the conventional development average.

Harmaajarvi's study shows that the average ecovillage produces more carbon dioxide per capita than the average conventional development. Ecovillage #4 produces 33% more carbon dioxide per capita than the average conventional development while Ecovillage #2 produces 13% less carbon dioxide per capita.

One factor that explains variations in carbon dioxide emissions is private automobile use, which is largely dependent on neighbourhood location. The four ecovillages are remote, thereby creating a reliance on private automobiles. Harmaajarvi does not explicitly state the distances travelled in private automobiles by each community; however, he does state that certain communities are located in closer proximity to city centers. Other important factors that influence carbon dioxide emissions include consumption of heating energy and electricity. The environmental impacts associated with food systems are not included in Harmaajarvi's study.

Figure 2.3: Life Cycle Carbon Dioxide Emissions of Four Finnish Ecovillages



2.4 *Environmental Behavioural Change*

The above research shows how intentional communities compare to conventional communities with respect to environmental impacts. The question remains, however, whether members of intentional communities would have had similarly low environmental impacts if they continued to live in conventional communities, or are environmental behavioural changes induced by living in an intentional community? Meltzer (2000a, 2000b) addresses this question in his research on cohousing with some of his results summarized in Bamford and Hindmarsh's 2001 paper.

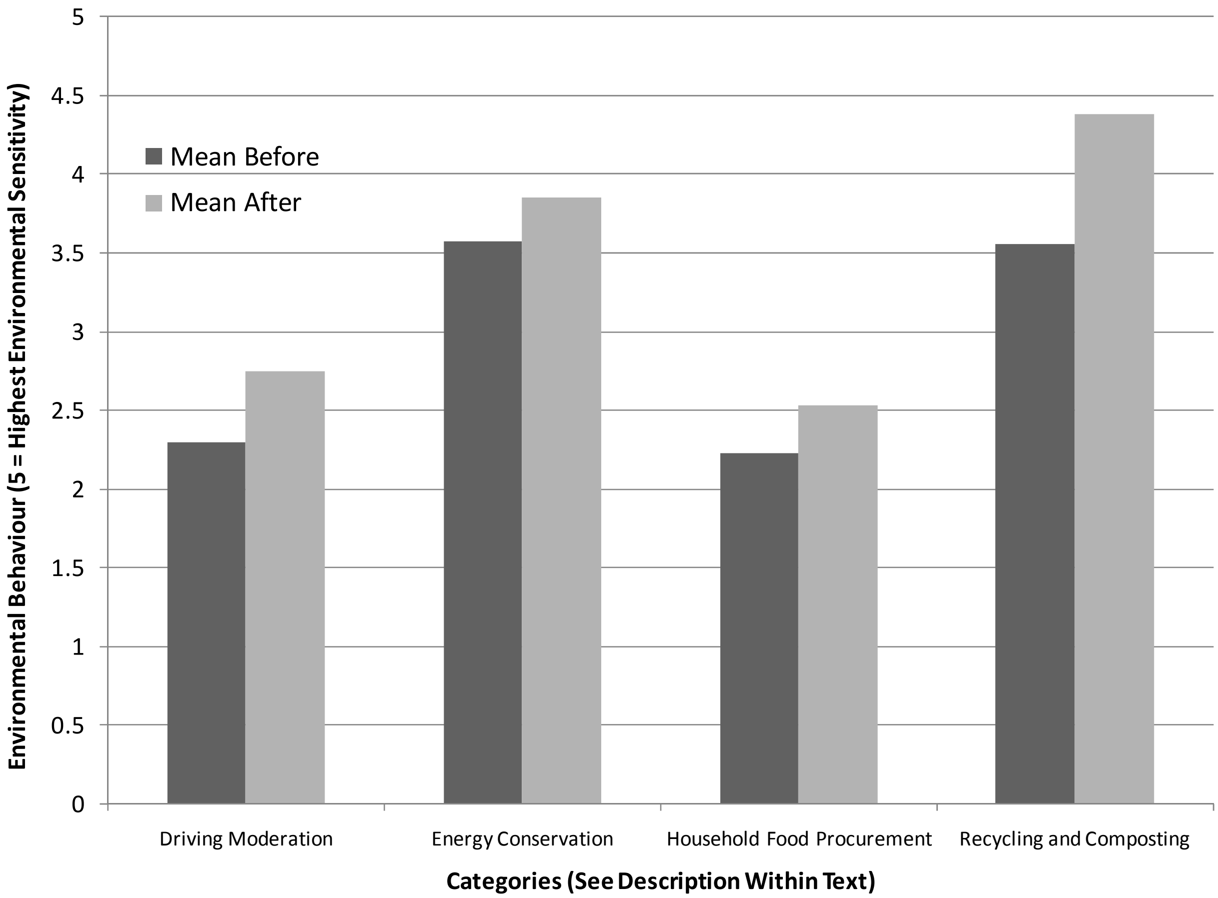
Meltzer attempts to quantify the extent to which living in cohousing, in the USA, produces pro-environmental behavioural change in its residents. His research involved surveying 346 households in 18 different cohousing communities. Meltzer finds that the average cohousing resident moved from a larger dwelling unit to a smaller unit when transitioning into cohousing. He also finds a reduction in consumables due to an increase in shared amenities.

Figure 2.4 shows the reported improvements in pro-environmental behaviour after moving to cohousing based on four categories:

1) *Driving Moderation* – Car pooling, biking or walking instead of driving
2) *Energy Conservation* – Low energy fittings, switching lights off, turning heat down
3) *Household Food Procurement* – Purchasing food in bulk and local food production
4) *Recycling and Composting* – Separating waste streams and composting organic materials

Residents ranked their behaviour before and after moving to cohousing on a scale of 1 (never) to 5 (always). A higher number coincides with greater environmentally-sensitive behaviour. The figure shows that residents tend to increase their pro-environmental behaviour after moving into cohousing communities. The improvement in driving moderation is likely more significant considering that most cohousing communities are located away from city centers. Using a composite indicator for four household behaviours (water and energy conservation, waste and toxicity reduction), Meltzer also finds that pro-environmental behaviour increases with time spent in cohousing.

Figure 2.4: Environmental Behaviours Before and After Relocating to a Cohousing Community



Residents of intentional communities, including cohousing, commonly choose to be part of a specific community in order to behave in accordance with their values. Meltzer's research suggests that living in an intentional community, with others who have similar values, may contribute to personal behavioural change over time.

2.5 *Discussion of Previous Findings*

The above permits a number of conclusions:

1. Many intentional communities, including ecovillages and cohousing projects, have arisen from ecological concerns.

2. There are many methods or indicators by which to assess the ecological impacts of a community including ecological footprint analysis, carbon dioxide emissions and life cycle analysis.

3. Intentional communities are variably effective in reducing their ecological impacts relative to conventional communities. Several studies indicate that intentional communities have less ecological impact per capita than conventional communities. Harmaajarvi's 2000 study in Finland, however, shows contrary results where the average ecovillage emits more carbon dioxide per capita than the average conventional development, pointing to the important relationship between neighbourhood location and transportation impacts. It should be noted that Harmaajarvi's study does not include the emissions associated with food systems, which could have altered his findings.

4. A community's ecological impact can be disaggregated into many categories including food, housing energy, transportation, built infrastructure and consumables. The relative ecological impact of each category is a function of many variables including design, technology, planning, behavioural choices as well as the interrelationships between these variables. In general, food, housing energy and transportation are the most ecologically impactful areas.

5. Pro-environmental behaviour may be influenced by living in an intentional community. A US study suggests that living in an intentional community, with others who have similar values, may enhance environmental behavioural change.

3.0 Methods, Data Collection and Calculation Assumptions

3.1 *Methods*

Of the methods reviewed in Section 2, I chose to use ecological footprint analysis (EFA) in this study over other methods due to its prevalence in the literature for this type of assessment, its comprehensiveness in the face of data constraints and the fact that it incorporates sequestration of carbon dioxide emissions. Life cycle analysis has extensive data requirements and has limited utility for this type of study as it is usually conducted on one product or service at a time.

I used the component ecological footprint method due to its applicability at the community scale. Table 3.1 outlines the variables included in my study as well as each variable's data source(s). I used a simplified version of the component method that encompasses 14 of 24 variables (Simmons *et al.* 2000). Many variables are not applicable to the study sites and are therefore disregarded. This includes road haulage, rail freight, sea freight and air freight as well as electricity produced by means other than hydropower, which does not apply to either community. Other variables are not included in my study because of challenges with data availability. This includes water consumption, forest products, and inert and commercial wastes. Water use is not metered at OUR Ecovillage; therefore, I decided to exclude this variable in the EFA especially considering that the footprint associated with water consumption is typically low relative to other footprint components. Some forest products were incorporated in the EFA as part of separate components including paper use and wood consumed for heating. Additional forest products would require extensive monitoring periods and were therefore excluded from the EFA. Similarly, inert and commercial wastes were excluded from the EFA because they are only generated during intermittent renovations and would need to be monitored over extended periods of time.

