Sustainability Review

Swedish Expert Team

on behalf of

Swedish Trade Council

December 2004

Contents:

Executive Summary

1. Introduction
1.1 Background
1.2 Purpose of the review
1.3 Evaluation strategy
1.4 Organization
1.5 Implementation of the review

2. Sustainable Precinct Planning on the Toronto Waterfront
2.1 East Bayfront Precinct Plan
2.2 West Don Lands Precinct Plan
2.3 Sustainable Transportation
2.4 Sustainable Green Areas and Public Spaces
2.5 General Recommendations for planning of the Waterfront area as a whole

3. Sustainable Municipal Infrastructure and District Systems
3.1 Building an Infrastructure Network
3.2 Sustainable Energy
3.3 Sustainable Water Management
3.4 Sustainable Waste Management

4. Sustainable Building Design

5. Managing and Implementing Sustainability
5.1 Policies and programs – ideas for improving the TWRC Sustainability Framework
5.2 Integration of sustainability issues to ensure proper planning, design, tendering, construction, maintenance and operation
5.3 Environmental assessment in the planning stage
5.4 Environmental performance evaluation of buildings

6. Exemplary Initiatives: The Sustainability Centre

Appendix: Swedish Sustainability Principles and Practice
1 The Sustainable City Concept
2 Hammarby Sjöstad – the Stockholm Revitalization Waterfront project

Index of figures

Executive Summary

Executive Summary

Introduction

The Sustainable City Concept and Hammarby Eco-cycle Model (see Appendix 1 and 2) illustrate that there are excellent opportunities to integrate sustainability into all phases of Toronto waterfront revitalization. An integrated systems approach is crucial to ensure that community building actions are combined in a way that optimizes sustainability. In this review, special attention is given to using urban planning as a framework for developing synergies between infrastructure systems and other sectoral systems and strategies.

The following sentences from the *Making Waves*[1] express the City of Toronto's ultimate hopes for the waterfront area:

"A dream of transforming and re-energizing its waterfront into one of the great waterfronts of the world. A dream of building a spectacular gateway to this city, this province and this country."

Sustainability in its broadest sense may be achieved by *"building successful communities that combine long-term viability with the interlinked goals of economic, environmental and social gains"* (Sustainability Framework, Draft) One challenge for the waterfront area is to express the link between economic, ecological and social dimensions of sustainability in a clear way.

The Swedish Ministry for Foreign Affairs – through the Swedish Trade Council – works in partnership with Swedish industry to share Swedish knowledge and technology worldwide. During a Federation of Canadian Municipalities study tour to Sweden for municipal leaders, the Toronto Waterfront Revitalization Corporation was introduced to an integrated systems approach to designing, building and operating cities, widely practiced in Sweden. The approach is recognized globally as leading the way in innovative and exemplary sustainability practice.

The Swedish Trade Council organized a delegation of university researchers, municipal officials and sustainability practitioners from Sweden to undertake a sustainability review of Toronto Waterfront revitalization to date. The results of the exercise will allow the TWRC to ensure that all planning and projects, both underway and proposed, are consistent with international best practice in sustainability.

The Sustainability review of the waterfront area is to a large extent based on visions and ideas presented in the Sustainable City Concept, launched by the Swedish Ministry of Foreign Affairs, the Swedish Ministry of the Environment and the Swedish Environmental Technology Network (see Appendix 1). The City of Stockholm has recently revitalized a neglected waterfront area- Hammarby sjöstad. This example is a valuable reference case for integrated sustainability design, planning and implementation (see Appendix 2).

The Swedish model of sustainable city building is characterized by a holistic and integrated systems approach to land-use planning, major infrastructure development, building and public space design, cultural features, architectural distinction and community programming and education.

There are excellent opportunities to capture environmental, economic and social benefits using a sustainability approach to waterfront revitalization. This Review contains many suggestions designed to result in strong and sustainable communities on the Toronto waterfront. While the

[1] City of Toronto (2001) Making Waves: Principles for Building Toronto's Waterfront

Review team completed a five-day visit to the Toronto waterfront site in October 2004, many of the ideas contained in this review may need to be tested in more detail for feasibility in the local setting.

As well, leadership in sustainability is not absolutely dependent on implementing all of the suggestions included here. What is important is to ensure that a sustainability approach is applied to those activities that do go forward. As well, some of the suggestions in the review may be too costly or unsuitable for implementation on the Toronto waterfront, in the short-term at least. However, it must be borne in mind that it is much more cost-effective to build sustainability into planning and design from the very beginning rather than proceeding with more conventional approaches and then adding on sustainability features at a later date. Cost-effective solutions are, in fact, a vital component of a sustainability approach.

The observations and recommendations in this review are presented according to four areas of focus:

- Precinct Planning (Section 2)
- Municipal Infrastructure (Section 3)
- Building Design (Section 4)
- Implementation (Section 5)
- Exemplary Initiatives (Section 6)

It should be emphasized, however, that all of these areas are interrelated and that a sustainability approach to waterfront revitalization must reflect an understanding of the relationships between different components such as site and building design and decisions concerning major infrastructure.

Suggestions for leading sustainability initiatives are highlighted throughout the review but several major ones are also included in Section 6.

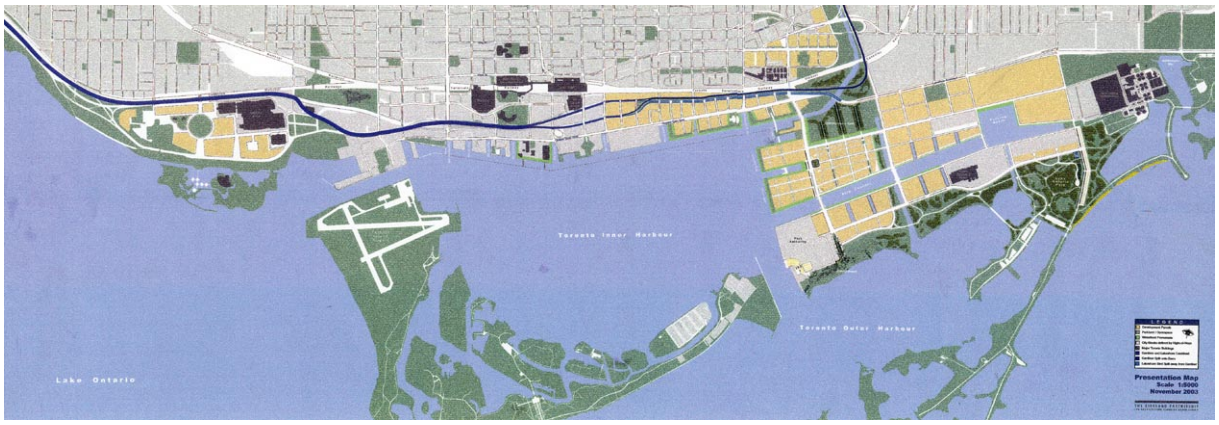


Figure S1 – An overall Plan of the Toronto Waterfront Area

Sustainable Precinct Planning on the Toronto Waterfront

Both the East Bayfront Precinct Plan and the West Don Lands Precinct Plan present a set of proposals and commitments that, to a large extent, are well aligned with sustainability principles. The current plans go a long way towards addressing environmental, social, cultural and economic considerations as part of land use development. At present, there is no direct link between the environmental commitments made in the plans and more detailed site and building design but the plans do appear to support the type of sustainability policy outlined in the TWRC's draft Sustainability Framework. The value of the plans as sustainability tools will

be dependent on future detailed site design and planning and the way in which sustainability principles and practice are integrated into all phases of the revitalization process.

Ideally from a sustainability perspective, precinct planning would not have gone ahead until information was available and decisions made regarding the most sustainable form of major infrastructure across the waterfront. Infrastructure decisions traditionally go hand-in-hand with decisions about commitment of major financial resources and are notorious for requiring years of study and debate before a resolution is reached.

In order for the Toronto Waterfront Revitalization Corporation to move forward with waterfront revitalization, land use planning for the site was the most reasonable path to take. Early work on site planning did not rule out sustainable infrastructure options. It may have added to the costs of implementing sustainable infrastructure solutions due to the need to work with predetermined block and street layouts rather than starting from a completely blank slate.

Almost all of the discussion throughout this review has implications directly and indirectly for the precinct land use plans, which are commented below.

East Bayfront

The East Bayfront Precinct Plan East would be improved by placing the Gardiner expressway underground and decking and building over the railway. These measures would radically change the conditions for land use planning in the northern part of East Bayfront.

In a SWOT-analysis of the precinct plan, strengths and weaknesses are outlined in more detail in Chapter 2. In our view the main strengths of the plan are:

- The current precinct plan presents an excellent environmental program on four charts, including seven principles of sustainable development: energy; harmful discharges; materials; biodiversity; water; indoor environment; human participation. Strategies for achieving each principle are listed.
- Clear and succinct objectives are set for sustainable community services including a proposed affordable housing strategy
- The area between Queens Quay and the waterfront is designed in a manner that supports sustainability.
- The central public transportation spine has the potential to be an attractive link between different areas of the waterfront. Better links to the rest of the City should be explored.
- The prerequisites are in place for using solar radiated energy for heating, lightning and electricity generation and for utilizing wind for natural ventilation and electricity generation.
- The prerequisites for linking the blocks to district heating and cooling systems are favourable due to the high urban density
- There are good options for installing a vacuum transportation system for source separated waste and for installing a dual storm water system
- The zoning of the waterfront promenades is a feature with great sustainability merit.
- The idea of louvered covered walkways that open and close depending on the season is a powerful design concept.

Chapter 2 includes an analysis of some of the weaknesses of the current plan from a sustainability perspective and addresses these weaknesses as a basis for further improvement of the plan.

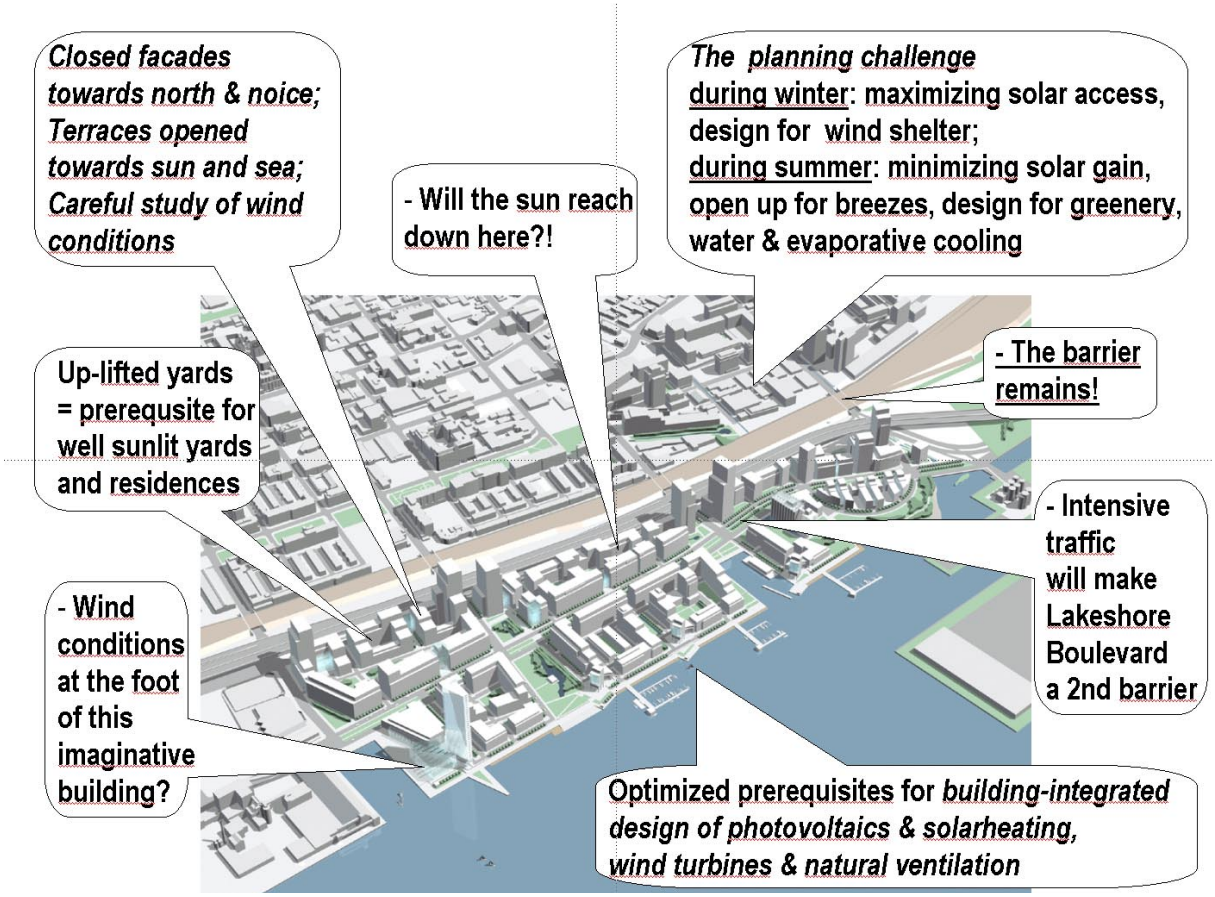


Figure S2 East Bayfront Precinct Plan – some important Issues

West Don Lands Precinct Plan

The West Don Lands Precinct Plan present a well-thought out, almost traditional, street plan that is well adapted to the conditions and requirements of the site. The plan places buildings within the blocks in a way that is compatible with sustainable building practices. The potential for capturing the energy benefits of allowing sunlight into residential spaces and inner courtyards is adequately planned for although passive and active use of solar energy and wind energy are not clearly addressed.

In a SWOT-analysis of the precinct plan strengths and weaknesses are summarized. According to our view the main strengths of the plan are:

- The overall plan includes an analysis, public consultation framework, and proposal for private development guidelines and neighborhood character that set the stage for a strong response to several sustainability issues.
- The design of Front Street and Mill Street with generous spaces for walking and relaxation is a good prerequisite for community vibrancy.
- The northern and western parts of the area are well integrated in the cityscape. The distillery area is an integral part of the plan.
- The recommended transit service with an exclusive streetcar line on Cherry street gives excellent public transportation access to the central part of the West Don Lands.
- The prerequisites for linking the blocks to district heating and cooling systems are favorable due to the high urban density.
- There are good options for installing a vacuum transportation system for source-separated waste in the area.

- There are also good options for installing a dual storm water system.
- The overall landscape design of green spaces especially the Don River Park provides potential for detailed design and for the protection of the area from the eastern bow of the railway.
- The relatively low scaled buildings and closed yards within the blocks may contribute to wind-protected areas. Greenery and trees along the streets contribute to wind protection and good air quality.
- The overall plan provides good potential for expressing sustainability architecturally for example by integrating photovoltaic cells and/or small windmills into the roofs and walls of buildings.

In Chapter 2 some of the weaknesses of the precinct plan are also addressed as a basis for further improvement of the plan.

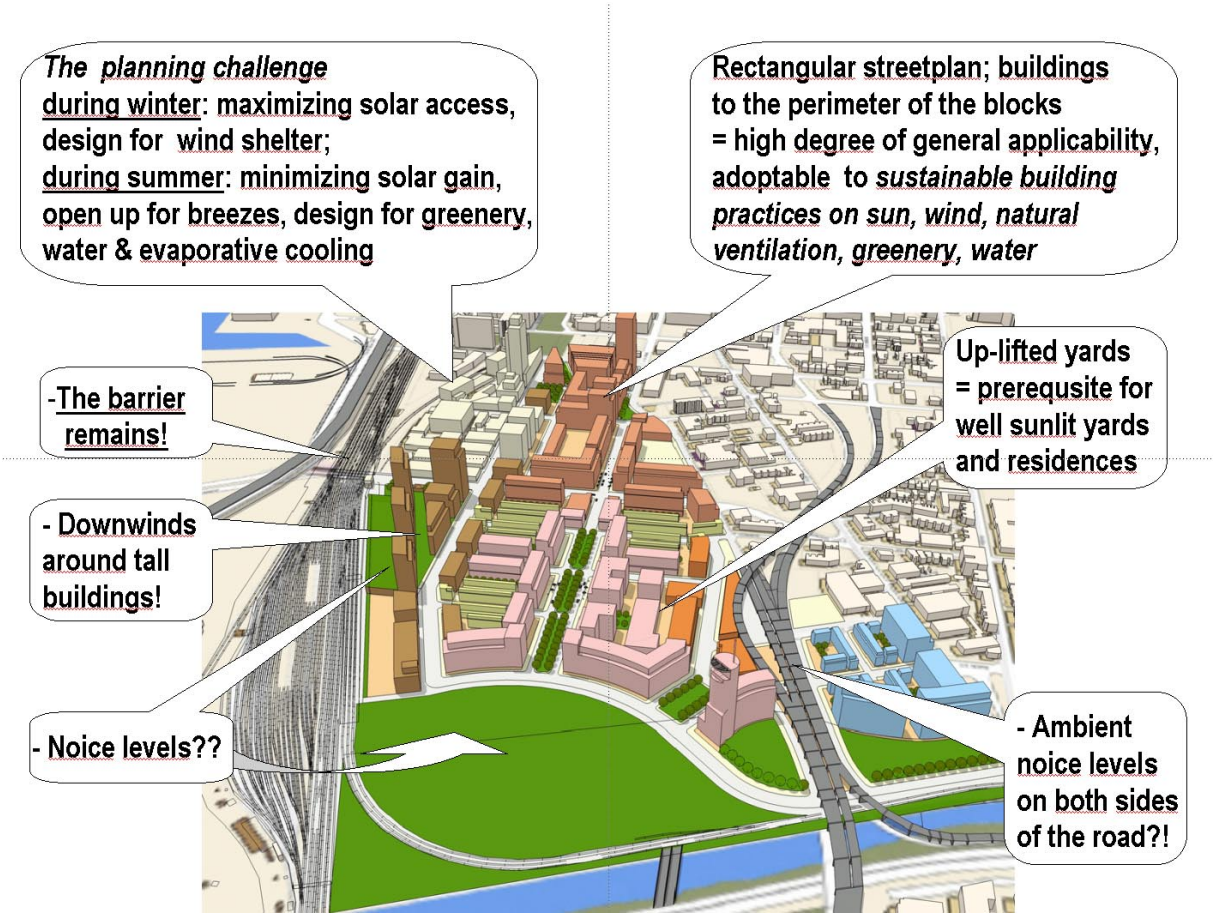


Figure S3 – West Don Lands Precicnt Plan – some important Issues

Sustainable Transportation
Sustainability is strengthened when urban planning and design discourage use of the automobile and make public transportation, bicycling and walking more accessible and comfortable. This element of a sustainable city is evident in the current precinct plans. A public transportation, bicycling and walking spine should be developed along the main streets of the waterfront areas – Queens Quay, Cherry Street, Commissioner Street and Unwin Avenue. The public transit stops should be designed as climate-protected mini-terminals with information clearly displayed.

The public transit stops should be located in mixed-use areas with reduced parking ratio but have direct, climatically protected access to cycling and walking links to adjacent blocks. Car-pools for cars fuelled by biogas and bicycle storages should placed at reasonable intervals throughout the waterfront. Public transit by boat is also possible.

Sustainable Green Areas and Public Spaces
Four notions underlie the achievement of sustainable green areas and public spaces, most of which are addressed in some form in the Central Waterfront Public Space Framework However, to strengthen the sustainability of the Central Waterfront Public Space framework it is recommended that the following issues be explored further:

- Public spaces and the green areas as social meeting areas.
- The micro-climate and energy savings impact of green areas along the waterfront in tandem with consideration of wind directions in wintertime and provision of shade in the summer time.
- Connecting the waterfront in an east-west direction to the same extent as the north-south axis currently evident in the precinct plans. This could be accomplished through a sequence of public places and green areas as well as the installation of integrated cycling and walking paths.
- Development of the Don River Park as an urban ecological and recreational park and its integration with the Tommy Thompson park and the rest of the waterfront without the highway and railway barriers currently in place.

General Recommendations for Precinct Planning:
Plan the Waterfront Area as Whole – An appraisal of urban planning and urban design concepts on the Toronto waterfront from a sustainability perspective dictates that the separate planning areas (or precincts) on the Toronto waterfront be considered as a single piece of the urban fabric. It is understandable from a phasing and scale perspective why the three precincts of East Bayfront, West Don Lands and the Portlands are being planning separately but maximum sustainability will depend on linking the three waterfront areas when making decisions regarding issues such as energy and transportation infrastructure, and green areas and public spaces.

Remove the Physical Barriers – As has been acknowledged in the Central Waterfront Plan and the plans for East Bayfront and West Don Lands, the waterfront must be better connected to the rest of the City of Toronto. For example, the existing physical barriers such as the highway and the railway corridors that separate the West Don Lands from the city should be removed for example by tunneling the highway and by decking and construction over the railway. This is the type of suggestion that would need to be evaluated locally based on economic, socio-cultural, ecological and spatial sustainability criteria but removing the physical barriers is key to ensuring integration with the City as a whole.

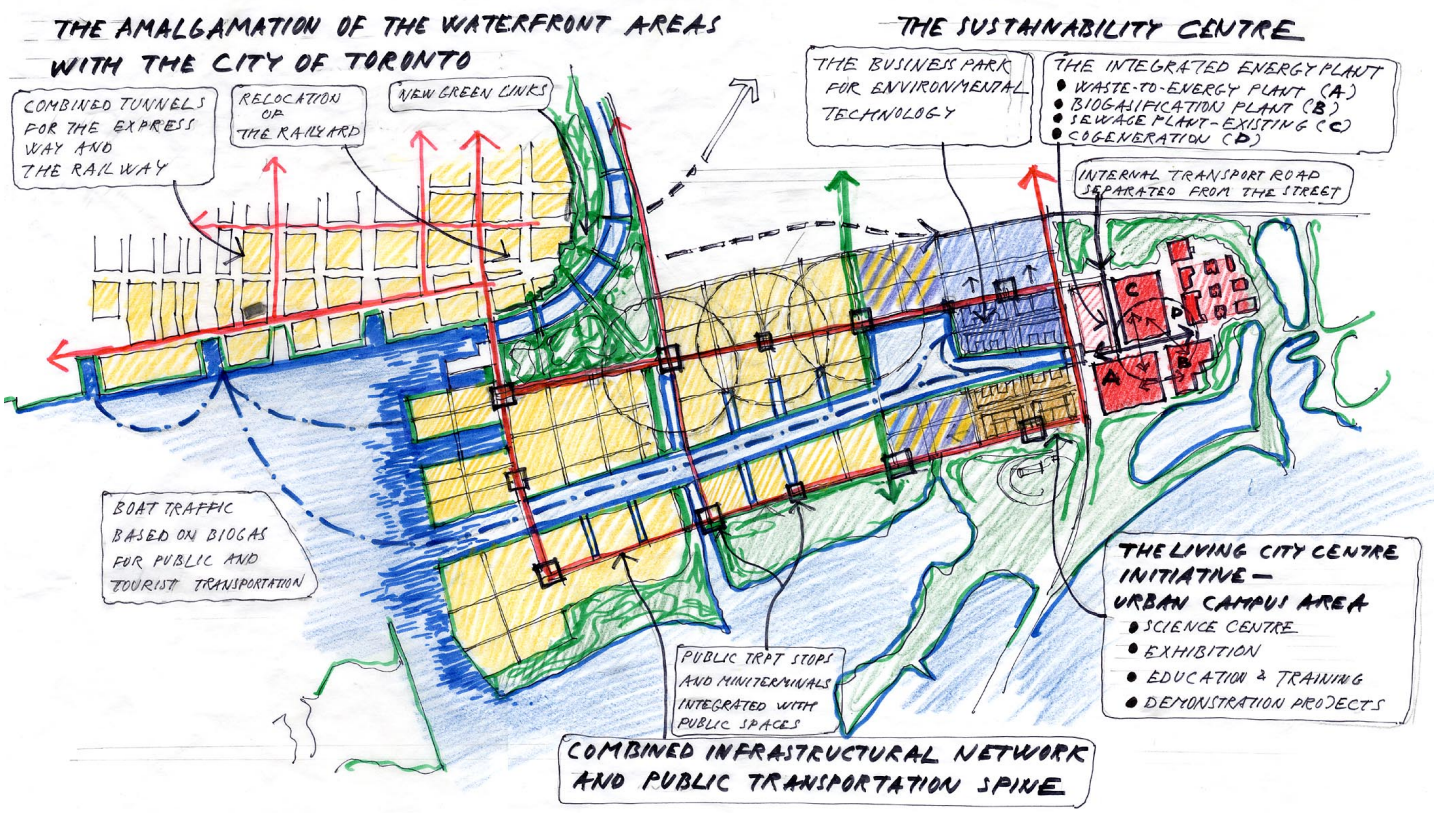


Figure S4 An overall Vision of the Waterfront Area. The figure should not be seen as a detailed land-use planning proposal. It points out some of the issues which are discussed in sections 2,3 and 6 of the report

Sustainable Municipal Infrastructure and District Systems

An eco-cycle model is a strategy for minimizing energy demand and optimizing a coordinated, sustainable energy supply. It is an approach that has been widely applied in Sweden and is relevant for the Toronto waterfront. Initial work relevant to an eco-cycle model can be found in the Toronto Waterfront Scan and Environmental Improvement Strategy Study, particularly the chapter dealing with energy. The model is based on the integration of energy from waste and energy from wastewater as well as from other renewables such as solar and wind energy and energy for cooling from the lake. Three problems have to be considered when developing the model:

- Supply shortage of electricity in the province of Ontario
- Toronto's ongoing landfill in Michigan
- The low costs in Canada for electrical energy as well as for gasoline compared to the European cost levels

Every facet of infrastructure development requires consideration of how to integrate sustainability principles into design, construction and operation.

Building an Infrastructure Network

Sustainability on the waterfront will be strengthened by the placement of an infrastructure network that is coordinated with the precinct land use plans. The infrastructure network should include a series of pipes designed for a variety of uses including district heating and cooling, the vacuum transportation of organic waste, and transport of drinking and wastewater. The pipes should be located side-by-side and placed below traffic and green space corridors. In addition, ducts should be laid for the distribution of energy, broadband communication and other services.

Sustainable Energy

Sustainable energy planning is based on widespread implementation of energy efficiency measures at each stage of revitalization coupled with maximizing the use renewable energy sources and minimizing the use of fossil fuels.
Five steps must be taken on the Toronto waerfront to meet international standards for sustainable energy production and use:

Step 1 – Reduce electricity consumption.
The most important component of a sustainable energy strategy is the application of deep lake water cooling (DLWC) as summer cooling demand in Toronto downtown area constitutes as much as 55% of the total electricity load. As these solutions will drastically reduce electricity consumption in the Toronto area we question the establishment of a new natural gas fired energy plant. Instead, the issue should be to utilize DLWC so efficiently that plants for production of electricity could be closed down.

Step 2 – Increase energy efficiency of the building stock and infrastructure
The four principles for energy planning presented under the heading Building Design (below) and addressed in more detail in Section 4 should be applied.

Step 3 – Apply renewable energy supply technologies
Technologies for renewable electricity generation, such as wind turbines, must be given greater priority. A feasibility study of the concept of wind turbines offshore is of high interest as 25

units producing 250 GWh can meet electricity needs for the entire waterfront if we assume the application of DLWC system for cooling of both apartments and offices.

Step 4 – Evaluate integrated energy production
An energy plant located adjacent to and coordinated with the Ashbridges Bay Sewage Treatment Facility has the potential for producing both heat and electricity from waste and wastewater. The size of the plant should be optimized in relation to other renewable resources such as wind and solar energy. If the energy efficiency of the building stock is increased (step 2), DLWC is applied and wind energy is captured then options for waste-to-energy facilities could be discussed.

Step 5 – Infrastructure for district heating and cooling
Due to the planned densities on the waterfront district heating and cooling are the superior options from both a long-term sustainability perspective and short-term environmental perspective. A district energy system is also the most economically feasible alternative, even with the currently low price of various energy sources in Canada.

Deep lake water cooking is also key to a significant reduction in electricity demand in the summertime.

Sustainable Water Management

The review supports TWRC's plans to extend the existing City distribution network to the waterfront as a whole. Small-scale systems or private systems are not recommended.

Experience in Sweden has demonstrated that household metering systems that track the quantity of hot and cold water used and provide that information immediately back to the household can have a dramatic effect on reducing water consumption. The Ashbridges Bay wastewater treatment plant is a well-functioning secondary treatment plant with a capacity to receive water from waterfront communities. For the Toronto waterfront at large, it is suggested that:

- systems for capturing the nutrients at the plant are investigated, and that experiences from other countries are studied;
- there is little to be gained from separating urine or black water systems in new waterfront buildings. However, the technology is suitable for inclusion in demonstration buildings in each precinct.
- a program is launched with the objective of tracing sources of environmentally hazardous substances that end up at WWTP, with a subsequent action plan to eliminate or reduce these sources.

With respect to stormwater management, a dual stormwater system is proposed. The main advantages are:

- The polluted stormwater from traffic areas can be treated in properly designed oil separators and settling tanks underground.
- The relatively clean water from roofs and open spaces can be treated in a pond, inside or outside the planned flood protection berm in West Don Lands. The ponds could be designed as an integral part of the green spaces across the site.

Sustainable Waste Management

There are already existing and proven systems for source separation of packaging, paper,

cardboard and organics in place in the City of Toronto. Some of the systems have to be further developed, especially the source separation systems for apartment buildings. In new areas, such as the Toronto Waterfront, it is recommended that a centralized vacuum collection system (CVC-system) be installed for the collection of waste and separated fractions. A preliminary environmental impact analysis comparing the operational impact of a CVC-system with conventional rear loading waste collection trucks for the area shows that the air emissions, the traffic load and the ground level area needed will be considerably less if a CVC-system is used.

There will be a need for an increased capacity of biological treatment as a result of the increasing collection of source-separated organics. Locating a biogasification plant in Portlands would give a total capacity in Toronto for the biological treatment of about 300,000 tons of organics, locally and in central treatment plants.

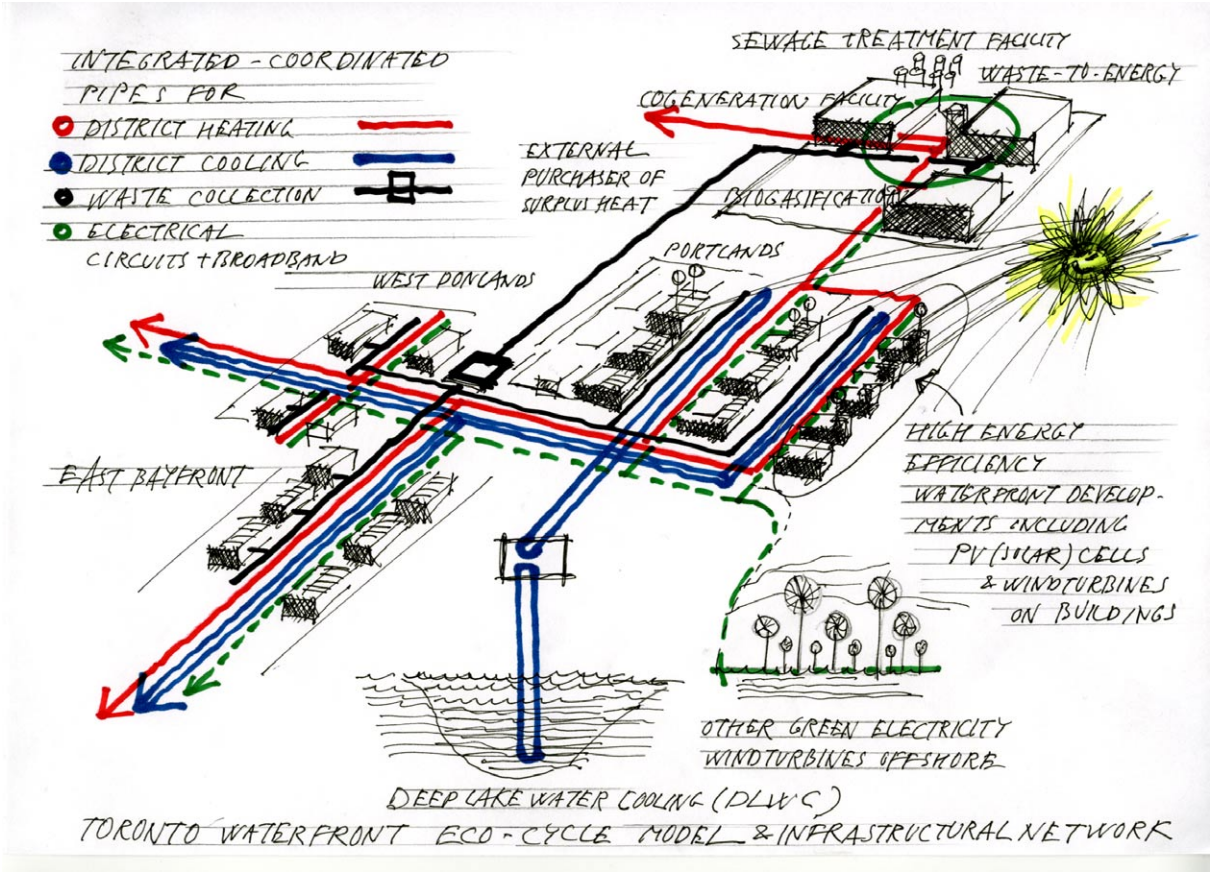


Figure S5 The proposed integrated Infrastructure Network for the entire Waterfront

Sustainable Building Design

The opportunity to achieve high standard sustainable buildings across the site is dependent on integrating sustainable design principles into the detailed planning for the precincts and site-wide infrastructure and in identifying and implementing a suitable set of sustainable building standards for all built form on the waterfront.
In general, the sustainability of buildings is related to:

- Environmental impact caused by **energy consumption during operation**;
- Environmental impact caused by **materials use**, including waste treatment, during construction and operation;

- Use of **environmentally harmful materials** during construction and operation – materials harmful to ecosystems and human health; and
- Impact on **air quality and noise level** in homes and premises, caused by the design, construction, operation and maintenance of buildings elements and systems.

The **energy issues** are addressed in the planning and infrastructure development stages through:

- Layout of the areas and its buildings, streets and squares with regard to sun and wind;
- Minimization of energy demand by way of architectural means;
- Use of renewable energy sources, with priority for passive solar systems and for active solar systems.
- Use of best available technologies for meeting energy efficiency goals.

