A Guide to Eco-Business Zone Planning & Development

Toronto and Region Conservation for The Living City

TOWN OF CALEDON

light house

FINAL VERSION MARCH 24, 2014

- Eco-Business Zone Subdivision Planning Guide
- Eco-Business Zone Infrastructure Design Guide
- Eco-Business Zone Parcel Development Guidelines
- Triple Bottom Line Costs and Benefits
- Implementation Tools

The preparation of this eco-business zone planning & development guide was carried out with assistance from the Green Municipal Fund, a Fund financed by the Government of Canada and administered by the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

Cover photos:

Upper left (Credit: Light House) - TaigaNova Eco-Industrial Park stormwater management pond, AB

Center (Credit: SAB Magazine) - Schlüter Systems Canada Headquarters at Sainte-Anne-de-Bellevue, QC, is a 6100 m^2 building that includes office space, a studio showroom, training facilities and a product warehouse. The design emphasizes occupant comfort, energy efficiency, flexibility, longevity and ease of maintenance. The performance of this showcase building:

- Energy Intensity (building and process energy) = 404.82 MJ/m^2/year
- Locally Sourced Material (by value) = 31%
- Recycled materials in new construction (by value) = 22%
- Potable Water consumption (building and process) = 400 Litre/occupant/year
- Municipal Water consumption savings relative to model building = 50%

Table of Contents

Appendices

Table of Figures

Section 1: Overview

1

1.1 Purpose

The purpose of this guide is to provide staff guidance on the planning, design and subsequent development of eco-business zones throughout the Town of Caledon.

The Town of Caledon has taken a strong stance on its identity as the "Greenest Town in Ontario". To maintain that reputation and building on other sustainability efforts, the Town and TRCA have partnered to create *A Guide to Eco-Business Zone Planning & Development*. This Guide provides staff guidance on the planning, design and subsequent development of eco-business zones in new employment areas.

The guide has been produced within the planning context of the Ontario Planning Act, Provincial Policy Statement (PPS) 2005, Region of Peel Official Plan and the Town of Caledon Official Plan. Aligned with the Town's key strategic plans (i.e. Community-Based Strategic Plan, Community Climate Change Plan, Economic Development Strategy) the Guide incorporates regional and international best practices and innovative approaches to support eco-business zone development.

1.2 Why Eco-Business Zones?

Eco-business zones are areas of employment and/or industrial activity that promote environmental quality, economic vitality and social benefits through the continuum of planning, design, construction, long-term operations and deconstruction. The Eco-business zone concept establishes a balance between social, economic and environmental objectives, which are clearly established at the forefront of the process and which can lead to the following benefits:

Economic	Social/Cultural	Environmental
✓ Attract progressive development ✓ More resilient employment areas o More diverse employment base o Attracting high performing businesses ✓ Infrastructure and operational savings	✓ Better integration of industrial lands into the Town fabric for greater community benefit ✓ Enhance the culture of conservation ✓ Building a collaborative business community ✓ Improved sense of identity through better building and public realm design	✓ Meaningful environmental impact ✓ Demonstrate environmental leadership ✓ Resiliency to climate change
E.g. Innovista Eco-Industrial Park, Hinton, AB reduced the width of paved area for internal roads and highway access, ***reducing land used for roads by 25%.***	*E.g. Partners in Project Green actively engages* ***over 900 businesses every year*** *to form a community built on collaboration to achieve sustainability objectives.*	*E.g. TaigaNova Eco-Industrial Park, Fort McMurray, AB – buildings are required to be* ***25% more efficient*** *than model national energy code*

1.3 Moving Forward

Embracing the principles of eco-business development is the first step towards the emergence of more responsible, more resilient employment lands. In order to realize its vision, the Town will need to take measures to integrate the guide's tenets into the organization, and complete a number of necessary steps.

MEASURES TO INTEGRATE GUIDING PRINCIPLES
Empower Town staff to implement the present Eco-Business planning & development guide
Build internal capacity in the form of training and resource allocation
Require the Eco-Business planning & development guide to be referenced in future employment land planning policy development

NEXT STEPS
Form an Integrated Design Process (IDP) team and identify champions and functional lead(s)
Provide training to IDP team on the integrated design process and eco-business principles
Formalize Town's process* i.e., to align future Secondary Plans with employment land components with this guide
Explore the need for mechanisms & tools to support those principles that the Town deems to be most important and applicable across its jurisdiction (e.g. marketing materials, incentives, etc.)
Identify eco-business development opportunities to pursue

**Process will differ based on the Town's role in any given project.*

1.4 How to Use This Guide

This document is intended to provide conceptual design and planning guidance for staff at the Town of Caledon, the Region of Peel, CVC, and TRCA. Using Coleraine Drive West employment area as a case study (See Section 7) and other case studies this document provides and illustrates guiding principles and performance objectives that can be used to achieve higher levels of sustainable performance.

It may be used to inform the development of official plan policies, subdivision planning principles, infrastructure design, parcel design and Zoning by-law regulations for proposed employment lands.

The document is divided into 8 sections addressing the following topics:

▶ **Section 2**	**What is an Eco-Business Zone?**	Guiding principles and examples.
▶ **Section 3**	**The Integrated Design Process**	What is it and how to form the team?
▶ **Section 4**	**Eco-Business Zone Subdivision Planning**	Land use, subdivision layout, access, movement, open space and stormwater management frameworks.
▶ **Section 5**	**Eco-Business Zone Infrastructure Design**	Land use, overall infrastructure layout, transportation, access, movement, open space, landscape and stormwater management frameworks, water & wastewater, energy systems and materials use & management.
▶ **Section 6**	**Eco-Business Zone Parcel Development**	Parcel use, site layout, built form and character, transportation, access, movement, private open space, landscape and stormwater management frameworks, water & waste water, energy systems and materials use & management.
▶ **Section 7**	**Case study: Coleraine Drive West**	Hypothetical Eco-Business Zone and triple bottom line evaluation.
▶ **Section 8**	**Implementation Tools**	Zoning and incentives.

Each section is illustrated and has additional resources and information.

The Guide is built around the planning process and is grounded in an integrated design approach. Although all sections are inter-related, the document is structured so the reader can quickly reference one section based on their interest and role.

Section 2: What is an Eco-Business Zone?

2

2.1 Guiding Principles for Eco-Business Zones

"An Eco-Business Zone is a geographically defined area, mostly built-out, and largely consisting of commercial or industrial land uses where businesses and local government share an overarching goal to create collaborative strategies for sustainable business operations. Eco-Business Zones typically feature green, high performance buildings situated within ecologically respectful settings, and efficient, low impact infrastructure systems." (*Partners in Project Green Policy Toolkit, Glossary of Eco-Business and Sustainability Terms*)

Eco-business zones are areas of employment and/or industrial activity that promote environmental quality, economic vitality and social benefits through the continuum of planning, design, construction, long-term operations and deconstruction. The Eco-business zone concept establishes a balance between social, economic and environmental objectives, which are clearly established at the forefront of the process.

Eco-business zones, and related eco-industrial parks, are emerging as an innovative model for communities striving to accommodate employment and business growth in a more sustainable manner, allowing municipalities to respond to economic goals supporting green jobs as well as environmental goals related to reducing the impacts of climate change and resource consumption.

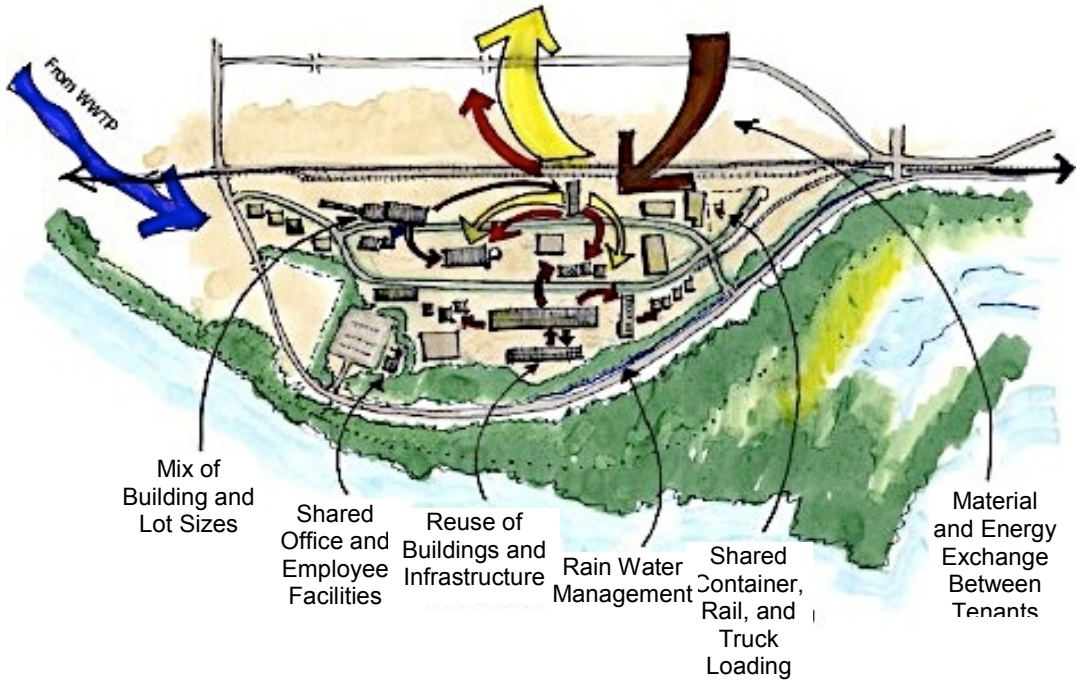


Figure 1. Concept of Eco-Business Zone (Source: Squamish Smart Growth on the Ground Design Charrette)

The overarching principles guiding the planning, design and operation of an eco-business zone are to:

I. Apply lessons from nature to support more efficient and effective resource use.
II. Take a systems approach to maximize ecological and economic effectiveness, and reflect the integration of business activity within the larger ecosystem.

With these overarching principles in mind, the following general guiding principles were developed with input from local land development companies, consultants and with the Town of Caledon, Region of Peel and TRCA.

Table 1. Example of Principle-in-Action at Each Development Stage

PRINCIPLE	Subdivision Planning	Infrastructure Design	Parcel Development & Building Design	Operations
A. Innovation:	Support land uses that facilitate innovative (alternative) infrastructure for eco-business uses.	Consider deviating from "business-as-usual" systems, choosing design and technologies that help improve overall sustainability performance.	Consider deviating from "business-as-usual" systems, choosing design and technologies that help improve overall sustainability performance.	Foster industrial symbiosis, getting businesses to reconsider "waste" as a misplaced resource.
B. Adaptability:	The overall structure should respond to future land use / activity changes, keeping the employment lands viable.	Future proof for emerging technologies that might not quite be feasible now.	Future proof for emerging technologies that might not quite be feasible now.	Structure supply 'webs', rather than supply 'chains' that allow for more stable response to system change.
C. Resiliency (Diversity):	Accommodate a variety of land uses, lot sizes, and configurations to help facilitate economic growth and employment.	Accommodate multi-modal pedestrian *and* goods movement.	Design buildings to respond to changes in uses / market conditions,	Increasing distributed renewable energy generation to create a more resilient energy system.

PRINCIPLE	Subdivision Planning	Infrastructure Design	Parcel Development & Building Design	Operations
D. Integration:	A systems approach demands thinking beyond eco-business zone boundaries. Establish a compact and efficient urban structure that integrates with the surrounding land uses and systems e.g., agricultural or residential.		Building design should allow building operations to integrate with employment land infrastructure systems e.g., energy or site-wide stormwater management.	Foster industrial symbiosis connections among businesses, creating collaboration around materials, energy and water flows.
E. Efficient Use of Resources:	Provide an appropriate mix of complimentary land uses to support the primary employment uses and help reduce vehicle miles travelled (VMT).	Establish design goals to reduce greenhouse gas emissions, water consumption, etc. compared to business-as-usual designs and technologies.	Encourage shared use of facilities that capitalizes on economies of scale to reduce costs and increase efficiencies (i.e. district energy systems, shared stormwater management, shared facilities.)	Support knowledge transfer and capacity building around efficient operational practice by fostering social networks among businesses.
F. Productivity:	Address efficient movement of people and goods through integrated land use and transportation planning as well as deliver high quality public realm.	Design infrastructure systems that can reduce business operating costs e.g., by providing reclaimed wastewater.	Buildings should be designed to maximize daylighting and indoor air quality, which supports higher emloyee productivity.	Support sustainability literacy programs that can help employees and management identify cost-saving measures.
G. Visibility and Marketability:	Plan for interpretative nodes that allow the public to learn about what is happening in the eco-business zone.	Consider making innovation visible e.g., ‘peepholes’ into lift stations.	Buildings should celebrate visible sustainable approaches as part of the architecture including use of light shelves, Building Integrated Photovoltaics, roof top PVs and stormwater cisterns.	Eco business development should be marketed and branded on themes of innovation that provide a visible and engaging approach to sustainable design performance as compared to other standard employment areas.

PRINCIPLE	Subdivision Planning	Infrastructure Design	Parcel Development & Building Design	Operations
H. Natural Systems:	Plan for low impact development that manages stormwater in a way that respects and incorporates natural systems.	Consider technologies and designs that reflect ecological processes e.g., LID or solar aquatic system wastewater treatment.	Site and building design should utilize, respect, respond to and learn from natural systems (i.e. LID), energy and water cascading and native and natural plantings.	Support the retrofit of parking areas to incorporate LID practices to an even greater extent.
I. Transferability and flexibility:	The planning and design of the proposed employment lands should provide opportunities that help address the Town of Caledon's economic development objectives.	When considering innovative practices, place a greater emphasis on those that may have the most applicability to other employment (or non-employment) lands.		Support knowledge transfer and capacity building around efficient operational practice by fostering social networks among businesses.

Collectively, the application of these principles results in Eco-Business Zones that have characteristics such as:

- Compact and efficient urban structure that integrates with the surrounding community while reducing impacts through 'right sized' infrastructure, low-impact development (LID), and providing an accessible and well-designed park and open space system, with compatible land uses and densities with supporting amenities and services;
- High performance, green buildings that consume less energy and water while producing fewer emissions, waste water and waste products.
- Support networks and systems to create closed-loop systems for by-products and co-locate infrastructure and/or systems (such as co-generation, heat exchange systems, etc.) to maximize environmental benefits while reducing costs; businesses and industries which have a commitment to corporate social responsibility (CSR) with a mission to operate eco-efficiently within a collaborative networks to recover one sector's wastes to be used as another sector's inputs;
- Operational collaboration such as for space (refrigerated storage or parking, stormwater retention ponds, etc.) or products (e.g., green technology purchases like solar hot water heaters).

2.2 Eco-Business Zones and Industrial Ecology

Land Use Compatibility and Potential for Industrial Ecology

Eco-business zones are largely defined by the types of land uses and activities that are located within them. Targeted marketing and economic development strategies will need to focus on attracting green businesses and activities to the area. These types of businesses will be attracted to locations supported by a sustainability vision. The Town should identify companies that have adopted a corporate social responsibility strategy with clearly defined metrics on sustainable performance within their operations. Land use designations will inform the range of activities and potential resource requirements associated with those land uses.

Eco-business zones or eco-industrial parks are characterized by highly inter-connected networks of multiple businesses acting collectively to gain competitive advantage typically through the physical exchange of resource materials, energy, water and waste outputs (Chertow, 2000). Synergies between land uses capitalize on use of waste by-products. For example, energy and water "cascading" make use of waste heat or excess stormwater for industrial processes that are "downstream" from the original use. The waste heat from refrigeration of food warehouses can be used for heating water as part of the industrial wash down and cleaning process. Stormwater can be captured, stored and then used for the same purpose. The principle of industrial ecology can expand to capitalize on the use of land and limited resources for serving multiple purposes. Examples include land use activities that coordinate and develop shared training and resource facilities, contribute to shared shuttle buses that help reduce amount of employee surface parking and shared stormwater wet ponds and other ecological services.

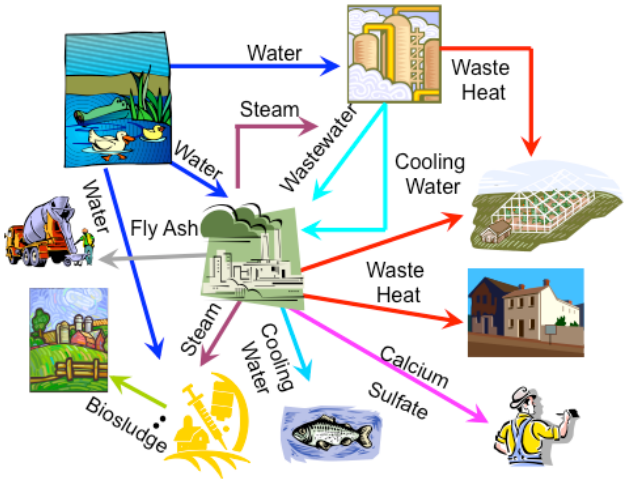


Figure 2. Example of By-Product Synergy

2.3 Eco-Business Zone Examples

Below is the summary of eco-business/industrial park case studies in Canada. The first three examples are developed eco-business zones or eco-industrial parks and the others are new business parks still in the planning stage. These case studies are

- Pearson Eco-Business Zone (Toronto, ON)
- TaigaNova Eco-Industrial Park (Fort McMurray, AB)
- Innovista Eco-Industrial Park (Hinton, AB)
- Clarington Technology Business Park (Bowmanville, ON)
- Boxwood Business Park (Cambridge, ON)

More detailed case studies are listed in Appendix B.

Case Study 1 - Pearson Eco-Business Park (Toronto, ON)

Over 14,000 hectares of industrial and commercial land surrounding Toronto Pearson International Airport. The area falls under four municipal jurisdictions, including the Region of Peel, City of Toronto, City of Mississauga and the City of Brampton.

Green Feature:

- Partners in Project Green delivers programs and services related to Waste Management, Water Stewardship, Energy Performance, and Engagement to improve the financial and environmental performance of businesses:
  - Eco-Efficiency Program
  - Energy Leaders Consortium
  - Green Purchasing Alliance
  - People Power Challenge
  - Materials Exchange
  - Sustainability Consortiums
  - Sustainability Skills Labs & Eco Business Breakfasts
- 'Single Window' Info – One window resource to find information on cost saving programs, best practices, green business tools, and funding opportunities.
- Business Collaboration – Harnessing the creative capital of private and public sector leaders to create unique collaboration opportunities resulting in unprecedented individual and collective financial and environmental benefits.
- Municipal Resources – Toolkit provides resources for creating policies, regulations, incentives & programs for eco-industrial activity. http://www.partnersinprojectgreen.com/policytoolkit.

Figure 3. Existing Business Parks within the Pearson Eco-Business Zone

Best Practices

- Catalyst organization to foster sustainable operations
- Green purchase blocks/alliance
- Context specific Policy Toolkit, includes communication materials; primers (subject matter briefings); policy templates; staff training
- Industrial land assessment can help build baselines and identify resource consumption and help establish targets in forthcoming strategies

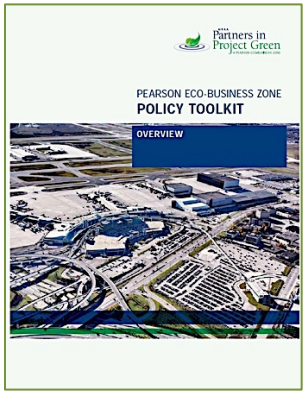


Figure 4. Policy Toolkit Cover

Case Study 2 - TaigaNova Eco-Industrial Park (Fort McMurray, AB)

TaigaNova was developed on a 131-acre greenfield site, subdivided into 26 lots and zoned C4 (Highway Commercial District) and BI (Business Industrial District).

Green Feature:

- New land use by-law amendments require businesses to:
  - Make buildings that will be at least 25% more efficient than Model National Energy Code
  - Provide preferred parking for car-pool or low emissions vehicles
  - Reduce environmental impacts during construction
  - Consider strategies to reduce resource use, reduce waste generation and increase land use efficiency
  - Consider by-product synergy
- Stormwater management pond is designed as both an amenity and habitat.
- Pedestrian connectivity allowing people to easily walk or bicycle between businesses and to amenity areas.
- Narrowed Internal Roads to reduce asphalt use.

Figure 5. TaigaNova Eco-Industrial Park: Bio-swale System; LEED-certified Building

Best Practices

- Use by-law and design variety of lot sizes to accommodate different land uses
- Adopt low impact design
- Low maintenance landscaping
- Preferential parking for fuel-efficient vehicles
- Minimize light pollution
- Safe and clearly-marked pedestrian and bicycle pathways
- Explore opportunities to reduce resources needs and waster generation
- District energy system ready

Case Study 3 - Innovista Eco-Industrial Park (Hinton, AB)

Innovista was developed on a 108-acre greenfield site, with 32 acres of parks and ecological reserves. Zoned M-E1 (Eco-Industrial District).

Green Feature:

- Land Use By-law was amended to create an Eco-Industrial District, which includes new uses, provisions for future district energy connection, encourages green roofs, and reduces development setbacks.
- The site layout was designed to facilitate by-product synergies. Easements, both underground and at the back of each lot, allow for the transfer of resources between facilities.
- Use Small-Bore Sewer (SBS) System to provide biological pre-treatment at each site to reduce the amount of wastewater sent to a central waste water treatment plant.

Figure 6. Innovista Eco-Industrial Park Concept Site Layout

- Lot owners are encouraged through the Design Guidelines to implement green building strategies, with potential cost and resource savings in construction materials, technologies and operations.

Best Practices

- Designated zone for eco-industrial businesses
- Utilize green infrastructure for long-term self-sufficiency
- Innovation sewer treatment
- Passive solar heating and cooling
- Natural lighting and ventilation
- Attractive connections between buildings and trails
- Share driveway and parking Facilities
- Reduced roadways width
- Identify by-product synergy and resource sharing opportunities
- Utilize systems using non-potable water

Case Study 4 – Clarington Technology Business Park (Bowmanville, ON)

352 acres greenfield site. The Secondary Plan will provide amendments to create consistency between Clarington Official Plan and the zoning by-law for this area.

Green Feature:

- Flexible Land Use Framework that is based upon an open space network and road system.
- Sustainable Design Guidelines encourage LEED standards and promote best practices in development:
  - Compact Development
  - A Mix of Land Use
  - Transit Use
  - Promotion of Walking and Cycling
  - Natural Habitat Preservation and Restoration
  - Alternative Energy Sources
  - Green Buildings
  - Energy and Water Efficiencies
  - Waste Management
  - Innovation Stormwater Management

Best Practices

- Allow a range of business uses to be accommodated
- Streets designed for a variety of transportation modes
- Mixed Use Corridor
- Higher Density Land Uses
- Passive Solar Landscaping
- Encourage Consolidated and Shared Utility Trenches
- Require businesses submit Sustainability Plan
- Establish a Network of Connected Open Space

Figure 7. Clarington Technology Concept Plan

Figure 8. Concept Site Layout for Prestige Employment (Up) and Mixed-Use Corridor (Bottom)

Case Study 5 – Boxwood Business Park (Cambridge, ON)

220 acres city-owned greenfield site with more than 30 acres designated as open space. The site is subdivided into lots ranging from 1 to 20 acres.

Green Feature:

- Ensure the protection of the woodlots and creek valleys; also incorporate buffers to protect these sensitive areas.
- Trail and bike paths, transit access to promote environmental friendly transportation.
- Street layout design with southern exposure to facilitate alternative energy options for landowners.
- Encourage on-site measures that enhance infiltration, or re-use stormwater for non-potable plumbing requirements or for irrigation.

Best Practices

- Targeted sectors
- Maintain natural creek corridors and wetlands for ecological value, instead of developing into high-impact uses
- Design street layout to facilitate renewable energy and passive solar design

Figure 9. Boxwood Business Park Concept and Site Photo

2.4 Additional Resources and Information

Industrial Symbiosis

- Chertow, M.R. “Industrial symbiosis.” Encyclopedia of Energy. Ed. C.J. Cleveland. New York: Elsevier, 2004, p. 407-415. http://www.sciencedirect.com/science/article/pii/B012176480X00557X.

Eco-Business Zone / Eco-Industrial Park Case Studies

- **Partners in Project Green Pearson Eco-Business Zone** is a growing community of businesses working together to green their bottom line by creating an internationally-recognized 'eco-business zone' that includes four municipal jurisdictions – the Region of Peel, City of Toronto, City of Mississauga and City of Brampton. http://www.partnersinprojectgreen.com
- **More Case Studies:** Eco-Business Zone Policy Case Studies, http://www.partnersinprojectgreen.com/files/policy_tools/13%20EcoBiz%20Policy%20Case%20Studies.pdf

Section 3: The Integrated Design Process

3

3.1 What is an "Integrated Design Process"?

Integrated Design Process is critical at all stages – from concept to operations, and for "both sides of the fence" – within government and on the developer / business side.

Developing an eco-business park is not just a matter of applying the latest green technologies or for attaining a green standard rating. Rather, it is a process of understanding the site and surrounding context such that they are complimentary and synergistic with the natural environment. This approach is called an Integrated Design Process (IDP) where each element of the design optimizes the building and site performance where different elements and systems within the building and site are re-evaluated, integrated, and optimized as part of a whole building solution.

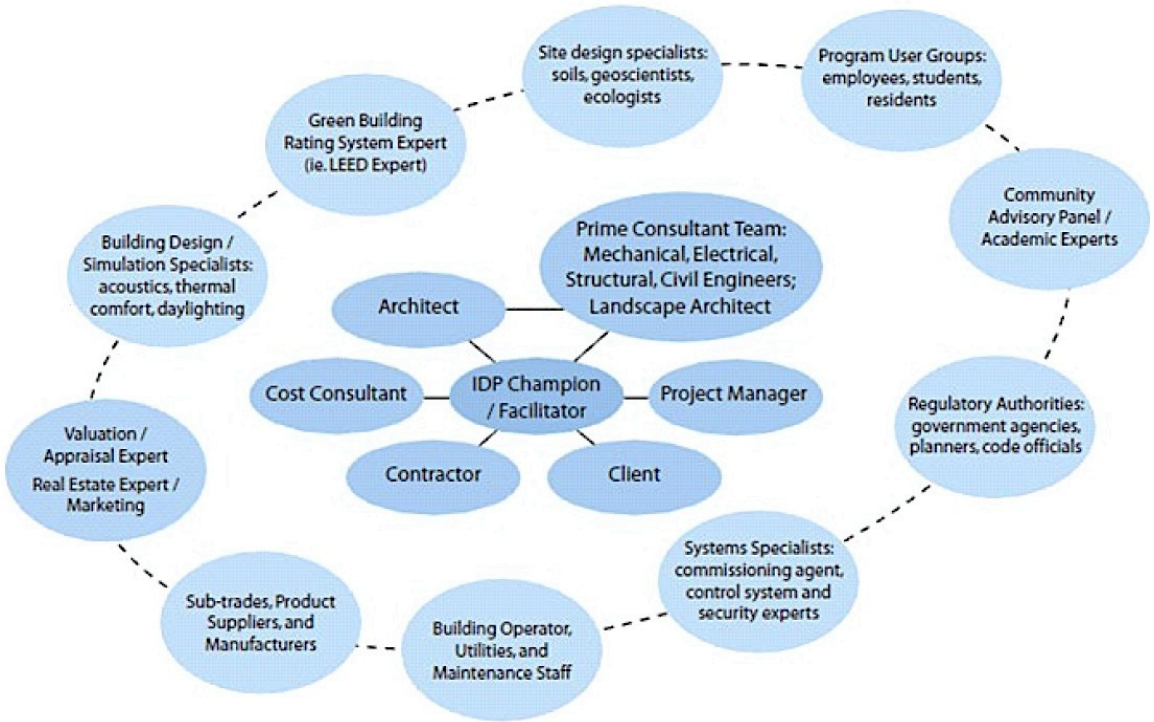


Figure 10. An IDP brings stakeholders together in new and collaborative ways. (Credit: Roadmap for the Integrated Design Process, Busby Perkins+Will)

IDP can be applied at various stages and scales of an eco-business park: from conceptual site master planning to building design. In the context of an eco-business zone, IDP is useful in identifying interrelationships amongst features such as: the building siting in relation to sun path to optimize day-lighting and thermal loads or developing a water balance model that considers both landscape and building design with the objective of reducing overall water demand.

IDP can be applied at regulatory review to identify policy objectives and regulations early in the process and ensure the applicant and design team are working in concert to address them in a coordinated and efficient manner. The IDP helps to reduce potential costs associated with designs that don't meet regulatory or policy requirements. IDP also helps to facilitate efficient and timely regulatory review and helps to identify synergistic design approaches that save money and time through the continuum of planning, design, construction, operation and maintenance.

Synthesis of Design

'Synthesis of Design' means integrating engineering infrastructure, land use planning, landscape design and building architecture. An outcome of the integrative design process is that it will help achieve greater efficiencies and cost savings when developing infrastructure systems. By designing the site to incorporate its natural assets it yields environmental and economic benefits. Centralized or district infrastructure and shared systems that are typically duplicated at the individual site or at the building level will reduce space requirements that in turn yield a greater amount of gross floor area.

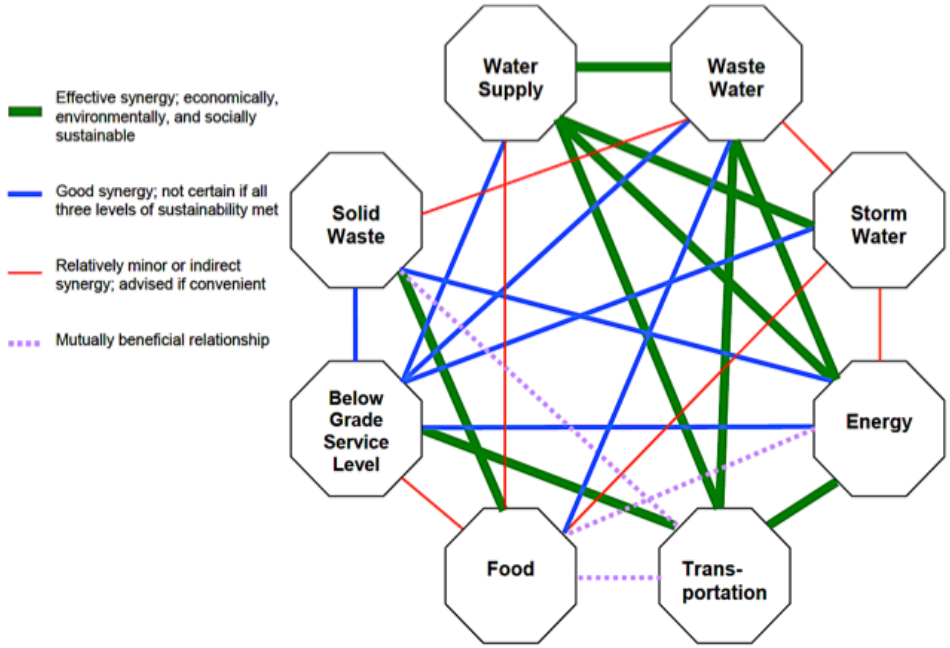


Figure 11. Infrastructure Service Relationships. (Source: Demonstrating the Economic Benefits of Integrated, Green Infrastructure, FCM, 2004)

General Steps in the Integrated Design Process

- Establish the full team early in the process and outline the site program, roles and responsibilities.
- Set the vision, objectives and targets for the project early and set out requirements for collaborative design approaches.
- Develop a process with involvement of key design professionals and a good facilitator who understands IDP and sustainable design.
- Conduct an accurate and detailed assessment of site conditions and outline opportunities for advancing the principles around an eco-business zone.
- Communicate the expectations around recapturing cost savings through innovative and efficient design approaches (for example, the architect, mechanical/civil engineer with progressive stormwater management experience and landscape architect should collaborate in designing integrated building and landscape systems to capture, store and utilize stormwater for process and irrigation water).
- Incentivize and reward design team members for developing "out of the box" solutions that result in efficiencies and potential cost savings.
- Establish fluid communication channels to keep specialized disciplines from reverting to business as usual approaches through the use of project portals and dashboards that keep the team engaged in "whole design process".
- Explore options for sustainable outcomes prior to design to inform decisions about site design, construction, operation, and maintenance.