Table 3.1: Ecological Footprint Component Variables Included in Study

Components	Variable	Data Source(s)	
		OUR Ecovillage	Quayside Village
Transportation	Travel by Private Vehicles	Surveys	Surveys
	Travel by Airplane	Surveys	Surveys
	Travel by Bus	Surveys	Surveys
	Travel by Train	Surveys	Surveys
	Road Haulage	Not applicable	Not applicable
	Rail Freight	Not applicable	Not applicable
	Sea Freight	Not applicable	Not applicable
	Air Freight	Not applicable	Not applicable
Energy	Electricity - domestic	Utility Bills	Utility Bills/Survey
	Natural Gas - domestic	Not applicable	Utility Bills
	Electricity - other	Not applicable	Not applicable
	Gas - other (Wood)	Community Estimate	Not applicable
Consumption & Waste	Household Waste (Landfill)	Community Monitoring	Community Monitoring
	Recycled Paper	Community Monitoring	Community Monitoring
	Recycled Metal	Community Monitoring	Community Monitoring
	Recycled Glass	Community Monitoring	Community Monitoring
	Recycled - Other (Plastic)	Community Monitoring	Community Monitoring
	Compost	Not included	Community Monitoring
	Inert Waste	Not included	Not included
	Commercial Waste	Not included	Not included
Food	Food consumption	Surveys/Receipts	Surveys/Receipts
Other	Water consumption	Not included	Not included
	Forest products	Not included	Not included
	Built land	Site Drawings	Site Drawings

3.2 *Data Collection*

Data were derived from a variety of sources to calculate the ecological footprints of Quayside Village and OUR Ecovillage. As shown in Table 3.1, data necessary to calculate the transportation footprint were derived from survey questionnaires. Data for the energy component were primarily derived from utility bills. Quayside Village provided utility bills from Terasen Gas and BC Hydro. Terasen Gas bills account for all the natural gas consumed by the community while BC Hydro bills only account for electricity consumed in the complex's common spaces. I therefore asked Quayside Village residents to report on their household electricity consumption. OUR Ecovillage provided BC Hydro bills that account for all the community's electricity consumption. The ecovillage is not serviced by Terasen Gas. Their primary heating source is wood with some residents also relying on propane gas. The ecovillage provided an estimate of their wood consumption for the 2009/10 winter season.

One resident from each community participated in a waste monitoring program during May 2010. Various waste streams were monitored including garbage destined for the landfill, compost, and recycling of paper, metal, glass and plastic.

In the areas of housing-related energy and transportation, the ecological footprint of Quayside Village was compared to that of its chosen conventional counterpart, North Vancouver. Data were derived from the City of North Vancouver's 2007 Community Energy and Emissions Inventory (BC Ministry of Environment 2010).

3.2.1 Survey Questionnaires

I administered two structured quantitative questionnaires in a cross-sectional design: a preliminary and final survey. The preliminary survey was intended to allow for a cursory comparison of the study sites and to help inform how to conduct the final survey. I invited potential participants to complete a 10-15 minute internet survey during February and March 2010. In addition to residents of OUR Ecovillage and Quayside Village, I invited 305 households from North Vancouver to participate in the preliminary survey. Due to their low response rate (1.6%), data from North Vancouver residents are not included in my results or discussion.

I distributed the final survey in hard copy format to residents of Quayside Village and OUR Ecovillage during April and May 2010, inviting potential participants to complete a 30-60 minute questionnaire (Appendix B). In conjunction with the final survey, community residents collected and submitted grocery receipts and restaurant bills for the month of May 2010.

Table 3.2 summarizes the number of responses for both the preliminary and final survey questionnaires. Since one person completed a questionnaire on behalf of all members of his/her household, the final column of Table 3.1 outlines the total number of people for whom data were collected as part of the final survey. Sixteen of the ecovillage's nineteen full-time residents, and nineteen of Quayside Village's thirty eight full-time residents, were represented by the data derived from the final survey.

Table 3.2: Summary of Survey Responses

Community	**Total # of Households**	**# of Respondents**		**# of People Represented**
		Prelim Survey	**Final Survey**	
OUR Ecovillage	7	6	5	16
Quayside Village	19	12	11	19
Totals	**26**	**18**	**16**	**35**

3.3 *Calculation Assumptions*

The ecological footprint of each community is determined by using conversion factors to translate consumption categories into areas of land. In some cases, as with transportation and energy, this first involves translating measured variables into a quantity of greenhouse gas emissions, measured in kilograms of carbon dioxide equivalent[4] (kg CO2-e). Then, an additional conversion factor, 2.7 x 10^{-4} gha/kg CO2-e, is used to translate greenhouse gas emissions into global hectares of forest land necessary for carbon sequestration (GFN 2009). Waste variables are translated directly into a land area. Table 3.3 outlines conversion factors for variables related to transportation, energy and waste.

Table 3.3: Conversion Factors

			Conversion Factor		
	Variable	Description	Value	Unit	Source
Transportation	Travel by Private Vehicles	Emissions per liter of fuel consumed for small gasoline vehicles in BC	2.4	kg CO2-e/L	BC Ministry of Environment 2010
		Emissions per liter of fuel consumed for small diesel vehicles in BC	2.7	kg CO2-e/L	BC Ministry of Environment 2010
		Emissions per passenger-kilometer for cars in Metro Vancouver	0.220	kg CO2-e/passenger-km	Poudenx & Merida 2007
	Travel by Airplane	Emissions per passenger-kilometer (incl. upper atmosphere effects)	0.176	kg CO2-e/passenger-km	IPCC 2010
	Travel by Bus	Emissions per passenger-kilometer for a diesel bus in Metro Vancouver	0.070	kg CO2-e/passenger-km	Poudenx & Merida 2007
		Emissions per passenger-kilometer for the SeaBus in Metro Vancouver	0.164	kg CO2-e/passenger-km	Poudenx & Merida 2007
	Travel by Train	Emissions per passenger-kilometer for the Skytrain in Metro Vancouver	0.002	kg CO2-e/passenger-km	Poudenx & Merida 2007
Energy	Electricity	Emissions per GJ of energy for BC Hydro electricity generation	6.9	kg CO2-e/GJ	BC Ministry of Environment 2010
	Natural Gas	Emissions per GJ of energy for Terasen natural gas production	51.0	kg CO2-e/GJ	BC Ministry of Environment 2010
	Gas - other (Wood)	Emissions per kilogram of softwood	0.89	kg CO2-e/kg	Resurgence 2010
Consumption & Waste	Household Waste (Landfill)	Ecological footprint per tonne of landfilled paper	3.4	ha/tonne	Chambers *et al.* 2000
		Ecological footprint per tonne of landfilled aluminum	13.6	ha/tonne	Chambers *et al.* 2000
		Ecological footprint per tonne of landfilled glass	1.05	ha/tonne	Chambers *et al.* 2000
		Ecological footprint per tonne of landfilled plastic	3.85	ha/tonne	Chambers *et al.* 2000
	Recycled Paper	Ecological footprint per tonne of recycled paper	2.45	ha/tonne	Chambers *et al.* 2000
	Recycled Metal	Ecological footprint per tonne of recycled aluminum cans	0.65	ha/tonne	Chambers *et al.* 2000
	Recycled Glass	Ecological footprint per tonne of recycled glass	0.85	ha/tonne	Chambers *et al.* 2000
	Recycled Plastic	Ecological footprint per tonne of recycled plastic	2.2	ha/tonne	Chambers *et al.* 2000

[4] Since greenhouse gases have different global warming potentials, the total global warming potential is often expressed in CO_2 equivalents (CO2-e) with 1 kg of CH_4 being equivalent to 25 kg of CO_2, and 1 kg of N_2O equivalent to 298 kg CO_2 over a 100-year time horizon (IPCC 2007).

With respect to private vehicle use, residents of Quayside Village and OUR Ecovillage were asked to report on the type and age of their vehicles. When this information was provided, fuel consumption was estimated using the vehicle's average fuel efficiency. In this case, GHGs were then calculated using the BC Ministry of Environment (2010) conversion factors below for small gasoline or diesel vehicles. When vehicle information was unavailable, the Poudenx & Merida (2007) conversion factor was used to translate VKTs into GHG emissions.

4.0 Results and Discussion

Section 4.1 presents socioeconomic information for OUR Ecovillage and Quayside Village while Section 4.2 considers the results of an online footprint quiz that was conducted by residents of both communities. Subsequently, I examine ecological footprints for both intentional communities estimated using a simplified component method. Sections 4.3 – 4.7 each consider one of the various components of the two intentional communities' ecological footprints including housing energy, transportation, consumption & waste, food and built-up land. Section 4.8 aggregates the ecological footprint components for an overall EF comparison of the two communities. Finally, Section 4.9 presents an overall discussion of my findings.

4.1 *Socioeconomic Comparison*

Participants reported on their household income and cost of living in the survey questionnaires. For the purpose of this study, cost of living only includes rent and/or mortgage payments for housing. Table 4.1 summarizes the average annual income, income tax, cost of living and disposable income for OUR Ecovillage and Quayside Village. The disposable income of the average Quayside household is 30% greater than the average household at OUR Ecovillage.

Table 4.1: Income Levels of Surveyed Households

	Annual Average Per Household			
	Pre-Tax Income	Income Tax	Cost of Living	Disposable Income
OUR Ecovillage	$43,250	$7,000	$8,400	$27,850
Quayside Village	$61,900	$12,500	$13,400	$36,000

4.2 *Preliminary Footprint Comparison*

As part of the online preliminary survey, participants had the option to undertake the Global Footprint Network's ecological footprint quiz (GFN 2010). This quiz allows users to compare their personal ecological footprints to national and global averages. I used the quiz to understand how the ecological footprints of residents in both communities compare to one another as well as how they compare to conventional averages.

Table 4.2 summarizes the average and range of ecological footprints for respondents in both communities. Figure 4.1 illustrates the average per capita ecological footprint for each community. The minimum ecological footprint that can be obtained from the GFN quiz is 4.3 gha. Approximately 2.6 gha of every user's ecological footprint is attributable to services, which is not a variable in the calculator. Services encompass a variety of elements including health care, legal, government and military services.