Figure S6 A Swedish Reference Example of Sustainable Building Design: Gårdsten in Gothenburg and Mälarstrand in Stockholm

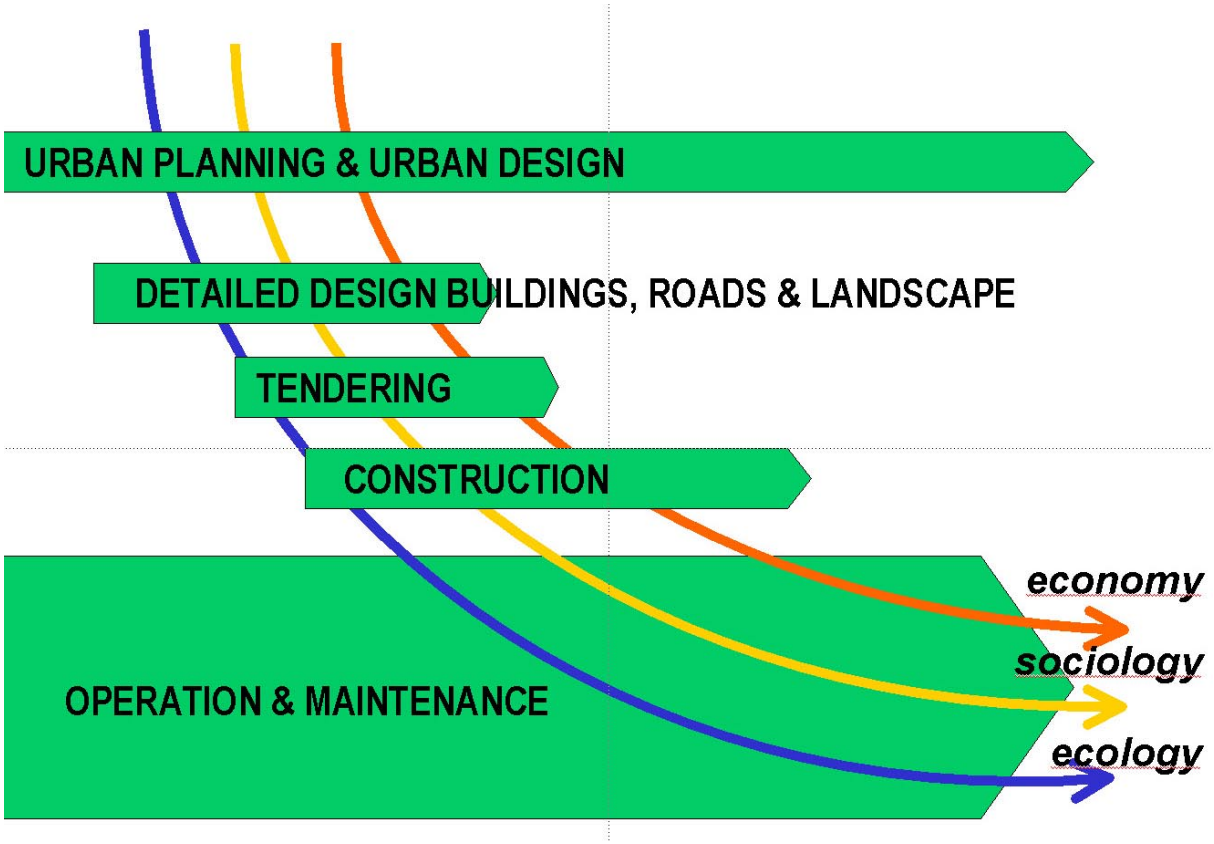


Figure S7 – Sustainability Issues have to be integrated in all Phases of the transformation Process

Managing and Implementing Sustainability

The TWRC Sustainability Framework is the crucial document for achieving the goal of making the city's waterfront both a national and a global model for sustainability, setting new standards for best practices not only in Canada but throughout the world. The Framework presents a broad and holistic sustainability vision, a wide analysis of the sustainability challenge and a concrete action plan with important guidelines for the Toronto Waterfront Area.

Support for the Sustainability Framework from the three governments is a prerequisite for success. It is also essential that a change of government and short-term policies do not interfere with the TWRC's sustainability policies or process for sustainability implementation.

It is recommended that a summary of policies, goals and targets contained in the Sustainability Framework be produced and updated at regular intervals over the next 20 years. The essential messages of the framework must be clearly and succinctly communicated to assist the public and other major players on the waterfront with understanding and remembering the TWRC's sustainability objectives. The Swedish Sustainable City concept may be useful as a source of inspiration on how to introduce the framework to a wider audience.

In Section 3 of the framework, it would be useful to separate objectives and targets from proposed actions and technical solutions. This will allow development of alternative innovative technologies and strategies beyond those currently known.

The specifics of the "practical integration of sustainability issues into all phases of the waterfront revitalization process" need to be developed further. It is important to identify the crucial sustainability issues in each phase of waterfront development such as: comprehensive and detailed urban planning and design, design, tendering and construction of buildings, roads and parks and maintenance and operation. A sustainability checklist should be developed for each phase. The checklist for *Hammarby sjöstad* could serve as a model for this task. It is, however, important to point out that the development of the checklist should be part of an intense dialogue between the local experts and stakeholders in order to take local conditions into account.

It is sometimes difficult to directly transfer detailed technical solutions developed in one context to another due to differences in institutional, economical and social conditions. Strategies, approaches and working tools, however, can more easily be used in different contexts as they focus more on the process, the dialogue, desired outcomes and the general working procedure than specific local details.

Figure S8 – Swedish Reference Examples of Exhibtions communicationg Sustainability Issues – The Information Centre of Hammarby Sjöstad and the World Culture Museum in Gothenburg

Exemplary Sustainability Initiatives

A ***Sustainability Center*** should be established in the Portlands area based on an integrated energy plant and based on the eco-cycle principle. A business park focused on environmental and energy technologies and an urban campus area based on the Living City Center initiative should also be developed as integral parts of this centre. By locating the center physically at the site of the Ashbridges Sewage plant this area at the far end of the Portlands will be a focal point for sustainable urban development that will contribute to the overall urban quality of both the waterfront areas and the City of Toronto.

The three elements of the center reflect economic- technological, socio-cultural and ecological perspectives on sustainable urban development. The energy plant includes production of energy for heating and electricity (cogeneration) from renewable resources such as waste, wastewater or bio-fuels combined with solar energy and wind-energy from wind turbines offshore. The emissions to the surrounding environment can be reduced to a negligible level by modern technology. The size of the plant can be optimized in order to cover the needs of the waterfront development or additionally to supply energy for other parts of the City of Toronto.

The business park can practically illustrate that environmental protection and energy efficiency can promote economical growth and be a vehicle or lever for economical progress. A waterfront campus of the Toronto and Region Conservation Authority's ***Living City Centre*** initiative could be seen as an urban satellite of the main campus area north of the City of Toronto. A science center, exhibitions, education and training functions as well as demonstration projects for objectives such as renewable energy in connection with the energy plant should be developed and built. The centre could be the place where sustainability demonstration projects for the entire waterfront area are organized and coordinated. Citizens of Toronto, the region, the province, the country and the rest of the world could be drawn to the waterfront to see the on-going, innovative examples of sustainability in action.

Concluding remarks

It has been a real challenge for the Swedish Expert Team to evaluate the comprehensive and excellent planning, design and sustainability policy documents prepared for the Toronto waterfront. In our opinion, the basic approach to waterfront revitalization is sound and, in most ways, is consistent with high standards for sustainability

We have tried to emphasize the issues that we have found critical for both short-term and long-term success towards the ultimate goal of becoming a leading edge sustainability example for the world. Our main efforts have focused on:

- Appraisal of the precinct plans as they relate to integrated land-use, infrastructure, transportation, landscape and buildings vis-à-vis the economic, socio-cultural and ecological aspects of sustainability
- Providing suggestions and examples of procedures, programs, methods and tools for achieving sustainability on Toronto's waterfront.
- Identifying leading edge sustainability initiatives for the waterfront such as the integrated infrastructure and energy approach focusing on the synergies between waste, waster water and energy and the interplay with high energy efficiency developments and renewable energy resources such as wind and solar energy

We hope that some of our recommendations will contribute to the process of integrating sustainability issues into all phases of waterfront revitalization. We fully realize that ideas with roots in a European and Scandinavian context may not so easily be adapted in a Canadian context with its differing legislation and policies and differing local conditions. We would consider it a honour if there were potential for further dialogue and exchange of experiences between Sweden and Canada in the effort of transforming and re-energizing the Toronto waterfront into one of the great waterfronts of the world and to make the dream sustainable in its broadest sense.

1. Introduction

1. Introduction

1.1 Background

Toronto is a culturally diverse Canadian city of over 2 million people located on the banks of Lake Ontario, in northeastern North America. Like many cities situated on water, Toronto's waterfront has historically been very important to the city. Over time, the area of the city adjacent to the lake has shifted from being the focus of industrial and economic activities to becoming a part of the city characterized by tracts of abandoned, and in some cases, contaminated land. Access to most of the water's edge is not easy and it has often been said that over the last fifty years the City has turned its back on the waterfront.

In 2001, the Federal Government of Canada, the Province of Ontario and the City of Toronto established the Toronto Waterfront Revitalization Corporation (TWRC) to:

Transform the Toronto waterfront for the use and enjoyment of the people of Toronto, Ontario and Canada, to foster economic growth and to re-define how the city, province and country are perceived by the world.[2]

The City Planning Division within the City of Toronto has completed a general plan focused on 800 hectares along the Central Waterfront[3] that anticipates over 40,000 new housing units for over 68,000 people. The TWRC has been carrying out more detailed planning for several districts within the waterfront area and work has also begun on energy and transportation strategies along with parks and open space planning.

Implementing Sustainability

The TWRC has recently completed a draft sustainability framework that lays out a set of principles, targets and actions for ensuring that sustainability principles are integrated into all facets of waterfront revitalization. The TWRC, along with the three levels of government involved in revitalization efforts, is strongly committed to maximizing the sustainability opportunities on the Toronto waterfront. The TWRC views a sustainability approach as the only way to ensure innovative and progressive waterfront revitalization that will result in dynamic livable communities that provide a wide range of economic, environmental, cultural and social benefits to the people of Toronto, the province and to Canada as a whole.

At the time the three levels of government gave their commitment to waterfront revitalization, several waterfront projects were launched- largely independently of each other - before a senior management team was put in place. These projects began before corporate policies on sustainability were developed.

Swedish Involvement in the Sustainability review

The Swedish Ministry for Foreign Affairs- through the Swedish Trade Council- works in partnership with Swedish industry to share Swedish knowledge and technology worldwide. During a Federation of Canadian Municipalities study tour to Sweden for municipal leaders, the Toronto Waterfront Revitalization Corporation was introduced to an integrated systems approach to designing, building and operating cities that are widely practiced in Sweden. The approach is recognized globally as leading the way in innovative and exemplary sustainability practice.

2 Toronto Waterfront Revitalization Corporation (2001). Corporate Mission Statement
3 see City of Toronto (2003) Making Waves: Central Waterfront Secondary Plan, (http://www.toronto.ca/waterfront/waterfront_part2.htm)

Figure 1:1 The Sustainable City – A Systems Approach on Sustainability (see Appendix 1 for further presentation)

The Swedish Trade Council has organized a delegation of university researchers, municipal officials and sustainability practitioners from Sweden to undertake a sustainability review of Toronto waterfront revitalization. The results of the exercise will allow the TWRC to ensure that all planning and projects, both underway and proposed, are consistent with international best practice in sustainability.

1.2 Purpose of the review

Two main tasks were completed:

A review of sustainability opportunities across the waterfront from the perspective of infrastructure and related planning for energy, waste, water and wastewater, and transportation. The emphasis is on how to combine infrastructure systems to maximize economic, environmental and community benefits. The principles driving the completion of this task are consistent with the relevant objectives, targets and actions within the TWRC's draft Sustainability Framework.

An appraisal of the West Don Lands Precinct Plan and of **the East Don Lands Precinct Plan** to determine the extent to which each one supports the TWRC's sustainability goals and the opportunities for maximizing sustainability as determined during Task 1.

An overall focus of the work was to identify what it is possible to do to strengthen the integration of sustainability in all planning, design, tendering, construction and operation. The starting-point for the work was the comprehensive material already produced. From there the approach was to try to identify relatively new or refined strategies and technical solutions for achieving sustainability on the waterfront from the short-term, medium-term and long-term perspectives.

1.3 Evaluation strategy

In order to fulfill the overall objective of the review to maximize the sustainability opportunities presented by the Toronto waterfront we have applied an evaluation strategy that is primarily based on a systematic methodology for sustainable spatial and urban planning and combined that with the conceptual framework of ”the Sustainable City”project.

The following steps have been carried out during the review. Each step includes systematic benchmarking activities, best-practice examples of methods, tools, solutions and systems from Sweden as well as analysis and suggestions regarding how to implement Swedish experience.

Step 1: Institutional arrangements and policies for the future
Step 2: Analysis of external and internal conditions
Step 3: Formulation of overall visions and goals, objectives targets and indicators
Step 4: Further development of planning proposals, technical systems and technical solutions
Step 5: Analysis of the consequences of plans, programs and projects (strongly linked to Step 3)
Step 6: Strategies for implementation of plans and projects

Each step may applied to the following areas; urban governance; community planning; community consultation; systems integration; transportation and traffic; parks and open spaces; energy infrastructure; integrated waste management; water and waste water; soil remediation and building and site design.

1.4 Organization

The Swedish project team includes the following five experts:
Prof. Ulf Ranhagen , Technical University of Luleå and chief architect at SWECO FFNS, Team leader for the Swedish expert group
Mr Håkan Rylander, CEO SYSAV and President ISWA 1996-98
Ms Kerstin Blix, Senior Advisor, the National Rail Administration (former Environmental Manager, Hammarby Sjöstad)
Mr Henrik Berg von Linde, Senior Architect and expert on sustainable buildings, SWECO FFNS
Prof. Per-Arne Malmqvist, University of Chalmers in Gothenburg, Head of the MISTRA Urban Water program
Mr Rutger Engsäll, Vice President of the Swedish trade Council in Stockholm has been the Head of the Swedish Delegation and has also been deeply involved in the planning and organization of the review in collaboration with Mr Johan Ögren, President of the Swedish Trade Council in Canada and Angelica Ingerdal at the Swedish Trade Council in Stockholm.

Other experts who have been consulted are:
Prof. Thorbjörn Andersson, University of Life Sciences, Ultuna
Mr Gunnar Nordberg, Master of Engineering and energy expert, SWECO Energuide
Mr Jonas Thörnblom and Mr Yngve Forsgren, ENVAC
Mr Björn Kvist, Master of Engineering and expert on tunnel construction, SWECO VBB
Mr Sverker Hanson, Master of Engineering and expert on traffic planning, SWECO VBB

Our main contact persons at TWRC have been Mary MacDonald, Director, Sustainable Development Systems and John Campbell, President and CEO of TWRC
Robert W. Webb, Senior Vice President of Marshall, Macklin Monaghan has been involved in the discussions of the technical parts of the material. During our visit to Toronto in October we took part of several presentations/discussions, including but not limited to:
– The precinct plans; Pino Di Mascio and Joe Berridge, Urban Strategies, Joe Lobko UDA associate
– Municipal Services and transportation; Steve Willis, Marshall Macklin Monaghan, City of Toronto staff and Province of Ontario staff
– Natural Heritage Issues across the waterfront including Aquatic and Terrestrial Habitat
– Toronto and Region Conservation for the Living City
– Enwave District Energy Limited

1.5 Implementation of the Review

The work was carried out during October – December 2004 in the following phases:

Phase 1 Preparation
Phase 2 Local study
Phase 3 Conclusions
Phase 4 Final delivery

In the following figure presents major tasks for each phase of the work:

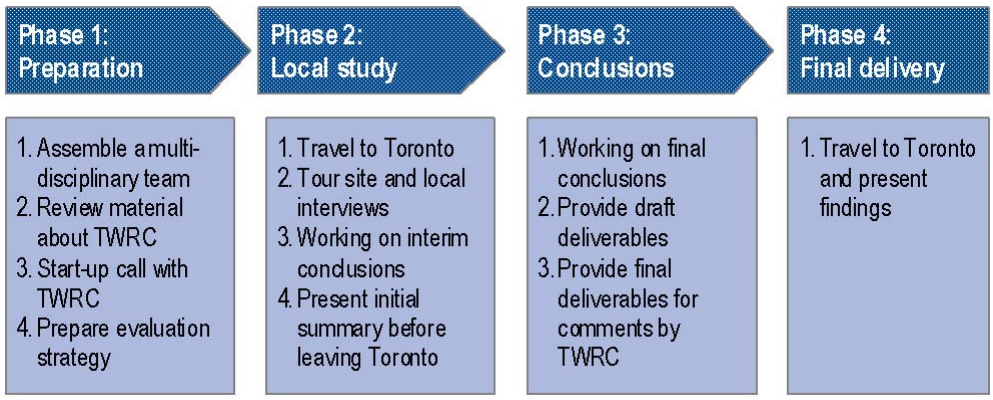


Figure 1:2 Major Tasks for each phase of the Work

2. Sustainable Precinct Planning on the Toronto Waterfront

2. Sustainable Precinct Planning on the Toronto Waterfront

To begin, it is important to realize that the sustainability of the precinct plans will be determined by several factors. For example, the sustainability of a new building or block of buildings on the waterfront will be influenced by the extent to which sustainability principles have been incorporated into site planning, infrastructure planning, waterfront-wide planning and prevailing City of Toronto plans and policies as well as the plans and policies of provincial and federal agencies. *The sustainability potential for the two precincts are thus dependent on a coordinated infrastructure concept including an integrated energy concept for the waterfront* ***– concepts which have not yet been developed.*** Therefore, as commented on in more detail in Section 3, *the sustainability of these concepts and their application to precinct planning cannot currently be evaluated.*

An evaluation of the potential for sustainability and sustainable buildings within the context of the West Don Lands and East Bayfront precinct plans has to take into account all aspects of sustainability, that is, environmental, economic, social and cultural. However, *this part of the review will to a large extent be confined to the technical aspects of environmental performance evaluation,* when commenting on the proposed built environment of the two precinct plans. At the end of this section, we put forward general ideas concerning sustainability issues in a broader sense for the waterfront as a whole.

Secondly, the sustainability of the precinct plans is, in part, dependent on the environmental programs laid out in the two plans. The **East Bayfront** Precinct Plan presents a well thought-out *environmental program* on four charts, including seven principles of sustainable development: energy; harmful discharges; materials; biodiversity; water; indoor environment; and public consultation. Proposed strategies for implementing each principle are listed. The **West Don Lands**, on the other hand, presents one chart on the theme of sustainability, which mainly refers to future work to be done according to the TWRC Sustainability Framework. (The expert group finds the TWRC draft Framework, as commented on in Section 5 of this review, to be an excellent, carefully prepared document.)

The environmental programs, such as the one in the East Bayfront plan and in the TWRC Framework, are indispensable prerequisites for sustainability planning and design as are a waterfront-wide infrastructure plan that includes a strategy for achieving sustainable energy objectives. Our judgment is that there are good options for strengthening the connections between the proposed environmental programs and the two precinct land use plans.

2.1 East Bayfront Precinct Plan

The East Bayfront area has extraordinary sustainability potential, not only with regard to its lakeside location and view, but also due to wide exposure to the south. The extensive southern exposure provides excellent access to energy from the sun, which is strengthened by the sun's reflection in the nearby water. The precinct is also well-positioned from the perspective of wind power and natural ventilation.

The East Bayfront Precinct Plan would be improved with the removal of the Gardiner Expressway and the railway. An underground localization of the Gardiner expressway and a railway tunnel or decking of the railway would radically change the conditions for the layout

of the blocks in the northern part of East Bayfront. The Bayfront area is influenced along its entire length by the Gardiner expressway which means that the northern blocks are seemingly jammed, affected by traffic noise and traffic exhausts.

The review team felt that the building schemes for Option A, B and C presented in the model photos and discussed in accompanying written material give the impression of being rather roughly outlined.

However, it is possible to interpret that the plan proposed relatively low buildings along the shoreline and successively raised building heights to the north, allowing views over Lake Ontario and allowing sun into the buildings. Car parking under raised yards in the northern part of the blocks raises the above ground yards into the sun. Closed, wind sheltered yards are to be combined with sightlines over the lake. The possibilities of passive and active utilization of sun energy are immense, as well as utilization of wind for energy and natural ventilation. The idea of louvered covered walkways, that open and close depending on the season, is a powerful design concept that would place the Toronto waterfront on the world map for sustainability, if applied along the entire quay.

Conceptual systems for water management in East Bayfront are discussed in Section 3 of this report (see 3.3.4 Water Management in East Bayfront).

A summarized judgment of the Swedish expert team is that the layout of the building schemes within the blocks must be designed in greater detail to ensure the necessary consistency with sustainability principles. However, the proposed precinct plan has great potential in this regard. The restrictions given by the northern barriers of the Gardiner and the railway pose an on-going problem. The extraordinary sustainability opportunities of the lakeshore site must be convincingly exploited.

Aspects	***Strengths***	***Weaknesses***
Principles of sustainable development, methodology	Goals and ambitions summarized in seven principles of sustainability. The evaluation of alternatives regarding water, wastewater, stormwater and utility corridors and transportation alternatives give a good basis for further design	There is no comprehensive evaluation of the three urban planning and design options A, B and C with regard to stated goals and ambitions
Social aspects	Clear and succinct objectives for sustainable community services, demography and proposed affordable housing strategy	Except for the buildings along the water's edge there are no analyses or spatial illustrations on commercial, cultural and social service functions with housing and work-places within the proposed blocks in options A, B and C The illustrated structure of the courtyards seems somewhat messy and accidental with no clear division of public, semi-public and private spaces
Sustainable urban planning – functional aspects	The area between Queens Quay and the waterfront appears very functional due to the rectangular or square proportions of the blocks	It may be difficult to obtain flexible and well functioning blocks in the northern part of the area due to the narrow, oblong and triangular shape of the area between Queens Quay and the Gardiner expressway. The north facades along the expressway must be designed to protect the Bayfront area from traffic noise and to resist accidental impact.

Aspects	*Strengths*	*Weaknesses*
Mobility – sustainable transportation	The central public transportation spine has good potential for being an attractive link between the waterfront areas	The options for connecting the area with the city should be further investigated; there is too much emphasis on the east-west axis.
Sustainable buildings *Energy aspects*	There are good options for a variety of building types in the blocks along the water edge that should be systematically investigated Good potential for utilizing solar radiated energy for heating, lightning and electricity generation respectively for utilizing wind for natural ventilation and electricity generation. This later possibility requires a feasibility evaluation. The prerequisites for linking the blocks to district heating and cooling systems are favorable due to the high urban density. The realization of this potential will depend on the next stages of detailed design and planning.	The triangular and oblong shape of the area north of Queen's quay limits to a certain extent the options for designing the buildings in a sustainable way The layout of the blocks and the orientation of buildings should be studied more in detail in order to maximize the options for passive and active solar systems. The northern part of the area has a large amount of shaded building space.
Waste and water	There are good options for installing a vacuum transportation system for source-separated waste in the area. There are also good options for installing a dual stormwater system. The realization of this potential will depend on the next stages of detailed design and planning	
Green areas	The zoning of the waterfront promenades in three zones for flexible uses, recreational cyclists and inline skaters and walkways for pedestrians is a meritorious feature with good options for further development consistent with sustainability principles.	There is a lack of clarity concerning the overall green structure .The principles for the green areas should be further developed to reflect the notions and hierarchies of public spaces, ecological content, green spaces and recreational opportunities. Ecological and hydrological issues should be considered as an integral part of the green areas
Outdoor climate	The idea of louvered covered walkways that open and close depending on the season incorporating energy efficient design features has the potential to be a leading global example of sustainability practice. Wind conditions provide for well ventilated streets with the air quality of the lake.	
	Microclimatic/wind simulations are necessary as a basis for further design of both buildings, parks and streets Solar access and solar shading must be simulated during the design process	
Visual aspects – interplay between built environment, street design and landscape design		The preliminary proposals do not seem to be based on an analysis of the townscape of the City of Toronto and do not adequately address architectural expressions of sustainability. This is important in order to raise awareness of sustainability as a real and substantial dimension of daily living.

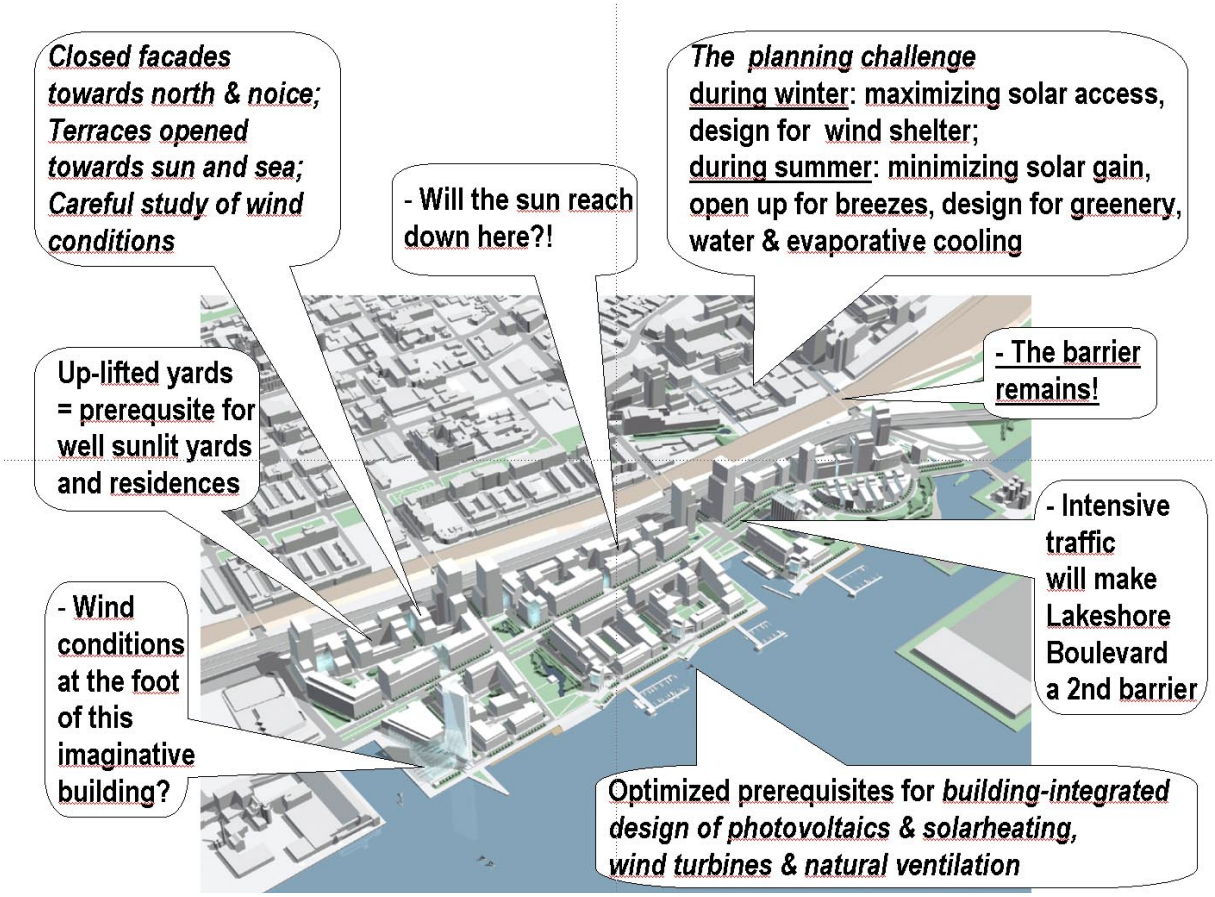


Figure 2:1 East Bayfront Precinct Plan – some Issues to consider

2.2 West Don Lands Precinct Plan

The West Don Lands Precinct Plan presents a well-thought out, almost traditional, street plan that is well adapted to the conditions and requirements of the site.

A main objective of the planning layout is to connect the Don Lands precinct to the surrounding city area. In this respect the existing railway area and the Gardiner connections constitute obstacles to integrated Waterfront revitalization. In addition, the blocks adjacent to the railway will have to cope with high ambient noise levels and this could influence the south facades of the buildings. These same building façades need to be open to the sun and to views of the waterfront.

The plan presents building layouts of mainly rectangular blocks with buildings around the perimeter. This bodes well for applying sustainability building practices from the perspective of working with the building volumes and designing the technical infrastructure.
The suggestion for raising yards above car parks and placing business and commercial space in the lower stories of buildings on the perimeter means a well sunlit inner yard and residences with good sunlight conditions.

The buildings should be designed to minimize the need for mechanical heating, cooling and ventilation by means of the building envelope and its appliances – as stated in the environmental program of East Bayfront precinct plan and in the TWRC Sustainability Framework. Electrical cooling devices and on-site natural gas heating should not be permitted if the waterfront is to pursue a sustainability energy strategy.

Aspects	*Strenghts*	*Weaknesses*
Principles of sustainable development, methodology	The overall plan includes an analysis, public consultation framework and proposal for private development guidelines and neighbourhood character that set the stage for a strong response to several sustainability issues.	The presentation of sustainability objectives as they relate to the precinct plan need to be developed
Social aspects	Social issues such as affordable housing and community facilities have a greater emphasis than other issues There is a distinct division of public, semi-public and private spaces. The design of Front Street and Mill Street with generous spaces for walking and relaxation provide good prerequisites for community vibrancy.	The retail areas and the areas for offices and institutions are concentrated to the western, northern and southern parts of the area. The blocks along the eastern part of Front street are purely residential which could result in a socially less vibrant environment Some of the courtyards are small and oblong which may promote privacy but prevent vibrant social life – this could be both an advantage and an disadvantage.
Sustainable urban planning – functional aspects	A well thought out, grid plan with blocks surrounded by traditional streets provides good general applicability. The northern and western parts of the area are well integrated in the cityscape. The distillery area is an integral part of the plan.	The block between Mill Street and the railway yard lacks some flexibility due to its special form. The Eastern Avenue separates four blocks in the northern part of the area from the rest of the area
Mobility – sustainable transportation	Transportation (streets, pedestrian and bike circulation) has been thoroughly investigated in the report The recommended transit service with an exclusive streetcar line on Cherry street gives excellent public transportation access to the central part of WDL	Options for providing the eastern part of WDL with good access to public transportation an east-west street-car line or a bus line passing by Mill Street or Front Street should be investigated
Sustainable buildings *Energy aspects*	There are good options for a variety of building types along the perimeters of the blocks but also on the raised parking yards The prerequisites for linking the blocks to district heating and cooling systems are favorable due to the high urban density The realization of this potential will depend on the next stages of detailed design and planning.	The buildings below Eastern Avenue have been designed without special consideration for vibrations and noise The layout of the blocks and the orientation of buildings have to be studied in more detail in order to maximize the options for passive and active solar systems. The high urban density in many of the blocks results in a large amount of shaded building facades
Waste and water	There are good options for installing a vacuum transportation system for source-separated waste in the area. There are also good options for installing a dual stormwater system. The realization of this potential will depend on the next stages of detailed design and planning.	

Aspects	Strenghts	Weaknesses
Green areas	The overall landscape design of the green areas especially Don river Park provides good prerequisites for the detailed design and for the protection of the area from the eastern bow of the railway. The tree plantings along the streets contribute to a pleasant environment	The overall principles for green areas should be further developed to reflect the notions and hierarchies of public spaces, ecological content, structured green and recreational content. Ecological and hydrological issues should be considered as an integral part of the green areas
Outdoor climate	The relatively low scaled buildings and closed yards within the blocks blocks may contribute to wind-protected areas. Greenery and trees along the streets contribute to wind protection and good air quality	The high-rise buildings along the railway yard and in other part of the area may result in high wind speeds at the ground level and the production wind-tunnel effects
	Microclimatic/wind simulations are necessary as a basis for further design of both buildings, parks and streets Solar access and solar shading must be simulated prior to the detailed design process	
Visual aspects – interplay between built environment, street design and landscape design	The planning proposal seems to be based on an analysis of the townscape of the City of Toronto whereby the perspectives reflect an ambition to obtain clear spatial relationships between buildings, green areas and streets as well as overall visual harmony and a variety of the building design. The overall design provides prerequisites for a detailed design expressing sustainability architecturally for example by integrating PV-cells into the roofs and walls and small wind turbines on the roofs.	

The building blocks adjacent to streets should be carefully studied and deliberately designed with regard to sun and wind conditions. The planning challenge during winter months is to maximize solar access and wind shelter, and during summer months to minimize solar gain, open up for summer breezes and to make use of greenery for transpiration and water for evaporative cooling.

Tall buildings bring downwind as is well known in Toronto. Thick buildings may mean one-sided apartments, which must be studied carefully regarding sun and wind. Concepts for daylighting inner green yards and for natural ventilation should be considered.

Conceptual systems for water management in West Don Lands is discussed in Section 3 of this report (see 3.3.5 Water Management in West Don Lands).

2.3 Sustainable Transportation

The overall goals formulated in the Sustainability Framework provide clear direction on the measures needed to achieve sustainable transportation: “Make alternative transportation options such as walking and cycling and public transit the natural choice for residents and visitors to the waterfront area”. The Framework presents strategies actions and targets linked to objectives to “minimize car use” and “increase walking, cycling and public transit use”.

On the overall City level, nine main attributes of a transportation vision are presented in the City’s Official Plan including reducing car dependence – transportation options for the City of Toronto and transportation building blocks for the Official Plan. Activities that support a sustainable approach to transportation and alternative mobility include:

- Integrated land use and urban design that leads to fewer and shorter trips;
- Public transit service that is more competitive with the private automobile; and,
- Traffic engineering and street design that encourage walking and cycling.

In the plan for an environmentally sustainable Toronto the importance of sustainable transportation is underlined, a sustainable transportation vision for Toronto is presented and moves towards sustainable transportation are identified: information, infrastructure, integration, involvement, investment, implementation, innovation and indicators. In the report “Making Waves” plans for removing barriers and making connections are elaborated.

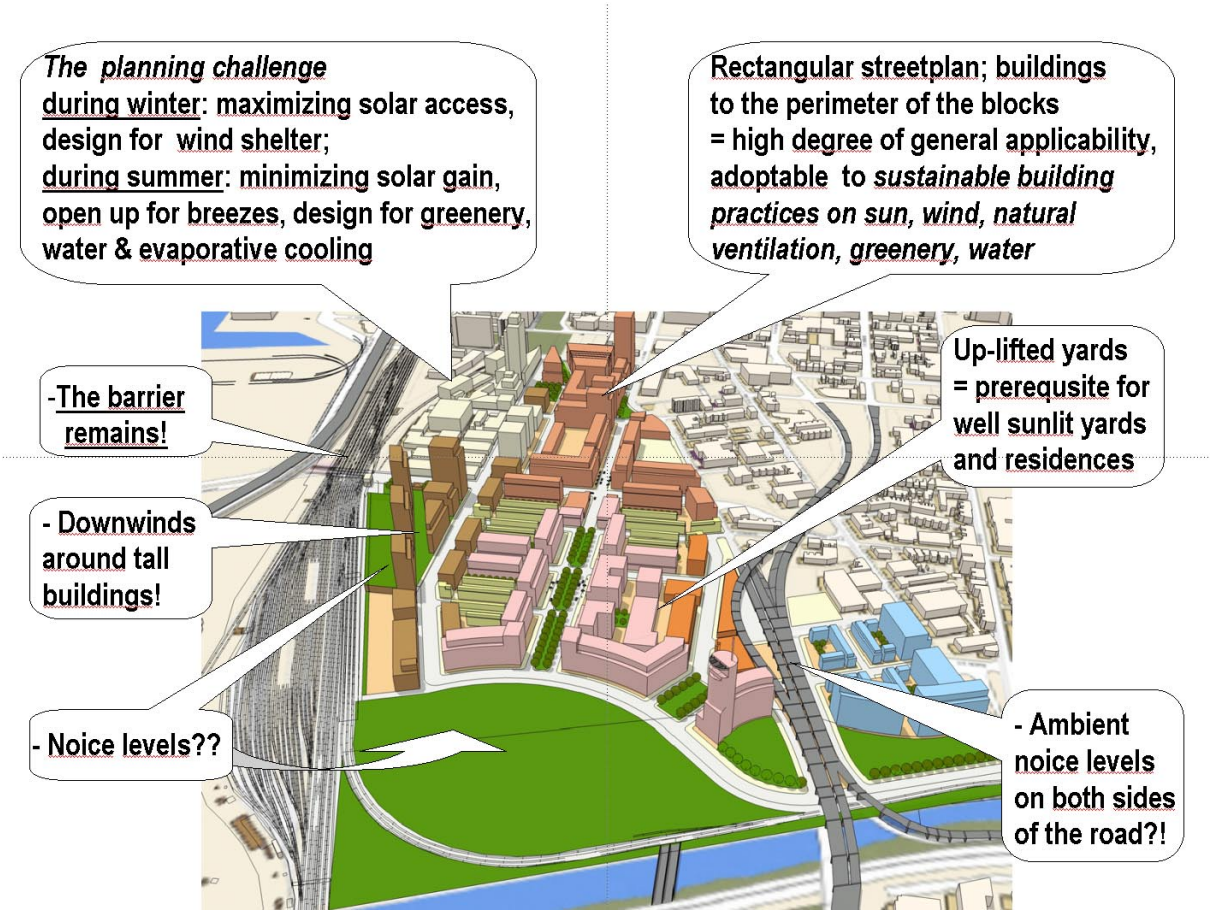


Figure 2:2 West Don Lands Precinct Plan – some Issues to consider

The challenge is to transform the overall goals and objectives into reality. A lot of transportation proposals are presented in a variety of documents. The comments here focus on issues that have not explicitly been discussed.