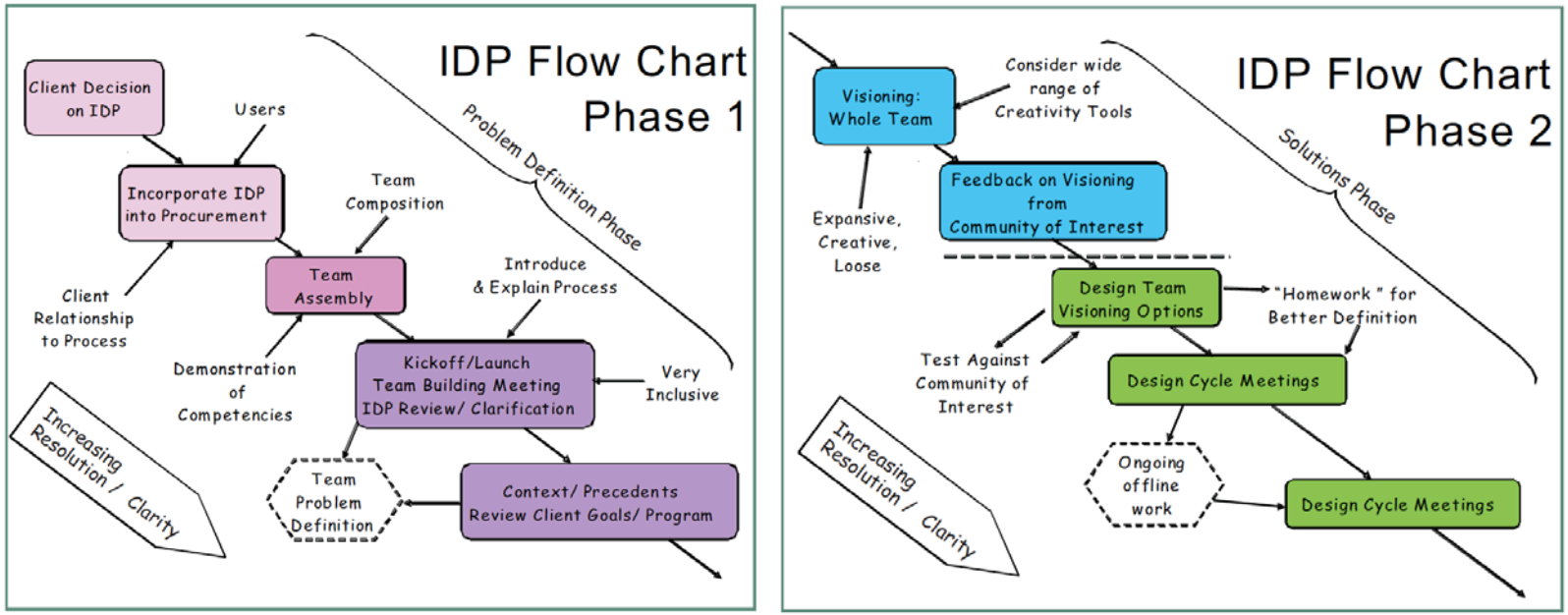


Figure 12. IDP Flow Charts (Credit: The Integrated Design Process: Report on a National Workshop held in Toronto in October 2001)

3.2 Choosing the Right Team

To achieve the principles and objectives that have been set forward as part of an eco-business zone initiative requires a range of skills, knowledge and experiences across a variety of design disciplines and professions. Selecting the right design team who are experienced in sustainable development and green building design will help identify design solutions that yield multiple benefits. A good team will be able to develop design solutions that reduce costs through design development, timely application review process, increased efficiency in operation and reduced long-term maintenance costs.

Developer Teams

Typically, a client or developer will approach a multi-disciplinary planning/architectural/engineering firm to lead the design of the project. The lead consultant plays a significant role in helping to define project objectives and coordinate the sub-consultants in aligning their design inputs to achieve these objectives.

Therefore it is very important to select design professionals that have applied experience in sustainable design, low impact development (LID) and are accredited with a recognized green building rating system (LEED™, BuiltGreen, BOMA BESt) as well as being knowledgeable with local, regional and provincial policies and regulations that are applicable to the site.

The integrated design team would include all of the design team professionals (e.g., architects, landscape architects, electrical engineers) plus client and regulatory representatives should be included at strategic points in the process (e.g., as part of any 'visioning' charrettes held early in the project). To ensure that this is successfully achieved, the Town could outline the requirements of IDP as part of the development review process and have the applicant demonstrate outcomes from the IDP process (i.e. meeting notes, checklist of design professionals, requirement to achieve LEED V.4.0 New Construction, Integrated Process credit IPc.1)

Town Teams

In its regulatory role, it would likely facilitate compliance with these guidelines if the Town also mimicked an IDP in its approach to establishing plans and policies, and in reviewing and responding to development applications. For example, a Town integrated team could include professionals playing roles related to economic development, transportation, parks, water and sewer, etc. An example of applying IDP is in the formulation of a Secondary Plan where staff would engage an IDP facilitator (internal or outsourced), urban designers, civil engineers, landscape architects, ecologists and architects to develop an overarching site structure plan (subdivision plan) which integrates stormwater management, public realm, transportation and built form that address the guiding principles outlined in this document. To ensure experienced professionals are engaged, the Town can make IDP experience an explicit requirement within RFPs. This ensures that IDP does not become an "add-on", which limits the effectiveness of the approach and can lead to higher consulting costs. The Town should also endeavor to provide training to staff on IDP.

Whether it is the Town or the Developer retaining consultants to prepare plans and designs that comply with these guidelines, the following checklist identifies a few of the qualities that make a good green team professional:

- Ensure the consultants have up-to-date credentials and have a good standing within their professional associations.
- Look for consultants that have a good reputation in their respective field. Ask for professional references, portfolios and testimonials.

- Ensure the consultant has applied experience with registering and certifying green buildings and have knowledge with eco-business or eco-industrial design and development.
- Select engineers and landscape architects that have experience with designing and implementing Low Impact Development (LID) and green (LEED™) projects.
- Look for compatibility between design team members so that they work collaboratively to address performance objectives and the principles of an eco-business zone.
- Select at least one member of the team that can facilitate the project through an Integrative Design Process and has a green building accreditation.
- Review company profiles and project portfolios to ensure that they can deliver a high quality green development.
- Does the team have local or regional experience and understand appropriate local responses to achieve the performance objectives for the project (for example, knowledge of soil and drainage conditions to develop workable and cost-effective approaches to stormwater management?

3.3 Additional Resources and Information

Integrated Design Process

- Integrated Design Process Guide, Canada Mortgage and Housing Corporation. http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/Integrated_Design_GuideENG.pdf
- Public Works and Government Services Canada website, http://www.tpsgc-pwgsc.gc.ca/biens-property/sngp-npms/bi-rp/conn-know/enviro/pci-idp-eng.html
- Roadmap for the Integrated Design Process: Part 2 Reference Manual ftp://ftp.cmhc-schl.gc.ca/cmhcInternational/CMHC%20WUF%202008%20Handouts/IDP%20Road%20map%20_%20Part%203.pdf
- Whole Building Design Guide provides an overview of the Integrated Design Process and the interface of each discipline http://www.wbdg.org/design/engage_process.php#mjr

Section 4: Eco-Business Zone Subdivision Planning

4

4.1 Introduction

This is the earliest stage in the planning process – when key land use and structure decisions e.g., road and greenway networks, are made. From the Partners in Project Green Policy Toolkit: Considerations for Eco-Business Zone Development Standards:

The layout of the site (or a subdivision), including the location and orientation of buildings, has a significant impact on the site's appearance and economic and environmental performance. Eco-business zones encourage convenient linkages with adjoining businesses and access to nearby public lands or open space. Site layout considerations for eco-business zones include:

- Strategies to maximize building orientation to facilitate passive heating, cooling and ventilation.
- Strategies to maximize land use efficiency and reduce development footprints, such as with stackable warehousing options, joint logistics facilities and building clustering.
- Facilitate shared service and access areas with adjacent parcels.
- Support the concept of 'utility islands' to promote potential synergies between different infrastructure systems.
- Leverage easements to allow future business-to-business infrastructure connections.
- Diversity in parcel sizes to increase potential for by-product synergy

Decisions at this stage lay the foundation for subsequent eco-business zone infrastructure design, parcel development, and operations. For example:

- Infrastructure design may involve a district energy system. The subdivision plan should have contemplated this by making sure land use designations allow such a facility.
- Parcel development may involve orienting buildings to take advantage of solar gain. A subdivision plan that establishes a street network conducive to this outcome may make it easier.
- Operations might include the transfer of hot wastewater from one business to another business. A subdivision plan that establishes alternative utility corridors would facilitate this.

To re-cap, the general eco-business principles underpinning subdivision planning, as well as an example of each principle in action, is shown in the table below:

Table 2. Example of Principle-in-Action at Planning Stage

PRINCIPLE	Subdivision Planning Stage
A. Innovation:	Support land uses that facilitate innovative (alternative) infrastructure eco-business uses.
B. Adaptability:	The overall structure should respond to future land use / activity changes, keeping the employment lands viable.
C. Resiliency (Diversity):	Accommodate a variety of land uses, lot sizes, and configurations to help facilitate economic growth and employment.
D. Integration:	A systems approach demands thinking beyond eco-business zone boundaries. Establish a compact and efficient urban structure that integrates with the surrounding land uses and systems e.g., agricultural or residential.
E. Efficient Use of Resources:	Provide an appropriate mix of complimentary land uses to support the primary employment uses and help reduce vehicle miles travelled (VMT).
F. Productivity:	Address efficient movement of people and goods through integrated land use and transportation planning as well as deliver high quality public realm.
G. Visibility and Marketability:	Plan for interpretative nodes that allow the public to learn about what is happening in the eco-business zone.
H. Natural Systems:	Plan for low impact development that manages stormwater in a way that respects and incorporates natural systems.
I. Transferability and flexibility:	The planning and design of the proposed employment lands should provide opportunities that help address the Town of Caledon's economic development objectives.

4.2 Land Use & Subdivision Layout

Overall Land Use

The following guidelines should be considered as part of the planning for eco-business zones:

<SUBDIV.1> Accommodate a variety of land uses to help facilitate economic growth and employment consistent with the policy directions set forward in the Places to Grow Act.

<SUBDIV.2> Accommodate land uses that facilitate innovative eco-business uses and activities within the area e.g., recycling facilities or renewable energy installations.

- Cluster or co-locate utility systems to promote potential synergies and waste exchanges between different infrastructure systems, and to minimize utility lot dedications.
- Dedicate parcels for alternative infrastructure such as a wastewater treatment and reclamation plant.
- Allow for multi-objective public lands e.g., park on the surface, geo-exchange field below surface.

<SUBDIV.3> Where Prestige Industrial is to be accommodated, cluster this use along highly visible exterior or 'gateway' areas; adjacent to commercial or residential uses; or near environmental features that may enhance the aesthetic of prestige industrial buildings.

<SUBDIV.4> Locate larger or more intensive industrial and business uses that result in heavier traffic and noise along major arterial roads.

<SUBDIV.5> Ensure the types and location of land uses are compatible with adjacent land uses especially agriculture and residential.

<SUBDIV.6> Integrate sustainable land use patterns to leverage efficient use of transportation and supporting infrastructure.

<SUBDIV.7> Provide an appropriate mix of complementary and integrated land uses that support efficient use of all infrastructure systems e.g., help reduce vehicle miles travelled (VMT) or facilitates use of reclaimed wastewater.

<SUBDIV.8> Where feasible, include common employee amenity areas.

These might include bicycle parking, parks, and indoor / outdoor picnic areas. Encouraging employee interaction can help to build relationships and result in the idea exchange that underpins business-to-business eco-industrial activity.

[Note: The developer and Town will likely have to negotiate maintenance responsibilities, considering the location, size, and type of amenity. The creative use of rights-of-way and / or public utility lots may assist with the assignation of responsibilities.]

Shape and Pattern

The following guidelines should be applied to inform the shape and pattern of future subdivisions:

<SUBDIV.9> Provide a range of lot sizes to address current and future demands for small (i.e. 1-5 acres), medium (5-15 acres) and large (greater than 15 acres) lots.

<SUBDIV.10> Optimal subdivision layouts are achieved by providing a lot frontage to depth ratio of 1:1.5. This increases the number of available street fronting lots while also providing efficient building and parking/loading layouts.

Figure 13. Example of Various Lot Sizes

<SUBDIV.11> Lot frontage should be a minimum of 30 metres to ensure sufficient room for "front of house" active uses (office, reception, assembly and display), visitor parking, and side yard driveway to rear loading bays.

<SUBDIV.12> Allow for smaller lots (i.e. between 0.50 to 3 acres) to facilitate a limited amount of finer grain local commercial and retail services uses to serve the area.

<SUBDIV.13> Corner lots at major intersections will provide gateways into the site and should be larger in size to accommodate higher-end uses that celebrate building and landscape sustainability features.

4.3 Access & Movement Framework

The best transportation plan starts with a good land use plan. In an eco-business zone, the transportation framework provides the foundation not just for sustainable, multi-modal goods and people movement, but also for LID stormwater collection and conveyance, alternative infrastructure systems e.g., district energy, and for industrial symbiosis transfers e.g., hot wastewater from one business to other businesses. In this way, the 'transportation' framework is about far more than achieving vehicle circulation.

Street Network

The following street network guidelines provide direction in terms of the hierarchy and contemplated network to serve an eco-business zone efficiently.

<SUBDIV.14> The street network shall provide safe, comfortable and efficient movement for all current and projected modes of transporting people and goods.

<SUBDIV.15> Street network should be designed to be double-loaded to maximize the number of access points and reduce total amount of street construction and associated site disturbance.

<SUBDIV.16> Create a road network that facilitates parcel and building orientation to take advantage of passive solar gain.

<SUBDIV.17> Locate land uses and businesses that generate high traffic and truck volumes in close proximity to defined truck routes.

<SUBDIV.18> Street networks shall also be designed to accommodate future transit services. Wherever possible, streets alignments should attempt to avoid encroaching or intersecting with Environmental Policy Areas.

<SUBDIV.19> Street alignments should provide efficient and safe access to newly developed parcels within the site with clear sight lines between driveway entrances and the street.

<SUBDIV.20> Proposed street networks within greenfield sites should integrate seamlessly with the existing street network pattern to provide continuity of movement and increased legibility.

<SUBDIV.21> Plan for "right-sized" road rights-of-way, minimizing carriageways while still maintaining safe goods and people movement.

Figure 14. Efficient Street Network (TaigaNova EIP concept plan)

<SUBDIV.22> Minimizing carriageways reduces stormwater generation and greenhouse gas emissions. Wider / flared corners can accommodate a narrower carriageway while still providing for safe turning radii.

<SUBDIV.23> Plan to incorporate innovative eco-business infrastructure within the road right-of-way where possible to multiply environmental benefits and reduce overall construction costs.

This could include underground district energy piping and other servicing ducts and pipes, such as sewer and stormwater swales. In Europe and Asia, residential subdivisions now use underground freight pipelines (also called “capsule pipelines”) to move goods as large as a skid. While there are no industrial / employment land examples yet, it is conceivable that this technology becomes viable for these sites within our lifetime. A truly innovative employment land area might contemplate the location of such infrastructure within road rights-of-way, and consider the future impact on above-ground goods movement demand. Remember that forward-looking planning can help to future-proof the site, and make it easier to incorporate emerging technologies in the future.

Figure 15. Underground Transportation of Cargos (Credit: CargoCap GmbH)

Active Transportation

The transportation framework provides guidance and direction when developing a network of bicycle and pedestrian routes to serve an eco-business zone. Every mode of transportation begins and ends as a pedestrian – even for a transport truck driver. Planning and design should consider the quality and experience of the public realm for people using active modes of transportation.

<SUBDIV.24> Provide sidewalks, designed to provide universal design and accessibility, along one side on local industrial roads and both sides on collector roads.

<SUBDIV.25> Create space for dedicated cycling routes to provide safe and easy access to, from and within the eco-business zone.

<SUBDIV.26> Provide direct, comfortable and safe pedestrian and bicycle connections to nearby transit stops.

4.4 Public Open Space & Stormwater Management Framework

Given the region’s imperative for watershed health, and TRCA policies (e.g., as represented in its LID guide and Stormwater Criteria), public open space is intrinsically linked to stormwater management. Therefore, these two elements will be considered together. ***It should be noted that TRCA and CVC’s stormwater management policies and guides already outline best management practices that are consistent with eco-business zone planning.***

The public open space framework is focused on the principles of ecological repair and respect for natural systems. A key strategy of an eco-business zone is to develop an open space framework that leverages natural systems including streams and habitat areas to achieve multiple objectives for the area. The open space strategy seeks to protect and enhance natural drainage courses which play a critical role in the conveyance of stormwater runoff. As a result, the natural systems will need to be integrated into the landscape framework with the following goals:

- Integrate open space with natural systems to enhance the performance and ecological services.
- Design the built environment to respond and protect natural systems in which it is located.
- Incorporate sustainable Infrastructure including LID and stormwater management best practices.
- Leverage opportunities where open space and natural systems address multiple objectives such as stormwater wet ponds that provide an open space amenity.

Designing stormwater ponds as part of the naturalized landscape will help celebrate the importance of water and achieve a 'sense of place' by designing stormwater to contribute to the open space amenity.

Figure 16. Integrate Stormwater ponds with Open Space Amenities (TaigaNova EIP, AB)

The open space framework celebrates natural systems, ecology and cultural landscape as a defining feature of the site. A series of interpretive markers and signage can help celebrate cultural landscapes as well as provide increased awareness of sustainable landscape features that reinforce the 3 pillars of sustainability: environment, economy and social equity.

<SUBDIV.27> Preserve and enhance riparian, wetland, and buffer areas to improve flood control and water quality, stabilize soils, control erosion, and provide wildlife corridors and habitat. Potential strategies to achieve this may include:

- Establish water balance model
- Adding habitat structure;
- Restoring geomorphology;
- Limiting public access to environmentally sensitive areas;
- Restoring structural soils;
- Planting native riparian vegetation; and
- Re-grading (where necessary) to allow flood waters to rise while minimizing stream scouring.

<SUBDIV.28> Plan for stormwater retention and wet ponds to be primarily contained within public lands.

This will reduce requirements for distributed stormwater ponds within private parcels, which can affect parcel marketability and can result in uneven maintenance. For example, LID stormwater management in the TaigaNova Eco-Industrial Park in Alberta was achieved within road rights-of-way and Public Utility Lots. Parcel owners were required to comply with lot corner grades to support overall stormwater collection and conveyance to the public systems.

<SUBDIV.29> Plan for stormwater retention and wet ponds that mimic naturally occurring wetlands.

<SUBDIV.30> Use landscape to punctuate street-end views and provide amenity and interest including public art, water features and special plantings.

Figure 17. Public Arts and Water Features

<SUBDIV.31> Wherever possible, protect and preserve existing vegetation and mature trees as part of the development.

<SUBDIV.32> Provide adequate buffers between new development and Environmental Policy Areas, as defined by TRCA stream protection guidelines.

Figure 18. Landscape Strip along Stormwater pond.

<SUBDIV.33> Incorporate multi-use trails which can provide additional landscape buffer and improve integration of open space and amenity, considering the following criteria:

- Follow existing linear disturbances such as existing informal trails, sanitary easements, gas pipelines, and other infrastructure, rather than through undisturbed areas;
- Avoid sensitive habitats, flora and/or faunal species;
- Avoid the riparian zone of watercourses;
- Avoid active erosion zones, such as outside meander bends and valley walls where banks are eroding; and not increase risk to public safety;
- Avoid incompatible topography, where extensive grading or filling is necessary;
- Minimize the number of watercourse crossings;
- Be connected and accessible to the community or communities which they serve;
- Where pervious surfaces are converted to impervious surfaces, meet TRCA's stormwater management criteria;
- Undertake appropriate archeological assessments on ground disturbances proposed for TRCA-owned lands;

[NOTE: Siting a trail within an EPA buffer will only be considered under exceptional circumstances. Assess the compatibility of the proposed trail use within the buffer; impact on the buffer ecological function; and the need to expand the buffer beyond the minimum requirement to provide sufficient land-base for both the recreational use and buffer functions.]

Figure 19. Multi-Use Trail Acts as Landscape Buffer (TaigaNova Eco-Industrial Park, AB)

4.5 Additional Resources and Information

Access & Movement Framework

- Public Health and Land Use Planning: How Ten Public Health Units are Working to Create Healthy and Sustainable Communities, April 2011, Creating Healthy and Sustainable Environments (CHASE). http://healthyandsustainable.files.wordpress.com/2011/07/phlup-background-discussion-2011.pdf
- Smart Commute network (Brampton – Caledon). http://scbc.ca

Low Impact Development

- TRCA Stormwater Management Criteria available at http://trca.on.ca/the-living-city/water-flood-management/storm-water-management.dot
- TRCA Low Impact Development Stormwater Planning and Design Guide available at http://trca.on.ca/the-living-city/water-flood-management/storm-water-management.dot or http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/stormwater-management-lid-guidance-documents/low-impact-development-stormwater-management-planning-and-design-guide/. NOTE: The Fact Sheets in the Appendices are particularly helpful, covering topics such as: Site design, bioretention, permeable pavement, and dry swales.
- Stay Ahead of the Storm: Optimize Municipality and Business Performance with Low Impact Development. Credit Valley Conservation. http://www.creditvalleyca.ca/wp-content/uploads/2012/04/cvc-stay-ahead-of-the-storm.pdf
- Survey of Municipal Policies and Administrative Approaches for Overcoming Institutional Barriers to Low Impact Development. Credit Valley Conservation. http://www.creditvalleyca.ca/wp-content/uploads/2012/04/Muni_LID_Policy_withAppendix_Jan10.pdf
- Municipal Stormwater Financing Study. Credit Valley Conservation. http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/stormwater-management-lid-guidance-documents/credit-river-water-management-strategy-update-municipal-stormwater-financing-study/
- Compilation of LID Case Studies and sites in Ontario. Credit Valley Conservation. http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/green-technology-projects/
- Feasibility of Underground Pneumatic Freight Transport in New York City. http://www.uta.edu/ce/cuire/UPFT%20NY.pdf

Section 5: Eco-Business Zone Infrastructure Design

5

5.1 Introduction

> ***"Sustainable infrastructure is characterized by design that minimizes the demand for and use of resources such as energy, water and land. It also reduces the generation of waste such as greenhouse gases (GHG's), wastewater, excess heat, and material waste, and supports the cascading and recycling of these resources. These considerations extend throughout the design, construction and ongoing operation of the infrastructure systems."***
>
> ***Partners in Project Green Policy Toolkit, Glossary of Eco-Business and Sustainability Terms***

This is the second stage in the eco-business zone development process. Following key land use and structure decisions e.g., road and greenway networks, made at the subdivision planning stage, planning concepts (and commitments) must be translated into buildable infrastructure designs. This also tends to be the stage in the process where some concepts put forward in the planning stage are "taken off the table", usually due to one or more technical, economic, or regulatory factors. What is approved at the planning stage sometimes hits hurdles at the engineering stage. It is critical that any infrastructure design requests for proposals (RFPs) or tenders specify that an IDP is required, and that design options requiring deviations from standard, providing appropriate technical and economic rationale, are welcomed at the conceptual / preliminary design stages to advance innovation.

Decisions at this stage lay the foundation for subsequent eco-business zone parcel development, and operations. For example:

- Parcel development may involve site-level LID that is easier to implement within the context of larger, public LID stormwater management infrastructure.
- Operations might include the transfer of hot wastewater from one business to another business. Infrastructure design should establish approved locations and possibly design criteria for piping to move the hot wastewater e.g., acceptable piping materials.

The application of the eco-business zone principles at this stage will result in innovative, integrated, and efficient infrastructure. A re-cap of the application of the principles at this stage is presented in the table below:

Table 3. Example of Principle-in-Action at Planning Stage

PRINCIPLE	Infrastructure Design
A. Innovation:	Consider deviating from "business-as-usual" systems, choosing design and technologies that help improve overall sustainability performance.
B. Adaptability:	Future proof for emerging technologies that might not quite be feasible now.
C. Resiliency (Diversity):	Accommodate multi-modal pedestrian and goods movement.
D. Integration:	A systems approach demands thinking beyond eco-business zone boundaries. Establish a compact and efficient urban structure that integrates with the surrounding land uses and systems e.g., agricultural or residential.
E. Efficient Use of Resources:	Establish design goals to reduce greenhouse gas emissions, water consumption, etc. compared to business-as-usual designs and technologies.
F. Productivity:	Design infrastructure systems that can reduce business operating costs e.g., by providing reclaimed wastewater.
G. Visibility and Marketability:	Consider making innovation visible e.g., 'peepholes' into lift stations.
H. Natural Systems:	Consider technologies and designs that reflect ecological processes e.g., LID or solar aquatic system wastewater treatment.
I. Transferability and flexibility:	When considering innovative practices, place a greater emphasis on those that may have the most applicability to other employment (or non-employment) lands.

5.2 Land Use and Overall Infrastructure Layout

The general location of major infrastructure works will have been established in the subdivision planning stage. Refinements made during the design stage can reduce costly (and energy intensive) excavation and earthworks. Designs that balance the amount of cut and fill, and respect natural drainage patterns are essential. An understanding of natural drainage patterns will reduce construction costs and environmental impacts associated with disturbing, compacting existing soils and vegetation as well as avoid hauling and importing fill materials. This will result in cost savings, minimize the need for virgin material, material going to landfills, and reduce transport to bring material on-site or to dispose of material off-site.

<INFRAS.1> Minimize cut-and-fill requirements by working with the natural landscape and drainage patterns as much as possible.

An integrated design process (see Section 3) engaging engineers, ecologist, landscape architects and regulators will be particularly helpful when implementing this guideline, and will help identify synergies between grading plans, stormwater and drainage plans, and projected parcel grading.

Require statements from the design team that outlines strategies and design approaches at the pre-application stage and require pre/post development grading plans showing how the intent was met.

<INFRAS.2> Cluster or co-locate utility systems to promote potential synergies and waste exchanges between different infrastructure systems, and to minimize utility lot dedications.

5.3 Transportation, Access & Movement

Thinking back to our principles, there is an opportunity for eco-business zone road design to put many of the principles into action, such as innovation (e.g., design, materials selection) or resource efficiency (e.g., materials selection, construction practices, utility location). In an eco-business zone, the road network does more than just move trucks and commuter vehicles; it is also the circulatory system for stormwater, water, wastewater, business 'wastes', and even energy.

Street Design

<INFRAS.3> Street alignments should provide efficient and safe access to newly developed parcels within the site with clear sight lines between driveway entrances and the street.

<INFRAS.4> "Right-size" road rights-of-way, minimizing carriageways while still maintaining safe goods and people movement.

Minimizing carriageways reduces stormwater generation and greenhouse gas emissions. Wider / flared corners can accommodate a narrower carriageway while still providing safe turning radii.

Eco-business zone operations will likely incorporate transportation demand management practices, e.g., for employee trips, and be planned and designed to facilitate walking or cycling. Therefore, when establishing projected traffic counts, apply mode share targets (e.g., car/pedestrian/cycling) that reflect reduced vehicular traffic.

<INFRAS.5> Maximize the ability of road rights-of-way to accommodate general municipal and eco-business infrastructure, reducing overall construction costs and multiplying environmental benefits.

Consider incorporating underground district energy piping and other servicing ducts and pipes, such as sewer and stormwater swales, into street networks to multiply environment benefit and reduce overall construction costs. Future-proof for emerging, currently infeasible technologies, by dedicating right-of-way space for them.

Infrastructure corridors should be stacked vertically with road right-of-ways (in accordance with MOE guidelines, and Town and Region vertical and horizontal setback requirements) to avoid horizontal expansion of the ROW and increase development efficiency.

Design for joint shallow utility corridors that contain hydro, telecommunications, cable, television and gas.

<INFRAS.6> Implement PV powered pedestrian and street lamp-standards that are designed to enhance night time visibility while reducing light pollution and night sky lighting.

<INFRAS.7> All lighting to be high-efficiency (LED or solar) to further reduce energy consumption.

Investigate the use of integrated micro-wind turbines and solar PV lighting to further reduce energy consumption and provide visible sustainability on the site.

<INFRAS.8> Ensure that designated cycling routes have appropriate signage and road stencils to indicate that the road is a shared space. Cycling route design shall meet the requirements set forward by the Town of Caledon.

Figure 20. Examples of Clear Bike Lane Signage and Road Stencils

Utilities

<INFRAS.9> All utilities except transformers, switching and terminal boxes, meter cabinets, communication pedestals and other utility boxes that require more frequent maintenance access should be placed below grade.

<INFRAS.10> Combine lot services corridor zones for two or more parcels sharing a property line where timing of development is suitable.

<INFRAS.11> Service access points should be located within 12 to 18 inches of the gravel edge of the street apron. Inspection manholes (maintenance holes) are located at the property line and protected by easement.

Benefits of Alternative Road Design in Innovista Eco-Industrial Park, Hinton, AB

The road cross-section was modified, reducing the width of the paved area from 11 to 9 m for internal (local) roads, and from 12.5 to 11 m for the highway access (collector) roads (See Figure 21). The design still safely accommodates a WB-19 sized vehicle, as well as a walkway along to the road. Although it requires culvert crossings for driveways, and some additional maintenance, this design reduces land used for roads by 25%, and also reduces materials consumption (e.g., pit run gravel, crushed gravel, asphalt) as well as excavation requirements. While greenhouse gas emissions avoided / reduced could not be calculated for all materials or construction practices, it was estimated that reducing asphalt consumption for construction of the 580 m long local road and 60 m long collector road avoided 28 tonnes $_{e}CO_2$.