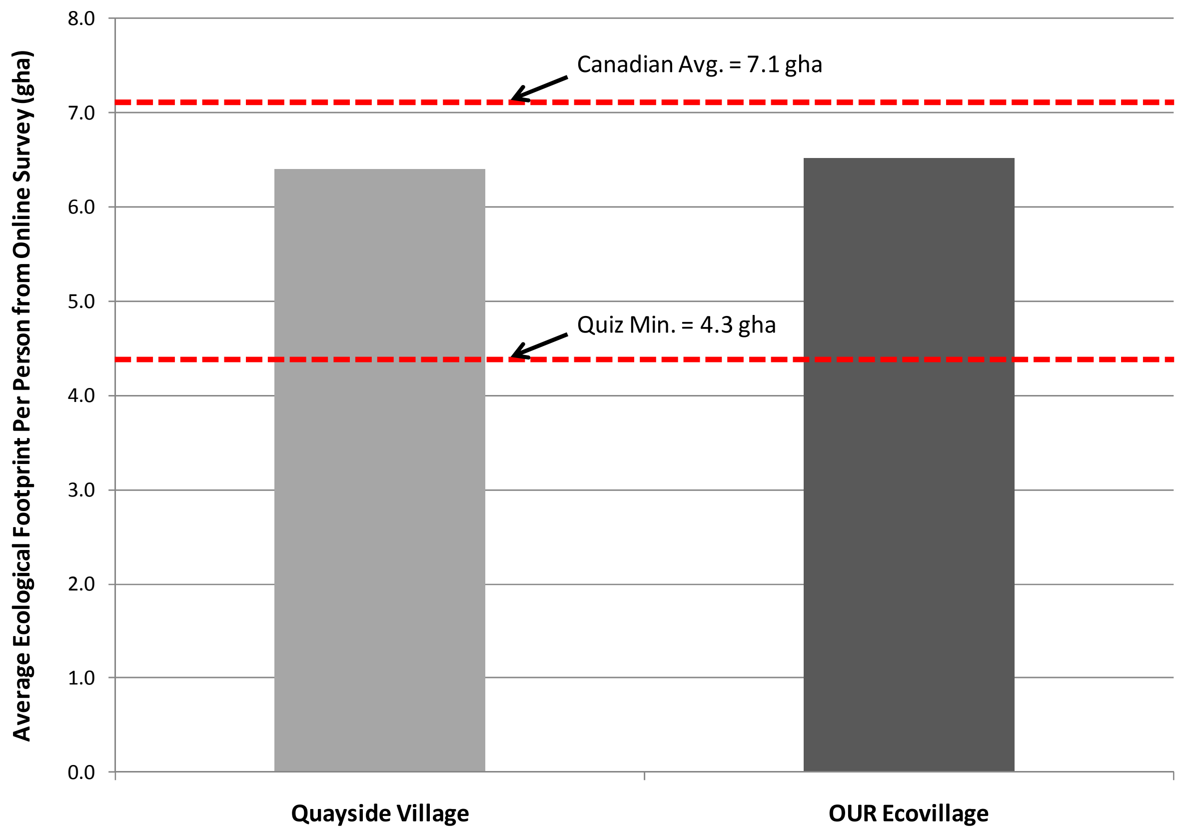
Table 4.2: Global Footprint Network Ecological Footprint Quiz Results

	Per Capita Ecological Footprint (gha)			Number of Respondents
Community	**Minimum**	**Maximum**	**Average**	
Quayside Village	5.7	7.1	6.4	5
OUR Ecovillage	4.8	8.8	6.5	6
		Canadian Average	**7.1**	

All five Quayside residents who completed the quiz exhibited ecological footprints at or below the Canadian average of 7.1 gha. Moreover, Quayside Village exhibited a difference of only 1.4 gha between the highest and lowest per capita footprints.

In contrast, OUR Ecovillage exhibited a difference of 4.0 gha between the highest and lowest per capita footprints. Furthermore, the ecovillage displayed both the highest and lowest individual footprints of all participants.

Figure 4.1: Average Per Capita Ecological Footprints from Global Footprint Network Quiz



Despite the small sample sizes, the above results suggest that:

1. Residents of the two intentional communities have, on average, lower ecological footprints than the average Canadian.

2. Quayside Village and OUR Ecovillage have, on average, similar per capita ecological footprints.

These preliminary conclusions are explored further in subsequent sections by examining the various components of each community's ecological footprint, which I derived using a simplified component method.

4.3 *Energy Footprint*

The energy component of a community's ecological footprint includes its consumption of electrical and heating energy. Both communities are serviced by BC Hydro for electricity. Quayside Village's primary heating source is natural gas from Terasen Gas while OUR Ecovillage's primary heating source is wood from on-site and off-site sources. The dwelling units at Quayside are each equipped with a natural gas fireplace and electric baseboard heaters for space heating. Natural gas is also used to heat water at Quayside Village. OUR Ecovillage uses a mix of softwood for space heating and a combination of propane and solar energy for water heating. The ecovillage has one outdoor shower that is connected to a solar collector, which is used by guests and interns in the summer months. The ecovillage's Climate Change Demonstration Building is equipped with electrically-powered hydronic radiant floor heating[5].

Table 4.3 summarizes the per capita energy consumption, greenhouse gas emissions and ecological footprint associated with each energy source for 2009. Figure 4.2 illustrates the per capita energy ecological footprint for each community. The ecological footprint for both communities is approximately 0.3 gha/person with the footprint predominately associated with heating via natural gas or wood.

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[5] Hydronic radiant floor heating is an efficient method of heating, which uses hot water to disperse heat through a system of plastic or metal tubes/pipes laid within the floor.

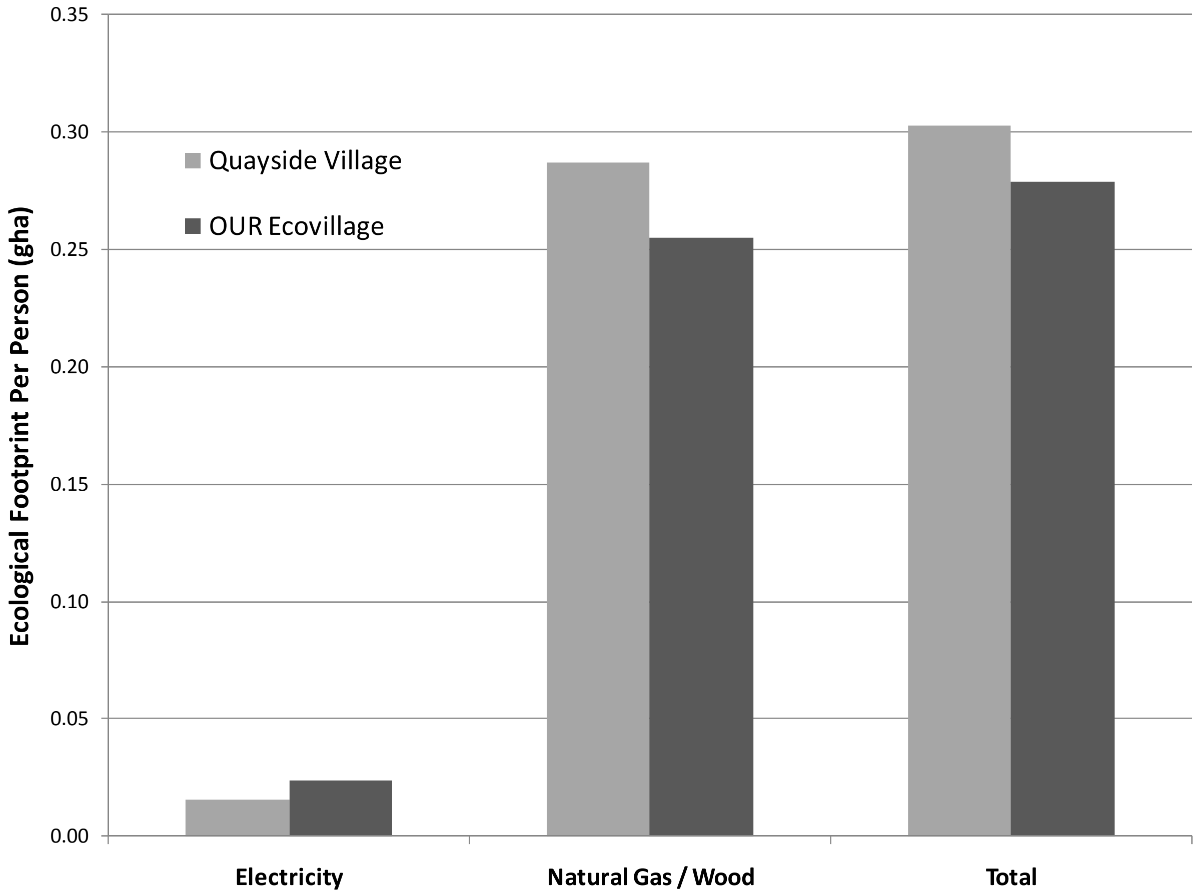
Table 4.3: Per Capita Energy Consumption, Greenhouse Gas Emissions and Ecological Footprint by Energy Source for Quayside Village and OUR Ecovillage (2009)

	Consumption (2009)			GHG Emissions (ton CO2-e)		Ecological Footprint (gha)	
Energy Source	**Quayside**	**OUR**	**Units**	**Quayside**	**OUR**	**Quayside**	**OUR**
BC Hydro	2336	3550	kWh	0.06	0.09	0.02	0.02
Terasen Gas	21	N/A	GJ	1.05	0.00	0.29	0.00
Wood	N/A	1000	kg	0.00	0.93	0.00	0.25
			Total	**1.11**	**1.02**	**0.30**	**0.28**

OUR Ecovillage consumed 50% more electricity per capita than Quayside Village in 2009. It is presumed that this is, in part, due to the high number of guests and interns that use the ecovillage's facilities in the summer. Both communities host a number of events and guests; however, OUR Ecovillage hosts more guests than Quayside Village. Due to the challenge of accurately estimating the number of guests in both communities, they were not accounted for when calculating per capita consumption and impacts. Instead, the total electricity consumption of each community was divided by the number of full-time residents.