It is very important to develop ***an attractive environment for public transportation*** as well as for bicycling and walking. The proposed tunneling of the Gardiner expressway and the railway presented in section 2.6. should contribute to better integration of all the Waterfront areas and reduce barriers for pedestrians and bicyclists.

A public transportation, bicycling and walking spine should be developed along the main streets of the water front area – Queens Quay, Cherry Street, Commissioner Street and Unwin Avenue. The term spine indicates that the design of the environment for public transportation, bicycling and walking should be accentuated so that it will encourage and attract people to choose these sustainable transportation modes.

The stops along the public transportation system should be designed as climate protected mini-terminals with clear traffic information, nice seating places and arts integrated into the area. The Curitiba example in Brazil illustrates options for a dramatic increase in the modal shift towards public transportation (25-50 times increase in public transportation within a few years period of time). The location of the stops should be carefully studied in order to maximize the accessibility from both residents and work places within 100 – 350 m distances.[1]

The stops should be integrated in market areas with shops, restaurants and other service facilities demanded by the travelers during both weekdays and holidays. Thus the size of the waiting areas may be reduced and used more efficiently. The spacing of the stops should take into consideration options for optimizing the number of bus lines passing a certain stop by proper scheduling the lines. A bus stop dimensioned for two buses (18 m length) at the same time may serve 5-6 bus lines. The size of such a efficiently used bus-stop is approximately 40m x 3.5m.

Figure 2:3a Sustainable Public Transportation – Swedish Reference Examples. Tvärbanan – a light-rail Line in Stockholm connecting Hammarby Sjöstad with the Subway System of the City of Stockholm.

[1] Swedish and Danish research shows that the share of people choosing public transportation (regional trains) is twice higher when the distance to a station is 100 m compared to a distance of 400 m.

Figure 2:3b Sustainable Public Transportation – Swedish Reference Examples. A light-rail Line in a separate lane in the City of Norrköping.

In the areas surrounding public transportation stops the parking ratio should be reduced. In order to increase the number of people traveling by public transport the areas around stops and mini-terminals should be planned for mixed uses. Connected paths for pedestrians and bicyclists should have direct links with bicycle parking and storage at the stops. It should also be possible to bring bikes on buses or on streetcars. Incentives for shifting transport mode from cars to public transportation and walking should be introduced for example:

- To avoid free car-parking in office buildings in the area but instead encourage public transportation by offering free public transit for employees.
- To encourage the use of step-counters and trip meters on bicycles as a part of health programs and contests regarding sustainable transport modes.

As an alternative to the traditional streetcars or buses automated or ***semi-automated transport systems*** on the ground or elevated above street level should be investigated and compared with the traditional systems. A modern system of this kind could at least be planned and built as part of a demonstration project in the sustainability center connecting the business park, the Living City Center and the demonstration projects of the energy plant (see Section 6).

Such a system could be an inspiring showcase for future-oriented transport technology based on renewable energy. A prerequisite for such a system is that it be integrated in the environment in an attractive way for example by letting the track go right through development blocks or shopping malls . It is also very important to have narrow construction, which is considerably smaller than a raised highway corridor. One interesting example of this solution is the light-rail line through the shopping areas of Canary wharf in London.

Figure 2:4 The Curitiba Example in Brazil. A Bus-Stop along a separate Lane for Express Buses.

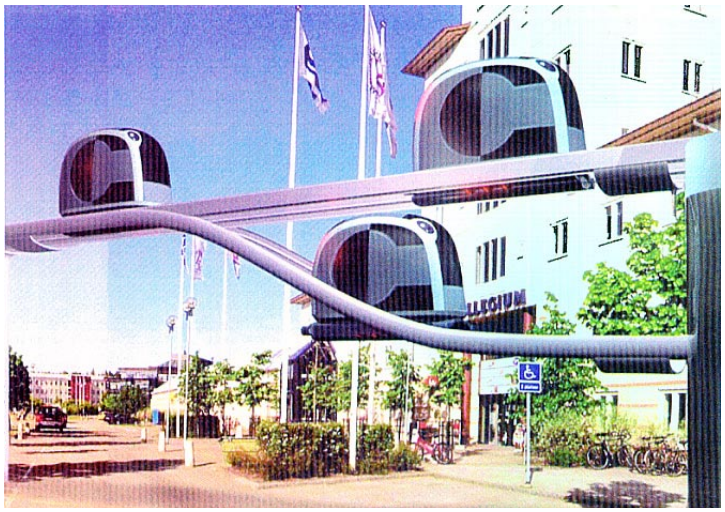


Figure 2:5 Example of an automated Public Transportation System.

Car-pools or car sharing systems can be organized in the community districts of the waterfront area. The cars should be fuelled by renewable energy, preferably biogas or hydrogen cells. Tank-stations should be located adjacent to car-pools. European programs for improving the traffic situation in European cities that might be of relevance for the waterfront project are "Trendsetter", "Moses" and "Cute" (Clean urban transport).

The wide channel through the Portlands area facilitates boat traffic (using renewable fuels like biogas) between East Bayfront and the proposed Sustainability Center with a number of other stops along the route.

In our opinion, the width of the ***redesigned Lakeshore Boulevard*** with 2x4 car lanes will make the street a considerable barrier between the city and the waterfront. Swedish experience indicates that a street of this kind can have a maximum width of 2x2 lanes of car traffic and still be considered as an integral part of the urban environment. A wider street is experienced more as a major highway. If it is not possible to reduce the width of the street, we propose it be divided in two lane-sections separated by narrow green areas and a wider green areas with rows of trees in the central part of the street . It is also important to reduce the average traffic flow as much as possible, to attempt to cap the velocity of cars and buses or street-cars at 30 kilometers per hour.

If the Gardiner Expressway is relocated to ground level and the railway is kept at its present level, two options for pedestrians and bicyclists should be investigated:

- A number of wide bridges for pedestrians and bicyclists
- A number of wide tunnels for pedestrians and bicyclists

The design of bridges or tunnels must take people's security and comfort as its starting-point. Swedish examples that may be a source of inspiration are Knutpunkt Hjalmar in Gothenburg (a wide well-lit tunnel for pedestrians and bicyclists) and Haga Norra (a bridge for pedestrians and bicyclists).

Figure 2:6 Knutpunkt Hjalmar in Gothenburg – An Example of a Tunnel for Pedestrians and Bicyclists

As for the streets throughout the waterfront area, 2x1 lanes of car traffic should be investigated as compared to the already proposed 2x2 lanes in order to establish public transportation, bicycling and walking as the main transport modes. Separate bicycling paths should be arranged both along the main streets and along the water's edge and through the green corridors.

Our experience is that s***eparate bicycle*** lanes should be located adjacent to pedestrian paths and located parallel to roadways in order to facilitate access to shops and other functions located along busy streets. For this reason, bike lanes are not normally moved to protected routes since no noticeable increase in traffic safety has been observed. Separate cycling lanes along the water's edge should be designed for rapid commuter bicycling thus promoting the bicycle as a convenient transport modes to and from the City. Important quality indicators for bicycling and walking paths are: directness of route, continuity, easy orientation and minimized barriers.

Figure 2:7 An example of a separate Path for Pedestrians and Bicyclists centrally located in a Street Space. Erik Dahlbergsgatan in Stockholm.

2.4 Sustainable Green Areas and Public Spaces

A basic document for the planning of green areas and public spaces is the Central Waterfront Public Space Framework. The purpose of the framework is to come to a more detailed understanding of the nature, character and relationships of public spaces, new and proposed, along the central waterfront. It establishes the public realm as the foundation for the central waterfront's overall revitalization. A series of 10 principles provide a foundation for the central waterfront public space framework. These principles should direct the detailed resolution of the waterfront's public spaces.

In a sustainable city, a landscape design to capture the rejuvenating power of nature is more or less implicit. Furthermore, this fundamental principle should be formulated and interpreted in ways that address the specific project area, its problems and its qualities.

In addition, designed landscapes should supply a variety of features and experiences and create character in the city. In the case of the Central Waterfront, the relationship with the landscape can be expressed in four categories each having its individual validity. These categories all support a sustainable approach to designing green space and are suggested as guidelines for landscape design in this area:

1 Notion of public space.
The landscape, except for private gardens, represents and embodies *public space*. Streetscapes, bicycle paths, walkways, parks, plazas are all examples of public space that strengthen social life and evoke human contact. Such landscapes enhance the structure of public space in the city.

Site example: The north–south Toronto streets each face a point where they end up at the water. These spots can be developed into a sequence of public spots in attractive locations.

2 Notion of ecological content.
The landscape supplies *ecological content*. Proximity to nature, presence of flora and fauna and experience of natural processes are nowadays considered valuable parts of daily living especially in urban surroundings. Landscape design can also improve technical solutions to environmental problems such as storm water treatment and wind/climate considerations.

Site example: If the Don River mouth is restored it can be developed into a city park on a scale that permits natural habitats to develop

3 Notion of "Green Structure".
Greening of a modern city is based on connecting different parts of the city including parks and open spaces along a safe *green network*. The parameters of a green network can also help define city districts or, on the Toronto waterfront, communities.

Site example: The east-west south-facing quay can connect to the restored park at the mouth of the Don River which in turn can be connected to Tommy Thompson park.

4 Notion of recreational content.
Recreation and physical exercise is essential for the general health of city dwellers and is also an important leisure activity. A well-designed landscape provides for spaces that support such activities. In this respect, the designed landscape should address the needs of all types of citizens including young and old; physically fit as well as disabled.

Site example: The park at the mouth of the Don River with its central location is ideal for establishing a large recreational area close to developing areas of the city.

The points at which 16 of Toronto's main north/south streets meet the waterfront creates an opportunity to introduce a series of distinctive public spaces – the "foot of Toronto places" (notion no 1). This provides opportunities for the planning and design of very attractive spots for all citizens of Toronto. To strengthen the north/south axis for car traffic is not the most important issue. This axis should also be planned for high-standard bicycling and pedestrian paths. It is also important to connect the public spaces and the separate areas of the waterfront in an east/west direction with high-standard bicycling and walking paths (notion no 3).

The planning and design of green areas has a considerable impact on the microclimate and on the energy consumption of buildings since vegetation and other landscape features influence the intensity of winds in the area (**notion no 2**). Stormwater flows may also be considerably decreased and detained by a series of control measures related to the planning and design of green areas such as ponds and wetlands, porous paving and green roofs (see section 3.3. for further discussion of stormwater). These issues are not explicitly discussed in the framework but should be considered in more detail.

The use of public spaces and green areas and their potential for becoming social meeting-points and nodes for waterfront activities (**notion no 1**) are dependent on their connection and integration with adjacent housing and employment areas. Planning and design for recreational, sports and cultural events will also influence the intensity of use.

The area between West Don Lands, East Bayfront and the Portlands raises critical issues with regard to the quality of the green areas (**notion no 4**). The re-naturalized river mouth will connect a series of wetlands with trails along the development edge and may provide the opportunity for active recreation in Commissioners Park and within West Don Lands. The rail yard south of West Don Lands as well as the eight lane wide expressway is an extreme barrier between the City and the Portlands area.

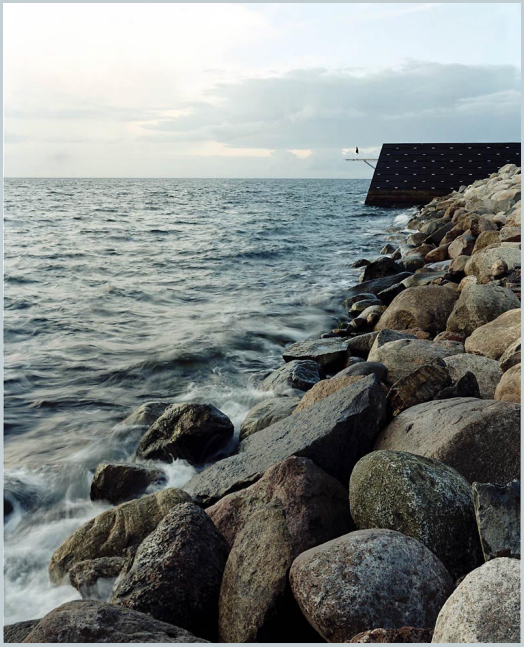
The major road and rail barriers dramatically reduce the recreational value of the whole area and might also be a threat to many species that otherwise would find the wetlands an attractive environment. The barriers make it more difficult to develop attractive paths for bicycling and walking between West Don Lands and Commissioners Park as long tunnels or bridges are needed under or over the rail yards and the expressway. The proposed tunnels and the relocation of the rail yard (see above) could considerably improve this important green link (notion no 3) between the city and the Portlands area as well as the recreational value of the Commissioners Park.

Case study: **Dania Park**

Dania Park is situated in the so-called western harbour in Malmö, the third largest city in Sweden. The area is a former harbour, now transformed into a city district. The large-scale park embraces the sweeping contours of the landscape in this equally windswept and magnificent location. The location at the edge of the sea encompasses certain duplicity – a desire to approach the water coupled with a need for shelter from the brisk ocean winds.

A protective wood palisade has therefore been erected along the shoreline's rough stone embankment. This palisade is in turn punctuated by three sloping concrete troughs, called "the Lookouts", that seem to empty into the sea. Dania Park is an example of how to dramatize a landscape due to proximity to the sea, with use of the very special design features.

Dania Park and the Western Harbour was awarded the Swedish Association of Landscape Architects´ Siena Prize for the year's best outdoor environment in 2001 (Landscape Architecture for the Dania Park by Thorbjörn Andersson and PeGe Hillinge).



Figures 2:8 The Dania Park is situated in the western Harbour of Malmoe in the southern part of Sweden.

2.5 General Recommendations for planning of the Waterfront area as a whole

Consider separate planning areas as a single piece of urban fabric

The Central Waterfront Plan is built on four core principles. These are:

1. Removing Barriers/Making Connections
2. Building a Network of Spectacular Waterfront Parks and Public Spaces
3. Promoting a Clean and Green Environment
4. Creating Dynamic and Diverse Communities

It is a great challenge to fulfill these core principles by amalgamating the different planning areas – the Portlands area, the East Bayfront Area and the West Don Lands area to a unified but varied urban fabric. Obstacles to realizing these visionary core principles include current location of the Gardiner Expressway, the rail corridor through the city center and the rail yard south of West Don Lands.

These barriers prevent the West Don Lands from being an integral part of the waterfront as it is isolated from both the Portlands and the East Bayfront area. The barriers also make it difficult to realize fully integrate the East Bayfront into the City of Toronto. The barriers also interfere with implementing urban design that is based on sustainability principles due disruptions to the microclimate, noise , and spatial and social connections. Without removing these barriers at least in the medium-term or long-term it is doubtful if the Toronto waterfront can become one of the great waterfronts of the world with fulfillment of inter-related economic, social and ecological goals.

In order to remove the barriers we propose three options to be further investigation and evaluation:

1. An expressway tunnel through the central part of the area;
2. Decking and construction over the railway in the central area of Toronto but also in the East Bayfront areas and in the West Don Lands, including the rail yard.
3. A railway tunnel combined with the relocation of the rail yard.

Option 1 may be combined with Option 2 and Option 3. We consider that the most advantageous solution taking into account functional, social and visual aspects would be a combination of Options 1 and 3. In our first draft of this report we proposed coordinated highway and railway tunnels as a way to remove the barriers between the City and the waterfront. These options give the most favorable connections for walkways and bicycle lanes between the City and the waterfront areas.

After receiving feedback from our Canadian colleagues, we acknowledge that the combined tunnel approach may be considered as too complicated and too costly. One reason is that lowering the railway would exacerbate the problem of flooding. Other obstacles are the required grades of the railway, the distance required to slope up and down, the impact on current operations and, significantly, the cost.

As for Option 2, we have been informed that there has been discussion for the last 30 years regarding decking and construction over the railway. The decking of the central areas has generally been considered more feasible than in the West Don Lands and East Bayfront since in the downtown the railway is depressed relative to Front Street and the land values are much higher than in the areas to the east.

Our opinion is that options for erecting buildings at the border of a deck along East Bayfront and along the railway yard south of West Don Lands should be further investigated and evaluated from a sustainability perspective. The proposed building row towards the Gardiner expressway in the precinct plan for the East Bayfront could be moved to the edge of such a deck thus improving the microclimatic, ecological, social, functional, and visual qualities of these blocks. In the West Don Lands a deck over the railway yard makes it possible to erect buildings that bridge the barrier.

Ideally, the rail yard should be relocated and integrated with rail yards located in the outskirts of the city. Our understanding is that the railway yard is currently being transferred from general railway operations to commuter train operations. It is necessary to store commuter trains in the downtown area for travel to the outlying areas in the afternoon peak period. In any event, alternative storage locations within approximately 5 km from the West Don Lands should investigated and compared with the West Don Lands rail yard from a sustainability perspective. This is important, as the railway is an extremely strong barrier between West Don Lands and the Portlands.

However, the most important message is that the removal of the barriers using one or more of the suggested options would bring significant sustainability benefits to the Toronto waterfront. These include:

Economic benefits

With removal of the barriers, a new centrally located area would become available for mixed-use development including floor space of approximately 240 000 sq m ground area (2000 m x 120 m), which means approximately 1 000 000 sq m of space, supposing an exploitation rate on the ground area of e = 4.0. The total potential revenue from this type of densification and development should be investigated and related to the total investment costs of barrier removal. Cost calculations should consider not only at economic profitability but also cost savings due to environmental improvements.

Toronto waterfront revitalization is of great importance not only to the city but to the province and the country as well. The land values of the surrounding areas will also increase which in turn will facilitate new investments. The other benefits – some of which are listed below – are qualitative in nature but may also be expressed in monetary terms.

Social and cultural benefits

- The social benefits will be considerable as very attractive locations for new housing, work places and services functions can be offered to citizens.
- The links and connections between all areas in the waterfront will be improved which will promote public life along the waterfront and also contribute to the social integration of the waterfront communities with the adjacent areas in the City. The potential for the central waterfront network of public spaces can be realized on a higher quality level than is possible with the existing barriers
- The recreational value of existing and planned green corridors, the natural and designed park areas as well as the public spaces and market places can be improved due to higher quality natural environment.
- Possibilities to arrange cultural events and gatherings in the open spaces will be enhanced

Ecological and environmental benefits

- Noise reduction and improved air quality will improve public health - physically and mentally
- Reduced traffic flows will result in enhanced traffic safety and accessibility for all – including children and the elderly.
- There will be better opportunities to establish green corridors with high biodiversity for all parts of the waterfront area.

Phasing of the development taking the removal of the barriers into consideration

Planning and design as well as the phasing of the development in the waterfront area as a whole should take the removal of the barriers into consideration. For example:

- By starting the development in the Portlands area and by postponing the development of the East Bayfront and the West Don Lands until the barriers have been removed.
- By starting the development of East Bayfront area along the lake and then postponing development of the northern blocks until the barriers have been removed.
- By elevating the area south of Mill Street in the West Don Lands in order to prepare for a connection of the area with a deck over the railway yard.

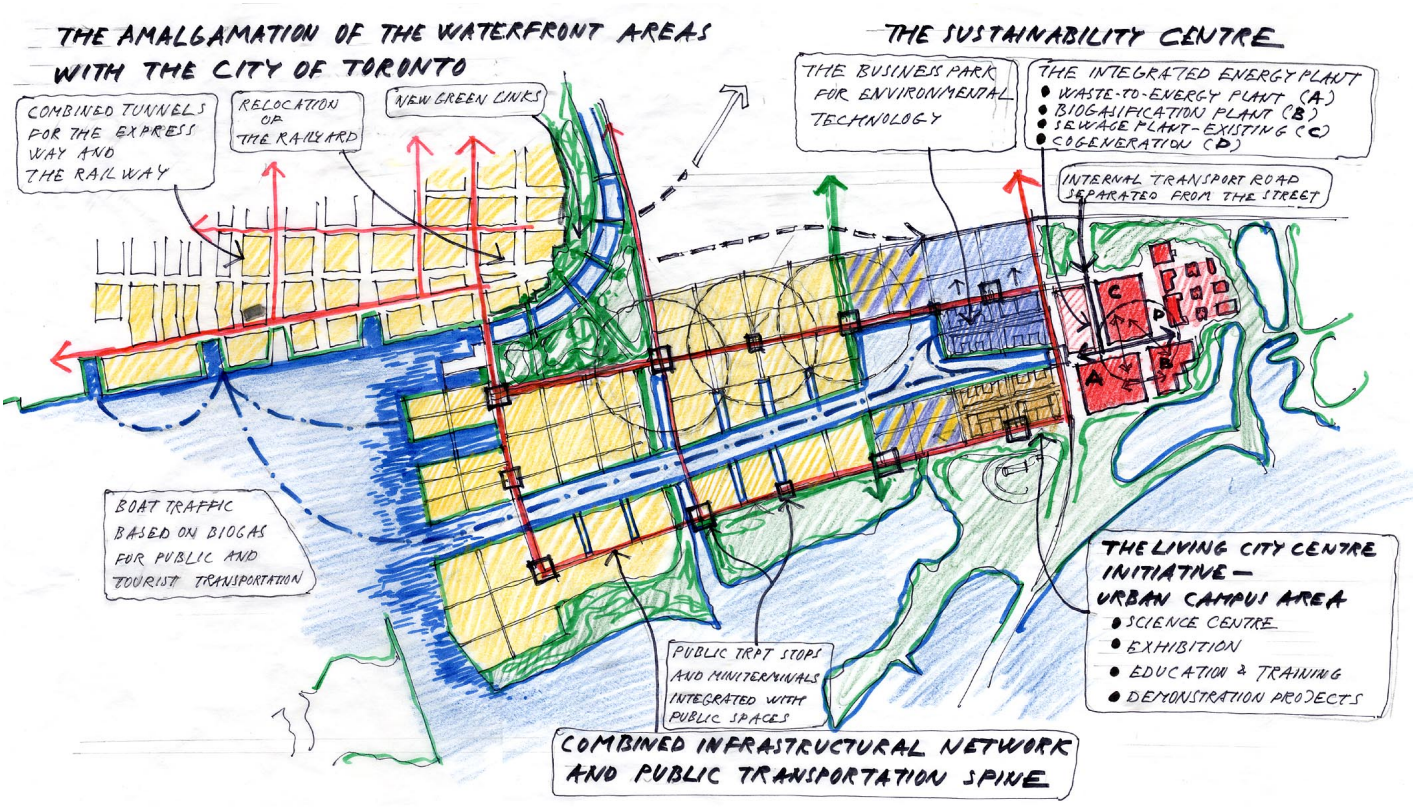


Figure 2:10 An overall Vision of the Waterfront Area. The figure should not be seen as a detailed land-use planning proposal. It points out some of the issues which are discussed in sections 2,3 and 6 of the report.

Figure 2:9 The Southern Link – a newly inaugurated Highway Tunnel in Stockholm.

Examples of infrastructure solutions in Stockholm aimed at reducing or eliminating barriers which may serve as sources of inspiration for the revitalization of the Toronto waterfront include:

- Stockholm area Södra Länken (The southern link – a newly inaugurated highway tunnel, 3.6 km length)
- Norra Länken (The northern link – a highway tunnel being designed at the moment)
- Södra station (The south station – a new urban district for approximately 4000 apartments and 4000 work places built on a deck over a railway and a diminished railway yard)
- Norra station (The north station – a new urban district for approximately 5000 apartments and 5000 work places is being planned on a deck over a railway yard in order to remove a barrier between the inner city of Stockholm and the Karolinska hospital area).

3. Sustainable Municipal Infrastructure and District Systems

3. Sustainable Municipal Infrastructure and District Systems

The City of Toronto's *Waterfront Scan and Environmental Improvement Strategy* focuses on the environmental component of sustainability and provides a comprehensive summary of technical infrastructure opportunities for creating sustainable waterfront communities. The Scan identifies four concepts as crucial for implementing sustainability on the waterfront. They include a coordinated environmental assessment process and a coordinated public consultation process both of which are important to reach sustainable outcomes. However, the concepts of integrated energy planning and implementation and a comprehensive and coordinated infrastructure approach are the most relevant to planning and implementation of sustainable municipal infrastructure on the waterfront. These concepts are defined as:

- **Integrated Energy Planning and Implementation –** this approach is based on ensuring a high standard of energy efficiency for wide range of endeavors as a means to reduce energy demand. High energy efficiency is then combined with energy supply technologies with relatively low environmental impacts.
- **A Comprehensive and Coordinated Infrastructure Approach –** this approach focuses on integrating the planning, development and implementation of infrastructure for energy, water and waste water, transportation/transit, waste management, and information technology.

Energy supply technologies that may be suitable for the Waterfront area but require further technical evaluation include:

- Deep Lake Water Cooling (assuming district cooling)
- Natural gas fired co-generation of electricity and heat energy (assuming district heating)
- Renewable energy sources such as solar and wind power
- Anaerobic digestion of source separated solid waste

The TWRC's Sustainability Framework correctly points out that *"There is no single approach to sustainability that fits every community"*. As well, the energy-related conclusions and the recommendations of the City of Toronto's Waterfront Scan and Environmental Improvement Strategy are largely supported by the TWRC's Sustainability Framework particularly goals for reducing per capita energy consumption and making greater use of low-impact renewable energy.

Successful application of the integrated infrastructure approach known as the **Waterfront Eco-cycle Model** must take into account existing environmental, economic and social conditions, including those in the surrounding GTA.

On-site investigations, a review of infrastructure-related documents and files such as "The Sustainability Framework PowerPoint.ppt" (TWRC/Marshall Macklin Monaghan July 30, 2004) and the City of Toronto's Waterfront Scan as well as meetings and discussions with TWRC staff and consultants and with City of Toronto staff led the expert review team to the conclusion that there is not yet enough information to design an integrated energy concept and associated comprehensive, coordinated infrastructure for the waterfront.

The opinions and reflections below are designed to support more detailed development of a needed integrated infrastructure concept for the Toronto waterfront:

3.1 Building an Infrastructure Network

The Expert Team proposes an integrated infrastructure network for the entire waterfront area. Pipes for district heating and cooling as well as pipes for transportation of source separated organic waste should be integrated and located in ducts along the main traffic lanes and green corridors. Separate ducts adjacent to or separated from these ducts are proposed for electricity distribution (electrical circuits) and for broadband cables.

In the Portlands, it is proposed that organic and solid waste from apartments, other residences and commercial spaces be transported in a closed vacuum transportation system to a waste-to-energy plant. The pipes will have a diameter of 500 mm given an estimated waste density approximately of 100 kg/m^2. The closed vacuum transportation system can be extended to West Don Lands and East Bayfront if the diameter of the pipes is increased to 600 mm. It is recommended that an intermediate reloading station be built underground (covering an area of approximately 15x15x8m). This station may be part of the underground construction for a proposed highway tunnel.

The ducts should be coordinated with roads and green corridors in order to give easy access to the pipes and to conflicts with cars, bicycles or pedestrians. Locating pipes in ducts will facilitate the maintenance and the repair of the systems and also improve the working conditions for staff needing to service them. As an alternative to a coherent net of ducts, a system of underground spaces for maintenance and inspection at regular distances is also possible.

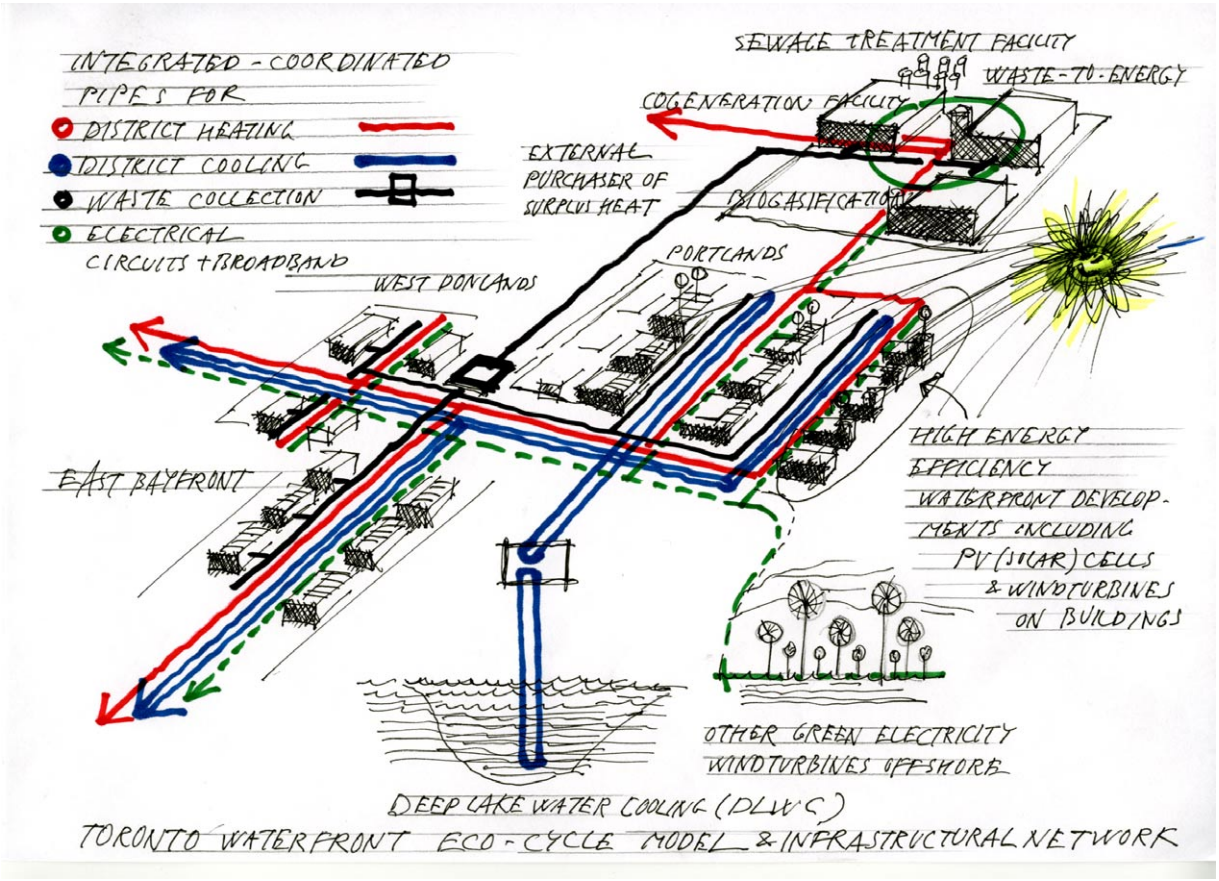


Figure 3:1 The proposed integrated Infrastructure Network for the entire Waterfront

The advantages of the proposed integrated approach include:

- A clean and healthy environment due to the closed system for vacuum transportation of waste. This type of system reduces heavy truck traffic for waste collection thus contributing to better air quality, less noise, reduced risks for accidents and less street litter.
- Land value will be increased due to clean and healthy transport of waste in a closed vacuum system.
- Construction and maintenance costs for the infrastructure system will be reduced due to placing pipes together in a coordinated fashion and due to efficient and well organized access spaces for repairs and inspection.
- The approach will allow phasing of the infrastructure network across the waterfront and will support extension and integration of district-heating and district-cooling systems with other parts of the City.

Vehicles will transport waste from other parts of the City to the waste-to-energy plant by the highway tunnel, by an access road through the working area and by an internal road separated from the other roads in the Portlands.

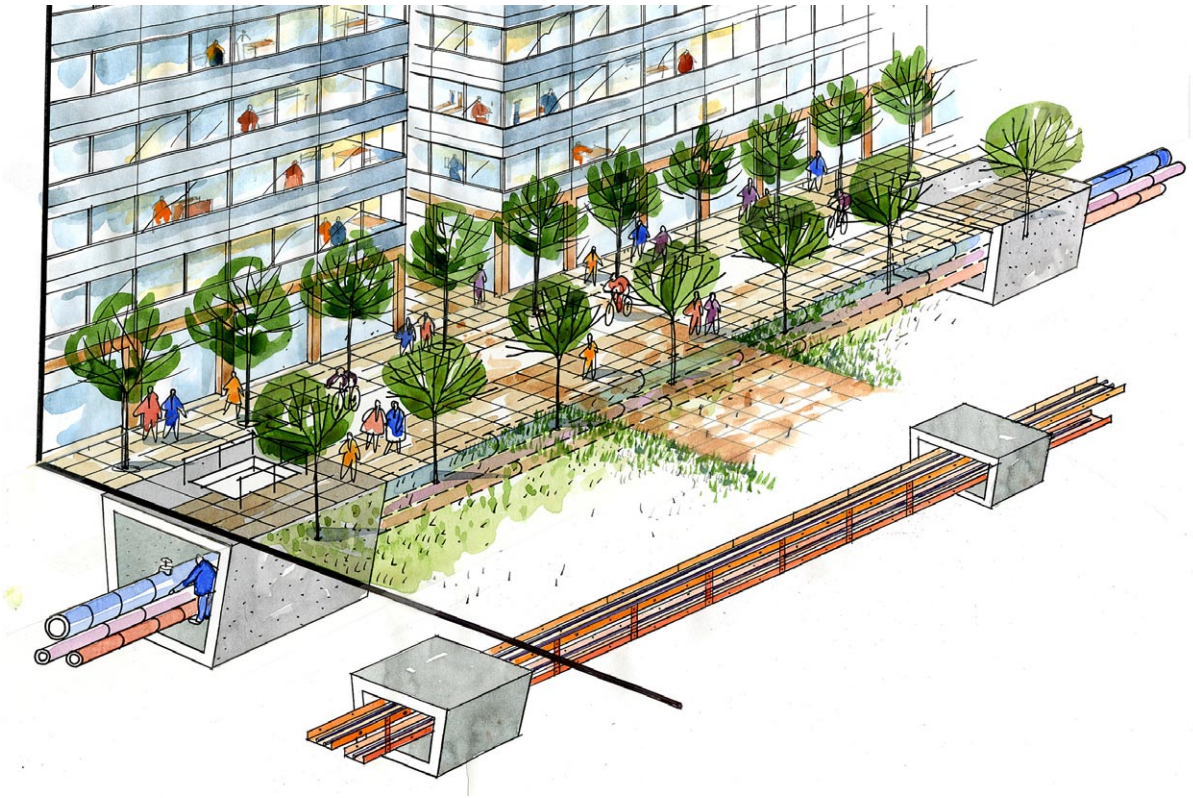


Figure 3:2 A coordinated Approach on the Location of different kinds of Pipes.

3.2 Sustainable Energy

Waterfront sustainability will be strengthened by the application of the Eco-cycle Model that requires a comprehensive coordinated approach to infrastructure design and implementation. Sustainable energy strategies are key to this approach. The Waterfront Eco-cycle Model pulls together objectives for:

- minimizing energy demand;
- optimizing and coordinating energy supply; integrating energy from waste and energy from wastewater; and
- nutrient recycling.

The team has identified three major issues that will influence the application of the Eco-cycle Model on the Toronto waterfront. They include:

– the shortage of electricity supply in the province of Ontario;
– the on-going shipping of waste to landfill in Michigan;
– the price of energy in North America.

This last point has significant implications for the TWRC's stated goal of making the Toronto waterfront a leading global model for sustainability. Consumer cost for electricity in Canada is one-third to one-sixth the price of electricity in the European Union while gasoline in Canada is about half the price. As a consequence, cost recovery time for energy investments may, in some cases, be more than three times longer when compared to energy investments in Europe. However, it is anticipated that, in the medium term and seen from a life-cycle-cost perspective, the price of energy in Canada will inevitably increase making payback on alternative energy investments an increasingly attractive option.

The Current Proposal for a 550 MW Natural Gas-powered Generating Station

There is currently a proposal for a 550 MW natural gas powered electricity generation plant to be located in the Portlands on the site of the old Hearn station. Due to administrative and business obstacles there are no plans for co-generation at the plant. The expert group has the following comments on these plans:

Establishing a new gas fired generation station that does not have co-generation capacity-essentially using less than two-thirds of the available energy - presents a serious credibility gap regarding establishing the Toronto waterfront as a national and global model for sustainability.

If waste-to-energy is included in the energy strategy for the waterfront, a natural gas fired plant would not be needed at all.