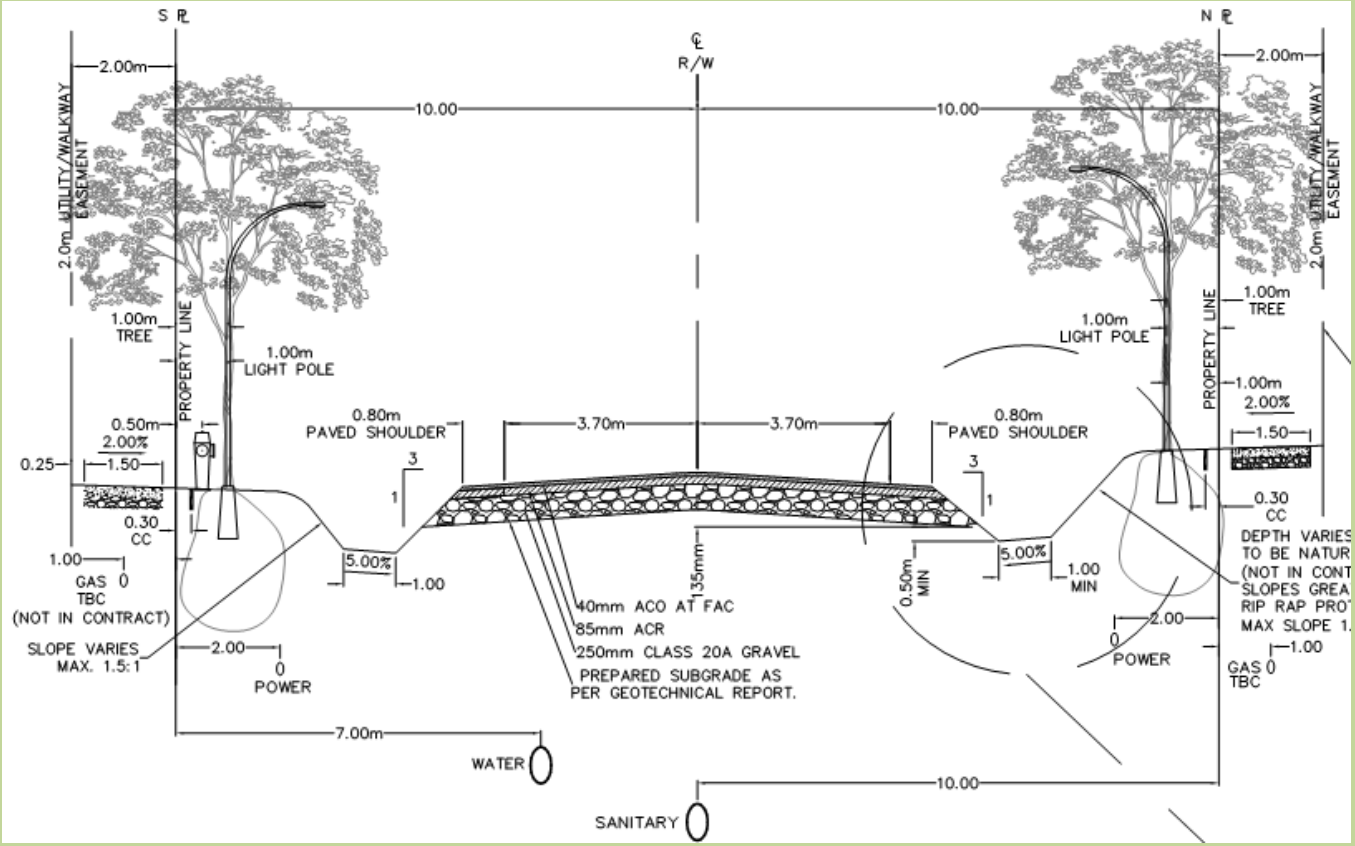


Figure 21. Internal road cross-section (Source: IBI Group for Eco-Industrial Solutions)

5.4 Public Open Space, Landscape & Stormwater Management

As noted in Subdivision Planning, regional stormwater management objectives create an intrinsic link between the designs of public open space, including public landscaped areas, as well for stormwater management. As part of an integrated approach to site servicing and infrastructure, consideration should be given to the natural systems and ecological services which serve the site. An understanding of existing topography, drainage patterns, soil conditions and solar orientation and sun path will help reduce the costs of infrastructure and supporting systems. As part of the overall design of public open space, landscape and stormwater management facility, a water balance approach should be undertaken. Land is also a limited resource and as such infrastructure corridors for utilities and services should be integrated as much as possible at the site plan level. For example, bio-swales can serve multiple objectives beyond conveyance of rain and stormwater. They serve to improve stormwater quality, help in the recharge of ground water aquifers, reduce urban heat effect, provide carbon sinks, as well as landscape and open space amenity that provide habitat.

Managing Stormwater Through Low Impact Development (LID)

Protecting, incorporating, and mimicking natural systems is by far the most important eco-business zone principle to apply here. This manifests itself through Low Impact Development (LID):

> ***"Low impact development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible. LID comprises a set of site design strategies that minimize runoff and distributed, small scale structural practices that mimic natural or predevelopment hydrology through the processes of infiltration, evapotranspiration, harvesting, filtration and detention of stormwater. These practices can effectively remove nutrients, pathogens and metals from runoff, and they reduce the volume and intensity of stormwater flows."***
>
> ***United States Environmental Protection Agency, 2007***

LID practices have been well-established throughout North America; locally-applicable criteria and standards have been developed by TRCA (see Additional Resources and Information).

Performance and Benefits of Low Impact Development Practices

The benefit of addressing stormwater at the source is that it reduces the impact on existing infrastructure and reduces the need for expanded capacity in the future. As site conditions vary between different developments, it must be noted that the effectiveness of the various low impact technologies will also differ. Between pre-development and post-development conditions, the goal of these stormwater management systems is to replicate the naturally occurring passage of stormwater with minimal impact to the surrounding environment.

The following table offers a relative comparison of potential performance and associated benefits between different Low Impact Development (LID) practices. The benefit level outlined below represents a "typical" use, design and installation. The actual comparisons are highly dependent on the design of the LID, the location, and if they are being used in combination or a treatment train. These elements can only be considered during the design process causing difficulty in establishing definite rankings.

It is recommended that Low Impact Development techniques are incorporated into the site design using various methods of infiltration, evapotranspiration, and storage and re-use. Also the soil type and water table may affect the opportunities and design of several LID practices.

Table 4. Performance and benefits comparison of different Low Impact Development practices (Source: TRCA)

LID Practice	Water Quantity [1]	Water Quality [2]	Water Temperature Reduction[3]	Aesthetic[4]	Installation Cost[5]	Maintenance Cost[6]	Other Benefits
Wet Ponds	High	High	High	Good	High	High	-
Dry Ponds	High	Low	Medium	Fair	Low	Low	-
Constructed Wetlands	Medium	High	Medium	Very Good	High	Low	Habitat/Ecological
Tree Clusters / Plantings	Low	Low	Medium	Very Good	Low	Low	Habitat/Ecological
Rainwater Harvesting	Low	Medium	Low	Poor	Medium	Medium	Energy/Water use
Green Rooftops	Medium	Medium	Medium	Very Good	Very high	Medium	Energy/Heating
Infiltration	Medium	High	High	Good	Medium	Medium	Groundwater Recharge
Bio-retention	Medium	High	High	Good	Medium	Low	Ecological
Oil Grit Separators	Low	Medium	Low	Fair	Medium	Low	-
Engineered Storage[7]	High	Low	Low	Fair	Low	Low	-

Notes:
[1] Ability to reduce either the peak flow of water leaving the area, or reducing the actual amount of water diverted from the system through infiltration or evapotranspiration/evaporation.
[2] Ability to reduce suspended solids, nutrients and/or other contaminants (e.g. Metals)
[3] Ability to provide a reduction in water temperature, for the benefit of the aquatic life in the receiving water.
[4] Relative aesthetic quality of the feature (may be subjective)
[5] Comparative installation cost for the typical application of the LID Practice
[6] Comparative maintenance burden, above routine mowing and landscape management
[7] Examples include rooftop storage, parking lot detention.

Open Space, Landscape Open Space, Landscape and Stormwater Infrastructure Guidelines

<INFRAS.12> Locate and design open space to function as an employee amenity for more than one lot.

<INFRAS.13> Design landscape to incorporate planting materials, soils and sub-soils to help increase absorption, infiltration and retention as well as increase evapotranspiration of precipitation.

Care must be taken when clearing snow that the snow, sand salt is not deposited on top of the bioswales or filtration strips, unless they have been specifically designed to manage snow loads e.g., as in TaigaNova Eco-Industrial Park.

Snow and salt management requirements should also be addressed when developing maintenance and inspection requirements.

Alternative deicing products such as calcium magnesium acetate should be considered, especially near vegetation or permeable paving to prevent excessive build-up of sodium and chloride in groundwater.

The US EPA has found that the annual costs for maintaining vegetated swales are approximately $1.90 per linear meter ($0.58 per linear foot) for a 0.5 meter (1.5-foot) deep channel.

<INFRAS.14> Use landscape design to punctuate gateways and street-end views by designing landscape features that provide amenity and interest including public art, water features and special plantings.

<INFRAS.15> To help define the newly emerging employment lands, punctuate the key intersections of streets entering the proposed employment areas with high quality landscape treatment.

<INFRAS.16> Create continuity of landscape treatment and outdoor amenity areas as much as possible with those on adjacent parcels.

<INFRAS.17> Integrate ecological features and functions, as well as 'walkable nature' into landscape design.

- Preserve, restore and enhance existing ecological features, functions and systems, including creeks, habitat, vegetation and topography, and integrate these into site design.
- Maintain a contiguous system of open space that retains its function ecological habitat.

<INFRAS.18> Use or adapt native species where landscaping is required.

<INFRAS.19> Incorporate interpretative education features into the landscape design to link it with the overall eco-business zone vision.

<INFRAS.20> If possible, plan to salvage native plants during the construction phase for re- use onsite or elsewhere.

<INFRAS.21> Where possible incorporate the site's natural materials in landscape or open space features, such as trees or large rocks removed during construction.

Figure 22. Landscape shall be designed to incorporate planting and soil.

<INFRAS.22> As much as possible, utilize LID methods for quantity and quality control.

Where LID is not possible and 'hard' systems are required, consider designing them to support the use of reclaimed stormwater by businesses or for irrigation.

<INFRAS.23> Minimize the amount of impermeable surface area to reduce post development stormwater flows.

Consider targeting post-development flows to equal original, natural flows from the parcel.

<INFRAS.24> Pursue integrated stormwater management design that captures and treats as much volume of rainwater at the source before being conveyed into regional or municipal stormwater infrastructure. Future stormwater management planning should include measures where feasible to minimize changes to existing ground water recharge rates.

<INFRAS.25> Prevent or minimize generation, mobilization, and transport of common stormwater pollutants and watershed-specific pollutants of concern to receiving waters, including surface water and groundwater, and combined sewers or stormwater systems.

<INFRAS.26> Avoid stormwater drainage to adjacent tributaries.

<INFRAS.27> Design stormwater storage ponds to integrate into the overall landscape, provide open space amenity, and/or provide natural heritage educational opportunities in addition to its functional value of storing water.

<INFRAS.28> Design stormwater retention and wet ponds to mimic naturally occurring wetlands, with a mix of native plantings that provision riparian habitat that is appropriate for local wetland conditions.

<INFRAS.29> Prepare a sediment and erosion control plan specific to the site, that conforms to local erosion and sedimentation control standards and regulations.

Integration and enhancement of EPAs with open space and stormwater management ponds

<INFRAS.30> Design the shape and form of stormwater management systems and wet ponds to mimic naturalized ponding patterns to reflect and compliment the meandering shape of the EPA as much as possible.

<INFRAS.31> Provide a riparian-planted edge along stormwater ponds and bio-swales to improve rainwater run off quality by helping to filter toxins and sediments.

<INFRAS.32> Incorporate trees that provide shade over streams and ponds to help keep cooler.

5.5 Water & Wastewater Systems

Water is a limited and valuable resource that requires a holistic and integrated management strategy for its collection and use. A water management plan is a fundamental step toward developing an integrated system that achieves a sustainable water supply balanced to meet future demands. The objective is to move toward a more site sufficient water budget that addresses economic and environmental constraints. **The strategy should assess the regional water cycle and climate with a target to develop a closed loop system that significantly reduces or eliminates the need for municipal potable water.**

Within eco-business zones, water and wastewater flows are especially inter-related, as 'wastewater' can be used in many ways in business operations, from truck washing to process water. There are many more types of wastewater generated within an eco-business zone, from 'clean' cooling water to highly contaminated process wastewater. However, the use of reclaimed wastewater can often not be established until businesses are operating. The infrastructure design stage should establish systems that help businesses (and buildings) reduce water consumption and cascade wastewater.

Partners in Project Green: A Pearson Eco-Business Zone Strategy (2008) did establish some water use intensities for the 23 existing business parks within the Pearson Eco-Business Zone, as shown in **Table 5**.

Table 5. Annual Water Consumption by Business Park (Source: Partners in Project Green Strategy (2008), Appendix A)

Business Park	Total Water Consumption (m^3)	Average Water Consumption (m^3)	Median Water Consumption (m^3)	# Businesses with matching water data	Total # Businesses
not in a business park	74,545,202	1,146,849	1,700	66	2,896
401 @ Steeles Business Park	287,990	4,363	1,015	66	498
401 Industrial Corridor	1,588,400	9,569	1,175	167	911
Airport	218,550	5,751	2,790	38	443
Airport 407 Business Campus	--	--	--	0	4
Bramalea Business Park I	1,151,290	16,215	1,690	71	210
Bramalea Business Park II	30,950	3,869	4,560	8	59
Brampton Industrial Park Goreway	70,990	7,099	4,365	10	58
Crossroads Business Centre	14,780	0	0	1	16
Delta Park	15,470	1,031	740	16	58
Gates of Brampton Business Park	17,700	1,609	780	11	29
Gateway	784,200	3,424	1,000	232	753
Goreway & 7 Business Park	186,750	10,985	2,460	17	40
Gorewood Business Park	46,800	15,600	16,100	3	6
Humberwest Industrial Park	34,170	0	0	1	5
Midair Court Industrial Park	37,670	7,534	8,110	5	5
Northeast	8,285,234	8,429	1,110	993	4,867
Orenda & East Drive	949,830	23,746	4,795	40	106
Orion Gate Business Park	34,990	2,333	1,960	15	45
Queensgate West	4,320	0	0	1	5
Rexdale Employment Area	19,542,000	51,836	891	378	1,465
Toronto Pearson	--	--	--	0	6
West Park Development	9,910	3,303	3,500	3	12
Westcreek Business Centre	705,490	352,745	352,745	2	3

Industrial water use intensities are generally much lower than would be predicted by most municipal engineering standards. In theory, this should reduce the actual demand for municipal water and wastewater infrastructure. Within employment lands, the sizing of water infrastructure is often driven by fire flow requirements, which can greatly exceed general demand. Therefore, having reduced water use intensities may not affect water infrastructure requirements, except where water intensive industries such as food processors, are projected. On the other hand, reduced water use intensities may impact the need for and sizing of wastewater infrastructure systems, such as lift stations. Demand management achieved through compliance with some of the parcel development and operational guidelines may further reduce businesses' water consumption and wastewater generation.

Developing an understanding of the actual water needs for projected businesses can impact water and wastewater infrastructure design, leading to opportunities to reduce costs and increasing the business case for pursuing alternative systems. While a private developer might undertake such analysis, the Town could support right-sized designs by researching and understanding actual water use and wastewater generation in its existing employment lands as well as for projected uses. It could be helpful to work with TRCA via Partners in Project Green's Pearson Eco-Business Zone.

In addition, it is possible that some of the businesses planning to locate in the new eco-business zone might be known at the infrastructure design stage, and might be able to provide more accurate projections for their actual water demand (especially in light of the parcel development guidelines). Even if they aren't known, consider that green buildings can reduce water consumption by 30 to 50 percent and generate wastewater cost savings of 50 to 90 percent according to the US Green Building Council.

The following guidelines should inform the terms of reference for any water and wastewater infrastructure design work in an eco-business zone.

<INFRAS.33> Right-size water and wastewater infrastructure, accounting for the best available knowledge of actual projected water consumption, taking into account the types of businesses known or likely to be in the eco-business zone; projected reclaimed wastewater or stormwater usage; and green buildings.

The Town could further support water conservation through policy / regulatory changes such as establishing water rate schedules that promote conservation and education/awareness programs on water conservation (including linking to Partners in Project Green programs.)

<INFRAS.34> Pursue designs and technologies that reduce energy, water, and materials consumption compared to the "business-as-usual" situation.

Such solutions may require deviation from current engineering standards. The Town should explicitly indicate a willingness to entertain such solutions, and may wish to specify the level of detail expected for feasibility analyses.

<INFRAS.35> Evaluate the feasibility of a distributed wastewater treatment plant, which can facilitate reclaimed wastewater use.

Consider the following factors:

- Who will own / operate the plant – one or combination of Town, Region, private facility?
- What is the impact of projected demand management on the business case?

- What are the opportunities for alternative technologies, such as living machines?
- Did the subdivision plan anticipate this use?

<INFRAS.36> Require consideration of the Parcel Development Guidelines for infrastructure such as pump/lift stations.

<INFRAS.37> Where feasible, consider innovative wastewater collection systems, such as small bore sewer™ systems.

<INFRAS.38> Accommodate the future conveyance of reclaimed wastewater (including business-to-business exchanges) and reclaimed stormwater from any 'hard' systems.

Create special rights-of-way or adapt planned 'business-as-usual' rights-of-way to accommodate wastewater recycling and/or non-potable water supply.

This can also help a business to send its clean wastewater to another business, which might extract some heat before discharging it back to the sanitary sewer.

<INFRAS.39> Use trenchless pipe technology to minimize site disturbance where appropriate. Select the least disruptive, available technologies for installing stormwater, sanitary sewer or combined storm/sewer lines based on current best practice.

<INFRAS.40> Ensure that wastewater infrastructure design integrates with energy systems design to support the viability of sewer heat recovery (see Energy Systems).

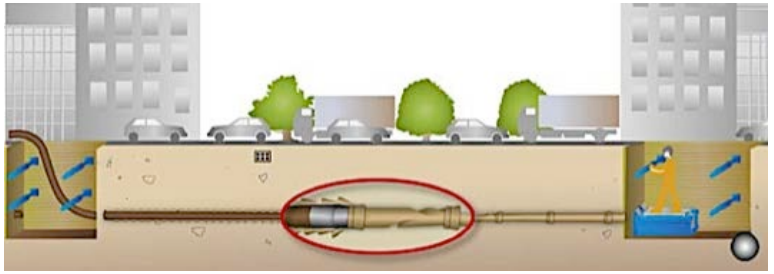


Figure 23. Trenchless technology (Credit: Tracto-Technik GmbH & Co. KG)

5.6 Energy Systems

Commercial, institutional and industrial facilities account for over 51% of Canada's total secondary energy use. The Province has set its energy policy agenda to move toward renewable energy supplies. Future development within the area may include large flat-roofed facilities ideal for roof-mounted PV arrays. Additionally, parcels with significant amounts of surface parking that would allow for PV covered car parking shelters. This would not only have an ability to generate energy but also help reduce urban heat effect typically associated with large areas of dark paving materials.

While many renewable energy solutions are more relevant to the parcel scale, there are renewable energy opportunities that exist at the subdivision scale, especially if the Town or the developer has an interest in owning or operating such systems, or there is an engaged private utility partner.

Subdivision scale energy systems should take into account the potential for parcel-scale renewable energy systems, as well as reduced energy demand associated with green buildings. It is estimated that building-related energy consumption in a new eco-business zone could be 25-35 percent below 'business-as-usual'.

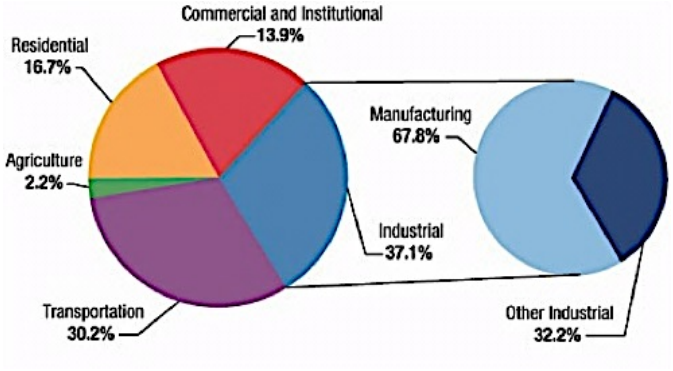


Figure 24. Canada's secondary energy consumption by sector, 2009. (Source: Natural Resources Canada)

<INFRAS.41> Evaluate the feasibility of district energy systems to support building heating and cooling requirements, as well as perhaps support some process energy requirements. Implement such systems where feasible.

Consider factors such as:

- Who will own and/or operate the system – one or a combination of the Town, Region, developer, private utility?
- What are the possible energy sources – geo-exchange? Sewer heat recovery? Natural gas? Biomass? (Table 6 lists the consideration of different energy sources for district energy system)
- Does the business case change if the system supports more than the eco-business zone?
- What is the impact of the application of parcel-level guidelines that reduce building and process energy demand?
- What is the impact of changing projected land uses?
- Support from the Town to enact policies such as requiring connection to the system as part of a development approval?
- Life cycle costing e.g., can revenue streams be managed to underwrite the investment in emerging sustainable technologies and offset operating costs?
- Can other parcels be connected by running pipes in road rights-of-way, or are other easements required?

In support of policy objectives to reduce greenhouse gas emissions, some municipalities e.g., City of Vancouver, have led such studies. Even before other eco-business zone infrastructure design officially begins, the Town of Caledon staff could undertake such a study.

Table 6. Energy Sources for district energy system (Source: City of Kelowna District Energy Prefeasibility Study)

Energy Source	Considerations	Approach	District Scale	Building Scale	Capital Cost	Operating Cost
Air-source heat pumps	● Good climate conditions ● Short payback	Low grade heat source & heat pump	+	+++	$	$$$
Geo-exchange (Closed-loop borehole)	● Soil properties affect drilling cost and sizing of ground heat exchanger ● Output depends on flow rate	Low grade heat source & heat pump	++	+++	$$$	$$
Geo-exchange (Open-loop borehole)	● Cost depends on drilling conditions ● Output depends on flow rate	Low grade heat source & heat pump	++	+++	$$	$$
Geo-exchange (Horizontal loop)	● Lower capital cost than borehole ● Require large surface area (such as parks or parking lots)	Low grade heat source & heat pump	+	+++	$$	$$
Heat recovery (Sewer mains or lift station)	● Cheaper if installed from beginning ● Heat output dependent on volume	Low grade heat source & heat pump	++	+	$$$	$$
Solar hot water	● Solar resource availability ● Require south orientation	Low grade heat source & heat pump	+	+++	$$$	$
Waste heat	● Existing source availability	Existing heat source with or without heat pump	+++	++	$$	$
Wood waste	● Long-term supply availability	Combustion or gasification	++	++	$$	$$$
Wood pellets	● Wood pellet deliveries availability ● Wood pellet unit price	Combustion or gasification	++	++	$$	$$$$

Legend: **'+'** Not usually a suitable application, **'+++'** Frequently a suitable application; '$' Relatively inexpensive, '$$$' Relatively expensive.

<INFRAS.42> Evaluate the feasibility of installing horizontal geo-exchange systems under publicly-owned lands. Implement such systems where feasible.

Feasibility might consider such factors as:

- Soil conditions and fill requirements.
- Based on the location of the site, how many parcels might connect to the geo-exchange system?
- Who would own and/or operate the system – one or a combination of the Town, Region, developer, or private utility?
- Can other parcels be connected by running pipes in road rights-of-way, or are other easements required?
- What is the impact of parcel-level energy demand management on the business case?

<INFRAS.43> Evaluate the feasibility of installing solar photovoltaic arrays and wind turbines on publicly-owned lands. Implement such systems where feasible.

Feasibility might consider such factors as:

- Who would own and/or operate the system – one or a combination of the Town, Region, developer, or private utility?
- Are there any physical issues, such as glare on trucks or flight patch restrictions?
- What is the impact of parcel-level energy demand management on the business case?

(Subject to helicopter flight path analysis) should be integrated as part of the eco-business zone by establishing utility easements or lots to serve the businesses.

<INFRAS.44> Consider infrastructure to support the use of alternative fueled vehicles such as charging stations for electric vehicles (ideally powered by solar energy) and stations offering biofuel.

<INFRAS.45> Within public rights-of-way, implement high efficiency light standards that incorporate the use of photovoltaic and micro-wind turbines that are integrated within the same lamp standard.

Figure 25. High efficiency outdoor lighting fixtures can also incorporate small PVs and micro wind turbines.

More about District Energy Systems:

District energy systems use one or more central plants to provide thermal energy to multiple buildings. This approach replaces the need for individual, building-based boilers, furnaces, and cooling systems. District energy system has many economic and environmental benefits especially for community or business / industrial parks under developing. Benefits include:

- Reduce land requirement to support distribution infrastructure
- Minimize energy and infrastructure cost
- Increase the security of energy supply
- Meet the demand for energy
- Reduce carbon emissions

Figure 26 is the illustrated concept of district energy system for Hamilton Community Energy Centre. It features a co-generation plant using natural gas as energy source and supplying electricity and steam through underground insulated pipes to its commercial, industrial and residential clients in the Hamilton area.

Figure 27 are the modeling results based on a high-performance natural gas-supplied CHP district energy system. It shows a significant energy saving in both commercial application and residential application. However, district energy systems require a certain level of demand in order to be economically viable. Consider implementing guidelines for buildings and facilities to be 'district energy ready' will help to prepare for the future demand on connecting to the system.

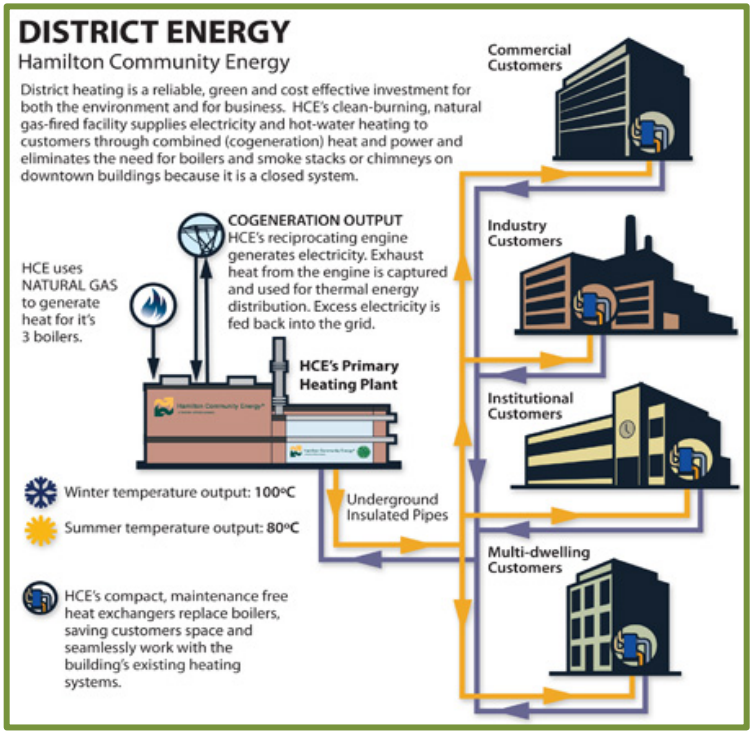


Figure 26. Concept of District Energy System. (Credit: Hamilton Community Energy, ON)

Figure 27. The energy saving and GHG Emission reductions provided by district energy compare to conventional energy system. (Credit: Canadian District Energy Association, 2007)

5.7 Materials Use & Management

The use of sustainable materials for infrastructure will have a significant impact in helping to reduce embodied energy, use of virgin raw materials and eliminate use of toxins that have an impact on our environment, health and economic systems. Durable infrastructure can reduce long-term maintenance and operational requirements. Increasingly, local municipal governments are beginning to incorporate recycled materials into material specifications for roads, pipes, shoring, backfill and landscapes.

Providing and operating central recycling and composting facilities for businesses by the Region of Peel will help to achieve the waste reduction goal and also benefit local economy and create employment opportunity.

Materials Selection Credits from Envision™ Sustainable Infrastructure Rating System

- Reduce Net Embodied Energy
- Support Sustainable Procurement Practices
- Use Recycled Materials
- Use Regional Materials
- Divert Waste From Landfills
- Reduce Excavated Materials Taken Off Site
- Provide For Deconstruction & Recycling

Envision™ is the product of a joint collaboration between the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure. Envision™ provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects.

(http://www.sustainableinfrastructure.org/)

<INFRAS.46> Require consideration of Parcel Development materials use and management guidelines for any buildings housing infrastructure

<INFRAS.47> Re-use site materials where possible for infrastructure construction e.g., aggregate, landscape features. (See Innovista example at the end of this section)

<INFRAS.48> Where possible, specify materials containing recycled content.

A target of a minimum 10% recycled material content for road base, pavement, sidewalks, concrete pipes, structural elements, sediment and erosion control would be consistent with recycled material contents for LEED certified buildings.

<INFRAS.49> Where possible, specify materials that are lower impact than business-as-usual selections e.g., pervious or high volume fly-ash concrete, or weldable HDPE versus PVC piping.

Consider developing material selection assessment and verification criteria, incorporating a life-cycle analysis approach, to help engineers select and specify lower impact materials as part of the design, tender and build process (see Resources and Other Information: The New York City Street Design Manual Chapter 3 - Material for more material information). Such criteria might include level of volatile organic compounds (VOCs), presence of heavy metals, generation of air pollutants.

Consider requiring the application of the materials selection credits from infrastructure rating systems, such as Envision™ (see textbox above), and Greenroads™ (See 5.8 Additional Resources and Information).

What is Greenroads™ Rating System?

A Greenroad™ is defined as a roadway project that has been designed and constructed to a level of sustainability that is substantially higher than current common practice. Greenroads™ is an award-based, flexible rating system (sometimes called a "performance metric") that can be used to rank, score and compare different road projects for their overall performance toward being more sustainable than an average road project. Material credits include:

- Life Cycle Assessment (LCA)
- Pavement Reuse
- Earthwork Balance
- Recycled Materials
- Regional Materials
- Energy Efficiency
- Conduct a detailed LCA of the entire project
- Reuse existing pavement sections
- Use native soil rather than import fill
- Use recycled materials for new pavement
- Use regional materials to reduce transportation
- Improve energy efficiency of operational systems

Greenroads™ is a research project that originated at the University of Washington and has developed in several versions since the initial beginnings of research work in 2007. Version 0.95 (2009) was developed jointly by the University of Washington (UW) and CH2M HILL. (https://www.greenroads.org/)

Figure 28. Innovista Eco-Industrial Park.

Materials Re-Use and Local Sourcing Innovista Eco-Industrial Park, AB

- Large boulders from the site were used to block vehicle access at trailheads.
- Soil was stockpiled, screened and reused for landscaping purposes.
- Grubbing materials were used for reclamation purposes at a decommissioned landfill located nearby. They were also used as biomass to supplement power needs at the local sawmill.
- Local excess woodchips were obtained from the local sawmill and used for mulch around plantings, instead of imported bagged product.

Expected Environmental Performance Report, Innovista Eco-Industrial Park. 2010.

5.8 Additional Resources and Information

Infrastructure

- National Research Council of Canada provides techniques, tools and guidelines for sustainable building and infrastructure http://archive.nrc-cnrc.gc.ca/eng/ibp/irc/ci/volume-11-n3-11.html
- Institute for Sustainable Infrastructure (ISI) develop and maintain a sustainability rating system, Envision™, provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects. http://www.sustainableinfrastructure.org/rating/index.cfm

Street Design

- The New York City Street Design Manual. This manual is a comprehensive resource for promoting higher quality street designs and more efficient project implementation. The manual is updated in July 2010. http://www.nyc.gov/html/dot/downloads/pdf/sdm_hires.pdf
- Reducing Greenhouse Gas Emissions in BC Road Building and Highway Maintenance. BC Road Builders and Heavy Construction Association. http://www.th.gov.bc.ca/publications/eng_publications/geotech/3348_Roadbuilding_BP-V13-232ppi.pdf
- Rhode Island LID Site Planning and Design Guidance for Communities by Horsley Witten Group, December 2010. Section 5 LID Roadway Design and Section 6 LID Parking Guidance examine individual elements of roadway and parking design, and provide guidance on how to develop lower impact roads and parking lot in an effort to reconcile some of the perceived conflicts between safety and reduced stormwater volumes. http://www.horsleywitten.com/DEM-LID-Guide/

Materials

- The New York City Street Design Manual, Chapter 3: Materials. This section provides information on specific materials with recommendations for infrastructure use, and references to appropriate specifications. http://www.nyc.gov/html/dot/downloads/pdf/nycdot_streetdesignmanual_ch3.pdf
- Greenroads Rating System: The Greenroads Rating System is a third-party, points-based system available to certify sustainable roadway and transportation infrastructure projects. The system provides metrics to measure the effect of design and construction practices which can be implemented on a project to earn points toward one of four certification awards. https://www.greenroads.org/

Water and Wastewater

- Water Efficiency Manual for Commercial, Industrial and Institutional Facilities. Produced by the NC Department of Environment. May 2009. http://infohouse.p2ric.org/ref/01/00692.pdf

Stormwater Management

- TRCA Watercourse Crossing Design and Submission Requirement
- TRCA “The Living City Policies” DRAFT (http://trca.on.ca/dotAsset/154424.pdf)
- TRCA Stormwater Management Guidelines and Best Practices
- Federal Fisheries Act (HADD) Sections 35 and 36

District Renewable Energy

- Ontario Ministry of Agriculture and Food is helping to create new opportunities for use of bio based feedstock and by-products into district energy systems. http://www.omafra.gov.on.ca/english/crops/bioproducts/bioproducts.html#bioe
- Ontario Power Authority is offering incentives and programs to promote the use of renewable energy including solar photovoltaic, wind turbines and bioenergy. http://www.powerauthority.on.ca/
- Natural Resources Canada (2012), Energy Efficiency Trends in Canada, Trends for 1990–2009.
- Biomass Energy Resource Center website provides case studies of community district energy application in the world, http://www.biomasscenter.org/resources/case-studies/communityde.html
- The New District Energy: Building Blocks for Sustainable Community Development On-Line Handbook, Canadian District Energy Association, January 2008.
- Pearson Eco-Business Zone District Energy Feasibility Study for Toronto and Region Conservation Authority, FVB Energy Inc., April 2012. http://www.partnersinprojectgreen.com/resources/reports

Financial Mechanism

- Environmental Protection Agency Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure. This document includes success stories for building a comprehensive green infrastructure program, and also provides insight into the barriers and failures these communities experienced while trying to create a stormwater management system that includes more green infrastructure approaches. http://www.epa.gov/owow/NPS/lid/gi_case_studies_2010.pdf
- Managing Wet Weather with Green Infrastructure: Municipal Handbook – Funding Options and Incentive Mechanisms, by US Environmental Protection Agency. This handbook includes a list of incentive mechanisms currently being used by municipalities around the United States. http://water.epa.gov/infrastructure/greeninfrastructure/gi_policy.cfm

Section 6: Eco-Business Zone Parcel Development

6

6.1 Introduction

This is the third stage in the eco-business zone development process – where individual parcel owners begin to build out their now serviced parcels. Whereas the Town itself might be the project lead for processes requiring consideration of the subdivision planning and infrastructure design guidelines, the Town's sole role at this stage is that of regulator (well, and perhaps as incentive provider).