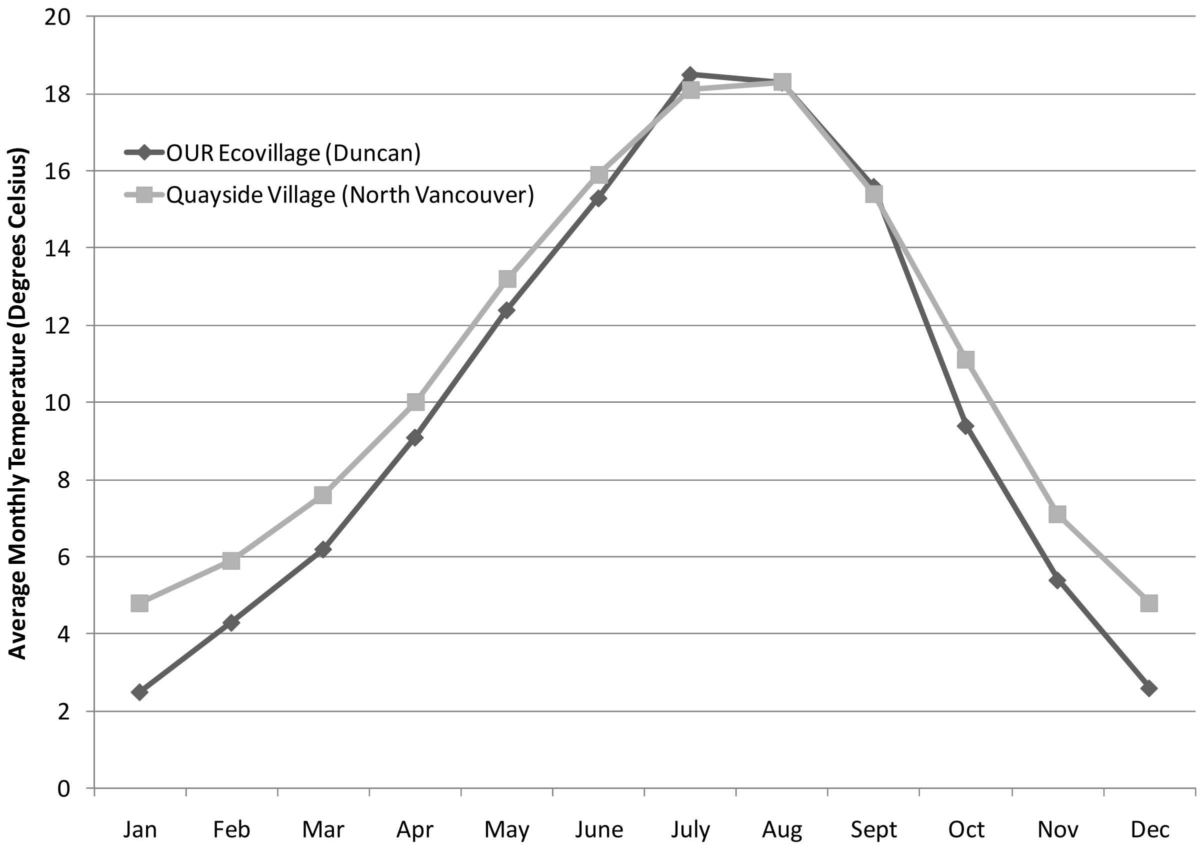
Another potential reason for higher electricity consumption at OUR Ecovillage is that ecovillage residents work on-site more than Quayside residents, resulting in electricity consumption throughout the day. Electricity is also consumed by the ecovillage's groundwater well pump that provides water for residents and the garden. On the other hand, Quayside residents rely, in part, on electricity for space heating. This suggests that further investigation is necessary to understand these differences in electricity consumption.

Figure 4.2: Per Capita Energy Ecological Footprint by Energy Source



The footprint associated with Quayside's gas consumption is approximately 15% greater than the footprint associated with the ecovillage's wood consumption. This difference is even more significant when one considers the additional energy consumed at Quayside for space heating via electrical baseboard heaters as well as climatic differences. As illustrated in Figure 4.3, the average monthly temperatures at OUR Ecovillage are lower than at Quayside Village, specifically during the winter months when space heating is required (Weather Network 2010).

Figure 4.3: Average Monthly Temperatures at OUR Ecovillage and Quayside Village



As with electricity, heating energy consumption of each community was divided by the number of full-time residents. However, the per capita calculations were not confounded by guests since space heating is primarily confined to winter months when there are limited guests in both communities.

It is important to note that the energy ecological footprint only represents energy land, or the forest area necessary to sequester GHG emissions. Built-up land would represent a nominal increase in the footprint associated with both energy sources. For example, the footprint associated with hydroelectricity generation would increase if one included the land area and embodied energy of BC Hydro's dams and other infrastructure.

4.3.1 Comparison with City of North Vancouver Averages

In 2007, the City of North Vancouver conducted an energy and greenhouse gas emissions inventory. According to this inventory, the City's residential buildings consumed 561,396 GJ of electricity and 670,647 GJ of natural gas in 2007 (BC Ministry of Environment 2010). Table 4.4 summarizes the per capita energy consumption, greenhouse gas emissions and ecological footprint associated with both energy sources in 2007 for the City of North Vancouver and Quayside Village.

Table 4.4: Per Capita Energy Consumption, Greenhouse Gas Emissions and Ecological Footprint by Energy Source for Quayside Village and City of North Vancouver (2007)

	2007 Energy Consumption (GJ)		GHG Emissions (ton CO2-e)		Ecological Footprint (gha)	
Energy Source	**Quayside**	**N. Vancouver**	**Quayside**	**N. Vancouver**	**Quayside**	**N. Vancouver**
BC Hydro	9.2	12.4	0.06	0.09	0.02	0.02
Terasen Gas	20.3	14.8	1.03	0.76	0.28	0.21
Total	**29.5**	**27.3**	**1.10**	**0.84**	**0.30**	**0.23**

In 2007, Quayside Village consumed approximately 25% less electricity, and 40% more natural gas, per person than the City of North Vancouver. Overall, Quayside consumed 8% more housing-related energy per person than North Vancouver. Since there is approximately 7 times more GHG emissions per unit energy for natural gas than hydroelectricity in BC (51 vs. 7 kg CO2-e/GJ), the overall energy footprint per capita of Quayside Village is 30% greater than North Vancouver.

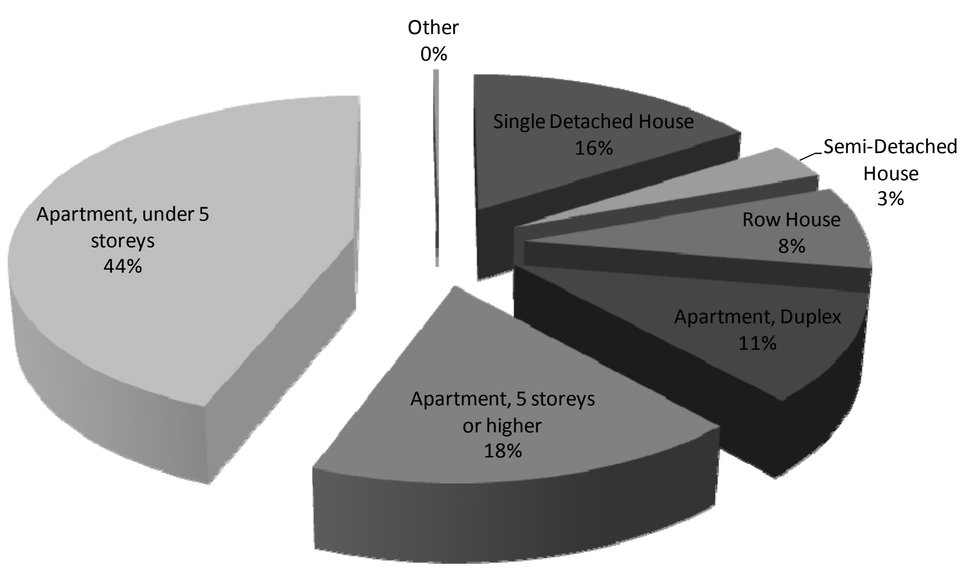
There are many potential reasons for these differences in energy consumption patterns:

1. Heating Energy Sources: Since many buildings in the City of North Vancouver are heated via electrical energy, it is not surprising that the average North Vancouver resident consumes more electricity than the average Quayside resident. Despite

having electric baseboard heaters, discussions with Quayside residents indicate that that most households rely primarily on natural gas fireplaces for space heating.

2. Building Typology: Energy consumption is dependent on building typology, or the design and construction characteristics of dwellings. Table 4.4 aggregates energy consumption data for all dwelling types in both communities. The majority of households in the CoNV and at Quayside are apartment units; however, both communities comprise other dwelling types. Figure 4.4 illustrates the composition of North Vancouver's building stock. Quayside Village's unique building typology includes a common house and individual dwellings in apartment and townhouse styles.

Figure 4.4: Housing Types in North Vancouver



3. Building Design: Quayside Village is comprised of a 240 sq.m common house plus 19 individual dwelling units arranged along an outdoor single-loaded corridor[6]. In addition to the common house creating heating demand, individual units experience heat loss from high surface areas exposed to the outdoor elements.

   Discussions with Quayside residents also highlighted inefficiencies of the common house's large fireplace. The fireplace is described as being ornamental as opposed to functional. A large quantity of heat produced by the fireplace is vented outside instead of being directed into the common house. This means that more natural gas is required to heat the common house than is necessary.

4.4 *Transportation Footprint*

The transportation component of a community's ecological footprint includes use of private vehicles, public transportation and air transportation. Table 4.5 and Figure 4.5 illustrate the per capita ecological footprint for transportation use at Quayside Village and OUR Ecovillage.

