The Reclamation and Re-occupation of the Burloak Employment Lands: Towards a Sustainable Community

By

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Ricardo Jesus Wulff

Abstract

By examining the interconnected relationship between humanity and the environment we live in, this thesis aims to bring new sustainable design approaches to a toxic industrial area known as the Burloak Employment Lands in Oakville, Ontario. At the heart of this vast site, a new train station is proposed as a catalyst for enriching and nourishing the local community's correlation to its immediately adjacent natural life. Additionally, the design of this station is embedded within an urban planning proposal that aims to lift the overall quality of life in the community by restoring ecological health to these wounded lands.

Acknowledgements

> *"Creativity is a type of learning process where the teacher and pupil are located in the same individual"*
> -Arthur Koestler-

Below is a list of the some of the key people who have acted as my "teachers" and helped make this thesis come to life:

My supervisor Professor Andrew Levitt and my committee members: Professor Marie-Paule Macdonald and Dr. Jeff Lederer. Their input has always been in the best interest of the thesis and my personal development as an architect.

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Dedication

To my lovely wife Julie, my daughter Nina, my mother Helena Isabel Wulff, and my father the late Eduardo Jesus Wulff. You kept me going, especially when I really didn't think I could.

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01 THE BIG PICTURE

1.1 Introduction

I have come to understand the earth as something that is alive and humanity as a crucial constituent to this planet's health. Many people have written about the philosophy of "a living earth" and I personally see no better explanation to describe humanity's relationship to the world. Further reading on the terms Gaia, eco-psychology and eco-philosophy can bring a better understanding of this idea. Also, scientists James Lovelock, Stephen J. Gould, and Martin Rees have supported this concept with strong scientific evidence. However, if we simply look at David Bleja's simulation entitled "Breathing Earth" (Figure 1-1), we can see how human activity instantly impacts the earth. In this simulation, we can see how human breathing all around the world emits tonnes of carbon dioxide at an extremely rapid rate. As we know, the earth takes in that carbon dioxide and uses it to absorb many infrared wavelengths of the sun's light as well as to feed plants which in turn transform this gas into oxygen completing the collective breathing cycle. At the end of the day, using this scientific observation it is evident that the earth is alive and our physical presence in the earth has a direct effect on its overall health.

With the exception of small indigenous communities and rare nature oriented settlements, most of us humans have collectively put the earth under all kinds of stress and deteriorated its health to magnificent extents. Although we may not have done it intentionally, we have unconsciously exhausted the earth's resources and have altered the earth's breathing through the creation of excess greenhouse gases to a point that we are now endangering our own existence in this planet. The terrible consequences of these actions are evident now as we learn about the implications of global warming and peak oil. Recent films such as Al Gore's *An Inconvenient Truth*, Gregory Greene's *End of Suburbia*, and Martin Sheen's *Who Killed the Electric Car* all begin to explain these issues further and describe how our collective economic and political agendas have created machines and cities that are unsustainable and are causing harm not only to the earth but also us humans.

If we work under the assumption that the earth is living, and that by taking care of the earth we are in turn taking care of ourselves, then a healthier relationship can begin to form and improve our current situation. Our physical health and our mental health can recover and we can co-exist with all the other living things that make up earth. The problems arrive when this important relationship is undermined and other agendas are put first in the order of priority. By not recognizing this relationship, humanity has taken the role of polluter and destroyer of the earth, rather than nurturing and embracing its energy with a sustainable goal in mind. In many ways, this current environmental crisis is not just about finding a technical or scientific solution, but also its about identifying and developing a more human and perhaps even spiritual understanding of our world.

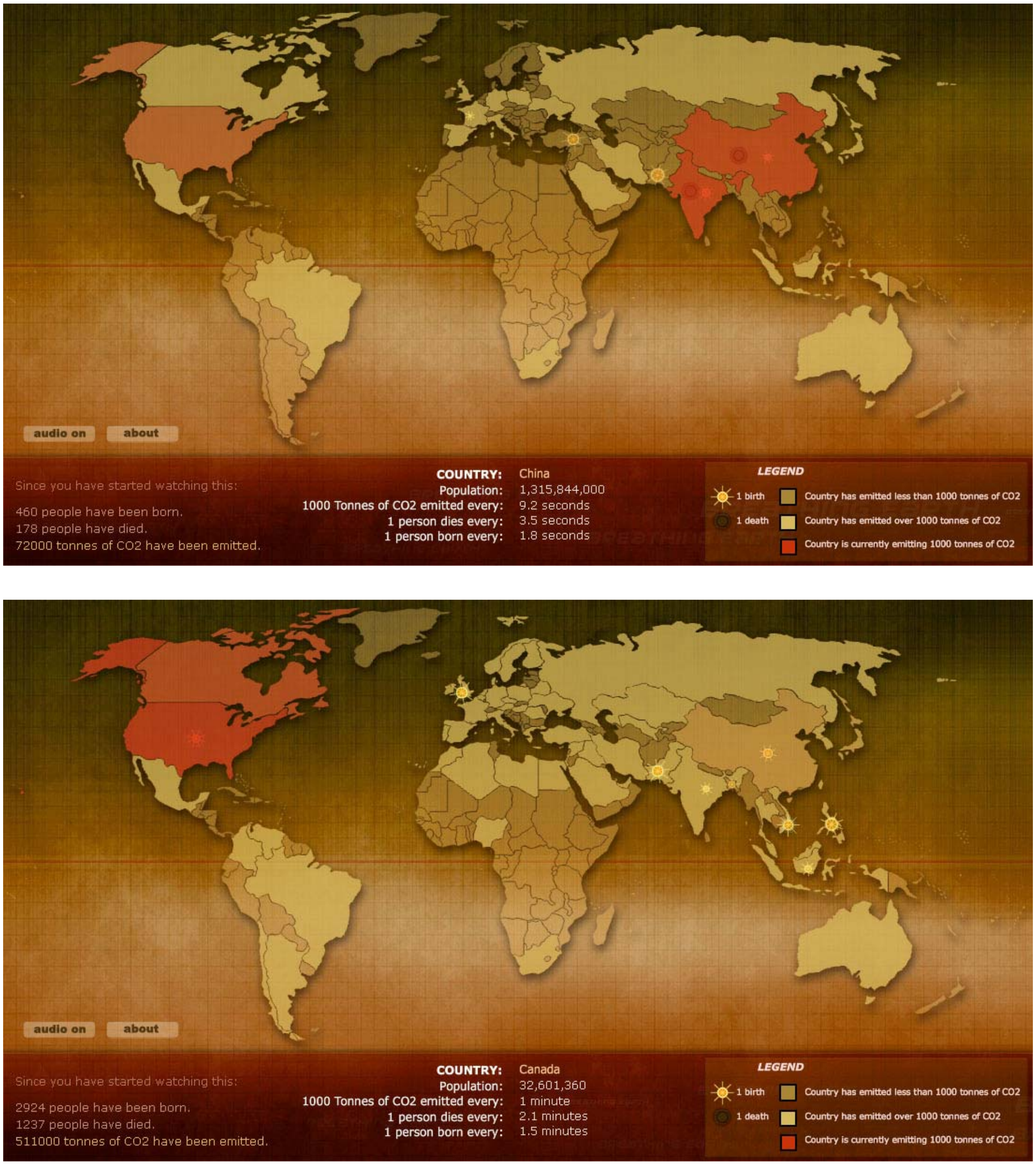


Figure 1-1: Images taken from David Bleja's *Breathing Earth*, an online simulated representation of human life cycles. The website accounts for all births, deaths, and "exhalations" of carbon dioxide all around the world.

1.2 An interconnected relationship

Figure 1-2: Artistic representation of the earth's interconnected relationship with the human mind.

> *"You never enjoy the world aright till the sea itself floweth in your veins, till you are clothed with the heavens and crowned with the stars; and perceive yourself to be the sole heir of the whole world, and more then so, because men are in it who are every one sole heirs as well as you."*[1]

Exploring the idea of a living earth, we can begin to understand our relationship with the earth in the same way we understand ourselves individually. Carl Gustav Jung formed a hypothesis for understanding the human psyche that took into account the realm of the conscious and unconscious. This Jungian psychology aimed to explain the human psyche in such a way that we could better understand ourselves and our relationships with others. Similarly, we can better understand our relationship with the earth using Jung's hypothesis.

> *"The upheaval of our world and the upheaval of our consciousness are one and the same."*[2]

In his writings, Jung explains the human psyche as being made up of conscious and unconscious elements. The conscious being those things we are aware of and the unconscious being the more complex and mysterious part of ourselves that we can never truly understand. According to Jung, the only way of accessing the unconscious part of our psyche is through our body, our dreams, and our shadow. (See Figure 1-3)

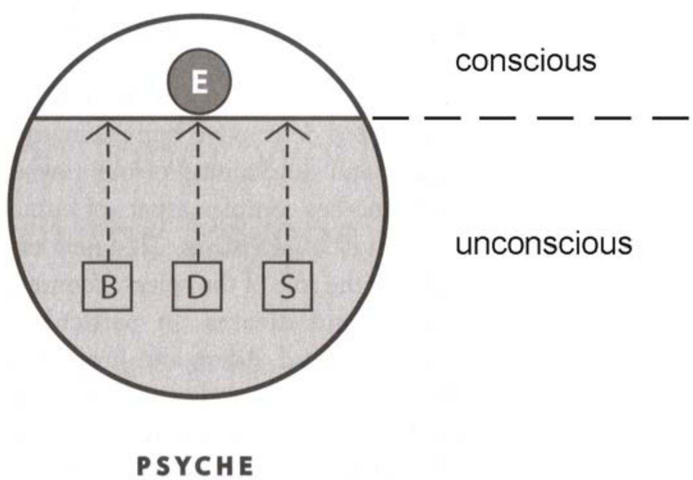


Figure 1-3: Diagram of the human psyche shows the ego in the white part of the circle as the conscious aspect of the psyche and the larger grey area as the unconscious. The body 'B', dreams 'D', and shadow 'D' are the messengers of the unconscious.

Similarly, we can think of our relationship with the earth as being made up of conscious and unconscious elements. If we indeed are an integral part of this living earth, then part of our role has to involve an awareness of both of these elements. The problem, according to Jung is that the unconscious is so little related to the conscious that most people do not hesitate to deny their existence outright. As he says in his writings:

> *"Many things occur semiconsciously, and a great many more remain unconscious"* [3]

It requires a special kind of attention for individuals to establish a connection with the unconscious. Nonetheless, Jung says, it is imperative for us to establish a relationship with our unconscious that allows us to learn from its products. By having this important relation, we can maintain a healthy mind and become "whole". Wholeness, in Jung's point of view, should be the goal of all human beings if they wish to be healthy and content. Consequently, it can be assumed that the goal of humans, as the nervous system of the earth, is to bring the unconscious into consciousness in order to contribute properly to the overall health of the earth. However, as Jung explains, this role is usually not taken and most things happen unconsciously.

1.3 Where did we go wrong?

Over the course of history, some of the most destructive actions humans have taken toward the earth have happened unconsciously. Humans did not consciously intend to deplete the earth of its natural resources and pollute the atmosphere to the point that it is today. However when human's first formed cities, they created something beyond their conscious understanding of the world. Lewis Munford's *The City in History* eloquently explains what happened when humans created cities over time:

> *"The city proved not merely a means of expressing in concrete terms the magnification of sacred and secular power, but in a manner that went far beyond any conscious intention it also enlarged all the dimensions of life. Beginning as a representation of the cosmos, a means of bringing heaven down to earth, the city became a symbol of the possible."*[4]

Munford explains how utopian visions formed the original constitutions of human cities, and precisely because they were ideal projections, they brought into life realities that would prove to be problematic. This problem has existed to this day, as seen in the visions of politicians and large corporations for places like suburbia and downtown high-rise buildings. With the creation of a new vision for cities, there has always been a great deal of unconscious harm done to humanity and the planet. With every action, there is reaction, and it was never evident what the reaction to these great visions would be is until they were built. While some of these cities did accomplish their ambitions, they came at a great cost. (See Figure 1-4, Figure 1-5, and Figure 1-6, Figure 1-7, and Figure 1-8).

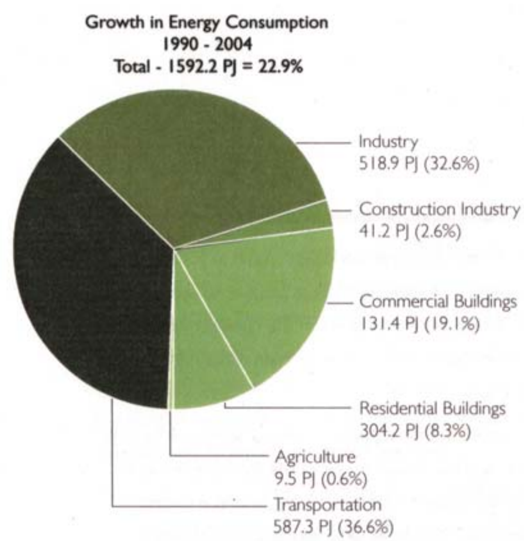


Figure 1-4 & Figure 1-5: (Top) - Chicago's Sears Tower is one of numerous examples of our collective desire to build a utopian world for ourselves. Regrettably, nobody took into consideration how buildings of this gigantic scale require such an immense amount of energy to operate (Bottom) - Pie Chart demonstrates how Commercial and Residential Buildings have increased energy consumption over the past decade. While many of these buildings are surely serving useful purposes, they are now collectively consuming an intolerable amount of the earth's resources.

Figure 1-6 & 1-7: (Top) - Markham, Ontario – Suburb of Toronto. The idea of suburban living also came from a utopian vision for human society. Though we didn't realize it at the time, the suburbs proved to be an urban planning mistake given their isolation from neighbours and their dependence on vehicles as a means of transportation. (Bottom) - Highway 401 Traffic in Toronto: The busiest highway in the world shows the congestion of vehicles suburban dwellers have to confront on a daily basis due to their dependence on the automobile.

"…the king's word was law. The power to command, to seize property, to kill, to destroy – all these were, and have remained 'sovereign powers'. Thus a paranoid psychal structure was preserved and transmitted by the walled city: the collective expression of a too heavily armoured personality"[5]


Figure 1-8 & Figure 1-9: (Left) Ex US President George W. Bush and King Abdullah, have played key roles in efforts to expand world oil output. (Right) US Army tank attacking Iraq in what's been regarded by many to be a war for oil. These leaders have gone to great extents to sustain and expand their nation's wealth and power. In the worst of cases, they have initiated wars with other countries that have led to the loss of lives and severely wounded the environment.

With the power to create industrial cities, there also came a power to rule over all other living things, a drastic change from the original rural villages humans had established.

"Now all organic phenomena have limits of growth and extension, which are set by their very need to remain self–sustaining and self directing. They can grow at the expense of their neighbors only by losing the very facilities that their neighbors' activities contribute to their own life. Small primitive communities accepted these limitations and this dynamic balance, just as natural ecologic communities register them.

Urban communities, engrossed in the new expansion of power, forfeited this sense of limits: the cult of power exulted in its own boundless display…"[6]

Figure 1-10: Photo of a traditional Native American hut. Many of these ancient rural communities respected the earth and used their resources in a responsible fashion.

Figure 1-11: Oil Fields in Belridge, California – As cities grow, we humans consume more of the earth's resources at an increasing rate. This oil field is one of numerous examples in the world where the scale of our consumption is clearly visible.

Since the time cities were first born, human society deviated from its original balanced and harmonious relationship with the living world (see Figure 1-9), and has evolved into a ferocious role of destroyer and polluter of all living things (see Figure 1-10). Cities have expanded throughout their natural surroundings without regard for all the living things around them.

"When an inner situation is not made conscious, it happens as fate"[7]

By not seeing the unconscious consequences of our actions toward the earth, we have collectively put ourselves at great risk. Global Warming is threatening human life on earth (see Figure 1-12); experts say oil is reaching its peak which means there will be a global crisis due to our current dependence on this resource to fuel every aspect of human life (see Figure 1-13); waste landfills are growing at an intolerable rate (see Figure 1-14); and the industrial infrastructure we use to uphold our cities has become dangerously large, endangering the health of all cities and their inhabitants (see Figure 1-15).

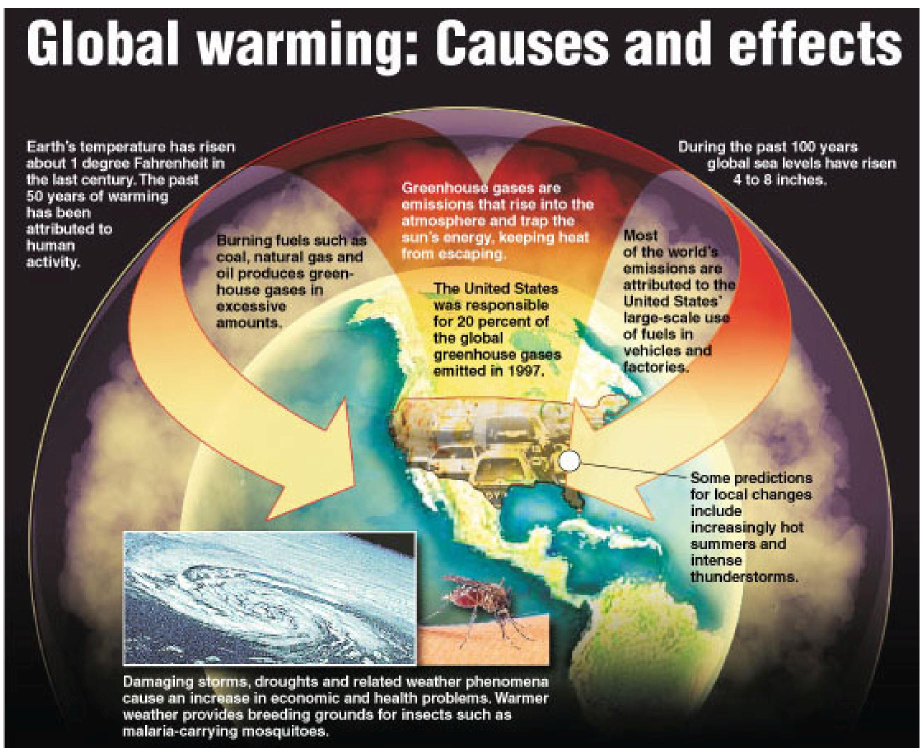


Figure 1-12: This diagram taken from the US Environmental Protection Agency website shows how the excess of greenhouse gases in the atmosphere caused by man made pollution has warmed the earth's temperature and caused dangerous weather phenomena; In addition the warmer temperature has provided breathing grounds for dangerous insects such as malaria carrying mosquitoes. These environmental conditions are wiping out large portions of human population across the world.

Figure 1-13: Oil is the world's premier source of energy and is fundamental to almost every important function of modern life. It fuels 95 percent of land, sea and air transport, so the efficient movement of raw materials and goods, as well as personal mobility, is almost entirely oil-dependent. Food production too relies heavily on oil to run farm machinery and to make fertilisers, herbicides and pesticides. Oil generates 40 percent of the world's commercial energy, provides heating fuel, and drives industry and commerce. No other existing energy source can match the versatility, convenience and low cost of oil. Moreover, it supplies feedstock for many thousands of manufactured products as diverse as plastics, medicines, clothing and building materials. However, experts say the era of cheap oil is over and if we don't come up with an alternate energy resource, we could have a major crisis as portrayed in the image above. This explains the term "Peak Oil".[8]

Figure 1-14: When we finish consuming the earth's resources, we dump into landfill sites like the one shown in this image and let our waste rot next to our cities. These landfill sites have become major toxic threats to nature's health as well as our own through their contamination of the air, land, and water within and around them.

Figure 1-15: Image taken of the explosion of a British Petroleum oil refinery in Texas in March 6, 2005. The proximity of the refinery to surrounding suburban communities proved to be unconsciously harmful. A study done on the potential risks of living close to Petro-chemical refineries later showed how not only the risks of explosion are hazardous, but also their emissions of chemicals such as sulphur proved to be leading causes of asthma, premature births, miscarriages, lower weight of newborns, leukemia, and cancer. Also, the petrochemical activity showed to be polluting the air with volatile organic compounds and water, soil, and flora near refineries were found to show increased levels of heavy metals.[9]

1.4 What do we do now?

> *"The future of mankind very much depends on the recognition of the shadow. Evil is, psychologically speaking, terribly real…it is a fatal mistake to diminish its power (it's effects are everywhere)"*[10]

In Jung's view, when the unconscious makes itself seen via the shadow, the body, and the dream, we have a responsibility to address its products and correct them if necessary. We cannot continue to carry on with our everyday lives and ignore these dark environmental issues emerging from within our collective condition.

Now that these environmental concerns are making themselves seen, numerous working professionals all around the world are trying hard to find solutions. Awareness of the topic has been advertised with great intensity and there is currently a growing global concern for the environment. Several energy alternatives are being taken into careful consideration as their attributes are evaluated for efficiency and cost. Among these alternatives are solar power, wind power, wave power, nuclear power, geothermal power, and bio-fuels. All of these have yet to be proven solutions to the problem. It is evident however that the environmental crisis goes beyond any technical or scientific answer we can possibly produce. There is a more deeply rooted struggle within our soul-taking claim over these collective challenges, and that is our morality.

In order to engage this existential challenge we collectively face today, we must individually come to the realization that there are unconscious natural forces beyond our control shaping the world. Though we cannot control our destiny, it is our moral responsibility to form a healthy relationship with the natural world. After all, we cannot deny the gift of life and all its fruits:

> *"The Promised Land is a gift to the fallen people…not a free or a deserved gift, but a gift given upon certain rigorous conditions.*
>
> *It is a gift because the people who are to posses it did not create it. It is accompanied by careful warnings and demonstrations of the folly of saying that 'My power and the might of mine hand hath gotten me this wealth' (Deuteronomy 8:17) Thus deeply implicated in the very definition of this gift is a warning against hubris, which is the great ecological sin, just as is the great sin of politics. People are not gods. They must not act like gods or assume godly authority…we must not use the world as though we created it ourselves."*[11]

While we live in this world, we have a moral duty to respect its fruit as a gift for our survival. The interconnected relationship we share with the earth requires us to have this honest respect, since we are not the creators of this world and cannot claim ownership of its fruit.

1.5 The role of architecture

Once we understand that it is our moral responsibility to nourish the divine and interconnected relationship we have with the earth, we will have the moral drive to take action in the way we live and shape our communities. Here, the role of architecture becomes crucial for it is the means by which all our cities take physical form. The way we construct, lay out, service, and use our buildings is directly related to how much energy we consume and how many greenhouse gases we release into the atmosphere. Recent studies show how buildings alone make up approximately 48% of the entire energy consumption in the United States today (see Figure 1-16).

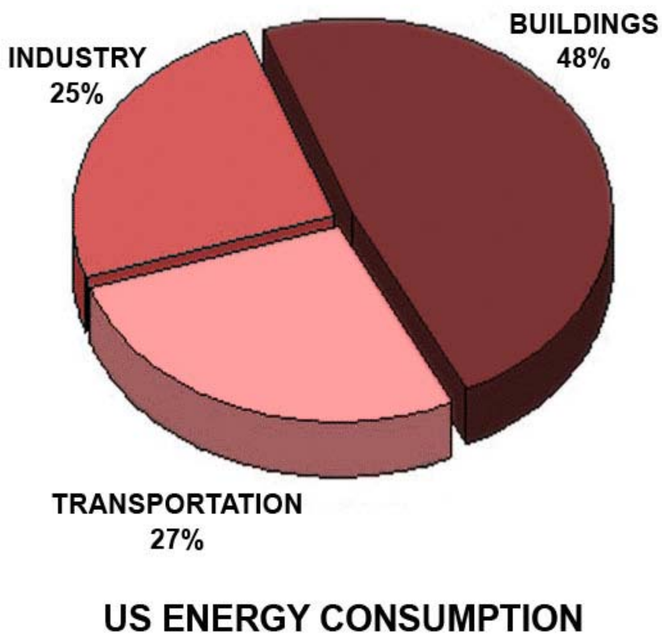


Figure 1-16: Pie graph taken from the US Environmental Agency, demonstrates the impact buildings have on the country's energy consumption.