An important goal for waterfront revitalization is to demonstrate energy efficiency. The extensive use of deep lake cooling would significantly reduce the demand for electricity in Ontario. If the natural gas fired plant must go ahead to compensate for closing down coal-fired plants in other parts of the province, then the plant should be located far outside downtown Toronto. If the location for the plant is to remain at the Portlands Energy Centre, then it is critical from a sustainability perspective that the plant be designed from the beginning for co-generation.

Key points to consider in the development of a detailed energy strategy for the Toronto waterfront:

Step 1: Reduce electricity consumption.

The most important component of a sustainable energy strategy for the Toronto waterfront is the application of Deep Lake Water Cooling (DLWC) as summer cooling demand in the Toronto downtown area constitutes as much as 55% of the total electricity load (City of Toronto Waterfront Scan 2001: 5.4.2). A full implementation of DLWC as shown in the Scan – Case I and Case II – will drastically reduce electricity consumption within the Toronto area. Assuming that the technical prerequisites for water intake & outlet in Lake Ontario can be met, the question might be not where to build a new gas-fired energy plant, but rather which energy plants should be closed down!

Emerging technologies for renewable *on-site* electricity production are important in order to reduce the need for external energy to supply individual buildings. Renewable energy technologies include both integrated photo-voltaic (PV) cells and small-scale wind turbines, the latter a Canadian innovation. A detailed analysis of the administrative and economic considerations for building-size renewable energy initiatives on the waterfront is required (see Section 5).

Step 2: Increase energy efficiency of building stock as well as the overall urban infrastructure.

The principles of energy conscious design may be described in four steps:

1. Layout of the area and its buildings, streets and squares with regard to sun and wind.
2. Minimization of energy demand by way of architectural design.
3. Use of renewable energy sources, with priority give to passive solar systems and, thereafter, active solar systems.
4. Use of best available technology for low energy appliances and all energy systems.

For comments on the principles of energy conscious design, see Section 4.

Step 3: Make use of renewable energy supply technologies.

Technologies for renewable electricity generation, such as wind turbines, must be given priority over traditional energy supply. A feasibility study of the concept of wind turbines offshore is of utmost interest. The City of Toronto has assumed annual energy production from a wind farm offshore to be of the magnitude 55 GWh. However, today, assuming wind conditions similar to the sea east of Sweden, the annual production of one windmill is 10 GWh, that is, 40 units produce 400 GWh per year. The electricity price level from a new windmill may well compete with that from a gas fired energy plant even outside of European conditions.

Techniques for renewable or low impact heat production, such as heat pumps in geothermal applications and heat pumps on treated water must be carefully evaluated, considering that an output of 3 kW heating requires input of 1 kW electricity. The on-going demand and shortage of electricity make heat pumps undesirable in central Toronto. Heat pumps consume electricity and reduce the heating demand for co-generation of electricity.

Step 4: Develop an efficient, coordinated , low-impact energy supply system

It is recommended that a co-generation facility be located adjacent to and coordinated with the Ashbridges Bay Sewage Treatment Plant. The energy center could then coordinate district

heating and cooling produced out of deep lake cooling, waste-to-energy; biogas from anaerobic digestion of waste and digestion of sludge from treated wastewater; and composting of waste and sludge.

The size of the energy center should be optimized in relation to renewable resources such as offshore wind and DLWC, as well as to the total demand of energy for the Waterfront and the requirements to deliver energy to the city as whole. In this context, the use of waste-to-energy presupposes treatment of waste from the surrounding Toronto area (see 3.4 below).

Step 5: Develop Infrastructure for district heating and district cooling.

District heating and district cooling presupposes the existence of a distribution network that is coordinated with the network for electricity, water and information infrastructure. Economic feasibility of district infrastructure would be based on mandatory hook up of all Waterfront buildings.

For district heating and cooling to be efficient and effective local on-site heating and cooling equipment must not be permitted.

Developing district heating and cooling

The expert team is aware of the legal and economic obstacles to district systems in Toronto including the current price of energy and the cost of district infrastructure construction. Nevertheless, the density of development that is being planned for the Waterfront means that, from a long-term sustainability perspective, district heating and cooling will provide superior environmental and economic benefits. District systems are also superior to conventional energy delivery in the short-term if considered from a full life-cycle cost perspective. It is anticipated that a district system will be economically feasible even now with the current low price of energy (by European standards) in Canada.

It is strongly recommended that The TWRC and the three governments take part in negotiations between all relevant parties in order to develop the legal framework and the business conditions necessary for the realization of a district infrastructure network. The obstacle of reasonable investment payback periods, due to the fact that the developer of residential buildings is not generally involved in long-term operations, must be addressed.

A district heating and cooling system must be designed for convenient expansion for each phase of waterfront revitalization. Buildings must be connected to the district network from the beginning. If the district system is to be established over a long period of time, then the central energy production facility must also be developed in phases in order to reduce up-front costs. An energy production plant may be located within or adjacent to a precinct either as a permanent small-scale production plant or as a temporary plant. The temporary district heating plant could be gas fired, the size of the plant being 15 – 20 MW within a building unit measuring 3 x 5 meters.

When developing a large energy distribution system such as the one that would be necessary for a fully revitalized Toronto waterfront, it is common practice to develop the system as separate single distribution units that are connected as the system is enlarged. To do this, infrastructure for pipes must be designed according to the desired outcome of a fully connected system. It is recommended that a feasibility study be conducted to compare the cost for installation of a temporary energy production plant with longer distance connections from a central energy source .In Sweden the investment cost level of pipelines within new development areas is in the magnitude of 500 – 700 Canadian dollars per metre.

Normally in a high density area the environmental benefits of a larger scale energy production unit (e.g. energy efficiency, facilitated transports and clean air) outweigh the disadvantages of

heat losses and maintenance of the distribution network when compared to a network of small-scale units.

Furthermore, a minimum size plant in the magnitude of 100 MW is a prerequisite for a co-generation concept based on renewable energy sources including energy from waste and water, due to the necessity for very high efficiency combustion and emission containment equipment.

Case study: **District heating Stockholm**

Small-scale energy plants working together on a district heating network are preferable within a less dense community. Within larger communities with a high degree of heat load, the heat losses of the distribution network is well compensated for by the more efficient larger energy plant.

The city region of Stockholm with approximately two million inhabitants uses a network of seven energy plants, with nearly all of the building stock hooked up to the district heating network. One centrally situated co-generation plant operates on coal and bio-oil with a heat pump on seawater and is subject to very stringent environmental restrictions. The remaining six plants, all of which operate mainly on bio-fuel, and energy-of-waste with a heat pump on treated water, expect for one are located in the periphery of the region. The largest plant distributes heat within a distance of some 50 kilometers.

Estimated Energy Demand for the Buildings on the Toronto Waterfront

Tables 1 to 3 (below) present information to assist with understanding the opportunities associated with an integrated energy strategy on the waterfront

Table 1 Specific energy demand:

Type of building	*Heat demand (kWh/m^2)*	*Electricity demand (kWh/m^2) Including cooling systems*
Apartments	50	50
Offices	50	100

Table 2 Total energy demand:

Type of building	*Building area (m^2)*	*Heat demand GWh/year)*	*Electricity demand (GWh/year) Including cooling systems*
Apartments	3,5 million (70 000 residents)	175	175
Offices	0,7 million	35	70
Total energy demand	**4,2 million**	**210**	**245**
Note: Energy for infrastructure adds to energy demand as above.			

Table 3 Waterfront energy productions:

Type of system	*Production per unit*	*Number of units*	*Total production*
Annual electricity generation			
Wind mill Park	10 GWh	40	400 GWh
Co-generation Waste-to-energy Scenario 3 (3.4.2)	90 GWh	1	90 GWh
Co-generation Waste-to-energy Scenario 4 (3.4.2)	210 GWh	1	210 GWh
Photovoltaic	400 kWh/m^2	10 % of roof area = 70 000 m^2	28 GWh
Total electricity generation			**518 - 638 GWh**
Annual heat production			
Waste-to-energy plant Scenario 3	210 GWh	1	210 GWh
Waste-to-energy plant Scenario 4	490 GWh	1	490 GWh
Total heat production			**210 – 490 GWh**
Annual maximum potential for energy "export"			
Heat			**280 GWh**
Electricity			**393 GWh**

Based on the above discussion priorities related to energy production include:

- **Deep Lake Water Cooling** – The no 1 opportunity!
- **Waste-to-energy** – A technical solution for the treatment of waste within the Toronto region cannot wait. *Feasible locations, as well as plant sizes* must be fully investigated.
- **Windmill farm** – the environmental and technical feasibility of a large scale wind farm supporting the waterfront must be investigated. Can anyone resist 400 renewable GWh per year?

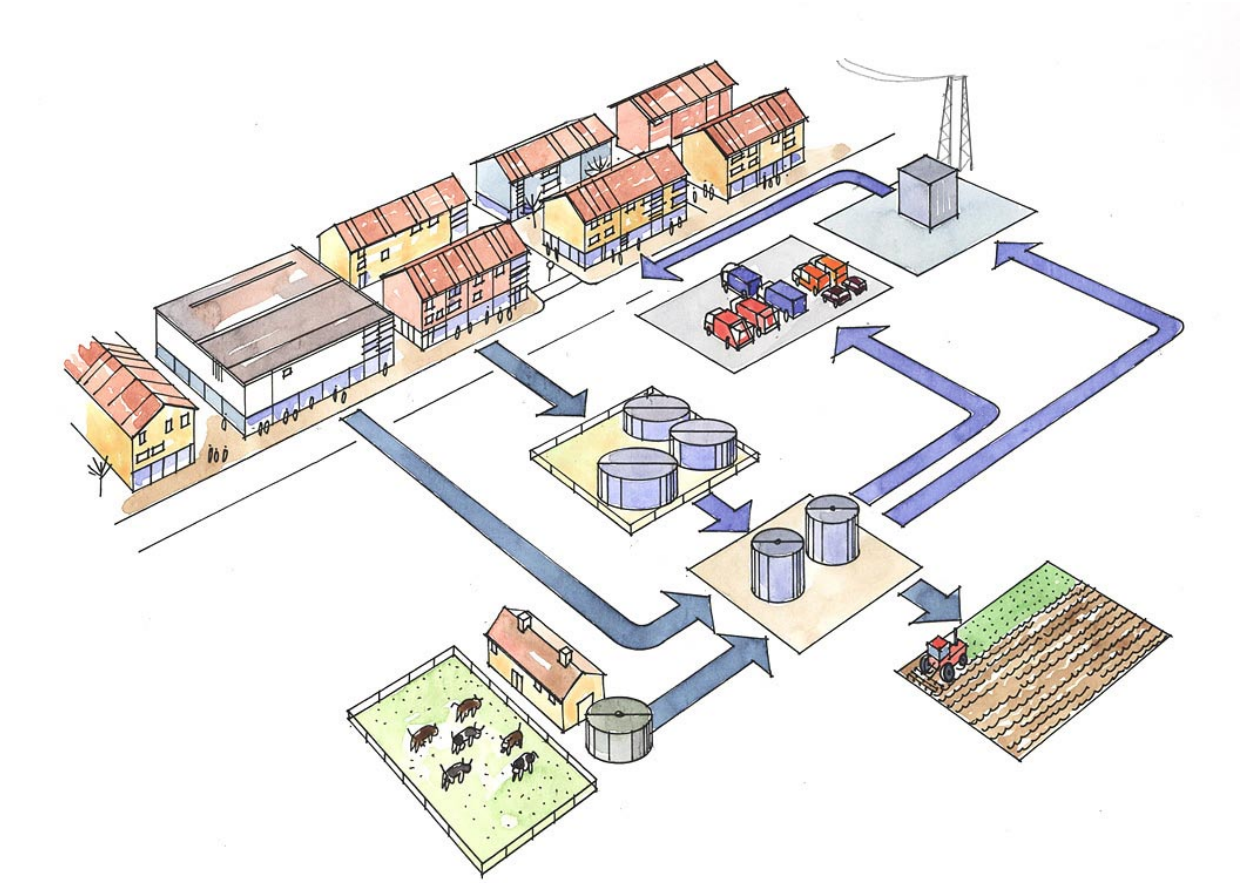


Figure 3:3a The Sustainable City Concept – Integrated Resources Managment

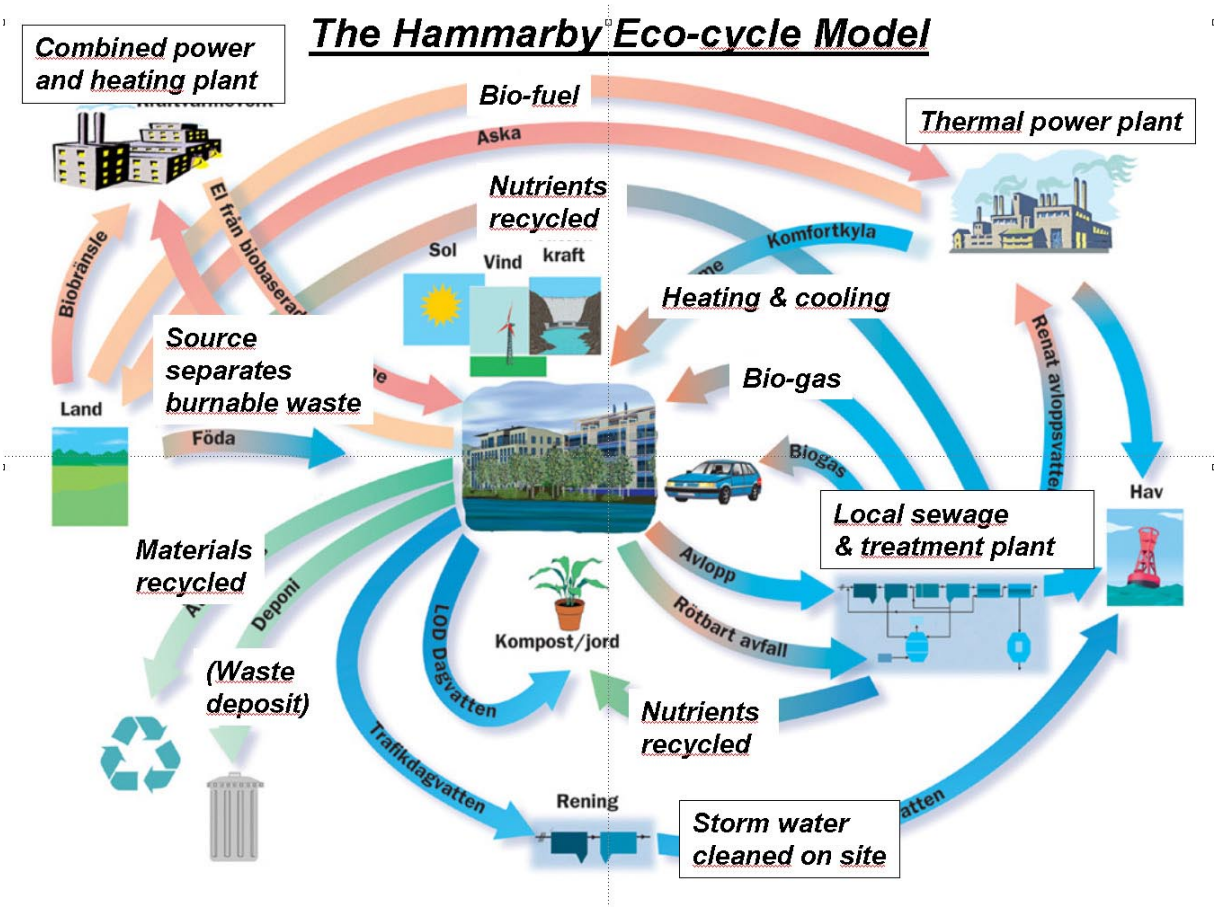


Figure 3:3b The Hammarby Model – An integrated Infrastructure Approach applied in Hammarby Sjöstad in Stockholm.

3.3 Sustainable Water Management

3.3.1 Drinking Water

Water treatment and distribution

Lake Ontario is the source for drinking water supply to Toronto. Water treatment and distribution is the responsibility of the City of Toronto. The water source, treatment and distribution network are of a high quality and will not be of concern in this context. We support the TWRC plans to extend the distribution to the waterfront areas according to the system used in the city as a whole. Small scale systems or private systems are not recommended.

Water efficiency

There is no need to save water, in itself, since there is an abundance of water in Toronto. From a sustainability point of view, conservation of water brings about savings in the use of electricity, chemicals and transport both in the drinking water system and the wastewater system. The City of Toronto's "Water Efficiency Plan" (December 2002) provides clear advice on how this may be achieved and what objectives may be reached. In particular, savings on hot water use is important. Swedish experience indicates that metering of cold and especially hot water in the households, with an immediate feedback to the households, is important. Water tariffs should be linked to quantities of water used.

3.3.2 Wastewater

Background

The Ashbridges Bay Wastewater Treatment Plant (WWTP) is a well-functioning secondary treatment plant with capacity to receive water from future waterfront developments. The connections throughout the waterfront should be simple since a major trunk passes nearby. However, the outlet from the WWTP into the lake, is considered crucial for the estuary and plans exist to extend the outfall pipe into the bay. This is a responsibility of the City of Toronto and should not be of concern to the TWRC plans.

Environmental objectives

If the objectives of the city and the TWRC are restricted to impacts on health and impacts on receiving waters, the system used to today is adequate. If, however, the objectives are widened to include also a non-toxic environment, recycling of nutrients, and recovery of energy other kinds of systems may be more appropriate. In Sweden, a provisional requirement for recycling of 75% of the phosphorus per generation is being discussed.

Choice of systems

Assuming that the recycling of nutrients to agriculture is an issue, and that the quality of the sludge (concentrations of priority pollutants) does not reach the goals set, three different strategies deserve consideration:

1. The nutrients are captured at the treatment plant: Physical/chemical and biological technologies are being used at treatment plants to extract nutrients from sludge, wastewater or ashes. Most of the technologies extract only phosphorus, in different chemical forms, either suitable for direct use in agriculture or as raw material for the fertilizer industry. Other essential nutrients such as nitrogen, potassium and sulfur are difficult to extract. Another sludge treatment block at the WWTP has to be constructed.

2. The nutrients are captured at source: Four main nutrients- phosphorus, nitrogen, potassium and sulfur- are found in the black water fraction (the toilet water) of household wastewater. In some European countries for example, Sweden and Germany, houses and residential blocks have been constructed according to separation principles, using separating toilets, dual

Figure 3:4 Strategy 1: The Nutrients are captured at the Treatment Plant

wastewater piping and tanks for the intermediate storage of the urine or black water. After transport to farmland, the urine or black water must be stored for at least six months in order to reduce the pathogens content. One important prerequisite is that both households and the farmers that receive the products are positive about the process. A question that still has not been answered concerns the contents of pharmaceutical and cosmetic residues and hormones in the urine. So far, only small-scale areas, blocks or houses have been equipped with these kinds of separating systems, and evaluations are being carried out in some cities in Europe.

Case study: **Hammarby Sjöstad**

For Hammarby Sjöstad separating systems were not installed although they were called for in the original plans. Reasons for rejecting this type of separation included:

- the economic risks and uncertainties regarding liability;
- the reluctance from farmers to receive the products and to share the costs;
- unwillingness to introduce new technology that has not been proven on a larger scale.

3. The pollutants are captured at source: The possibility of using sewage sludge as a fertilizer is strongly dependant on the quality of the sludge. Contaminants of concern include heavy metals, organic hazardous substances, and pathogens. Pollutants come from a variety of sources including:
Stormwater in a combined system is a major source of heavy metals and organic hazardous substances such as polycyclic aromatic hydrocarbons (PAHs). Stormwater is dealt with more in detail below.

Households are a major source of heavy metals such as copper (from the drinking water pipes), cadmium and zinc (from installations), and nickel and chromium from stainless steel installations and fittings. Pharmaceutical residues, flushed down the toilet directly or after having passed through the body, are of great environmental concern, especially synthetic hormones and bactericidal substances. Cosmetic products and dishing and washing agents

Figure 3:5 Strategy 2: The Nutrients are captured at the Source

often have a content that is difficult to know and to control. Disruptive effects in wastewater treatment plants have been noticed when substances such as phosphorus have been substituted for other substances with unknown effects. The effects on receiving waters are largely unknown. Flame-retardants have more recently been observed as an environmental problem. They are found not only in electronic devices but also on most imported textiles, subsequently washed down sewers. Triclosan is often used as a bactericide in dishing and washing agents, in toothpastes and elsewhere.

Industries and small enterprises contribute wastewater the quality of which varies depending on the production process used by the business. It is assumed that large industries in Toronto either have treatment plants of their own or are under strict regulations concerning what they are permitted to flush to the sewer.

Small independent enterprises, collectively may constitute a larger risk than industry since they are not so strictly regulated. Examples include cadmium from artists' paints and mercury from dentists.

The above-mentioned sources of pollutants are only examples of what may be collected in a wastewater system. In a strategy where the objective is to use the sewage sludge as a fertilizer in agriculture, the sources of pollutants have to be addressed in a variety of ways. Some substances must be restricted and information campaigns combined with feedback to the source can help ensure compliance. Successful campaigns have been used in Stockholm, for example, by advertising in the subway concerning cadmium in artists' paints.

For the Toronto waterfront we propose that

- systems capturing the nutrients at the plant are investigated, and that experiences from other countries are studied. However, this would be the responsibility of the city of Toronto rather than that of the TWRC

- separation systems for urine or black water systems are **not** installed in households, but that developments in this area in some European countries be followed and the value of this strategy be considered in later phases of the development process. However, demonstration technology for this strategy could be included in one or two houses in each precinct
- a program is launched to trace the sources of environmentally hazardous substances that travel to the WWTP, with a subsequent action plan to eliminate or reduce these sources. Even if this is a concern for the entire City of Toronto, the Waterfront areas should lead the development and introduce not only environmentally benign building materials, but also try to influence waterfront residents concerning their purchasing habits such as their. choice of cosmetic products and what they flush down the drains.

We suggest that related outcomes in Stockholm, Sweden, be studied more in detail. Studies have shown the importance of different sources to contaminants in the wastewater, especially heavy metals. A detailed inventory has been made, and has been presented in a number of scientific papers and academic dissertations. As a result of these inventories, several information campaigns have been carried out with successful results. The heavy metals project is now being followed by a similar project for organic hazardous substances.

Figure 3:6 Strategy 3: The Pollutants are captured at the Source.

Energy from wastewater

Energy is available at the Ashbridges Bay WWTP in the form of heat and biogas.

Heat may be extracted by means of heat pumps, using the treated water. In Sweden most of the larger treatment plants have installed heat pumps. It is estimated that such a heat pump at the Ashbridges Bay WWTP might contribute of at least 200 MW, depending on the time of year. A prerequisite for using this energy is of course that a modern district heating system is available, there is a demand for the energy and it is available at the right price. Also note that an output of 200 MW heated water typically requires 60 MW of electricity, which may be contrary to the energy strategy for the waterfront (se above 3.2).

Biogas comes from a biogas plant (anaerobic digester), that uses sewage sludge as raw material. Due to the relatively high contents of pollutants such.as metals in the sludge, we do not recommend that the sludge be digested in the same reactor as the biosolids from the solid waste. The existing biogas reactor at the Ashbridges Bay WWTP produces biogas that is primarily used for internal purposes. From a marketing viewpoint it may be better to use the biogas, in a refined form, for the municipal cars and buses. Today the gas volume at the plant is 50-60, 000 m3 per day.

The sludge from the reactor may be composted and used for multiple of purposes, depending on the quality of the sludge compared to the provincial and city regulations and the acceptance of the farmers and the food industry.

The collection system

We support the City's strategy to reduce the frequency and severity of combined sewer overflows (CSOs) by constructing a major storage/conveyance facility south of the West Don Lands.

In order to eliminate leaking water, pipe materials should be made 100% tight by using plastic pipes with welded joints.

The receiving waters

"Healthy Rivers and Shorelines" and "Water we can trust" are major water quality objectives

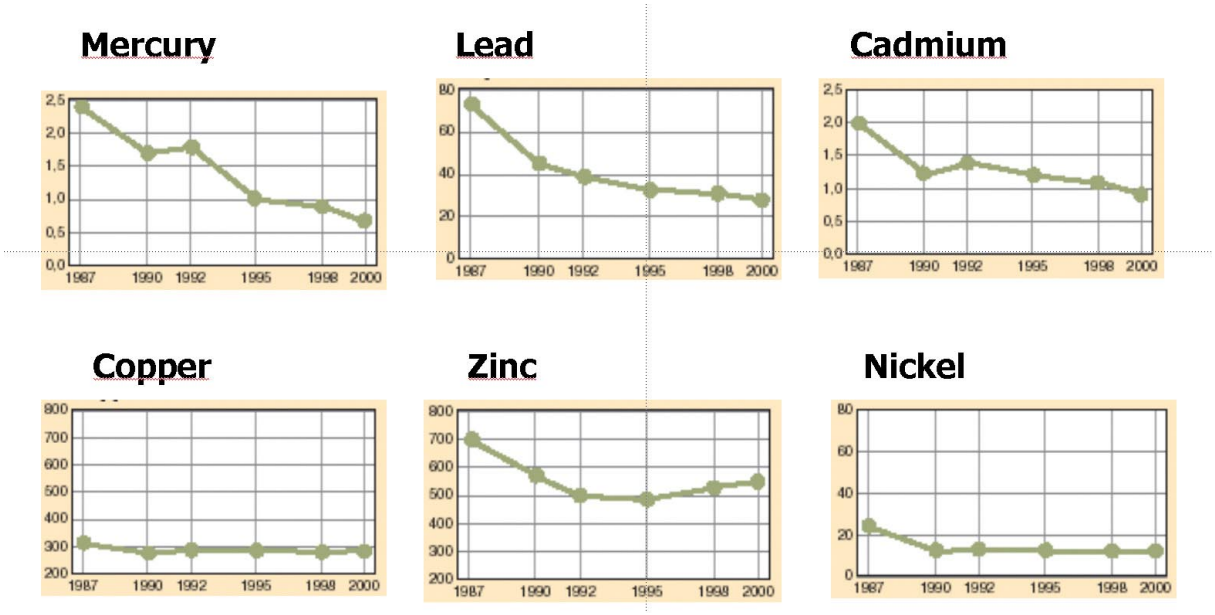


Figure 3:7 Concentrations of Heavy Metals in Sewage Sludge

according to the Toronto and Region Conservation Authority. The ultimate goal for all the Toronto waters is to make them fishable and suitable for swimming. In order to reach these goals, combined sewer overflows have to be eliminated or the number considerably reduced. In addition, stormwater quality must be improved by pollutant source reduction or treatment. Longer term measures for reducing pollutants at source include, for example, closing the North Toronto Treatment Plant which would have a positive impact on the the Don River.

3.3.3 Stormwater

The City of Toronto's Wet Weather Flow Management Master Plan (WWFMMP) identified principal ways of dealing with stormwater:

1. at source;
2. during conveyance; and,
3. end-of-pipe.

We strongly support the WWFMMP and its priorities.

Quantity
Stormwater flows can be considerably decreased by a series of source control measures, including swales, ponds and wetlands, green roofs, detention tanks, porous paving and other technologies. Treatment trains are preferred, where two or more technologies are operated in sequence. The choice of technology depends on available space, acceptance by the developers and the residents, and the type of soil (e.g. degree of permeability). Integrated stormwater management in each precinct area should be developed based on sound data concerning performance during a variety of rain and snow co nditions, with the overall aim of avoiding surface and basement flooding.

Quality
In order to improve the quality of the receiving waters measures have to be taken to reduce pollutants in the stormwater that reaches bodies of water and the soil.

We suggest that the stormwater from traffic and parking areas be separated from stormwater from roofs and open spaces. Stormwater from traffic and parking areas is considerably more polluted with heavy metals and organic hazardous substances.

Pollutant source control
The following comments about pollutant source control are valid regardless of whether the wastewater system is separated or combined.

Stormwater from traffic areas often have high concentrations of lead (if leaded gasoline is used), copper from brake linings, zinc from tires, platinum from catalysts, cadmium from tires and other sources, PAH from tires and from exhaust. Also as asphalt breaks down PAHs and heavy metals are released.

Stormwater from the roofs of houses as well as from open spaces may contain copper (from roofs and fittings), zinc (from galvanized lamp-posts, railings and fittings), phosphorus, nitrogen and pesticides from fertilized lawns, as well as bacteria from bird and dog droppings on lawns and open spaces.

If the sources of contaminants in stormwater from roofs and open spaces are identified early in the planning process, restrictions may be introduced in the detailed construction plans and/or in the building permits/contracts in order to control the choice of building materials. (For example, In Stockholm copper is only allowed when renovating roofs of historical buildings).

Stormwater from traffic areas should be treated in oil separators and sedimentation tanks, designed to remove most of the solids and thereby 50-90% of the heavy metals and PAHs. These tanks should be operated and maintained in the same manner as other treatment facilities. The contaminated sediments should be taken care of in the approved manner.

Stormwater from parking areas may be filtered using permeable paving. Experiences from Sweden have shown that most pollutants are retained in the upper layer of the soil below the paving. Long term effects on the environment, however, remain unknown.

Outdoor car washing should be restricted. Wash-water has a high content of cadmium and other heavy metals. Commercial car washes on the waterfront should be required to use a closed water recycling system.

Non-structural measures
Sweeping and vacuuming the streets can improve the stormwater quality. Swedish experience indicates that the cleaning must be fairly frequent to have an effect – every second day is recommended, depending on the frequency of the rain. Still, street cleaning may be a cost-effective way of reducing the stormwater pollutant loads where the receiving water is sensitive, or where there are spatial limitations to the construction of holding ponds.

Catch basins should also be frequently cleaned. The interval between cleaning times depends on the design of the catch basin.

Snow management
Snow management also affects the receiving waters. Melt water often has considerably higher concentrations of contaminants than stormwater from rain. A first-flush effect during rain events has an equivalent in a ”first-melt-effect”, meaning that dissolved substances leave the snow early during melting while contaminants attached to particles are generally left behind in ground sediments. These sediments should be cleaned in a responsible way since they can contain heavy metals and PAHs.

Figure 3:8 Stormwater Flows can be considerably decreased by a Series of Control Measures, here exemplified by Green Roofs, Ponds and Wetlands.

3.3.4 Water Management in East Bayfront

Only conceptual systems are discussed within the scope of this review.

The *”Municipal Services Planning Objectives & Evaluation of Conceptual Infrastructure Plans”* for the East Bayfront Area – Section 4.3 ”Stormwater Management”, was obtained

during our site visit to Toronto. We support the conceptual ideas and suggestions in that plan with a few comments:

- The largest pollutant load comes from the Gardiner Expressway. The stormwater should be treated in oil separators and settling tanks, properly designed, before outlet to the lake. It is not recommended that this stormwater be treated in the Ashbridges Bay WWTP. If, as hinted at in the plan, the stormwater will be treated together with the CSOs, this should be done in a separate treatment plant. The stormwater pollutants may otherwise contaminate the sewage sludge and prevent the use of the sludge for nutrient recovery.
- The suggested open conveyance systems for stormwater from roofs and open spaces, including green roofs, channels, swales and ponds where appropriate, are supported. However, experiences from green roofs in Europe are mixed. In a cold climate certain types of vegetation will suffer. Also, some vegetation requires fertilizer, which has lead to elevated levels of phosphorus in the runoff from the roofs, with subsequent eutrophication of channels and ponds. However, green roofs have probably been used more in Canada than in Europe and the experiences may be different.
- It should be noted that open stormwater systems require frequent maintenance due to littering. Over looking this step can cause a decrease in the quality of the living environment in nearby communities.
- The use of road salt during wintertime may damage vegetation, especially if the grass areas along or around the trees are used for infiltration. If sodium chloride is currently then use of an alternative de-icing agent should be considered.
- For aesthetic reasons, stormwater from streets should not be treated in open ponds or wetlands, since it has a high content of clearly visible suspended solids and oil.
- The reuse of stormwater from roofs and open spaces will probably not be cost-effective since there is an abundance of water in Toronto at a relatively low price. However, the public learning opportunity may be important. Drip irrigation will be the best technology for this purpose. If the irrigated area is used as a playground or other public use where there are children it is advised that the water be disinfected by means such as UV radiation, as proposed in the PM.
- The value of disinfecting water that is brought directly to the lake is doubtful. Even if there are pathogens in the stormwater that might pose some degree of risk to public health the water will be probably be diluted sufficiently to reduce this risk significantly..
- Storing stormwater in the old grain silos on the waterfront requires pumping, which may be cost-effective under current Toronto energy prices. However, from a sustainability point-of-view, the use of energy should be diminished as much as possible. It cannot be regarded as "leading edge" to use energy for pumping if there are alternatives.
- The quality of the water from areas of low pollution may be improved by introducing pollutant source measures, as dealt with above. Restrictions for certain building materials, in combination with operation and maintenance practices, would be an effective approach.

3.3.5 Water Management in West Don Lands

Only conceptual systems are discussed within the scope of this review.

The "*Draft Municipal Services Plan*" for the West Don Land precinct plan – Section 4 "Stormwater Management System", was obtained after investigations on site in Toronto. We support the conceptual ideas and suggestions in that document with a few comments.

Most of the suggestions and comments for East Bayfront also apply to the West Don Lands; *(see* Section 3.3.4 above).

We suggest a dual stormwater system in the West Don Lands. It has the following advantages:

- The polluted stormwater from traffic areas can be treated in properly designed oil separators and settling tanks underground. The size of these facilities will not be too large, and it will be possible to construct two or more separate facilities or even, as suggested, place them under parking garage. After treatment, the water can be conveyed either to the Don River or to the lake.
- The relatively clean water from roofs and open spaces can be treated in a pond, inside or outside the planned flood protection berm, The pond may serve only a part of the area or be divided in two or more ponds depending on the slope conditions. The purpose of this pond is dual: for flood protection during heavy rainstorms and for improving water quality. If the purpose is the latter one, as suggested in the PM, the size of the pond can be considerably smaller than the suggested 0.52 ha. Assuming that the total area, excluding streets and parks, is 17 ha and that the impermeable surface is 80 percent, the pond needs to be around 0.3 ha. This is based on findings from research in Sweden telling us that 2 percent of the impermeable surface is an optimal size for a sedimentation pond. Larger ponds only marginally improve the settling.
  The pond may also, if needed, be divided in two or more ponds.
- The treated water can be conveyed to the Don River which will decrease the need for piping. If required by regulations, the water can be disinfected by UV radiation as suggested. (This is not normally done in Sweden). However, the risk for infection by stormwater should not be exaggerated. In Sweden, where stormwater ponds have been are extensively for a long time, no incidents have been reported where people have been infected by the stormwater, although the possibility cannot be ruled out entirely.

A dry pond for relatively clean stormwater can have other uses such as for a playground during dry weather. There are several successful examples in Sweden and elsewhere. The littering effects have been easy to handle and the ponds do not smell or look ugly during dry weather. Alternatively, a wet pond in the eastern park area may have aesthetic and recreational values.

At buildings and yards and along the streets and boulevards, stormwater may be filtered. However, it is important that the soil the water runs through has not been is polluted by earlier industrial activities. Porous paving is probably the most cost-effective way to filter . Porous asphalt also reduces noise from traffic. Other advantages are that the surface remains dry during rainy periods and snow and ice melt faster. Stormwater pollutants, such as heavy metals and PAH, are mainly in a particulate form, and are effectively captured in the upper soil layers. Dissolved substances may be infiltrated to the groundwater but should not be of a great concern since the groundwater is not used for any purpose. Pollutant concentrations that eventually reach the lake should be difficult to detect. As a precaution, the use of pesticides and biocides in the catchment area should be avoided. Infiltration should be avoided where the soil is contaminated from old industrial activities.

If oil and grit separators are installed it is important that they are equipped with bypasses that work when the inflow is larger than the design flow. Experiences from Sweden show that if bypasses are not in place the separators will be washed out and have no effect at all during times of overflow.

Overflow stormwater or flush water, or sediments, should not be allowed to enter the WWTP if the plans are to use the sewage sludge for fertilizer purposes.