Table 4.5: Per Capita Ecological Footprint by Transportation Mode

	Ecological Footprint (gha/person)					
	Private Vehicles	Public Transport	Air Transport	Total	Lowest Value	Highest Value
Quayside Village	0.34	0.00	0.60	0.94	0.02	1.87
OUR Ecovillage	0.39	0.00	0.28	0.67	0.17	1.88

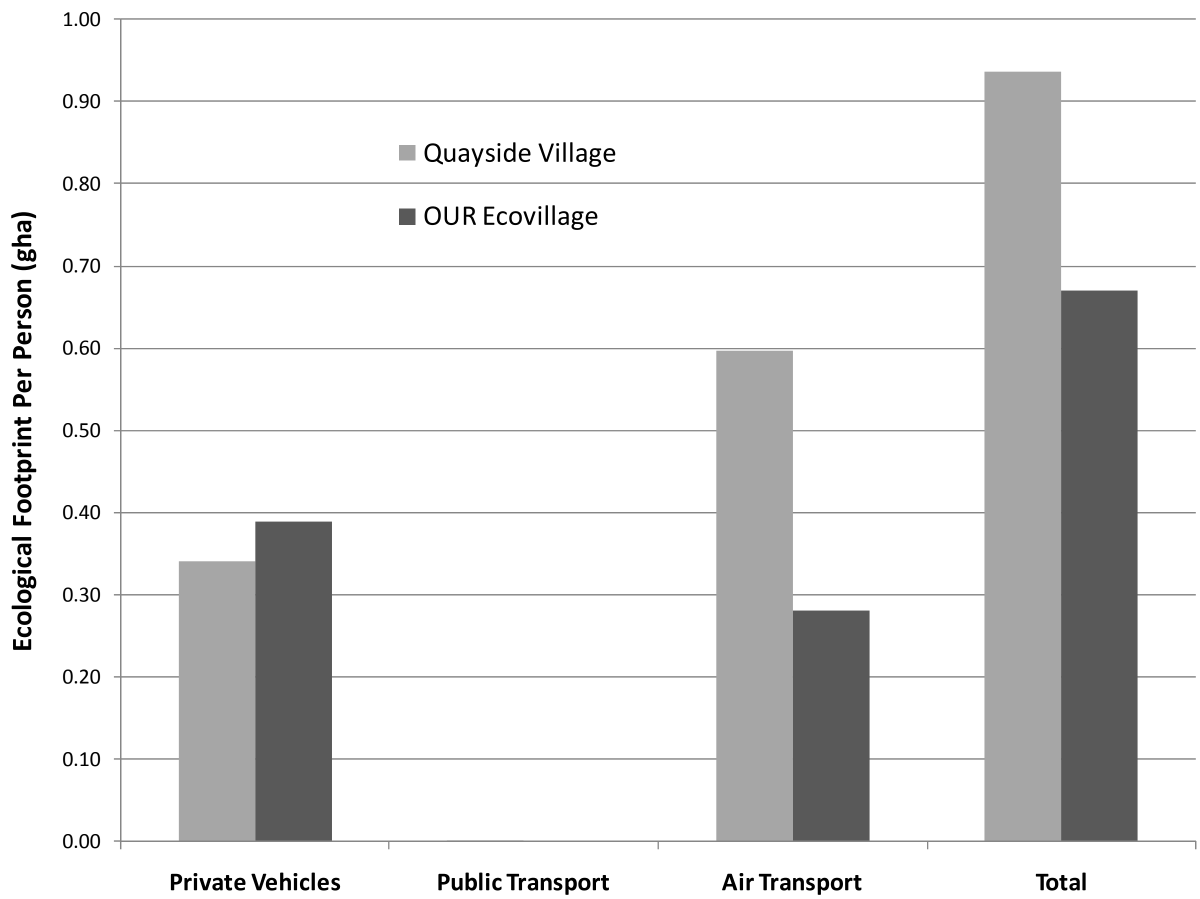
The total ecological footprint associated with transportation at Quayside Village and OUR Ecovillage is 0.94 and 0.67 gha/person, respectively. The majority of Quayside's

[6] A single-loaded corridor is a building arrangement where all the dwellings are along one side of the access corridor. The corridor can be outdoors or indoors.

transportation ecological footprint is attributable to air travel while the largest component of OUR Ecovillage's transportation footprint is attributable to private vehicles.

The per capita footprint associated with private automobile use at the ecovillage is approximately 15% greater than at Quayside Village. This corroborates my observations that OUR Ecovillage residents rely heavily on private vehicles. The ecovillage is located in a rural setting. Therefore, residents rely on private vehicles to access services and amenities. Residents often travel to Victoria or Duncan, which are 45km and 25km from the ecovillage, respectively. Conversely, Quayside residents are located in a dense, urban center where services and amenities are often within walking distance.

Figure 4.5: Per Capita Ecological Footprint by Transportation Mode



The per capita footprint associated with air travel at Quayside is approximately 200% greater than at OUR Ecovillage. This suggests that the average ecovillage resident may be more inclined to spend leisure or holiday time on-site, possibly because the ecovillage is host to many events and guests. However, this difference in air travel may also be associated with differences in disposable income levels, as discussed in Section 4.1. The disposable income of the average Quayside household is 30% greater than the average ecovillage household. Furthermore, the average household at Quayside reports to spend approximately $2,600 per year on holidays while the average household at OUR Ecovillage only reports to spend $1,000. It is also possible that the average ecovillage resident may be more environmentally conscious than the average Quayside resident with respect to the impacts of air travel and, therefore, chooses to limit his/her flights.

While spending time at OUR Ecovillage and Quayside Village, I observed differences in residents' commitment levels to environmentally superior forms of transportation. This observation is supported by the range of individual transportation footprints within each community. The per capita footprint ranges from 0.02 – 1.87 gha at Quayside Village and 0.17 – 1.88 gha at OUR Ecovillage. Members of two households in Quayside Village demonstrate a transportation footprint of less than 0.15 gha/person. In both cases, these residents have not travelled by air over the course of the past year. Moreover, both households do not own private vehicles and, instead, rely heavily on public transportation. Alternatively, every household at OUR Ecovillage owns a private vehicle.

Quayside Village is located in close proximity to many public transportation options including the SeaBus and local bus system. Many Quayside residents reported using public transportation on a regular basis. Still, the overall per capita footprint associated with public transportation is only 0.0004 gha. Public transportation options are limited for residents of OUR Ecovillage. Consequently, no ecovillage resident reported using public transportation. That being said, it is common for residents to carpool or car-share at the ecovillage.

4.4.1 Comparison with City of North Vancouver Averages

As discussed above, the City of North Vancouver conducted an energy and greenhouse gas emissions inventory in 2007. According to this inventory, over 37 million liters of gasoline and approximately 900,000 liters of diesel were consumed by passenger vehicles in the CoNV (BC Ministry of Environment 2010). Table 4.6 summarizes the per capita fuel consumption, greenhouse gas emissions and ecological footprint associated with both fuel sources for the City of North Vancouver and Quayside Village.

Table 4.6: Per Capita On-Road Transportation Fuel Consumption, Greenhouse Gas Emissions and Ecological Footprint for Quayside Village and City of North Vancouver

	Fuel Consumption (L)		GHG Emissions (ton CO2-e)		Ecological Footprint (gha)	
Fuel Source	**Quayside**	**N. Vancouver**	**Quayside**	**N. Vancouver**	**Quayside**	**N. Vancouver**
Gasoline	476	827	1.13	1.97	0.31	0.54
Diesel	42	20	0.11	0.05	0.03	0.01
Total	**518**	**846**	**1.25**	**2.02**	**0.34**	**0.55**

As shown in Table 4.6, the average North Vancouver resident consumes approximately 60% more on-road transportation fuel than the average Quayside Village resident. This translates into a 60% greater per capita transportation ecological footprint for the average North Vancouver resident.

It is important to note that, despite using the same conversion factor to translate fuel consumption into GHG emissions, the North Vancouver fuel consumption data were derived using a different method than for Quayside Village. Assuming comparable data, there are many potential reasons for the differences in fuel consumption patterns. One possible factor is proximity to services and amenities. Quayside Village may be located in closer proximity to services and amenities than the average North Vancouver resident, leading to less of a dependence on private automobiles. It is also possible, however, that the average Quayside resident is more environmentally conscious than the average North Vancouver resident and, as a result, chooses to use alternatives to the private automobile. This level of environmental consciousness may be linked to Quayside's unique cohousing model. Meltzer (2000a, 2000b) shows that residents decrease their dependence on private vehicles after moving into cohousing communities.

4.5 *Consumption and Waste Footprint*

The consumption & waste component of a community's ecological footprint includes the embodied energy of producing materials and the greenhouse gas emissions associated with disposing and/or recycling those materials. As is common with the component method, I used solid waste generation as an indicator of the impacts of both goods consumption and waste generation. However, it is important to note that many waste streams, and therefore consumption categories, are not accounted for in these calculations including compost, electronic waste (e-waste), construction & demolition waste, and wastes generated off-site but that are associated with each community's consumption.