In 1987, the United Nations defined sustainability as is written below:

> *"Sustainability can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*[12]

The way we build today is not sustainable since our buildings are consuming energy at a rate that we will not be able to sustain in the near future. If we apply sustainable design to our built world, then we will address the natural environment, public health, and social stability for the immediate and long-term future. Given our current environmental crisis, it is imperative that we apply sustainability concepts in the design and development of our buildings and cities.

1.6 Thesis Statement

This thesis aims to bring new sustainable design approaches to a toxic industrial area known as the Burloak Employment Lands in Oakville, Ontario. The following chapters will provide a better understanding of sustainable design as well as the site. The final chapter will integrate all of the research into a design proposal for the site centred around a new train station. The planning proposal along with the design of the train station aims to bring the local community a step closer to a sustainable lifestyle. In addition, the design aims to provide a place where humans can improve their relationship with nature.

It is important to note that the scale of the issues presented in this chapter present extremely challenging questions that cannot possibly be entirely answered in this thesis. However, this thesis aims to bring these issues into perspective and explore solutions to the current environmental crisis.

02 SUSTAINABLE DESIGN

2.1 A relatively new concept

The first recorded use of the term "Sustainable Growth" dates back to 1965.[13] This is not that long ago when we consider the fact we humans have been building cities for thousands of years. The reason why this term was never a concern before this date is in large part because the previous century marks some of the most radical changes in city planning history. An important reference for sustainable design is the architect and urban planner Jan Gehl. Gehl explains the radical transition that took place at turn the 19th century:

> *"Throughout the entire history of human habitation, streets and squares had formed formal gathering places, but with the advent of functionalism, streets and squares were literally declared unwanted. Instead, they were replaced by roads, paths, and endless grass lawns."*[14]

According to Gehl, the general organization of cities is fairly consistent in history up until the beginning of the 19th Century. The very first cities were really not planned at all; they simply developed spontaneously and were shaped by the residents of the city according to their specific needs and desires in a direct city-building process. This process was extremely slow and often took many hundreds of years, allowing continual adjustment and adaptation of the physical environment to the city functions. The result of this ancient process was urban spaces that to this day still offer exemplary public space conditions for vibrant and lively cities. Gehl uses Piazza del Campo in Italy as a fine example of (See Piazza del Campo, Figure 2-1)

The only two times a truly radical change in city planning history took place was first during the Renaissance when the profession of urban planning was born, and secondly in 1930 under the name of functionalism. The Renaissance planners assumed the task of building cities to be more than just a tool for assembling people but also as an artistic expression.

> *"No longer were the areas between buildings and the functions to be contained in them the major points of interest, but rather the spatial effects, the buildings, and the artists who had shaped them took precedence."*[15]

A perfect example of this shift in city planning can be seen in places like the Piazza Navona in Italy, where the focus was no longer the people in the spaces but rather the fountains and the Cathedral by Bernini and Michelangelo (See Piazza Navona, Figure 2-2)

Figure 2-1 & 2-2: Piazza del Campo (top) was designed to be a public living room for the community, a place for people. In contrast, Piazza Navona (bottom) was designed as a place for extravagant art.

The second radical change in city planning history was a significantly destructive one, the birth of functionalism. With the vast medical knowledge gained during the 1800's, functionalism derived new criteria for healthy and physiologically suitable architecture.

> "Dwellings were to have light, air, sun, and ventilation, and the residents were to be assured access to open spaces. The requirements for detached buildings oriented toward the sun and not, as they had been previously, toward the street, and the requirement for separation of residential and work areas were formulated during this period in order to assure the individual healthy living conditions and to distribute the physical benefits more fairly."[16]

This idea was conceived at around 1930 and it was well developed by the prominent 19th century architect, Le Corbusier, in his book entitled *"Towards a New Architecture"*. However the effects of functionalism's application to urban planning were not fully visible until the late 1950's & 1960's when many of the first generation of suburbs where completed. While it is true that the suburbs were at first considered homes for the mid-upper class of society, the over dependence and focus given to the automobile has with time proven to be a serious problem. Furthermore, the aesthetics of suburban functionalist planning have subconsciously led to isolated lifeless places at a scale that is too large to be inhabited by humans (See Figures 2-3 and 2-4).

Figure 2-3 & 2-4: Photos of typical suburban streets exemplifying basic concepts of functionalist planning. Though these dwellings are "healthier" in the sense that they each have plenty of light and ventilation, their planning provides poor outdoor public space that is predominantly occupied by cars and uninhabited roads.

With the birth of functionalism came the largest amount of urban development in history by industrial countries. In no other century has so much land been filled with buildings, and more importantly, buildings designed around the fundamental principles of functionalist planning. Due to the spatial requirements for this type of planning, large buildings and wide roads sprawled around major cities in developing countries at a remarkably fast rate. Now we are at the point that the planet is no longer predominantly made up of wild natural life but actually the world is now made up of man-made building developments.

> *"Today the real state industry encourages us to 'trade up' by casting off our present house like an old shoe in exchange for something more impressive and located in a more prestigious neighbourhood or we may regard a select parcel of productive agricultural land as simply awaiting development for more lucrative industrial uses that will make it more 'productive'."*[17]

The natural value of land has diminished over time and replaced by monetary value. As seen by the major global issues presented in the first chapter of this thesis, we humans have collectively failed to appreciate the interconnected relationship we share with the natural world. If we are to re-establish this relationship, we cannot adopt functionalist suburban planning as model for future living.

2.2 A harmony between Man and Nature

> *"…the idea of 'house' from our ancestral beginnings begins with a description of the word buan, the Old English and High German word for building. It meant 'to dwell.' 'To be a human being means to be on the earth as a mortal. Bauen further meant to cherish and protect, to preserve and care for specifically to till the soil, to cultivate the wine…'to build' was in this sense 'to nurture'".*[18]

In succession, sustainable design was born and developed as a direct response to the fundamental problems of functionalist suburban planning. Sustainable design aims to tackle the serious issues concerning suburban sprawl and its effects on both public health and the health of our planet. Essentially, the ultimate goal of sustainable design is to establish a harmony between man and nature.

To design with a sustainable goal does not necessarily mean to re-invent the wheel. In fact, our own human history contains examples of architecture that establishes this sustainable harmony between the human body and the harshness of the natural environment. Some of our earliest forms of dwellings exemplify how humans have a tendency to build structures as an extension of the human body. In his book entitled "Man and the Idea of a man-made world", author Norman Crowe depicts this basic human instinct by analyzing three primitive dwelling types: the inuit igloo from the arctic north, a Navajo hogan from the American desert southwest, and an indigenous house from tropical Southeast Asia (See Figure 2-5).

Crowe explains how each of these three dwellings is built with maximum efficiency in mind; thus each is sensitively, even delicately, attuned to its setting and the natural characteristics of the climate. All three are based on the same physical principles. Among these principles are such well-known and important scientifically verifiable phenomena as the facts that warm air rises while cold air sinks, that warm dry air carries away moisture which tends to cool our skin while warm moist air does not unless it is moving fairly fast, that cellular materials are good insulators to the transfer of heat through them while solid, dense materials are not, that heat reflects off shiny light colored surfaces while it is absorbed by dark and dull ones, that moving air promotes cooling while trapped and still air does not, and so on. Essentially they are each responding to the human body's needs through careful analysis of the natural environment.

The igloo is thus a smooth closed form trapping inside it the air heated by the bodies of its inhabitants. Its long tunnel like entrance places the living area away from the winds whistling around the front door. The dome shape presents the least amount of surface area to the outside environment for the transfer of cool air, and the simultaneously reflects all internal heat toward the inside.

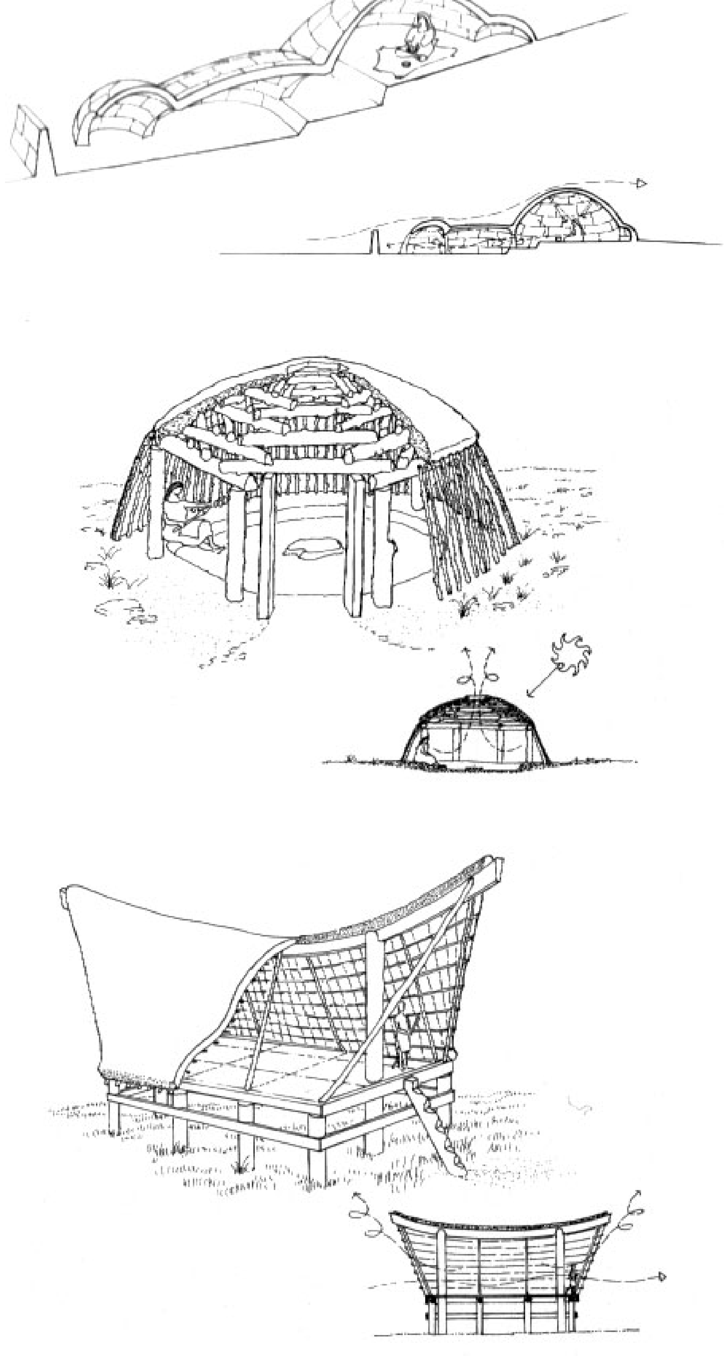


Figure 2-5: Primitive Dwellings shaped by man in accordance with the natural environment. An Inuit Igloo (Top), a Navajo Hogan (middle), and a Native Tropical house of Southeast Asia (Bottom).

The Navajo Hogan is built from dry locally abundant materials and works opposite to the igloo in the sense that its thick dark walls absorb the sun's daytime warmth and then radiate that warmth to the interior during the cool night. The smoke hole above the main living area lets the smoke out at night and allows light in during the daytime.

Finally the tropical house is open, light, and airy.   The living area is lifted up into the breezes, away from the moist earth and the scurrying insects and reptiles.   Its large roof provides maximum shade for the living area and is sloped to provide maximum protection against heavy rain.

All three of these dwelling types serve as evolved examples of fundamental shelter, and most importantly, a direct compromising response to the needs of the human body and the powerful elements that make up the natural world. As Crowe explains:

> "…Their direct, intricate, and delicate relationships with their environment serve as a constant reminder to those who live in them that there must always be a consummate resonance between what they build and nature. Beyond the basic requirements of shelter, they stand as paradigms of a man-made order constructed in response to a tangible and immediate world of nature."[19]

At a very fundamental level, these three basic dwellings exemplify the care and attention required for successful sustainable building design. The challenge this day in age is to adopt these intrinsic principles to the modern quality of life we have become accustomed to. Since the early 1960's when architects and planners began to become aware of the importance of sustainable design, several innovative ideas and technologies have been developed.   With the turn of the 21st century, the vast majority of the architectural and planning community is now primarily focused on preserving the natural environment through various sustainable design methods.

2.3 A harmony between city and nature

The understanding of the guiding principles behind the three primitive dwelling types and their relationship to the natural environment can be expanded and also used to understand the relationship between a community or city and the natural environment. Like these primitive dwellings, the most of important pre-requisite for sustainable city planning is the human body. We humans walk slowly, we stand upright and face forward, our natural instinct is to look straight ahead and so we perceive things horizontally rather than vertically (See figures 2-6,2-7, & 2-8). As simple as this may seem, modern cities have a difficult time addressing these issues mostly because of their overdeveloped focus on technology. With the invention of the automobile, and advances in building technology, we have built cities at an overpowering scale without careful consideration of the impact these technologies have on our inherent sense of space and travel.

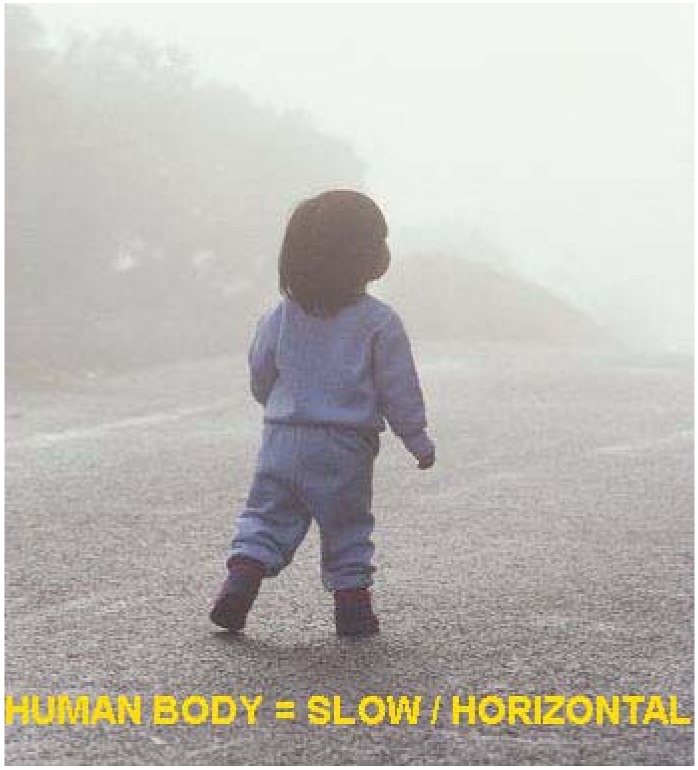
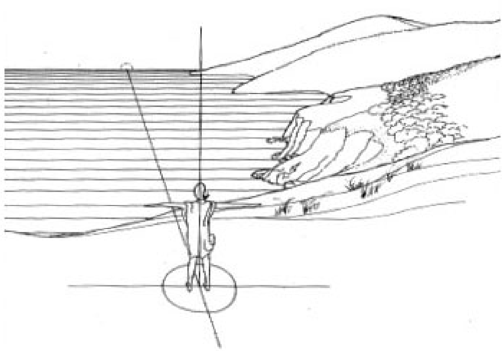


Figure 2-6: The human body travels at an average speed of 6km/per hour; it stands upright facing forward and perceives the surrounding environment with a horizontal perspective.



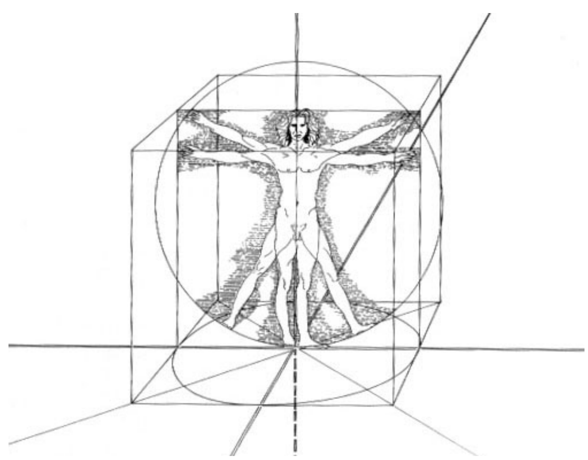


Figure 2-7 & 2-8: A person looking out toward the sea is oriented to the landscape by the geometry of his own body. By relating the world around us to the geometry of our bodies, we reconcile our place in nature.

Figures 2-9 & 2-10: (Top) a woman is overwhelmed with the vehicular traffic adjacent to her as she attempts to cross the road. (Bottom) The high-tech high-rise buildings surrounding this avenue cast vast shadows on the people below them, and once again the wide lanes of traffic make this space uncomfortable for people. Both of these places are unoccupied by people and exemplify the overpowering presence of technology in today's modern cities.

At the root of sustainable city planning, there is a focus on the human body and its fundamental ability of relating to the environment. Even though technological advances have amazing advantages, they need not overlook the core principles that make up the fundamental relationship between man and environment. A sustainable city incorporates the requirements of the human body to get around, to dwell, to eat, and to interact with each other and nature in a way that doesn't jeopardize the health of humans and natural life. It is for this reason most discussions regarding sustainable design focus on the following major topics:

- Site Remediation
- Building Design
- Transportation
- Agriculture, Food and Land Preservation
- Waste and Water Management
- Renewable Energy

The remaining portion of this chapter will provide a brief overview of how each of these topics form the fundamentals of sustainable design.

2.4 Site Remediation

The first and possibly the most important part of sustainable design today is focused on healing intoxicated industrial sites in the planet. Our oblivious lifestyle of the past has made many parts of our natural world ill and toxic. If we are to change the way we live, we must start by healing our natural world. This process of healing is referred to as remediation, and as we look forward to the future, remediation is a key to our survival.

Scientists all around the world have come up with various ways of cleaning up toxic sites that are infected with hazardous waste. A wide variety of highly scientific techniques exist today to clean up toxic land and water. In the case of contaminated land, these remediation techniques can be grouped into three basic strategies: In-Situ Capping, Dig and Dump, and Bioremediation. In-Situ Capping involves covering up a toxic site with several layers that physically confine the contaminants in the soil and prevent the migration of its pollutants (See Figure 2-11).[20] The Dig and Dump strategy involves digging up the toxic soil from the site and moving it to a rural area where it can be cleaned professionally with the use of large equipment and chemicals in a controlled environment (See Figure 2-12). Though this is the fastest way to clean up a site, it is usually the most expensive and many consider it a transferring of the problem rather than a solution to the problem. Finally, Bioremediation is a 100% natural method of cleaning up a site with the use of specific plants that effectively clean up different types of hazardous toxic soil. Though this process takes a long time, it deals with the problem head on without using any artificial man-made products (See Figure 2-13).

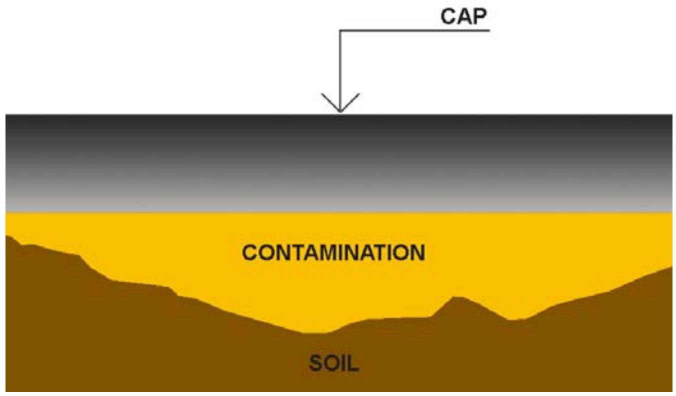
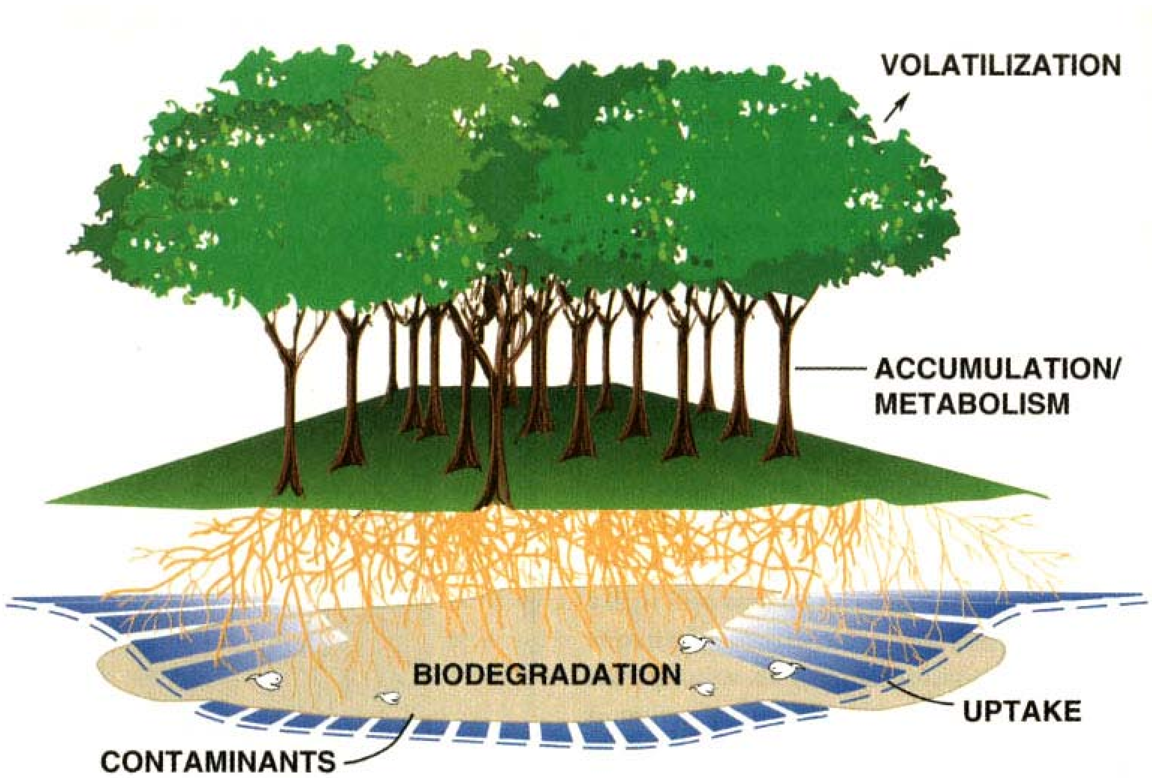


Figure 2-11: Diagram of a Site Cap over contaminated soil. In-Situ Capping are generally made of a combination of such materials as synthetic fibers, heavy clays, and sometimes concrete. All caps require periodic inspection for settling of the overlying soils, standing water, erosion, or disturbance by deep-rooted plants. Caps having only a synthetic liner as a barrier to the flow of outside liquids are usually designed to last a minimum of 20 years. The use of a synthetic liner that is supported by a non-porous base, such as clay can extend the design life to over 100 years as long as the contaminants are kept above the water table. Proper maintenance will extend the life of the cap even longer. Rigid barriers such as concrete are subject to cracking and chemical deterioration. However, these cracks can be exposed, cleaned, and repaired with relative ease. Concrete covers may have a design life of about 50 years.