Various

We have not found any measurable objectives for water quantity or quality in the precinct planning and related infrastructure documents. It would not be too difficult to estimate the effects of alternative strategies. Simulations with existing stormwater computer models may facilitate the task for determining the impacts of various pollutants. Simulations woul also give motivation and arguments for proposed plan restrictions and information campaigns.

In some Swedish cities, for example Stockholm, separate stormwater tariffs have been introduced. The costs for stormwater management were previously included as part of drinking and sewerage tariffs. Nowadays the landowner pays the stormwater management fees separately and the amount paid is dependent on the size and on the use of the property. This strategy gives the landowner a good incentive to take care of stormwater on-site.

Shutting down North Toronto treatment plant may make sense from an environmental perspective. However it provides base flow to the Don River in times of low flow and the residents around Ashbridge's Bay Treatment Plant will be opposed.

Our comment is that if the flow from the WWTP is needed in the river during dry summer months, the quality of the river water would be in question and the goal of water that is "fishable and swimmable" difficult to reach. Furthermore, the local opposition to WWTP cannot be disregarded but will occur wherever they are located. Shutting down the North Toronto treatment plant will only result in the need for a small extension of the Ashbridges Bay WWTP (Prof. Per-Arne Malmqvist)

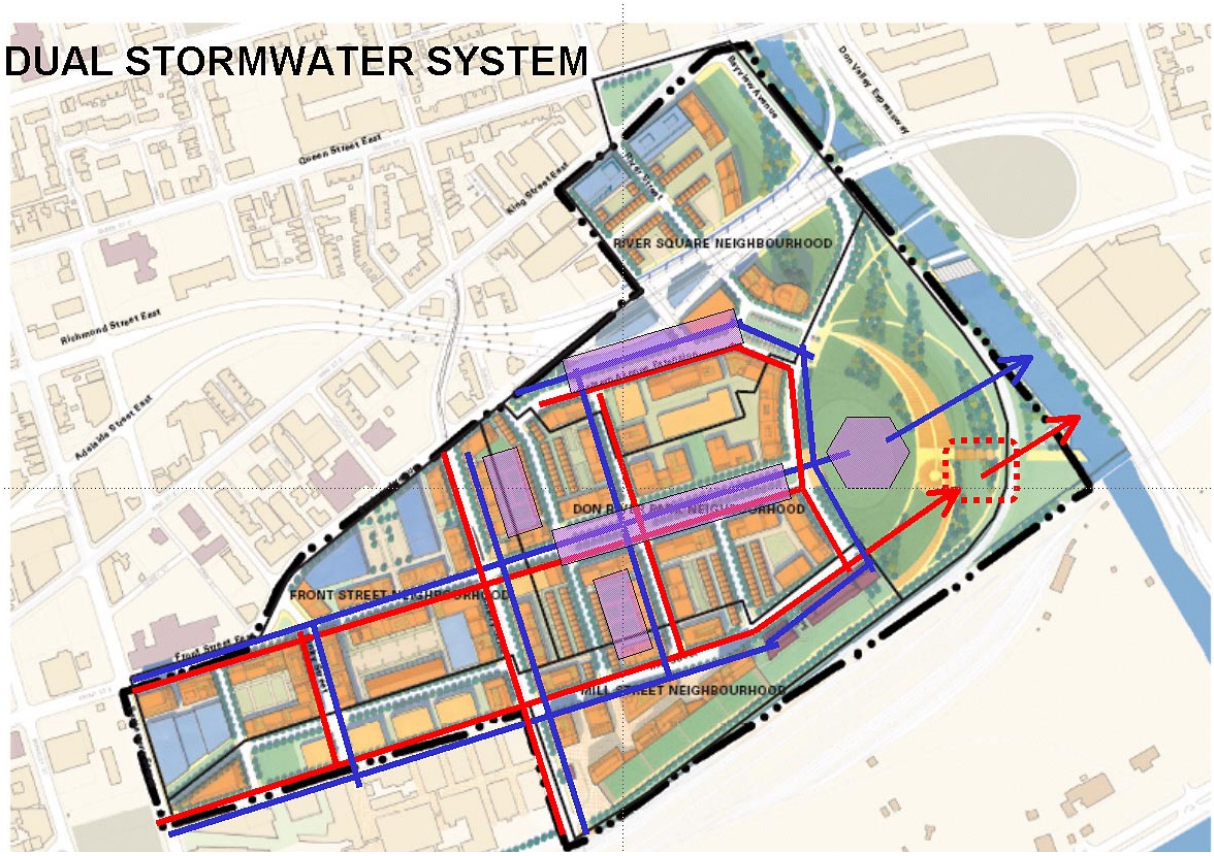


Figure 3:9 An Illustration of a possible Dual Stormwater System in West Don Lands

3.4 Sustainable Waste Management

3.4.1 General overview

The ECO-Cycle Society

Everyone involved in the protection and proper use of raw materials, who is concerned about natural resources and the environment and who is working in the daily operation of solid waste management should hope that as a community we operate in a way that is consistent with the "Eco Cycle Society". This means that each of us, in our present and future handling of raw materials, products, residues and waste will minimize the use of limited resources and bring back as many resources as possible into the closed resource management cycle.

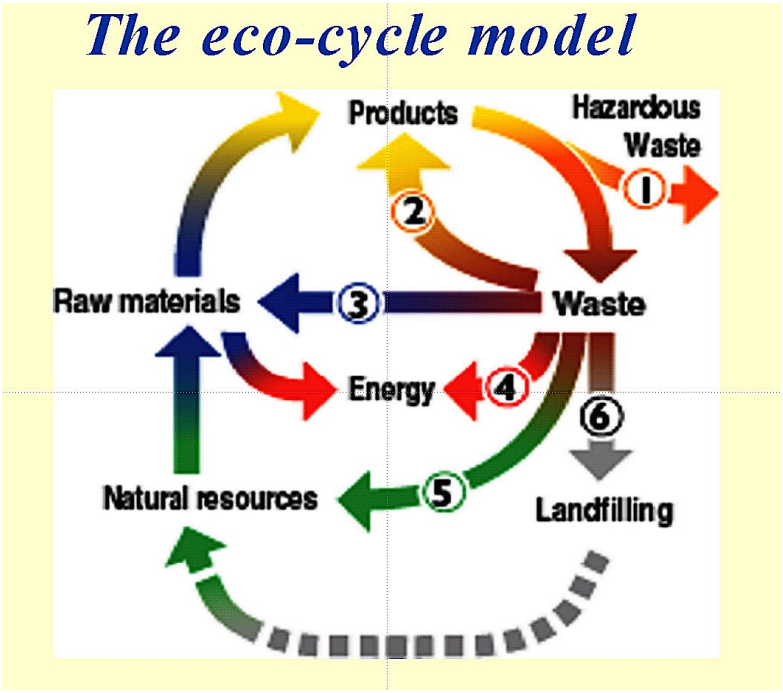


Figure 3:10 The Eco Cycle Model

Integrated Waste Management - A Combination of Methods.

Even with maximum compliance with waste reduction strategies, there will still be a need for waste treatment. The state of the art of waste treatment has advanced rapidly in recent years. Today, technologies are available to effectively treat wastes in an environmentally sound manner. For example, directives and standards for waste-to-energy units incorporate advanced and efficient air pollution control systems and emissions monitoring systems to control organic emissions, metals, acid gases and other pollutants. In biological treatment plants carefully separated waste is treated in order to ensure high quality end products such as biogas and/or compost. And odor emissions are minimized at each stage of waste management.

Today's state-of-the-art landfills meet with similar tough regulations. Most of them are equipped with leachate collection systems, with groundwater monitoring, with systems for control of landfill gas and recovery of its energy content, and with strategies for recovery of other resources where possible. Modern landfills also have detailed closure and post-closure programs to maximize the reduction of impacts to the environment and the community. The objective is to ensure that landfilling, when used, is performed in a manner that greatly reduces the chance of environmental degradation and also ensures that any release that does occur is quickly detected and remedied.

In many countries the following list of priorities is recommended to address the waste management issue:

1. Waste Reduction and Minimization
2. Reuse
3. Recycling
4. Energy recovery
5. Landfill

Any approach to waste management must be handled in a very careful and sensible way, and take into account the regional and local conditions. It is essential, when deciding upon which methods to use, that there is a market for any byproducts, including energy that may be produced. If not the economic, environmental and social considerations of waste management are taken into account together, we will not be aiming for an "Eco Cycle Society" but will, in a backward fashion, be dealing with the waste flow in an unacceptable linear way.

Results from different countries indicate the need to address waste management issues using an integrated waste system that makes use of a combination of many methods. An integrated approach maximizes the recovery of materials and energy from waste and also minimizes the need for landfill.

In working with a combination of different methods it is essential that those methods complement each other. Examples of components of an integrated waste management system include:

- Materials recovering from households and industries.
- Biological treatment of waste with use of the easily biodegraded part of the organic waste for the production of biogas and compost.
- Thermal treatment of waste, with energy recovery.
- Landfill, which will always be needed regardless of other methods used for non-recyclable materials and for residues from other waste treatment.

Source Separation and Collection

It is very difficult, almost impossible; to achieve successful material recovery or a successful biological treatment of waste from a mixed, non-source separated, waste. Experiences from the 1970s and 1980 clearly show the necessity of separating different materials and waste-flows as early as possible, already at the source to ensure high quality marketable materials and by-products. It has also been clearly shown that it is of the utmost importance to separate hazardous waste from the rest of the waste. Otherwise, there will be potential contamination and operational problems in all subsequent waste treatment methods.

The better information, the easier it is for households and industry to successfully separate the waste into different fractions. The Blue/Grey Box Program in Toronto for packaging, paper and recyclables, shows that a well-communicated and easy-to -understand source separation system achieves a good result. The Blue/Grey Bin Program can be used in single-family residences as well as in multi-family residences.

The newly introduced Green Bin Program, for the separate collection of organics, seems to work very well in the single-family residences where it has been introduced. It is only possible to successfully operate a biological treatment plant, with the necessary market for the end

products, if there is a quality-secured delivery system for "clean" organic waste. The Green Bin Program is hopefully such a system for the single-family residences, but it has to be carefully and continuously followed up with regard to information, separation discipline and the composition of the organic fraction in the Green Bins. The Green Bin Program will probably be very difficult to successfully introduce in the multi-family residences. In new apartment buildings, such as those proposed for the revitalized Toronto waterfront, the installation and the use of an alternative collection technology for the "green organic waste" should be considered. Centralized vacuum chute systems for the collection of one or two separated fractions could be such a solution.

Recovery of Biogas and Compost

Biological treatment of organics is one method, used in combination with other methods, for achieving successful waste diversion. All waste fractions cannot be recycled as materials and all waste fractions cannot be brought to a waste-to-energy plant, not even all organic fractions are suitable for a waste-to-energy plant. "Clean" organic fractions, easily identified at source in households and industry, could be used for the production of an enriched biogas and for the production of compost suitable for use on farmland. Successful outcomes, however, can only be achieved if "clean" organic waste is collected under strict quality control guidelines. The organic fraction must *not* be mixed with other wastes since that would jeopardize the operation of the biological process and the output from it.

A quality-assured biological process could start with the inflow of a guaranteed "clean" input of organics from the food industry, where it is quite easy to guarantee the quality. Such a basic inflow can then be followed by organics from the Green Bin Program and from the separate collection in apartment buildings.

Biological waste treatment can be dealt with in two different ways – biogasification and composting. In a biogasification plant there is production of an enriched biogas that can be used as a fuel or for heat or for electricity production. The big advantage compared with ordinary composting or landfilling is that the gas from the bioprocess can be fully controlled as opposed to more or less uncontrolled emissions to the atmosphere of landfill gases such as methane. The biogas from a biogasification plant should not be flared away but used, instead, for energy purposes. From a biogasification plant there will also be a residue with quality controls can be used on farmland. Another advantage of biogasification is that problems with odours can be handled in much more efficiently than with odors from composting.

With Toronto's ambitious Green Bin Program there will be a need for an increased biological treatment capacity. The biogasification capacity of the Dufferin Organics Processing Facility has to be realized with the development of a plant where the biogas easily can be used as a fuel for waste collection vehicles and public buses. Modifications such as these should be used to divert even more waste from landfill and to achieve overall sustainable waste management.

Waste-to-Energy

Waste-to-Energy is an established and well-functioning method for waste treatment and energy recovery. Due to far-reaching restrictions on landfilling of municipal waste in many countries there is an increased need for waste incineration with energy recovery, as a complement to recycling and biological treatment of waste. New plants are equipped for using the produced energy for heating purposes as well as for electricity production. Strict emission directives and guidelines result in the installation of very advanced flue gas cleaning systems that meet and exceed strict regulations such as the new EU-Directive on waste incineration.

There is only one objective for waste incineration that is relevant in the Eco Cycle Society and that is energy recovery. Volume reduction is no longer an objective even if it is an important parameter when comparing environmental impacts. In many countries, it is not possible to

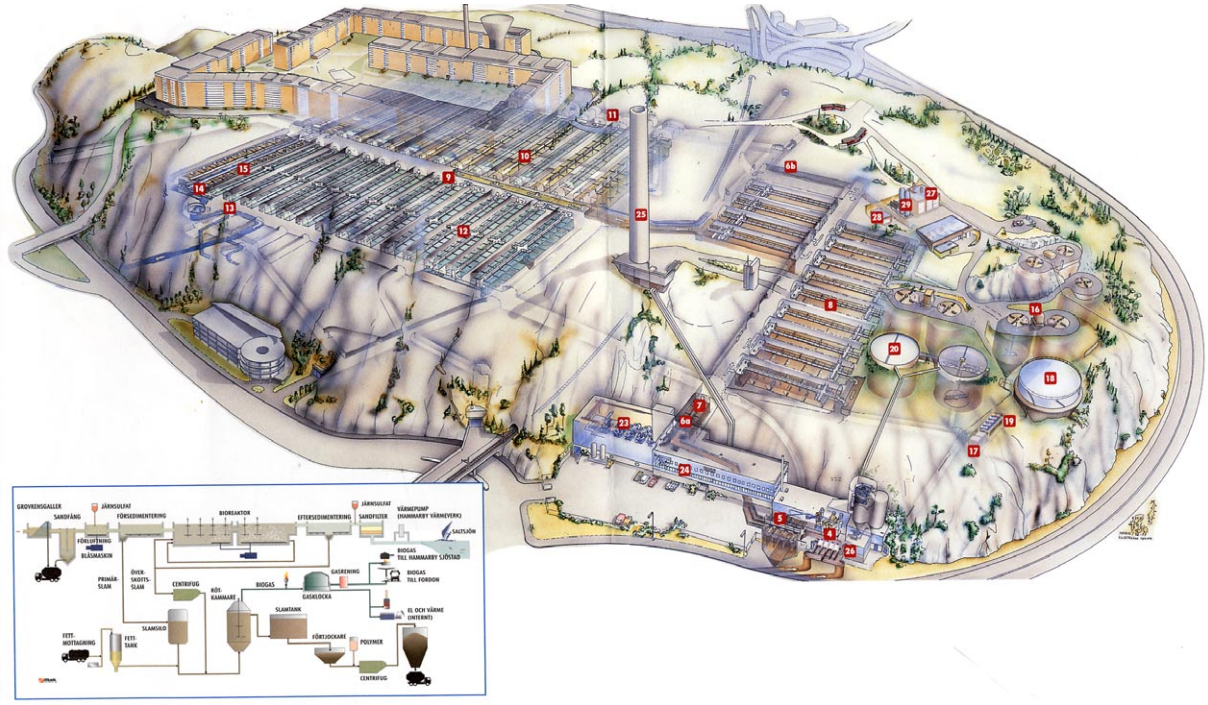


Figure 3:11 Henriksdals Wastewater Treatment Plant in Stockholm. Biogas is recovered from Organic Waste and Waste Water Sludge.

get permission to build a new waste incineration plant without recovering the energy that is produced. Besides, the operational costs in a modern plant equipped with advanced flue gas cleaning and strict residues handling procedures will be too high without any income from energy recovery.

In many countries today there is a significant trend towards combining energy producing with heat recovery. For example, in Scandinavian countries almost every new plant is equipped for heat recovery as well as for electricity production.

Current energy-from-waste technologies are far superior to those of even a decade ago. Many countries have seen significant increases in the per unit recovery of energy while, at the same time, emissions from the process have dramatically decreased. For example, while waste quantity has doubled in Sweden from 1985 to 2003, energy production has tripled and emissions been decreased by 96-99 percent (depending on the pollutant).

In Toronto there are excellent conditions for the introduction of waste-to-energy using high quality environmental protection technology and building on an already existing district heating system which can be expanded to the revitalized waterfront area. Burnable waste is a renewable, domestic waste that can replace fossil fuels.

Dioxins and Waste-to-Energy

The emission of dioxins has been very much discussed in connection with thermal treatment of waste. Significant improvements have taken place and waste-to-energy plants are no longer a major source of dioxins emissions due to extensive operational changes and the installation of very advanced flue gas cleaning technology. The improved source separation, where hazardous waste is separated early on in the process has also contributed to reduction in dioxin and other toxic emissions.

However, the subject of dioxins is inevitably raised and intensely debated whenever the issues of waste-to-energy is raised. Continuous efforts are being made to further improve waste-to-energy as a means of dealing with burnable waste, while also producing valuable energy. The

main aims are to further reduce the already low emissions to air and to ensure effective long-term deposition of ashes and other residues from the flue-gas treatment of the waste–to-energy process.

The Swedish Association of Waste Management (RVF) initiated the largest study to date into dioxins and waste incineration in Sweden. The study was led by Professor Stellan Marklund of the University of Umeå who has a doctorate in dioxins management and conducts research into incineration technology and environmental effects. The main aim of the study was to provide information about the current situation in the field of waste incineration for all of Sweden with a particular focus on dioxins. The report entitled *"Waste-to-Energy, an Inventory and Review of Dioxins"*, was published in November 2001. The results can briefly be summarized as follows:

The waste treated and used as fuel at Swedish waste incineration plants in 1999 contained dioxins of varying quantities, depending on the origin and composition of the waste. The information available, however, has not been sufficient for any reliable assessments to be made about the amounts of dioxins contained in the raw waste.

At the high temperatures involved in waste incineration in the plants, 90-95% of the dioxins in the waste are broken down into carbon dioxide, water and hydrogen chloride. A small quantity of dioxins (5-10 g total in 1999) in incoming waste is carried with particulates and found in slag and bottom ash (FB plants), which are used as filler or sent to landfill.
When the flue gases were cooled 115-125 g of dioxin was formed, and this went with the raw gases to the flue-gas treatment system. Flue-gas cleaning separated 110-120 g of dioxin and stored it in fly ash, sludge, etc., which was then sent to long-term landfill. Total emissions of dioxins into the air from waste incineration plants in Sweden amounted to just under 3 g.

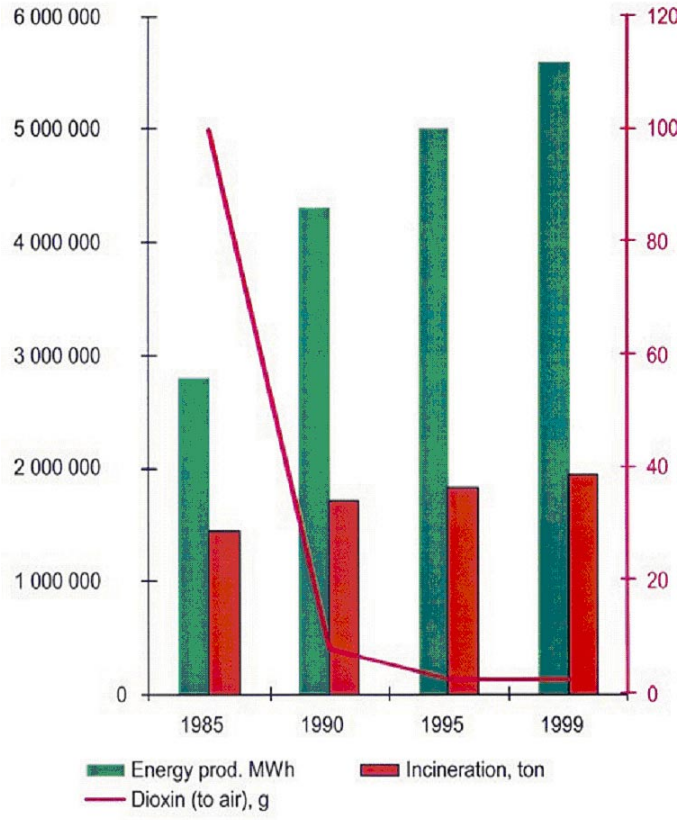


Figure 3:12 Incinerated Amounts of Waste, Energy Production and Dioxin Emissions 1985-1999 in Sweden.

In 2002 the emission of dioxins to the air from the 25 Swedish waste-to-energy plants amounted all together to 2 grams annually and is expected to decrease even more in the coming years in spite of more plants being constructed and operated. The Swedish Waste-to-Energy plants are no longer considered major sources of dioxin emissions.

A major advantage of waste incineration when dealing with the dioxins in society is that the vast majority of the dioxins separated after incineration through flue-gas cleaning are collected and deposited in ash and other residual waste from the flue-gas treatment system. Dioxins in these residues, and to an even higher degree in slag and bottom ash, are solidly fixed to particles, and many studies have shown that separate handling gives rise to practically no leaching at all.

The risk of dioxins in residues from waste incineration leaching out and polluting the environment is therefore very low, provided that the residues from flue-gas cleaning are deposited without coming into contact with other waste, at landfill sites which are designed and dimensioned for long-term disposal of hazardous waste. The question of what would happen to the waste and its dioxin content if it were not incinerated is therefore of interest when discussing the role of waste incineration as a dioxin source, and selecting a method of treating household waste.

The aim of the inventory and review carried out has been to chart and report current knowledge levels regarding the degradation and leaching properties of dioxins in ash and other residues from flue-gas cleaning from the waste incineration plants.

The most important conclusions from this charting and review work on the leaching of dioxins from ashes can briefly be summarized in the following points:

- Dioxins and other organic environmental toxins are solidly fixed to particles and it is primarily the small particles in the leachate that carry these pollutants.
- Dioxin in fly ash does not leach at all, or to a very small extent (0.004%) when using distilled water or unaffected natural water as a leaching agent.
- Tests have shown that using different types of solvent as leaching agents results in considerably larger quantities of dioxin leaching.
- Leaching tests have shown that an increased concentration of e.g. detergent or other substances which reduce surface tension in the leaching agent result in increased leaching – tests show that the increase can be 100 times or even more compared to pure water.
- The leaching tests also showed that acidic solutions have a similar effect to solvents, although they involve lower levels of dioxin leaching.
- The higher chlorinated dioxins, which are present in the highest quantities, leach to a greater extent than the low chlorinated toxic dioxins, which are found in lower quantities, despite the latter being more water-soluble.
- Background values for dioxins in rainwater and fall-out are at the same level as the dioxin contents in leachate.

These conclusions concur with experiences from previous research and studies. The results both on the dioxins' leaching properties and the factors, which affect leaching, are also concordant with earlier findings. The quantities and contents measured in tests using different leaching agents also tally well with previous findings.

The following conclusions can be drawn with regard to the degradation of dioxins in ashes.

Dioxins in ashes are characterized by high stability and low mobility, provided that the ashes are handled separately and isolated from the surroundings.

Under these conditions, the dioxins in ashes degrade very slowly and the half-life can be several decades.

Dioxins in contaminated soil can degrade significantly faster than dioxins in ashes, depending on the different composition, the soil's structure, water flow and other factors, which facilitate degradation.

Dioxins in ashes, which are handled separately and isolated from external influence, maintain their stability and degrade very slowly – particularly ashes containing unincinerated material.

Landfill

Regardless of other methods being used there will always be a need for landfill to handle, non-recyclable materials, and for residues from other waste treatment methods. The aim is and will be to minimize landfilling, but it will always be needed. Decreasing landfilling to a level of 5-10%, with a recovery rate of material and energy of 90-95%, must be recognized as a success.

Even if small amounts of waste will be land filled in the future, the citing landfills remains a problem as does the issue of how to handle such a small amount of waste in an economical way in the face of high waste diversion, considering the investments needed for construction of a modern landfill and the operation cost per tonne of waste. This clearly indicates the need for regional co-operation to be able to solve the landfilling problem in an environmental and economically viable way. This is true in Sweden and seems to be the case in Toronto and the in Toronto region as well.

Integrated Waste Management - The SYSAV-Example

The Swedish company, SYSAV – located in the most southern part of Sweden, owned by 14 local authorities and with a population of 630 000 inhabitants in the region – is working with a combination of a large number of different methods in order to maximize the recovery of material and energy out of municipal solid waste and out of industrial waste. In 2003 the SYSAV company group managed to achieve the following results, annually handling about 770 000 tons of municipal and industrial waste:

• Recycling of materials and compost:	42%	320 000 tons
• Energy recovery from waste:	41.5%	320 000 tons
• Landfilling:	13%	100 000 tons
• Separate handling of hazardous waste:	3.5%	26 000 tons

In 1990 most of the waste was incinerated (with energy recovery) and land filled. Very little was biologically treated or recycled as a material.

In 2004 the recycling of compost as well as energy recovery will increase and land filling will decrease even further, probably below 10%. The waste-to-energy plants will provide the City of Malmö with about 40% (about 1 TWh of heat) of the district heating demand in the city and deliver about 150 000 MWh electricity to the grid. The amount of recovered heat corresponds to the annual use of about 120 000 tons of oil or 160 000 tons of coal. By using waste instead of fossil fuels, like oil or coal, the emissions of CO_2 and other greenhouse gases to the atmosphere decrease significantly. These outcomes have been the result of a long term work program based around a combination of different methods as discussed

earlier (e.g. separation in households and in the industry, introduction of new methods and new technology for the sorting, separation and recycling of different materials out of waste and the recovery of all the energy produced in the two waste-to-energy plants, as heat and as electricity, with no cooling off of energy at any time during the year).

Figure 3:13 The Sysav Example of Integrated Waste Management

3.4.2 Waste Management for the Waterfront and for the Greater Toronto Area

A review of waste management in Toronto and in the Toronto waterfront leads to the following conclusions:

- Waste Management in Toronto has to be an integrated waste management system, with a combination of source separation, material recycling, biological treatment, waste-to-energy and landfilling. This is necessary to be able to handle the very large amounts of waste in a sustainable way, and in an environmental and economical correct way, and to be able to reach the very ambitious goals of diversion committed to by the City of Toronto. It is also not in accordance with sustainability principles to transport between 4.5 to 7 million tonnes of waste to landfill.
- Waste management in the Toronto waterfront cannot be seen as an isolated activity but has to be an integrated part of the whole City of Toronto waste management system. The Waterfront area is too small, even when fully developed, to economically motivate investments in different waste treatment plants.

Based on the above conclusions above the following overview & recommendations are given:

Source separation in Toronto

The ambitious and obviously very well functioning system of Blue and Grey Bins for recyclables, packaging and paper should be used as far as practically possible in the single-family residences on the waterfront as well as in multi-family residences (where it is feasible). The results so far are impressive and encouraging.

The Green Bin system which just recently has been introduced in single-family residences

shows promising results but has to be further implemented step by step in a very careful way not to jeopardize the quality of the input to the biological treatment and, consequently, not to jeopardize the output from the treatment either. The Green Bin system should first be introduced in single-family residences and the results carefully evaluated before the introduction in multi-family residences. If introduced in multi-family residences, areas should identified for receiving information about the system and where residents can be encouraged to participate and to sort their organics correctly.

The results from the two current projects for the collection of household organics in multi-residential complexes, the Deep Collection System and the Automated Chute Trial, are interesting to follow and will give valuable guidance as to which system(s) to choose for a successful separation and collection of organics in multi-residential areas.

If technically and economically possible, centralized vacuum collection systems should be installed in multi-family residences, especially in new ones, where they are more feasible to install than in existing residences.

Source separation in the Waterfront area

When planning for a new residential area there are at the same time excellent opportunities to plan and prepare the area for a well functioning waste management system, with easy access for residents and with as little disturbance as possible. For the newly planned waterfront precincts centralized vacuum collection systems are suggested. The system would consist of central collection points and make use light waste collection vehicles within the area. The system will be a safer and more silent compared to the pick up of waste by heavy trucks that takes place today. The recyclables, packaging, paper, glass, and cardboard separated by the residents, can be collected in accordance with the Blue, Grey system in separate rooms on the ground floor in the apartment buildings. Alternatively, the centralized vacuum collection system can be used for three fractions – organics, recyclables and an energy fraction. However, such a solution requires a more detailed sorting of the recyclables in different fractions after the collection.

Bulky waste can be delivered at separate recycling centers across the waterfront.

Two systems are now in place to handle **hazardous waste from household** -a household collection service and a retailer ”take back” program. The Swedish experience indicates that both systems can meet with practical problems including a retailers’ resistance to participate. A household collection service can be managed in two ways – one, where the residents put the hazardous waste in a special room in the apartment buildings and where it is collected regularly; and two, a system where a collection vehicle arrives at the household to collect hazardous waste according to a given timetable. The first system can be objected to due to safety considerations related to storing hazard wastes in residential buildings. The second system requires residents to remember the timetable. A third system, where the households deliver the hazardous waste to certain collection points (for example gas stations after agreement have been made with the owners) are watched and safely locked until pick up by the authorities should also be given consideration.

Centralized vacuum collection system

A centralized vacuum collection (CVC) system is an environmentally beneficial and efficient method of storing and transporting municipal waste under the streets of the city. A CVC-system consists of network of underground steel pipes with a diameter of 300-500 mm connecting all buildings in the area with one so called terminal station. The terminal station is located outside of the residential area so that the heavy transport of waste in the area can be eliminated.

- Is there any evidence of improved rates of waste diversion with the CVC-system?

Four factors affect the rate and effectiveness of waste diversion/separation among households:

1. **Incentives** such as deposits on beverage packaging. Here the return rate is a direct result of the value of the deposit/return.
2. **Accessibility** of waste separation. The closer the disposal or collection point is to the household, the higher the inclination to separate.
3. **Discipline/control factor**. Social controls should not be overlooked. Many housing developments in Scandinavia have chosen to place waste collection points at a central and often attractive position in the neighborhood, where public scrutiny is high.
4. **Information**. Frequent information campaigns are necessary in order to receive a high degree of acceptance among households to separate waste.

The CVC-system offers possibilities to enhance all of the above factors. Personal access cards can be applied which can be combined with incentive systems. Accessibility is normally better with a CVC system than with conventional waste collection system, since a CVC-system can offer waste disposal (inlet) possibilities closer to the apartment. Also the discipline/social control factor is enhanced with a CVC-system since the waste storage facilities are easier to maintain, keep odour- free and hygienic. There is a continuous need for public information associated with both systems.

- How important is air quality improvement?

In absolute terms driving the waste to Michigan produces much more air pollution than driving to collect the waste within the area. It is important to consider, though, that waste collection trucks consume 10-20 times more diesel fuel when it operating in collection mode (due to idling), as opposed to transporting long distance (distribution mode). Air emissions are directly correlated to the fuel consumption. Also, besides fuel consumption, the noise level of conventional waste collection trucks is higher in the collection mode.

- What are experiences with capital and operating costs for CVC vs. conventional waste collection?

The economic viability of CVC-systems depend on:

1. **The density of the area.** Single-family houses or semi-detached housing areas are not economically feasible for the CVC system. However apartment buildings with 4 or more floors have a much higher likelihood of profitability. The higher the buildings and the denser the area, the shorter the payback time of the CVC-installation versus conventional waste collection.
2. **Ground floor rent or sales price levels.** A CVC-system releases ground level space. Depending on the requirements for the waste rooms in the buildings between 0.2 and 0.5 sqm ground level surface per apartment built is saved. For offices this is about 1 sqm per 100 sqm office space. Also for shops and restaurants there are considerable space savings, since waste does not have to be stored on-site.
3. **Waste collection fees.** In general, there is a 30 to 40% reduction in collection costs versus conventional waste collection. The lower collection cost is a result of increased collection efficiency, and reduced need for manual labor.

(continued)

Over the years several studies in Stockholm have compared investment and operational costs of alternative waste collection systems. All things considered the CVC shows distinct long-term profitability[12] in a ten to twenty year time frame. The payback time, however, is mostly dependent on the ability to rent or sell the freed-up ground level surfaces.

- How are CVC systems received by residents and operators?

End user surveys for CVC systems have been conducted both in Sweden (Poseidon in Gothenburg) and in Spain (Majadahonda municipality and ATEGRUS-the Spanish waste collecting association[3]). Unanimously the results show a higher level of appreciation for the CVC system than for traditional, manual waste collection. The number of complaints on the waste collection (noise disturbance, odours, overfilled containers, bad hygiene, littering etc.) can be expected to drop significantly.

[1] Comparison of installation and and operating costs of (CVC) system and a manual waste collection system for the Södra Station project. BODAB, 1999 (summary in English available)
[2] Stockholms- Gatu- och Fastighetskontor, Västra Sjöstaden – Comparison between manual waste handling and a CVC system for three waste fractions (only in Swedish), done by SWECO in 2004.
[3] The latter study was presented at the Second International Conference on Automated Waste Collection systems (CVC) in Sevilla in April 2004.

CVC for the Waterfront area

A CVC-system for the three bulk waste fractions, gray, blue and green is recommended for the Waterfront area. A new type of waste inlet, which handles all three fractions separately in one chute, is proposed. One inlet conveniently located on each floor level can easily provide for the selective disposal of all waste fractions (gray, green and blue). Each inlet is connected via one chute to the central waste pipe system.

All three waste fractions will be transported in the underground pipe system to an underground terminal station from where the waste is transported to the Integrated Energy Plant. This transport can either be via container trucks or via air a separate underground pipe system.

Environmental impact analysis

A preliminary Environmental Impact Analysis (EIA) comparing the operational impact of a CVC-system with conventional rear loading waste collection trucks for the area, based on a population of 20,000 households, gives the following results:

Parameter	Rear loading truck	CVC
Global warming potential (kg CO_2/yr)	123 582	10 599
Acidification (kmol H+/yr)	22	1
Eutrophication kg O_2/yr)	5 897	206
Photochemical ozone creation (kg C_2H_4/yr)	10	2
Particulates (mg/yr)	961 000	22 000
Traffic load in region (km/yr)	13 357	1 506
Number of collection points	267	267
Total indoor ground level area needed for waste storage	4 929 m^2 (53 055 ft^2)	360 m^2 (3 875 ft^2)

Figure 3:14 An Example of a CVC-system. The Inlets of the System are carefully designed as part of the Urban Environment in Hammarby Sjöstad in Stockholm.

Biological Treatment

Currently in Toronto about 215 000 tons of organic waste are collected and treated in a biological way – with backyard composting, leaf and grass composting and with anaerobic digestion in the Dufferin Organics Processing Facility. With an increased collection of organics through the Green Bin Program and with installation of an extended centralized vacuum collection system, within a few years there will be a need for increased biological treatment capacity. A **biogasification plant with anaerobic digestion**, with a capacity of 100 000 tons organics per year will produce biogas as well as usable compost. Both products used in a way that is consistent with sustainable waste management.

The biogas could be used as fuel for waste collection vehicles, for city business and for other municipal vehicles. The compost must be of a consistently high quality to ensure a continuous market for the product. Since an organics management facility (the Dufferin plan) already exists in another part of the city, a new plant should be located a reasonable distance from the existing one to avoid long transports through the city and to meet with the increasing amount of organics being collected in the gradually expanding Waterfront area. If located close to the wastewater treatment plant in Portlands, the possibility would exist to coordinate the production and use of biogas from both facilities. With an anaerobic digestion plant in the Portlands there will be a total capacity in Toronto for the biological treatment of about 300 000 tons of organics annually, locally and in central treatment plants. The use of sewage sludge as raw material for production of biogas is treated in section 3.3.

Waste-to-Energy

The only way to reach the very ambitious goals for waste diversion set by the City of Toronto - varying between from 50 - 100 % by 2010 (100 % is in no way a realistic goal) is to work with an integrated waste management system. Waste-to-energy is one of the methods that can significantly contribute to reaching the City's diversion targets.