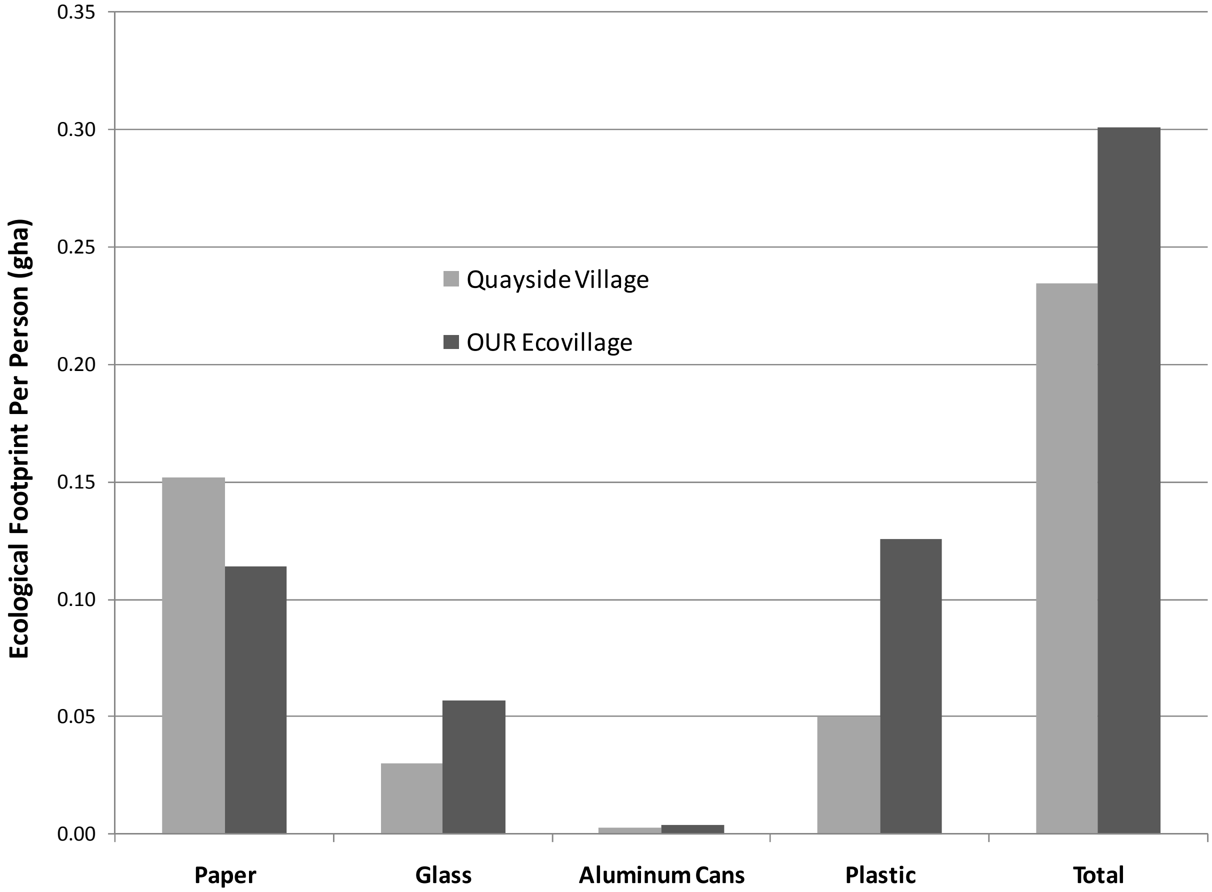
During the month of May 2010, Quayside Village and OUR Ecovillage monitored their community's waste generation including garbage destined for the landfill and recycling of paper, glass, aluminum cans and plastic. Table 4.7 and Figure 4.6 illustrate the per capita ecological footprint of consumption & waste generation at Quayside Village and OUR Ecovillage. As with energy, the consumption & waste footprint of each community was divided by the number of full-time residents; however, the visitor population in both communities was minimal during the monitoring period. A summary of calculations can be found in Appendix C.

Table 4.7: Per Capita Consumption & Waste Ecological Footprint by Material Type

	Quantity (tonne/person/year)		Ecological Footprint (gha/person)	
Material	**Quayside Village**	**OUR Ecovillage**	**Quayside Village**	**OUR Ecovillage**
Paper	0.06	0.04	0.15	0.11
Glass	0.03	0.06	0.03	0.06
Aluminum Cans	0.00	0.01	0.00	0.00
Plastic	0.02	0.04	0.05	0.13
Total	**0.11**	**0.14**	**0.23**	**0.30**

The ecological footprint associated with consumption & waste at Quayside Village and OUR Ecovillage is 0.23 and 0.30 gha/person, respectively. This includes the waste diversion efforts of both communities (i.e. recycling and composting). While spending time in both communities, I observed a high level of participation in recycling and composting. Both communities compost kitchen waste with the final product being used for on-site gardening and landscaping. OUR Ecovillage also uses cardboard as mulch in the garden.

Figure 4.6: Per Capita Consumption & Waste Ecological Footprint by Material Type



Quayside Village has established an extensive recycling program with reported diversion rates of 90-95%. Based on the solid waste monitoring program in May 2010, Quayside Village's diversion rate was found to be 87% by weight and 89% by volume. This exceeds the national average of 22% by approximately four times (FCM 2009). Quayside's ecological footprint would be approximately 50% greater without any of their recycling efforts.

Quayside Village's recycling program involves separating waste into 57 different streams. Some of these waste streams are collected by the City of North Vancouver; however, the majority of waste streams are transported off-site by Quayside residents to different recycling companies. One member of the community has championed the recycling program with other community members also taking on leadership roles.

4.6 *Food Footprint*

The food component of a community's ecological footprint includes the agricultural land and carbon sink required to grow, process and transport food and beverage for human consumption and to assimilate the associated carbon emissions. Table 4.8 illustrates the per capita ecological footprint for food consumption at Quayside Village and OUR Ecovillage. The footprint values were derived by inputting dietary information from the final surveys into the Global Footprint Network's online quiz (GFN 2010).

Table 4.8: Per Capita Ecological Footprint for Food Consumption

	Ecological Footprint (gha/person)		
	Average	**Minimum**	**Maximum**
Quayside Village	1.11	0.90	1.40
OUR Ecovillage	1.12	1.00	1.40

The average per capita ecological footprint for food consumption is approximately 1.1 gha/person at both Quayside Village and OUR Ecovillage. Residents who consume limited meat and dairy achieve the lowest food footprints. The lowest footprint, 0.9 gha, is achieved by a Quayside resident who does not eat beef, lamb or pork and only occasionally eats poultry, fish and dairy.

Residents of OUR Ecovillage share common meals during most of the year. The ecovillage employs one, or more, of its residents to purchase and prepare meals for the community and its guests. During summer months, the cook(s) will often prepare meals with food grown in the community's permaculture garden. Most meals are vegetarian; however, the ecovillage also raises animals for meat consumption including poultry, lamb and pork. Meat was only served once during my month spent at the ecovillage.

Residents of Quayside Village prepare most of their own meals at the household level. However, the community shares a meal once or twice a week in their common kitchen. Most of the common meals are vegetarian.

4.7 *Built-up Land Footprint*

Built-up land is the physical land area appropriated for human settlement, which includes buildings and paved surfaces. Built-up land is also known as degraded land as its productive bio-capacity has been lost to human development (Greater London Authority 2003). The built-up land at Quayside Village and OUR Ecovillage is approximately 0.10 ha and 0.15 ha, respectively. This translates into a per capita built-up land footprint at Quayside Village and OUR Ecovillage of 0.003 ha/person and 0.008 ha/person, respectively. Using the equivalence factor[7] of 2.39 for built-up land, this translates into a per capita built-up land footprint at Quayside Village and OUR Ecovillage of 0.006 gha/person and 0.019 gha/person, respectively (GFN 2009b).

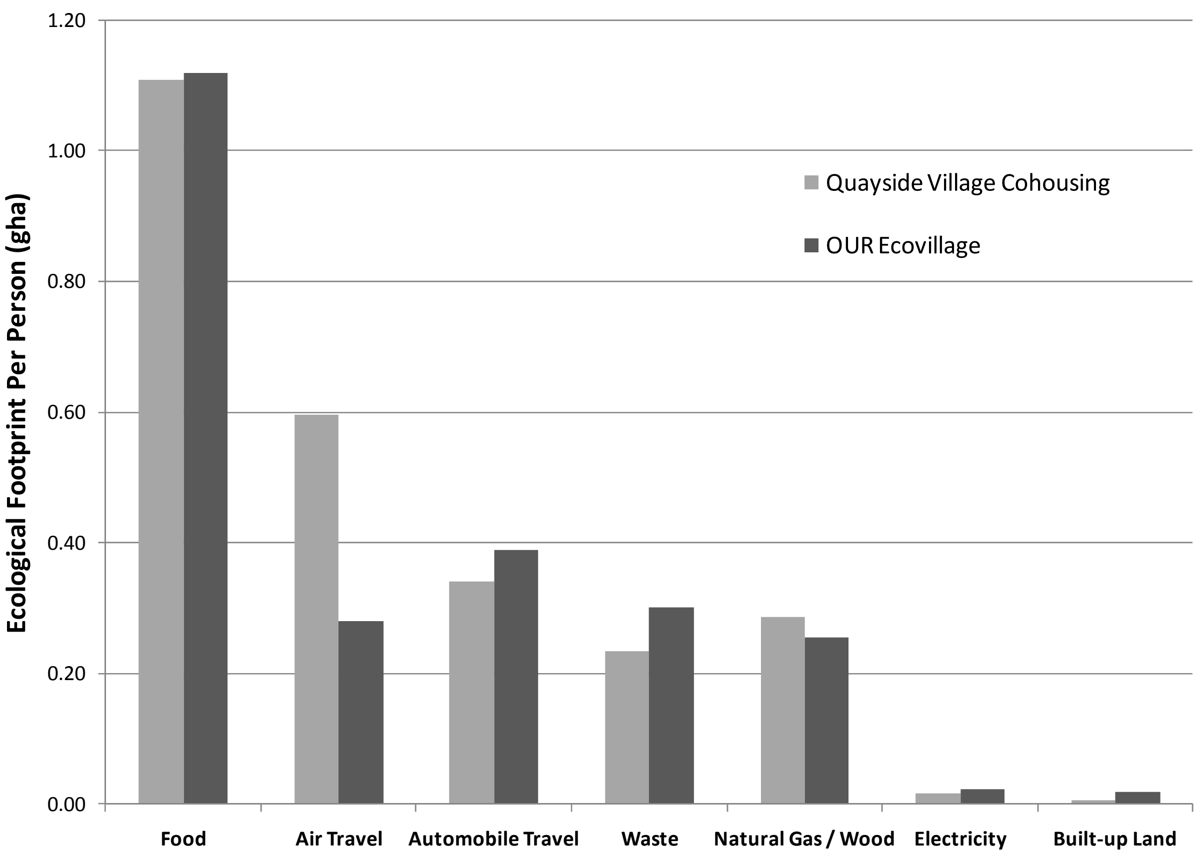
4.8 *Aggregated Footprints*

The total per capita ecological footprint for Quayside Village and OUR Ecovillage is 2.59 and 2.39 gha/person, respectively. Figure 4.7 illustrates the average per capita ecological footprint for both communities based on category.