Figure 2-12: The common "Dig and Dump" procedure involves taking contaminated soil out of the ground and trucking it to a landfill. Though this procedure allows for immediate development on a contaminated site once all the toxic soil is removed, it really only lays a new problem for landfill workers. This is also an extremely costly solution, usually costing millions of dollars in large industrial sites for merely removing the soil. However, if the development of the site means better infrastructure and economic development, accommodating the surrounding area in an efficient manner, then it can be worth paying the big bucks.



Soil contaminants are taken up in the root zone and degraded there or in the tissues of the plant itself; accumulated in the plant tissues; or expelled into the air.

Figure 2-13: Diagram of the bioremediation process shows how the roots of plants and trees accumulate all contaminants in the soil and gradually clean them up as they move through the branches until they evaporate in the air through the process of volatilization. In addition, Bioremediation is used because it takes advantage of natural plant processes. It requires less equipment and labor than other methods since plants do most of the work. Trees and plants can make a site more attractive as well. The site can be cleaned up without removing polluted soil or pumping polluted groundwater. This allows workers to avoid contact with harmful chemicals. Bioremediation has been successfully tested in many locations, and is being used at several Superfund Sites across the world.

In most cases, one or all three of these strategies are applied to a contaminated site, depending on the site assessment and the budget. However, the ideal way of cleaning up a toxic site is through bioremediation. Unlike the first two strategies, bioremediation is completely natural and affordable. The only down fall of bioremediation is it takes a long time to successfully clean up a site. Depending on the severity of contamination, the bioremediation process could take anywhere from 20 to100 years to completely clean up a contaminated site.

2.5 Building Design

"Buildings are our third skin. To survive we need shelter from the elements using three skins. The first is provided by our own skin, the second by a layer of clothes and the third is the building. In some climates its is only with all three skins that we provide sufficient shelter to survive, …"[21]

In many ways, the skin of a building plays a large role in the way it consumes energy and how it affects human and environmental health. The materials used and the way air flows through them is crucial in ensuring a building works to fulfill the needs of health and sustainability. The reason why most buildings consume so much energy is in large part because their skin or building enclosure is extremely poor and inadequate for its surrounding environment. In North America, significant changes in building materials and construction techniques took place during the post WWII economic boom. Most of the buildings built from this point forward have deteriorated rapidly and consume large amounts of energy due to the use of cheaper and thinner materials. Before this era, buildings were usually built out of strong masonry materials with solid structures that withstood the tests of harsh climate conditions (See Figure 2-14). In fact, many of the buildings constructed before WWII are still standing today and have aged extremely well. These buildings worked well because their skin was one solid layer of masonry that was durable and stored energy efficiently with very little heat loss.

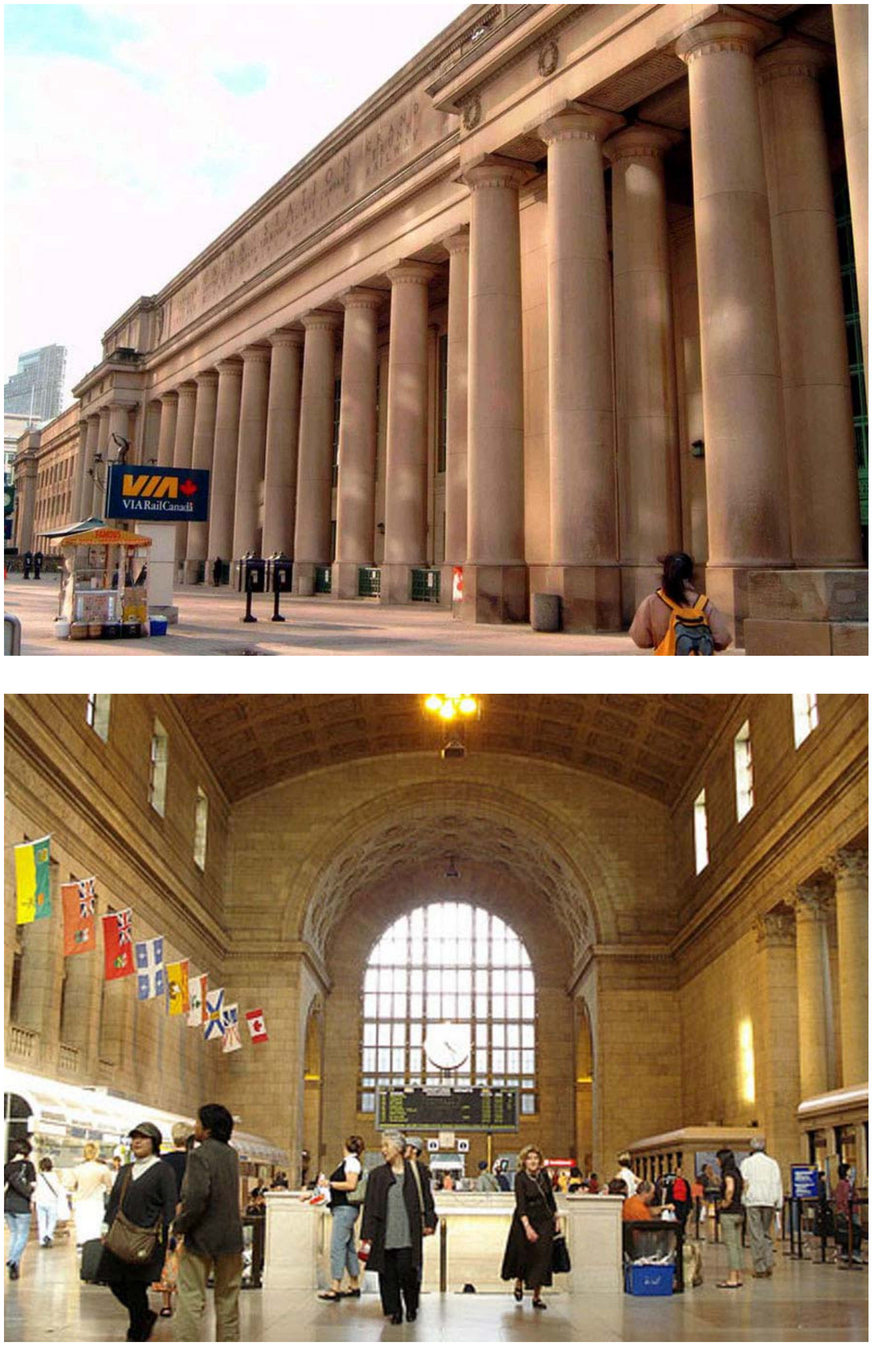


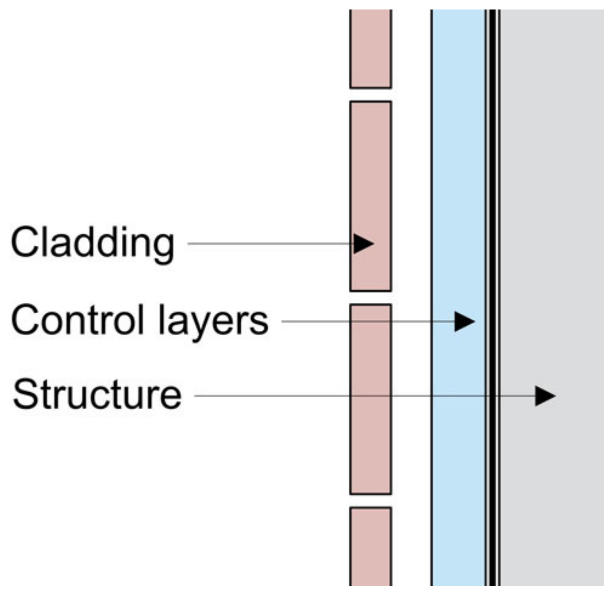
Figure 2-14: Completed in 1927, Union Station in Toronto is an excellent example of a pre WWII building that has withstood the test of time. Its solid "skin" or building enclosure serves as structure, insulation and finish all in one thick masonry layer. Unlike many of the buildings constructed after the war, the exterior shell of Union Station is practically intact and likely to last at least another 100 years.

The newer buildings constructed after WWII separated the "skin" into several thin layers each with different functions. These new affordable buildings had a hollow structure (usually stud framed walls), a separate material for cladding or covering the building and finally a finish material to make the building aesthetically pleasing. At first, post WWII buildings did not even have insulation. Instead, these buildings depended on large mechanical equipment for heating and cooling. Since energy was cheap after the war, these mechanical units seemed appropriate and affordable. With the first oil crisis of the early 1970's, energy became expensive and people began to insulate buildings in order to save on heating and cooling costs. Unfortunately, the buildings they lived in were not fit for insulation and thus began the era of sick buildings. Completely sealed buildings were unable to "breathe" and the air inside the buildings became stale and stagnant, causing people to get extremely sick (See Figure 2-15).

Figure 2-15: A residence built in the post war period shows signs of mould around both the exterior and interior of the building. The hollow structure was poorly insulated and sealed, causing water leakage that led to mould. Though it was cheap to build, it now faces very expensive repair costs and requires a large amount of energy to heat and cool.

The shift from heavy masonry to wood frame to aluminum frames with glass in just over 50 years has required an enormous adjustment in the building construction process. The ability to predict the performance of buildings has become extremely important since they alone are responsible for half the energy consumption in developed countries. In addition, people in North America spend the vast majority of their time inside a building. This means the indoor air quality of buildings plays an immense role in our overall health and well-being.

Over the past decade and a half, the focus on building enclosure has increased greatly and huge improvements in building enclosure have taken place to ensure new buildings are able to deal with all issues pertaining to any type of climate. The perfect "skin" or building assembly can be further understood as the successful control and manipulation of the following components:



Once these components are addressed appropriately according to the geographical location of a building and building use, the environmental impact of a building is reduced significantly. Thus, the diagram above exemplifies the perfect skin or building enclosure. Add to that perfecting skin the use of recycled materials or locally abundant materials (See Figure 2-16), an efficient building plan/volume (See Figure 2-17), and active systems of renewable energy and water usage (See Figure 2-18 and 2-19); and all the components of a "green" sustainable building with a "zero carbon footprint" are achieved. Meaning the building emits a tolerable level of carbon monoxide / greenhouse emissions, and is in equilibrium with the natural world.

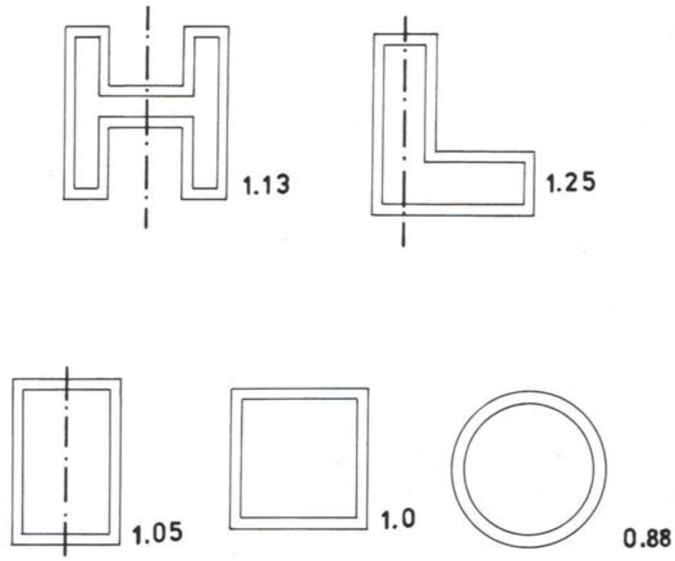


Figure 2-16: Buildings can have very different perimeter area ratios depending on the their plan form. The larger the perimeter, the more materials used and the harder it is to control heat loss in the building.

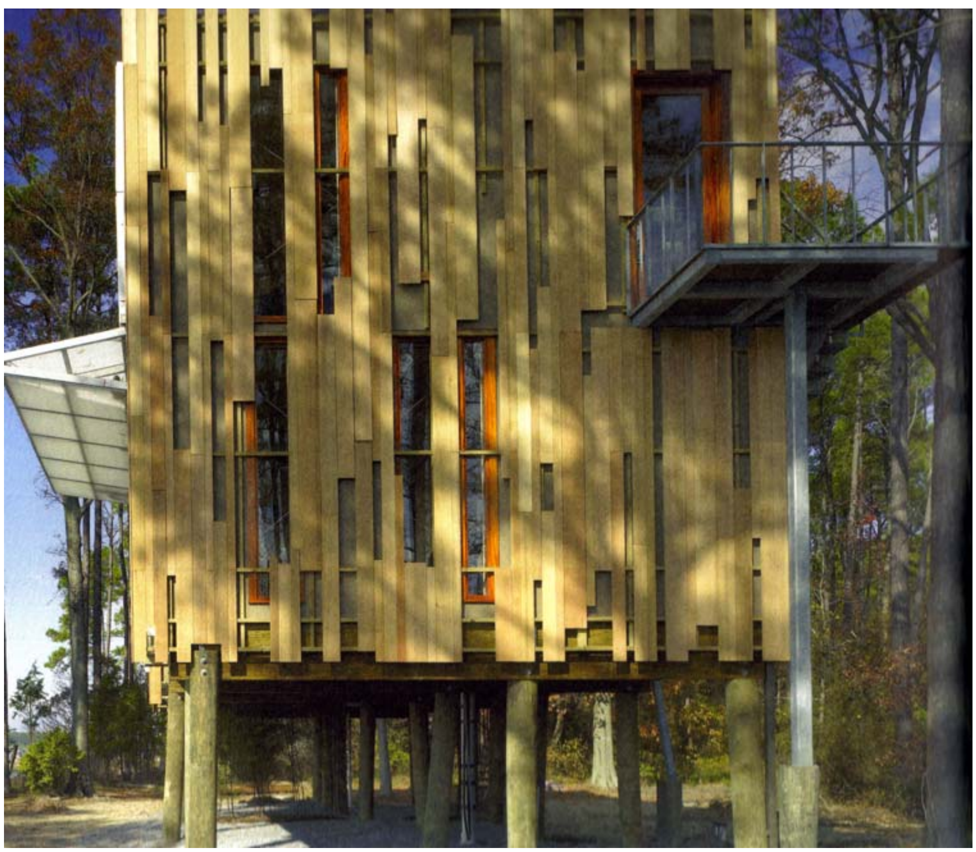


Figure 2-17: This dwelling was assembled on site using raw materials locally abundant in the area. The materials are not only appropriate for the local climate but also did not require much energy to produce or transport to the site.

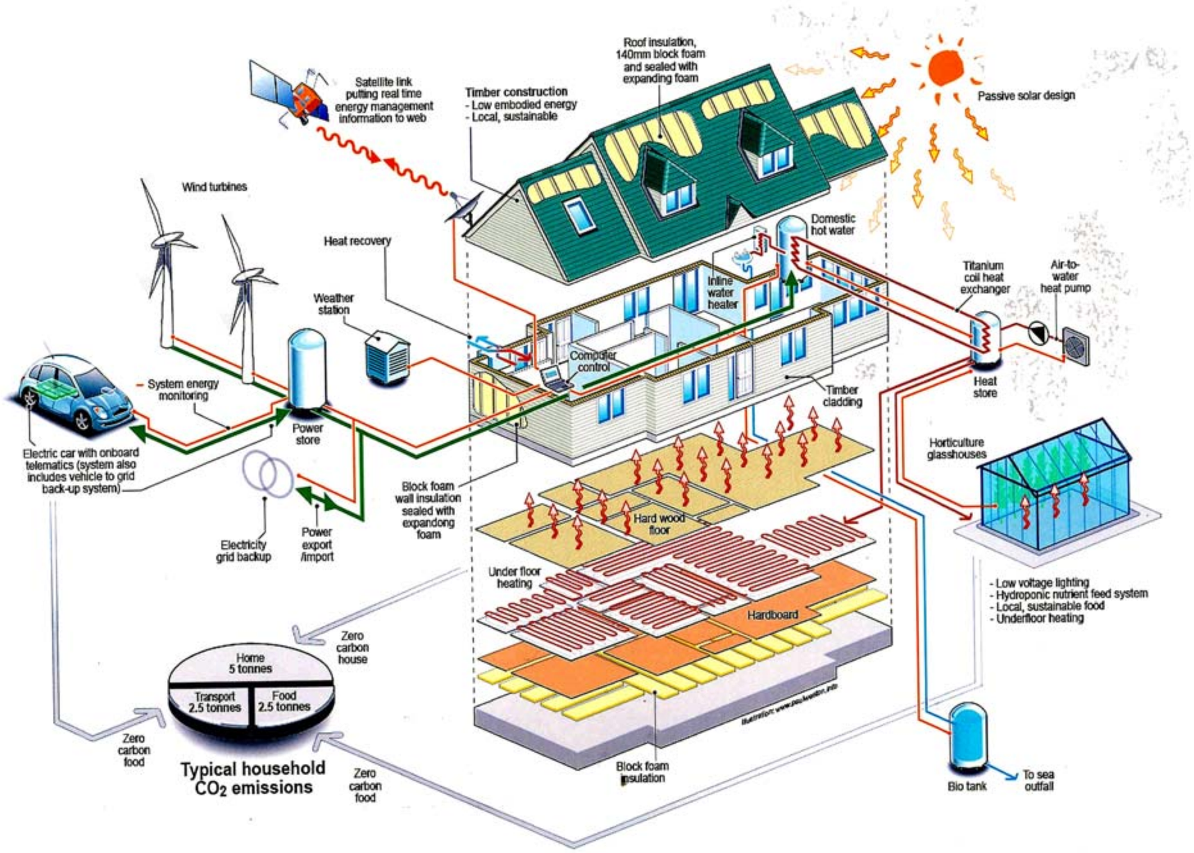


Figure 2-18: The diagram above shows how the active systems in a “zero carbon” house can work. The photograph below it shows that once these systems are in place, the house can look very similar to most conventional homes.

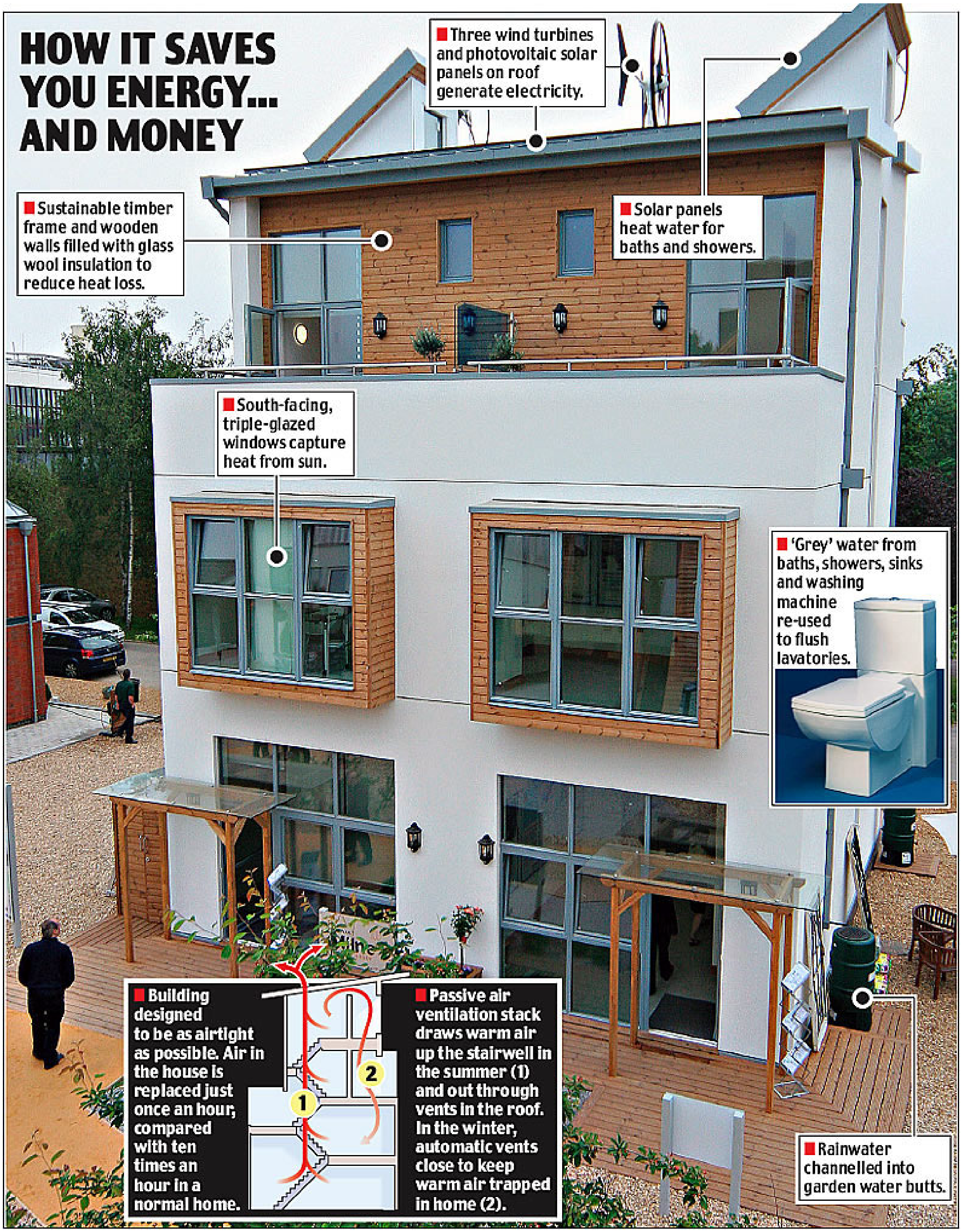


Figure 2-19: Diagram above briefly shows how the various systems for renewable energy work in a zero carbon house. Not only is this home in harmony with the natural world but it is also saving the owner a great deal of energy and money.

2.6 Transportation

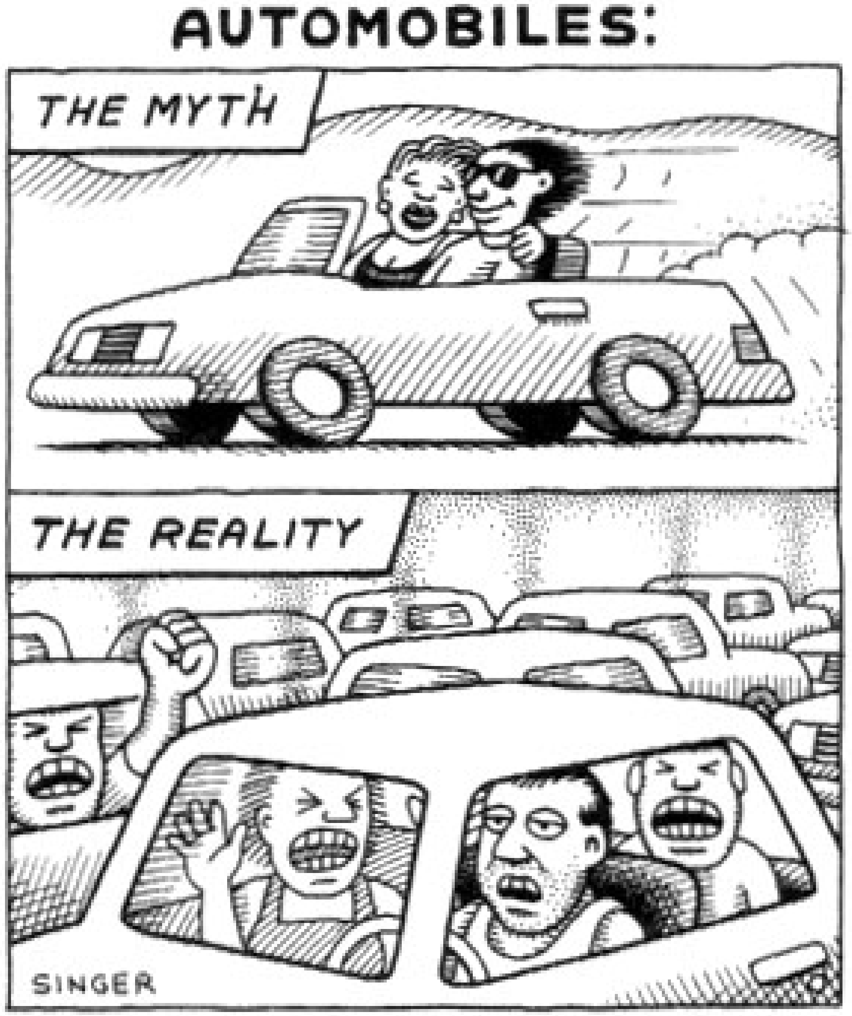


Figure 2-20: When automobiles first came into the city, there was plenty of room to drive around and get to places comfortably. As more and more people began driving and depending on cars to get around the city, streets became infested with traffic making it utterly frustrating to get around. However, to this day people still believe in the myth that driving is a comfortable way of getting around a busy city.