Decisions at this stage lay the foundation for subsequent eco-business zone operations, the heart of TRCA's current Partners in Project Green initiative. In fact, much of what is being promoted on a retrofit basis as part of Partners in Project Green e.g., green parking lot program (see http://www.partnersinprojectgreen.com/files/ppg_greenparkingprogram.pdf) can be implemented right-from-the start as part of the design and construction of new eco-business zone facilities.

The application of the eco-business zone principles at this stage will result in green buildings that are located within sustainably developed parcels and that make it easier for their occupants to operate a sustainable work place. A re-cap of the application of the principles at this stage is presented in the table below:

Table 7. Example of Principle-in-Action at Planning Stage

PRINCIPLE	Parcel Development & Building Design Stage
A. Innovation:	Consider deviating from "business-as-usual" systems, choosing design and technologies that help improve overall sustainability performance.
B. Adaptability:	Future proof for emerging technologies that might not quite be feasible now.
C. Resiliency (Diversity):	Design buildings to respond to changes in uses / market conditions.
D. Integration:	Building design should allow building operations to integrate with employment land infrastructure systems e.g., energy or site-wide stormwater management.
E. Efficient Use of Resources:	Encourage shared use of facilities that capitalizes on economies of scale to reduce costs and increase efficiencies (i.e. district energy systems, shared stormwater management, shared facilities.)
F. Productivity:	Buildings should be designed to maximize daylighting and indoor air quality, which supports higher employee productivity.
G. Visibility and Marketability:	Buildings should celebrate visible sustainable approaches as part of the architecture including use of light shelves, Building Integrated Photovoltaic (BIPV) panels, roof top PVs and stormwater cisterns.
H. Natural Systems:	Site and building design should utilize, respect, respond to and learn from natural systems (i.e. LID), energy and water cascading and native and natural plantings.
I. Transferability and flexibility:	When considering innovative practices, place a greater emphasis on those that may have the most applicability to other employment (or non-employment) lands.

6.2 Parcel Use & Site Layout

Building Orientation & Site Relationship

The siting of buildings should begin with an evaluation of existing natural systems and ensure the design responds to its context in a positive way.

<PARCEL.1> While respecting zoning setback requirements, orient and design the building to take advantage of natural light and natural ventilation.

<PARCEL.2> While respecting zoning setback requirements, orient buildings to optimize passive solar energy gain and improve thermal performance of the building OR position the building's primary edge should parallel to the street as close to the minimum setback to help frame the street edge.

<PARCEL.3> Site buildings such that the active uses of the building, such as visitor entrances, are oriented toward the public street edge.

Buildings should be carefully designed to ensure that active uses are oriented toward public streets, public spaces, car parking areas and other pedestrian routes. Use Crime Prevention through Environmental Design (CPTED) principles when developing the site program. [See Resource section for more information on CPTED]

<PARCEL.4> Site buildings close to the front of the lot to reduce the distance for infrastructure extensions from municipal roadways.

Locate buildings close to the street lot line with minimal setbacks to reduce walking distances between buildings and sidewalks, transit stops, and other buildings across the street.

<PARCEL.5> For corner sites, orient and design buildings so that there are active uses on both street edges, with quality architecture that provides prominence at the corner. The site program (both landscape and building) should help frame the corner of the property.

<PARCEL.6> Buildings sited closest to major intersections help to form the gateways to the eco-business zone.

These buildings should display enhanced architectural designs and visible sustainability features that help enhance gateways (including building massing, recycled water features, public art, day lighted foyer entrances, etc.).

Figure 29. Siting buildings toward public street edge helps frame the street edge.

Figure 30. Kellogg's Distribution Centre, West Jefferson, OH (Credit: ALD Precast)

Figure 31. Wirtz Beverage Distribution Centre, Cicero, Illinois (Credit: Ryan Companies US)

<PARCEL.7> Where possible, use building shape and projections to define parking along the side edge of a building so that parking does not predominate the front edge of the landscape.

<PARCEL.8> Provide dedicated, clear and legible pedestrian paths between public sidewalks and parking areas into the building entrance. Use landscape plantings and pedestrian friendly lighting to define pedestrian paths from the building to landscaped amenity/gathering areas within the site.

Landscaped Setbacks

Landscaped setbacks provide an important visual amenity for visitors and employees, and an environmental function to the site. In employment lands, landscape setbacks can help to extend continuity of landscape treatment and help screen more utilitarian uses from public view. They also help define public, semi public and private space. The landscape edge will help frame the street with trees and vegetation.

<PARCEL.9> Consider locating bio-swales to convey storm and rain water to stormwater management ponds using natural topography and grading within landscape setbacks, bordered with riparian plantings.

<PARCEL.10> Consider constructing berms within landscape setbacks to help screen views of parking, loading and storage.

As discussed in the Open Space, Landscape & Stormwater guidelines, plant native plants that are drought/pest resistant and easy to maintain.

<PARCEL.11> Provide a landscape edge of 1.5 meters along all interior side lot lines creating a shared landscape strip with abutting property of 3.0 meters wide. Bio-swales may be integrated into the landscape strip to maximize its functional and aesthetic performance.

<PARCEL.12> Where fences are constructed within or at the boundary of a landscape setback, ensure they are screened with plantings and vegetation and are no more than 1.5 metres high.

The placement of the fence shall allow for unobstructed access to the bio-swales and privately landscaped areas to allow for maintenance and upkeep.

Figure 32. Landscape Setbacks. (Shelby Office Park, California. Credit: Ridge Landscape Architects)

Figure 33. Rain Garden along lot edge. (Lowe's store, Concord, Credit: Blue-Green Building website)

6.3 Built Form and Character

Height and Massing

<PARCEL.13> Avoid large, blank, monotonous building walls facing public areas such as streets, car parking areas, or public open space.

Articulate buildings with recesses and projections to avoid long monolithic blank walls, unless such walls are to be the foundation for systems such as solar or vegetated walls.

<PARCEL.14> Articulate front building entrances placing design emphasis on height and form to differentiate from the rest of the building.

Modulation of height and massing for front entries and reception areas provide visual cues that helps to direct users to this area of the site.

Figure 34. Alternative to the big-box concept. (V. Suarez Atlantic Commercial Park, Puerto Rico. Credit: Max Toro)

Character and Design

<PARCEL.15> For street-oriented facades and gateway parcels, incorporate visible sustainable design features as part of the building and landscape architecture, using interpretative signage where possible to draw attention to the feature.

Such features might include cisterns for rainwater harvesting, solar walls, light shelves or high quality recycled and rapidly renewable materials. The design of any building, even the simplest industrial shed, should always make a positive visual contribution to its surrounding environment.

Figure 35. Prologis Park distribution center (Bolton, ON) is constructed with 35% recycled materials and 77% locally sourced materials.

<PARCEL.16> Use high quality and durable materials with variations in colour on architectural elements including cornices, parapets and entries to provide character and interest to the building.

<PARCEL.17> Use architectural features (such as parapets) to screen HVAC and other mechanical equipment from public view or set back mechanical equipment to eliminate views from the public streets.

Figure 36. Rooftop Photovoltaic panels/HVAC screen at Modesto Medical Center, CA. (Credit: Kaiser Permanente)

6.4 Transportation, Access & Movement

Site Access and Driveways

<PARCEL.18> Clearly mark site access to individual parcels with landscape features and low profile signage that is integrated as part of the building and landscape design.

<PARCEL.19> Ensure that landscape elements such as berms and signage shall not obstruct visibility between moving vehicles, pedestrians and bikes within the street.

<PARCEL.20> Where possible, create shared entries for two sites using side driveways to minimize the sidewalk cuts. This will require mutual easements and will require Committee of Adjustment approval as the use will exceed 21 years.

Figure 37. Clearly Marked Site Access. (TaigaNova EIP, AB)

Pedestrian & Cyclist Access

<PARCEL.21> Design buildings to offer protection from elements to pedestrians.

Coordinate weather protection between buildings to ensure shelter is continuous and the designs are compatible.

<PARCEL.22> Grade the site to direct snowmelt and runoff away from roads and pedestrian areas to avoid icy conditions.

<PARCEL.23> Maintain attractive connections between primary buildings on each parcel and any eco-business zone trail system to encourage walking & cycling.

<PARCEL.24> Provide bicycle parking on hard surfaces near employee and customer entrances to promote cycling.

<PARCEL.25> Provide covered bicycle racks in a secure and easily accessible location near the front entrance to the building entrance.

<PARCEL.26> Provide shower/change room and storage facilities for cyclists as part of the development

Figure 38. Weather Protection for Pedestrains. (TaigaNova EIP)

Figure 39. Covered Bicycle Rack. (Credit: Acer Engineering)

Parking and Loading Areas

<PARCEL.27> Consider known or probable transportation demand management e.g., coordinating with MetroLinx's SmartCommute, and consider reducing parking spaces.

This may require Town approval on a case-by-case basis.

<PARCEL.28> Locate main parking and all loading areas at the side and/or rear of buildings with well-defined pedestrian pathways that connect to main entrance areas.

<PARCEL.29> Locate visitor and priority parking for car share, alternatively fuelled or electric vehicles and disabled users at the front of the building or closest to the building if these spaces are within the main parking area.

For front-of-building parking, aim for a single-loaded row with landscape strips to capture rainwater runoff.

<PARCEL.30> Plant trees and shrubs throughout the parking area to intercept precipitation, reduce surface heating, enhance appearance and protect pedestrians from the elements. Select plant varieties that have tolerance of seasonal salt loadings, cold climate and pollutant uptake capacity.

Figure 40. Plant trees and shrubs throughout parking lot to intercept precipitation. (Heifer International Center, AR)

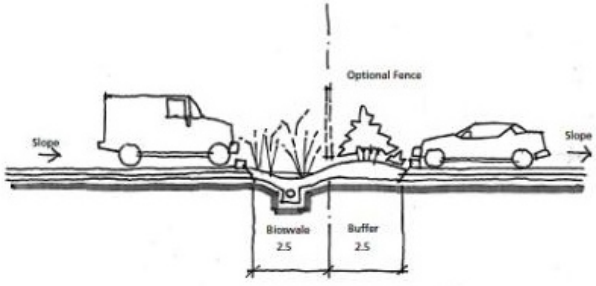


Figure 41. Filtration Strip Between Parking Stalls.

Care must be taken when clearing snow that the snow, sand salt is not deposited on top of the bioswales or filtration strips, unless they have been specifically designed to manage snow loads e.g., as in TaigaNova Eco-Industrial Park. Snow and salt management requirements should also be addressed when developing maintenance and inspection requirements.

Alternative deicing products such as calcium magnesium acetate should be considered, especially near vegetation or permeable paving to prevent excessive build-up of sodium and chloride in groundwater.

The US EPA has found that the annual costs for maintaining vegetated swales are approximately $1.90 per linear meter ($0.58 per linear foot) for a 0.5 meter (1.5-foot) deep channel.

<PARCEL.31> Incorporate permeable pavement and perforated under drains to help reduce direct rainwater/stormwater runoff where soil conditions are suitable OR where soil conditions limit the feasibility of permeable pavers, consider using the area beneath large parking areas for rain water storage using structural cells.

Research shows that permeable pavement can reduce dependence on salt for deicing roads and parking lots (University of New Hampshire Stormwter Center, 2009). This strategy can be used when combined with placing biowales and filtration strips between parking stalls to extend the life span of these stormwater management systems.

For underground systems,a technical and ecnonomic assessment, considering the level of comfort with the developer, technology, and ability / desire to enforce compliance with maintenance agreements, may be required.

Figure 42 illustrates stormwater storage cells beneath parking areas which can address stormwater storage and runoff quantities without having to create large SWM ponds.

<PARCEL.32> Reduce heat island effect and smog through light colored hardscape, porous materials, in place of dark, absorptive hardscape materials. Specify the use of hardscape materials with an solar reflectance value (SRI) of at least 29.

Servicing corridors and location of utility boxes

<PARCEL.33> Combine service corridors to serve two properties to minimize trenching costs, minimize equipment run time / fuel use, and avoid disruption to pedestrian zones.

<PARCEL.34> Locate all utilities except major power transmission lines, transformers, switching and terminal boxes, meter kiosks below grade where possible.

Advantages of On-Site Underground Stormwater Retention / Detention:

- Primary advantage: These systems capture and store runoff, thus helping meet the requirement to maintain pre-development runoff conditions at newly-developed sites.
- These systems are ideal for highly urbanized areas, particularly in areas where land is expensive or may not be available for ponds or wetlands.
- These systems can be installed quickly. For example, construction and installation of a 6' by 4' by 156' concrete system was installed under a car dealership in Tennessee in 3 days (Sherman Dixie Concrete Industries, Inc., 2000).
- These systems are very durable. Once in the ground, most systems can last more than 50 years.
- Because these systems are underground, local residents are less likely to have access to them, making them safer than ponds or other aboveground stormwater BMPs.

Disadvantages of On-Site Underground Stormwater Retention / Detention:

- Primary Disadvantage: These systems are not designed to provide stormwater quality benefits. However, if they are included in a treatment-train type system, underground detention systems can be an important part of an overall stormwater management process.
- These systems may require more excavation than surface ponds or wetlands.
- Recharge of the groundwater from an underground retention unit may contribute to groundwater contamination if flow from the site is directly discharged into the retention system before pretreatment. Therefore, EPA does not recommend that percolation systems be designed for sites with coarse soils or high groundwater tables.
- These systems are more difficult to maintain and clean than aboveground systems.

In Fairfax County, Virginia, where there are over 300 underground stormwater retention/ detention structures installed at commercial / industrial sites, private owners of the structures are required to sign a maintenance contract within the County that commits the owner to maintain the structure appropriately. Fairfax County also provides owners with a maintenance checklist and plans to inspect these structures regularly (i.e., at least once every five years) to ensure that they are functioning adequately. If an owner fails to maintain the structures, the maintenance agreement allows the County to perform the required maintenance at the expense of the owner. The Town of Caledon could require owner to undertake inspections on an annual basis and submit report to the Town for record.

U.S. EPA Stormwater Technology Fact Sheet: On-Site Underground Retention/Detention. 2001. Accessed at http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_runoff.pdf

Figure 42. Underground Stormwater Storage Chambers. (Credit: CULTEC Inc.)

6.5 Private Open Space, Landscape & Stormwater Management

Strategically used vegetation can help to manage stormwater flows, increase pedestrian comfort (shading, wind block), capture air pollutants, and reduce building energy consumption. And of course, landscape can create a higher quality 'look and feel' in the employment zone. Therefore, the parcel landscape plan cuts across many objectives.

<PARCEL.35> Utilize Low Impact Development (LID) designs and technologies to collect, convey, and treat stormwater. (See Section 5.4 for more detailed information about LID)

<PARCEL.36> Use Crime Prevention through Environmental Design (CPTED) to ensure site security and safety.

<PARCEL.37> Minimize the amount of impermeable surface area to reduce post development stormwater flows.

Consider targeting post-development flows to equal original, natural flows from the parcel.

<PARCEL.38> Plan the parcel to mimic surrounding natural systems, taking into consideration natural drainage patterns and existing watercourses that allow gravity to convey surface water toward primary stormwater conveyance systems or treatment ponds.

<PARCEL.39> For gateway parcels, consider higher quality landscape design.

<PARCEL.40> For parcels adjacent to Environmental Policy Areas, provide a landscaped setback with plantings that screen views into industrial or storage areas.

<PARCEL.41> For parcels adjacent to Environmental Policy Areas, provide a landscape strip along any security fences to improve visual amenity between the fence and the EPA.

<PARCEL.42> Incorporate rainwater harvesting strategies including connecting roof drains into cisterns that can be used for irrigation, toilet flushing and equipment and facility wash-down and HVAC / Cooling make-up.

Figure 43. Rainwater Cisterns collect and store rainwater for re-use. Right: Warren Skaaren Learning Center, Credit: Greg Hursley

<PARCEL.43> Consider designing parking or roof areas to provide temporary storage in major rain events when the rate of rainfall exceeds infiltration and conveyance capacity.

<PARCEL.44> Consider a green roof as part of a system of strategies to help mitigate peak flows from rain events and help filter "first flush" sediments before being conveyed into storm ponds or cisterns.

Figure 44. Green roofs on industrial buildings (Left to Right: Bondorf Distributions-Logistik GmbH, Germany; Adnams Distribution Centre, England; Ford Motor River Rouge Plant, USA).

<PARCEL.45> Place vegetation and/or vegetated structures in strategic locations around buildings to reduce building energy consumption.

<PARCEL.46> Use vegetation and planting to help soften long stretches of blank building walls or structures.

Fences, screens and buffers

<PARCEL.47> Perimeter fencing is permitted along the rear and side property lines that do not face onto a public street.

<PARCEL.48> Decorative fences such as green screens or architecturally designed fences may face onto public streets provided they do not obstruct sight lines between moving traffic and pedestrians. Maximum height of fences shall be 1.5 metres high on public streets. Chain link fences are not permitted to face on to public streets.

<PARCEL.49> Use 'green screens' as an alternative to chain link fencing to minimize visibility of storage areas, garbage areas and utility areas from public streets and EPAs.

<PARCEL.50> Provide riparian planting buffers are to be provided along bio-swales, EPAs and stormwater management ponds.

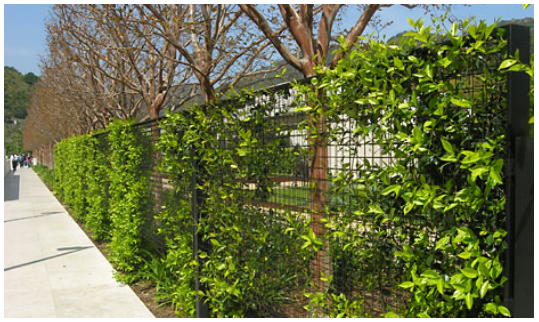


Figure 45. Green Screens

Interpretation, Education and Natural Heritage

<PARCEL.51> Incorporate interpretive landscape signage to illustrate innovation in design (for example, use of native/edible landscape, rainwater harvesting for irrigation, bio-filtration and remediation of stormwater runoff from parking lots).

<PARCEL.52> Celebrate the natural heritage of the site by incorporating historical elements, features and agricultural themes into the landscape, public art and buildings.

<PARCEL.53> Use recycled, reclaimed and/or locally-sourced signage materials consistent with eco-business zone goals.

Figure 46. Interpretive Signage. (McKinley Arts & Cultural center. Credit: Carolyn Rosner)

6.6 Water & Wastewater Systems

Water is a limited and precious resource. Unlike energy, there are no alternatives. Within eco-business zones, water and wastewater flows are especially inter-related, as 'wastewater' can be used in many ways in business operations, from truck washing to process water.

At a parcel level, when the end-user is known, it can make sense to identify parcel-level opportunities to re-use 'wastewater' on-site or from a nearby known business, and then to consider how this might affect building and site design requirements e.g., storage. Regardless of knowledge of the end user, green building design can reduce water consumption, and, by extension, wastewater generation.

WATER CONSUMPTION PERFORMANCE TARGETS:

- Reduce potable water consumption by 30% over standard industry reference benchmarks

<PARCEL.54> Design buildings to capture and use non-potable water to displace potable water.

Non-potable water sources include stormwater, greywater, 'clean' process water such as cooling water.

Non-potable water uses include operations such as irrigation, vehicle and equipment wash-down, cooling water, process water, janitorial uses and toilet flushing.

Explore whether non-potable water sources or uses exist beyond your parcel boundary. The Town may have some insight into this, and can advise of the status of any easements or other infrastructure designed to assist such businss-to-business connections.

<PARCEL.55> Consider integration of water and energy systems e.g., can heated process water be used to support space heating requirements?

<PARCEL.56> Specify high efficient / low flow systems, fixtures and fittings.

This could apply to bathrooms, staff kitchens, process equipment, and landscape irrigation.

<PARCEL.57> Avoid single pass cooling systems.

Single-Pass Cooling Equipment is Single-Pass or once-through cooling systems use large volumes of water that circulate through equipment systems for cooling and are then discharged into municipal drainage systems. Single-pass systems use 40 times more water than a cooling tower operated at 5 cycles of concentration.

The National Vehicle and Fuel Emissions Laboratory in Ann Arbor, MI reduced water use by 80% through replacement of its single-pass cooling system with an upgraded cooling plant involving a recirculating chilled water loop. This single conservation measure saved the laboratory 94 M litres of water and $235,000 annually.

<PARCEL.58> Develop an Operations & Maintenance Manual that identifies a leak detection preventative maintenance protocol, water conservation practices, and training requirements.

The Town and Region could require submission of such a manual for site plan approval.

Figure 47. Water Reduction Strategies (Left to Right): Use of recycled water for equipment washing; drip-irrigation; purple faucet identified non-potable water; dual-use water-saving toilet)

6.7 Energy Systems

At the parcel level in an eco-business zone, the primary goals with respect to energy are to reduce demand and then meet remaining demand with renewable energy (which may or may not be generated within the parcel).

Reducing demand (increasing building and process operational energy efficiency) reduces operational costs and GHG emissions, and can help local utilities to defer costly investments in infrastructure. Many energy-efficiency measures have short paybacks.

For eco-business zones in Caledon, there may an opportunity to team with the Pearson Eco-Business Zone and Partners in Project Green to access discounts on building products designed to reduce energy consumption.

GTAA PARTNERS IN PROJECT GREEN
A PEARSON ECO-BUSINESS ZONE

Partners in Project Green (PPG) has a number of programs and initiatives to assist the business community surrounding Toronto Pearson in improving their financial and environmental performance. The Purchasing Alliance (PA) is one of the core programs available to businesses in the Pearson Eco-Business Zones to reduce the cost of implementing energy efficient technologies.

The PA negotiates reductions in the cost of energy saving products and technologies by leveraging the incremental sales opportunity our partners represent. The PA encompasses a wide variety of mechanical and building envelope products. These technologies were selected primarily for their energy-saving and GHG reducing potential.

The PA discounts are viewed as price ceilings and competition between the supplier network and other suppliers is encouraged. Reductions in cost range from 5% to 45% on various building envelope technologies, as seen in the table.

(http://www.partnersinprojectgreen.com. Contact admin@partnersinprojectgreen.com for more information)

Table 8. Purchasing Alliance Products and discount

Category	Product Types	Suppliers	Discount Range
Building Envelope Products	Solar Control Window Film	3M	15 to 30%
	Reflective Roof Coatings	Tremco	15 to 20%
	Spray Foam Roofing	BASF-PFE	25 to 35%
Central Cooling Products	Large Tonnage Chillers	Carrier	5 to 20%
	Modular Chillers	Multistack	15 to 25%
	Solar Cooling	Climatewell	15 to 25%
Lighting	Fluorescent Lamps	GE Philips Osram Sylvania	5 to 20%
	Fixtures	Acuity Cooper	5 to 20%
	LED / Solid State	Cree Lemnis Finelite	5 to 30%
Building Scale Renewables	Solar Thermal Collectors	Kingspan	35 to 50%

Overall Building Design

BUILDING ENERGY PERFORMANCE TARGETS:

As demonstrated by an energy model:

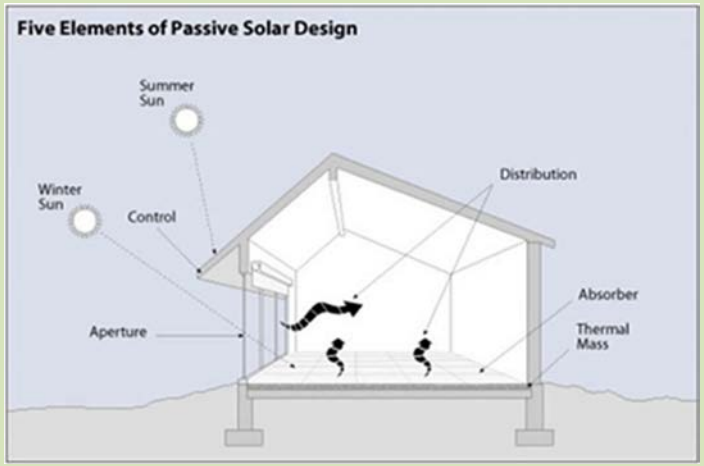
- 25% better than 1997 Model National Energy Code for Buildings; OR,
- 5% better than ASHRAE 90.1 (2010); OR,
- ASHRAE 90.1 (2010) and ASHRAE 189.1 (2009) envelope performance values.

RENEWABLE ENERGY PERFORMANCE TARGETS:

- Renewable Energy to supply 10% of total energy to the site prior to build out.

Figure 48. Building Integrated Photovoltaics. (Centre for Genomic and Oncologic Research Centre (GenYo), Spain. Credit: Onyx Solar)

<PARCEL.59> Use passive design strategies to preheat space and reduce energy demand. For example, use of Trombe Wall or Solar Wall to preheat ventilation air for buildings. Figure 49 is an example of Solar Wall installed at south side of building to harvest solar heat.



Aperture: Window area through which sunlight enters the building. Usu. faces within 30° of true south
Absorber: Exposed surface. Could consist of a masonry wall, floor, or partition (phase change material), or a water container—sits in the direct path of sunlight.
Thermal Mass: Made of materials that store heat produced by sunlight. Material below or behind Absorber.
Distribution: Natural heat transfer via conduction, convection, and radiation. Sometimes, fans, ducts, and blowers may help.
Other elements include roof overhangs, electronic sensing devices, operable vents and dampers, low-emissivity blinds, and awnings.

<PARCEL.60> Design a high efficiency building envelope that meets or exceeds the Model National Energy Code (MNEC) for Commercial / Industrial buildings.

<PARCEL.61> Where possible, generate renewable energy onsite using systems such as solar hot water heating, solar photovoltaics (PVs), solar walls, or vertical or horizontal geo-exchange loops (e.g., under large parking areas) to provide parcel energy.

Large industrial buildings result in large areas of underutilized real estate (rooftop or underground) that could be used to generate energy.

Consider that solar PVs can create a revenue stream through the Province of Ontario's FIT Program (http://fit.powerauthority.on.ca/).

Feasibility might consider such factors as:

- Soil conditions and fill requirements.
- Who would own and/or operate the system – one or a combination of the developer, the end user, the municipality, the Region, or private utility?
- For geo-exchange, can the business case be improved by connecting adjacent parcels? If so, can pipes be run in road rights-of-way, or are other easements required?
- What is the impact of the energy demand management success on the business case?

Figure 49. Solar wall installed at Mayfield Recreation Centre, Caledon. (Credit: Conserval Engineering Inc.)

Figure 50. Guelph Hydro's LEED facility (Credit: Austral Monsoon Building Products)

The Mountain Equipment Co-op store in Barrie incorporates generates power on-site via solar panels and is heated and cooled via ground-source heat pumps and a geo-exchange system. The store is 70% more efficient than a comparable retail building.

http://www.mec.ca/AST/ContentPrimary/Services/Stores/Barrie.jsp

<PARCEL.62> Investigate the potential for harnessing waste heat from cooling towers and refrigeration equipment for other processes such as space, process or air heating.

<PARCEL.63> When end user processes are known during the building design stage, ensure that process and building design are integrated and iterative to reduce overall energy demand, and to identify and capitalize on opportunities to integrate building and process energy demands e.g., Consider heat recovery from business industrial processes or even from another business in the eco-business zone to meet some of the building energy demand.

<PARCEL.64> Introduce natural ventilation such as operable windows and solar fans to reduce mechanical electric loads for heating and cooling.

<PARCEL.65> Establish central monitoring systems to facilitate measurement and comparison to benchmarks, and to ensure buildings are performing to design specifications.

<PARCEL.66> Once demand has been reduced as much as possible, and feasibility of all possible renewable energy sources and waste heat recovery options is complete, commit to purchasing green power or renewable natural gas credits or offsets.

The Town could investigate working with TRCA and Partners in Project Green to create a purchasing alliance or its own Green Power Challenge to incentivize the purchase of green power and reneweable natural gas credits.

Figure 51. Renewable Energy (Left to Right): Walmart Distribution Centre at Balzac, AB; Geo-exchange loops at Colorado College; BRC's manufacturing facility at Georgetown, ON; Testa Produce warehouse, Chicago)

Lighting and Equipment

LIGHTING POWER DENSITY PERFORMANCE TARGETS:

- For office use, target a 20% reduction beyond ASHRAE 90.1 (2007) requirement of 1W/ft^2; and
- For warehouse use, target a 20% reduction beyond ASHRAE 90.1 (2007) requirement of 0.8 W/ft^2

<PARCEL.67> Conduct sun-path analysis to determine optimal window to wall ratios that maximize use of natural light.

<PARCEL.68> Incorporate high-efficiency lighting (i.e. LEDs, T5 & T8s, CFL pot lights) to further reduce energy consumption.

<PARCEL.69> Use LEDs for exit and emergency lights.

<PARCEL.70> Use light-coloured paints for interior walls to diffuse light more efficiently.

<PARCEL.71> Use clerestorey windows, lightwells, skylights, light tubes, slit windows and other daylighting methods.

<PARCEL.72> Use light shelves to maximize daylight penetration into interior space and filter light, reduce shadows and glare.

<PARCEL.73> Integrate lighting controls and sensors to adjust lighting levels in accordance with the amount of natural light achieved through passive design strategies.

<PARCEL.74> Provide occupancy sensors for that turn lights on and off in response to presence of occupants.

<PARCEL.75> Include automatic sweeps at lighting panels to shut off non-emergency lights after hours (minimum 12 midnight to 6 am).

<PARCEL.76> Specify high efficiency HVAC and EnegyStar ™ rated equipment to reduce energy demands.

Figure 52. Use louvers and circulating fans to provide natural ventilation. (Credit: Austral Monsoon Building Products)

Figure 53. Trombe Wall can be energy efficient and aesthetic appeal. (Credit: Jeremy Levine Design)

Trombe Wall, made popular by French engineer Felix Trombe in the 1960s, but originally patented in 1881 by Edward Morse.

A Trombe wall is a sun-facing wall separated from the outdoors by glass and an air space, which absorbs solar energy and releases it selectively towards the interior at night.