There are excellent conditions for the large-scale implementation of waste-to-energy in Toronto, with a large demand for heating and cooling due to the climate and with an already existing district heating system, which can be expanded into new and planned residential areas, close to the already existing district heating system.

According to figures from Enwave, the steam load will not go below 59 MW throughout the year in the district heating system due to the domestic hot water load and the chiller load. That load corresponds to about 500 000 MWh of energy annually. For that load the necessary energy, today produced out of natural gas, could be produced in a waste-to-energy plant. In this way the fossil natural gas can be replaced by a fuel (waste), which to a large extent can be considered a bio fuel.

A suitable location for a waste-to-energy plant would be in the Portlands, at the same site as the above-mentioned biogasification plant, close to the wastewater treatment plant. There are several advantages with such a location – waste treatment facilities are concentrated to one place, with one reception and one weighbridge for both plants, with a staff that can operate both plants and with a possibility to co-ordinate and to rationalize the transports to and from the plants and to optimize the logistics within the site. The location is at the far end of the expanding Waterfront area, close to the expanding district heating system, which will be connected to the existing one in downtown Toronto.

Scenarios for the future waste management in Toronto

Four different scenarios for the future waste management in Toronto are presented below, all based using an integrated waste management with a combination of methods to achieve sustainable waste management.

The four scenarios comprise the waste management situation in 2010 and 2020. In scenario 3 and 4 the energy produced is meeting the energy demand for the waterfront. The table is based upon a first review and is just an indication of what might be achieved.

	Scenario 1		**Scenario 2**		**Scenario 3**		**Scenario 4**	
	Toronto Waste Management 2010		***Toronto Waste Management 2020***		***Toronto Waste Management 2010***		***Toronto Waste Management 2020***	
		Mtons		***Mtons***		***Mtons***		***Mtons***
Total Amount of Residential Waste		**1,000**		**1,200**		**1,000**		**1,200**
Material Recycling The Blue, Grey Bin Systems etc (Al, Glass, Paper, Plastics, Cardboard etc)	**25%**	**250**	**30%**	**360**	**25%**	**250**	**30%**	**360**
Biological Treatment	**25%**	**250**	**25%**	**300**	**25%**	**250**	**25%**	**300**
- Local yard-, Leaf-, Grass composting etc		100		100		100		100
- Central anaerobic digestion, composting		100		100		100		100
- Biogasification (PORTLAND)		50		100		50		100
- Gas fuel	9,000,000 m^3		18,000,000 m^3		9,000,000 m^3		18,000,000 m^3	
- Compost	25 Mtons		50 Mtons		25 Mtons		50 Mtons	
Waste-to-Energy (Portland)	**25%**	**250 (100 MW)**	**42%**	**500 (2x100 MW)**	**12%**	**120**	**23%**	**280**
Produced Energy	625 GWh		1,250 GWh		300 GWh		700 GWh	
- Heat	440 GWh		880 GWh		210 GWh		490 GWh	
- Electricity	185 GWh		370 GWh		90 GWh		210 GWh	
Landfilling	**25%**	**250**	**3%**	**40**	**38%**	**380**	**22%**	**260**

Conclusion: Future sustainable waste management strategies for Toronto and the waterfront are linked to each other based upon an integrated system using a combination of source separation, material recycling, biological treatment, waste-to-energy and landfill.

There are already existing and proven systems for source separation of packaging, paper, cardboard and organics. Some of the systems have to be further developed, especially the source separation systems in the apartment building areas. In newly revitalized areas like the Toronto waterfront, it is recommended that centralized vacuum collection systems be installed for the collection of waste and separated fractions.

Two questions for Håkan Rylander, CEO of SYSAV (South Scania Waste Company), Sweden:

– What do we lose by postponing the development of a sustainable waste management system? What should be done immediately, in the medium term and over the long term?

There is a very short and simple answer: the GTA is already very late in putting together a sustainable waste management program. Planning for a waste-to-energy plant has to start immediately. Planning for a biogasification plant can come later as a biological treatment plant already exists. It takes about 5 to 8 years from initial planning until you have a waste-to-energy plant in operation. During that time, most of the waste that is generated will have to be sent to landfill in the state of Michigan in the United States. Transporting waste over hundreds of kilometers to another country cannot be considered an acceptable or sustainable waste management solution.

– What are the risks for odours and littering in the vicinity of a waste-to-energy plant?

These issues are not a problem at a modern, well-operated waste-to-energy plant. The air for the incineration process is taken from the tipping-hall and from the bunker-hall, both of which have to be contained under a roof and within walls. In that way, low pressure in the tipping-hall and the bunker will prevent odours and litter from escaping from the plant. This is a very efficient way of operating a plant, at the same time providing the process with air and avoiding problems with odours and littering.

A biogasification plant has to be strictly operated in a closed way, with a closed reception area for the waste and with a closed process throughout the gasification cycle otherwise there will problems with odours.

The proposed location of a waste-to-energy plant together with the WWTP in the Portlands area will give the necessary distance to residential areas, at least 1 km. The advantage with the proposed location is that the plant will be there in good time before the location of new residential areas.

It is very important not to ”marginalize”, not to hesitate when it comes to the creation of a waste-to-energy plant. The GTA will run into terrible problems with the handling of large amounts of waste as they are beginning to do, if they drop consideration of a waste-to-energy plant as part of a successful waste diversion strategy.

– Risk of pollutant emissions

The risks of pollutant emissions from a waste-to-energy plant can be divided in two parts. There are the risks of pollutant emissions to the air and to the water.

In former days with mostly a poor incineration technology and with poor flue gas cleaning systems there were problems with emissions to the air with risks for human health and for the environment. Today, these risks are eliminated due to a much more advanced and opti-mised incineration technology and a much more advanced operation of the waste-to-energy plants, and due to very strict directives for the emission of different pollutants. For example, the European Union has presented directives for waste incineration, which have to be met by every single waste-to-energy plant in Europe. The directives have been established to minimise the risks and to avoid risks for human health and the environment from the emissions. Every new waste-to-energy plant is today equipped with the most modern flue gas cleaning system, which with a very good margin meets with the directives and restric-tions put up by the responsible authorities. The new waste-to-energy plant in the City of Malmö, Sweden, belonging to SYSAV, is equipped with a combined system of dry and wet cleaning, with an electrostatic precipitator, with three wet scrubbers, of which one also is a condensing scrubber, with a wet electro-venturi and finally with a catalyst. This very ad-vanced flue gas cleaning results in very low emissions, much lower than demanded in the EU-Directives, as seen below:

Emissions from SYSAV W-T-E Plant

Parameter	EU Directives	Emissions SYSAV W-T-E Plant 2003
Dust	10	2
TOC	10	1,2
HCl	10	1
HF	1	<1
SO2	50	3,5
NOx	200	41
CO	50	6
Dioxin	0,1	0,0015
Hg	0,05	0,0007
Temperature boiler	>850 °C	1020 °C

All values except Hg and dioxin in mg/m^3 dry gas, 273 K, 101,3 kPa, 11% O^2. Hg in ug/m^3 and dioxin in ng/m^3

The results above clearly show that the emissions to air are far below the level of risks for human health and the environment.

At a waste-to-energy plant equipped with a wet flue gas cleaning system you also have to clean the wastewater from the process, either in a wastewater treatment plant within the waste-to-energy plant or in a larger, ordinary, neighbouring wastewater treatment plant. The cleaning process must in both cases meet with the demands set up by the responsible author-ity, with possibility to emit the water to a recipient without any risk for human health and the environment.
The residues from the flue gas cleaning (2-3% of the total input of waste) have to be handled as a hazardous waste. If the ashes are handled in a correct way, separately from other wastes, in a landfill designed for hazardous waste the risks will be very low.

4. Sustainable Building Design

4. Sustainable Building Design

Minimization of environmental impact

The TWRC's Sustainability Framework states the goal for Sustainable Buildings as *"Elegant architectural building systems that reduce negative environmental impacts and provide high indoor air quality and exceptional comfort"*.

This goal requires a comprehensive definition of "sustainable building". From the perspective of nature, the best building would be no building at all. In other words, the only way to achieve zero negative environmental impact is to avoid building anything. The second best building is one that minimizes environmental impacts while meeting the needs of its occupants from a functional and economic perspective as well as socially and culturally.

The Swedish EcoEffect method provides an approach that illuminates the many inter-related factors that constitute a "low impact" or "sustainable building". Related information can be found in other sections of this report including in discussions on energy, materials, indoor environment and outdoor environment (see Sections 2 and 5).

During the year 2000, the professional organizations that make up the *Swedish Building Sector* including real estate owners, consultants, the construction industry and the materials and components industry, performed an *environmental audit according to ISO 14001*. The audit was to clarify to what extent community impacts on the environment originate from the building sector. Life cycle analysis was used to determine the environmental dimensions of buildings and also the relationships between buildings and infrastructure. This process highlighted that *significant environmental aspects* (ISO 14001) for buildings are:

1. ***Energy consumption during operation***
2. ***Materials use*** including waste treatment, during construction and operation
3. Use of ***environmentally harmful materials*** during construction and operation including materials toxic to ecosystems and human health
4. ***Air quality and noise level*** in homes and premises, related to the design, construction, operation and maintenance of buildings elements and systems.

Seen from a lifetime perspective, energy consumption during operation and maintenance of a typical Swedish residential or office building is in the magnitude of 85 percent of the building's total energy consumption. Energy consumption in this case includes not only heating and electricity but also embedded energy including energy used for manufacturing and transporting building materials and during construction. . The same magnitude of impact from energy holds true for total external impact (impact on nature) as indicated by link to global climate change. **No single environmental aspect of a building has more impact on the environment than energy consumption when considered from a life cycle perspective.**

It should be noted, though, that increased energy efficiency of a building means that a larger part of the building's lifetime energy consumption will be due energy embedded in the materials used rather than energy consumed for heating and cooling. Studies from Denmark using life cycle analysis have shown that embedded energy in homes with high energy efficiency is in the range of 20 to 30 percent of the total lifetime energy consumption of the building.

Energy Conscious Design

Pursing building design, construction and maintenance with the objective of reducing the energy impact of the building requires consideration of a broad range of factors.

The principle of **energy conscious design** may be described in four steps and applied to Toronto as follows:

1. Layout of the area and its buildings, streets and squares with regard to sun and wind

The Toronto climate means that to capture passive energy benefits from sun and wind the layout of buildings, streets and squares must take into the account the need to shelter from wind and open up to solar access in the winter. The opposite is true for the summer when it is important to minimize solar gain and to open spaces and buildings for cooling winds.

Office buildings, often with a high degree of surplus heat, may need a small amount of external heat gain during the winter. In summer, the issue of cooling has priority and solar heat gain must be minimized. *Residential buildings* needs heating in the winter and must be cooled in the summer.

The modern North American style of urban planning and building design causes potential problems such as clustering of tall buildings and narrow streets creating strong down winds, wind tunnels and shaded sections. These issues should be addressed through sustainable design principles.

2. Minimization of energy demand through architectural design

The building must be designed taking into account heating and cooling needs and addressing these through resourceful use of space and architectural features. For example, this includes interior zoning of buildings in different temperature zones, interior spaces that act as temperature buffer zones, courtyards that act as cool air reservoirs and water features that contribute to evaporative cooling. It also means design and construction of airtight, high-insulation floors, walls and roofs, energy efficient glazing and controlled sun radiation, and building structures with strategic heat-masses as well as design that takes account of controlled daylight.

3. Utilization of renewable energy sources, with priority for passive solar systems and thereafter active solar systems

A wide range of methods and techniques are available, including solar water heating, preheated intake air, natural ventilation, free night cooling, day lightning, local wind mills and photovoltaic.

4. Utilization of best available technology for obtaining low energy systems and appliances

Computer-based technology to achieve energy-efficient operation includes use of Building Energy Management Systems, which in turn includes individual monitoring of energy and water consumption displayed on intranet for each apartment.

Energy Efficiency Targets

Targets for energy efficiency of a building should relate to the potential environmental impact of the building. Clustering of criteria or indicators for sustainable buildings can be useful although it must be observed that an indicator in most cases is showing trends and connections, not directly revealing environmental impact.

For example, one commonly used indicator is the total amount of energy delivered (”bought”) to a building, expressed as *kWh per square meter and year*. Note, that this indicator says nothing about the kind of energy used, and thus very little about the grade of associated environmental impact. Also note, that environmental impact should relate to the service or the use of the building, implying that a far better indicator for office and residential buildings is kWh *per person* and year, which takes the area of the premise or the dwelling in account.

For further discussion on targets and environmental performance evaluation, see Section 5 of this report.

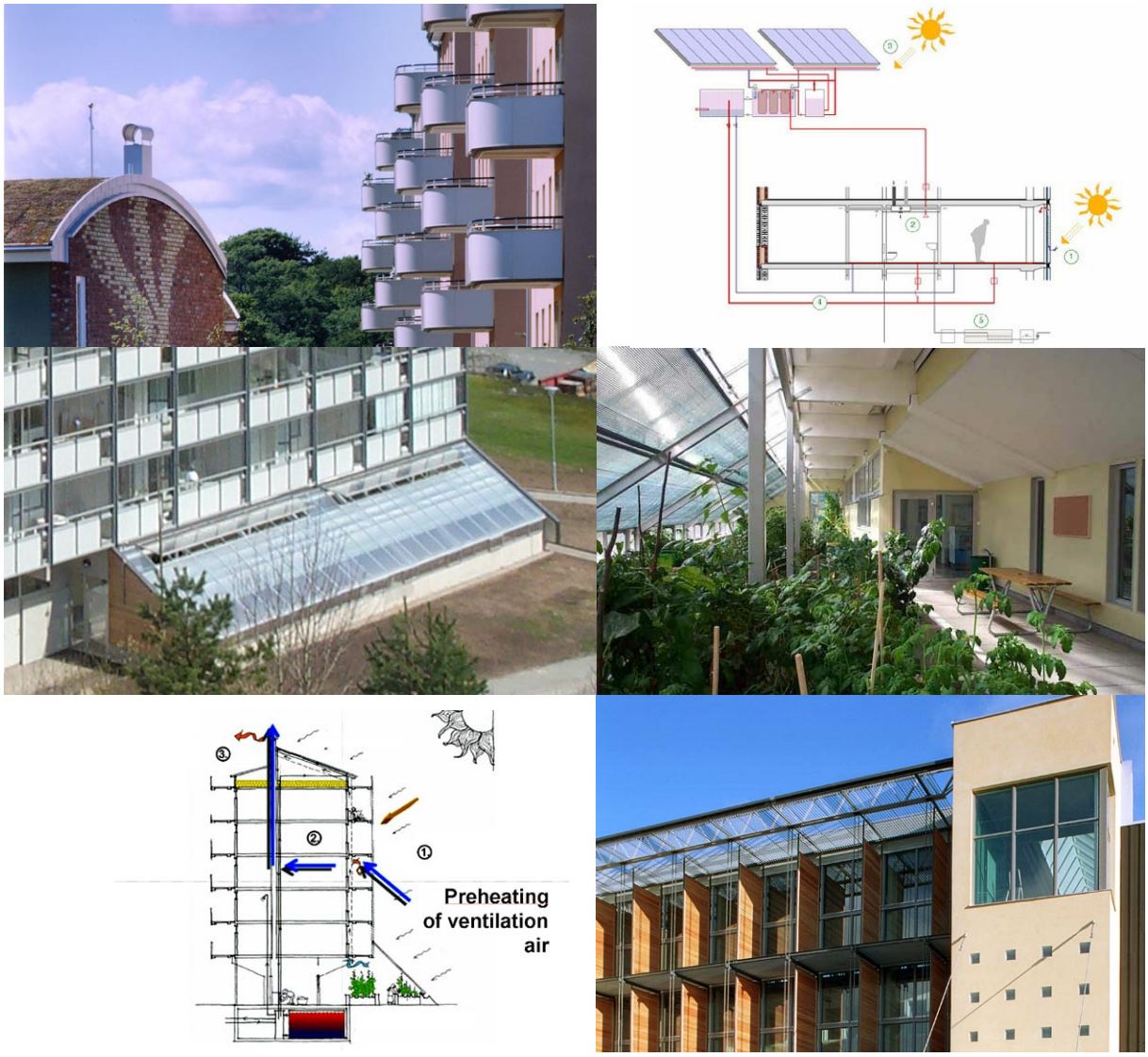


Figure 4:1 Swedish Reference Examples of Sustainable Building Design: Mälarstrand in Stockholm, Gårdsten in Gothenburg and Mid Sweden University in Östersund.

1:st prize in the invited competition on the environmentally most benign residential building in Hammarby Sjöstad was awarded the Swedish developer/contractor NCC Housing. Features of the project, named Kv Holmen, include

- Quality management for a dry construction process: minimized risk of mould and emissions from moisture in materials
- Choice of building materials with regard to the environment respectively to indoor climate. Consideration to allergic persons regarding indoor materials and outdoor greenery, as for indoor planning for cleaning.
- Design for day lightning combined with strategy for solar control
- Financial and spacial promotion of cyclists and environmental benign cars
- Building integrated photo voltaic. PV-panels integrated in facades, window partitioning and balcony fronts
- Energy efficient ventilation, lightning and household equipment
- Energy efficient glazing (Up-value 1.0)
- Envelope walls 340 mm insulation (Up-value 0.15)
- IT-technique for individual control of each resident's apartment.

Calculated energy use is 60 kWh/m2, year.

Figure 4:2 Kv Holmen in Hammarby Sjöstad

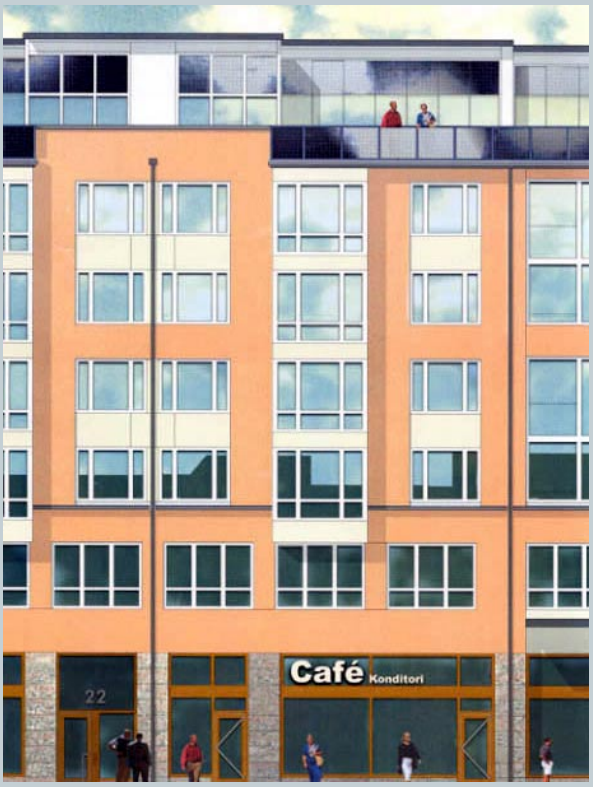


Figure 4:3 Kv Holmen, photovoltaic cells as integrated building components in window partitions, balcony fronts and facades.

5. Managing and Implementing Sustainability

5. Managing and Implementing Sustainability

5.1 Policies and programs - ideas for improving the TWRC Sustainability Framework

The TWRC's Sustainability Framework is the fundamental guide for achieving the goal of "making the city's waterfront both a national and a global model for sustainability", and setting "new standards for best practices not only in Canada but throughout the world".

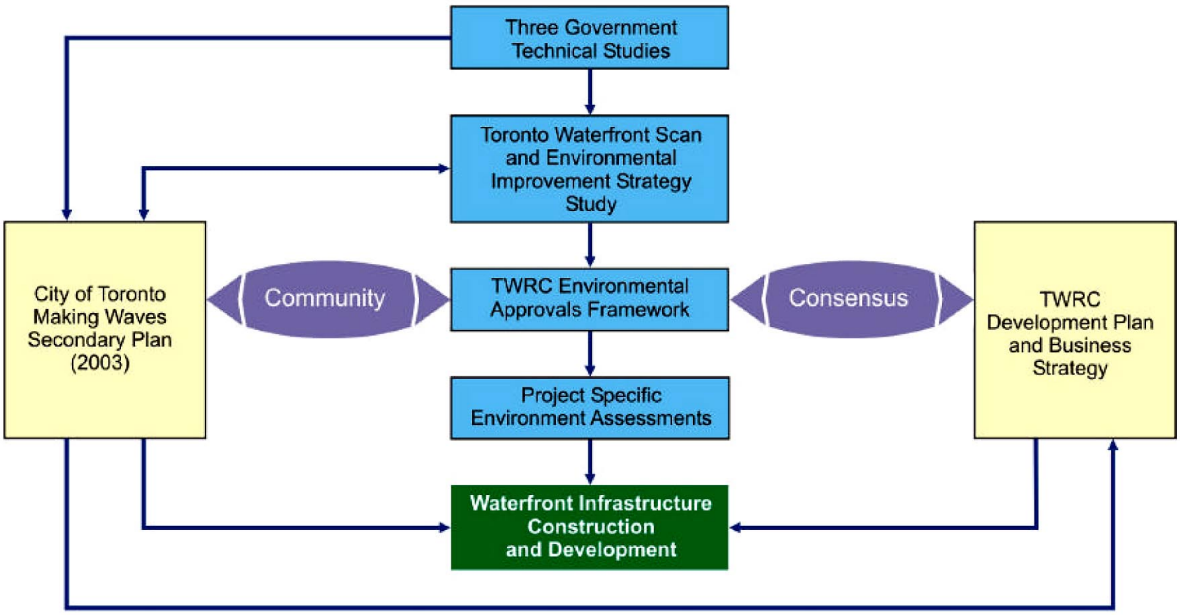


Figure 5:1 The TWRC´s Sustainability Framework

The Framework presents a comprehensive sustainability vision, a brilliant and broad analysis of the sustainability challenge, and a concrete Action Plan with important guidelines for the environmental aspects of the Toronto Waterfront Project. The Framework takes a holistic approach, serving both as a planning tool and as a basis for contracts and agreements drawn up during the course of implementation. The Framework will also serve as a basis for checklists facilitating following-up actions such as evaluation and revision.

The review technique in this part of the Sustainability Review is to comment on the sections of the Framework, bringing forward ideas and reflections with the intention of strengthening the framework as a sustainability tool. The comments in some sections are relevant to more than one section.

TWRC Framework, section 1: The 21st Century Starts Here

As stated in the framework, achieving the stated sustainability goals is dependant on the full commitment of each participant in waterfront revitalization (´Who Will Make It Happen?´).

The goals, objectives and targets of the framework need to be fully supported by all levels of Canadian society. This support is acknowledged in the introduction to the City of Toronto's Waterfront Scan and Environmental Improvement Strategy. A good example of interacting

targets on the three governmental levels is shown in the Framework (Section 3 Energy) concerning targets for reducing CO_2 emissions. It is recommended that the hierarchy of government policies, goals and targets relevant to the TWRC's Sustainability Framework be summarized and continually updated for information and education purposes during the 20 years of waterfront development to come.

Development of successful waterfront projects in other cities, like Hammarby Sjöstad, has proven that a separate corporation with a strong mandate to coordinate and oversee an integrated strategy is crucial to making a complex project like the Toronto Waterfront Revitalization a reality. It is recommended by the expert team that once the three governments have approved the TWRC's sustainability goals, the Corporation then be given the widest possible executive mandate to fulfill those goals. Change of governments and short-term politics must not interfere with the process.

"The TWRC" (Section 1, Determining Priorities) "is determined to focus, first, on those strategies that make the greatest contributions to sustainability in the most cost-effective way." As discussed below (Section 5.3 and 5.4), there are well-established methods and tools for evaluating and monitoring progress during the different phases of the development process. It is recommended that the TWRC place a strong emphasis on the further development of specific environmental objectives and targets. These should as far as possible be quantified and measurable to make control and follow-up practical. In doing so, the choice of methods for assessment is crucial.

TWRC Framework, section 2: Made in Toronto

"There is no single approach to sustainability that fits every community". The Swedish expert group fully agrees with this statement. This is most evident in the case of determining a sustainable energy strategy for the waterfront (see Section 5.2).

The current draft Framework has the advantage of being pleasant to read, in parts almost poetic. Nevertheless the essential messages of the Framework – the goals, objectives and targets – must be easy to communicate and remember. It is recommended that the TWRC produce a condensed version of the Framework, emphasizing the objectives and targets stated in the Action Plan in Chapter 3 of the Framework.

Under the heading "Overview of TWRC´s Sustainable Framework" "five broad, distinctive goals" and "eleven interrelated themes" are presented. The expert group does not fully understand or support the idea of the five "broad goals". Also, it would be more helpful to list the related objectives in connection to each of the broad goals according to content.

TWRC Framework, section 3: Sustainability Action Plan

The expert group fully appreciates the good work underlying this section of the Framework. Our comments are primarily at the detailed level.

Generally, it is important to separate objectives and targets from technical solutions for achieving objectives and targets. However, this principle does not exclude prescribing a particular design or technical solution where it is warranted.

Energy: The final energy strategy for the waterfront will have effect on the targets, objectives and actions contained in this part of the Framework. The difficult task is to ensure that principal energy concepts or technical systems do not contradict or work against each other. As a consequence, the energy strategy for individual buildings must be part of the overall energy strategy for the waterfront as a whole.

- Financial incentives for pilot projects for new technologies or sustainability technologies that

are not yet economically feasible (e.g. photovoltaic) are of the utmost importance.
The expert group has not been able to fully evaluate the target: 50% and 60% more energy efficient than Canada's Model National Energy Code for Buildings. A globally competitive target for energy consumption (external energy supply) is in the range of 50 – 100 kWh/m^2 per year, which is valid for both residential and office buildings. This seems to equate with the greater than 60% MNECB.

Targets for CO_2 emissions may followed up by use of life cycle analysis as demonstrated by the EcoEffect method (see Section 4.4).

Case Study: **Energy targets for Hammarby Sjöstad**

- Total amount of external energy supply not to exceed 60 kWh/m^2 per year
- 80% of added energy-from-waste and treated wastewater to be reused
- Total amount of energy supply to be renewable

Energy supply – mainly district heating - was during 2002 a mix of heat from wastewater (heat pump, 64%); waste-from-energy (47%); bio-oil (16%). The energy strategy includes district heating; district cooling (as a by-product from heat pumps for heating); photovoltaic (pilot projects); fuel cells (pilot projects); biogas; solar heating; smart-house-technique/IT applications.

Calculated energy demand for the buildings in the first stages varies from 35 kWh/m^2, per year to 125 kWh/m^2 per year for a typical building. The prognosis is approximately 100 kWh/m^2 per year to be compared with the target of 60 kWh/m^2 per year and the current Swedish standard for new buildings of approximately 150 kWh/m^2 per year.

No target is set for CO_2 emissions, but every consumed kWh is calculated according to environmental impact caused by emissions such as CO_2-equivalents, So_x-equivalents, No_x-equivalents etc. Not only are the buildings influencing the achievement of the targets but price levels of different fuels, energy taxes and concern about energy conservation in from a larger societal perspective are also of a great importance. So are also the behavioral habits of the residents and of the employees in the area.

Sustainable Buildings. The expert group fully agrees with the excellent formation of what needs to be considered for sustainable buildings.. However, the application of LEED gold and platinum standards as – or instead of – targets is questioned. The use of LEED as an incentive and as a kind of target is a good start but still not quite satisfying. Utilized as a checklist, to put people on the environmental track, to get people consider targets related to technical solutions, LEED makes sense. But sustainable buildings are not that simple.

There is no clear link between environmental impact and LEED credit points. The LEED system gives credit for achievements that are due to planning prerequisites or due to agreements between the TWRC and the estate owner, all of which cannot be influenced by design of the individual building. Credits are given without consideration for the environmental impact of the rewarded measure (see Sections 5.3 and 5.4 below).

Human Communities: Showcase projects such Year Round Covered Walkways; Internet Shopping Link with Local Businesses; and the Ecology Information Center, are powerful ideas.
Target F5. : Ambient noise level of 45 dB (A) in residential areas is setting the bar very high and may need to be reviewed.. Swedish guidelines stipulate ambient noise levels of 55 dB (A) / momentary 70 dB(A); indoor 30 – 45 dB(A). Current research addressing differentiated noise level guidelines adapted to different situations.

Target F6: Roof gardens, community gardens and balcony gardens. Very relevant examples of greenhouses adjacent to multi family houses are available within Scandinavia.
Materials & Waste: The City target ”100% diversion from landfill” must be said is utopian, but 97% can be reached (see Section 5.3).
Indoor Climate should be given a theme of its own. Objectives and targets may include moisture readings and requirements for addressing allergies. Indoor targets on the detailed building level may relate to air quality; thermal climate; noise; sun and daylight; lighting; electrical considerations and finishes. The EcoEffect method provides some guidance in this area.

TWRC Framework, section 4: What the TWRC Will Do

Referring to Hammarby Sjöstad, the following activities are recommended:

- An **architectural program** or quality design program that is made project-specific including, as one of several main features, emphasis on the environment and eco-cycles, implying new requirements for architecture. The new required targets will be met by technical and architectural solutions and will be highlighted demonstration and eco-cycle buildings such as a new environmental info-center.
- **Environmental program** made project-specific for each major undertaking, based on the Framework, including detailed targets and activities for follow-up.
- **Technical procurement requirements** designed to stimulate the development of new technologies and techniques. Examples include are high performance glazing; attendance regulated ventilation; photovoltaic installations and ”smart house” technologies.
- **Architectural competitions** highlighting the most ”environmentally benign building”, where environmental criteria is used for evaluation.

5.2. Integration of sustainability issues to ensure proper planning, design, tendering, construction, maintenance and operation

In order to integrate sustainability into all aspects of Toronto waterfront revitalization we recommend checklists for all phases. The checklists should be developed in a dialogue between experts within different fields.

The lists presented below represent a summary of experiences at **Hammarby Sjöstad** with regard to crucial issues at different phases of planning, development and construction. They may also serve as a source of inspiration in Toronto waterfront revitalization. Checklists should also be developed for the operation and maintenance phases.

Environmental checklist: The Planning Process – detailed comprehensive plans	
Landscape and Ecosystems	Consider saving and/or developing existing green areas
Recreational Qualities	Set quotas for built area/parks and green spaces Secure recreation facilities by the water and shores
Hydrology	Integrate storm water treatment
Cultural Heritage and Existing Structures and Buildings	Consider saving and/or developing existing structures and buildings where possible
Major Infrastructure	Consider alternative energy solutions Set standards for waste management – the entire chain Design waste water management
Transportation Facilities	Plan for attractive public transit as the primary mode of transportation Ensure "car-free zones"
Industry and Businesses that need a ´Safety Distance´	Make inventory and plan accordingly
Parking Facilities	Differentiate parking lots; the closer to the buildings, the more environmentally friendly cars (e.g. bi-fuel cars, car-sharing cars), do not forget bike and boat parking
Energy Efficiency	Consider sun and wind conditions; orientate buildings accordingly to save energy (where possible, sea view is also important)
Design of Blocks and Buildings	Promote and ensure design quality with environmental specifications Design competitions for public and private projects should be evaluated according to environmental features and impact
Environmental aspects should be integrated at all stages of the planning and implementation of the project. The aim is that environmental issues be dealt with as a coordinated improvement and development project. Each employee is to ensure that the environmental work is carried out according to the set guidelines. Similarly, ***management and supervisors have a particular responsibility to ensure that guidelines are adhered to in all decision-making processes****.* *The above specifics should be established before starting the Development Phase once the general extension of both public spaces and private development is publicly known.*	

Environmental checklist: The Development Process	
Property Acquisition	Competitive bidding process with pre-determined development criteria and design criteria – with decisions based on superior environmental qualities Consider contamination and demolition needs
Site Clearing	Make demolition plans with inventory of harmful and toxic substances; demolish accordingly
Soil Remediation	Determine strategy, set standards and choose methods that can be justified environmentally;
Major Infrastructure	(According to environmentally approved plans) Establish close cooperation with the operators
Local roads	Set traffic regulations and restrictions
Agreements with Builders and Contractors	Agreements should include conditions for environmental qualities

Environmental checklist: The Construction Process	
Transportation and Storage of Goods	Plan for coordination of transport and logistics (cooperation) - demand environmentally adapted vehicles (agreements)
Materials	Prioritize environmentally benign materials (set standards) Secure sorting at source of building materials (set standards and targets) Protect constructions and materials from rain and snow (inspections on-site)
Use and Storage of Chemicals and Fuels	Set standards for choice of chemicals and fuels All chemicals must have a declaration of contents Ensure safe storage of chemicals and fuels on the site (restrictions)
Working machines	Ensure environmental features; e.g. low fuel consumption and low noise impact
Noise	Plan for measuring excess noise on-site and outside the building site
Others	Consider and minimize disturbances from dust, vibrations, electric and magnetic fields Make environmental inspections on the site Check results and compliance with agreements Publish the environmental records Arrange competitions (e.g. ”Committed Contractors”)

The expansion of the Toronto Waterfront is to be implemented in such a way that natural resources and transportation is used to a minimal degree while priority is given to environmentally friendly transport solutions. Environmentally hazardous materials and substances should be avoided and only materials and methods that minimize the use of resources and environmental damage, will be used. A healthy indoor climate is to be achieved. Demolition should be preceded by an environmental inspection. Disturbances from the building process should be minimized.

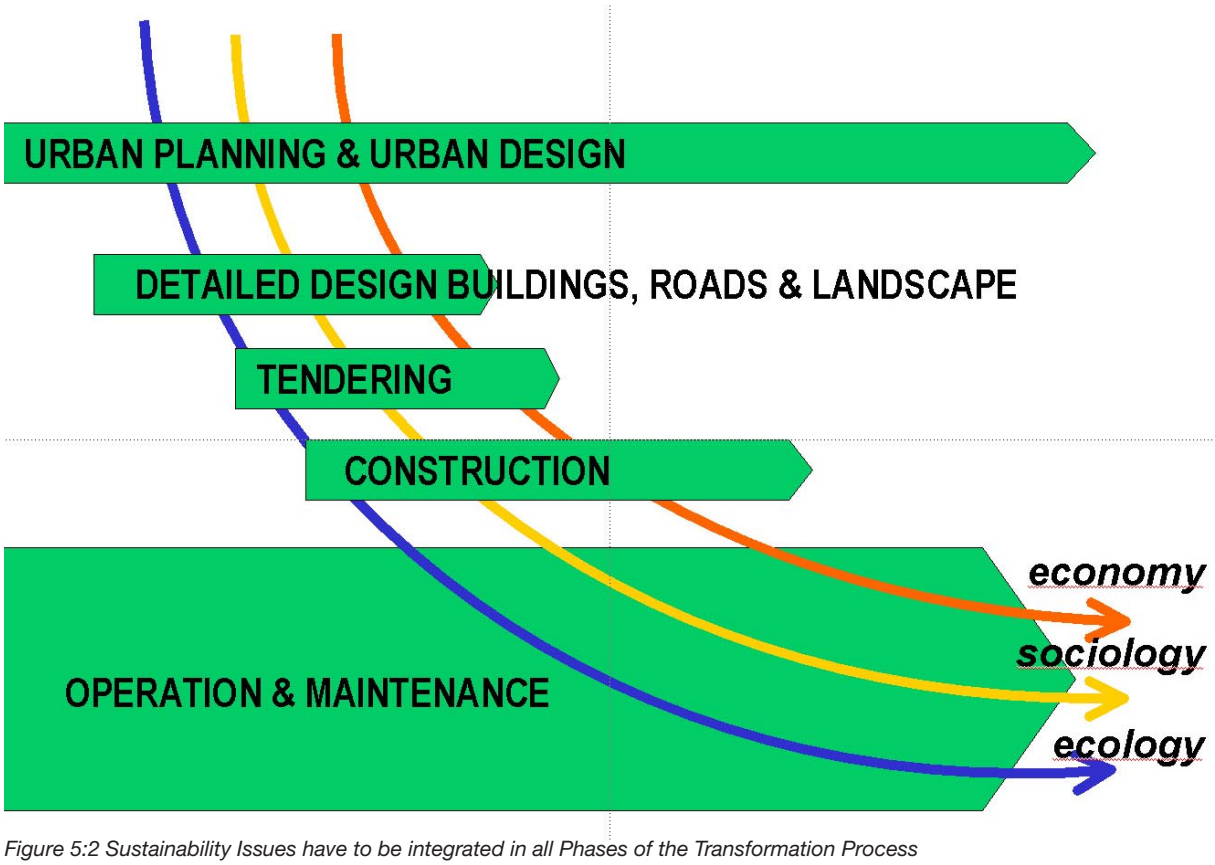


Figure 5:2 Sustainability Issues have to be integrated in all Phases of the Transformation Process

5.3 Environmental Performance Evaluation in the planning stage

It may be difficult to transfer solutions developed in one context into another context due to different institutional, economic and social conditions. It may be more fruitful to apply general methods and tools as an instrument for developing new and improved solutions where the methods and tools take local conditions into consideration.