> *"Technical fixes for the automobile are held out as the solution to the problems cars cause, and the coming decades will probably see several advances that would reduce the burden of automobility. Keep in mind, however, that even if cars become quicker, safer, cheaper, more efficient, and less polluting, they still impose enormous burdens on the city, its inhabitants, and the global ecosystem"*[22]

Further developing the primary concepts of sustainable design, it is important to look beyond the design of a building and into the other elements that surround it. One of these very important elements is transportation. The way people get around in cities can also have a significant impact on the amount of greenhouse gases and carbon emissions created. Sustainable transportation's primary goal is to eliminate these carbon emissions as much a possible by improving pedestrian access and public transit. The biggest obstacle for sustainable transportation is the predominant car culture that exists in most modern cities. Cars not only pollute the environment and cause all kinds of dangers to humans, but they also dramatically affect the design of cities in a negative way. Because of cars, buildings are spread out across the land at distances that make it extremely difficult for people who don't own a car to get around. As these large cities grow, they invade the natural life that exists around them, including trees and animals. To create a sustainable way of life, people need to have alternate means of travel that do not involve driving a car. It is therefore imperative for sustainable transportation to promote alternate ways of getting around. As seen in Figure 2-11, there are numerous ways of getting around a city that do not involve driving a car.

- 6,592,000 people commute to work each day by public transit
- 14,300,000 people carpool to work each day
- 3,417,000 people walk to work each day
- 158,000 people commute by motorcycle each day
- 2.8 million people occasionally commute by bicycle
- 567,000 people regularly commute by bicycle
- 4,075,000 people work at home and do not commute at all

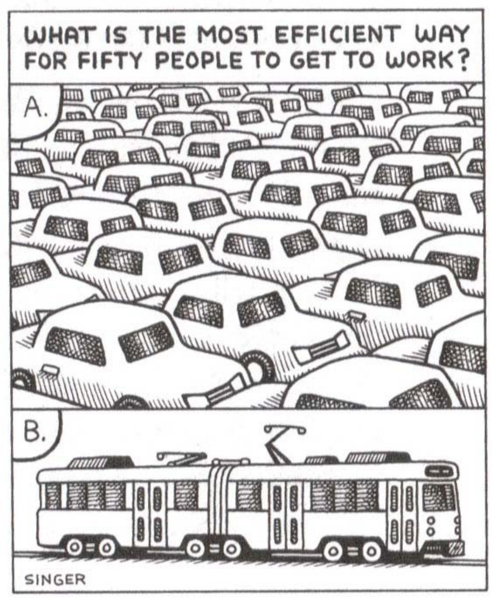


Figure 2-21: Statistics from a 2000 Census in the United States show how it is perfectly feasible to get around a city without owning a car.

Getting more people out of their cars and bringing them back to their feet is key to establishing a sustainable city. In Copenhagen, Denmark, Jan Gehl was able to reduce the smog and pollution caused by cars and simultaneously improving the quality of pedestrian traffic by lengthening pedestrian streets and eliminating parking spots in the city (Figure 2-22). This simple process of eliminating vehicles and lengthening "pedestrian only" streets has transformed Copenhagen into an exemplary city for sustainable transportation (See Figures 2-23 & 2-24).

Figure 2-22: The city of Copenhagen in Denmark has become one of the best examples in the world for sustainable community design. Over the past 40 years, it's gone from a polluted traffic infested city to a clean and almost entirely pedestrian friendly city. Through the extension of major pedestrian promenades that incorporate local businesses and commercial development, people have gradually stopped driving and started using environmentally friendly way of getting around. Bicycles and pedestrians are seen everywhere in the city all year around, even in the wintertime. Long distance transportation is done trough an efficiently designed subway system that allows for the development and growth of green spaces in and around the city.

Figure 2-23: The reduction of vehicles in Copenhagen has made a safe space for bicycles and pedestrians. People in Copenhagen are part of a large bicycle culture that exists all times of the year, even during the cold winter months.

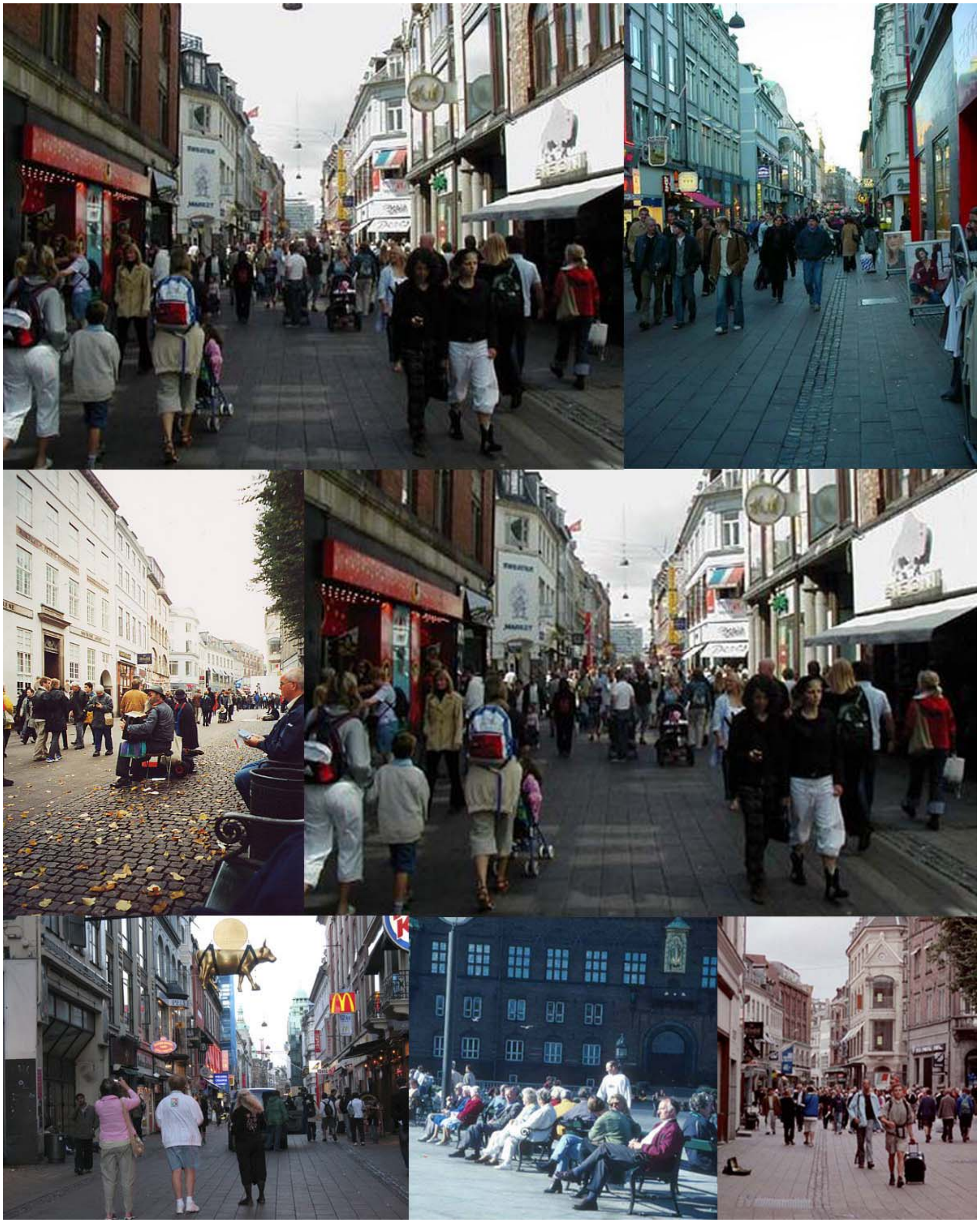


Figure 2-24: By removing as much vehicular traffic as possible and promoting people to walk in the city, the streets of Copenhagen have become alive with pedestrian activity. Businesses have flourished in pedestrian streets and the air is much cleaner in the city. Copenhagen is now one of the best examples in the world for sustainable urban planning.

2.7 Agriculture, Food and Land Preservation

How and what we eat plays another important role in sustainable design. The amount of food imported and exported across the world today is astounding (See Figure 2-25). In addition, the mass production of food created in today's modern world is equally astonishing (See Figure 2-26). Though the environmental impact of food and agriculture is not as large as some of the other aspects of our lifestyle, food is still an essential human need and it is imperative for human civilization to improve the way we eat for the sake of our own health and the health of the planet.

Figure 2-25: Photo of a cargo boat carrying imported products overseas. Canada's merchandise imports and exports reached record highs in 2007 following the rapid appreciation of the dollar, the housing slowdown in the United States, and rising energy prices spurred by the soaring price of crude oil. While the organic sector could be leading the development of a sustainable food system, global trade and distribution of organic products fritter away those benefits and undermine its leadership role. [23]

Figure 2-26: Image of tractor spreading oil-based fertilizer on farm soil. Farming in today's modern world is heavily dependant on oil. Vast amounts of oil and gas are used as raw materials and energy in the manufacturing of fertilisers and pesticides, and as cheap and readily available energy at all stages of food production: from planting, irrigation, feeding and harvesting, through to processing, distribution and packaging. In addition, fossil fuels are essential in the construction and the repair of equipment and infrastructure needed to facilitate this industry, including farm machinery, processing facilities, storage, ships, trucks and roads. The industrial food supply system is one of the biggest consumers of fossil fuels and one of the greatest producers of greenhouse gases.[24]

Traditionally, humans were an agricultural society. People's lives used to revolve completely around land and farming. However, with the growth of the industrial revolution and the densification of cities an enormous shift took place. Today, the majority of people live in developed countries and work in cities rather than farms.[25] Consequently there is a higher demand for food then ever before and there are less people producing it. In addition, the food is mass-produced using preservatives, pesticides and growth hormones; and it is transported over long distances to accommodate the fast growing urban population. This process requires a dependence on oil-based industries that are in turn adding to the excessive amount of greenhouse gases in the atmosphere.

Sustainable agriculture aims to respond to this urgent demand for food in a fast growing urban population without causing irreversible damage to ecosystem health. In terms of urban planning and architecture, some of the methods for accomplishing sustainable agriculture include eco-villages in rural areas (Figure 2-27), the 100 mile diet (See Figure 2-28), edible gardens in the home (See Figure 2-29), vertical farms (See Figure 2-30), and increased population density to preserve agricultural land and reduce urban sprawl (See Figure 2-31 and Figure 2-32).

Figure2-27: Aerial view of Eco Village Ithaca in New York State, USA. Founded in 1991, the Ithaca Eco Village is a firm example of a successful self-sustainable community. Village residents all work where they live, and contribute to the use and maintenance of two 30-home co-housing neighbourhoods, FROG and SONG, and a third neighbourhood (TREE) in the planning stages, an organic CSA vegetable farm, an organic CSA/U-Pick berry farm, office spaces for cottage industry, a neighbourhood root cellar, community gardens and varied natural areas. Over 80% of the 175 acre site is planned to remain green space, including 55 acres in a conservation easement held by the Finger Lakes Land Trust.[26]

When the average North American sits down to eat, each ingredient has typically travelled at least 1,500 miles—call it "the SUV diet."

Figure 2-28: Logo for website "100milediet.org" encouraging people to eat locally in order to preserve the environment. The website provides recipes for those who wish to eat locally grown food in order to promote the reduction of greenhouse gases from food transportation. A 100-mile radius is large enough to reach beyond a big city and small enough to feel truly local.[27]

Figure 2-29: Having a vegetable and fruit garden in the home is an excellent way to reduce the pollution from the trip to the grocery store and the industrial process in the food supply system. Having an indoor garden makes it even more sustainable since it can operate all year round in countries with varied weather seasons.

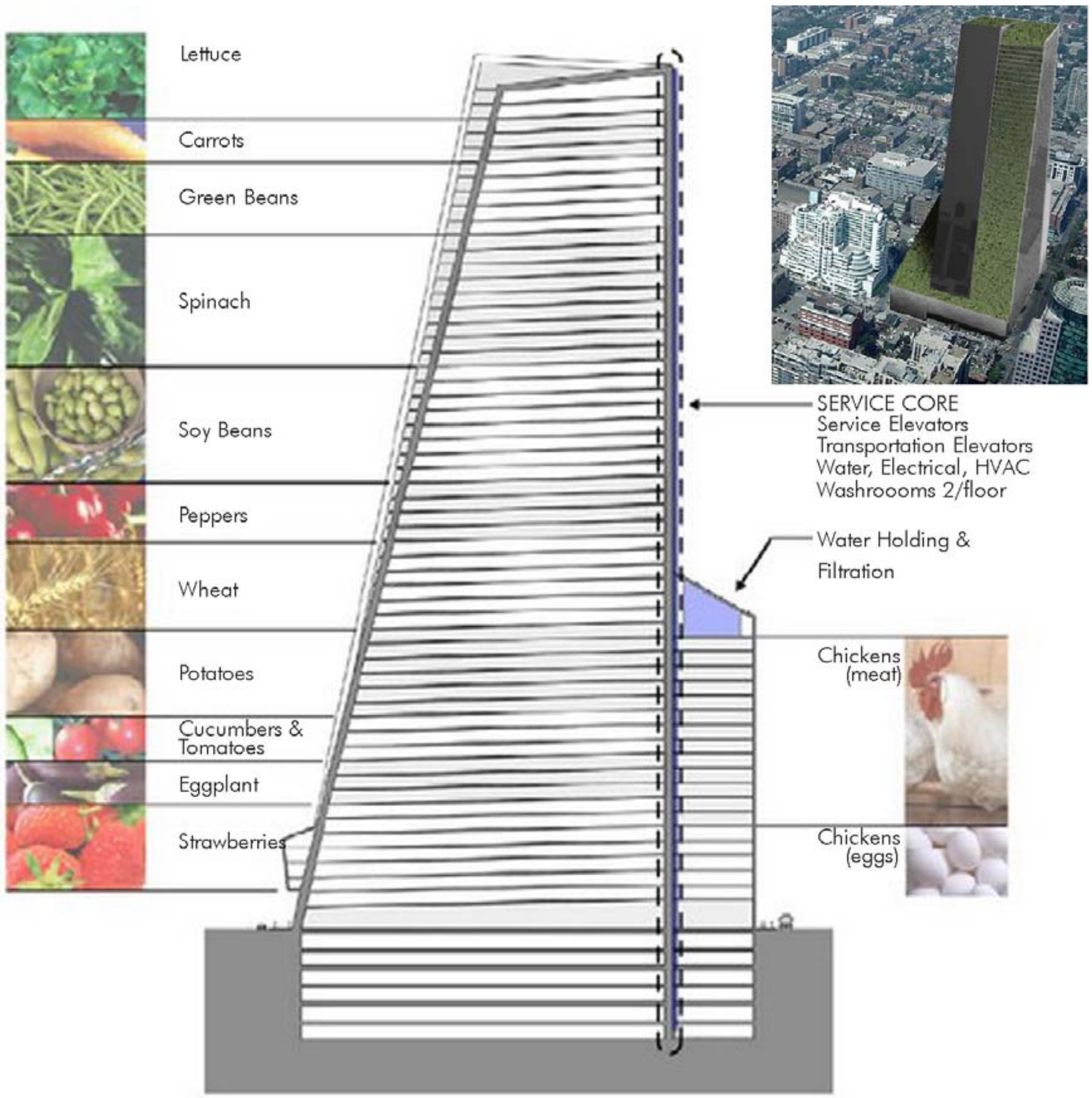


Figure 2-30: The "sky farm" proposal by Gordon Graff, Toronto, is an example of a vertical farm. Proposed is a 58-storey tower with 2.7 million square feet of floor area and 8 million square feet of growing area. It can produce as much food as a thousand acre farm, feeding 35 thousand people per year. Skyscraper farms can operate year-round with artificial lighting, so, on average, one indoor acre is the equivalent to between four and six outdoors, and companies are vying to reap the financial rewards that come from this increased efficiency.

Figure 2-31: The Mithun Centre for Urban Architecture is a proposal for an entirely self-sufficient urban farm that will grow both vegetables and chickens for local consumption. While its footprint occupies a mere 0.72 acres on the site, the 23-story building contains 318 one- and two-bedroom apartments and produces enough food to feed 450 people annually. The building is also sheathed in over 34,000 sq ft of south facing solar panels that will theoretically match 100 percent of the building's energy consumption. The ground level features an organic café that will serve food grown on the site to reinforce the importance of travel-free food consumption.

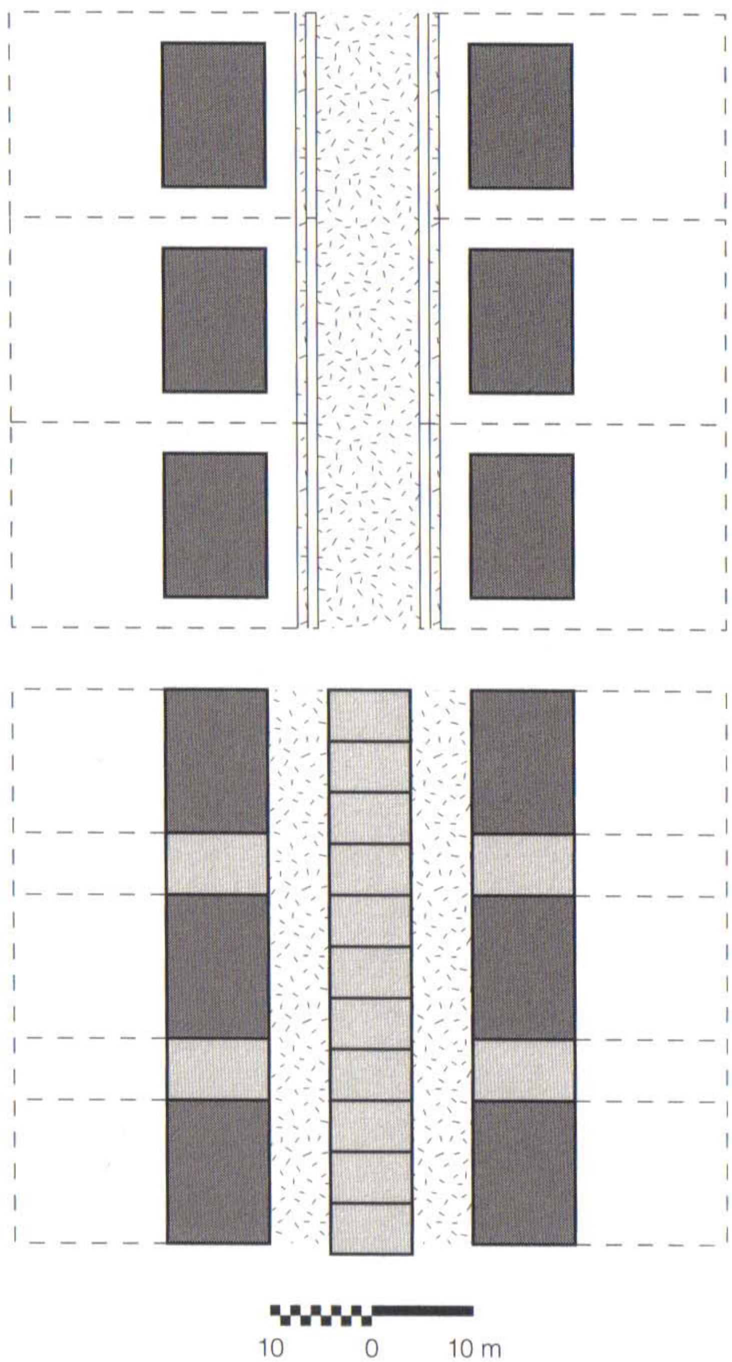


Figure 2-32: Diagram above shows the potential for infill housing in a suburban street (Upper drawing: Existing Condition, Lower Drawing: Infill Buildings Added). A wide street can easily be converted into two smaller pedestrian streets. Densification strategies for suburban areas such as this one, are key to ensuring cities do not sprawl any further and whatever is left of our rural green areas remains unbuilt and natural.

2.8 Waste and Water Management

> *"Recycling is an aspirin, alleviating a rather large collective hangover . . . over consumption. The best way to reduce any environmental impact is not to recycle more, but to produce and dispose of less".*[28]

Sustainable design cannot be complete unless it addresses the current waste and water crisis. As mentioned in the first chapter waste landfills have reached intolerable scales and are harming both human life and natural life within and around them. Population growth and post WWII consumer culture are said to be the primary culprits of this waste problem.[29]

The most popular response to this disorder has been to recycle waste. Recycling has been a common practice for most of human history, with recorded advocates as far back as Plato in 400 BC. It was a consistent process specially when it came to metals and products requiring a great deal of energy to produce. However, with the 1970's oil crisis, rising energy costs caused governments to invest in recycling in order to save money and reduce waste. In retrospect, the process of recycling aluminum uses only 5% of the energy required by virgin production. Glass, paper and metals have less dramatic but very significant energy savings when recycled feedstock is used.

Much of the difficulty inherent in recycling comes from the fact that most products are not designed with recycling in mind. Architect William McDonough and chemist Michael Braungart laid out a book pointing out this problem with recycling and proposed that every product (and all packaging they require) should have a complete "closed-loop" cycle mapped out for each component—a way in which every component will either return to the natural ecosystem through biodegradation or be recycled indefinitely. In this way, the process of recycling can actually be considered "sustainable".[30] (See Figure 2-33)

Figure 2-33: Diagram of the closed loop recycling process, where plastic bags and film are collected following their intended use and returned for recycling and reintroduction into the same market application.

This closed loop cycle can be applied not just to solid waste but also to water management. Being our most essential need, water preservation is crucial to our survival:

> *"Though we appear to be solid, we are in fact, liquid bodies, similar in a way to gelatin, which also seems to be solid but is in fact largely water, "gelled" by the presence of an organic material"*[31]

Depending on our age, our bodies are made up of approximately 50-75% water. Without water we would die a terrible death. Given the importance of water to our survival it is extremely important to consider how much of it we consume and what is happening to it after it is consumed. Waste water gets dumped into our rivers and lakes at an increasing rate and there is a great deal of speculation from scientists that the world is running out of freshwater:

> *"Water scarcity may be the most underappreciated global environmental challenge of our time….unless we change our ways, by the year 2025, two thirds of the worlds's population will face water scarcity. The global population tripled in the twentieth century, but water consumption went up sevenfold. By 2050, after we add another three billion to the population, humans will need an 80 percent increase in water supplies just to feed ourselves. No one knows where this water is going to come from."*[32]

As incredible and scary as this statement is, it is imperative for us to act toward a sustainable response. Several strategies have been developed and continue to develop in the area of sustainable water mangement. Amongst these are rainwater collection strategies (see Figure 2-34), and living machines (Figure 2-35).