A high-mass concrete or masonry wall is installed on the south side of building. Then a layer of glass or clear glazing is added a few inches apart from the mass. When the sun hits the wall, it enters through the glass or glazing and is trapped by the wall.

The Trombe wall works best in the climates that have a high temperature difference between day and night. *(http://solar.calfinder.com/blog/passive-solar/trombe-wall/)*

For more information, visit http://www.nrel.gov/docs/fy04osti/36277.pdf

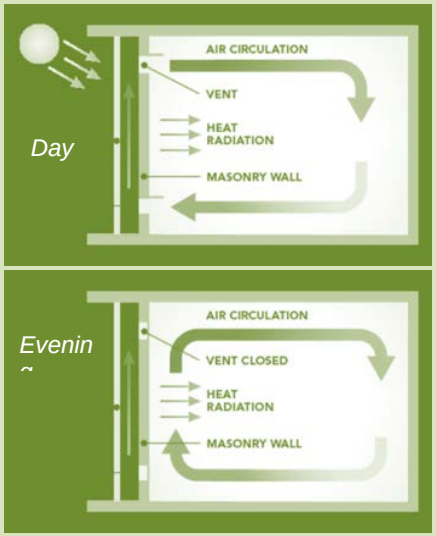


Figure 54. Concept of Trombe wall

6.8 Materials Use & Management

In an eco-business zone, waste is considered a misplaced resource – material that was paid for and that should be put to a higher value use. At the building design stage, this means designing to minimize waste, and selecting materials that incorporate recycled content and low impact substances.

At the parcel level, construction often generates significant wastes. Within an eco-business zone, the goal is to minimize the generation of this waste and then to ensure that any remaining waste is diverted for recycling or reuse.

Sourcing high quality durable materials that are available with the local market area can also minimize the impact of materials use. By selecting sustainable and durable materials the lifespan of buildings is extended, supports the local supply chain and economy while reducing environmental impacts associated with the extraction, manufacturing and transport of those materials.

In addition, an eco-business zone sets the stage for long-term business collaboration (or synergies) that adds value to waste and increase circular flows of materials.

Design Stage

MATERIAL SOURCING PERFORMANCE TARGETS:

- Integrate recycled material content into buildings or as part of site landscape features, with an aim to achieve a minimum of 20%.
- Incorporate at least 20% locally and regionally sourced materials located within 1200 km (800 miles) via ship or rail or 800 km (500 miles) via truck (from extraction site or manufacturer to the development site). Figure 57 highlights the areas within 800 km and 1200 km radius taken Town of Caledon as the centre.
- Use rapidly renewable materials for a minimum of 2.5% of the total building materials and products used in the project.

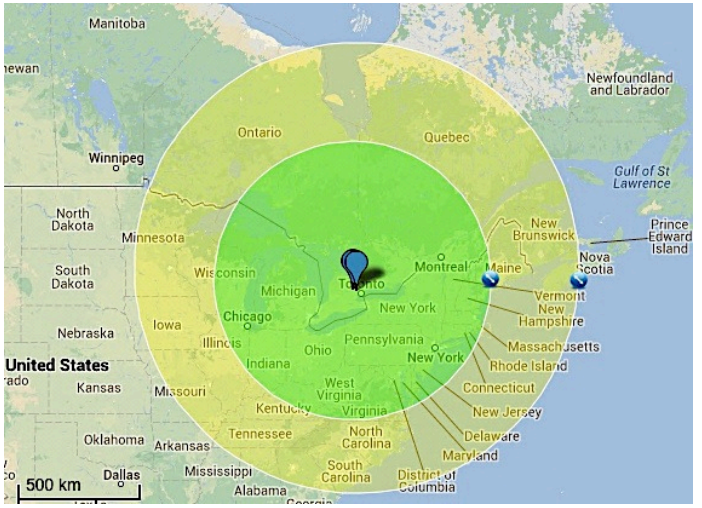


Figure 55. 800 km (green) and 1200 km (yellow) Radius Map (Credit: Google Map)

<PARCEL.77> Plan to deconstruct, rather than demolish, any existing buildings to ensure that materials can be recovered and re-used.

<PARCEL.78> Design landscape and buildings to re-use site or previous building materials where possible.

<PARCEL.79> Design buildings to provide appropriate storage and sorting to help end users increase operational recycling.

<PARCEL.80> Specify locally and regionally-sourced materials early in conceptual planning stages and ensure local and regionally sourced material targets are being achieved through specifications at construction stages.

<PARCEL.81> Where possible, specify materials that are lower impact than business-as-usual e.g., recycled content or no volatile organic compounds.

Online resources such as EcoSpex (www.ecospex.com) or GreenWizard (www.greenwizard.com) can help to identify and compare products.

<PARCEL.82> Communicate goals and targets to quantity surveyor early in the integrated design process

<PARCEL.83> Use quality, durable and sustainable materials to help differentiate the front of the building from the more utilitarian uses that are oriented toward the back.

<PARCEL.84> Design for deconstruction, also referred to as Design for Disassembly, to ensure that the design of buildings or products allow for future changes and the eventual dismantlement (in part or whole) for recovery of systems, components, and materials. This design process includes developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal.

Construction Stage

CONSTRUCTION WASTE PERFORMANCE TARGETS:

- Achieve a 75% diversion rate for construction waste from the land fill

<PARCEL.85> Define the target requirement as part of the construction tender to implement construction waste management and recycling program.

<PARCEL.86> Provide recycling containers for excess materials including wood, concrete, plastics and metal.

<PARCEL.87> Provide dedicated space and facilities for exterior recycling storage that is clearly marked and easily accessible.

<PARCEL.88> Require the general contractor to identify a reputable hauler and review all receiving facilities in advance of construction.

<PARCEL.89> Require the general contractor to include on-site training briefs to address construction waste diversion requirements. This can be addressed as part of the regular on-site orientation and workplace safety meetings.

* For further tools and supporting guides refer to *The Little Green Site Book: The Construction Worker's Pocket Guide to Green Building* published by Light House Sustainable Building Centre.

Figure 56. Little Green Site Book: The Construction Worker's Pocket Guide. (Light House)

6.9 Additional Resources and Information

Trombe Wall

- Trombe Walls in Low-Energy. Buildings: Practical Experiences, National Renewable Energy Laboratory, July 2004. http://www.nrel.gov/docs/fy04osti/36277.pdf
- Meadowlarke Builders website, http://www.meadowlarkbuilders.com/green-building/advanced-building-techniques/passive-energy-strategies

Crime Prevention through Environmental Design

- CPTED (pronounced "sep-ted") incorporates urban design approaches to crime prevention strategy utilized by planners, architects, police services, security professionals and everyday users of space.
- For an overview of techniques and approaches see http://www.cptedontario.ca/

Passive Design Strategies

- Case study of applied passive design approaches for a commercial warehouse. http://www.colorcoat-online.com/file_source/StaticFiles/Colorcoat%20Online/pdf/eco_factory.pdf
- Whole Building Design Guide: Warehouses http://www.wbdg.org/design/warehouse.php
- Whole Building Design Guide: Passive Design http://www.wbdg.org/resources/psheating.php?r=warehouse

Building Integrated Photo Voltaic (BIPV)

- Eiffert, Patrina and Kiss, Gregory J. "Building Integrated Photovoltaic Designs for Commercial and Institutional Structures: A sourcebook for Architects". This sourcebook provides an excellent overview of the BIPV with supporting case studies, design approaches and cost benefit analysis. The case studies and design briefs provide technical data about the BIPV systems that have been used including the systems weight, size, and efficiency. http://www.nrel.gov/docs/fy00osti/25272.pdf

Landscape and Open Space

- Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways, USDA National Agroforestry Center. This publication provides over 80 illustrated design guidelines synthesized and developed from a review of over 1400 research publications. Each guideline describes a specific way that a vegetative buffer can be applied to protect soil, improve air and water quality, enhance fish and wildlife habitat, produce economic products, provide recreation opportunities, or beautify the landscape. http://nac.unl.edu/buffers/docs/conservation_buffers.pdf
- The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009, American Society of Landscape Architects. This document includes criteria for sustainable land practices that will enable built landscapes to support natural ecological functions by protecting existing ecosystems and regenerating ecological capacity. http://www.sustainablesites.org/report/Guidelines%20and%20Performance%20Benchmarks_2009.pdf
- The Case for Sustainable Landscapes provides a set of arguments - economic, environmental, and social - for the adoption of sustainable land practices, American Society of Landscape Architects. http://www.sustainablesites.org/report/The%20Case%20for%20Sustainable%20Landscapes_2009.pdf

Energy-efficient Building Materials

- 10 Cutting-edge, Energy-efficient Building Materials by Rebecca Fairley Raney, http://home.howstuffworks.com/home-improvement/construction/green/10-cutting-edge-building-materials.htm#page=10

Green Roof

- City of Toronto Green Roof Web Page: Toronto Green Roof By-law, Green Roof Biodiverse Guidelines, Green Roof Construction Standards. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=3a7a036318061410VgnVCM10000071d60f89RCRD

  - Cool roof alternative to the Green Roof requirements for industrial buildings: http://www.toronto.ca/legdocs/by-laws/2011/law1381.pdf
  - Technical amendments to the Green Roof Requirements: http://www.toronto.ca/legdocs/by-laws/2012/law1598.pdf
- Green Roofs for Healthy Cities: Provide standards in support of the development of the green roof industry. Design guidelines approved by ANSI have been developed for Fire, Wind Uplift and Root Repellency. http://www.greenroofs.org/

Water

- US Environmental Protection Agency Sustainable Water Infrastructure
  http://water.epa.gov/infrastructure/sustain/availability_wp.cfm

Waste

- Reducing Waste in the Construction Industry (including toolkit)
  http://www.metrovancouver.org/services/solidwaste/businesses/constructionwaste/Pages/default.aspx

- 3Rs for Construction and Demolition Projects. Ontario Ministry of Environment and Recycling Council of Ontario
  http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_080783.pdf

Section 7: Hypothetical Eco-Business Zone Case Study: Coleraine Drive West Employment Land

7

7.1 Introduction to Coleraine West Case Study

To facilitate an appreciation for the guidelines presented in the previous section, a hypothetical Caledon case study was created. This case study considers what the Coleraine Drive West Employment Lands ("Coleraine West"), shown in Figure 57, *might* look like if the subdivision planning, infrastructure, and parcel development guidelines were applied. No concept planning or feasibility analysis was completed, although the Coleraine West context was considered where possible. As such, the case study represents more of an aspirational vision than a concept plan. The hypothetical case study for Coleraine West takes into account current knowledge of site conditions and current policy.

Given its employment lands designation, Coleraine West is a suitable location for an eco-business zone case study, and is of a scale that could support sustainable infrastructure systems such as stormwater management ponds, waste/recycling areas, bio-swales and even areas for renewable energy supply. This is a hypothetical, illustrative exercise only executed at a pre-concept level. The study area is defined by Coleraine Drive to the east, Mayfield Road to the south, the industrial precinct to the north and the western concession line that divides the site from the northern boundary to Mayfield Road. The area is generally flat and characterized by privately owned agricultural lots and a few private residences. Coleraine West also includes an Environmental Policy Area (EPA2) that straddles the western concession line and a Special Policy Area (SPA) that has been reserved for a future GTA Highway or transportation corridor on the southerly portion of the area and existing road network.

It is also important to recognize that no two eco-business zones will be developed the same. Site influences, market conditions, existing policy and regulations (and the flexibility of staff to support deviations), and the developer's personality will all influence the final product – and the development proforma. Furthermore, it is not possible to implement all of the guidelines in one project, as some are contradictory. In addition, the uptake of some guidelines now might be low due to current technology costs, but ten years from now, technological and design advances may make it cost effective. For example, consider that a decade ago, industrial rooftop greenhouses were almost risible, but now, there are several North American firms that have successfully commercialized such installations. In addition, the availability of government or utility incentives, which can greatly influence the feasibility of implementing many water and energy-related guidelines, is somewhat fluid, even over the development timeline of a single employment land area.

An integrated design process (see Section 3) is key and should underpin even a concept plan. Such a process can help to find synergies between street, site and building orientation; identify more efficient land uses (looking above and below surface, double-loaded); and integrate stormwater management with open space and the public realm. An integrated design process will also help to anticipate and address barriers to innovation that might occur later in the cycle, by engaging professionals and municipal staff with expertise and interest in many different stages of the full planning and development cycle.

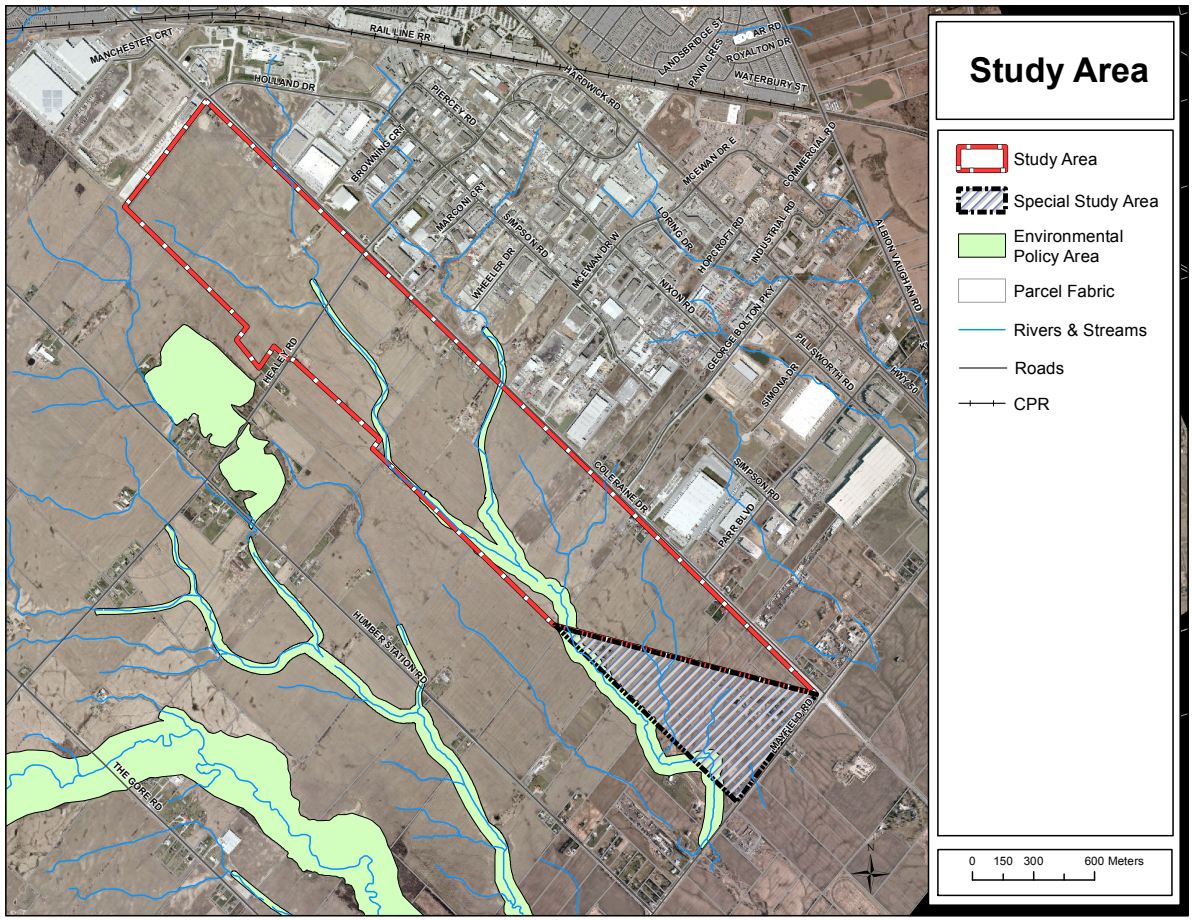


Figure 57. Coleraine West Hypothetical Case Study Area

Prior to initiating the actual planning for eco-business zones, it is important to undertake a thorough site investigation to understand natural and community characteristics that will influence site structure and layout. Natural site characteristics such as soils, geology, topography, flora and fauna should be considered when formulating the site structure and layout. Surrounding community characteristics include land uses, built form, heritage and culture.

The Town and any developer should commit to an integrated design process (see Section 3) from the outset of any actual planning, design, technical study or related work on Coleraine West. This will ensure elements such as energy / wastewater, or street orientation / site orientation / building orientation or use of space (integrating above and below ground functions), are addressed from an integrated systems perspective.

7.2 Coleraine West: Existing Conditions

As of mid-2013, Coleraine West can be characterized as follows:

Location / Topography

Coleraine West is strategically located adjacent to the Bolton Rural Service Area and provides excellent transportation access to nearby Provincial Highways, the intermodal facilities and Pearson International Airport.

The topography in Coleraine West is generally flat, with a maximum grade change of 25 metres from the northern to southern boundary over a distance of 4,130 metres (slope=0.6%). In future, an analysis of existing site grades, hydrology, vegetative coverage and natural drainage patterns will help the Town and the Developer's design team to use the natural drainage patterns to their advantage. The hypothetical case study will generally consider this existing topography.

Site Design Influences

The adjacent South Simpson Industrial Secondary Plan exhibits a block and street pattern that will be similar to what is being proposed for the Coleraine West Secondary Plan. Characteristic of the South Simpson Industrial Secondary Plan, the road network is used to define the perimeter of blocks and those blocks sites are subdivided using a variety of lot sizes to accommodate various business and development activities. In the context of Coleraine West, the hypothetical case study site structure and street network should reflect the surrounding road network, while respecting other elements such as the Environmental Policy Areas and natural systems.

Land Uses

Coleraine West is characterized by agricultural land uses interspersed with rural residential dwellings. Some of the existing farms and parcels are not actively being used for agriculture or remain vacant. There are a few residential/farm buildings that have been identified as having heritage or cultural value. A number of houses within the proposed employment lands have been identified for listing.

A competitive analysis study of various economic sectors was completed by urbanMetrics Inc. in 2006 and concluded that the Town of Caledon should focus on attracting the following industrial and commercial activities:

- Manufacturing and advanced manufacturing (of industrial machinery, fabricated structural metal, plastic products, and food)
- Professional, Scientific and Technical services (including engineering services, research and development, and high technology & media services)
- Transportation and Logistics (freight warehousing and logistic services and general and specialized freight services)

It should also be noted that, as part of the overall strategy to accommodate employment growth throughout the region, the Ministry of Transportation has identified a Preliminary Study Area for the proposed transportation corridor commonly known as the Greater Toronto Area West (GTA West) corridor. The "Special Study Area" boundary is defined within Schedule "C" of the Proposed Regional Plan Amendment. The hypothetical case study will consider the uses recommended by the urbanMetrics study, as well as the presence of this Special Study Area.

Adjacent Land Uses

The South Simpson Industrial Secondary Plan area is immediately east of Coleraine West. The South Simpson Industrial Secondary Plan area accommodates a variety of industrial and employment uses on parcels ranging from 0.5 acres (0.2 ha) to10 acres (4 ha). The majority parcels are less than 5 acres (2 ha) in size, which are not suitable for larger-scale developments. Prestige Industrial sites (Zoned MP) are generally fronting along Coleraine Drive, with general industrial zoning designation for interior lots. The hypothetical case study will consider the presence of these adjacent uses, especially those right along Coleraine Drive.

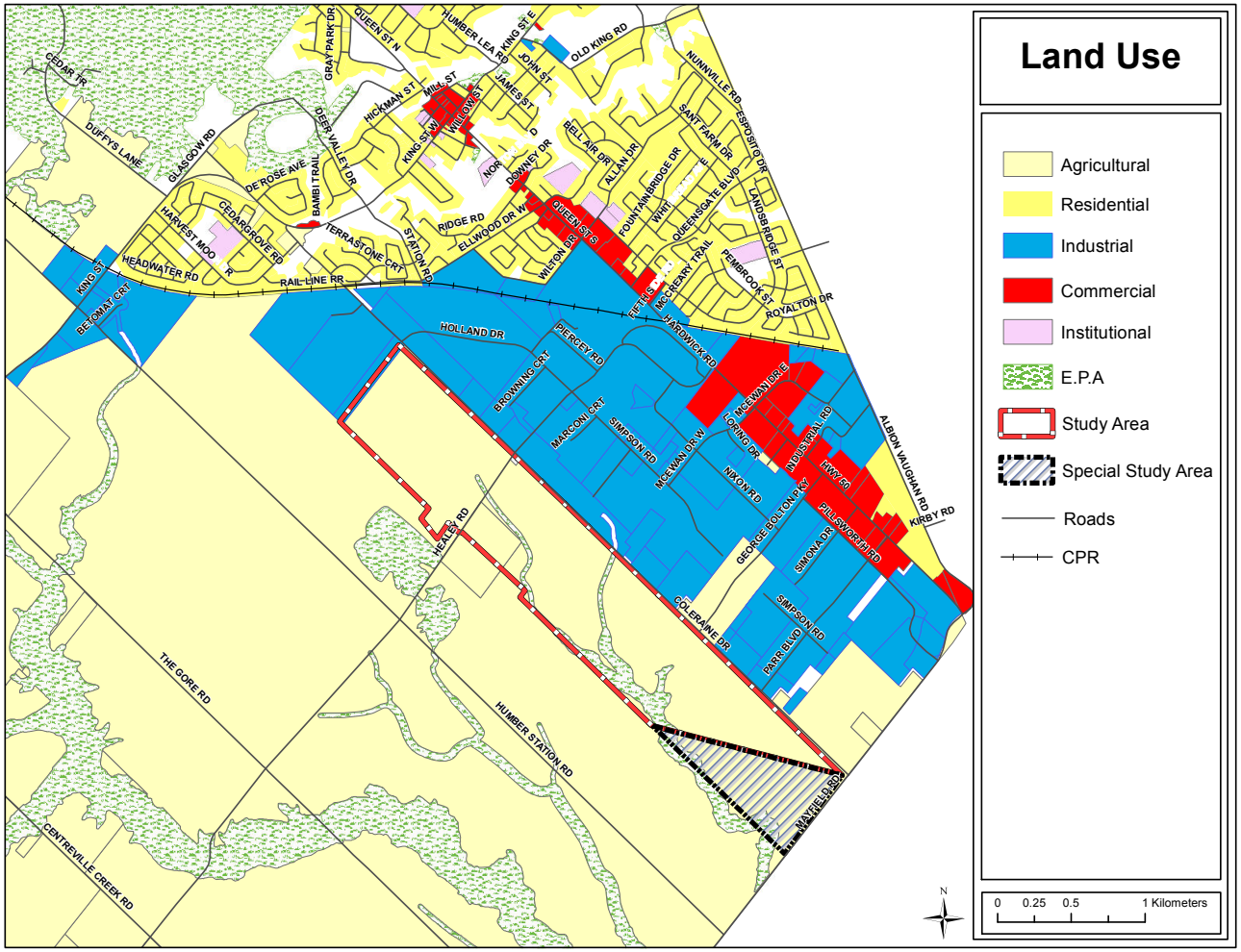


Figure 58. Land Use Map of Coleraine Drive West and surrounding area

Environmental Policy Areas

As shown in Figure 59, Coleraine West contains designated Environmental Policy Areas, which will play a significant role in shaping the development of Coleraine West. Within Coleraine West, south and west of Bolton, there are several small headwater streams that are part of the larger West Humber River Sub-Watershed. These watercourses are designated as Environmental Policy Areas (EPA 2) in the Caledon Official Plan. An Environmental Policy Area (EPA 2) meanders from the northern edge of the study area straddling the western boundary of the site to the southern boundary along Mayfield Road.

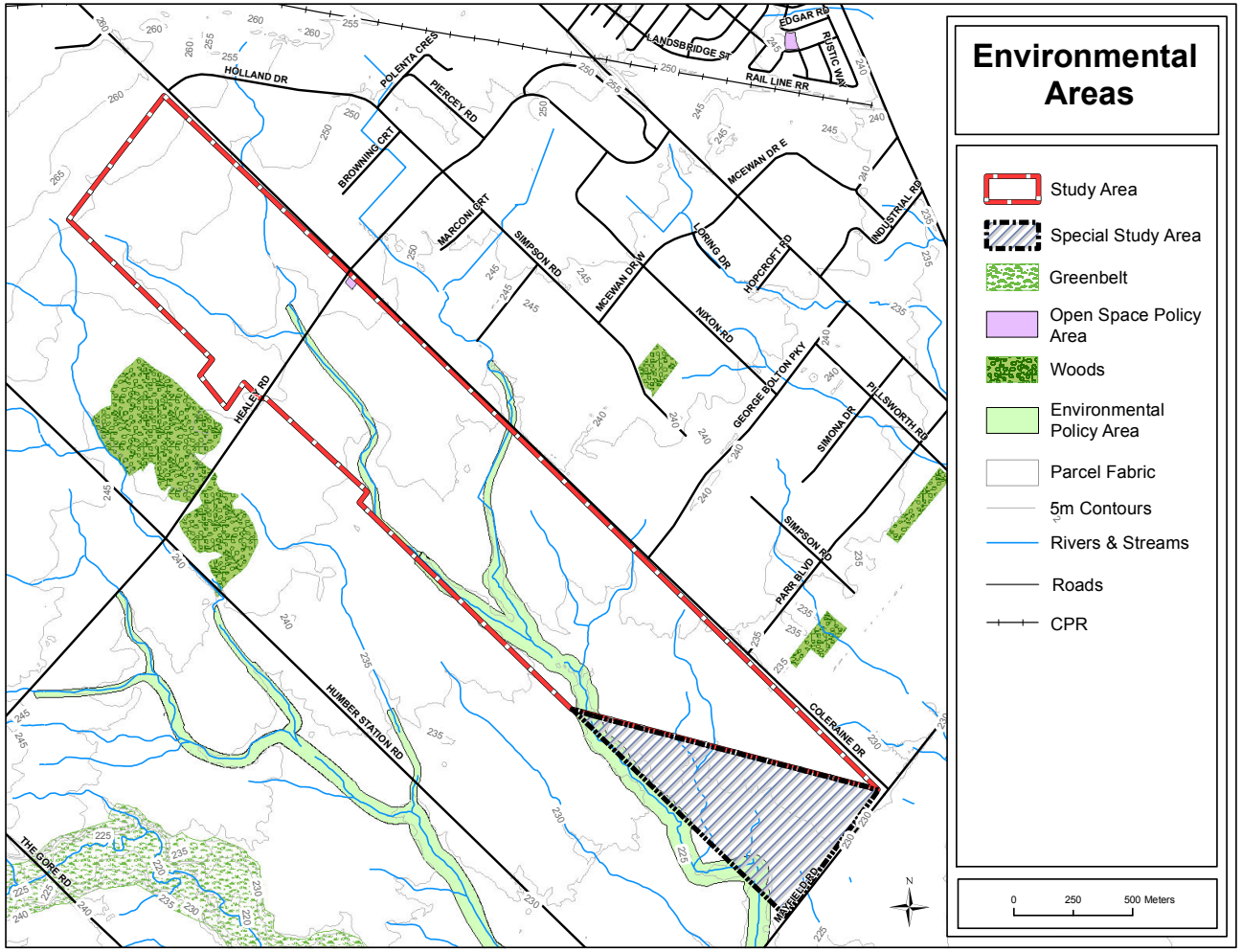


Figure 59. Existing Environmental Areas within Coleraine West.

The Toronto Region Conservation Authority (TRCA) Valley and Stream Corridor Management Program requires that a riparian habitat be retained or (re) established where absent. The riparian zone should be a minimum 10 metre wide vegetated area located on each side and directly adjacent to the banks of the watercourse channel, as per the TRCA Valley and Stream Corridor Management Program (October 28, 1994). Section 11 of the Town of Caledon's Zoning By-law requires that there be a minimum setback of 3 m from an Environmental Policy Area 2 for driveway or parking. Under the existing Town of Caledon zoning by-law definitions, there is allowance for "Environmental Management" which may include wetland restoration and creation, vegetative planting, enhancement and rehabilitation". The objective is to ensure that surrounding development improves both the ecological, environmental performance of defined areas while allowing some opportunity for natural aesthetic enhancement. These areas should be protected and incorporated into open space framework, a goal reflected in the hypothetical case study.

7.3 Case Study

A. Hypothetical Land Use & Overall Layout

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine Eco-Business Zone
• EPAs as defined by TRCA • Uses set forth in UrbanMetrix study • Special Study Area • Focus on very large parcels	Baseline, ***plus***: • Prestige Industrial • Aquaculture, greenhouse, recycling, locally-serving commercial, public / public-private utilities • Greater diversity of parcel size • Surplus land in Special Study Area for potential innovative uses

As projected by Caledon's economic development studies, Coleraine West is anticipated to be home to a mix of manufacturing and advanced manufacturing; professional, scientific and technical services; and transportation and logistics uses, varying from SMEs to large multinationals (e.g., Canadian Tire). Coleraine West will also include a large Environmental Policy Area; publicly owned stormwater management areas; and public and private utility uses. In addition, there could be an option to incorporate some ancillary commercial uses to create better integration with the surrounding community, and to provide amenities for Coleraine West employees are proposed. A variety of lot sizes are also proposed to meet the diversity of uses and activities allowed in Coleraine West.

The Province will have completed its plans for a highway interchange for the Special Policy Area in the south. The Town could consider exploring uses of the surplus land in that area to integrate that area with innovative infrastructure e.g., stormwater management or energy generation utilities.

Prestige industrial uses would be situated along Coleraine Drive, to match those already established on the east side, and Healey Road. Prestige industrial uses would mirror the Prestige Industrial Uses within the existing South Simpson Industrial Secondary Plan area.

Figure 60 illustrates a ***hypothetical*** land use plan; the future actual land use plan will require the usual background studies; detailed planning and engineering studies; financial studies; etc., and, of course, would be underpinned by an IDP.