[7] Due to productivity differentials of different land types, equivalence factors are used to convert actual land areas into their global hectare equivalents.

Food is the largest component of both communities' ecological footprints followed by transportation, housing-related energy, consumption & waste and built-up land.

Figure 4.7: Average Per Capita Ecological Footprint by Category for Quayside Village and OUR Ecovillage



4.8.1 Comparison with Global Footprint Network Quiz Results

According to the Global Footprint Network quiz results presented in Section 4.2, Quayside Village and OUR Ecovillage demonstrated per capita ecological footprints of 6.4 and 6.5 gha/person, respectively. However, using a simplified component method, I calculated per capita ecological footprints for Quayside Village and OUR Ecovillage of 2.59 and 2.39 gha/person, respectively. In other words, there is a difference of approximately 4 gha/person between each method. There are two main reasons for this difference:

1. The full component method includes 24 variables. For the purpose of this study, I completed a simplified version of the component method, which only includes 14 of these variables. See Section 3 for details.

2. The GFN online quiz assigns a constant value of 2.6 gha to services, which includes health care, legal, government and military services. These services are not included in the footprint I calculated using the simplified component method.

The per capita ecological footprints for Quayside Village and OUR Ecovillage would be 5.2 and 5.0 gha/person, if I were to add 2.6 gha/person as a base value for all Canadians who rely on consumption to maintain national services. This addition would not only decrease the difference in results obtained through the GFN quiz and component method, but would also decrease the percent difference between the per capita ecological footprints of Quayside Village and OUR Ecovillage.

4.9 *Discussion of Results*

Despite moderate sample sizes and response rates[8], a number of conclusions may be derived from the results:

1. The per capita housing-related energy footprints of OUR Ecovillage and Quayside Village are slightly higher than an average North Vancouver dwelling. This suggests that the two intentional communities do not possess an environmental advantage over conventional communities in relation to household electrical or heating energy.

[8] The transportation and food elements of the EFA are based on survey results while the energy and waste elements are based on data gathered at the community-scale. The transportation and food footprints are, therefore, affected by response rates of the final survey.

2. The overall per capita transportation footprint of Quayside Village is greater than OUR Ecovillage. While the average Quayside resident relies less on private vehicles than the average ecovillage resident, they use more air transportation. This suggests there may be a difference in the transportation habits of rural and urban intentional community residents, which may be explained by differences in on-site leisure opportunities and/or access to services and amenities. The average Quayside resident also relies less on private vehicles than the average North Vancouver resident suggesting there may be ecological benefits to Quayside's location and/or community model.

3. Both Quayside Village and OUR Ecovillage have extensive solid waste management programs. Quayside Village's program is particularly noteworthy as it diverts approximately 90% of material away from the landfill. Quayside Village and OUR Ecovillage may offer insights to conventional communities with respect to waste management and resource recovery.

4. Food is the largest component of the per capita ecological footprint at Quayside Village and OUR Ecovillage. Further research and attention is required to understand the life-cycle environmental impacts of both communities' food systems including year round monitoring or reporting of food consumption.

5. Overall, Quayside Village and OUR Ecovillage have similar per capita ecological footprints. This suggests that residents of urban and rural intentional communities may demonstrate similar environmental behaviours.

5.0 Conclusions and Recommendations

Several studies show that intentional communities have per capita ecological footprints that are less than those of conventional communities. I corroborate these findings through my own ecological footprint analyses of Quayside Village and OUR Ecovillage, in southwestern British Columbia. These communities have per capita ecological footprints that are smaller than some conventional averages. Overall, Quayside Village and OUR Ecovillage have comparatively similar per capita ecological footprints, suggesting that residents of urban and rural intentional communities may demonstrate similar environmental behaviours.

5.1 *Policy Recommendations*

The above suggests that intentional communities may offer insights on how to reduce household ecological footprints in Canada. At present, however, intentional community living is confined to small-scale grassroots initiatives so even the aggregate environmental benefits are insignificant. The following policy recommendations may help to extend the pro-environmental practices of intentional communities to society at large:

1. **Enhance the prevalence of intentional communities, especially in urban settings.**

   This can first be accomplished by increasing the number of cohousing developments. There is empirical evidence that a demand exists for this housing model in British Columbia (Hendrickson & Roseland 2010), which can be satisfied with the help of land developers and municipalities. Land developers can help potential residents by leading the design process and facilitating dialogue regarding appropriate governance and ownership models. Municipalities can help by working with groups to establish site-specific zoning and overcome other regulatory barriers. For example, the Cowichan Valley Regional District worked with OUR Ecovillage to establish a unique integrated land use zoning designation, R-4 Rural Community Residential. Similarly, the City of Chilliwack worked with Yarrow Ecovillage to establish an 'ecovillage' zoning. Municipalities are also positioned to provide financial incentives that favor communities with lower ecological footprints. Municipalities may waive or reduce Development Cost Charges (DCCs) to projects that have little or negligible impact on utility infrastructure, as may be the case with ecologically-oriented intentional communities.

There is also the potential to integrate ecovillage-type developments in an urban setting. According to the Global Ecovillage Network, there are nearly 50 self-proclaimed urban ecovillages worldwide (GEN 2009). Municipalities can provide a variety of incentives to citizens and land developers to promote ecovillage and cohousing projects.

A major barrier to enhancing the prevalence of intentional communities is the stigma or stereotypes associated with this type of development. Municipalities and land developers can assist to change the image of intentional communities through public awareness-building campaigns. Intentional communities can be profiled using local examples such as Quayside Village and OUR Ecovillage. It may also be necessary to rebrand intentional communities to appeal to a broader audience with specific attention to current demographics and housing needs.

2. **Adapt pro-environmental practices of intentional communities to a conventional context**

First, pro-environmental practices of intentional communities can be adapted to a conventional context through physical design. Municipalities can establish design guidelines that encompass cohousing and/or ecovillage principles, including:

a. Decreased individual dwelling unit sizes in exchange for increased common space and shared amenities (e.g. common kitchen, guest rooms, laundry facilities, play area, vehicles, computers & electronics, etc.). Vehicle sharing, in particular, may help to decrease the ecological impacts of transportation.

b. Community-scale waste management and resource recovery

c. Community-scale permaculture gardening and sustainable food production. It is especially important to focus efforts on food since it represents such a large portion of a community's ecological footprint.

The latter two design elements may pose particular regulatory challenges. For example, regulators may uses zoning ordinances to prohibit agricultural uses to be mixed with residential uses, especially if the agricultural uses are deemed unfavorable due to their unconventional nature. Similarly, community-scale waste management requires infrastructure, which must adhere to local codes and standards. In both cases, it is essential to first educate regulators of the advantages of these unconventional techniques. It is also essential to align with professionals who are trained in these alternative methods.

The pro-environmental practices of intentional communities can also be adapted to the conventional context through governance models. Conventional strata councils can establish rules and structures that encompass cohousing and/or ecovillage principles, including consensus decision-making and specific conflict resolution techniques.

5.2 *Future Research*

Future research is required to corroborate and enhance this study's findings. It is first necessary to increase the overall sample size by studying other similar communities. Moreover, future research should monitor all energy and material flows for longer periods of time (i.e. one year) to provide more confidence in the ecological footprint calculations.

As shown above, food is a significant component of a community's ecological footprint; however, it is also the area with the greatest uncertainty in this study. Further research is required to understand the life-cycle environmental impacts of food systems including agricultural production techniques and dietary consumption choices. This would help to refine the ecological footprint associated with community-scale food systems.

Further research is also necessary to understand the social elements of intentional community living that result in, or support, pro-environmental behavior. This would help to refine policy recommendations to advance pro-environmental practices of intentional communities.

Finally, research is required to understand the steps necessary to enhance the prevalence of intentional communities as well as adapt pro-environmental practices of intentional communities to a conventional context.

Ongoing research is necessary in the quest to reduce the environmental burdens of human settlements. Ultimately, humans need to find ways to live within the regenerative capacity of the planet by transcending conventional practice and realizing truly sustainable development models.

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Appendix A

Ethics Approval Form

The University of British Columbia
Office of Research Services
Behavioural Research Ethics Board
Suite 102, 6190 Agronomy Road, Vancouver, B.C. V6T 1Z3

CERTIFICATE OF APPROVAL - MINIMAL RISK

PRINCIPAL INVESTIGATOR:	INSTITUTION / DEPARTMENT:	UBC BREB NUMBER:
Maged Senbel	UBC/College for Interdisciplinary Studies/Community & Regional Planning	H09-01602

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
N/A	N/A

Other locations where the research will be conducted:
Questionnaires will be sent to community residents to complete in the privacy of their own homes.