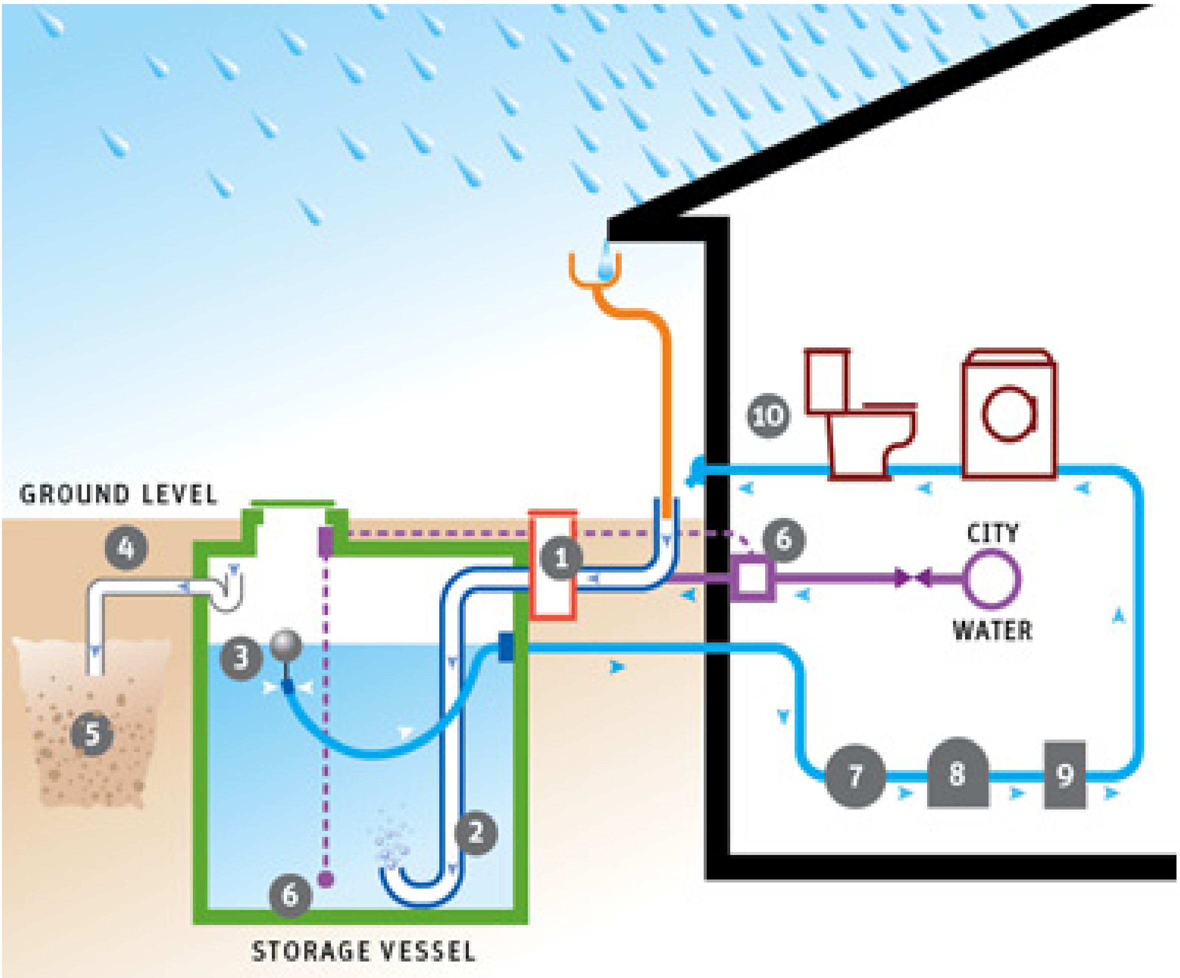


Figure 2-34: A rainwater cistern makes it simple and affordable to collect and use the abundant supply of naturally pure and soft rainwater that falls on your roof every time it rains. The shortage and cost of producing purified water for drinking is a growing problem, yet every day a large percentage of this treated water is wasted in homes and industry on uses such as toilet flushing, laundry, pool and hot tub filling, car washing, fire suppression, and lawn and garden watering. A rainwater cistern can vastly reduce this over consumption of purified water.

Figure 2-35: Photograph of a Living Machine System invented by biologist John Todd as an engineered solution to managing human and manufacturing wastes in today's water systems. Living Machines are natural wastewater treatment systems, site-specifically engineered to imitate the water-cleansing properties of natural wetlands (i.e. ponds, marshes and meadows). Unlike septic and other chemical treatment systems, the technology relies entirely on living organisms to convert "wastes" into healthy nutrients. Water treated by Living Machine technology is currently being reused around the world for irrigation, indoor plumbing, and more.

2.9 Renewable Energy

Finally, sustainable design ought to incorporate the use renewable energy into our way of life. Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides and geothermal heat; which are renewable – meaning naturally replensished. Renewable energy technologies include solar power (Figure 2-36), wind power (Figure 2-37), hydrogen power (Figure 2-38), waste energy (See Figure 2-39), and biofuels (See Figure 2-40).[33] Briefly mentioned in the building design section of this chapter, renewable energy aims to replace the current conventional means of generating energy through oil and coal. Both oil and coal are not naturally replenished resources and are being consumed at an increasing rate exponentially with the fast growing population of the world. It is the prediction of many scientist that there soon will come a point when there will not be enough oil to sustain the population of the world. In additiion, energy generated from both oil and coal destroys natural life and pollutes our land, air, and water. In contrast, renewable energy is naturally replenished and can be consumed endlessly without harming the natural world.

Figure 2-36: Photograph of the 1.9 MW solar electric project at the main Google headquarters in Mountain View, California. This project includes solar array designs for three different types of rooftops and two different steel carports. Solar power can be used in two different ways: 1) Solar panels or slates can convert the sun's energy to heat in order to provide hot water, or 2) Photovoltaic tiles can create electricity. Both types of solar power will not only save a building owner money, but will also significantly reduce the carbon emissions of the building.

Figure 2-37: Photograph of one of the windmills at the Erie Shores Wind Project in Southern Ontario. The project brings 99 Megawatts of electricity into Ontario Hydro's main power lines. Due to the fact that wind is inconsistent, the wind turbine project cannot be used as a primary source of power, however, wind power can significantly reduce the stress on conventional means of generating electricity. Out of the 550 Kv of electricity generated by Ontario's main power plants, 115Kv are generated by wind power. Each wind turbine in the Erie Shore Wind Project cost approx. $2million dollars and generates 660 Volts of electricity (Enough to power approx. 700 homes). There are 66 wind turbines in total spread across several farms in Southern Ontario. The sites were identified by research studies as strategic places to locate wind turbines.

Figure 2-38: Hydrogen is a clean burning resource that is beneficial to the environment because it does not emit greenhouse gases while it is being used. Hydrogen powered vehicles have the possibility of being highly efficient and effective if the proper refuelling infrastructures are created. However, using hydrogen is an expensive endeavour that may not seem worth it in the short run. Nonetheless, research studies found that during a 20-30 year lifetime, hydrogen fuel technologies not only pay back the original energy investment, but also the emissions produced from their own manufacturing. U.S. automakers GM have been testing a hydrogen-powered fuel-cell vehicle that will eventually be put into production as soon as government legislation allows it.

Figure 2-39: This incineration plant is one of several plants that provide district heating to the city of Vienna in Austria. Incineration is a popular Waste-to-energy technology generally used to create energy in the form of electricity or heat from a waste source. Such technologies reduce or eliminate waste that otherwise would be transferred to a landfill.

Figure 2-40: Also known as agro fuel, biofuels are mainly derived from biomass or bio waste. These fuels can be used for many purposes, but the main use for which they have to be brought is in the transportation sector. The greatest motivator for producing biofuels is the global warming caused by the constant burning of fossil fuels like coal and oil.[34] Biofuels cause less pollution and are also biodegradable. The main controversy with biofuels is that food that could have been used to feed millions of starving people is being used to produce fuel. According to the World Bank around 100 million people face starvation in the wake of the current food-shortage crisis. Although many claim that the food shortage has been triggered by a sudden shift in the eating habits of people in China and India, the impact of biofuel production on food-security cannot be ignored. In addition, the production of biofuels have accelerated rate of deforestation since every kind of plant can be used as fuel. [35]

2.10 Sustainable Design Summary

> *"All things are interconnected. Everything goes somewhere. There is no such thing as a free lunch. Nature bats last."*[36]

In essence, sustainable design can be understood as design that sensibly responds to the interconnected relationship between humans and nature, by addressing the following topics:

1. Site Remediation: cleaning contaminated land that has been damaged by industry and waste, by reclaiming it as part of the natural world and restoring its natural health.
2. Building design: dealing with building enclosure, orientation, materials and systems efficiently to ensure buildings don't consume energy in a wasteful fashion but rather preserve energy and perhaps even provide energy to the rest of city.
3. Transportation: ensuring the means of transportation in the city don't add to higher greenhouse gas emissions but rather eliminate pollution and urban sprawl through the development of public transit, pedestrian walkways, bicycle lanes, fuel-efficient vehicles, and slower vibrant streets that accommodate the human scale.
4. Agriculture/food and land preservation: eliminating the use of toxic pesticides in farms and long distance transportation of food, by introducing more locally grown organic food along with urban planning strategies that preserve and nurture our natural infrastructure.
5. Waste management: consuming less and ensuring our all of our products fit into a closed loop cycle that will either return it to the natural ecosystem through biodegradation or be recycled indefinitely.
6. Water management: reducing water consumption is critical given the lack of fresh water resources n the planet; along with the removal of toxic chemicals found in our waterways today, by instilling natural processes of collecting and cleansing the water we use and returning it to lakes, rivers, and oceans.
7. Renewable energy: making a transition from energy that is consuming limited amounts of natural resources (ie. Oil and coal) in a wasteful fashion to energy that is naturally replenished by such natural resources as sunlight, wind, water, rain, tides in the water, and geothermal heat.

Architects along with all the professionals involved in the process of planning, building, and developing cities have a responsibility to integrate these sustainable design topics into their work. In addition, they have an important role to play as educators in their community. In order to address the economical crisis we face today, it is important to raise awareness about these issues and the solutions that are developing. The culture of over consumption and wastefulness needs to change. People will not change their ways unless someone explains to them the damage they are causing and the alternative choices they can make to help the cause.

	SITE REMEDIATION	BUILDING MATERIALS	BUILDING THERMAL COMFORT	TRANSPORTATION	AGRICULTURE, FOOD & LAND PRESERVATION	WASTE & WATER MANAGEMENT	ALTERNATIVE ENERGY
BUILDING LEVEL	Capping	Recycled / Reused Materials	Building Enclosure / Orientation	High Density - Avoid Urban Sprawl	Homegrown Vegetables & Fruits (ie. Edible Garden in Home)	Recycling	Batteries
	Dig and Dump	Locally abundant Materials	% of Windows - Daylight & Views	Bicycle Storage & Changerooms	100 Mile Diet (Eating Local Food)	Composting	Bio-Diesel
	Bio-Remediation	Durable low maintenace Materials	Fireplace	Preferred Carpool Parking	Hydroponics	Overhangs, Eaves, Sills, Etc.	Bio-Fuel
		Blue Jean Insulation	Overhangs - Shade	Electric Vehicle chargers		Rainwater Cistern for Toilets and Landscaping	Electric Cars
		Certified Wood	Cross Ventilation			Hot water Panels-Radiant Floor	Ethanol
		Low Emitting Adhesives, Paints, Carpets, Laminate Floors	Carbon Monoxide Monitoring			Living Machine-John Todd	Fuel Cells
		Indoor Chemical Pollutant Control				Water Reclamation-Jens Steenberg	Geothermal Energy
							Human Power/Pedal Power
COMMUNITY LEVEL	Re-development of Brownfields and Contaminated Sites	Recycled materials	Narrow Streets	Pedestrian Only Streets	Reduce Urban Sprawl - High Density Population in Cities	Recycling	Hydro Power
		Locally abundant materials	Low buildings	Public Transportation (ie. Trains, Buses, Streetcars)	Eco-Villages	Composting	Hydrogen Fuel
		Durable low maintenace materials	Abundant Trees	Bicycle Paths / Access	Vertical Farms	Stormwater Treatment Ponds	Solar Power / PhotoVoltaics
			Shaded Public Space	Alternative Fuel Vehicles	Re-development of Brownfields and Contaminated Sites	Living Machine - John Todd	Tidal and Wave Power
							Waste Energy
							Wind Power - Wind Farms

Figure 2-41: Sustainable Design Summary Chart

03 SITE

3.1 An appropriate Site for Sustainable Design

Figure 3-1: My first personal encounter with the Burloak Employment Lands was from the commuter train on my way to work. The enormous size of the Petro-Canada refinery in the site in contrast with the surrounding suburban homes caused me to pause and reflect on the way we humans sustain our cities.

This thesis was instigated by my personal encounter with the Burloak Employment Lands (See Figure 3-1). Having recently moved to a new subdivision adjacent to it with my wife and daughter, I came into close proximity of this industrial site when I first rode the train to work. The experience of learning about this site and its impact on the surrounding area has fired up my profound interest in the health of my community and its integration with the planet. The research and analysis presented in this chapter aims to explain all that I have learned about this site and why it is imperative that a new vision for the site is proposed using a sustainable design approach.

3.2 Site Overview

The Burloak Employment Lands are located between the City of Toronto and the City of Hamilton, in the town of Oakville (See Figure 3-2). These lands are designated for industrial use and are currently surrounded by suburban development and precious natural areas (See Figure 3-3). The long history of industrial activity in the site, particularly the Petro-Canada Plant that currently occupies most of the site, has made this area hazardous to the community and its natural environment.

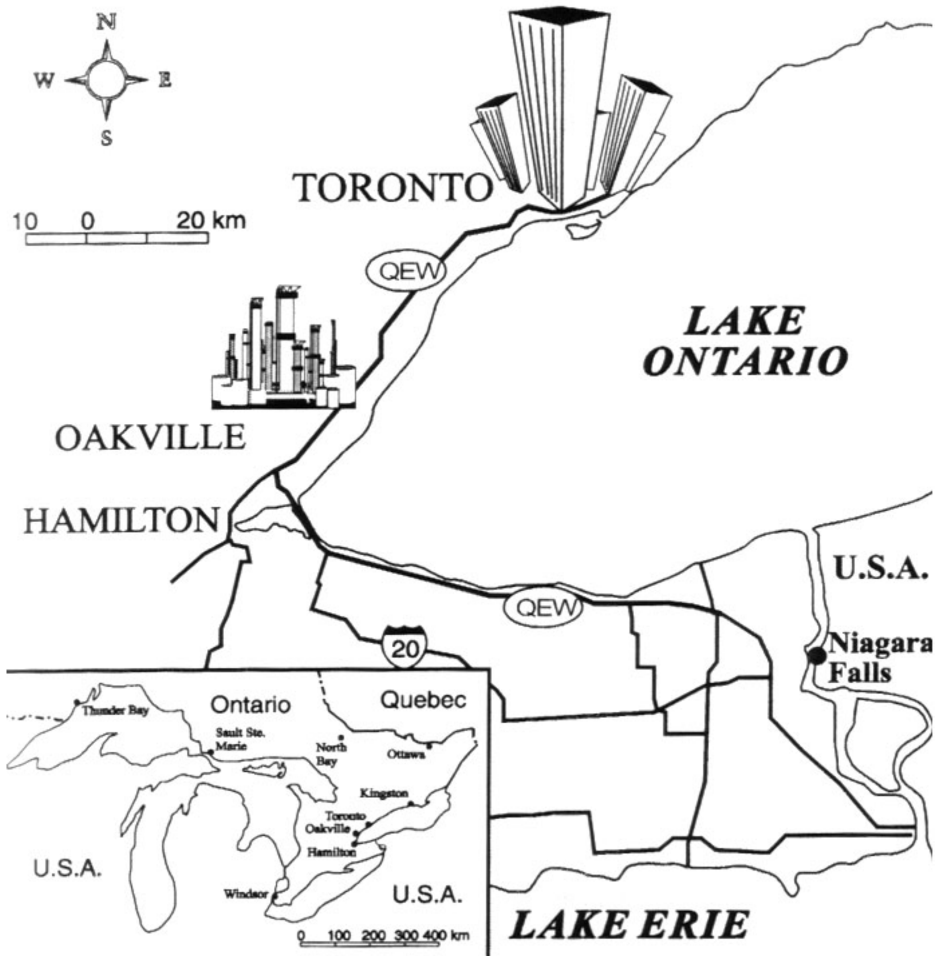


Figure 3-2: Key map of Oakville, Ontario.

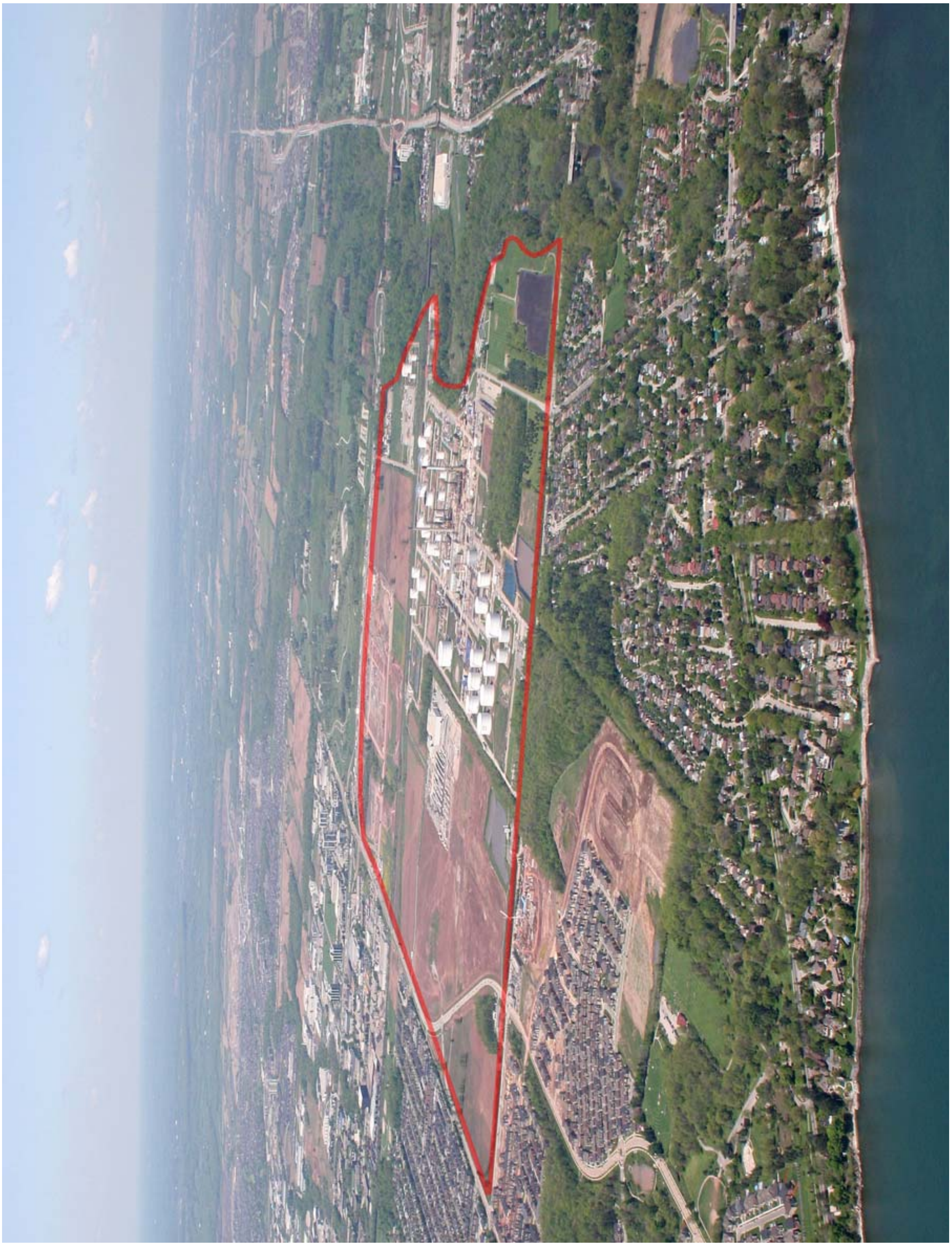


Figure 3-3: Aerial photograph taken from the south side of the Burloak Employment lands in May 2007. The red outline indicates the extents of the site. The Petro-Canada oil refinery occupies the vast majority of the site and is surrounded by suburban residential development.

3.2 History

When the town of Oakville was incorporated as a town in 1857, it was primarily an agricultural community with a population of about 1,648 people. Having an attractive lakeside location with harbour facilities and small residential and industrial developments, it was a popular summer resort destination for many city dwellers in Ontario. By 1945, the end of the war, the town's population had grown to 4,399 people. [37] Aside from a small farmhouse near the sixteen mile creek (see Figure 3-4), there was no sign of any development at the Burloak Employment Lands in Oakville until 1958, when the then called "Trafalgar Refinery" was constructed by Cities Service Oil Company Ltd. (See Figure 3-5). Employing over 1,500 people, the Trafalgar refinery was one of the largest in the country at the time.

Following the birth of this refinery, economic growth and development continued for several years. A series of corporate takeovers took place as companies continued to succeed in the oil business. First British Petroleum Canada Ltd. purchased all assets of the Trafalgar refinery in 1964. A year before that, 1963, Shell Canada opened a new refinery on adjacent lands to the British Petroleum refinery (See Figure 3-4).[38]

The oil business in Oakville kept flourishing until the mid 1970's oil crisis. At this time, Arab countries decided to discontinue the shipping of oil to Western countries, including Canada and the United States, because of their support of Israel in the Yom Kippur War. As a result, the price of crude oil rose rapidly during this time and western countries were left to their own devices in the acquisition of oil.[39]

In order to meet Canada's high demand for oil products, a national oil company was created by an Act of Parliament in 1975; it was called Petro-Canada. The next year Petro-Canada began buying control of several oil companies in Canada and the United States. Among these companies was Pacific Petroleum, which is still to date the most expensive takeover in Canadian History at $1.5 billion. Other companies bought by Petro-Canada include Atlantic Richfield Canada (ARCAN), Petrofina Canada Inc., and finally in 1983, the purchase of British Petroleum Canada.

After the purchase of British Petroleum Canada ($419 million) in Oakville, Petro-Canada established itself as the biggest oil company in the country. Simultaneously, twelve other Canadian refineries closed down in Ontario, including Shell Canada's refinery next door in 1983 due to declining demand for oil products. At this time, Shell's refinery was disassembled and removed from the site. The Petro-Canada refinery became the only industrial occupant in the Burloak Employment Lands.[40]

Figure 3-4: The first sign of architecture at the Burloak Employment Lands was this Farm house, built before the first oil refinery moved into the Burloak Employment Lands. The house now serves as a corporate meeting place for Petro-Canada business executives.