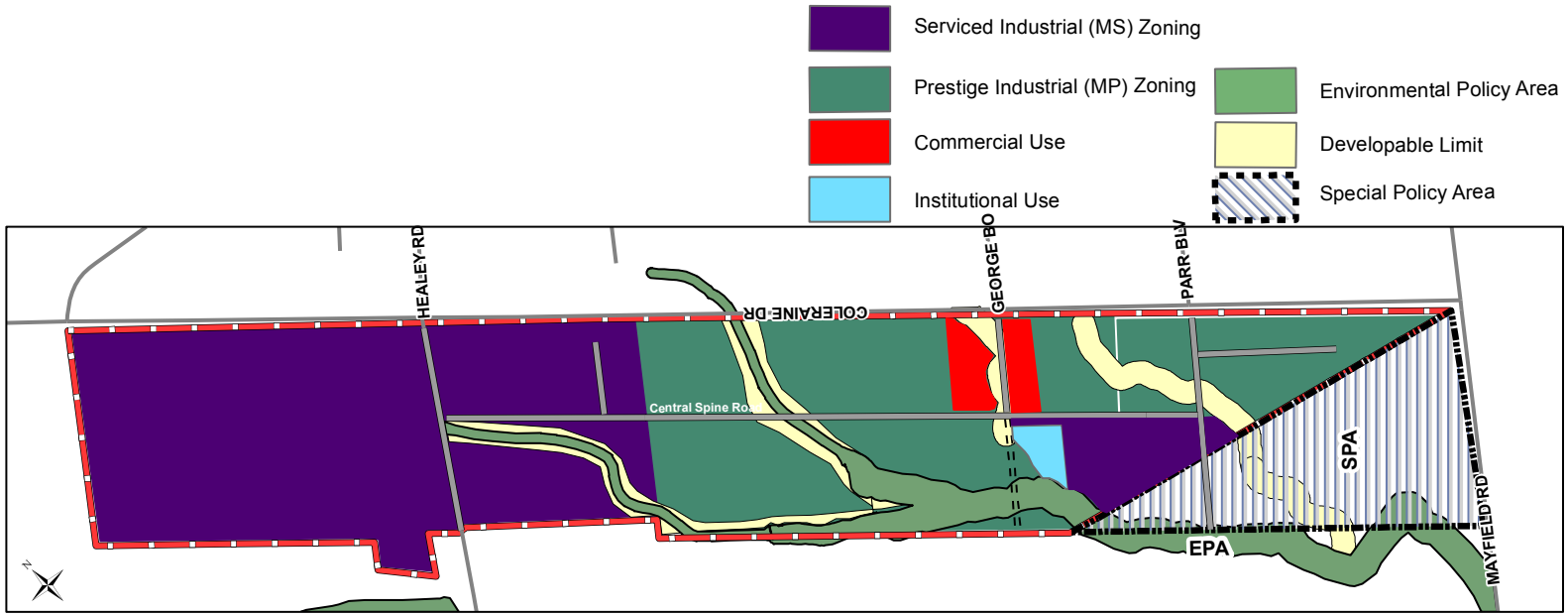


Figure 60. Hypothetical Land Use Plan for Coleraine West Case Study

B. People and Goods Movement

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine Eco-Business Zone
• Limit new access off Coleraine Drive • Standard No. 206 or 208 or 209 Local Industrial Road • No trails. Sidewalks along both sides of all roads.	• Internal spine road and new extensions to maximize accessibility and integrate this area with surrounding uses • Alternative cross section for internal roads, accommodating LID and possible district energy or business-to-business exchanges • Site-wide integrated bicycle and pedestrian trail network (gravel) linking the subdivision to surrounding trails and neighbourhoods. • Additional trails adjacent to EPAs • Sidewalks on both sides of all roads, except Coleraine Drive West,

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine Eco-Business Zone
	which is already partially developed on one side. In general, if pedestrian traffic is not significant then having a sidewalk on one side of the road is a reasonable trade-off. • Adopt Envision™ sustainable infrastructure rating system or Greenroads™ rating system (See Section 5.7) • High recycled-content and locally-sourced materials for infrastructures (e.g. roads, sidewalk and trails). • Pavements are long-life, and permeable in 25% of the site. • Less than 10% cut and fill difference • Monitoring program to measure pavement condition every 2 years

Coleraine West would likely accommodate multi-modal goods and people movement, as fitting for an eco-business zone. Several new roads / extensions would thus connect Coleraine West to the existing transportation network, creating safe and efficient movement within as well as into and out of Coleraine West, and helping to integrate the eco-business zone with surrounding uses. To maximize accessibility within the area and respect the Town's desire to limit new access off Coleraine Drive, an internal spine road is proposed. As a result, buildings along Coleraine Drive 'face' into Coleraine West, necessitating the use of visual treatment and landscaping to maintain a high aesthetic along Coleraine Drive.

Figure 61 shows the proposed transportation network and possible road improvements within the case study area. The road design in Coleraine West would differ from the standards in place in 2013 (as reflected in the design guidelines). The road rights-of-way may be redesigned / reconfigured to better accommodate Low Impact Development stormwater management (see next section, C. Open Space, Landscape and Stormwater Management) and increase pedestrian / cyclist movement; and right-sized to minimize resource use while still allowing for safe traffic flow.

Figure 62 and Figure 63 show some hypothetical (but aspirational) alternative cross-sections for Industrial / Commercial Collector Streets, Local Industrial Streets and Private Access Streets to Industrial Subdivision.
Note: These are not engineered designs but represent the vision for Coleraine West.

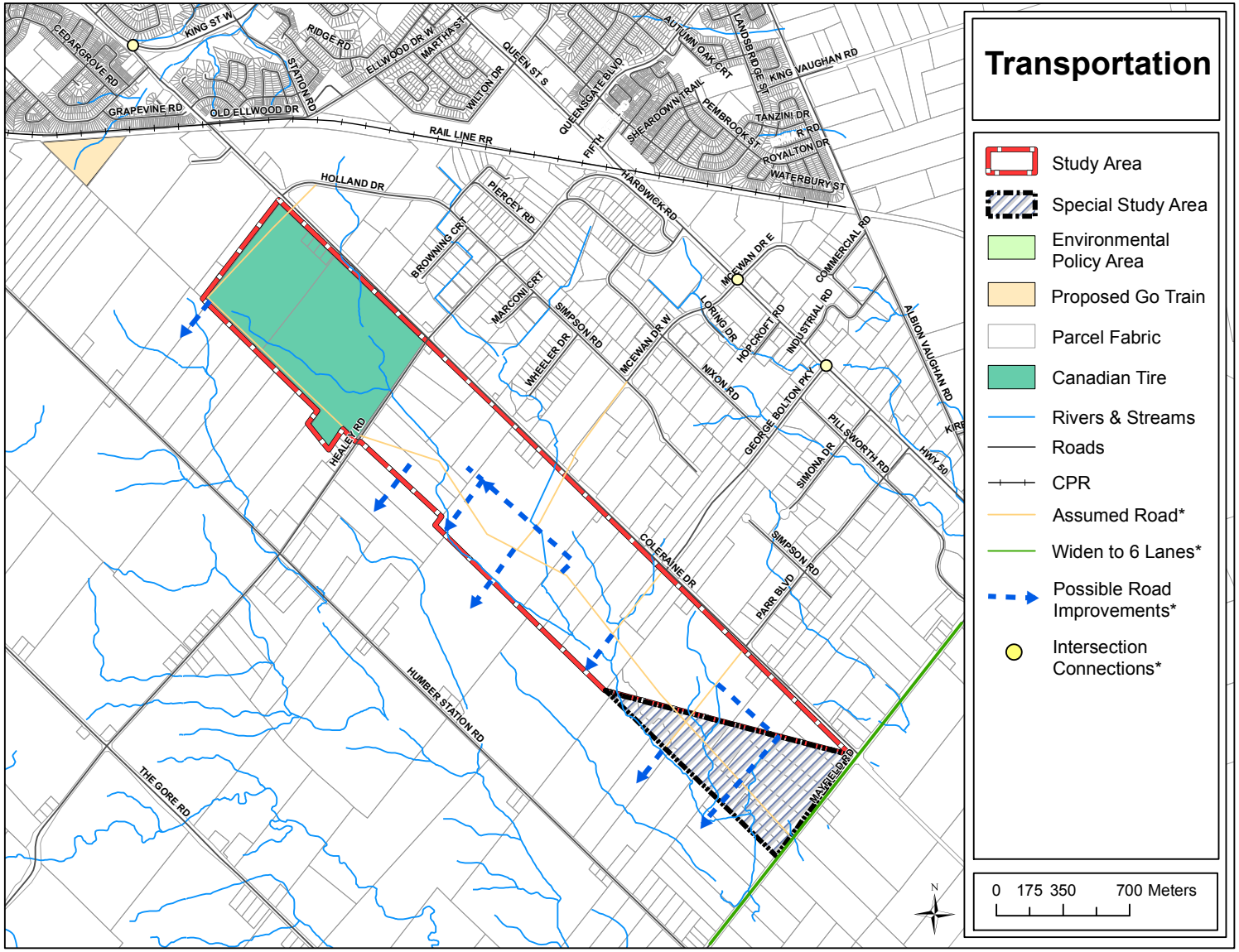


Figure 61. Hypothetical Transportation Network in the Coleraine West Case Study

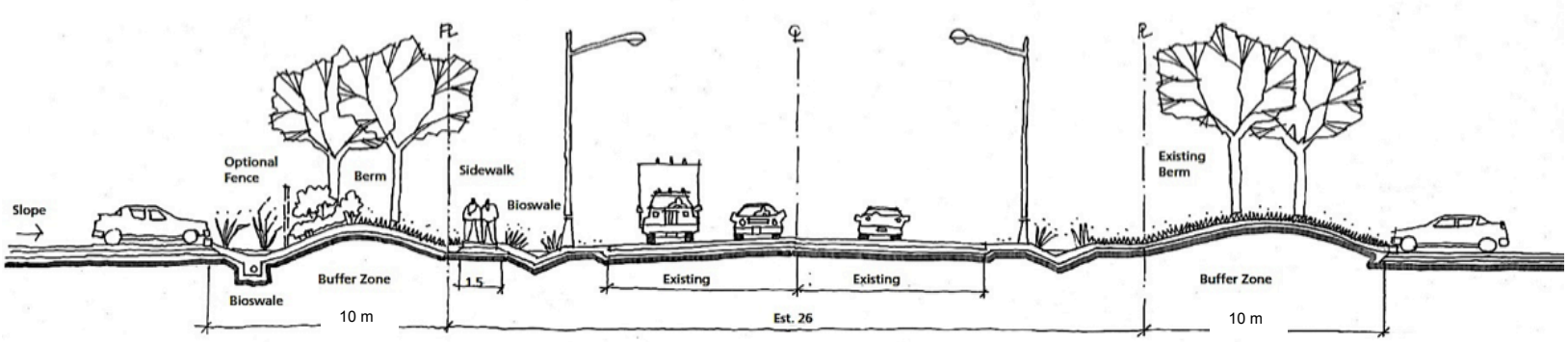


Figure 62. Sketch of Hypothetical Coleraine Drive Cross-Section

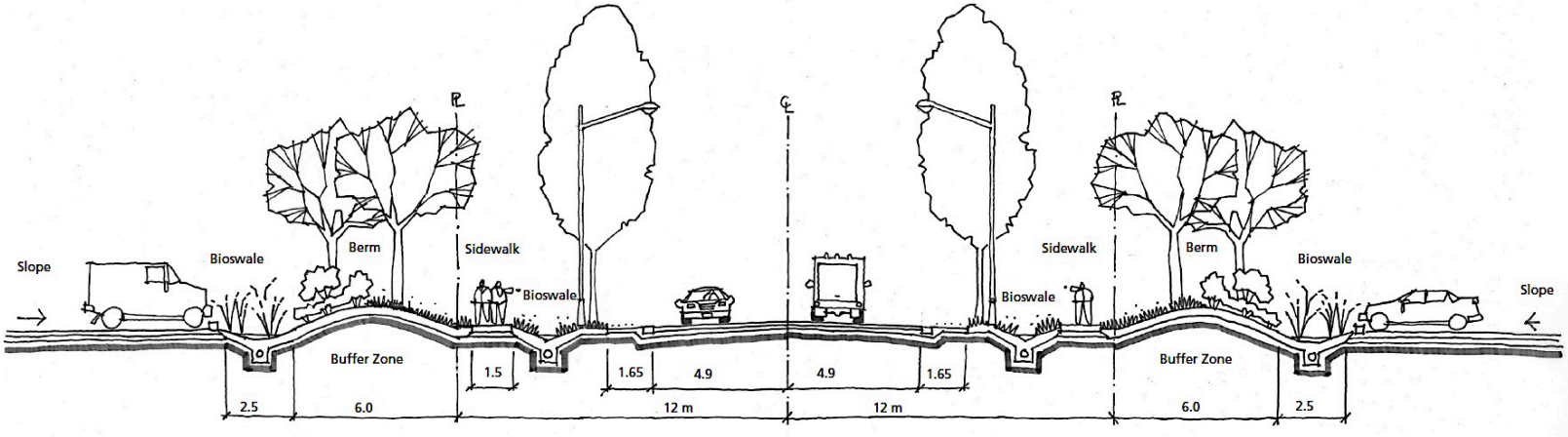


Figure 63. Sketch of Hypothetical Industrial Collector Road (Internal) Cross-Section

The hypothetical Coleraine West case study would incorporate a site-wide integrated bicycle and pedestrian trail network; businesses would be ensured safe and easy connectivity from their buildings to the network and provided bicycle facilities for their employees.

Figure 64 illustrates a hypothetical bicycle, pedestrian and trail network for Coleraine West.

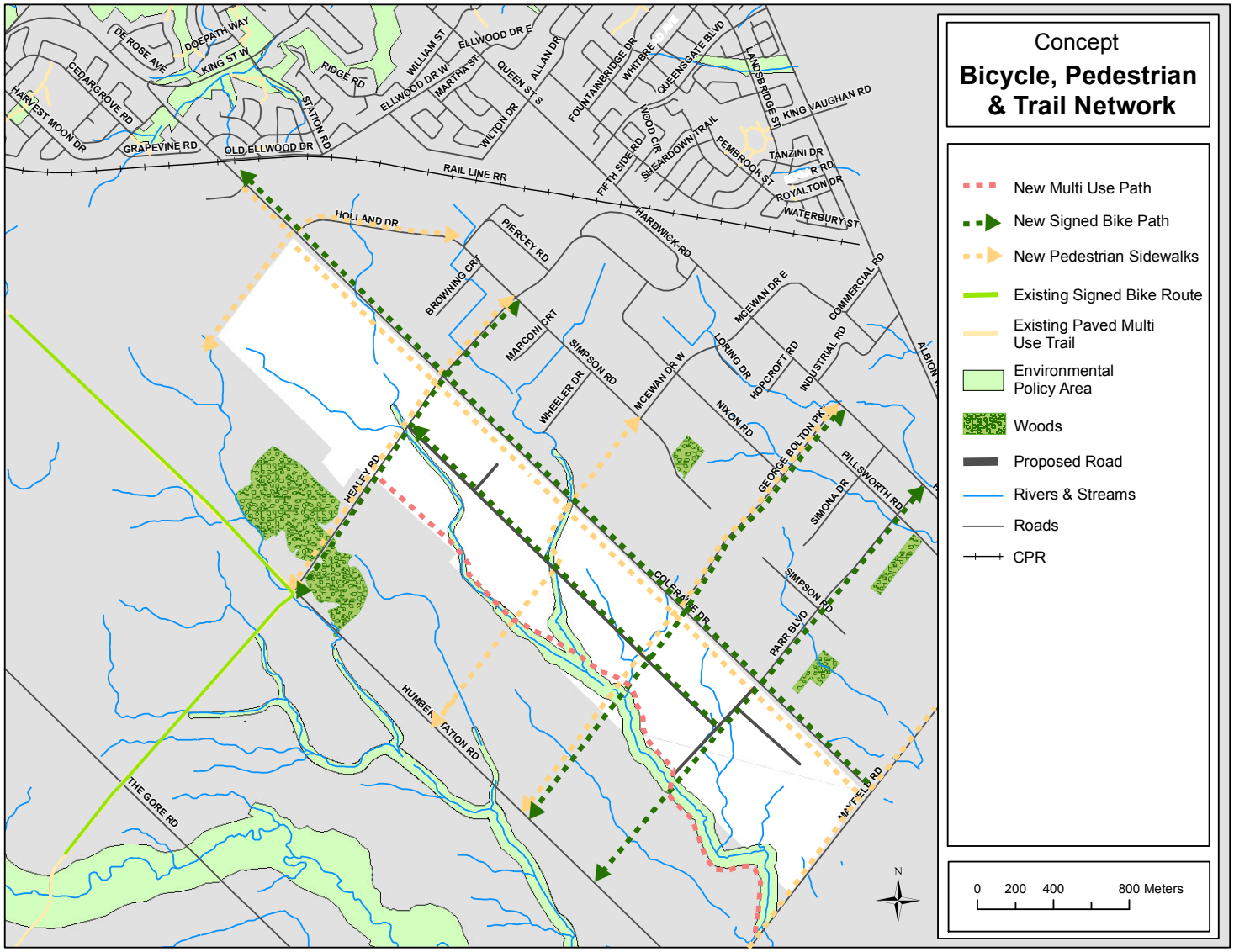


Figure 64. Hypothetical Bicycle, Pedestrian and Trail Network in Coleraine West Case Study

The hypothetical case study assumes that, at the time it was preparing its tenders for infrastructure design or preparing agreements for developers to deliver infrastructure design, the Town would have decided to require shadowing or compliance with the Envision™ sustainable infrastructure rating system or Greenroads™ rating system (See Section 5.7) for their sustainable roadway and transportation infrastructure projects. Therefore, the hypothetical eco-business zone roads and infrastructure would include the most recycled content of any employment lands road in Ontario. Pavements would be long-life, and permeable in 25% of the site and local sourcing would be significantly greater than for other projects. The difference between cut and fill is proposed to be less than 10% of the average total volume. As per its Greenroads™ requirement, the Town would measure pavement condition every 2 years to gain a better understanding of the impact of design and construction decisions made within the eco-business zone, maximizing the learning and innovation spin-off potential from the eco-business zone.

C. Open Space, Landscape and Stormwater Management

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine Eco-Business Zone
Public Open Space & Landscape • Protect EPA	Public Open Space & Landscape • EPA as 'visual buffer' between existing agricultural uses and the future industrial uses. • Integrated multi-use trail as a physical buffer between EPA and stormwater management ponds. • Parcels adjacent to major arterial streets to provide a 12.0 m landscape setback, which includes a berm and bioswale with attractive riparian and native plantings.
Stormwater • A collection system of curbs and gutters, catch basins, underground PVC pipes, and concrete manholes. • No stormwater treatment (possibly some oil / water separators in large parking areas) • No reclaimed stormwater uses	Stormwater • A collection system of vegetated swales, with culverts underneath driveways. • LID best practices on individual lots. • Some cisterns or underground cells for on-site storage and use of reclaimed stormwater • Several centralized engineered stormwater management ponds located on public lands, designed for passive treatment and controlled discharge. • Ecologically designed to maintain and maximize native water bird, amphibian and invertebrate habitat. • Integration with a site trail system, as a public amenity. • Reclaim stormwater for irrigation or truck washing on-site

The presence of the EPA and the significant stormwater management objectives for Coleraine West e.g., managing 1 in 200 year storm events, are two of the biggest factors shaping the hypothetical Coleraine West case study. The case study public open space framework could be focused along the EPA 2, which straddles the westerly boundary. This would provide a 'visual buffer' between existing agricultural uses and the industrial uses moving into the area.

The hypothetical case study assumes that, the Town and TRCA will study the pros and cons of consolidated stormwater management ponds versus distributed (i.e., parcel level) stormwater management, and support consolidated stormwater management ponds. Such a study could conclude that a consolidated pond system will be easier to maintain and that there is a chance that distributed systems could affect the marketability of Coleraine West. A hypothetical illustration of consolidated ponds and possible subdivision plan for Coleraine West case study is shown in Figure 65.

Figure 65. Hypothetical Consolidated Stormwater Management Ponds in Coleraine West Case Study

In the hypothetical case study, 100% of stormwater would be managed *within* Coleraine West; Coleraine Drive is not used to convey stormwater generated from within Coleraine West. LID practices and ecological design would dominate stormwater management design at the municipal infrastructure *and* parcel scales. As per best LID practices, swales and driveways would exist in harmony through the use of simple practices like culverts. Due to some challenges with infiltration e.g., soil conditions, the Town may work with several of the parcel developers to incorporate on-site large event storage, such as via blue roofs and parking lots.

The cross section sketch below shows the hypothetical relationship between the stormwater management pond and the EPA, in which a multi-use trail is incorporated as a physical buffer between the stormwater ponds and the EPA. In the hypothetical case study, the stormwater ponds would be partially located within the development limit but provide a minimum 10-metre setback from the edge of the EPA. *Note: This cross section does not represent an engineered design.*

Figure 66. Example of stormwater management pond designed to integrate into the overall surroundings. (TaigaNova EIP, AB)

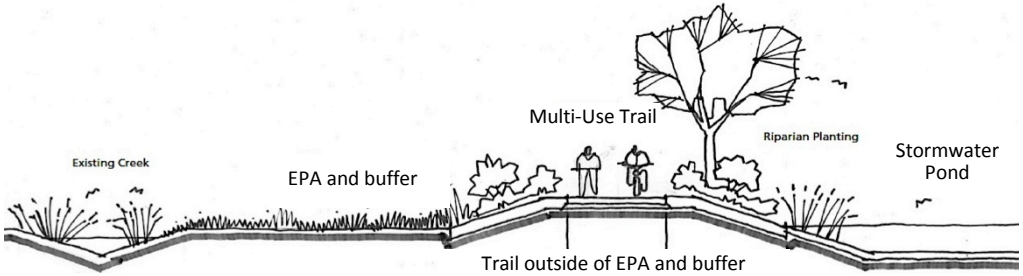


Figure 67. Hypothetical sketch showing EPA relationship to trail and storm pond (cross-section)

In the hypothetical case study, parcels adjacent to major arterial streets could provide a 12.0 m landscape setback, which includes a berm and bioswale with attractive riparian and native plantings.

To reflect the agricultural heritage of the area, and integrate with surrounding uses, edible landscape may be provided along the EPA buffer with interpretative signage. Hypothetically speaking, such landscape could be developed in partnership between TRCA and a local community food non-profit formed in response to TRCA's call for proposals, and the area could draw educational groups several times a year.

D. Water and Wastewater Systems

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine Eco-Business Zone
Water and Wastewater Systems • Water treatment plant off-site • No Demand Side Management (DSM) guidelines or programs • Network of underground pipes beneath the roadway • Wastewater treatment plant off-site • Sanitary connection to existing sewer main.	Water and Wastewater Systems • Water treatment plant off-site • Significant DSM measures (e.g., via compliance with guidelines) and programs (e.g., hypothetical future Partners in Project Green programs) • Network of underground pipes • Possible wastewater cascading (business-to-business connections) • Possible Sewer Heat Recovery (see E. Energy System) • Some stormwater reclamation for irrigation and truck washing (see C. Open Space, Landscape and Stormwater Management)
Buildings (impacting water and wastewater systems) • Typical building design practices • Typical use of water, natural gas, electricity • Typical generation of wastewater	Buildings (impacting water and wastewater systems) • Greener building design practices • Reduced use of water (30% less), natural gas and electricity, and reduced generation of wastewater through the application of required and optional design guidelines.

In meeting the performance targets established by the parcel development design guidelines and implementing the guidelines (and participating in Partners in Project Green programs), the buildings in Coleraine West will be expected to consume 30% less water (and generate 30% less wastewater) for basic sanitary uses than the 2013 business-as-usual case. The reduced water consumption and wastewater generation would help to free up capacity elsewhere in the system and reduce / defer some downstream capital investments.

In the hypothetical case study, it is assumed that the Town and Region would decide against pursuing distributed wastewater treatment due to the infrastructure already in place in and around Coleraine West. Hypothetically, depending on the water usage profile of actual parcel uses, the Town may consider a reclaimed wastewater treatment plant, and its cost could possibly be reduced as a result of water efficient designs. The hypothetical case study does not assume that there will be a distributed wastewater treatment plant, but does assume that there would be some business-to-business wastewater cascading and increased on-site water recycling. For example, one large logistics business, which has its own onsite truck wash, could hypothetically recycle 90% of its wash water on-site. In addition, as noted in the Wastewater description, in the hypothetical case study there would be some limited stormwater reclamation, which offsets potable water use. Due to the overriding objective to respect and restore the natural hydrologic cycle in this area, LID design would dominate stormwater management in the hypothetical Coleraine West case study. Due to low permeability of soils, storage of stormwater would become more important. In the hypothetical case study, several parcels wouldstore stormwater onsite e.g., via blue roofs, parking areas, cisterns or underground cells, and occasionally draw on this source for irrigation, industrial processes, or truck washing.

E. Energy Systems

Baseline – Business-As-Usual Employment Lands	Hypothetical Case Study – Coleraine West Eco-Business Zone
Energy Systems • No building owners or businesses purchase green power • Conventional electrical and natural gas servicing	Energy Systems • Conventional electrical and natural gas servicing • 20% businesses purchase green power and renewable energy credits (participation in hypothetical Partners in Project Green program), results in GHG emissions reduction • Allowance for energy utilities as a use in this area to encourage on-site renewable energy systems • Allowance for district energy piping in the road right-of-ways • Potential bio-gas plant being explored
Buildings (as impacting energy) • Typical construction materials, such as: - Steel - Cast-in-pace concrete - Rigid form insulation - Roofing - Lumber - Double-pane Window • Typical construction practices • Typical building design practices • Typical use of water, natural gas, electricity • Typical generation of wastewater	Buildings (as impacting energy) • Greener construction materials, such as: - Recycled steel - Insulating concrete forms - Plant-based Polyurethane rigid form - Light-colored or high reflective roofing (cool roofing) - Recycled wood / Plastic Composite Lumber - Low-E Windows • Greener construction practices • Greener building design practices • 25% less energy demand than business-as-usual case through greener building design and participation in hypothetical Partners in Project Green programs • Reduced use of water (30% less), natural gas and electricity, and reduced generation of wastewater through the application of required and optional design guidelines and participation in (hypothetical future) Partners in Project Green programs

In the hypothetical Coleraine West case study, overall demand for thermal and electrical energy would be 25% less than the 2013 business-as-usual case, via application of the optional and required parcel development guidelines and through participation in (hypothetical future) Partners in Project Green programs. Hypothetically speaking, 20% of the businesses would be encouraged to opt in to purchasing green power and renewable energy credits. As a result, the Town would be able to claim progress in meeting its community energy emissions reduction targets.

As noted in the land use and layout, the hypothetical case study assumes that energy utilities would be allowed in Coleraine West and district energy piping in its road rights-of-way, making it easier for a private utility owner to build a hypothetical Sewer Heat Recovery Plant, which would recover heat from the 750mm trunk sewer on Coleraine Drive and provides latent heat energy to off-set heating loads for buildings in the area. The Town will debate making connection to the SHR system mandatory, but the private utility owner would be able to 'pre-sell' enough load to several of the parcel owners.

In the hypothetical case study, the Town and another private utility partner would jointly investigate establishing a bio-gas plant, given the large proportion of agricultural land uses adjacent to Coleraine West.

While some developers may not be able to implement rooftop solar technologies during their design phase, the hypothetical case study assumes that TRCA and the Town would continue to work with the building owners to encourage rooftop solar retrofits through Partners in Project Green and other governmental incentive programs.

Overall carbon footprint would be reduced via the application of the design guidelines, which encourage practices such as the use of greener construction materials (reduced embodied and transportation-related carbon); greener construction (reducing equipment fuel consumption); and green building design (reduced embodied and operational energy).

Hypothetical Case Study for Coleraine West: Summary of Elements

The following table summarizes the description of the hypothetical case study for Coleraine West Eco-Business Zone. This summary will form the basis of the triple bottom-line evaluation presented in the next section.

Table 9. Summary of Hypothetical Coleraine West Eco-Business Zone Case Study Description

Element	Baselines – Business-As-Usual Employment Lands	Case Study – Coleraine Eco-Business Zone
Land Uses	• EPAs as defined by TRCA • Uses set forth in UrbanMetrix study • Special Study Area • Focus on very large parcels	Baseline, ***plus***: • Prestige Industrial • Aquaculture, greenhouse, recycling, locally-serving commercial, public / public-private utilities • Greater diversity of parcel size • Surplus land in Special Study Area for potential innovative uses

Element	Baselines – Business-As-Usual Employment Lands	Case Study – Coleraine Eco-Business Zone
People and Goods Movement	• Limit new access off Coleraine Drive • Standard No. 206 or 208 or 209 Local Industrial Road • No trails. Sidewalks along both sides of all roads.	• Internal spine road and new extensions to maximize accessibility and integrate this area with surrounding uses • Alternative cross section for internal roads, accommodating LID and possible district energy and business-to-business exchanges (linear corridors) • Site-wide integrated bicycle and pedestrian trail network (gravel) linking the subdivision to surrounding trails and neighbourhoods. • Additional trails in adjacent to EPAs • Sidewalks on both sides of all roads • Adopt Envision™ sustainable infrastructure rating system or Greenroads™ rating system • High recycled-content and locally-sourced materials • Pavements are long-life, and permeable in 25% of the site. • Less than 10% cut and fill difference • Monitoring program to measure pavement condition every 2 years
Public Open Space & Landscape	• Protect EPA	• EPA as 'visual buffer' between existing agricultural uses and the future industrial uses. • Integrated multi-use trail as a physical buffer between EPA and stormwater management ponds. • Parcels adjacent to major arterial streets to provide a 12.0 m landscape setback, which includes a berm and bioswale with attractive riparian and native plantings.
Stormwater Management	• A collection system of curbs and gutters, catch basins, underground PVC pipes, and concrete manholes. • No stormwater treatment (possibly some O/W separators in large parking areas) • No reclaimed stormwater uses	• A collection system of vegetated swales, with culverts underneath driveways. • LID best practices on individual lots. • Some cisterns or underground cells for on-site storage and use of reclaimed stormwater • Several centralized engineered stormwater management ponds located on public lands, designed

Element	Baselines – Business-As-Usual Employment Lands	Case Study – Coleraine Eco-Business Zone
		for passive treatment and controlled discharge. • Ecologically designed to maintain and maximize native waterbird, amphibian and invertebrate habitat. • Integration with a site trail system, as a public amenity. • Reclaim stormwater for irrigation or truck washing on-site
Water and Wastewater Systems	• Water treatment plant off-site (conventional municipal system) • No Demand Side Management guidelines or programs • Wastewater treatment plant off-site (conventional municipal system) • Sanitary connection to existing sewer main.	• Water treatment plant off-site (conventional municipal system) • Wastewater treatment plant off-site (conventional municipal system) • Significant DSM measures (e.g., via compliance with guidelines) and programs (e.g., hypothetical future Partners in Project Green programs) • Possible wastewater cascading (business-to-business connections) • Possible Sewer Heat Recovery (see Energy) • Some stormwater reclamation for irrigation and truck washing (see Stormwater)
Energy Systems	• No building owners or businesses purchase green power • Conventional electrical and natural gas servicing	• Conventional electrical and natural gas servicing • 25% less energy demand than business-as-usual case through greener building design and participation in hypothetical Partners in Project Green programs • 20% businesses purchase green power and renewable energy credits (participation in hypothetical Partners in Project Green program) • Reduced GHG emissions • Allowance for energy utilities as a use in this area • Allowance for district energy piping in the road right-of-ways • Potential bio-gas plant being explored

Element	Baselines – Business-As-Usual Employment Lands	Case Study – Coleraine Eco-Business Zone
Buildings	• Typical construction materials, such as: - Steel - Cast-in-pace concrete - Rigid form insulation - Roofing - Lumber - Double-pane Window • Typical construction practices • Typical building design practices • Typical use of water, natural gas, electricity • Typical generation of wastewater	• Greener construction materials, such as: - Recycled steel - Insulating concrete forms - Plant-based Polyurethane rigid form - Light-colored or high reflective roofing (cool roofing) - Recycled wood / Plastic Composite Lumber - Low-E Windows • Greener construction practices • Greener building practices • Reduced use of water (30% less), natural gas and electricity, and reduced generation of wastewater through the application of required and optional design guidelines and participation in (hypothetical future) Partners in Project Green programs

Table 10. Hypothetical Case Study Completed Guideline Checklist (Subdivision Planning and Infrastructure Design Only)