As the planning situations vary it is important to have access to a *toolbox* including tools for all steps of the planning process.[1] Figure 5:3 presents some useful tools.
The ecological footprint illustrates how much space a population requires per capita for subsistence compared with the available bio-capacity per capita. The existing planning conditions could be analyzed by a *SWOT-analysis* combined with *mental and geographical maps* visualizing strengths (qualities) and weaknesses (problems) of an urban area.

Reconnaissance trips involve direct inspection of the area being considered by mixed teams of local people and technical experts. They are used to familiarize everyone with the physical environment and key issues at the start of the planning processes and to review progress at intervals.

[1] The Swedish Environmental Protection Agency and the national Board of Housing, Building and Planning (2000) Planning for sustainable development (the SAMS-project). The starting-point of the study is the 15 environmental objectives of Sweden.

Scenario development and back casting promotes a long-term perspective when developing planning alternatives. The techniques encourage innovative concepts and creativity as the initial scenarios should be free from the obstacles associated with the present situation. In a second step, alternative scenarios should be related to the present situation whereby sequences of development steps and strategic choices are defined. Global information systems (GIS) and computer-assisted design allows the visualization of alternatives and connects geographical information with other types information such as environmental.

Monitoring and Performance Evaluation

What makes a city district sustainable? There is probably no definitive answer to this challenging and difficult question. Still, there is a need to find systems for evaluating planning alternatives, proposed solutions as well as existing urban environments. However it is difficult to find one unitary system of assessment and evaluation.

The sustainability performance evaluations of plans and proposals will probably have their focus on systematic and well structured but qualitative methods. The proposed seven main aspects of sustainability presented in the Urban Agenda 21 may serve as a starting-point for development of a performance evaluation system where each theme could be divided into criteria and indicators. The fifteen national environmental objectives of Sweden as well as national transport policy and public health objectives are also a possible basis for assessment. The planning indicators developed within the SAMS-project are based on the fifteen national objectives. Both objectives and associated planning indicators could be used in the performance evaluation of plans and projects. It might be interesting in the further process of specifying objectives for the waterfront development to compare the Swedish and the Canadian way of formulating different kinds of objectives.

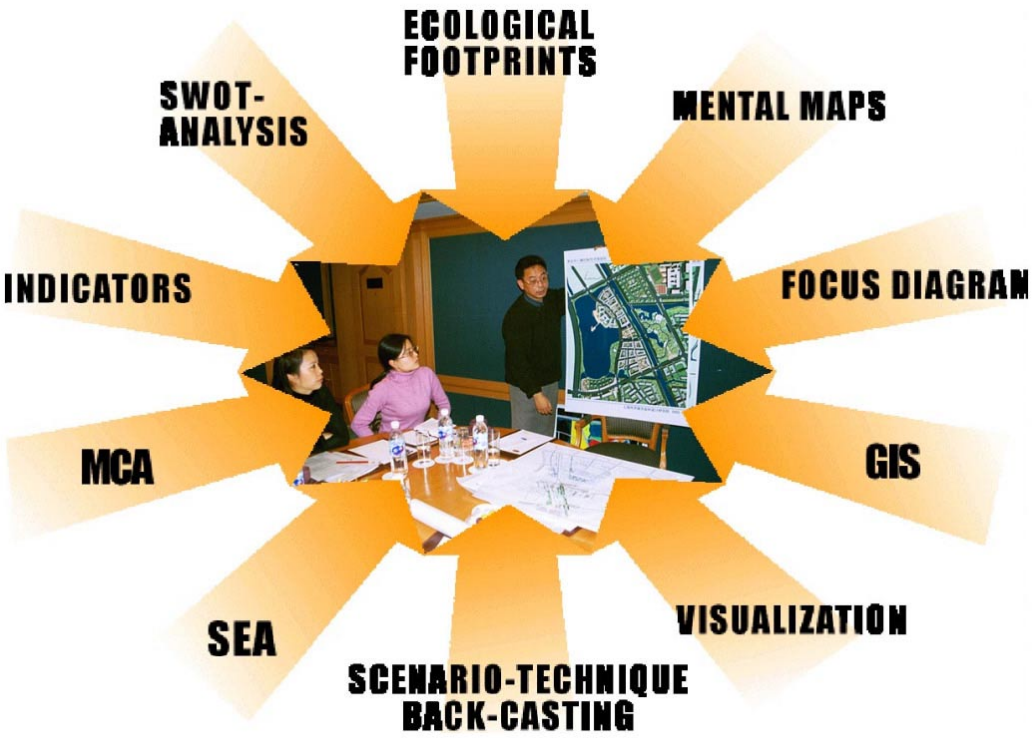


Figure 5:3 Examples of Tools for integrating Sustainability Issues in the Planning Phase

SEA (Strategic environmental assessment) is a method for incorporating environmental aspects at an early stage in planning by facilitating the comparison of alternative planning proposals and policies. *MCA (multi-criteria analysis)* is used to evaluate the total quality of a plan alternative by weighing environmental criteria or indicators in relation to each other..

MCA is a tool this is used for the evaluation of the quality of a certain aspect or indicator. MCA may also be used in order to compare several alternatives based on an evaluation of their qualities. Alternative planning, design and technical proposals for the waterfront area as a whole or for separate areas may be evaluated according to the MCA technique. The following six steps comprise the evaluation process:

In the ***first phase***, the evaluator develops an overview of the reasonable alternatives to a policy, plan or proposal making herself or himself acquainted with the specific characteristics of each proposal

In the ***second phase***, the qualities of each alternative with respect to the sub aspects and related indicators within each main aspect are assessed. The following performance evaluation scale is proposed:

4 = Excellent
3 = Very good
2 = Good
1 = Acceptable
0 = Not acceptable

If a sub-aspect is found to be irrelevant for the choice between alternatives it will be taken away from the list.

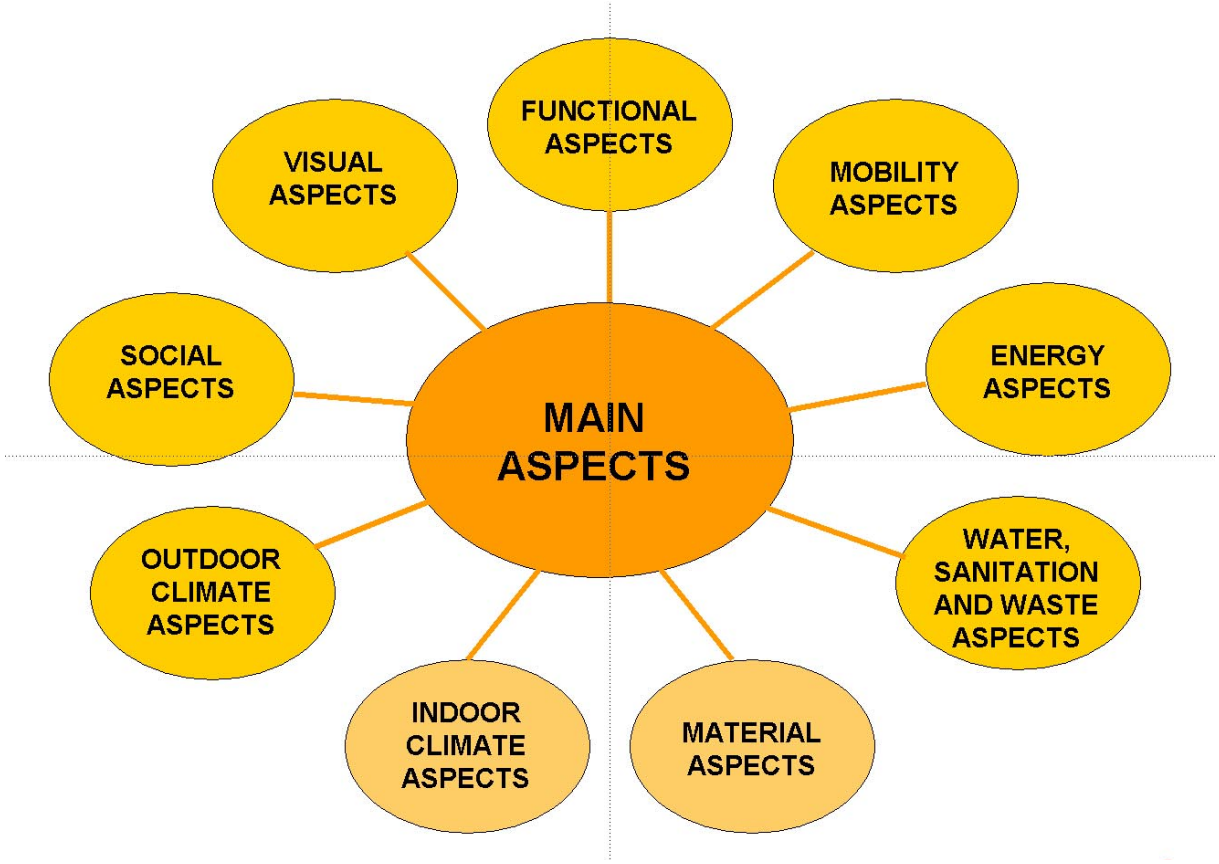
In the ***third phase*** the sub-aspects within each main aspect are ranked according to their relative importance. 100 marks are distributed between the sub-aspects in order to reflect the relative weight of each sub-aspect. The use of extreme values is permitted (for example 0 or 100 for a certain sub-aspect).

In the ***fourth phase*** the main aspects are considered and ranked according to their relative importance. In the same manner as for the sub-aspects, 100 marks will be distributed between the main aspects in order to reflect the relative weight of each main aspect.

In the ***fifth phase*** calculations will be carried out where the sums of evaluated qualities for each alternative, both with and without weights, are calculated. Diagrams showing the relative difference between the alternatives are produced.

In the ***sixth phase*** the result is discussed and critical observations may be done with regard to certain aspects. Since many qualitative aspects assigned numbered values it is important to do an analysis of the meaning and importance of the proposed weights. A sensitivity analysis may also be done where the importance of a certain weight may be changed in order to understand its impact on the order of preferred alternatives.

The evaluation should focus on different aspects of sustainability. “The Sustainable City” – concept developed by SWECO in collaboration with the Swedish Ministry for Foreign Affairs, Swedish Ministry of the Environment and the Swedish trade Council serves as a starting point for the subdivision and formation of the proposed aspects and indicators.



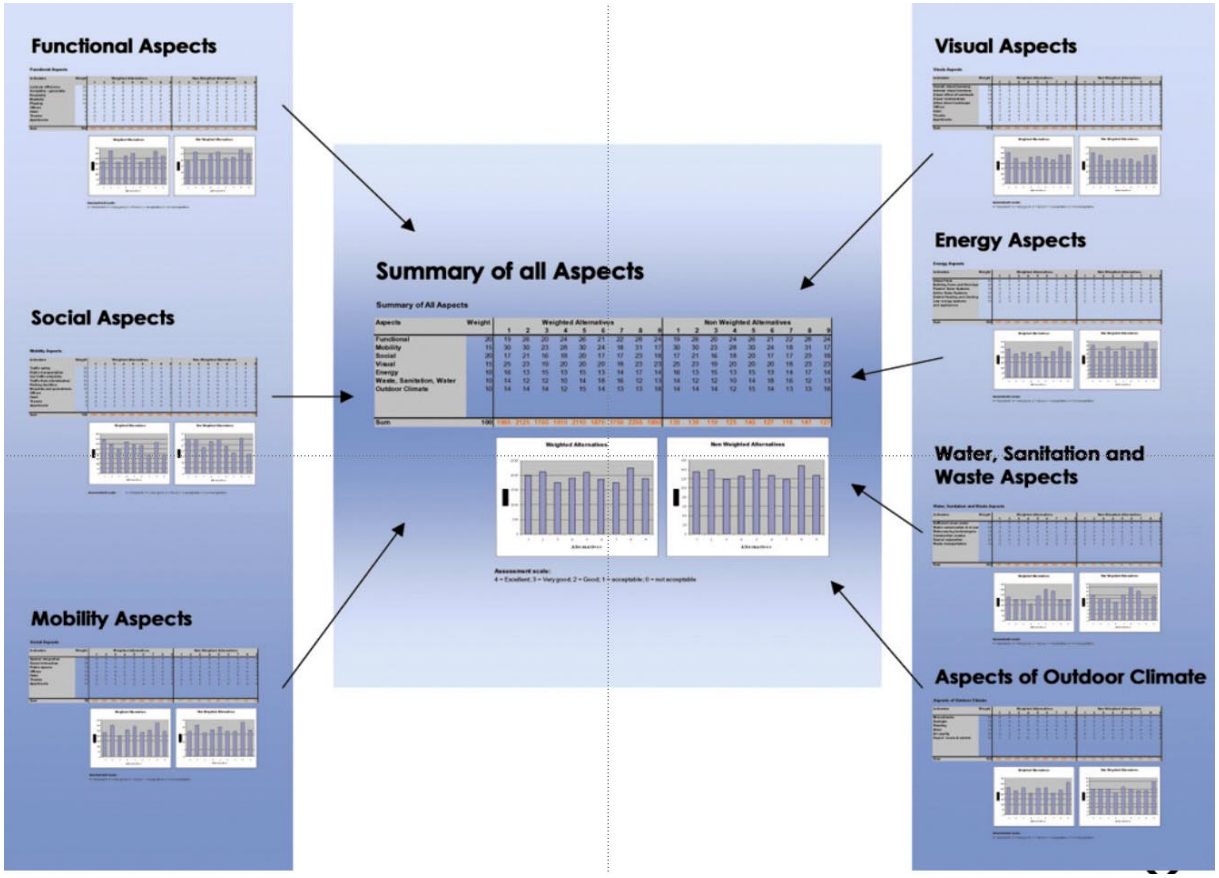


Figure 5:4 A practical example from SWECO FFNS Architects of an Application of the MCA-methodology on teh Evaluation of Competition Proposals (Suntrans – Beijing)

The following seven main aspects are proposed as a starting-point for the environmental performance evaluation of the waterfront planning and design schemes:

- Functional aspects
- Social aspects
- Mobility aspects
- Visual aspects
- Energy aspects
- Water, sanitation and waste aspects
- Outdoor climate aspects

For the next phase of the evaluation we propose indicators regarding the following two main aspects be considered:

- Indoor climate aspects
- Material aspects

Each of these main aspects has been subdivided into 5-10 sub-aspects. The number of aspects has thus been defined in order to facilitate the evaluation process. Each evaluation sub aspect is related to indicators, which will be used in the comparison and evaluation of proposals.

5.4 Environmental Performance Evaluation of Buildings

Calculating environmental impact caused by buildings

How do I know which strategy and which action is the most important to achieve the lowest environmental impact? How do I set environmental **objectives and targets, which are measurable and can be followed-up**? How do I describe the environmental status of a building? Which of two buildings – existing or under construction – constitutes the most environmentally benign building?

There is a need for a holistic method to calculate and assess environmental impact caused by buildings and real estate throughout their life cycle. Within the building sector, a number of different tools are commonly used for assessing environmental impact of buildings and building elements. The tools include:

Procedural tools	**Environmental Management System** (EMS) *ISO 14001* respectively *EMAS*
Analytical tools	**Life Cycle Assessment (LCA)** among others: BEAT (Denmark), EcoQuantum (The Netherlands), LEGOE (Germany), ENVEST (UK), ATHENA (Canada), EcoEffect (Sweden)
	Life Cycle Cost analysis (LCC)
Tools out of tools	**Criterion systems** and **Environmental Indicators** or **(Green) Key Indicators** among others BREEAM (UK), BEPAC (Canada), LEED (USA), Green Building Tool (Canada & 14 GBC countries)
	Checklists
	Environmental Product Labeling Type I (third part commissioned), Type II (self made), Type III (input for LCA to ISO standard)

Life Cycle Assessment (LCA) is a tool to assess environmental impacts and used resources throughout the lifetime of a product, from raw materials acquisition, through production, utilization and disposal. **Life Cycle Cost analysis (LCC)** can be used to assess the costs of a product or a service from a life cycle perspective, including environmental costs.

Starting in the late 1980s with the development of **environmental criteria** for buildings, the concept *"environmental assessment of buildings"* was born in the UK, where the l BREEAM system was developed. It has been followed by other criteria -based systems such as BEPAC (Canada) and LEED (USA and, recently, Canada). The latest and most developed system is the Green Building Tool (Canada), which has been developed in international cooperation among 14 countries that take part in the Green Building Challenge.

A criteria-based system is easy to understand and may include anything that can be formulated with specific limits. However, if a criteria system grows too large, the overall philosophy will get lost and any resulting assessment will be difficult to comprehend. The development of an **indicator** relates to a measurable parameter, showing or indicating the state of a large system, for example, information on an environmental impact. It must be observed that an indicator is nothing but an indicator, showing trends and possible causal relationships but never revealing the whole truth.

A more detailed description of methods and tools for assessment is given in APPENDIX 2. Combined criterion and indicator systems, such as LEED, make good sense when used as checklists, but are of limited value used for evaluating environmental impacts from buildings. To obtain a comprehensive view of the environmental impact of a building or set of buildings life cycle analysis (LCA) must be used. The Canadian Athena Institute has released Version 3 of the software EIE (Environmental Impact Estimator) that supports LCA assessment of buildings, with a focus on the environmental impact caused by the use of different building materials. Currently the US Green Building Council and the Athena Institute are cooperating to integrate LCA tools into the LEED system.

Case study: The EcoEffect method

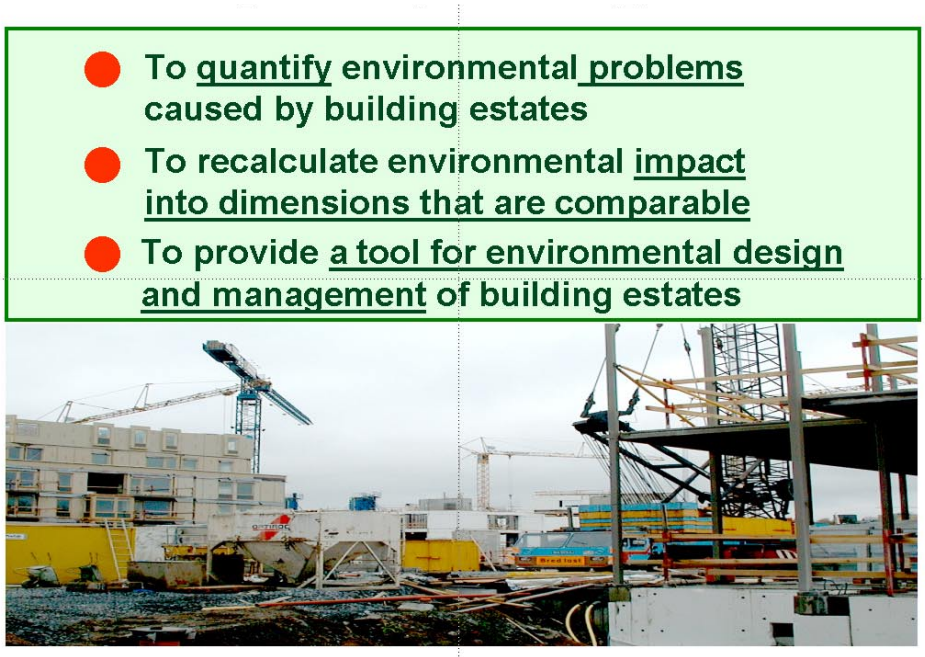


Figure 5:5 Purpose of the Eco Effect Method

The EcoEffect method is a Swedish system that uses LCA for environmental performance evaluations of the built environment. The EcoEffect system includes the LCA operations performed within the assessment system used for Hammarby Sjöstad, but is now considerably more developed and addresses issues such as indoor environment as well as means of information presentation and software.

Facilitating co-operation between the Swedish EcoEffect and Canadian Athena program could help the Toronto waterfront become a leader in sustainable building design and understanding of related environmental impacts.

One unique feature that distinguishes EcoEffect from other sustainable building guidelines is that it directly links the characteristics of buildings or activities to environmental impacts.

EcoEffect is a holistic method used to calculate and assess the environmental impact caused by buildings and real estate developments. The method is intended for the programming, design and construction, and operation and maintenance phases of a building. The method and the computer tools were developed between 1998 – 2004 at the Royal Institute of Technology in Stockholm and the University of Gävle, with support from a number of companies and organizations within the Swedish building sector.

The objective of the EcoEffect method is to:

- **Quantitatively describe environmental and health impacts** from real estate and built environment
- **Provide a basis for comparison and decision-making** that can lead to reduced environmental impact

The method targets decision-makers within planning, designing and management fields. The EcoEffect Software, together with the Input Data Sheet are tools for using the EcoEffect method.

The method has a holistic perspective on environmental issues with **five parallel areas** of focus:

External environment:
- **Energy,**
- **Material Use**

Internal environment:
- **Indoor Environment,**
- **Outdoor Environment,** and,

Cost calculation:
- **Life Cycle Costs**.

Environmental performance evaluation is carried out within each area for a number of different **impact categories** such as climate change, acidification and noise.

The intent is, to quantify the contribution of buildings to different environmental problems, over a long a time as possible.

EcoEffect results are easy to understand and underlying assumptions and conditions are easily accessible. The method is currently developed for multi-family residential houses, offices and schools. It is the characteristics of the building and its associated physical environment that is assessed. The occupants of the estate are assumed to use the building and its fixtures in a pre-determined manner, having a "normal" life style based on national averages of consumption.

A weighting method has been developed in order to present an aggregated result that simplifies comparisons.

Characteristic features of the EcoEffect method

Transparency	The origins of all information and results can easily be followed
Problem – orientation	The calculations as well as the result have a direct connection to different types of environmental impact e.g. acidification, noise etc. and their significance to people's health and well-being
Simplifies comparisons	Companies, real estate clusters, buildings and building elements can easily be compared in terms of environmental loads.
Function based	Environmental loads show per function/use, e.g. per user
As metrics for characteristics and activities	Shows measurable health risks and environmental impacts caused by buildings and the associated the physical environment
Holistic approach	Many different types of environmental impacts are presented to avoid sub-optimization
Simplifies environmental decisions	Consequences of the requirements on indoor and outdoor environment can be directly monitored as loads on the external environment (e.g. climate change)
Life cycle perspective	Contains the whole chain of environmental impacts from raw material extraction to the use of waste products/ demolishing associated with the energy and material flows, LCA (Life Cycle Assessment)
Flow Analysis	Assesses the majority of all energy and substance flows
System boundary	Buildings are selected as primary objects of comparison. Partly because there is an owner who has the possibility to influence decisions and partly because operation flows are usually measured at the building level.
Aggregation	Facilitates the weighting of results, which is usually a pre-requisite for practical comparisons. Weights can be changed and used for sensitivity analysis.

The results can be summarized in different ways: as **comparisons** between different real estate/ buildings, as **environmental profiles** or as **indicators**.

The overall comparison shows an aggregated performance evaluation of impact on the indoor & immediate outdoor site environment (named the **internal environmental impact**) together with the aggregated performance evaluation of impact on the world outside of the property border (**external environmental impact**).

The sum of the loads should be as small as possible since the goal is to have a good internal environment at the same time as having the lowest possible external environmental impact load.

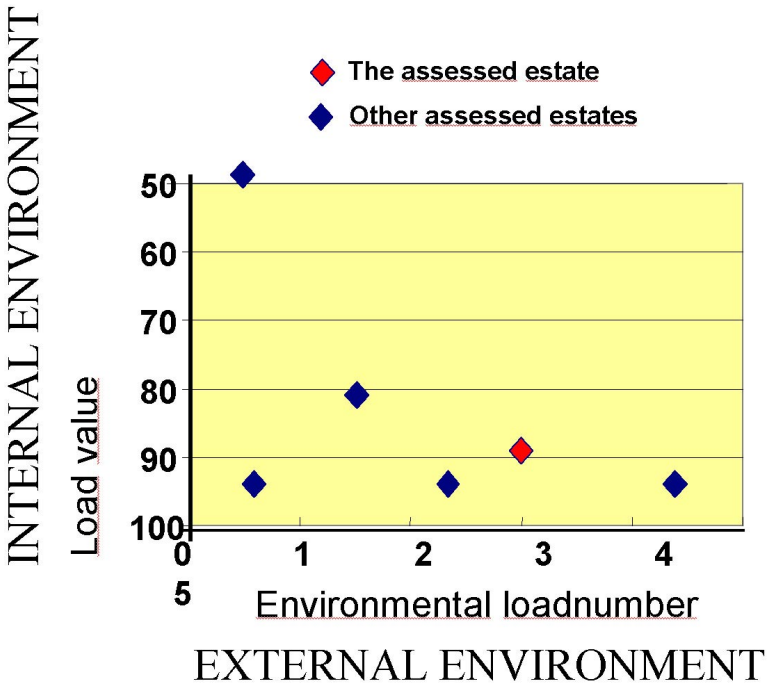


Figure 5:6a External and Internal Environment: One assessed building compared to a sample of other buildings

The above diagram presents a *summary of internal and external environmental impacts. The internal impacts shows the risk that users will be negatively affected by the environment within the boundaries of the building and its site (e.g. sick building syndrome, radon gas) and the external impact shows the contribution of the building and the site to greater environmental issues such as climate change or acid deposition.*

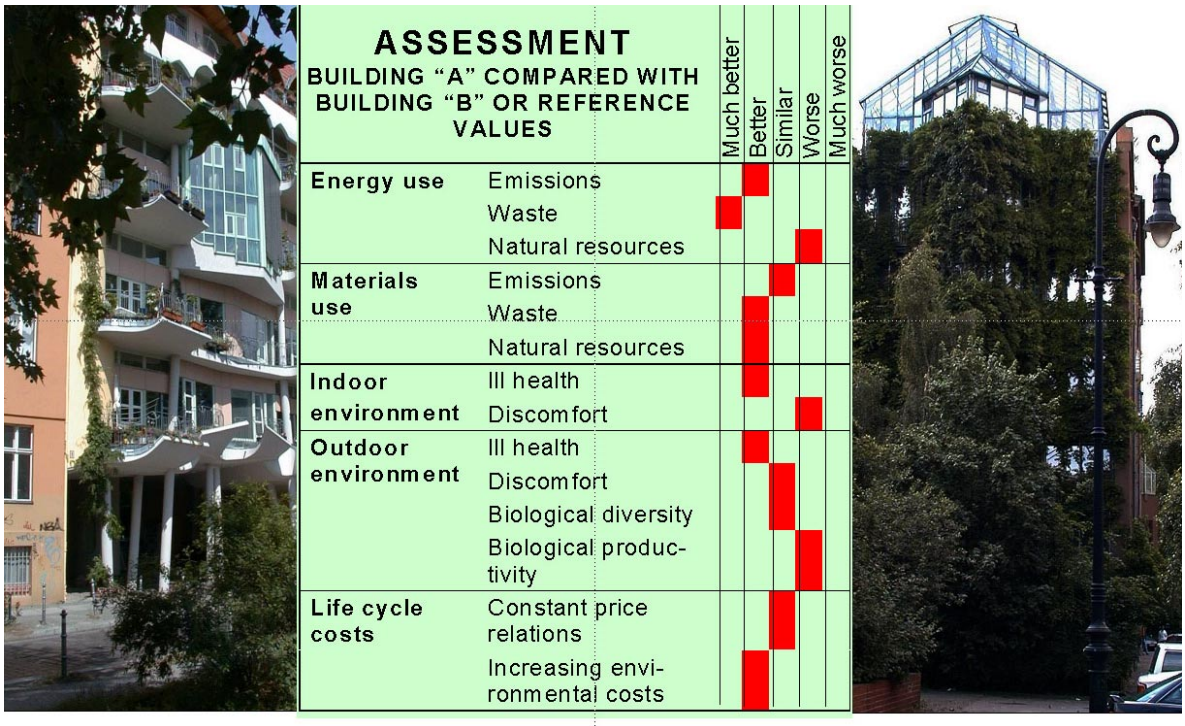


Figure 5:6b Comparison between two buildings

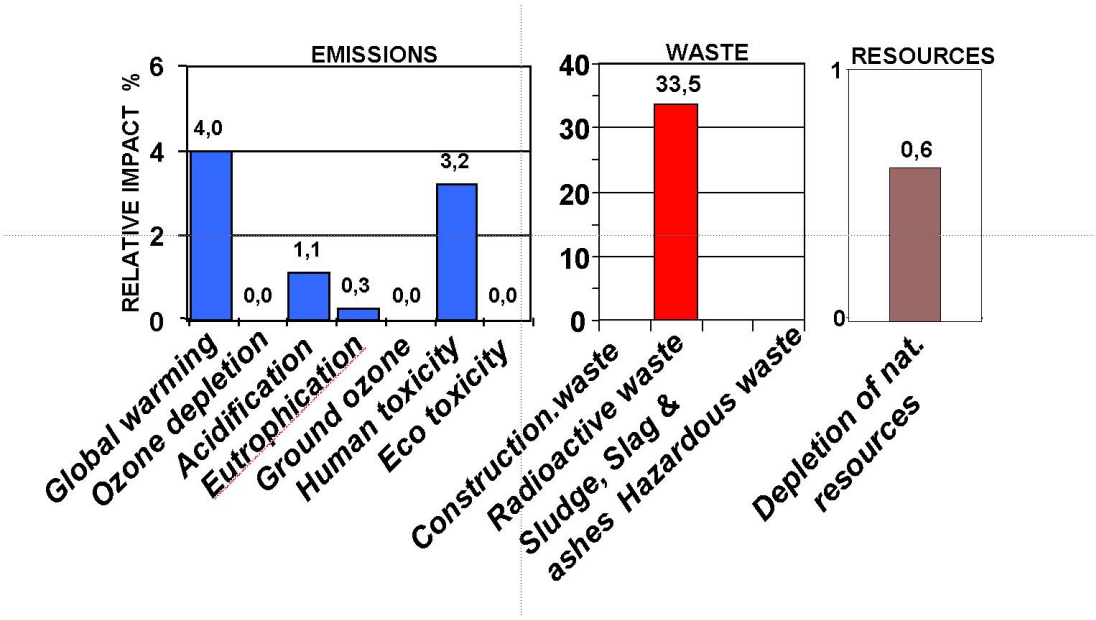


Figure 5:7a External environmental impact of a building

The **environmental profiles** are bar diagrams where each bar shows a certain type of impact from a given building.

There are un-weighted and weighted profiles with all impact categories or with impact categories summed up under each areas. The weighting method developed in EcoEffect is based on the severity of different environmental problems, related to human beings now and in the future.

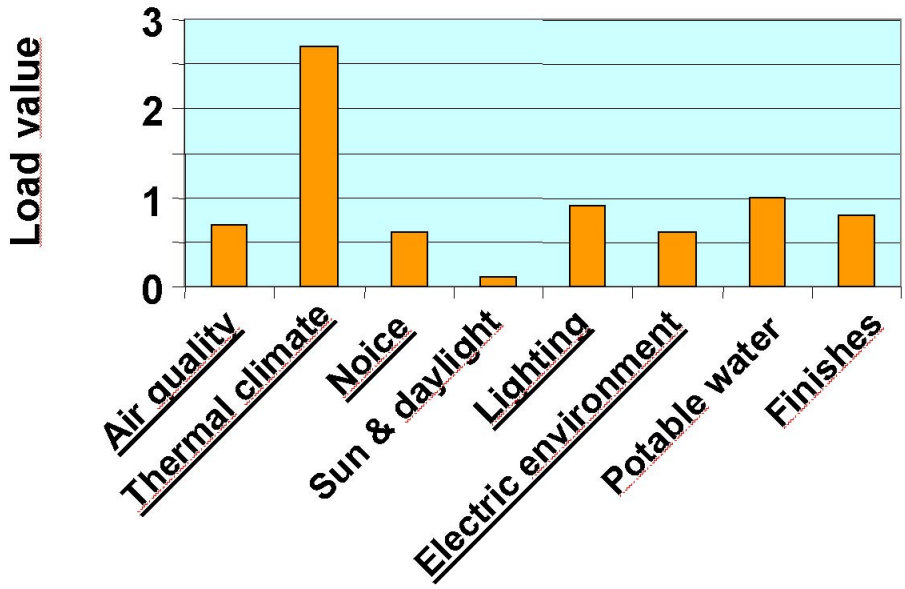


Figure 5:7b Internal environmental impact of a building shown as an indoor profile

6. Exemplary initiatives: The Sustainability Centre

6. Exemplary initiatives: The Sustainability Centre

In order to strengthen the sustainability profile of the waterfront area we propose the development of a Sustainability Centre in the Portlands area. The centre would demonstrate sustainability in action by reflecting the interplay between ecological, economic, social and cultural dimensions of sustainability.

Important elements of the Sustainability Centre concept include:

- Developing **an integrated plant for producing energy (heat and electricity) and biogas for vehicles from waste or other renewable fuels.** This would be done by applying leading Swedish and Canadian planning principles and technology. The technical aspects of such a plant have been described more in detail in section 3.
- Developing a **sustainable business park** especially designed and marketed for companies and organizations involved in research, innovation, consulting, light manufacturing and marketing of sustainable, environmental and energy technologies. The partnering firms and organizations would preferably have input to the planning, design and construction of the integrated plant, demonstration projects or other sustainability features of relevance to the waterfront.
- Developing **an urban campus based on the Toronto and Region Conservation Authority's Living City Center initiative.** The campus would be integrated with the energy plant, the business park, the mixed use planning areas of the Portlands and with Tommy Thompson Park.