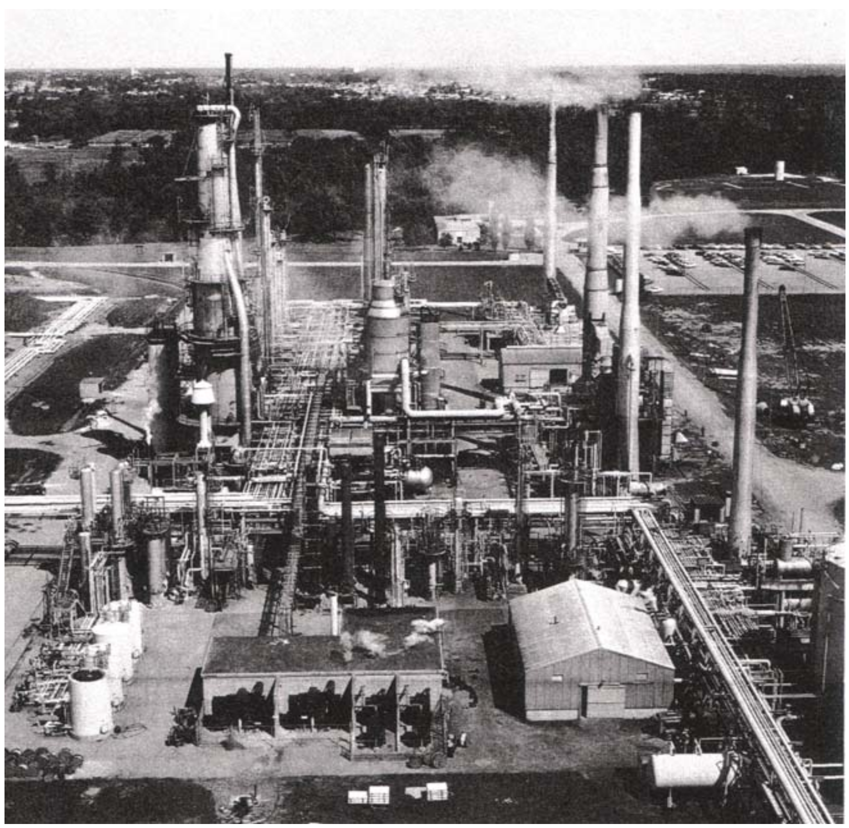


Figure 3-5: Trafalgar refinery Plant No. 1. Originally built in 1958 by the Cities Service Oil Company, the project employed more than 1,500 Canadian Craftsmen during peak periods of construction.

Since 1983, Petro-Canada continued its operation in the Burloak Employment Lands until 2003, when the company decided to stop refining oil at the Oakville site due to Environment Canada's new specifications for ultra-low sulphur gasoline and diesel (See Figure 3-6 & 3-7). The 350 employees in the refinery worked until September of 2007 to disassemble and remove the refining equipment in the site. The Petro-Canada Oakville Plant now remains in the site solely as a storage and distribution facility of a variety of oil products. The aging refinery needed approximately $250-$300 million dollars in upgrades in order to meet the new government requirements for low-sulphur. [41]

Figure 3-6: Aerial photograph of the Petro Canada Plant in Oakville back in 1986.

Figure 3-7: View of the Petro-Canada Plant from the highway in January of 2007. The mere sight of the refinery to the public is uninviting and evokes a feeling of gloom in the community.

Figure 3-8: An aged "cat-cracker" is shown after its disassembly. Following the 2003 closure of the refinery, this refining equipment was no longer needed by Petro-Canada and was removed from the site.

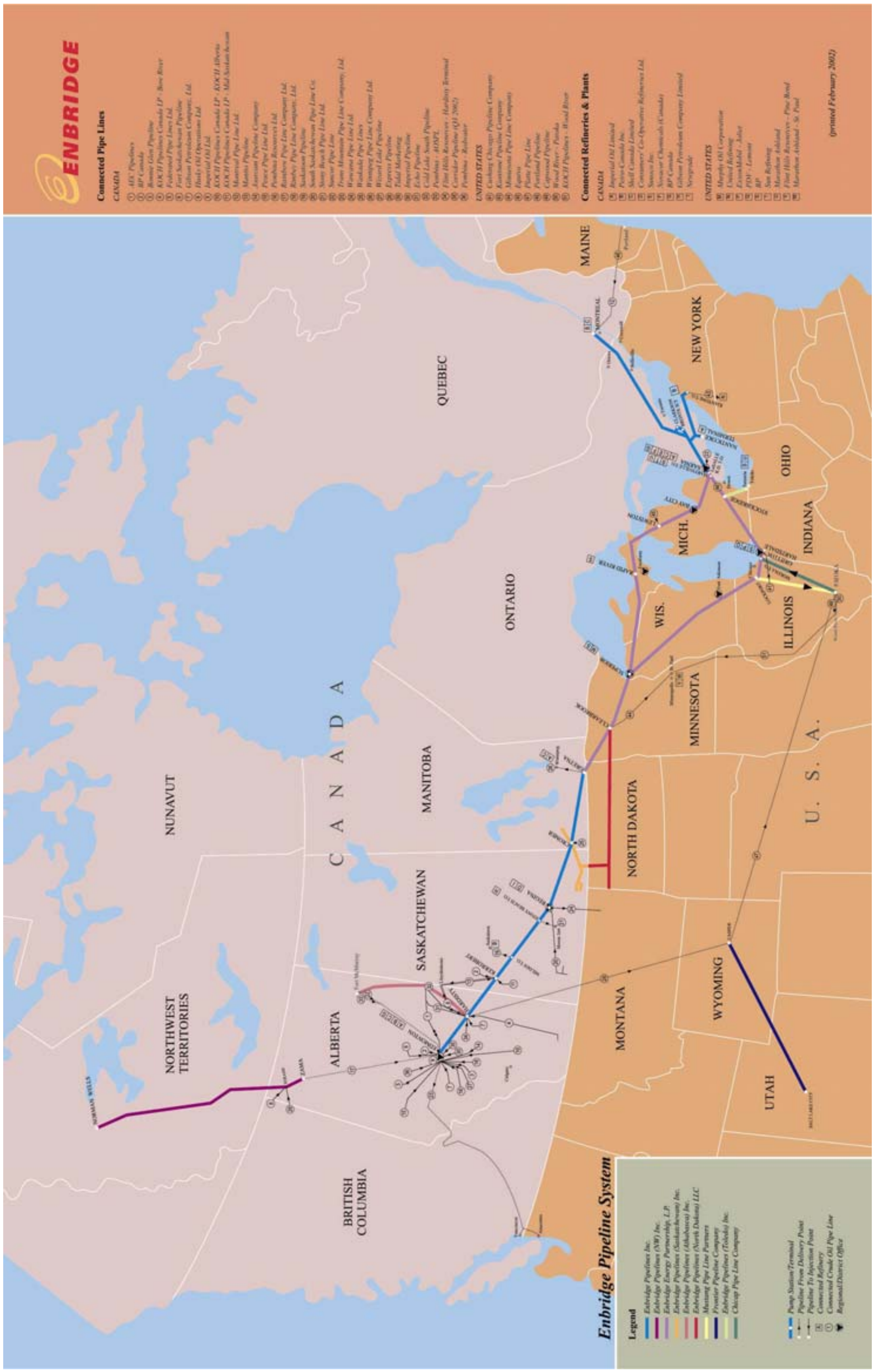
3.4 The Burloak Employment Lands Today

The Petro Canada Oakville Plant currently stores and distributes oil products such as gasoline (various grades), diesel fuel, aviation fuel, heating oils, asphalt, sulphur, propane, butane, and industrial residual fuels (See Figure 3-8, 3-9, & 3-10). These oil products come from both crude and refined contents via the embridge pipeline system that spans across the entire country and down to some northern parts of the United States (Figure 3-11). The immediately adjacent land at the Petro-Canada site remains undeveloped for the time being and its future is uncertain. At the north end of the site, next to the highway, a box retail development has been built called the RIOCAN Centre. This development houses large commercial tenants that include a Home Depot, a Longo's grocery store, a Cineplex movie theatre, and several box retail outlet stores (Figures 3-12,3-13, 3-14, & 3,15).

Figure 3-9: An average gasoline tank in the Petro-Canada Refinery measures and astonishing 114 feet in diameter (approx. the width of a football field) and 60 feet high (approx. 6 storeys). In February of 2002, there were 42 tanks spread across the Petro-Canada Site.

Figure 3-10: Ethanol Domes are similar in scale to gasoline tanks but require a dome ceiling.

Figure 3-11: Propane and Butane tanks are slightly smaller than gasoline tanks and there are only six in total in the entire site.



Figures 3-12: A key map of the Embridge Pipeline System shows the route for crude oil, starting at Fort McMurray in Alberta. The Pipeline spreads along the entire country, passing trough the United States and Southern Ontario, and terminates just outside of Montreal in Quebec.

Figure 3-13: Photos of the RIOCAN centre, made up of box retail developments. The commercial complex is located immediately north of the Petro-Canada Plant. It was built in less then a year and there are plans to continue this type of development along the site.

3.3 Environmental & Health Effects

Figure 3-14: The Petro-Canada Oakville Plant after complete disassembly. Five years after it stopped refining crude oil, the plant remains visible to the public. Its physical presence continues to be detrimental to the health of the local community and the planet.

> *"... ultimately a regulation is a signal of design failure. In fact, it is what we call a license to harm: a permit issued by a government to an industry so that it may dispense sickness, destruction, and death at an 'acceptable rate'."*[42]

A year before the Oil Refinery's 2003 closure, the environmental group Friends of the Earth released a report under the Access to Information Act identifying the Petro-Canada oil refinery in Oakville amongst the top five dirtiest oil refineries in the country. The other four were also located in southern Ontario and all five were reported to be the major contributors to summer smog in their surrounding communities. The sulphur content in the Petro-Canada refinery was at 500 parts per million, almost five times higher than the new government regulation calling for 150 parts per million sulphur content.[43]

Medical research has revealed that the exposure to odours and air born chemicals from industrial sources, such as oil refineries and chemical plants, have a considerable impact on general health and well-being, affecting both physiological and psychosocial status. Psychosocially speaking, both odour perception and worry about environmental health effects from the sites were strongly related to symptom reporting (e.g., headaches, nausea), and that the combined effects of odour perception and worry were even stronger.[44] The "perceived" harm of seeing the refinery was proven to be harmful due to increased stress and anxiety in the community. The "real" harm is much worse, since the exposure to chemicals such as sulphur are proven to be leading causes of asthma, premature births, miscarriages, lower weight of newborns, leukemia, and cancer.[45] With regard to environmental health, petrochemical activity pollutes the air with volatile organic compounds, and water, soil, and flora near refineries are found to show increased levels of heavy metals[46] (See Figure 3-15).

3.5 Natural Infrastructure

The main natural conservation areas in Southern Ontario are the Oak Ridges Moraine and the Niagara Escarpment. These two strips of untouched natural land connect to a series of river valleys all of which lead to the prominent Lake Ontario. One of these river valleys is Bronte Creek. This lengthy creek connects the Niagara Escarpment with Lake Ontario (See Figure 3-16). At the mouth of Bronte Creek, where it meets Lake Ontario, are the Burloak Employment Lands. Stretching out through the entire east end of the Burloak Employment Lands, Bronte Creek is the most significant natural feature in the site (See Figure 3-17).

Immediately north of the site is Bronte Creek Provincial Park. Frequently used by the local community, this park inhabits a petting zoo, outdoor swimming facilities, an outdoor skating rink, picnic areas, hiking trails, fishing areas, and camping facilities. It is a place where humans enjoy and take advantage of their relationship with nature (See Figure 3-18).

As the creek crosses the Burloak Employment Lands, it remains untouched but also inaccessible to the public. Given the private nature of the Petro Canada Plant, Bronte Creek ceases to have any pedestrian or bicycle paths in the areas adjacent to the plant (See Figure 3-15). Once the creek crosses the site, it ends at Bronte Village, a charming part of Oakville containing some historical buildings, and well-used waterfront trails with commercial and residential developments facing Lake Ontario (See Figure 3-19).

Figure 3-15: Photograph of Bronte Creek at the area adjacent to the Petro Canada Plant. Though shallow in depth the creek is wide and has a great abundance of trees and wildlife. Unfortunately, there are no pedestrian paths in it and it is inaccessible to the public. It is also unclear how clean the Creek is at this point given its years of exposure to Petro-Chemical activity.

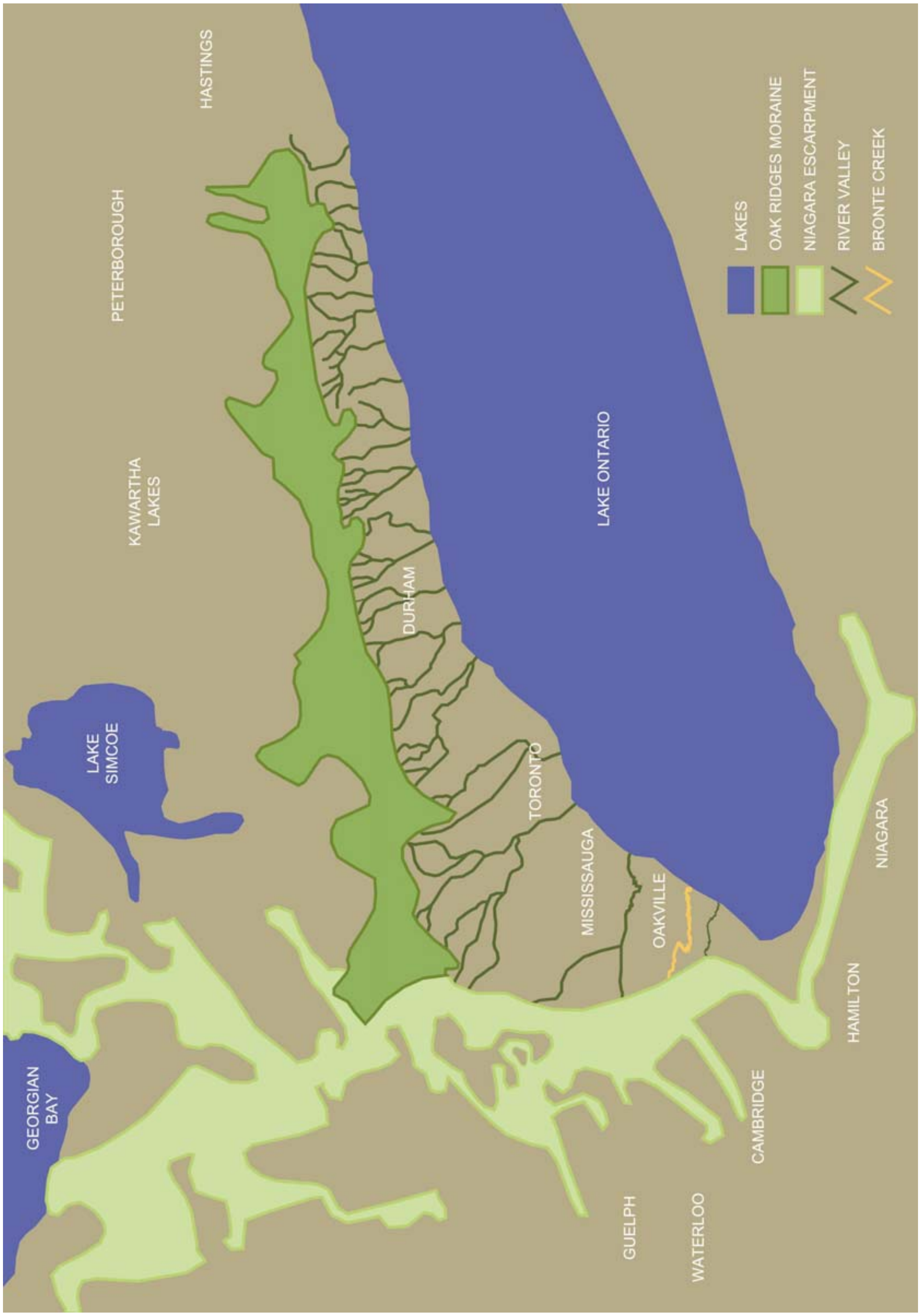


Figure 3-16: Diagram showing the main natural components of Southern Ontario. Bronte Creek is highlighted as one of the recurrent River Valleys connecting the Niagara Escarpment with Lake Ontario

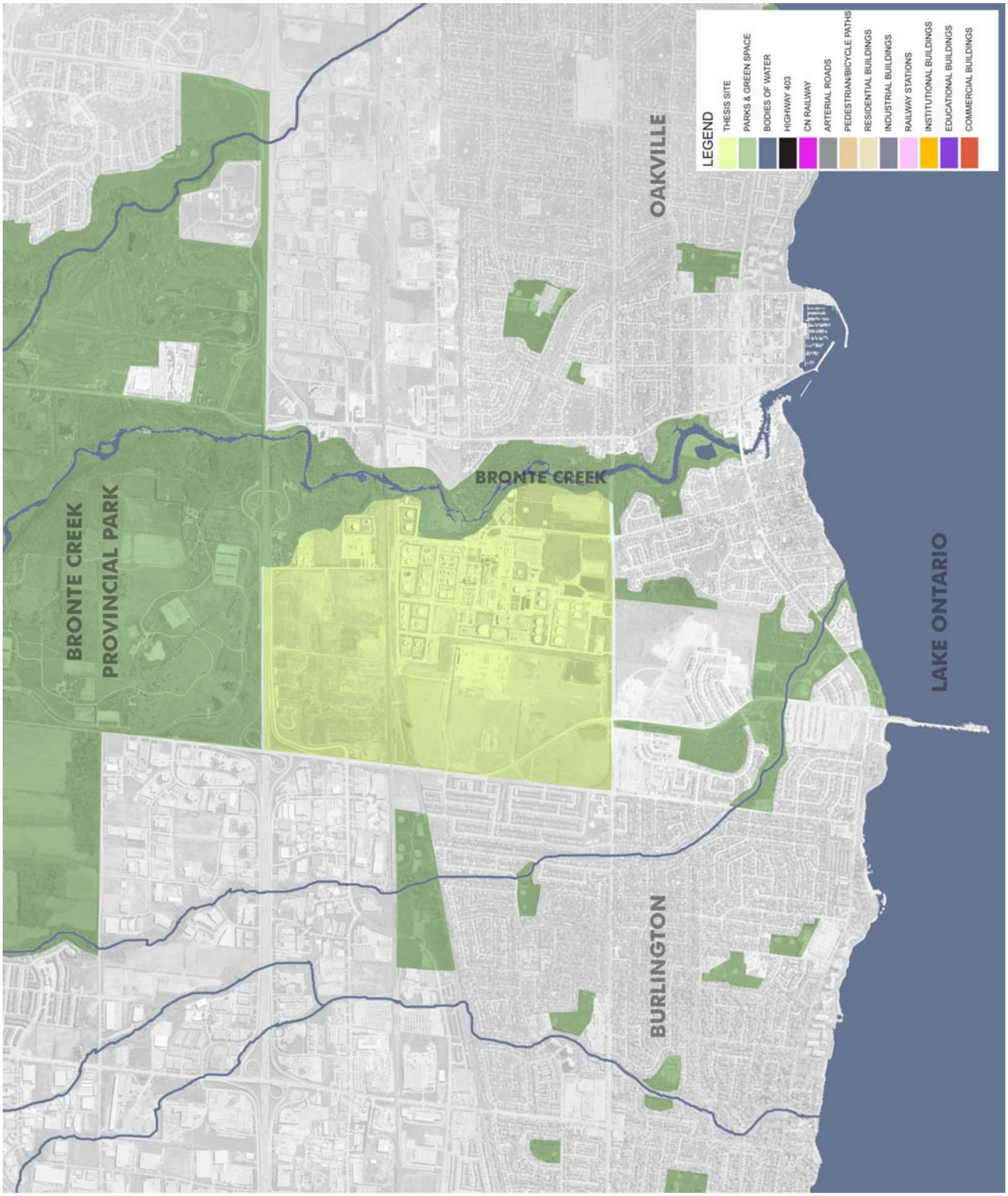


Figure 3-17: Diagram showing Natural Parks/Green spaces and Bodies of Water in and around the Burloak Employment Lands.

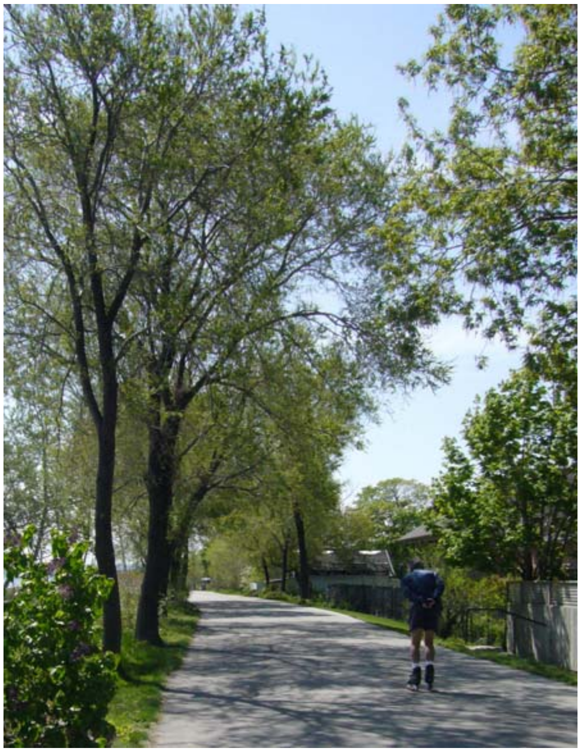


Figure 3-18: Photograph of a pedestrian/bicycle trail around Bronte Village. Abundant with trees and views toward Lake Ontario, this trail is mostly used for recreational purposes by the local community.

Figure 3-19: Photograph of the Bronte Village Harbour. The harbour houses a wide mix of activities and buildings, including apartment buildings, restaurants, shops, and recreational parks facing the water.

3.6 Transportation Infrastructure

The main components of transportation infrastructure in the site are Highway 403, the CN railway corridor, large suburban scale roads, and pedestrian/bicycle trails (See Figure 3-21). Highway 403 runs in an east-west direction at the north end of the site. It separates Bronte Creek Provincial Park from the Burloak Employment Lands. It is an extremely busy highway since it is the main vehicular connection between the city of Toronto and the city of Hamilton. The CN railway corridor passes through the middle of the site also in an east-west direction. This railway corridor is occupied by all kinds of trains, including commuter trains, Trans-Canada Via Rail trains, and CN cargo trains (See Figure 3-20). The suburban scale roads make up much of the urban fabric around the site and serve as the main means of transportation for the local community. Finally, there is one main pedestrian/bicycle path that is broken up in the site at the east and west sides of the site. The local community in both the town of Oakville and the city of Burlington use this path mainly for recreational purposes (See Figure 3-18).

Figure 3-20: Photograph showing the proximity of the CN railway corridor to the Petro-Canada Plant. This railway corridor is frequently occupied by Go Transit, the local commuter train which travels across southern Ontario from the city of Hamilton across downtown Toronto and terminating at the city of Oshawa. Train stations are located at the major nodes of all the cities along the rail line. Amongst these train stations is Toronto Union Station, considered to be a central node for Southern Ontario.