CO-INVESTIGATOR(S):
Waleed Giratalla

SPONSORING AGENCIES:
N/A

PROJECT TITLE:
Comparative Study of the Ecological Impacts of Intentional and Mainstream Communities

CERTIFICATE EXPIRY DATE: July 23, 2010

DOCUMENTS INCLUDED IN THIS APPROVAL: | **DATE APPROVED:** **July 23, 2009**

Document Name	Version	Date
Protocol:		
Research Proposal	1	June 22, 2009
Advertisements:		
Flyer Advertisement	1	June 22, 2009
Questionnaire, Questionnaire Cover Letter, Tests:		
Questionnaire	2	June 28, 2009
Cover Letter	1	June 22, 2009
Letter of Initial Contact:		
Letter of Initial Contact	4	July 20, 2009

The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board
and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair
Dr. Ken Craig, Chair
Dr. Jim Rupert, Associate Chair
Dr. Laurie Ford, Associate Chair
Dr. Anita Ho, Associate Chair

Appendix B

Final Survey

Assessing Your Ecological Footprint

The ecological footprint is one way to assess our impact on the environment. It is a measure of the land area required to sustain a person's consumption and absorb their wastes.

Instructions

This survey questionnaire is divided into five sections. The questionnaire should take 30 – 60 minutes to complete. Please only fill in one questionnaire per household and complete the questionnaire on behalf of the other members of your home. You must be 19 years or older to participate. Forms must be completed and returned by **June 5, 2010**.

In addition, we ask that you **please collect and submit all food receipts for the month of May** in the envelope provided. This includes all grocery receipts and restaurant bills. Please include the portion of the receipt that indicates the items you purchased.

Part I: General Information

1. **What is your postal code? ________________**

2. **When did you move to your current home (month/year)? ________________**

3. **How many people live in your household?** *Household refers to the members of your home.*
    a. One
    b. Two
    c. Three
    d. Four
    e. Other – please indicate how many: ________

4. **How many people in your household are under the age of 15?**
    a. Zero
    b. One
    c. Two
    d. Three
    e. Other – please indicate how many: ________

5. **How would you describe your type of housing?**
    a. Apartment
    b. Single-family home
    c. Other: _______________

6. **What size is your home?**
    a. Studio or 1-bedroom
    b. 2-bedroom
    c. 3-bedroom
    d. Larger than 3-bedroom

7. **What is the approximate annual income of your household?** *Please report the combined income of all the members of your household before income tax. If possible, please report your household's income from 2009.* _______________

8. **How much does your household spend on housing per month (i.e. rent, mortgage)?**
____

9. **How much money does your household spend on holidays per year?** _______________

Part II: Energy Footprint

Your energy footprint may include consumption of electricity, natural gas, wood, propane or a variety of other energy sources. Please note that the information you provide in this section is being combined with information collected at the community-level (i.e. past utility bills) to derive the energy footprint.

1. **My home is heated by the following source(s):**
    a. Electricity
    b. Natural Gas
    c. Wood
    d. Propane
    e. Other: _______________
    f. I don't know

2. **If you answered d. or e. to the above question, please report the amount (e.g. liters of propane) your household uses <u>in a typical year</u>: _______________**

Part III: Transportation Footprint

1. **I would like to give distances in:**
    a. Kilometers (Km)
    b. Miles (Mi)
    c. Other: _______________

2. **How far do you and the members of your household travel by automobile in <u>a typical week</u>? _______________**

3. **On average, how many people ride together in a vehicle?**
    a. One
    b. Two
    c. Three
    d. Four
    e. Other: _______________

4. **How many vehicles has your household owned since moving to your current home?**
    Please include vehicles you currently own and no longer own.
    a. None
    b. One
    c. Two
    d. More than two – please indicate how many: _______________
    e. I co-own(ed) a car with a member of another household

5. **If you answered a. to the previous question, please proceed to question 6. If not, please complete the following table about your vehicles.**

	Make, Model & Year	**Date Purchased**	**Mileage at Purchase**	**Mileage at Present (or when sold)**	**Diesel, Gasoline or Other?**
Example	*1998 Ford Escort*	*January, 2002*	*50,000 km*	*150,500 km*	*Gasoline*
Vehicle #1					
Vehicle #2					
Vehicle #3					
Vehicle #4					

6. **Please fill in the following table about the flights you and the members of your household have taken <u>in the past year (May 1, 2009 – May 1, 2010)</u>. Please use additional paper if required and attach to end of questionnaire. Draw a line diagonally across the page if the members of your household have not taken any flights in the past year.**

Date	From	To	Via (Optional)	Number of People	One-Way or Round Trip?
December 21, 2008	*Vancouver, BC*	*Cairo, Egypt*	*Frankfurt, Germany*	*2*	*Round-Trip*

7. **Please fill in the following table about you and your household's travel by other modes of motorized transportation <u>in a typical week</u>. Please indicate an address in the 'From' and 'To' columns OR indicate the approximate distance. There are four lines available per mode of transportation. Please use additional paper if required.**

Mode	**Average # of People in Vehicle**	**Number of Trips Per Week**	**From**	**To**	**Distance**
Taxi					
Bus	N/A				
Train	N/A				
Other – Please indicate: ___________					

Part IV: Food Footprint

Please remember to collect and submit all food receipts for your household for the month of May. This includes all grocery receipts and restaurant bills. Please include the portion of the receipt which indicates the items you purchased.

1. **Approximately what percentage of your household's food receipts and restaurant bills from the month of May are you submitting?** _______________ %

2. **How often do you eat beef or lamb?**
   a. Never
   b. Infrequently (once every few weeks)
   c. Occasionally (once or twice a week)
   d. Often (nearly every day)
   e. Very often (nearly every meal)

3. **How often do you eat pork?**
   a. Never
   b. Infrequently (once every few weeks)
   c. Occasionally (once or twice a week)
   d. Often (nearly every day)
   e. Very often (nearly every meal)

4. **How often do you eat poultry (e.g. chicken)?**
   a. Never
   b. Infrequently (once every few weeks)
   c. Occasionally (once or twice a week)
   d. Often (nearly every day)
   e. Very often (nearly every meal)

5. How often do you eat fish?

a. Never
b. Infrequently (once every few weeks)
c. Occasionally (once or twice a week)
d. Often (nearly every day)
e. Very often (nearly every meal)

6. How often do you eat eggs, milk and dairy?

a. Never
b. Infrequently (once every few weeks)
c. Occasionally (once or twice a week)
d. Often (nearly every day)
e. Very often (nearly every meal)

7. How much of your diet is based on processed and packaged foods?

a. None (most of my food is fresh, unprocessed and unpackaged)
b. About one-quarter (25%)
c. About half (50%)
d. About three-quarters (75%)
e. Most of my food is processed and packaged

Part V: Goods, Consumables & Waste Footprint

1. **How much does your household spend on clothing, footwear and/or sporting goods <u>in a typical month</u>?**
    a. Less than $50 (maybe some t-shirts and socks)
    b. Approximately $150 (maybe new pants and shirt)
    c. Approximately $325 (maybe new pants, shoes and shirts)
    d. More than $400

2. **How much does your household spend on furnishings <u>in a typical year</u>?**
    a. $200 or less (maybe some bedding)
    b. $500 (maybe a new lamp or table)
    c. $2,500 (maybe a new couch or bedroom set)
    d. $4,000 or more

3. **How much does your household spend on appliances (e.g. fridge, stove, microwave, blender) <u>in a typical year</u>?**
    a. $50 or less (we don't typically buy appliances)
    b. $200 (we only replace broken appliances)
    c. $400 (we sometimes replace out-of-date appliances with newer models)
    d. $1,000 or more

4. **How much does your household spend on home entertainment, computer equipment and other electronic gadgets <u>in a typical year</u>?**
    a. $200 or less (we rarely make such purchases)
    b. $400 (maybe replacement of broken TV or computer equipment)
    c. $900 (replace out-of-date models and occasionally buy new gadgets)
    d. $2,000 or more

5. **How much of your household's paper, cardboard, metal, glass and plastic waste do you recycle?**

   a. None
   b. Some (Less than 50%)
   c. Half (50%)
   d. Most (More than 50%)
   e. All possible

You have completed the formal questionnaire. Please provide any additional comments or feedback here:

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Thank you for your participation! Please send your completed questionnaire **<u>and food receipts/restaurant bills</u>** to:

Appendix C

Waste Footprint Calculations

Footprint Calculations - Waste

Quayside Village

Material	Quantity (tonne/year)		Per Capita Ecological Footprint (ha)*		
	Recycled	Landfilled	Recycled	Landfilled	Total
Paper	0.050	0.008	**0.12**	**0.03**	**0.15**
Glass	0.025	0.008	**0.02**	**0.01**	**0.03**
Aluminum Cans	0.004	0.000	**0.00**	**0.00**	**0.00**
Plastic	0.008	0.008	**0.02**	**0.03**	**0.05**
Total	**0.088**	**0.025**	**0.17**	**0.07**	**0.23**

OUR Ecovillage

Material	Quantity (tonne/year)		Per Capita Ecological Footprint (ha)*		
	Recycled	Landfilled	Recycled	Landfilled	Total
Paper	0.009	0.027	**0.02**	**0.09**	**0.11**
Glass	0.034	0.027	**0.03**	**0.03**	**0.06**
Aluminum Cans	0.006	0.000	**0.00**	**0.00**	**0.00**
Plastic	0.010	0.027	**0.02**	**0.10**	**0.13**
Total	**0.059**	**0.081**	**0.08**	**0.22**	**0.30**

* Using average footprint conversions below.

Footprint Conversions

Material	Footprint (hectare years per tonne)		
	Low	High	Average
Paper-Landfilled	2.8	4	**3.4**
Paper-Recycled	2	2.9	**2.45**
Glass-Landfilled	1	1.1	**1.05**
Glass-Recycled	0.8	0.9	**0.85**
Aluminum Cans-Landfilled	9.4	17.8	**13.6**
Aluminum Cans-Recycled	0.4	0.9	**0.65**
Plastic-Landfilled	3.6	4.1	**3.85**
Plastic-Recycled	1.1	3.3	**2.2**

(Source: Chambers *et al* . 2000.)