Eco-Business Zone Subdivision Planning

Section		Guideline Reference	Description of Guideline	Described in the Case Study	Comment
aaaa4.2 Land Use & Subdivision Layout	Overall Land Use	SUBDIV.1	Accommodate a variety of land uses to help facilitate economic growth and employment consistent with the policy directions set forward in the Places to Grow Act targets for the Town of Caledon.	●	
		SUBDIV.2	Accommodate land uses that facilitate innovative eco-business uses and activities within the area.	●	
		SUBDIV.3	Where Prestige Industrial is to be accommodated, cluster this use along highly visible exterior or 'gateway' areas; adjacent to commercial or residential uses; or near environmental features that may enhance the aesthetic of prestige industrial buildings.	●	
		SUBDIV.4	Locate larger or more intensive industrial and business uses that result in heavier traffic and noise along major arterial roads.		Applicable but not described
		SUBDIV.5	Ensure the types and location of land uses are compatible with adjacent land uses especially agriculture and residential.	●	
		SUBDIV.6	Integrate sustainable land use patterns to leverage efficient use of transportation and supporting infrastructure	●	
		SUBDIV.7	Provide an appropriate mix of complementary and integrated land uses that support efficient use of all infrastructure systems	●	
		SUBDIV. 8	Where feasible, include common employee amenity areas. These might include bicycle parking, parks, and indoor / outdoor picnic areas.	●	
	Shape and Pattern	SUBDIV.9	Provide a range of lot sizes to address current and future demands for small (i.e. 1-5 acres), medium (5-15 acres) and large (greater than 15 acres) lots.	●	
		SUBDIV.10	Optimal subdivision layouts are achieved by providing a lot frontage to depth ratio of 1:1.5.		Applicable but not described
		SUBDIV.11	Lot frontage should be a minimum of 30 metres to ensure sufficient room for "front of house" active uses (office, reception, assembly and display), visitor parking, and side yard driveway to rear loading bays.		Applicable but not described
		SUBDIV.12	Allow for smaller lots (i.e. between 0.50 to 3 acres) to facilitate a limited amount of finer grain local commercial and retail services uses to serve the area.	●	
		SUBDIV.13	Corner lots at major intersections will provide gateways into the site and should be larger in size to accommodate higher-end uses that celebrate building and landscape sustainability features.		Applicable but not described
4.3 Access & Movement Framework	Street Network	SUBDIV.14	The street network shall provide safe, comfortable and efficient movement for all current and projected modes of transporting people and goods.	●	
		SUBDIV.15	Street network should be designed to be double-loaded to maximize the number of access points and reduce total amount of street construction and associated site disturbance.	●	
		SUBDIV.16	Create a road network that facilitates parcel and building orientation to take advantage of passive solar gain.		Applicable but not described
		SUBDIV.17	Locate land uses and businesses that generate high traffic and truck volumes in close proximity to defined truck routes.		Applicable but not described
		SUBDIV.18	Street networks shall al be designed to accommodate future transit services. Wherever possible, streets alignments should attempt to avoid encroaching or intersecting with Environmental Policy Areas.	●	Uses culverts

Section		Guideline Reference	Description of Guideline	Described in the Case Study	Comment
		SUBDIV.19	Street alignments should provide efficient and safe access to newly developed parcels within the site with clear sight lines between driveway entrances and the street.		Applicable but not described
		SUBDIV.20	Proposed street networks within Greenfield sites should integrate seamlessly with the existing street network pattern to provide continuity of movement and increased legibility.	●	
		SUBDIV.21	Plan for "right-sized" road rights-of-way, minimizing carriageways while still maintaining safe goods and people movement.		Applicable but not described
		SUBDIV.22	Minimizing carriageways reduces stormwater generation and greenhouse gas emissions. Wider / flared corners can accommodate a narrower carriageway while still providing for safe turning radii.		Requires technical Study
		SUBDIV.23	Plan to incorporate innovative eco-business infrastructure within the road right-of-way where possible to multiply environment benefit and reduce overall construction costs.		Applicable but not described
	Active Transportation	**SUBDIV.24**	Provide sidewalks, designed to provide universal design and accessibility, along one side on local industrial roads and both sides on collector roads.	●	
		SUBDIV.25	Create space for dedicated cycling routes to provide safe and easy access to, from and within the eco-business zone.	●	
		SUBDIV.26	Provide direct, comfortable and safe pedestrian and bicycle connections to nearby transit stops.	●	
4.4 Public Open Space & Stormwater Management Framework		**SUBDIV.27**	Preserve and enhance riparian, wetland, and buffer areas to improve flood control and water quality, stabilize soils, control erosion, and provide wildlife corridors and habitat.	●	
		SUBDIV.28	Plan for stormwater retention and wet ponds to be primarily contained within public lands. This will reduce requirements for distributed stormwater ponds within private parcels, which can affect parcel marketability and can result in uneven maintenance.	●	
		SUBDIV.29	Plan for stormwater retention and wet ponds that mimic naturally occurring wetlands.	●	
		SUBDIV.30	Use landscape to punctuate street-end views and provide amenity and interest including public art, water features and special plantings.		Applicable but not described
		SUBDIV.31	Wherever possible, protect and preserve existing vegetation and mature trees as part of the development.		Applicable but not described
		SUBDIV.32	Provide adequate buffers between new development and Environmental Policy Areas, as defined by TRCA stream protection guidelines.	●	
		SUBDIV.33	Incorporate multi-use trails which can provide additional landscape buffer and improve integration of open space and amenity.	●	

Eco-Business Zone Infrastructure Design

Section		Guideline Reference	Description of Guideline	Described in the Case Study	Comment
5.2 Land Use and Overall Infrastructure Layout		INFRAS.1	Minimize cut-and-fill requirements by working with the natural landscape and drainage patterns as much as possible.	●	
		INFRAS.2	Cluster or co-locate utility systems to promote potential synergies and waste exchanges between different infrastructure systems, and to minimize utility lot dedications.		Requires technical study
5.3 Transportation, Access & Movement	Street Design	INFRAS.3	Street alignments should provide efficient and safe access to newly developed parcels within the site with clear sight lines between driveway entrances and the street.		Applicable but not described
		INFRAS.4	"Right-size" road rights-of-way, minimizing carriageways while still maintaining safe goods and people movement.		Applicable but not described
		INFRAS.5	Maximize the ability of road rights-of-way to accommodate general municipal and eco-business infrastructure, reducing overall construction costs and multiplying environmental benefits.		Applicable but not described
		INFRAS.6	Implement PV powered pedestrian and street lamp-standards that are designed to enhance night time visibility while reducing light pollution and night sky lighting.		Applicable but not described
		INFRAS.7	All lighting to be high-efficiency (LED or solar) to further reduce energy consumption. Investigate the use of integrated micro-wind turbines and solar PV lighting to further reduce energy		Applicable but not described
		INFRAS.8	Ensure that designated cycling routes have appropriate signage and road stencils to indicate that the road is a shared space. Cycling route design shall meet the requirements set forward by the Town of Caledon.	●	
	Utilities	INFRAS.9	All utilities except transformers, switching and terminal boxes, meter cabinets and other utility boxes that require more frequent maintenance access should be placed below grade.		Applicable but not described
		INFRAS.10	Combine lot services corridor zones for two or more parcels sharing a property line where timing of development is suitable.		Applicable but not described
		INFRAS.11	Service access points should be located within 12 to 18 inches within the gravel edge of the street apron. Inspection manholes (maintenance holes) are located at the property line and protected by easement.		Applicable but not described
5.4 Public Open Space, Landscape & Stormwater Management	Open Space, Landscape and Stormwater Infrastructure Guidelines	INFRAS.12	Locate and design open space to function as an employee amenity for more than one lot.	●	
		INFRAS.13	Design landscape to incorporate planting materials, soils and sub-soils to help increase absorption, infiltration and retention as well as increase evapotranspiration of precipitation.	●	
		INFRAS.14	Use landscape design to punctuate gateways and street-end views by designing landscape features that provide amenity and interest including public art, water features and special plantings.		Applicable but not described
		INFRAS.15	To help define the newly emerging employment lands, punctuate the key intersections of streets entering the proposed employment areas with high quality landscape treatment.		Applicable but not described
		INFRAS.16	Create continuity of landscape treatment and outdoor amenity areas as much as possible with those on adjacent parcels.		Applicable but not described
		INFRAS.17	Integrate ecological features and functions, as well as 'walkable nature' into landscape design.	●	
		INFRAS.18	Use or adapt native species where landscaping is required.	●	

Section		Guideline Reference	Description of Guideline	Described in the Case Study	Comment
		INFRAS.19	Incorporate interpretative education features into the landscape design to link it with the overall eco-business zone vision.		Applicable but not described
		INFRAS.20	If possible, plan to salvage native plants during the construction phase for re- use onsite or elsewhere.		Applicable but not described
		INFRAS.21	Where possible incorporate the site's natural materials in landscape or open space features, such as trees or large rocks removed during construction.		Applicable but not described
		INFRAS.22	As much as possible, utilize LID methods for quantity and quality control.	●	
		INFRAS.23	Consider targeting stormwater flows post-eco-business zone build out that are equal to original natural flows.		Applicable but not described
		INFRAS.24	Pursue integrated stormwater management design that captures and treats as much volume of rainwater at the source before being conveyed into regional or municipal stormwater infrastructure.		Requires technical study
		INFRAS.25	Prevent or minimize generation, mobilization, and transport of common stormwater pollutants and watershed-specific pollutants of concern to receiving waters, including surface water and groundwater, and combined sewers or stormwater systems.		Applicable but not described
		INFRAS.26	Avoid stormwater drainage to adjacent tributaries.		Applicable but not described
		INFRAS.27	Design stormwater storage ponds to integrate into the overall landscape, provide open space amenity, and/or provide natural heritage educational opportunities in addition to its functional value of storing water.	●	
		INFRAS.28	Design stormwater retention and wet ponds to mimic naturally occurring wetlands, with a mix of native plantings that provision riparian habitat that is appropriate for local wetland conditions.	●	
		INFRAS.29	Prepare a sediment and erosion control plan specific to the site, that conforms to local erosion and sedimentation control standards and regulations.		Applicable but not described
	Integration & enhancement of EPAs with open space	**INFRAS.30**	Design the shape and form of stormwater management systems and wet ponds to mimic naturalized ponding patterns to reflect and compliment the meandering shape of the EPA as much as possible.	●	
		INFRAS.31	Provide a riparian-planted edge along stormwater ponds and bio-swales to improve rainwater run off quality by helping to filter toxins and sediments.	●	
		INFRAS.32	Incorporate trees that provide shade over streams and ponds to help keep cooler.		Applicable but not described
5.5 Water & Wastewater Systems		**INFRAS.33**	Right-size water and wastewater infrastructure, accounting for the best available knowledge of actual projected water consumption, taking into account the types of businesses known or likely to be in the eco-business zone; projected reclaimed wastewater or stormwater usage; and green buildings.		Applicable but not described
		INFRAS.34	Pursue designs and technologies that reduce energy, water, and materials consumption compared to the "business-as-usual" situation.	●	
		INFRAS.35	Evaluate the feasibility of a distributed wastewater treatment plant, which can facilitate reclaimed wastewater use.	●	Central system in place
		INFRAS.36	Require consideration of the Parcel Development Guidelines for infrastructure such as pump/lift stations.		Applicable but not described
		INFRAS.37	Where feasible, consider innovative wastewater collection systems, such as small bore sewer™ systems.		Applicable but not described

Section	Guideline Reference	Description of Guideline	Described in the Case Study	Comment
	INFRAS.38	Accommodate the future conveyance of reclaimed wastewater (including business-to-business exchanges) and reclaimed stormwater from any 'hard' systems.	●	
	INFRAS.39	Use trenchless pipe technology to minimize site disturbance where appropriate. Select the least disruptive, available technologies for installing stormwater, sanitary sewer or combined storm/sewer lines based on current best practice.		Applicable but not described
	INFRAS.40	Ensure that wastewater infrastructure design integrates with energy systems design to support the viability of sewer heat recovery (see Energy Systems).	●	
5.6 Energy Systems	**INFRAS.41**	Evaluate the feasibility of district energy systems to support building heating and cooling requirements, as well as perhaps support some process energy requirements. Implement such systems where feasible.	●	Requires technical study
	INFRAS.42	Evaluate the feasibility of installing horizontal geo-exchange systems under publicly-owned lands. Implement such systems where feasible.		Requires technical study
	INFRAS.43	Evaluate the feasibility of installing solar photovoltaic arrays and wind turbines on publicly-owned lands. Implement such systems where feasible.		Requires technical study
	INFRAS.44	Consider infrastructure to support the use of alternative fueled vehicles such as charging stations for electric vehicles (ideally powered by solar energy) and stations offering biofuel.		Applicable but not described
	INFRAS.45	Within public rights-of-way, implement high efficiency light standards that incorporate the use of photovoltaic and micro-wind turbines that are integrated within the same lamp standard.		Applicable but not described
5.7 Material Use & Management	**INFRAS.46**	Require consideration of Parcel Development materials use and management guidelines for any buildings housing infrastructure		Applicable but not described
	INFRAS.47	Re-use site materials where possible for infrastructure construction e.g., aggregate, landscape features.	●	
	INFRAS.48	Where possible, specify materials containing recycled content. A target of a minimum 10% recycled material content for road base, pavement, sidewalks, concrete pipes, structural elements, sediment and erosion control would be consistent with recycled material contents for LEED certified buildings.	●	
	INFRAS.49	Where possible, specify materials that are lower impact than business-as-usual selections e.g., pervious or high volume fly-ash concrete, or weldable HDPE versus PVC piping.	●	

7.4 Triple Bottom Line Costs & Benefits

The hypothetical case study for Coleraine West described in Section 7.2 presents a qualitative, aspirational vision demonstrating what the application of the present guidelines might look like. As no concept planning or design was completed, the hypothetical case study is not quantitative. Similarly, while some background technical information exists for the area[1], it is not possible to construct a quantitative baseline for Coleraine West that reflects the baseline described in the hypothetical case study summary table. Both a quantitative case study *and* a quantitative baseline (i.e., the completion of actual technical background studies plus a concept plan involving some actual pre-design) are required to quantitatively compare the hypothetical case study to a "business-as-usual" baseline. Nevertheless, the following section illustrates the types of benefits that would be anticipated as a result of the choices made for the development of this hypothetical eco-business area.

Triple Bottom Line – Concept

Triple bottom line (TBL) is an accounting framework that incorporates three dimensions of performance: social, environmental and financial. This differs from traditional reporting frameworks as it includes ecological (or environmental) and social measures that can be difficult to assign appropriate means of measurement. The TBL dimensions are also commonly called the three Ps: people, planet and profits. This framework was formulated by John Elkington in 1994.

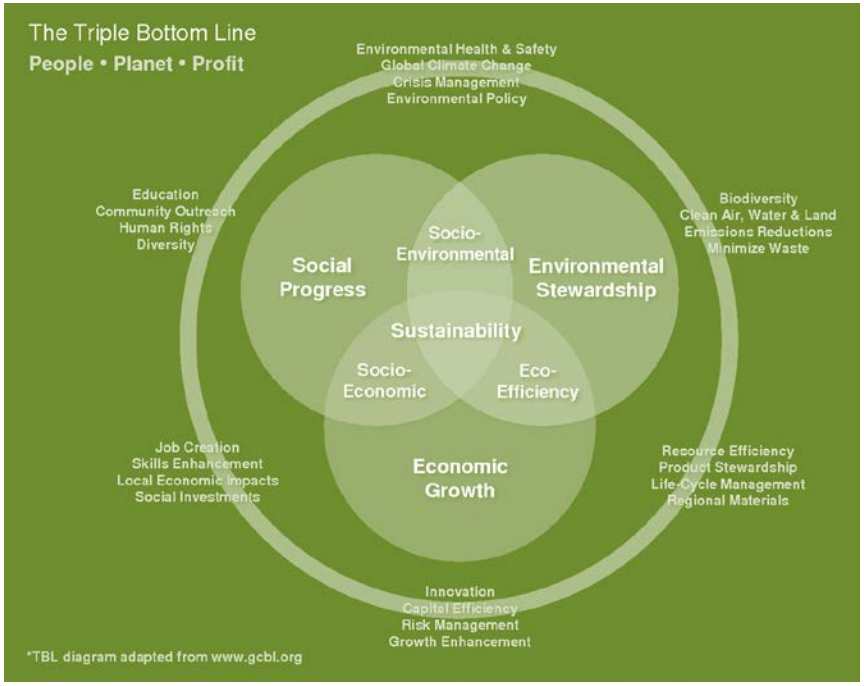


Figure 68. Concept of Triple Bottom-Line (Source: www.gcbl.org)

[1] The Town commissioned a fiscal impact statement, completed by Watson & Associates, and a transportation study, completed by Paradigm Transportation Solutions Ltd. However, due to several uncertain elements, particularly those within regional or Provincial jurisdiction, the Town advised that neither of those studies could be relied upon for this project.

Triple Bottom Line – General Assessment

Municipal governments are responsible for over 60% of Canada's infrastructure. With limited financial sources such as property taxes and some cost levies, municipalities are challenged to address aging 'grey' infrastructure, expand existing infrastructure to address growth and consider green infrastructure opportunities. By relying on an Eco-Business Zone approach that seeks synergistic opportunities and efficiencies through the design, construction and operation, capital and operating costs savings can be realized. Whereas traditional infrastructure design typically takes a 'silo' approach in terms of providing infrastructure resource use such as energy, water and by-product re-use, an eco-business zone approach seeks to reduce the capital expense through matching resources to end use requirements. Cost savings have been demonstrated in the following areas:

- ***Cascading Resources or 'Matching' Resources to end-use*:** An example of this is in the traditional use of potable water that is used for a full spectrum of use from drinking to flushing toilets. However, the water quality needs differ for the spectrum of uses and activities. The eco-business zone approach looks at the end use needs and determines potential alternatives sources to address those needs by directing potable water from municipal system for drinking while using grey or stormwater for other grade end uses such as truck cleaning, wash-down and toilet flushing. This approach can help to reduce network distribution costs, treatment, conveyance and ultimately reduce greenhouse gas emissions.
- ***Leveraging Natural Systems for service provision*:** Increasing infrastructure reliance on natural systems to passively integrate slopes and gravity for stormwater conveyance, use of geothermal energy, or sunlight and wind to help offset the 'loads' placed on infrastructure systems and resource use. Ecological engineering and green infrastructure seek to incorporate synergistic efficiencies through mimicking biological relationships.
- ***Increased resilience and adaptability*:** Green infrastructure within Eco-Business zones is typically more resilient because they provide alternative supporting infrastructure to help achieve 'off the grid' efficiencies. Examples of this include district energy systems that incorporate renewable energy sources as primary or secondary inputs. The alternative energy sources, closed loop systems and on-site harvesting add a greater level of resilience against external resource inputs.
- ***Co-location and efficient utilization of infrastructure space*:** Green infrastructure approaches within Eco-business zones look to create locational efficiencies through combined utility corridors. Examples include use of flat rooftop space for urban agriculture or solar PV, combined utility corridors, EPAs that function as green space and stormwater management

Triple Bottom Line assessment allows local governments like the Town of Caledon to undertake a more holistic evaluation of eco-business zone development approaches that considers performance, both internally and externally, and broader societal, environmental and economic implications over a longer time horizon. TBL assessments allow local government to respond to community pressures such as demonstrating transparency and accountability as well as the Town's commitment to sustainability. The TBL assessment framework can be used to help evaluate future implementation of eco-business zones and can be used to monitor progress against the Town's sustainability objectives.

Triple Bottom Line – Expected Benefits Based on Experience & Case Examples

The following quantitative savings and qualitative benefits for many of the major eco business zone elements are generalized and are not specific to the hypothetical Coleraine West case study with exception of the road cross section.

Sustainable Infrastructure (in general)

The Town of Hinton, Alberta, attempted to quantify the benefits of sustainable infrastructure in its 108-acre Innovista Eco-Industrial Park. The "business-as-usual" baseline was theoretically constructed based on the Town's existing Engineering Standards. Innovista infrastructure included several features that deviated from the Town's standards, such as natural stormwater management; a Small Bore Sewer™ sanitary collection system; and changes in construction practices. In addition, Innovista was subject to eco-industrial design guidelines. The report, Project Environmental Description & Expected Results Report, prepared by Eco-Industrial Solutions Ltd was part of the Town's reporting requirements for its Green Municipal Funds (GMF) award. As shown below, it demonstrates the waste and energy savings and the amount of land protection achieved for the project.

Table 11. Summary of Sustainable Infrastructure Costs / Benefits in Innovista Eco-Industrial Park, AB

Indicator	Baseline	Expected	Difference
Land Use for Infrastructure (m^2)	18,000	21,800	3,000
Land Protected / Restored (m^2)	0	119,300	119,300
Waste Production (kg)	4,100	1,100	-3,000
Waste Production (kg/year)	1,500	1,000	- 400
GHG Emission (kg eCO_2)	182,700	137,900	- 44,700
GHG Emission (kg eCO_2/year)	281,900	222,800	- 59,200
Renewable Energy Consumed (GJ/year)	0	50	50
Energy Consumed (GJ)	8,200	6,600	-1,600
Energy Consumed (GJ/year)	3,500	2,600	-900

Note: the above results were based on incomplete data, due to the challenges in collecting data from contractors and a dearth of published life cycle analyses related to infrastructure.

Right-Sized Roads

Right-sizing carriageways, as proposed in the planning and subdivision guidelines, while still providing safe goods movement, can reduce road construction costs by reducing the amount of materials and labour associated with constructing paved lanes.

A high level quantitative 'before and after' comparison can be made within the hypothetical Coleraine West case study – that of possible eco-business zone road cross sections to the probable business-as-usual road cross-section represented by the Town's engineering standards. Keeping in mind that the hypothetical case study cross-sections do not represent any level of engineering design, a quantitative evaluation of this cross-section to a business-as-usual baseline is presented later in this section. Furthermore, the guideline sections contain references to quantitative (and qualitative) benefits from other project case studies, as well as links to other third-party supporting information.

A comparison of the hypothetical case study alternative local (internal collector) road to the Town standard is presented in **Table 12**.

Table 12. Comparison of Hypothetical Industrial Collector Road to Standard Cross-Section

Cross-Section Use	Baseline: Standard 211 (m)	Eco-Business Zone X-Section in Fig. 66 (m)	Difference (m)
Total Width	26.0	24.0	-2.0
Pavement	13.9	9.8	-4.1
Other	12.1	14.2	2.1
Sidewalk	3.0	3.0	0.0
Landscape & Utilities*	9.1	11.2	2.1

***includes bioswale in the hypothetical eco-business zone cross-section**

The hypothetical alternative cross-section would reduce paved area by up to 29%, which also has associated stormwater management and greenhouse gas emission benefits, as seen in the Innovista study. At the hypothetical, high-level stage, it appears possible that bioswales could be accommodated within the road-right-of-way, even if the right-of-way is 2 m narrower than the Town standard.

Other guidelines related to facilitating pedestrian and bicycle movement can also reduce transportation demand, impacting road design and O&M needs. On the operational side, design guidelines to facilitate car sharing, coordinated shipping and receiving, and other features can reduce transportation demand, as could linking to Pearson efforts around TDM e.g., MetroLinx SmartCommute, green logistics training and education, programs to co-ordinate employee shift start/end/length. Collectively, these efforts could help to reduce road requirements, road construction costs, and operations and maintenance requirements.

Water & Wastewater

Many of the guidelines will reduce water demand and wastewater generation through building design and operational practice. RealPac's 2011 study found that commercial buildings instituting best practices for water management consumed almost 75% less water than the Canadian average for commercial buildings.

By supporting the Pearson Eco-Business Zone programs, the Town would help businesses in the Coleraine West eco-business zone further reduce water demand and wastewater generation by facilitating the implementation of water conserving practices and technologies and the use of reclaimed wastewater, such as cooling water from one business being used by another business's process.

Reducing water consumption and corresponding wastewater generation can help to reduce the sizing and, therefore, capital cost, of upstream or downstream infrastructure, and can help to free up capacity for other uses.

Stormwater Management

Given TRCA's updated requirements for stormwater management, LID would likely be required to some extent, regardless of whether Coleraine West is developed in a business-as-usual manner or as an eco-business zone.

Developing the employment lands as an eco-business zone could reduce the incremental costs to the Town for this additional stormwater management. Many of the design guidelines increase natural stormwater management within the industrial parcels, reducing the amount of flow that would need to be treated by the public stormwater management ponds, and thereby reducing pond size and cost of construction. In addition, the alternative cross-section proposes the use of bioswales rather than conventional piped collection systems. These systems are frequently less costly to construct, and, as shown in the Innovista study, reduce greenhouse gas emissions as well. While the project costs are not publicly available, the authors' experience with the TaigaNova Eco-Industrial Park project in Fort McMurray is that there is a construction cost savings when concrete or 'hard' stormwater management systems are replaced by LID.

The actual combination of LID elements in Coleraine West will depend on a number of factors, such as: findings of future additional technical studies; development agreements negotiated with developers (i.e., which guidelines are implemented); the actual land uses; the Town's triple bottom line assessment of any actual design options. With respect to the latter factor, an example might be weighting given to a particular LID feature that also increases the attractiveness of gateway entrance areas.

As a reference, the Town might consider the incremental costs and costs per gallon for various LID measures evaluated by the Sherwood Design Institute for two projects in New York State:

Table 13. Evaluation of Incremental LID Element Costs for Two Projects In New York State

Source Control	Incremental Capital Cost (per sq. ft. or unit)	Net Present Value (per sq. ft. or unit)	Lifespan (years)	Cost (per year)	Gallons (per sq. ft. or unit)	Cost to Capture Gallon	Annual Cost per gallon
Blue Roof (2 -inch detention)	$4.00	$4.00	20	$0.20	1.25	$3.21	$0.16
Rain Barrel (55-gallon tank)	$200	$200	20	$10	55	$3.64	$0.18
Sidewalk Bio-filtration	$36.81	$39.68	20	$1.98	8.60	$4.61	$0.23
Porous Asphalt Parking Lane	$8.13	$10.33	20	$0.52	2.18	$4.74	$0.24
Porous Concrete Sidewalk	$6.83	$8.67	20	$0.43	1.82	$4.77	$0.24
Swale	$18.73	$22.50	40	$0.56	1.82	$12.39	$0.31
Blue Roof (1-inch detention)	$4.00	$4.00	20	$0.20	0.62	$6.42	$0.32
Cistern (500-gallon tank)	$3,700	$3,700	20	$185	500	$7.40	$0.37
Green Street	$42.67	$82.79	30	$2.07	5.24	$15.81	$0.53
Sidewalk Reservoir	$98.48	$110.41	20	$5.52	3.74	$29.52	$1.48
Green Roof	$24.45	$62.39	40	$1.56	0.47	$133.37	$3.33

Reference Cases	Incremental Capital Cost (per sq. ft. or unit)	Net Present Value (per sq. ft. or unit)	Lifespan (years)	Cost (per year)	CSO Gallons (per sq. ft. or unit)	Cost to Capture Gallon	Annual Cost per gallon
Newtown Creek Tunnel	$1,299,000,000	$1,300,000,000	50	$26,000,000	40,000,000	$32.50	$0.65
Flushing Bay Tunnel	$1,038,000,000	$1,039,000,000	50	$20,800,000	25,000,000	$41.56	$0.83

Source: Sherwood Design Institute

Amenities

In addition to sustainable infrastructure contributing to lower capital, operational costs and reduction in GHGs, sustainable infrastructure can also serve an important community and social amenity. Non-structural stormwater management ponds and bio-swales when integrated with open space design can add ecological and amenity value to an eco-business park. The stormwater management ponds can provide buffers between industrial and agricultural uses, provide landscape buffers between properties and reduce urban heat gain by reducing amount of impervious surface areas. The combination of EPAs in combination with bio-swales in the medians can also provide opportunities for recreational trails for pedestrians and cyclists. These amenities would be greater in an eco-business zone than in a business-as-usual employment land area.

Built Space Density

Like many jurisdictions across Canada, Metro Vancouver has been studying industrial intensification in detail. Its 2013 report, Summary Report: Opportunities for the Intensive Use of Industrial Land[2] included many case studies as well as a prototype mixed office and industrial building with a density of 6,631 m2/ha. Building density data is not available for the Pearson Eco-Business Zone, but, as of 2008, the median coverage within industrial lots was 37%, with many examples of coverage between 40% and 60%. Conceptual planning, detailed land use analysis, and market studies would be required to project a building density for Coleraine West. Nonetheless, best and emerging practice, suggest that it is reasonable to increase the building density; there are several guidelines in this document that, if applied, will also support increased built space density.

Increasing built space density compared to business-as-usual could increase job density and the total amount of property tax revenues generated by Coleraine West. Increasing built space density also contributes to increased walkability. On the other hand, depending increasing built space density might also increase transportation demand from the area (although, it also increases the business case for transit service).

Town Revenues:

The assessed value of green buildings may be higher than business-as-usual buildings (see Light House White Paper *Does Building Green Create Value?*). Therefore, the Town may see increased property taxes compared to a business-as-usual scenario. Findings about green building cost-benefit from a few selected studies are shown below:

[2] http://www.metrovancouver.org/planning/development/EconomyIndustrialLands/EconomyIndustrialDocs/OpportunitiesForIndustrialLandsIntensification-Feb2013RevisedFinalTitle.pdf

Source	SmartMarket Report: "World Green Building Trends - Business Benefits Driving New and Retrofit Market Opportunities in Over 60 Countries, McGraw-Hill Construction, 2013.
Link	http://naturalleader.com/pdf/WorldGreenBuildingTrendsSmartMarketReport-2013-Final-Full.pdf
Key Findings	• Survey of firms across 62 countries around the world. • 76% report that green building lowers operating costs. • More than one third point to higher building values (38%), quality assurance (38%), and future-proofing assets (i.e., protecting against future demands) (36%) • 78% of firms believe that new green buildings do require some additional upfront costs. However, 63% think the paybacks will take less than ten years, likely mostly through operating cost savings.
Source	SmartMarket Report: Business Benefits of Green Buildings (2010): Building & Occupant Performance Driving Green Investment in Existing Commercial Buildings, McGraw-Hill Construction, 2010.
Link	http://www.environmentalleader.com/2010/11/18/greenbuild-roundupday-2-green-buildings-yield-substantial-financial-benefits/
Key Findings	• Green buildings are on average 25%-30% more energy efficient than conventional buildings. • Energy benefits were calculated at $5.69/sf and include payback period of six years. • Through strategies such as efficient plumbing, rainwater harvesting and on-site wastewater treatment, green building can reduce water use by 39%. • Owners' perspective: 4% higher ROI; 5% increase in building value and occupancy; 8% lower operating costs, and 1% rise in rental income. • Building managers' perspective: 70% of those surveyed believe that green helps attract and retain tenants; 94% of building managers observe higher tenant satisfaction levels; at least 10% of a green building's tenants have seen improvement in worker productivity; • Tenants' perspective: over 20% report that they have experienced more effective client meetings and easier employee recruitment; 14% of tenant firms were willing to pay 2-3% more to rent a space with green features.
Source	Global Real Estate Sustainability Benchmark Report, 2012 (global survey of 340 firms).
Link	http://gresb.com/content/2012_GRESB_Report.pdf
Key Findings	• Survey of 443 firms and 36,000 properties • A year-on-year reduction of 6% in standardized energy. • Greenhouse gas emissions of 171 property companies were reduced by 5.6% in 2011. • Water consumption was reduced by 1.8%.

	• Green building certification is becoming more prevalent, with 51% including green building certificates in their portfolio, of which LEED is most widely adopted. • Demonstrates general trend of commercial investors, especially large pension funds, to be working to increase their environmental performance
Source	Assessing Green Building Performance, A Post-Occupancy Evaluation of 22 GSA Buildings, US General Services Administration, 2012
Link	http://www.wbdg.org/pdfs/gsa_green_bldg_performance.pdf
Key Findings	Compared to national averages, this study found the buildings: • used 25% less energy (66 kBtu/sf/yr) • lowered aggregate operational costs by 19% ($1.60/sf) • rated 27% higher in occupant satisfaction • produced 36% fewer CO_2 emissions (19 lbs/sf/yr)
Source	Green Buildings and Productivity, The Journal of Sustainable Real Estate, 2009. Survey of over 500 tenants who have moved into either LEED or ENERGY STAR-labeled buildings managed by CB Richard Ellis (CBRE)
Link	http://www.costar.com/josre/JournalPdfs/04-Green-Buildings-Productivity.pdf
Key Findings	• 45% respondents agree that their employees took fewer sick days, with an average of 2.88 days fewer compared to previous location • Over 70% respondents agree that green buildings provide good image for owners/shareholders, clients and public. • 61% agree that green building can provide favorable amenities for attracting/retaining employees. • 55% agree that they have convenient access to alternative transportation • From the average survey results, the average productivity increases 4.88%

Furthermore, by ‘going green’, the Town of Caledon could attract additional infrastructure funding, such as from the Green Municipal Funds.

Overall Triple Bottom Line - Qualitative Assessment Summary

The degree to which the above qualitative and quantitative benefits would apply to the hypothetical Coleraine West case study has not been determined. However the Town can reasonably assume that the scale of the described benefits would translate to the application of those elements in Coleraine West and other applicable areas.