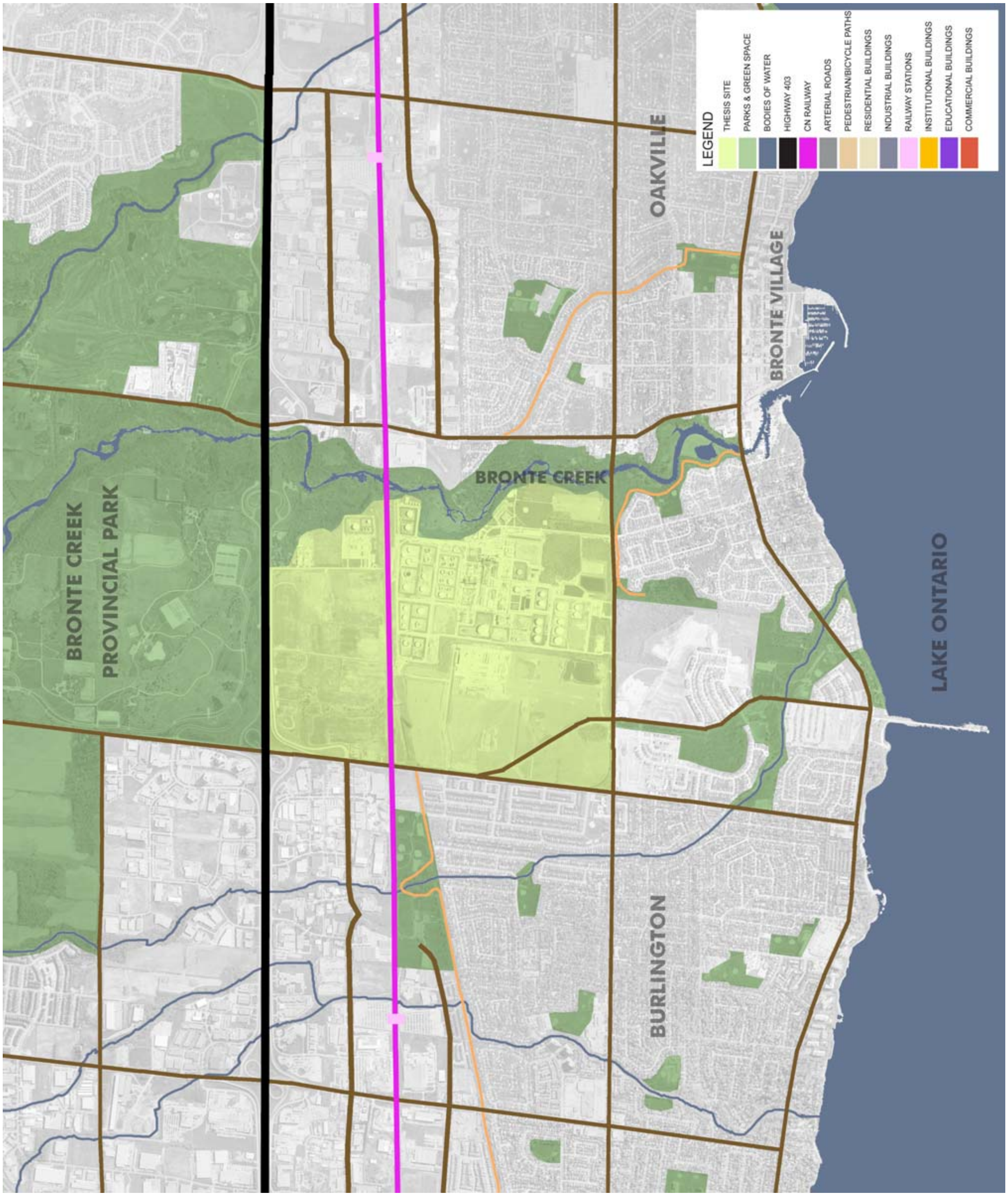


Figure 3-21: Diagram showing the main components of transportation infrastructure in and around the Burloak Employment Lands.

3.7 Land Use and Density Analysis

Large-scale suburban development surrounds the Petro Canada Plant. Aside from a buffer of large box retail stores and industrial warehouse buildings facing highway 403, most of the buildings in the area consist of residential houses (See Figure 3-23). Most residential development consists of single 1 or 2 storey detached houses and occasionally some 3-3 storey townhouse developments next to mid-rise 8-15 storey apartment buildings (See Figure 3-22). Commercial activity within these areas usually happens in commercial plazas with large parking lots and frequent car traffic. There are a few schools spread sporadically within these adjacent residential developments. These schools generally occupy a large portion of land that is generally used for soccer and baseball fields.

The density of people relative to the amount of land in this area is commonly studied using Floor Area Ratios or FAR (See Figures 3-24 & 3-25). The FAR for buildings in the town of Oakville and the city of Burlington is approximately 1.0. In contrast, more vibrant cities such as Paris, Rome & Venice have a FAR closer to 1.5 (See Figures 3-26, 3-27 & 3-28).

Figure 3-22: Photograph showing the 1-2 storey residential houses found along Burloak Drive, immediately adjacent to the Petro Canada Plant. Streets and houses of this type occupy most of the land in Oakville and Burlington. People who live here depend almost entirely on the car as the primary form of urban transportation.

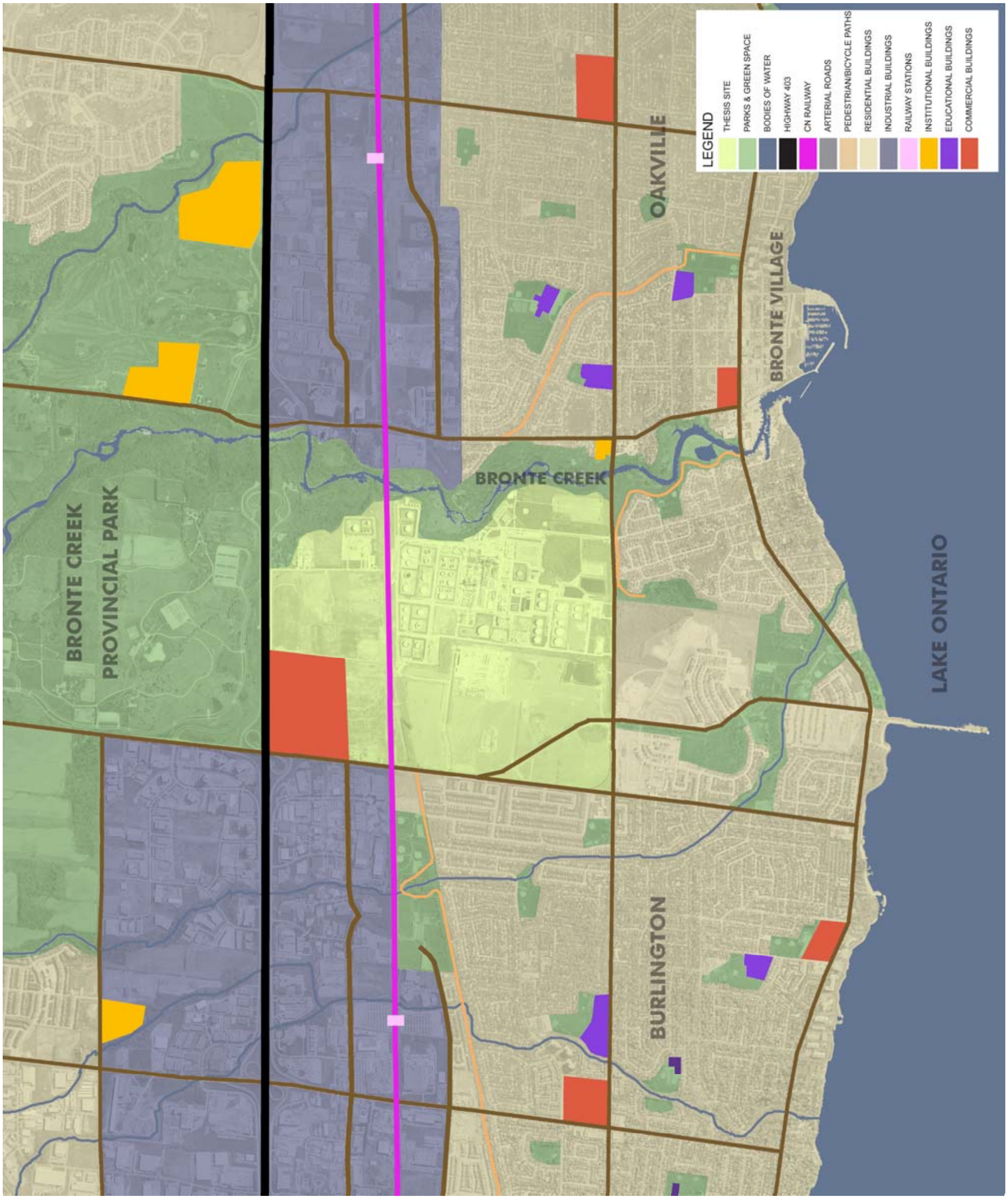


Figure 3-23: Diagram showing the varying types of land use in and around the Burloak Employment Lands.

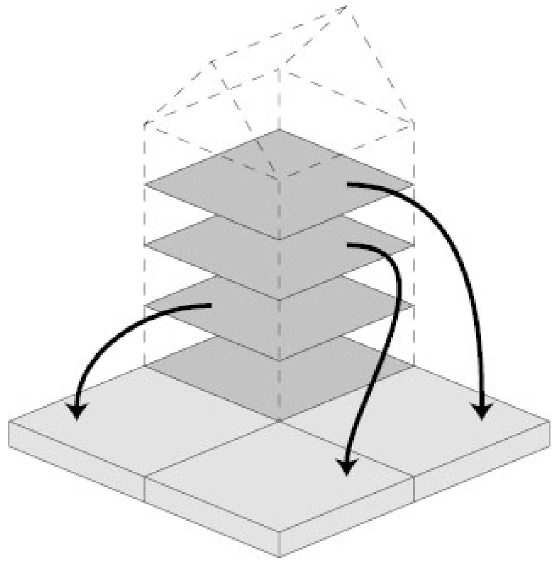


Figure 2-24: The illustration above shows a Floor Area Ratio (FAR) of 1.0. This simply means that, if the area of a plot of land is 100 square meters, then 100 square meters of gross floor area has been built on the plot of land. The illustration above shows a 4-story building covering 1/4 of the site, giving a FAR of 1.0. Four floors of 25 square meters each are built on a site of 100 square meters.

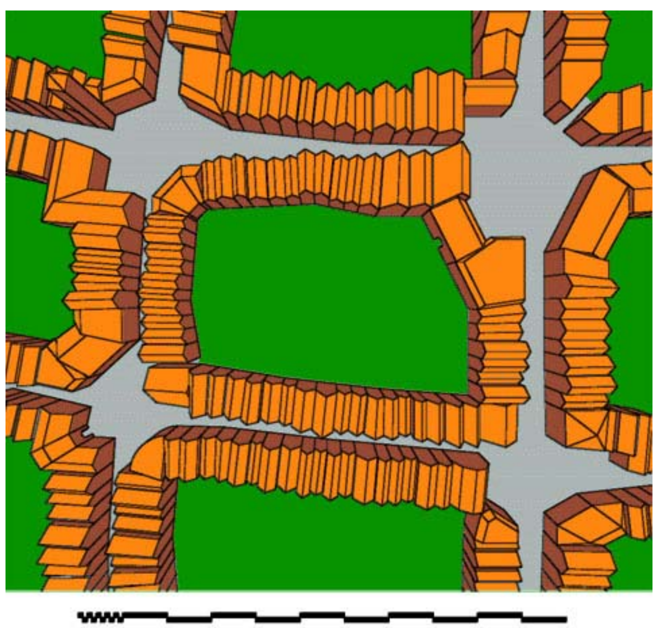


Figure 3-25: Diagram by J.H. Crawford showing a city block with a FAR of 1.5. Crawford identifies this ratio as the minimum for building a sustainable city. From his research, a high FAR of 1.5 allows for maximum activity in relatively little land.[47] This means approximately one and a half times the area of the lot is built up. This density is not unusual in vibrant urban places like Rome, Paris and Venice. It requires 4-story buildings and narrow streets with modest interior courtyards. According to Crawford, higher buildings would leave more room

for streets and gardens, but buildings higher than 4 stories are not desirable because they are expensive to construct and are unpleasant to live in.

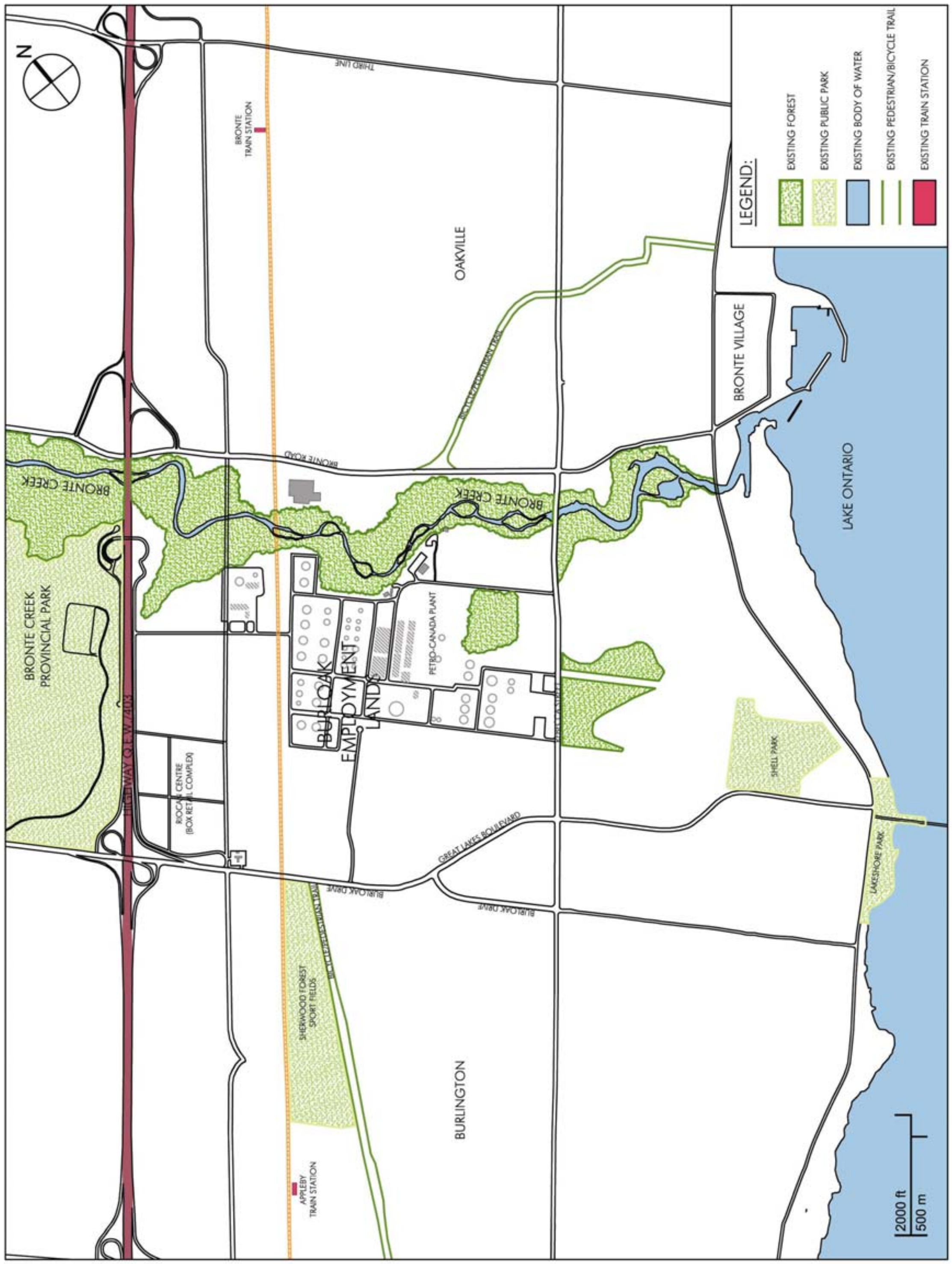


Figure 3-26: Existing Plan of the Burloak Employment Lands.

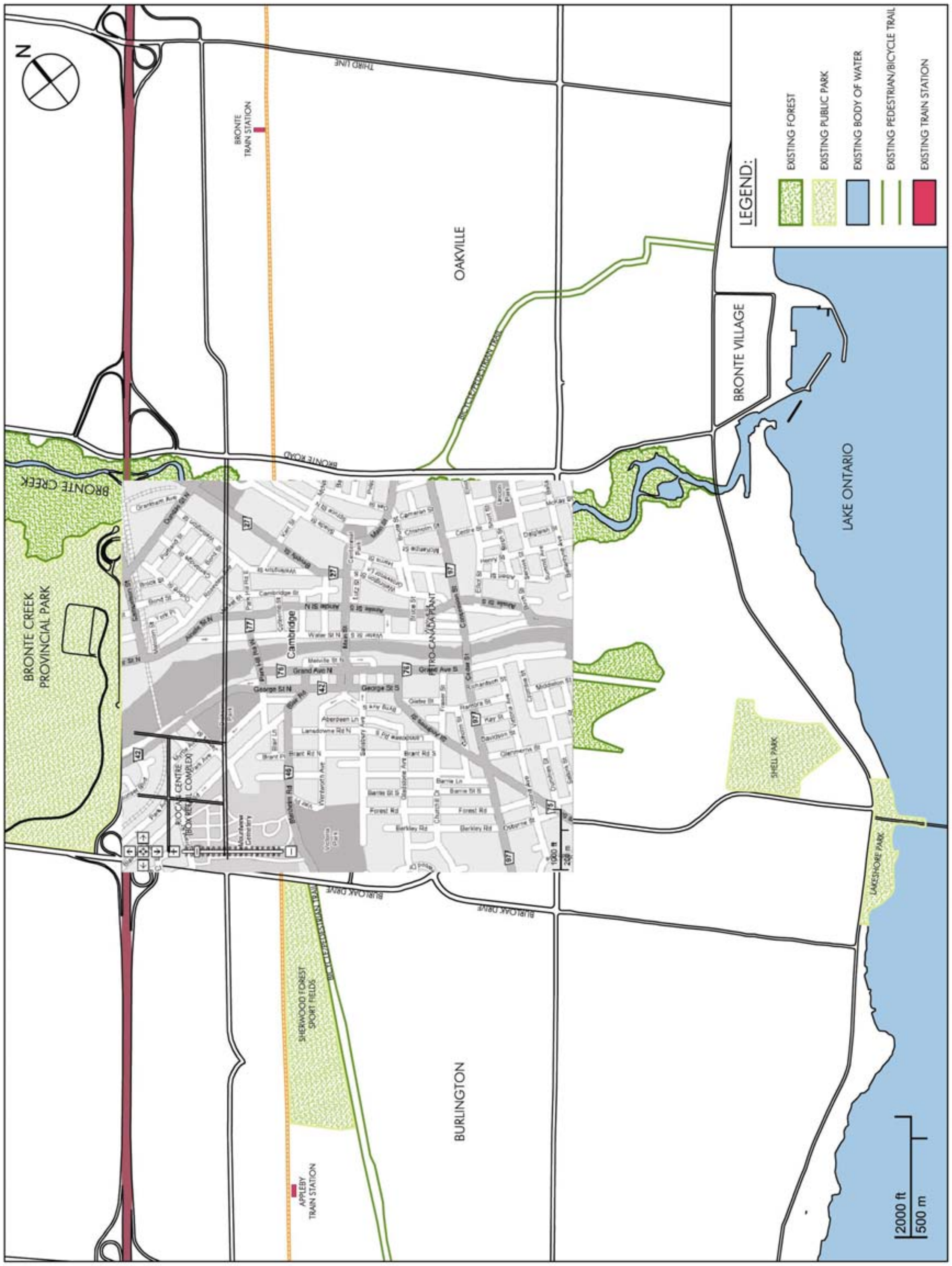


Figure 3-27: Overlay of Cambridge, Ontario, and the Burloak Employment Lands at the same scale.

Figure 3-28: Overlay of Rome, Italy, and the Burloak Employment Lands at the same scale.

3.8 Future Potential

Aside from the Petro Canada Plant, the Burloak Employment Lands remain largely underdeveloped and have appealing surroundings. Homes in this area are upscale and many have been built within the last decade. The adjacent Bronte Creek Provincial Park, Bronte Creek in itself, and Lake Ontario make it an attractive natural place with a vast amount of greenery and wildlife. In addition the proximity to highway 403 and the CN railway bring about the potential for higher density developments. The only barrier standing in the way of further developing the Burloak Employment Lands is the presence of the Petro Canada Plant. Given its damaging impact on the health of the planet and the local community, it is imperative to bring about a new sustainable use to this Plant and the land it occupies. A symbol for what this land could be is presented in Figure 3-29.

Figure 3-29: Symbol for a sustainable vision of the Burloak Employment Lands.

04 RECLAMATION/REOCCUPATION

4.1 Design Overview

The research thus far leads to the understanding that the Burloak Employment Lands are part of a large network of natural infrastructure expanding throughout the entire province of Ontario. As seen in the previous chapter, Bronte Creek is one of the numerous arterial creeks that connect the province's green belt (Niagara Escarpment and the Oak Ridges Moraine) with Lake Ontario. Given the phenomena of urban sprawl in southern Ontario, it is imperative to preserve and revitalize this vital natural framework. In Oakville, Bronte Creek is the largest green strip of land and it is unfortunate that it has been blocked off to the public by the presence of the Petro Canada Plant at the Burloak Employment Lands. It is the intent of this thesis proposal, to take down the barrier between the local community and the Petro Canada Plant; and reclaim this precious land by cleaning it and occupying it in a healthier way.

The research presented in the second chapter leads to the conclusion that sustainable design is essentially achieved through an appropriate response to site remediation, building design, transportation, agriculture and land preservation, waste and water management, and renewable energy. These basic principles are co-related, and must be considered at all times during the design process. The design presented in this final chapter aims to cohesively apply these sustainable design principles to the site.

Site Remediation

The first step toward reclamation is remediation. This thesis proposes the currently decommissioned Petro Canada Plant be transformed into an eco-park. The eco-park will be filled with remediation plants that will begin to clean up the toxic site. Keeping the general arrangement of the refinery, the areas surrounding the gas tanks can be identified as the most toxic and thus should have the largest abundance of bioremediation plants. The gas tanks can be cleaned and re-used as "living machines" which act to clean up the local wastewater from the surrounding area through a completely natural process before it is returned to Lake Ontario. The existing paved roads of the refinery are then transformed into pedestrian and bicycle trails within these "green tanks", with benches and tree lined edges. At various points in each green tank "quad", the processes of bioremediation as well as the mechanics of a living machine are explained through graphic signs that people can stop and read as they pass through the park.

Building Design

At the heart of the site, is a zero carbon foot print train station. Burloak Station is a catalyst for change in the site, bringing people together and presenting them with a building that meets the needs of the local community while simultaneously being sensitive to its surrounding environment. Constructed out of recycled materials, the station has a large glue lam roof hovering above the track platforms and the station's amenities. All amenities in the station have their own green roof. The station's amenities aim to make the building a pleasurable place to use even if you are not taking the train. Amongst these amenities are a public library, a farmer's market, a bicycle/ski shop, a bakery, a restaurant/bar, and a coffee shop. The mixed-use nature of the building ensures the building is animated with a wide variety of people at all times of the day.

Some passive design techniques to save energy include large overhangs to protect the building from rain/snow/sun; tree lined edges to protect people under the large roof from strong winds in winter and sun in summer; large windows in the roof and around the amenities ensure plenty of natural light is available and reduce the need for artificial lighting; vestibules at all entries to the amenity buildings as well as minimal inclusion of doors, to ensure there is minimal heat loss; and the naturally ventilated train station reduces the need for large mechanical equipment to heat/cool the building. It should also be noted that there are no escalators or elevators in the station; instead, there are ramps and stairs in order to reduce the electricity needs and maintenance.

In addition to the train station, the pedestrian oriented high-density development north of the site is designed using J.H. Crawford's design parameters for a sustainable city. Using a 1.5 floor area ratio, the development houses approximately 36,000 people. The 4 storey buildings in the development are joined at the sides and form rectangular blocks with interior courtyard spaces. In between the blocks are narrow 15m pedestrian only streets. This high density low rise approach allows for animated streets at a human scale, with plenty of natural light and the potential for vibrant ground level commercial activity. Four stories are considered the ideal height because it reduces the need for elevators, large mechanical/electrical support, and because it works best to maintain pleasurable natural light and thermal conditions at street level.