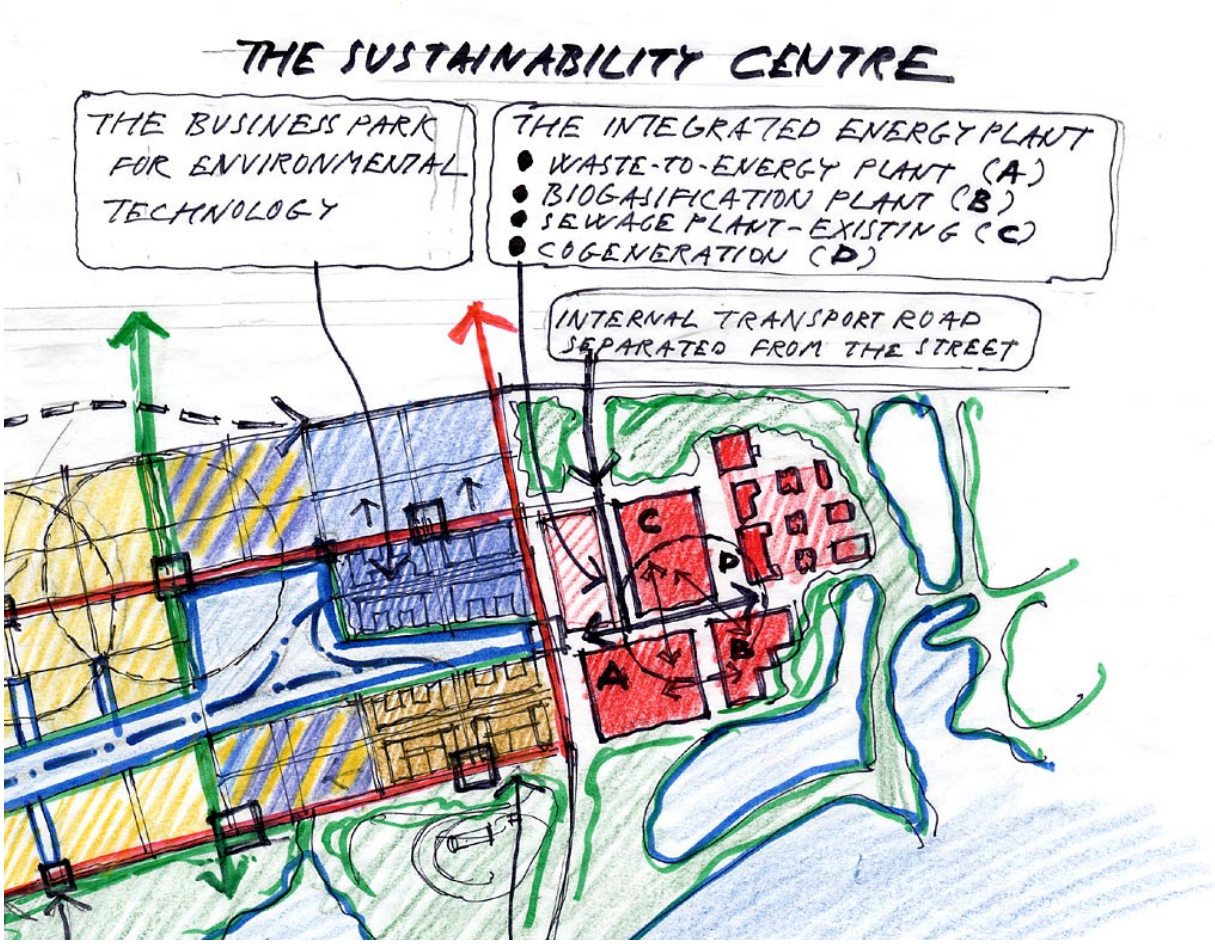


Figure 6:1 The Sustainability centre

The integrated Energy Plant

A suitable location for an integrated plant including waste-to-energy or other renewable resources, biogasification is in the area of the Ashbridges Bay Wastewater Treatment Plant. There are several advantages to this location. They include concentrating waste treatment and facilities for handling of other renewable resources such as biofuel in one place, with one reception and one weighbridge for both plants, staff that can operate both plants and the possibility of co-ordinating and rationalizing the transport of materials to and from the plants. It is also possible to optimize logistics within the site, obtain a high quality work environment, use urban space more efficiently and to integrate the plant architecturally into the surrounding landscape and built environment.

The plant should be seen as an integral part of the waterfront area not as a "disruptive" element. The integrated plant should therefore be planned and designed to minimize emissions and noise to the surrounding areas. At the same time, the plant should be planned as a large demonstration project that includes state-of-the-art and future-oriented demonstration sustainability technologies.

In order to minimize negative impacts on the existing housing areas north of the sewage treatment plant the new parts of the plant (waste to energy cogeneration facilities and the biogasification plant) should be located south of the existing Ashbridges Bay plant with a minimum protection distance between residential land use and the new components of the plant of at least one kilometer. By locating the business park and the living city centre urban campus as a buffer zone west of the plant, a protective distance of one kilometre between the plant and any new housing or mixed-use estates in the Portlands will be assured.

It is important to note that emissions from the new components of the plant will be so low that a buffer zone of less than one kilometer would still offer adequate protection. However, the precautionary principle and community sense of well-being dictate a minimum one kilometer buffer.

The layout and design of the plants should be to such a high architectural standard that the plants are considered an urban landmark. The design of the site should integrate surrounding green areas with the built environment in a way that adds beauty to the site and to the area – beauty being an important part of sustainability. Examples of technical projects known for their high quality architectural design include the Signal Box located in Basel, Switzerland and other projects by the designers Herzog & deMeuron.

An important part of sustainability is to use centrally located areas efficiently. By combining energy, waste and water facilities it will be easier to recycle and reuse resources. It will also be possible to minimize the need for space by organizing functions on several levels using approaches such as vertical transportation. Closed loops may be developed in order to minimize environmental impacts and thus improve both the external environment and the work environment for residents and workers in the area.

It is proposed that the Hearn Generation Station be replaced by the new integrated waste to energy plant at the sewage treatment plant. The ground area of the Hearn station would be a favorable location for housing or mixed-use development. Alternatively, the Hearn may be used as museum or for activities related to the Living City Center. If the Hearn is demolished, some of the material may suitable for reuse in new buildings within the sustainability business park or other waterfront areas.

The Sustainability Business Park

Sustainability is often directly related to environmental and ecological issues. The TWRC sustainability framework has a broader vision as it focuses on the interplay between ecological, social and economical perspectives. A sustainability business park focusing on environmental and energy technology should be built next to the integrated energy plant. The purpose of the business park is to practically illustrate that environmental protection and energy efficiency can promote economic growth or be a vehicle or lever for economic progress through innovation.

The location next to the energy plant may be favorable for companies that wish to demonstrate sustainable solutions and systems. The firms that establish themselves in the sustainability business park may also be involved in other projects in the waterfront area, in the City of Toronto or in other parts of the province or country. Any company locating in the business park will have to comply with certain sustainability criteria and conditions.

The Swedish Trade Council suggests collaboration between Sweden and Canada where Swedish companies are encouraged to participate in contests and bidding to locate activities in the business park. The central location dictates that the Sustainability Business Park should have a strong focus on research and innovation, development of different types, consulting services and small-scale light production of products and systems. Strong links should be developed with other clusters of environmental and energy technology in Canada and elsewhere in the world.

The Living City Center Urban Campus Area

The third cornerstone of the Sustainability Center is to develop an urban campus as part of the Living City Center initiative based on the powerful vision of sustainable communities expressed in the TRCA's Living City initiative: *"To facilitate broad community understanding, dialogue and action toward integrated approaches to sustainable living and city building that improves the quality of life for residents, businesses and nature"*. The overall objective for the Living City center Initiative is: *"To engage leadership in bringing the community together to transform greater Toronto into one of the most sustainable, livable city regions in the world"*.

Figure 6:2 Swedish Reference Examples of Exhibtions communicationg Sustainability Issues – The Information Centre of Hammarby Sjöstad and the World Culture Museum in Gothenburg.

The urban campus would function as a science center with sustainability exhibits and educational facilities including a library, video equipment and state-of-the-art communication technology. It may be seen as an "urban satellite" of The Living City Center Campus area 40 km north of the city of Toronto. It could complement the main campus area with green building demonstration projects and renewable energy training facilities.

The urban campus should be organized, planned and designed in order to attract and inform all nearby residents and visitors from the rest of the City and all parts of the globe about the latest thinking and technology related to sustainability. Interactive systems will be offered at the resource center in order to enhance the experience for visitors, particularly for children and students. Both permanent and provisional exhibitions regarding sustainability will be part of the campus area and will highlight examples of high quality design and public art.

The proximity of the integrated energy plant and the business park allows for a natural cooperation between different parts of the centre. Visits to the urban campus exhibition area can be combined with study trips to full-scale systems in the energy plant or with workshops with the firms and organizations in the business park.

7. References

7. References

For the sake of comparison and for practical reasons Swedish and European conditions and references are frequently referred to in this Sustainability Review. However, this does not exclude benchmarking against other projects and programs in other parts of the world.

The oft-mentioned ”Hammarby Sjöstad” is a waterfront revitalization project in Stockholm, Sweden, including 8,000 new residential units and 10,000 places of work. Planning and construction 1990 – 2010 (Sjöstad means Seaside Town).

Review materials provided by the TWRC included but were not limited to:

- TWRC Development Plan and Business Strategy
  http://www.towaterfront.ca/dbdocs/3fc3a581ae691.pdf

- TWRC draft Sustainability Framework (and background research reports)
  http://www.towaterfront.ca/dbdocs/40b65889cbb54.pdf

- Making Waves :The Central Waterfront Secondary Plan
  http://www.city.toronto.on.ca/waterfront/waterfront_part2.htm
- East Bayfront Precinct Plan, date unknown.

- West Don Lands Precinct Planning Report
  http://www.towaterfront.ca/dbdocs/41337bf42f753.pdf

Parks and Public Spaces Framework
http://www.towaterfront.ca/dbdocs/3fd13c5131e87.pdf

Additional Studied documents regarding water management

TWRC. West Don Lands Precinct Plan. Municipal Services Engineering. *Draft Municipal Services Plan*. March 2004

TWRC. East Bayfront Precinct Plan. Municipal Services Engineering Working Paper #2. *Municipal Services Planning Objectives & Evaluation of Conceptual Infrastructure Plans*. March 2004.

Leadership in Energy & Environmental Design -LEED Standards for United States; LEED Standards for Canada (2004)

West Don Land Precinct Plan. June 2004

City of Toronto: *Wet Weather Flow Management. Master Plan Overview and 25 Year Implementation Plan*. July 2003.

Sustainable Opportunities – A Primer for East Bayfront Precinct Plan. Sustainable Edge Inc. June 2004

Toronto Waterfront Scan and Environmental Improvement Strategy Study – Chapter 8: Water City of Toronto: *Water Efficiency Plan*. December 2002. Toronto Works and Emergency Services and Veritec inc.

City of Toronto: Biosolids and Residuals Master Plan. Executive Summary. KMK Consultants and Black&Veach. September 2004.

Various information leaflets on water efficiency etc.

Slides shown at meetings.

Ranhagen, U, 2004, The Sustainable City – A Partnership Initiative. Swedish Ministry of foreign Affairs. Swedish Ministry of the Environment.

Ranhagen, U, 2000, Planning with environmental objectives –a guide. National Board of Housing, Building and Planning in Sweden. Swedish Environmental Protection Agency.

Appendix

Appendix 1:
Swedish Sustainability Principles and Practice

The Sustainable City Concept

The sustainability review for the Waterfront is to a large extent based on the visions and ideas presented in the Sustainable City concept, which was launched by the Swedish Ministry of Foreign Affairs, The Swedish Ministry of the Environment and the Swedish Environmental Technology Network. The concept has been developed and refined by SWECO and Luleå Technical University.

The Sustainable City Concept is a development and marketing concept serving as a basis for dialogue and discussions between Sweden and other countries regarding strategies for achieving sustainable urban development. It was first presented at the World Summit on Sustainable Development in Johannesburg in August 2002 and it has also been an important part of Swedish efforts to strengthen the collaboration with China, Thailand, Mexico, Russia and the new member countries of the European Union.

The concept was presented and discussed during s visit to Sweden by 40 Canadian Mayors and representatives of the TWRC in August 2004. The visit to Sweden included a tour of Hammarby sjöstad as well as visits to energy plants in Linköping and Malmö. Both during the visit and afterwards, possibilities for applying the sustainable city approach to the Toronto waterfront revitalization were considered. Finally, an agreement was struck to complete this sustainability review for the TWRC based on the Sustainable City Concept.

Vision

The overall VISION of the project "the Sustainable City" could be subdivided in four parts:

First to apply a HOLISTIC CONCEPT FOR SUSTAINABLE URBAN DEVELOPMENT primarily based on experiences and best practice. All aspects of sustainability should be considered. Objectives for each aspect should be fulfilled at the same time as each aspect contributes to the entirety in a well-balanced and harmonic way.

Figure a The Holistic Concept of Sustainable Development

Secondly, to use an INTEGRATED SYSTEMS APPROACH where different fields of actions will be co-coordinated and combined in an optimal way. INSTITUTIONAL ARRANGEMENTS AND POLICIES– shown in the central part of this figure will be used as tools to create integrated concepts, ideas, strategies and practical solutions.

Sectored fields considered in the project are shown as smaller circles around the central part of the figure.

Figure b The Integrated Systems Approach

Thirdly, to put special focus on how urban planning may be used as a framework for developing SYNERGIES between different fields of actions and activities. Urban planning has the potential to be used as a platform for a broad systems approach whereby different services and products will be combined. All aspects of sustainability have spatial components. This could contribute to a better integration and coordination of different systems.

In urban planning the relationship between different systems, for example the built environment for housing and work places etc, infrastructure, transportation and traffic are considered as well as the interplay between rural and urban areas.

The intention is that the concept may be adapted to different development levels of cities and towns as well as different planning situations, for example PLANNING OF NEW SATELLITE TOWNS AND THE RENEWAL AND EXTENSION OF EXISTING CITIES/TOWNS.
As part of the project ”The Sustainable City” planning tasks in China, South Africa and elsewhere representing different types of urban planning are utilized as reference planning cases for developing visionary and practical concepts.

Fourthly to promote the development of INTERNATIONAL PARTNERSHIP AND COOPERATION among public authorities on all levels, private industry and research institutions in finding sustainable solutions in an urban context. In order to intensify the efforts to achieve sustainability it is important to attract and inspire decision-makers, citizens and other stakeholders in a continuous involvement in the challenge of developing sustainable cities.

Sustainable multi-disciplinary actions and activities (including institutional arrangements and policies)

The multi-disciplinary activities refer to activities of special importance for obtaining synergies between different technical fields of actions. *Urban governance* includes urban management and the administration of economical and other resources of relevance for the implementation of measurements constituting a Sustainable City. Urban governance may concern all fields of action, the combination of a few fields (for example energy, waste and water) or one specific area (for example water) including all sub areas discussed below.

Among multi-disciplinary activities *urban planning* from the regional to the detailed level plays an important role by representing the spatial (physical) coordination of land-use, infrastructure, green areas and urban functions. Urban planning results in the spatial framework for the planning and design of all specific structures and systems. A well-developed interplay between urban and *rural planning* is a prerequisite for an efficient recycling of resources like energy and food.

Municipal environmental work during recent years has mainly been conducted with Local Agenda 21 as a point of departure. The majority of the municipalities in Sweden also work with the integration of Local Agenda 21 in comprehensive planning. A *participatory approach* combined with *education and training* of the participants is very basic in this context and many fruitful experiences from both small and large municipalities in Sweden and elsewhere may be utilized within the Sustainable City-project.

A central dimension of sustainable urban development is to promote participation from all stakeholders concerned and to encourage a process based on an open, creative and constructive communication (dialogue) and cooperation between decision-makers, experts and citizens. It is very important that the participatory process has a broad arena aiming at cross-cutting strategies and projects regarding all these factors: institutional needs (1), capacity building (2), awareness & education (3), regulatory reviews of framework and means of enforcement (4), information management (5), partnerships (6) and long-term integrated planning (7). As the planning situations vary it is important to have access to a *toolbox* including tools for all steps of the planning process. The Sustainable City concept includes a number of methods and tools applicable on all levels of planning and design. Some of the tools that have specific relevance for the waterfront projects will be touched upon in section 4.

To obtain sustainability in connection with both new and existing Cities and towns it is important to develop a continuous *cooperation between planning authorities and private enterprises* representing top competence in different fields of consultancy as well as manufacturing companies with innovative sustainable products. It is important to develop forms of cooperation, which absolutely guarantee the democratic rules. In order to measure the directions in which cities and towns develops it is necessary to develop systems for assessing (evaluating) all aspects of sustainability for example within the framework of environmental and quality urban management systems. A multi-stake holder dialogue includes meaningful ways of discussions and cooperation between public and private sectors as well as NGOs.

The informatics revolution will have large consequences not only for the urban life but also for the planning, design, implementation and management of cities. By integration of new and innovative *IT-concepts* in systems for governance, urban planning, participation, education and training, the efficiency and transparency in all the multi-disciplinary activities will be raised. At present only about 15% of the world's population (approx 1 billion people) are connected to the Internet and 5 billion peopled are not connected at all. In this situation the urban planning must facilitate the location and construction of communication canters available also for poor people where needed.

Visionary and practical systems and solutions

An essential feature of the Sustainable City-concept is the integration of land-use planning with the planning of the systems of infrastructure, transportation and green areas (landscaping).

An ***integrated infrastructure and land-use planning*** is a prerequisite for a definitive turn from linear to circular flows of resources. Traditional energy production and sewage systems often mean extraction of non-renewable resources and inefficient treatment of end-products which results in general environmental degradation, such as large waste mountains, pollution etc.

In a Sustainable City the greater part of the resources extracted are renewable, the use of resources are minimized and treated in order to facilitate reuse of resources.

In the City of Stockholm an integrated resources management approach has been applied illustrating a principle, that reflects a visionary systems approach. This approach will be described in section 2.2.

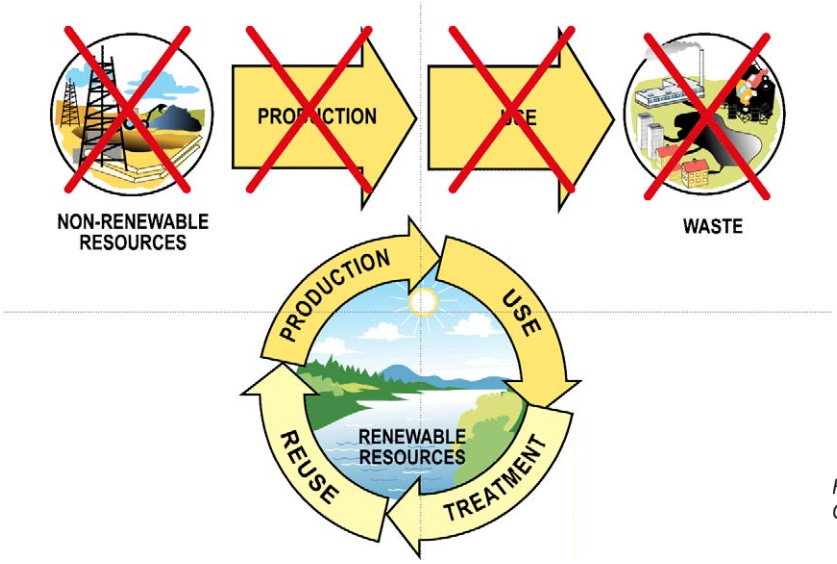


Figure c The Turn from Linear to Circular Flows of Resources

Integrated transport and land-use and planning are a key factor in improving the vast environmental, social and economic problems connected to transportation. It is obvious that land-use planning and other transport policy measures (public transport subsidies, traffic management measures etc) are necessary for changing travel demand in urban areas. For new exploitations, such policy measures will in practice decide on future transport load. In parallel,

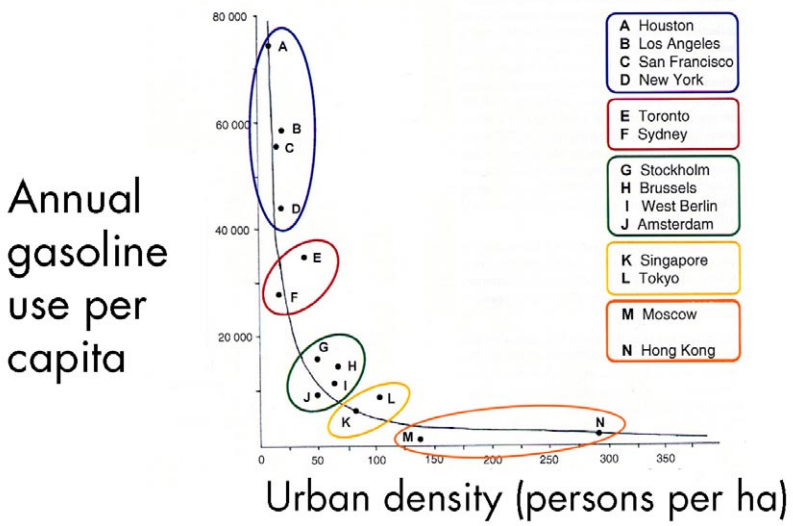


Figure d One key success Factor for the Public Transportation System is the Urban Density

policy measures concerning e.g. regulations on exhaust emissions, vehicle inspection etc, are important in order to improve safety and reduce emissions from road transport that cannot be avoided. A key success factor for the public transport system will be the accessibility from different functions to bus stops and mini-terminals for the express bus and the feeder buses combined with attractive walking and bicycle paths.

Integrated landscape and land-use planning

The multifunctional importance of the green environment from the perspective of sustainable development has been increasingly observed. There is now sufficient evidence from research on the connections between health and the quality of the outdoor environment showing that it is important to have access to green areas in order to gain positive health effects.

Integrated landscape and land-use planning makes it possible to prepare properly dimensioned green areas around a town in order to facilitate the exchange of resources between town and rural areas. (see above). It also facilitates the development of green wedges from the peripheral parts of a city or town into the central parts, which facilitates for an urban population even in large cities to have good access to green areas at the same time as the green wedges could function as ecological corridors for animals and plants (as in the Stockholm City region).

Figure e The Green Environment has a multifunctional Importance

Implementation strategies

The holistic concept of the Sustainable City may be applicable on a wide range of planning situations in both developing and developed countries. Due to the current situation in a certain country the demand for products and services lies on different technological levels. The urban scale and the time-perspective are also crucial issues when deciding on the implementation strategy.

Pilot-projects are often didactic as they show crucial features of a solution in a small-scale context. Pilot-projects may be implemented on a low, a medium or a high technological level. If the pilot-projects are successful they may also be used as a basis for medium or large-scale implementation in town-districts or entire cities.

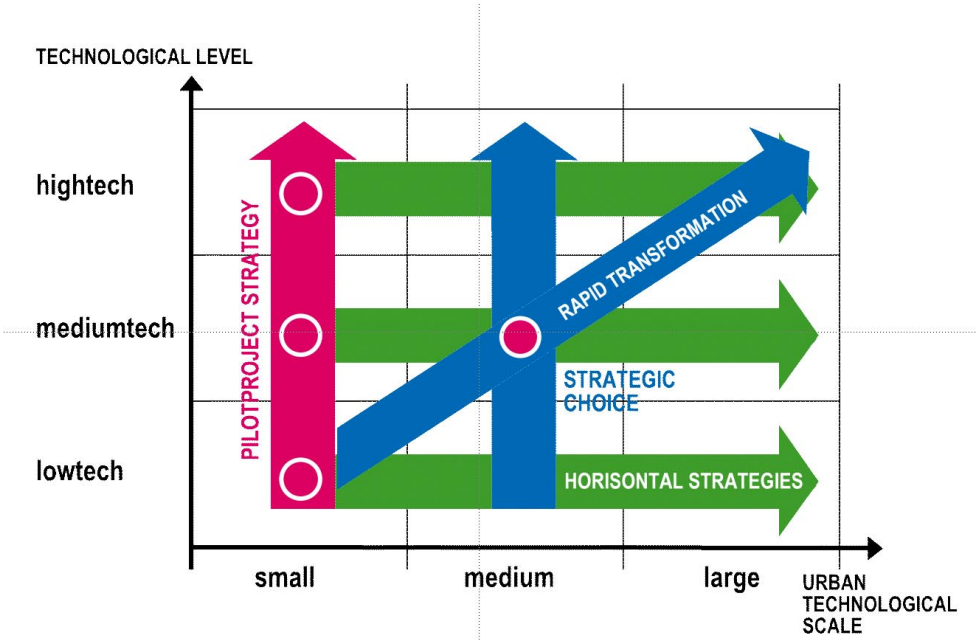


Figure f The proposed Implementation Strategy of the Sustainalbe City Concept

Expected benefits of the concept

- The integrated approach of the concept will make it possible to avoid sub optimization and to promote cost efficiency and also to reduce the increasing costs related to environmental degradation.
- The concept has didactic and participatory benefits by increasing the awareness of many stakeholders regarding both problems and opportunities regarding the sustainability
- The concept contributes to transfer and disseminate best-practice solutions, methods and tools regarding sustainability between Sweden and Canada
- The concept promotes leaps from a low to a high technology level in order to avoid economic, social and environmental problems

It is important to point out that the concept is meant to

- be applicable both in large and small scale developments as well as on different technological levels in Canada -Toronto
- be adaptable to local conditions in Canada-Toronto
- be part of a long-term process of co-operation between local authorities and the business sector in Canada-Toronto and Sweden

Appendix 2: Hammarby Sjöstad

– the Stockholm Revitalization Waterfront project

One major Swedish example of special relevance for Toronto Waterfront Revitalization is Hammarby sjöstad (the Hammarby Waterfront project) in Stockholm. This example may serve as a valuable reference case regarding both the overall sustainability approach and the solutions for different technical systems.

Hammarby sjöstad is the largest urban development in Sweden in many decades. When this city district is fully developed it will include 8000 apartments for 20 000 residents as well as 350 000 m2 business area. Altogether, 30 000 people will live and work in the area.

The fundamental concept underlying the planning and design was to seize the unique opportunity presented by the location of large underutilized industrial and docklands areas at the seaside. By transforming these areas into a modern urban environment a new ”annual ring” could be added to the inner city area.

Major advantages are the central location that boasts both proximity to the inner city and the substantial green areas of the region. In addition, the architecture is new and exciting with many examples of flexible design, combining the characteristics of a traditional town center with an open, modernistic approach. Open spaces, views towards the water green areas are all an integral part of the new environment. Restricted building depth, duplex apartments, roomy balconies and terrace, large windows, and lightly plastered frontages facing the water are all present in the modernistic program of the architecture.

Hammarby sjöstad is the most progressive Swedish example of an urban area planned from a holistic, integrated systems approach on sustainable urban development. Thus it is a good practical example of the Sustainable City concept.

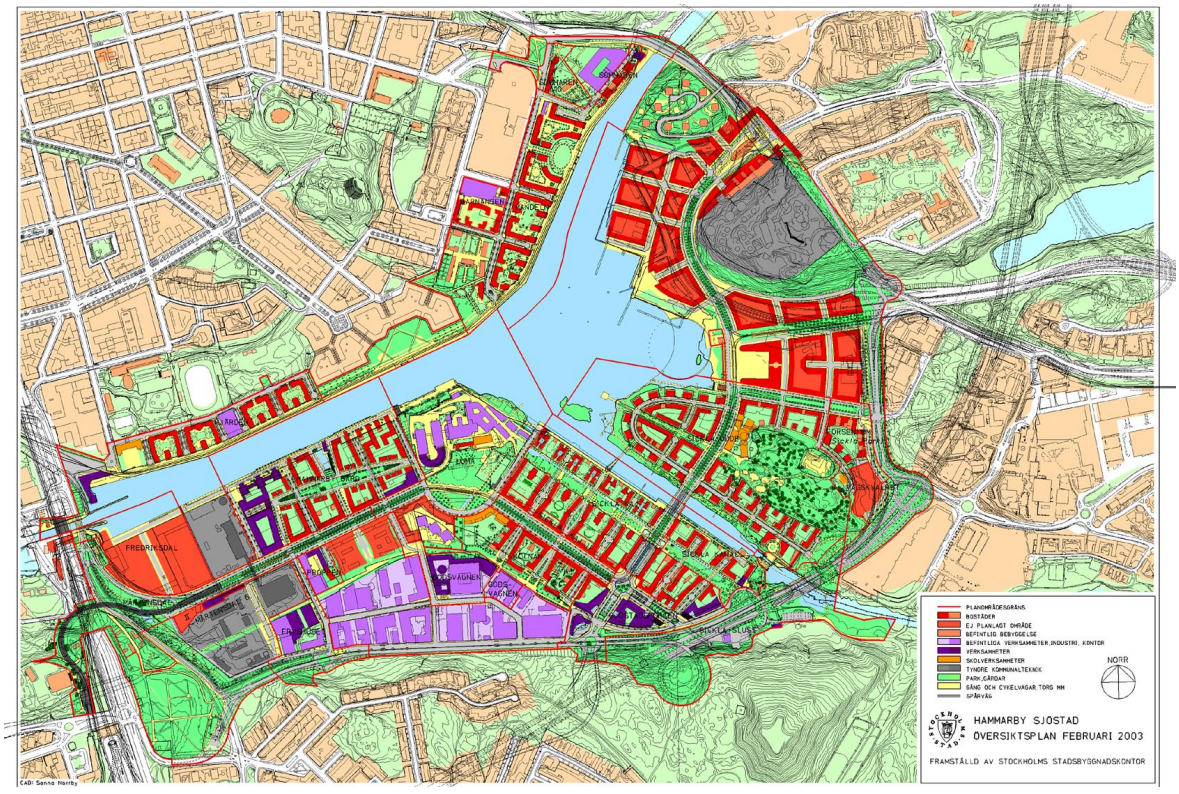


Figure g The Comprehensive Plan of the Town district of Hammarby Sjöstad

Several *program documents* govern the development of the area. The city district has its own environmental program created with the intention of focusing on environmental matters both during the planning and design stages and during the tendering, construction/implementation and maintenance/operation phases.

The overall objective of the environmental program may be summarized as twice as good as today. The consequence is that be best practice techniques of today must be improved with a factor 2. Together with changes of life styles, attitudes and opinions stimulated by economical, social and technical driving forces, a performance better than factor 2 may be expected. The architectural program highlights, as one of five main points, the emphasis on environment and eco-cycles, implying new requirements for the architecture. New symbol values are asked for, partly as new technical and architectural solutions integrated in the blocks of the town district, partly as specific eco-cycle buildings such as a new wastewater treatment plant and a new environmental info-centre.

The Hammarby sjöstad example illustrates the practical realization of integrated land-use and infrastructure, transportation and landscape planning which is an essential part of the Sustainable City concept.

The Hammarby model

The Hammarby model, - the eco-cycle system in Hammarby sjöstad - , links the supply of electricity, heating and cooling with waste and sewage treatment. The heating in the area is supplied mainly by using recovered combustible waste and by heat pumps running on waste heat from treated sewage water. The sewage sludge is used to produce biogas which ca fuel gas cookers and cars. The storm water is drained into the ground locally and road storm water is treated separately.

Transportation

As part of the drive to create an environment friendly area, substantial investments have been made in public transport in order to reduce the use of private cars. The cross-town light-rail line with four stops within the area links the town district to other parts of the city region. A number of bus lines serve the area of which one operates all night between the town district and the Stockholm city center. A biogas fuelled ferry is being planned to link the area to other city districts with departures every ten minutes from early morning to midnight. The Statoil Company offers a car-pooling system that is open to all residents with permanent parking space around the area. As there is only a limited number of parking spaces, a new system for sharing spaces between residents and commuters will be tried.

Landscape planning

Water and greenery are accessible assets in Hammarby sjöstad. The central stretches of water form a visual park, the area's gleaming blue eye. Parks and greenery represent the natural qualities that tremendous efforts have been made to preserve and also to create additional new green areas. Even the very first residents were able to enjoy the conserved oak tree woods as an attractive park and the wooden jetties with benches along the entire length of the central half island of the town district.

Figure h Pictures from Hammarby Sjöstad – the City meets the Sea.

Index of figures

Executive Summary

Figure S1
An overall Plan of the Toronto Waterfront Area
Figure S2
East Bayfront Precinct Plan – some important Issues (2:1)
Figure S3
West Don Lands Precicnt Plan – some important Issues (2:2)
Figure S4
An overall Vision of the Waterfront Area. The figure should not be seen as a detailed land-use planning proposal. It points out some of the issues which are discussed in sections 2,3 and 6 of the report. (2:10)
Figure S5
The proposed integrated Infrastructure Network for the entire Waterfront (3:1)
Figure S6
A Swedish Reference Example of Sustainable Building Design (4:1 – ett exempel)
Figure S7
Sustainability Issues have to be integrated in all Phases of the transformation Process (5:2)
Figure S 8
Swedish Reference Examples of Exhibtions communicationg Sustainability Issues – The Information Centre of Hammarby Sjöstad and the World Culture Museum in Gothneburg. (6:2)

1. Introduction

Figure 1:1
The Sustainable City – A Systems Approach on Sustainability (see Appendix for further presentation)
Figure 1:2
Major Tasks for each phase of the Work

2. Sustainable Precinct Planning on the Toronto Waterfront

Figure 2:1
East Bayfront Precinct Plan – some Issues to consider
Figure 2:2
West Don Lands Precinct Plan – some Issues to consider
Figure 2:3a
Sustainable Public Transportation – Swedish Reference Examples. Tvärbanan – a light-rail Line in Stockholm connecting Hammarby Sjöstad with the Subway System of the City of Stockholm.
Figure 2:3b
A light-rail Line integrated with car traffic in the City of Norrköping.
Figure 2:4
The Curitiba Example in Brazil. A Bus-Stop along a separate Lane for Express Buses.
Figure 2:5
Example of an automated Public Transportation System.
Figure 2:6
Knutpunkt Hjalmar in Gothenburg – An Example of a Tunnel for Pedestrians and Bicyclists
Figure 2:7
An example of a separate Path for Pedestrians and Bicyclists centrally located in a Street Space. Erik Dahlbergsgatan in Stockholm.
Figure 2:8
The Dania Park is situated in the western Harbour of Malmoe in the southern part of Sweden.
Figure 2:9
The Southern Link – a newly inaugurated Highway Tunnel in Stockholm,
Figure 2:10
An overall Vision of the Waterfront Area. The figure should not be seen as a detailed land-use planning Proposal. It points out some of the issues which are discussed in sections 2,3 and 6 of the report.

3. Sustainable Municipla infrastructure and District Systems

Figure 3:1
The proposed integrated Infrastructure Network for the entire Waterfront
Figure 3:2
A coordinated Approach on the Location of different kinds of Pipes.
Figure 3:3
The Hammarby Model – An integrated Infrastructure Approach applied in Hammarby Sjöstad in Stockholm.
Figure 3:4
Strategy 1: The Nutrients are captured at the Treatment Plant
Figure 3:5
Strategy 2: The Nutrients are captured at the Source
Figure 3:6
Strategy 3: The Pollutants are captured at the Source.
Figure 3:7
Concentrations of Heavy Metals in Sewage Sludge
Figure 3:8
Stormwater Flows can be considerably decreased by a Series of Control Measures, here exemplified by Green Roofs, Ponds and Wetlands.
Figure 3:9
An Illustration of a possible Dual Stormwater Systgem in West Don Lands
Figure 3:10
The Eco Cycle Model
Figure 3:11
Henriksdals Wastewater Treatment Plant in Stockholm. Biogas is recovered from Organic Waste and Waste Water Sludge.
Figure 3:12
Incinerated Amounts of Waste, Energy Production and Dioxin Emissions 1985-1999 in Sweden.
Figure 3:13
The Sysav Example of Integrated Waste Management
Figure 3:14
An Example of a CVC-system. The Inlets of the System are carefully designed as part of the Urban Environment in Hammarby Sjöstad in Stockholm.

4. Sustainable Building Design

Figure 4:1
Swedish Reference Examples of Sustainable Building Design
Figure 4:2
Kv Holmen in Hammarby Sjöstad.
Figure 4:3
Kv Holmen, photovoltaic cells as integrated building components in window partitions, balcony fronts and facades.

5. Managing and Implementing Sustainability

Figure 5:1

The TWRC´s Sustainability Framework
Figure 5:2
Sustainability Issues have to be integrated in all Phases of the Transformation Process
Figure 5:3
Examples of Tools for integrating Sustainability Issues in the Planning Phase
Figure 5:4
A practical Example of an Application of the MCA-methodology on teh Evaluation of Competition Proposals (Suntrans – Beijing)
Figure 5:5
Purpose of the Eco Effect Method
Figure 5:6a

External and Internal Environment: One assessed building compared to a sample of other buildings
Figure 5:6b
Comparison between two buildings
Figure 5:7a
External environmental impact of a building
Figure 5:7b
Internal environmental impact of a building shown as an indoor profile

6. Exemplary Sustainability Initiatives

Figure 6:1
The Sustainability centre (uppförstoring av den högra delen av figur 2:10)

Figure 6:2
Swedish Reference Examples of Exhibtions communicationg Sustainability Issues – The Information Centre of Hammarby Sjöstad and the World Culture Museum in Gothneburg. (6:2)

Appendix Swedish Sustainability Principles and Practice

Figure a
The Holistic Concept of Sustainable Development
Figure b
The Integrated Systems Approach
Figure c
The Turn from Linear to Circular Flows of Resources
Figure d
One key success Factor for the Public Transportation System is the Urban Density
Figure e
The Green Environment has a multifunctional Importance
Figure f
The proposed Implementation Strategy of the Sustainalbe City Concept
Figure g
The Comprehensive Plan of the Town district of Hammarby Sjöstad
Figure h
Pictures from Hammarby Sjöstad – the City meets the Sea.