An attempt to facilitate the triple bottom line evaluation of the hypothetical case study is presented in Figure 70. A matrix was used to identify the proposed eco business zone elements with the associated economic, environmental and social benefits.

CALEDON ECO-DESIGN GUIDELINES TRIPLE-BOTTOM LINE EVALUATION MATRIX

Evaluation Criteria	Reduces Capital Cost to Developer	Reduces O&M Costs to Town	Potential for New Revenues to Town & Utilities	Ease of Implementation / Adaptability	Improves Marketability of Employment Parcels	Comments	Reduces Transportation Demand / Improves Transportation Efficiency	Reduces Water Demand / Improves Water Efficiency	Reduces Wastewater Generation / Improves Wastewater Quality	Reduce Stormwater Flow / Improves Stormwater Quality	Leverages Existing Infrastructure	Comments	Reduces Material Use / Use of Eco-friendly Materials	Reduces Energy Demand	Reduces GHG Emissions	Support Low Impact Development	Integrates, Protects and/or Restores Existing Local Habitat	Comments	Positive Town Image & Aesthetics	Promotes Business-to-Business Collaboration	Supports Educational Opportunities	Comments
Case Study Element	**FINANCIAL & TECHNICAL**						**INFRASTRUCTURE**						**ENVIRONMENT**						**SOCIAL**			
Land Use	○	○	◒	●	●	The mix of prestige, general and light industrial uses address future economic expansion and provide for eco-business uses. The diversity of land uses provides a variety of business activities, thereby improving economic resilience. Increases property tax and business license revenues.	◒	–	–	–	◒	Ensuring an adequate mix of land use types that supports the employment needs will reduce number of discretionary trips. For example, the case study allows for a small amount of commercial, retail and service uses to support local businesses and visitors.	–	–	◒	◒	●	Provides local employment and ancillary support services to local community. The Caledon EBZ is situated in relatively close proximity to multi modal hubs and the airport thereby reducing vehicle kilometers travelled.	◒	●	◒	Provides opportunities for green employment, promoting green technologies and companies which share similar philosophy.
People and Goods Movement	◒	◒	○	●	●	The proposed street network integrates into the surrounding transportation network. A complimentary network of bicycle, pedestrian and recreational paths provide convenient access. Preferential parking for car-coops and ride-share programs potentially reduce total number of parking spaces.	●	–	–	–	●	Helps to promote alternative transportation modes, ride-sharing (through preferred parking and incentive programs), shuttles which place less demands on local/regional transportation infrastructure. The area is well served by regional transportation corridors and future transportation investments including Go-Train station and future highway expansion plans.	◒	–	◒	◒	●	See below. Provides visual and landscape amenity and help augment the designated EPAs.	◒	◒	◒	Supports active transportation and activity within the public realm. Supports crime prevention through environmental design (CPTED). Refer to Section 6.2
Open Space & Landscape	◒	◒	○	●	–	Open space and landscape design integrates the EPA as a major amenity on the site and proposed riparian areas with additional buffers provide a positive landscape transition adjacent between industrial and agricultural uses. Native and drought resistant plantings are proposed.	–	–	–	●	◒	Integration of storm water ponds are intended to provide visual amenity to replicate natural wetlands while reducing peak storm runoffs. Open space provides multiple benefits that include reducing need for "grey infrastructure" and potentially deferring downstream capital upgrades to infrastructure to accommodate future growth.	◒	–	–	●	●	Guidelines support native, drought resistant species that attracts supports flora and fauna. Integration of storm water ponds are intended to replicate natural wetlands mimic storm water flows. Helps protect and enhance water quality of EPAs which flow into fish bearing waters.	●	○	◒	Guidelines support higher quality public realm and promotes ecological awareness and education. Supports crime prevention through environmental design (CPTED). Refer to Section 6.5.
Storm Water Management	◒	◒	○	●	●	An integrated storm water management approach that includes LID will help to reduce downstream demands for large centralized systems as well as reducing O&M costs associated storm water infrastructure such as cleaning and maintaining pipes, CBs, oil separators pump stations, etc.	–	◒	–	●	◒	Consolidated and integrated storm water management strategy attempts to mimic natural conditions utilizing point source controls and a series of measures which helps reduce quantity and improve quality. Storm water retention ponds are proposed to be designed to provide landscape amenity.	◒	–	–	●	●	Guidelines support on-site storm water management to mimic natural conditions which help to prevent erosion, sedimentation, scouring that result from peak storm events. SWM also helps to improve water quality downstream for fish bearing waters.	●	○	●	Guidelines support and increase awareness around environmental sustainability through design of sustainable systems on site.
Water & Wastewater Systems	◒	●	○	●	–	A water balance method is incorporated as a strategy to reduce overall demand for potable water and substitute rainwater for irrigation, toilets and wash-down. Utilization of gray water and rainwater reduces downstream flows and may help to defer long range capital investments in wastewater treatment systems.	–	●	●	–	●	A water balance method is incorporated as a strategy to reduce overall demand for potable water and substitute rainwater for irrigation, toilets and wash-down. Utilization of gray water and rainwater reduces downstream flows and may help to defer long range capital investments in wastewater treatment systems.	◒	◒	◒	◒	–	The guidelines supports a water balance approach that reduces potable water demand and wastewater outflows thereby reducing environmental impacts associated with excessive use of natural resources.	◒	●	●	As above.
Energy Systems	○	◒	◒	◒	–	The guidelines promote use of alternative energy systems including solar PV arrays, solar thermal, geothermal and heat exchange facilities. Currently, there are financial incentives in place to encourage PV installations with a payback of 7 to 9 years[1]. Neighborhood Energy Utility use can demonstrate positive revenue stream at a local level.	–	–	–	–	●	Guidelines support DSM and energy efficiency measures which will help defer capital investments and increase resiliency.	–	●	●	–	–	Guidelines support renewable energy systems which reduces demand for fossil fuel extraction and GHG emissions. Local energy systems typically have higher efficiency in delivery and less residual loss through transmission.	◒	●	●	As above.
Buildings	○	–	○	●	–	Green buildings reduce overall operational and maintenance costs over the lifecycle of the building. The cost-benefit ratio are 10 times the cost premium over a 20 year period (NPV)[2] Building commissioning ensures building are operating according to their specified design intent and can help achieve savings of 20%.	◒	●	●	●	●	Guidelines support higher performance buildings which help to reduce resource demands and waste generation.	●	●	●	◒	◒	The guidelines promote improved building performance with a focus on energy, water and waste efficiency. Efficient buildings use less water, energy which results in less GHG emissions.	●	◒	●	Promotes visible sustainability on buildings and incorporates sustainable systems which teach employees, visitors and residents about environmental stewardship.

[1] Based on OPA incentive rate schedule and estimated costs of purchasing and installing PV arrays for 50,000 sq. metre warehouse with flat roof construction.
[2] Estimated costs savings based on Greening Built World Study.

○ Does not meet criteria ◒ Meets criteria ● Strongly meets criteria – Not Applicable

Figure 69: Triple Bottom Line Qualitative Evaluation of the Hypothetical Case Study for Coleraine West Eco-Business Zone

Section 8: Implementation Tools

8

8.1 Eco-Zoning By-law Sample

What is an Eco-Zoning By-law?

Zoning by-laws provide the legal underpinning to achieve an eco-business zone that aligns with the Town of Caledon's vision to demonstrate leadership in the area of sustainable development. The eco-zoning by-law also provides the Town of Caledon the regulatory mechanism to achieve its employment growth targets that have been defined through the Places to Grow Plan and incorporated into subsequent Official Plan Amendments. Town of Caledon's eco-zoning by-law provides a foundation in terms of defining sustainable land-uses, form of development, appropriate setbacks to facilitate optimum orientation of buildings, land use patterns which help to minimize demands on transportation infrastructure and resource use.

As part of the future phases of planning, the Town of Caledon should engage green business and industries to ensure the by-law provisions address potential needs and requirements associated with this evolving sector of the economy.

Alignment to Economic Strategy

When complemented by policy, guidelines and tools, the eco-zoning by-law will help implement the Town of Caledon's vision for sustainable development. The sample eco-zoning by-law that follows also reflects the Town of Caledon's economic development strategy to provide opportunities for:

- Economic growth and investment to improve Caledon's work/live balance
- Creating a diverse and sustainable economic base
- Augmenting the non-residential tax base
- Ensuring continued supply of serviced industrial land and diversity of parcel sizes to meet future demands
- Creating synergies between local land-uses that leverage proximity to regional infrastructure including multi-modal transportation and logistic hubs, airports, freight infrastructure and expanded truck routes to facilitate goods movement.

Based on the economic strategy and supporting competitive analysis, the eco-zoning by-law will permit the following industries and activities including:

- Industrial machinery
- Specialized design services
- Fabricated structural metal products
- Plastic products
- Food products

As well the eco-zoning by-law will allow for professional, scientific and technical services including:

- Management, scientific and technical services
- Specialized design services
- Engineering Services

Eco-Zoning to Achieve Low Carbon Buildings

The eco-zoning by-law incorporates best practice approaches in allowing building designs to incorporate the use of passive design strategies that improve overall energy performance and reduce greenhouse gas emissions by incorporating the following:

- Floor area exclusions for energy efficient equipment and apparatus
- Floor area exclusions that support grey water recycling
- Floor area exclusions that support thicker walls to achieve higher thermal performance and shading devices such as light shelves to reduce solar heat gain in summer
- Exclusions that allow for natural ventilation shafts to improve indoor air quality and air exchanges
- Maximum height exclusions for appurtenances that support renewable energy (e.g. small wind turbines, solar PV panels, solar hot water heating systems), intensive green roofs or urban agriculture, etc.

Sustainable Land Use

When appropriately distributed within the Town of Caledon, land use plays a fundamental role in helping to achieve sustainable communities through job-housing balance. The eco-zoning allows the Town of Caledon to achieve its stipulated employment targets defined through the Places to Grow Plan and to provide employment opportunities to neighbouring residential communities such as Bolton. Additionally it is well served by existing and future transportation infrastructure providing sufficient access to the site and the surrounding service area.

Site Planning

The eco-zoning by-law and supporting guidelines allows for building orientation to address passive solar heat gain, providing setbacks requirements that allow for temporary storage and conveyance of stormwater through bio-swales and integrated permeable parking lots. Parking lots may be designed to accommodate multiple uses (i.e. recreational activities after working hours for basketball, hockey, tennis, etc).

Additional setbacks are recommended to provide buffers adjacent to Environmental Policy Areas (EPAs) to allow increased native landscaping and opportunities for recreational paths. Where warranted, the Town may require proponents to prepare one or more management plans that describe how the facility will manage the following:

(a) Materials and solid waste
(b) Liquid waste and water efficiency
(c) Noxious odours
(d) Noise and vibration

(e) Energy efficiency
(f) Traffic

In consideration of a District Energy System, the Development Authority may require developers to connect buildings to a District Energy System or to make provision for future connection to this system.

Sample Eco-Business Zoning By-law Amendment

Town of Caledon

Preamble

Zoning by-laws provide the legal foundation and regulatory underpinning to achieve an eco-business zone. Through zoning by-laws, a municipal government can require new development applications to achieve elements that support sustainable development.

A zoning by-law regulates the development and use of land and the location and use of building and structures within the area defined under the zoning by-law.

This sample eco-business zoning by-law provides a template for the Town of Caledon to reference when drafting future area zoning by-laws to govern a site to become an eco-business zone.

INTENT

The intent of this sample zoning by-law is to provide an illustrative template that would regulate and direct future employment growth within the Town of Caledon to attract innovative land uses, densities and building forms that support the principles and directions of emerging eco-business zones.

The zoning by-law shall be used in conjunction with the Eco-Business Zone Guidelines.

The land uses within this zoning by-law are intended to be compatible with surrounding land uses and compliment and support the planned functions of an employment expansion area while also facilitating land use activities that exemplify sustainable uses such as renewable energy supplies, waste to energy, industrial symbiosis, recycling, green technologies, research and development that support innovative technologies around resource efficiency.

Residential uses are not permitted as it is envisioned that the location of eco-business zones provide employment opportunities close to existing and future residential neighbourhoods thereby reducing overall vehicle distance travelled.

Small scale commercial and retail uses that serve the local area are permitted as long as they are limited to at-grade uses.

Ancillary office use is permitted as long as it does not exceed 10% of total gross floor area. It is envisioned that commercial and retail uses be permitted to provide opportunities for restaurants, cafes, financial institutions, dry cleaning, and laundry mats. Also, the eco-zoning by-law supports service uses such as print shops, photographic studios, repair shops, photofinishing,

catering, health clinics, professional offices and technical or trade academies.

This zoning by-law is intended to be used with the applicable Eco-business zone guidelines. Where there is a conflict between the zoning and guidelines, the zoning by-law will take precedent.

NEW DEFINITIONS IN THE ZONING BY-LAW TO SUPPORT ECO-BUSINESS ZONES

1. By-product Synergy
2. District Energy
3. Eco-Business Zone
4. Eco-Industrial Park
5. Green Energy
6. Green Jobs
7. Green Infrastructure
8. Green Procurement
9. Low Impact Development
10. Roof Garden

By-product Synergy	By-Product Synergy (BPS) is the matching of under-valued waste or by-product streams from one facility with potential users at another facility to create new revenues or savings with potential social and environmental benefits. Also referred to as Waste Exchange.
District Energy	An energy distribution system that delivers thermal energy (in the form of hot water, steam or chilled water) from a central plant to multiple buildings.
Eco-Business Zone / Eco-Industrial Park	An Eco-Business Zone or Eco-Industrial Park is a geographically defined area, mostly built-out, and largely consisting of commercial or industrial land uses where businesses and local government share an overarching goal to create collaborative strategies for sustainable business operations. Eco-Business Zones / Eco-Industrial Park typically feature green, high performance buildings situated within ecologically respectful settings, and efficient, low impact infrastructure systems.
Green Jobs	Employment opportunities that substantially contribute to preserving and restoring environmental quality. This includes, but is not limited to jobs that are involved in: helping to protect ecosystems and biodiversity; reducing energy, materials and water consumption; decarbonizing the economy; and minimizing or avoiding generation of waste and pollution.
Green Energy	Clean, sustainable production and use of energy, including generation from renewable sources and conservation and efficiency measures.
Green Infrastructure	Green infrastructure is characterized by design that minimizes the demand for and use of resources such as energy, water and land. It also reduces the generation of waste such as

	greenhouse gases (GHG's), wastewater, excess heat, and material waste, and supports the cascading and recycling of these resources. These considerations extend throughout the design, construction and ongoing operation of the infrastructure systems.
Green Procurement	The integration of environmental performance considerations (such as potential impacts and costs over the life cycle of the goods and services) throughout the procurement process, including planning, acquisition, use and disposal.
Low Impact Development (LID)	A sustainable landscaping approach that can be used to replicate or restore natural watershed functions and/or address targeted watershed goals and objectives. It also referred to as sustainable urban drainage systems (SUDS), water-sensitive urban design (WSUD), natural drainage systems, and onsite stormwater management. (Ref. Wikipedia)
Roof Garden	A roof garden is any garden on the roof of a building. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, and recreational opportunities.

ECO SERVICED INDUSTRIAL ZONES (ESI)

An Eco Zoning By-law Amendment is proposed from the current Agricultural One (A1) and Environmental Protection Area Two (EPA2) zones to allow for Eco Serviced Industrial zones (ESI) for the subject lands while implementing the policies of the Town of Caledon Official Plan. A draft Eco zoning By-law has been prepared and includes additional permitted uses from the General Provisions and standard Serviced Industrial (MS) zone provisions.

In summary, the Eco Serviced Industrial zone (ESI), the following uses are proposed to be permitted:

- Bio-Fuel Production Facility;
- Bulk Storage Facility;
- Contractor's facility;
- Composting of Organic Materials/Bio-Solids;
- Dry Cleaning or Laundry Plant;
- Greenhouse or Plant Nursery;
- Equipment Storage Building;
- Factory Outlet;
- Brewing or Distilling;
- Gasoline Pump Island, Accessory;
- Industrial Use;
- Light Equipment Rental Establishment;
- Maintenance Garage, Accessory;
- Merchandise Service Shop;
- Motor Vehicle Body Shop;
- Motor Vehicle Repair Facility;

- Open Storage Area, Accessory;
- Outside Display or Sales Area, Accessory;
- Public utility infrastructure and equipment including energy, water (treatment and distribution) and wastewater;
- Research Establishment;
- Recycling Depot;
- Waste Processing Facility;
- Waste Transfer Facility;
- Transportation Depot and transportation service provider;
- Warehouse; and
- Warehouse, Public Self-Storage.
- Wholesale or retail solely of products manufactured within the eco-business zone.

In addition to the permitted uses noted above, the following additional uses are proposed to be permitted in the eco-zoning by-law:

- Business Office; and
- Trade and Technical Schools
- Daycare facility primarily for use of employees of businesses within the Eco-business Zone
- Place of Worship;
- Place of Assembly

	Caledon Zoning By-law - MS Zone	Proposed Eco Zoning By-law amendments
Building Area / Parcel Coverage	50%	(a) The maximum coverage of the site with buildings and impermeable materials shall be 60% except that, where applicants can demonstrate compliance with the relevant EBZ Stormwater Management Plan as identified by the Development Authority. (b) Up to 50% of the required permeable area of the site (i.e. 20% of site area) may be provided on the roof of a building as a rooftop garden.
Parking and Loading Requirements	Zoning By-law 2006-50 Section 5 Parking, Loading and Delivery Standards 5.2.3 For Industrial Use, a) If accessory office and retail *net floor area*s are 15% or less of the total *net floor area*:	(a) Parking shall be provided as required in Park By-law (Section 5 of Zoning By-law 2006-50) (b) In addition, each business shall provide 1 preferential parking space for every 20 required parking spaces (minimum of 1 space) for use only by the vehicles displaying disabled parking placard and/or a disabled license plate (to be cross-checked with provincial regulations for final draft); and (c) Each business shall provide 1 preferential parking space for every 20 required parking spaces (minimum of 1 space) for use only by any of

	- < 5,000 m_2 – 1 *parking space* per 60 m_2 - 5,000 to 10,000 m_2 – 83 *parking spaces*, plus 1 per 90 m_2 - Over 10,000 m_2 – 139 *parking spaces*, plus 1 per 170 m_2 b) If associated office and retail *net floor areas* are more than 15% of the total *net floor area*: In addition to (a), the applicable *net floor areas* exceeding 15% shall be subject to the applicable office or retail parking requirements. 5.3.2 Loading Space Requirements: The minimum number of *loading spaces* required: For net floor area that is 301 m_2 to 2,325 m_2: 1 space 2,326 m_2 to 7,440 m_2 : 2 7,441 m2 or greater: 3 spaces plus 1 additional for each additional 9,300 m_2 or portion thereof in excess of 7,441 m_2	the following types of vehicle: i. Car pool or van pool vehicles ii. Gas/electric hybrid vehicles; or iii. Hydrogen fuelled vehicles; or iv. Smart cars. (d) Preferential parking spaces shall be in a convenient location and may be located within the front, side or rear yard of a building. Preferential parking spaces shall count towards the total required parking spaces. (e) Parking areas shall be located, designed, landscaped and developed in accordance with the EBZ Development Guidelines: - Locate parking at the front or side of buildings. - Parking is not generally permitted at the rear of buildings to ensure a strong connection between the building and the natural landscape. - Exceptions may be discussed with the Development Authority if good connections to green space are maintained. - Shared parking spaces should be considered and incorporated among buildings and with adjacent parcels. - Minimize the size of parking areas and avoid large, barren parking areas. - Plant trees and shrubs throughout the parking area to intercept precipitation, reduce surface heating, enhance appearance - Minimize light pollution of the night sky and forested areas by ensuring that lighting is shielded and directed towards the ground. - Design parking and other paved areas to minimize negative impacts on surface runoff volume and quality (f) Loading bays/spaces shall be located and developed in accordance with the EBZ Development Guidelines: - Locate loading bays at the front or side of buildings. - Locate loading bays so they are easily accessible but not visually prominent from primary street frontage and main building entries. - Provide visual screening of loading with a combination of evergreen planting and fencing that is consistent with building materials and character. Or consider constructing berms within landscape setbacks to help screen views of loading and storage.
Planting Strip Width (Minimum) and Location /	6 m. A planting Strip shall be required along each front lot	(a) A minimum depth of 3 metres of landscaping shall be provided to buffer parking, loading and outdoor storage areas from a public right-of-way and public trails while maintaining reasonable sight lines and

Landscape Buffers	line. In addition, the following provisions shall also apply: (i) Minimum width abutting an arterial road or Provincial Highway: 9.0 m (ii) Minimum width where truck *parking* or *loading spaces* are provided adjacent to an arterial road or Provincial Highway: 12.0m (iii) Minimum width required on all *interior side yards* except where there is a mutual *driveway* along an *interior side lot line:* 1.5 m	visual permeability for Crime Prevention through Environmental Design (CPTED) purposes to the satisfaction of the Development Authority. (b) Lots that are adjacent to an existing EPA shall provide an additional landscape setback of minimum 10 m to allow for active public paths and additional native landscaping to increase natural habitat and natural landscape screening from industrial or business activities.
External Appearance	No Requirement	The external appearance of buildings shall be designed and maintained in accordance with the EBZ Development Guidelines.
Building Heights	12.2 m	The following appurtenances are permitted to extend above the maximum allowable height of 12.2 m: - Apparatus for renewable energy including solar PVs, solar hot water heaters, micro wind turbines - Apparatus that supports intensive green roofs and roof top gardening (urban agriculture)
Net Floor Area (Maximum)		- Floor area exclusions for energy efficient equipment and apparatus that delivers building energy (not process energy equipment) - Floor area exclusions that supports grey water recycling - Floor area exclusions that support thicker walls to achieve higher thermal performance and shading devices such as light shelves to reduce solar heat gain in summer - Exclusions that allow for natural ventilation shafts to improve indoor air quality and air exchanges

8.2 Consideration of Municipal Incentives

In future, the Town may also wish to consider incentives to support the requirement or encouragement of the adoption of certain guidelines. While incentive program inventories, strategies, development, consultation, and evaluation were not within the scope of this study, some general incentive examples are provided below.

Incentives can help to address any real incremental costs associated with new green practices, or they can simply motivate behavioral change when there are perceived additional costs or general aversion to risk for innovation. Pearson Eco-Business Zone Policy Toolkit – Municipal Incentives provides an overview of incentive types that might be used to support eco-business activity. Here are some sample incentives:

Table 14. Sample incentives from other municipalities (Source: Pearson Eco-Business Zone Policy Toolkit)

Incentive	Type	Summary (Website)
Imagination, Manufacturing, Innovation, Technology (IMIT) Grants *City of Toronto*	Construction Incentive	The program will be made available for a five-year period. Eligible development will benefit from a grant of up to 60% of the increase in the municipal taxes attributable to eligible new commercial and industrial construction over a 10-year period. (http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=bc2c4b5073cfa310VgnVCM10000071d60f89RCRD&vgnextchannel=6e4032d0b6d1e310VgnVCM10000071d60f89RCRD)
Industrial Water Rate Program *City of Toronto*	Financial Incentive	Companies who submit water conservation plan and meet the Sewers By-law compliance requirements, can receive a reduced water rate of almost 30 per cent less than the general rate. (http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=85f75830a898e310VgnVCM10000071d60f89RCRD&vgnextchannel=1c4bfd788a5af310VgnVCM10000071d60f89RCRD&vgnextfmt=default
Better Buildings Partnership - New Construction *City of Toronto*	Service Incentive	Assist building owner and developers access the Ontario Power Authority's High Performance New Construction (HPNC). Program. The HPNC program provides financial incentives for modeled projects that perform better energy saving compare to a reference building that meets minimum requirements of the Ontario Building Code. The program also supports up to 100% of the cost of modelling a building (up to $10,000) for the building owner. (http://bbptoronto.ca/new-construction/)
TaigaNova Eco-Industrial Park *Fort McMurray, Alberta*	Education and Outreach	The Wood Buffalo Housing and Development Corporation (WBHDC), the developer of TaigaNova and a wholly-owned subsidiary of the Regional Municipality of Wood Buffalo, offered a free workshop to introduce buyers to green building and eco-industrial activity and provide resources on assembling green design teams. It also allowed for businesses to contact each other prior to design of new facilities to identify opportunities to collaborate during construction or during future business operations. (http://www.taiganova.com)
Fast Track Development Approvals *Port Coquitlam, British Columbia*	Service Incentive	The City created an optional sustainability checklist that is made available to applicants seeking a development permit. As an incentive to encourage developers to adhere to the city's desired sustainability criteria, applicants that fill out the checklist are offered a fast tracked application. The reduction in time and associated costs provides the City with a low-cost financial incentive to attract green development. (http://www.portcoquitlam.ca/Assets/Sustainability+Checklist+Planning.pdf?method=1)

Incentive	Type	Summary (Website)
Multiple, Co-ordinated Incentive Package *Kamloops, British Columbia*	Financial Incentive	The North Shore Neighbourhood Plan creates a rating system indicating the combination of incentives that are available to developers who meet a specified number of green development criteria. Both the number of incentives, as well as the amount awarded within each type of incentive increase with the number of criteria that a developer chooses to meet. Incentives include: tax exemptions for up to 10 years, reduced development charges, reduced parking requirements, density bonusing, expedited permit processing and funding for improvements to public right-of-ways. (http://www.city.kamloops.bc.ca/communityplanning/northshore.shtml)

Mechanisms to Support Sustainable Storm and Waste Water Management

The Town and TRCA have experience in implementing stormwater management incentives. The Town had created a Development Charge for stormwater, but found tracking a challenge, so now requires developers to enter into a development charge credit agreement. TRCA did have a cash-in-lieu program to fund stormwater management retrofits, but this program has ended. TRCA does have a compensation mechanism, but, while an economic instrument, is not really an incentive.

In general, financial mechanisms that could support sustainable stormwater management include:

- **Development Charges** that allocate infrastructure funds toward sustainable stormwater management practices including shared stormwater management detention or retention ponds for excess rain and stormwater that is not utilized or managed on site. In June 2008, The Town of Caledon introduced development charge discounts for new green commercial and industrial buildings that incorporate LEED certification or technologies. Stormwater management approaches described in these guidelines will yield LEED credits and development charge discounts.
- **Property Tax surcharges** for higher volumes of storm and wastewater discharges provide a demand side management approach to helping reduce volumes. Other approaches include “fee-bates” which defines a threshold in which fees are charged for higher volumes and are graduated down to no fees for properties with zero discharges.
- **Stormwater User Rates** are based on the contribution of stormwater runoff from each property to the municipal drainage system (ditches, sewers) and end of pipe infrastructure (ponds, creeks) as measured by the amount of impervious surface area contained on each property. There is precedent in Ontario with municipalities such as Kitchener-Waterloo.
- **Infrastructure Stimulus Funding** (FCM) provides funding for municipal infrastructure projects with priority going toward projects that implement sustainable approaches to infrastructure design that reduce downstream impacts and help defer infrastructure upgrades. The Innovative Infrastructure Fund (IIF) provides loans and grants to municipalities for innovative, sustainable infrastructure pilot projects, including asset-management initiatives, and to leverage best practices and innovation to other projects.

The benefits and limitations of these financial mechanisms are listed in the following table:

Table 15. Comparison of Financial Mechanisms that support sustainable stormwater management (Source: City of Waterloo, Stormwater Management Program and Funding Review- Supplemental Report to PWS2009-16, December 2009)

Mechanism	Benefits	Limitations	Example Municipalities
Tiered Flat Rate (Based on the property's zoning/land use classification)	• Low administration cost (i.e. compared to an Impervious area based stormwater rate); • Maintains constant revenue stream for the City's SWM program. • Minimal database management system required to implement the charge.	• Charge has less correlation with the runoff contribution from each property. • Tax-exempt properties, such as governmental properties, schools, colleges, and universities, do not support any of the cost of stormwater management, even though many of them are major contributors of stormwater runoff. • Property owners have limited ability to reduce their charge (i.e. no incentive to adopt source controls).	City of London, City of St. Thomas, City of Aurora City of Richmond Hill
Property Tax Surcharges (Dedicated Tax Levy)	• Property-tax-based revenues are already accepted as the primary existing source of revenue for municipalities. • The billing system is already established for property taxes. • Maintains status quo for property owners (maintains tax exemption and PILOT contributions for currently eligible properties). • Additional administration costs are negligible. • Maintains constant revenue stream for the City's SWM program.	• Property taxes are based on a property's value, which may not equate to its runoff contribution. • Property owners have limited ability to reduce their charge. • Tax-exempt properties contribute very little or nothing to support the stormwater management program. • When revenue requirements change, it is difficult to equitably increase the charge commensurate with runoff.	City of Mississauga

Stormwater User Rates (Based on impervious surface area)	• Dedicated and stable funding source, allows for long-range planning and large-scale capital improvements. • Fair and equitable fee that is based on runoff contribution rather than property value. • Costs for municipal Stormwater Management services are equitably distributed to all privately and publicly owned properties. • Introduction of a credit program will induce incentive to property owners to reduce stormwater runoff and pollutant discharge hence creating environmental awareness • Provides a mechanism to ensure privately owned Stormwater Management infrastructure is properly maintained.	• Additional implementation costs may be incurred (e.g. database management, billing and customer service). • The possibility that a new fee may not be well received by the public. • There is no way to remove or discontinue services for non-payment. Secondly, the service is provided to all properties without choice. • The actual service rendered to the property is often difficult to quantify.	City of Kitchener, City of Waterloo

While many municipalities charge property owners a certain fee for funding stormwater management systems, other financial and non-financial incentives can be used to encourage property owners to reduce stormwater runoff:

- **Credits for managing stormwater on site**. Municipalities like Waterloo and Kitchener have developed a stormwater credit program that offers property owners financial incentives for reducing the amount of stormwater runoff and pollutants that enter the municipal stormwater management system. The incentives include lower monthly stormwater management fees to all rate payers who demonstrate best practices in managing stormwater runoff. Practices such as using rain barrels to collect rainwater, installing stormwater treatment devices in parking lots and using permeable pavement to control runoff are eligible for credits.
- **Zoning** could be used to incentivize improved stormwater management by requiring a higher standard of performance. This is relatively easy to administer and provides developers with clear direction (e.g., more lot coverage is permitted if a certain percentage of that coverage is permeable).

Table 16. Framework for Stormwater Fee Discount Programs

Goal of Discount	Mechanism for Fee Reduction	Process for Implementation
Reduce Imperviousness	• Percent fee reduction • Per-square-foot credit	• Percent reduction in imperviousness • Square feet of pervious surfaces
On-site Management	• Percent fee reduction • Quantity/Quality credits (Performance-based)	• List of practices with associated credits • Total area (square feet) managed
Volume Reduction	• Percent fee reduction • Performance-based quantity reduction	• Percent reduction in imperviousness • Performance-based • Total area (square feet) managed • Practices based on pre-assigned performance values
Use of Specific Practices	• Percent fee reduction • One-time credit	List of practices with associated credits

Case Study: Green Permit Program - Chicago, Illinois

Established in 2005, the Department of Buildings' Green Permit Program offers owners and developers an innovative incentive to build green. Qualifying projects may benefit from an expedited permitting process and lower permitting fees. Projects qualifying for Tier I benefits will receive permits in less than 30 business days. Since earlier construction starts generally lead to earlier sales and reduced interest on construction loans, this time savings can translate into significant financial savings. Projects qualifying for the more demanding Tier II benefits may also receive a direct financial benefit in the form of reduced permitting fees of up to $25,000.

Chicago's comprehensive green infrastructure program results in highly visible changes in the City's landscape and also less visible but impressive changes, include that the expanded adoption of green practices and materials among developers and design community because of the familiarity of Low Impact Design.

See "Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure" for more case studies on financial mechanisms.

Figure 70. Chicago Green Permit Program. This building features a green roof, permeable pavers and bioswales, which meet Chicago's stormwater management requirements.