Transportation

According to the Statistics Canada 2001 Census, approximately 144,738 people live in Oakville right now. Out of those people, only 9,300 use local public transit to get to work. The Go Train line passing through Oakville has gone from serving 2.5 million people a year in 1967, to serving 14 million people a year (190,000 people a day) in 2006. Oakville station is currently the busiest station outside of Union Station in Toronto. Approximately 54% of Oakville residents commute outside the city to get to work. Their options are to either take the congested highway 403 during rush hour or take public transit. Given the shortage of parking at the current Go Train Stations available to them, and the infrequent bus services Oakville transit provides to them, most commuters choose to drive to work. It is for this reason that Oakville like many other suburban cities around Toronto, contribute to both the congestion on major highways and the poor air quality.

The addition of a train station within the high-density development of 36,000 people will certainly increase go train rider ship in the local community by accommodating more commuters and allowing them to get to and from the train station in a wide variety of ways. The proposed master plan for Burloak Station gives priority to those people who choose not to drive. The extension and development of the existing pedestrian/bicycle trails work as the major transportation arteries in the site. Those who ride their bicycle or ski to the station can come directly under the large roof and use the bicycle/ski racks next to the train platform. Bicycle and ski rentals are also available at the bicycle/ski shop in the station.

Pedestrian/bicycle trails are wide and lined with benches and trees on so as to make them comfortable and enjoyable to use. Those who take the bus are dropped off at the main entrance of the station and are provided with a long covered bus shelter. Though less important, car access is still required for those who are travelling long distances, and as a result the station provides a car drop-off lane at its north side. Also, a parking lot immediately adjacent to the west side of the station accommodates fuel-efficient vehicles, car share users, and rental cars. Those who drive regular cars can park in the forested parking areas available at the far north end of the site where all the car oriented box retail warehouses are located.

Agriculture, Food and Land Preservation

The transformation of the refinery to a public Eco Park plays a big role in preserving the land. Furthermore, the high-density development at the north end of the site encourages centralization in the community and is the anti-thesis to urban sprawl. The incorporation of a farmer's market inside the station allows the community to take advantage of locally grown organic food. Given its centralized location at the heart of the Burloak community, the market is conveniently accessible to all people in the surrounding area. People can buy fresh local food on their way back from work if they take the go train. If they don't take the train, they have a pedestrian friendly network of trails and streets that will facilitate their access to the market. Bringing local food back into this community will eliminate the carbon emissions associated with imported food from other countries. In addition, more control over how this food is grown will be available, and regulations to remove the use of pesticides can be implemented with less difficulty.

Waste and Water Management

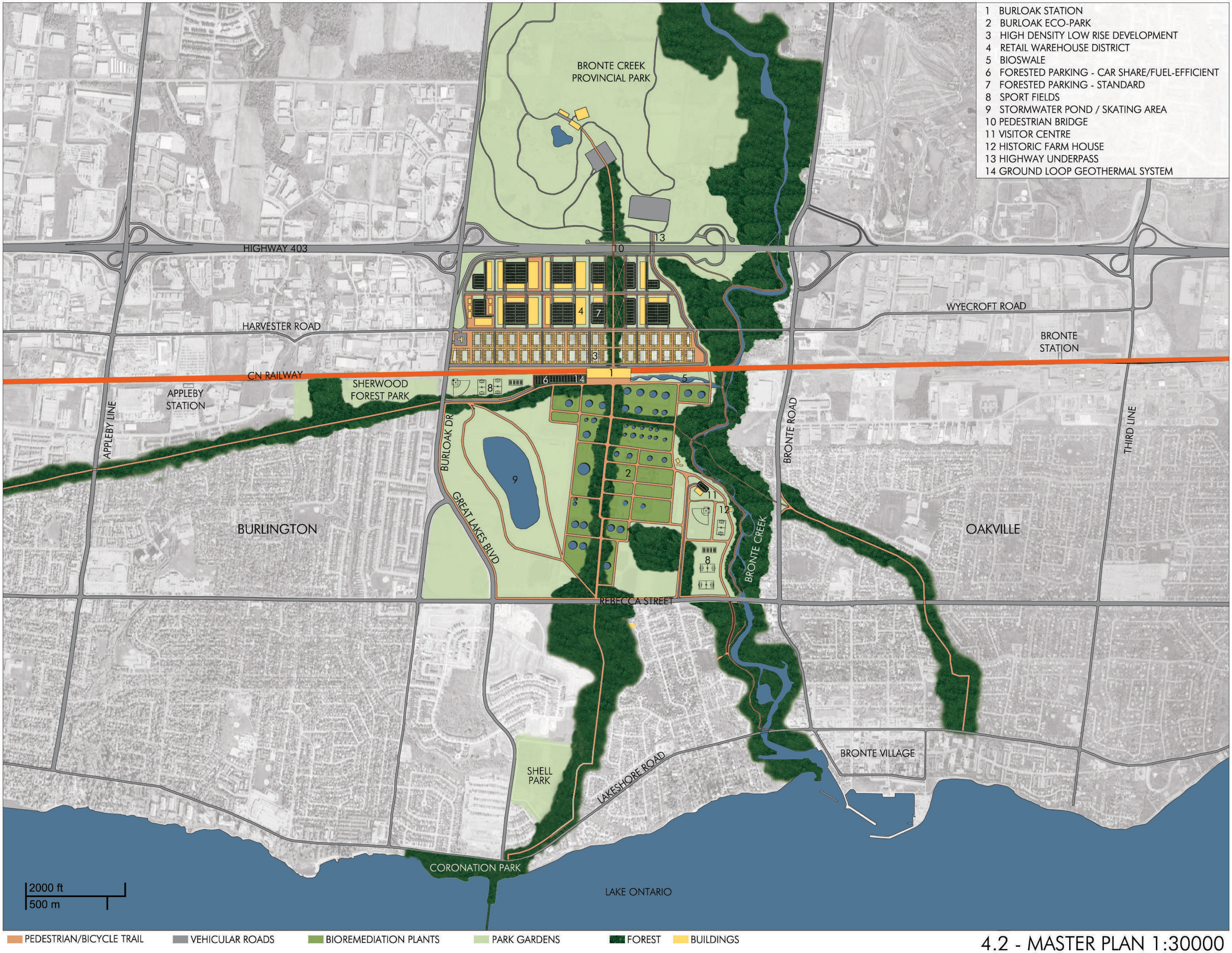
In addition to the living machines in the eco-park, the collection of rainwater plays an important role in the design of this thesis. The sloped roof collects rainwater to the ground where a gutter channels the water to the bioswale located at the east end of the station. The water is then naturally cleaned as it passes through the bioswale and is then returned to Bronte Creek where it goes through its natural cycle. The permeable pavers complement this natural cycle by allowing any excess storm water to naturally drain into the surface through the voids in between the pavers. This promotes the infiltration of rainwater and also helps to recharge the groundwater. The pavers also eliminate any contaminated storm water runoff from entering the natural waterways.

Renewable Energy

The main renewable energy component in the design is the use of photovoltaic solar panels on the roofs of the train station and the high-density development. Photovoltaic power is one of the most benign forms of electrical power available. It produces no emissions, uses no fuel, and other than the power storage batteries, PV system components are all solid-state, with no hazardous materials involved. Most rigid photovoltaic panels come with 20-25 year warranties on their rated power input, and they require virtually no maintenance during that time. Cleaning the surface of the panels and maintaining a proper fluid level in the storage batteries are the two primary maintenance duties.

For commercial and industrial use, photovoltaic panels can be put to use powering monitoring stations, signal lights, telecommunications towers, and other remote sites where there are no full-time employees stationed. Solar power is also useful for small power loads even in grid-powered areas where running grid power to the load would be inconvenient or expensive (such as signal lights for the trains or parking lot lighting).

Along with the PV panels, geothermal power is provided using the model pioneered by Patkau Architects in the Gleneagles Community Centre (Vancouver, B.C.). In the adjacent parking lot, an underground heat pump provides energy using a closed loop geothermal system.



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4.3 - SITE PLAN 1:15000

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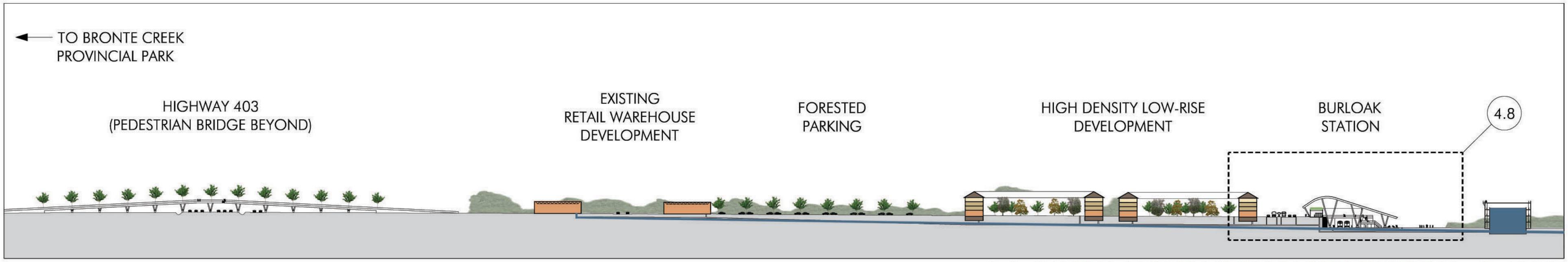

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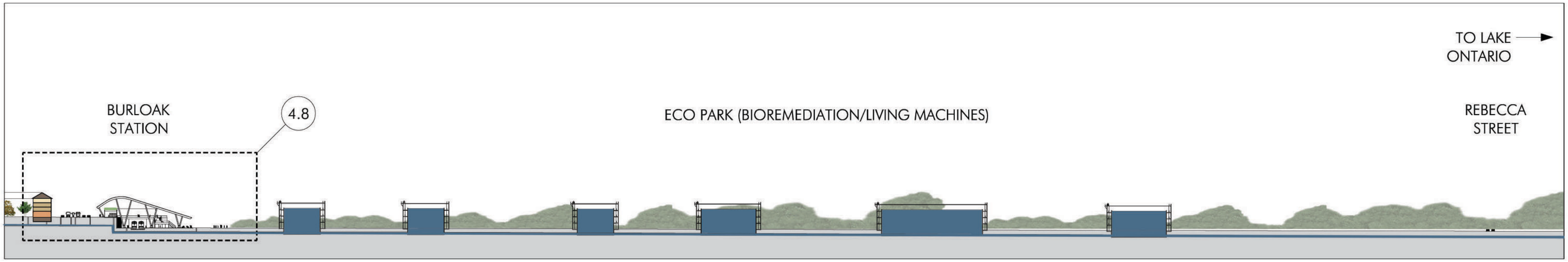

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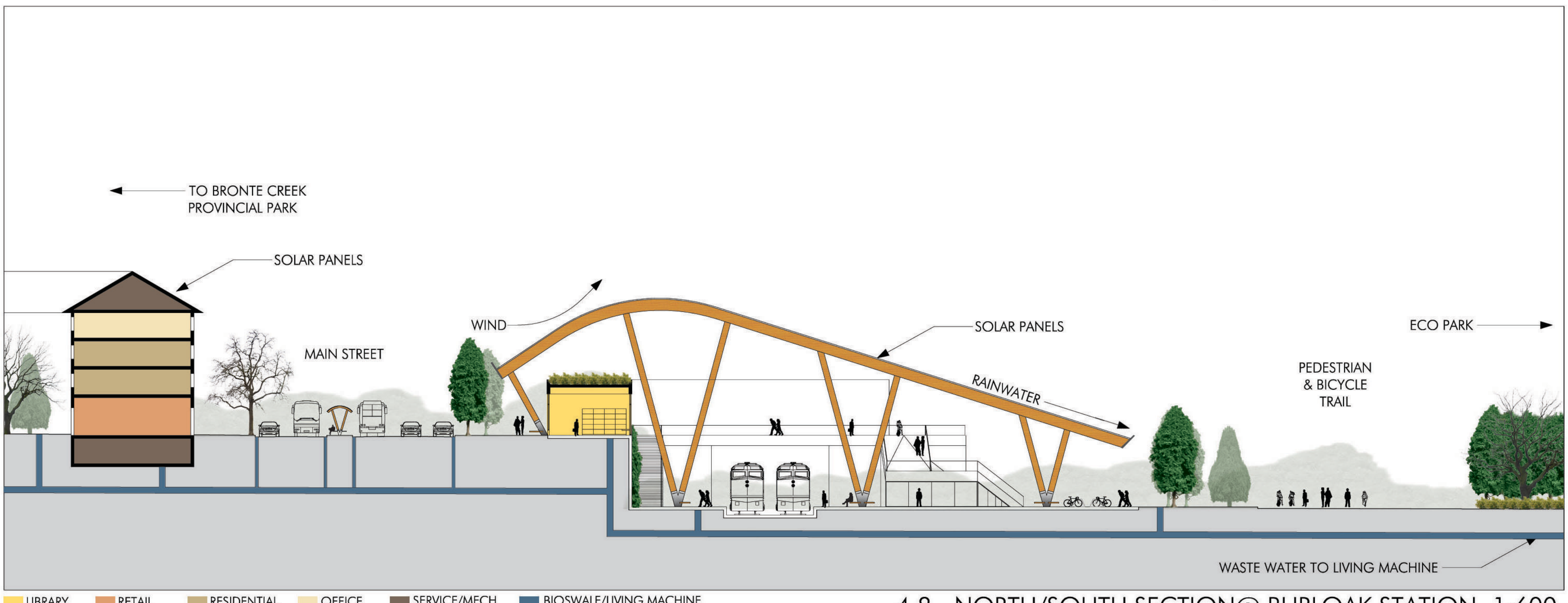

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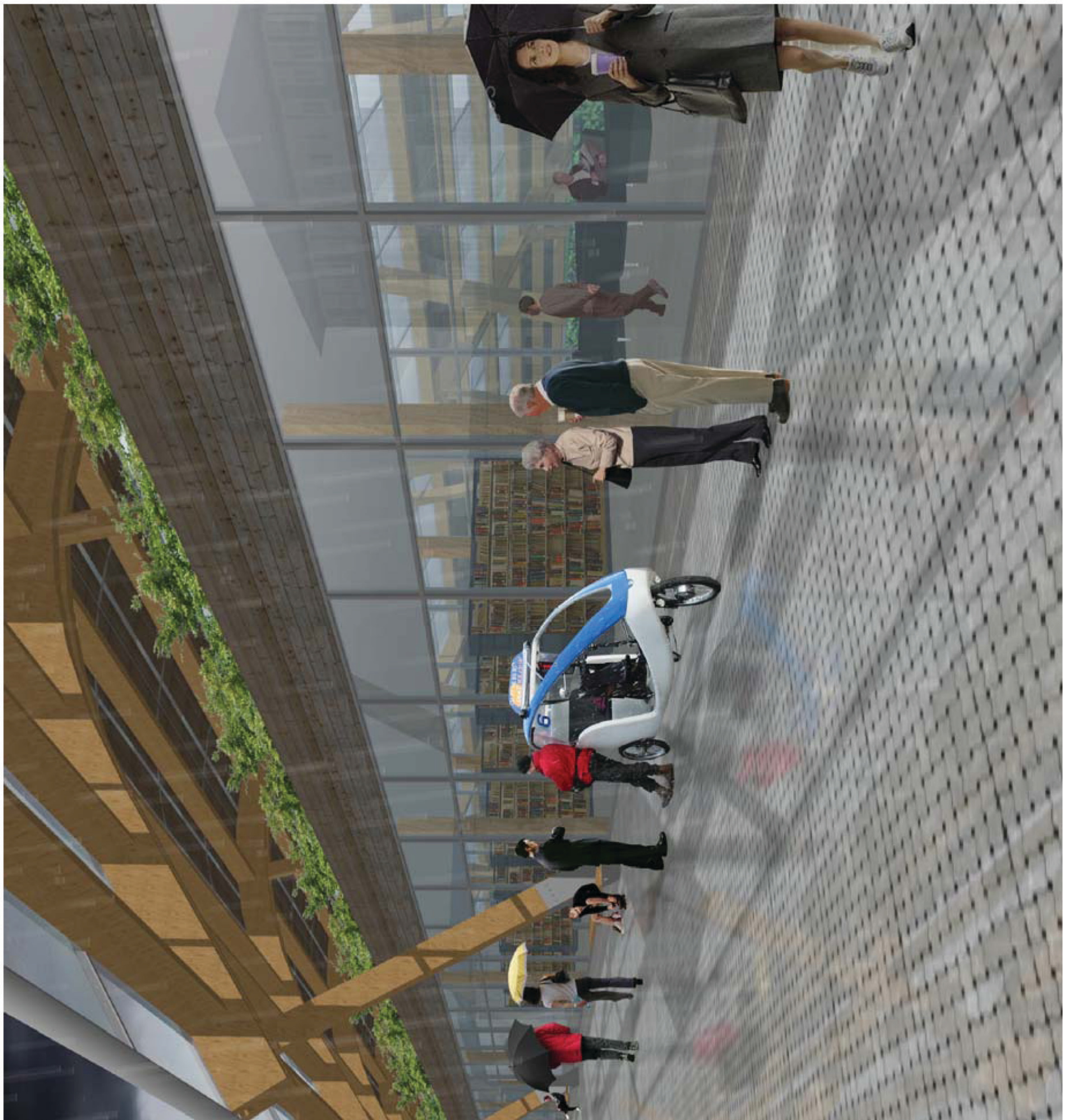

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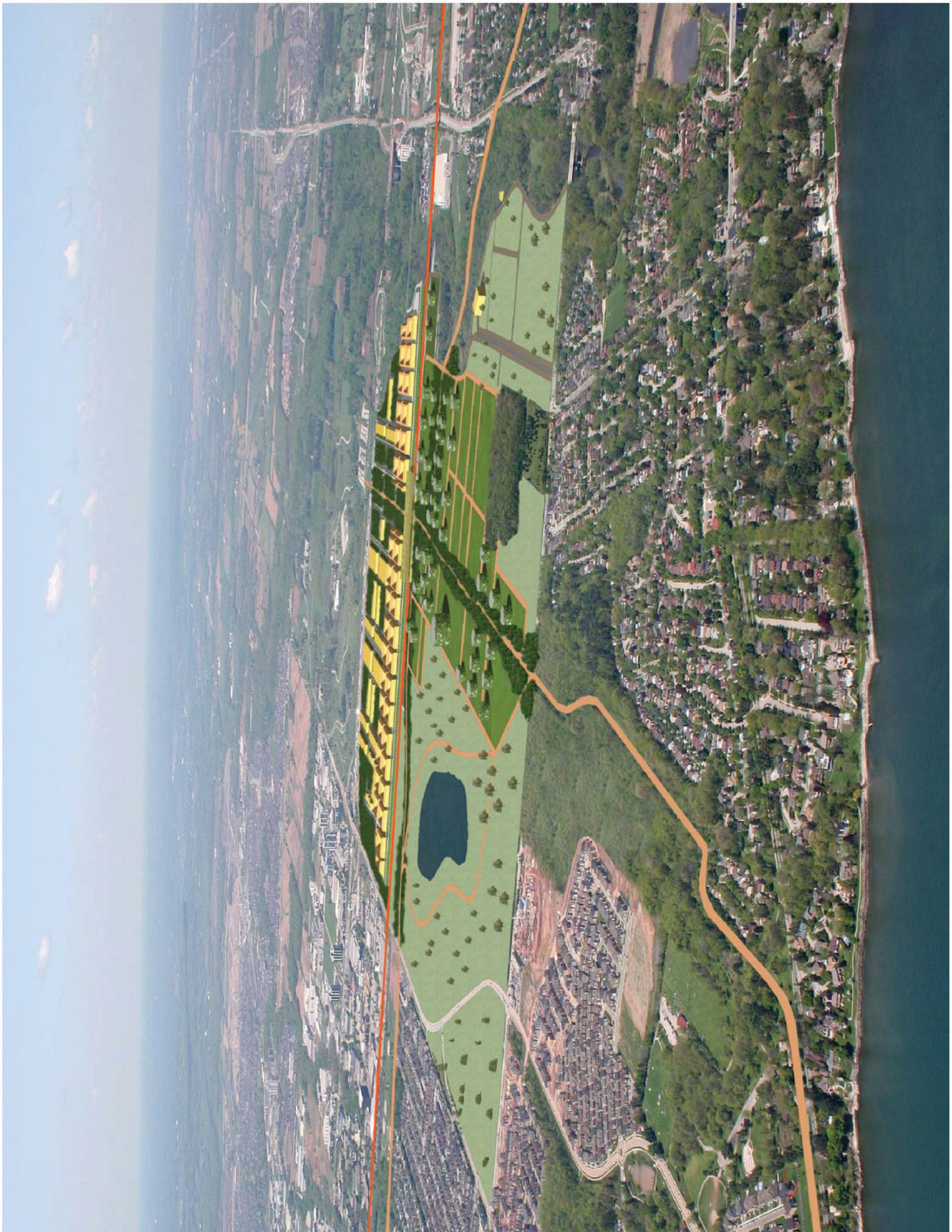

4.15 AERIAL VIEW OF MASTER PLAN

4.16 Conclusion

> *"Never doubt that a small group of thoughtful citizens can change the world. Indeed, it is the only thing that ever has."*
> -Margaret Mead-

The environmental crisis experienced today can be better understood as a failure in humanity's unconscious collective negligence toward the planet earth. This negligence is visible in the over consumption of the planet's natural resources simultaneously with the production of toxic chemicals that harm all living things. It is the intent of this thesis to explore solutions to the current planning and architectural practices that have played a powerful role in these destructive outcomes. The key source for the solutions presented in this thesis has been the interconnected relationships found in nature. Everywhere one looks in nature one sees interconnected systems and overlapping, often mutually beneficial systems. The sustainability factors presented in this thesis rest on this principle by stressing the design integration of the wide ranging disciplines that plan, build, and develop cities. For this reason this thesis has attempted to bring the concerns of planning, architecture, transportation, energy, and water stewardship to bear on decision making. Surprisingly, the way we create and develop communities today does not depend on using an integrated design approach. For example, the transportation department has little dialogue with architects who are planning buildings for the community. Water management issues have limited dialogue with the land stakeholders or infrastructure requirements. The conventional design process involves numerous professionals who pass on their work and expertise without looking at the big picture or even communicating with the other professionals involved. All of the departments associated with development of settlements need to form a new relationship if sustainable design principles are to work. This thesis calls for an integrated design strategy to ensure cities are sustainable and the laws of nature are respected.

The success of this thesis proposal comes from the fact that it takes into account the numerous rich and complex disciplines and attempts to cohesively bring them together to form a sustainable master plan proposal. The city of Brampton is applying this new integrated approach to design. Their block plan is ensuring all new building developments are addressing the design principles required to make a sustainable community. To see examples of this approach visit the city's Block Plan site:

http://www.city.brampton.on.ca/city_dept/pdd/special-programs/community-design.tml

This new integrated approach is certainly the right direction to take in the future with regard to community design. If this approach is not taken, then the health of the environment and the community will continue to be at risk. Future research for the development of this thesis would require further analysis of the integrated design approach. Of particular value would be an examination of the political and professional processes that seem to separate rather than collect and reconcile responsibilities. Given that these disciplines inherently overlap, developing a rich "ecosystem" at the professional level would seem to hold great promise. A better understanding of how each of the various disciplines can co-operatively influence sustainable design in the community is imperative. If this were to take place, then sustainable growth may become a reality. Finally, and perhaps most importantly, a continuous exploration of the interconnected relationship we humans share with nature is essential to fuel the goals of this thesis and keep its spirit alive.

In closing, it may be true that the present day environmental crisis is overwhelmingly complex and unsolvable, but it is our moral responsibility to continuously battle this crisis. For me, the newfound knowledge that has come from writing this thesis has left me with no other choice but to address this crisis, not just in my work but also in my everyday life. Even if my daily efforts to heal the planet may seem small and insignificant, they may help to influence others and promote a shared approach to solving the environmental problems we face.

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