The Transformation of Landfills to Green Spaces: Identifying the Barriers and Benefits in the Greater Toronto Area (GTA)

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The Transformation of Landfills to Green Spaces: Identifying the Barriers and Benefits in the Greater Toronto Area (GTA)

by

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Abstract

In Canada, policy makers and planners have been paying significantly more attention to developing and improving the quality of life in urban areas. One issue that has been gaining momentum is the cleanup and redevelopment of urban landfills. As urban sprawl continues to grow, neighborhoods and communities are slowly reaching the boundaries of these once ‘rural’ landfills, and are creating a variety of social and environmental concerns. There has been a growing recognition among community groups and environmental organizations that landfills hold enormous potential for ‘greening’ city environments.

Green space development has been emphasized throughout this study as a realistic and beneficial redevelopment opportunity. Instead of leaving a landfill site derelict and underutilized with no economic value, cities and municipalities have the opportunity to redevelop a site and create a community asset.

This objective of this study is to identify and examine the barriers and benefits to transforming landfills to green spaces in the Greater Toronto Area (GTA). The identification of these barriers was derived from three distinct research strategies: a literature review, three case studies, and sixteen professional interviews. The data for this thesis derived from the sixteen interviews, based on their responses in filling out a ‘barrier matrix’.

The GTA has achieved considerable success in converting landfills to green spaces largely due to government’s commitment, various financial incentives, effective public-private partnerships, and a growing demand for urban green spaces.
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List of Abbreviations

3R’s: Reduce, Recycle, Reuse
BFTI: Brownfield Financial Tax Incentive Programs
BGC: Braeben Golf Course
BRTA: Brownfield Remediation Tax Assistance
BSLS: Britannia Sanitary Landfill Site
CAD: Canadian Dollar
C of A: Certificate of Approval
CCME: Canadian Council of Ministers for the Environment
CDF: Confined Disposal Area
CEPA: Canadian Environmental Protection Act
CFREB: Conjoint Faculties Research Ethics Board
CIPs: Community Improvement Plans
CIPAs: Community Improvement Project Areas
CO$_2$: Carbon Dioxide
EPA: Environmental Protection Act
ESA: Environmentally Sensitive Area
GHG: Green House Gas
GTA: Greater Toronto Area
GMF: Green Municipal Fund
IGRS: Integrated Gas Recovery Services
KVL: Keele Valley Landfill
LEL: Lower Explosive Limit
LFG: Landfill Gas
MNR: Ministry of Natural Resources
MOE: Ministry of the Environment
MW: Megawatts
NAL: Natural Attenuation Landfill
NRTEE: National Round Table on the Environment and the Economy
THC: Toronto Harbour Commission
TPA: Toronto Port Authority
TRCA: Toronto Regional Conversation Authority
TTP: Tommy Thompson Park
1. Chapter 1: Introduction to the Transformation of Landfills to Green Spaces

1.1 Description of Research Topic

Brownfields exist around the world in massive numbers: they comprise close to 25 percent of the Canadian urban landscape (GMF 2), totaling 30,000 across Canada (NRTEE, “Cleaning up the Past” 2). There are over half a million brownfields in the United States (Wernstedt, “Brownfields Regulatory Reform” 10) and an estimated 5 million acres of brownfields worldwide (World Bank 3). In Canada, brownfields occur when industrial areas move outward as cities expand, leaving sites abandoned and underutilized (De Sousa, “Turning Brownfields” 1).

An effective definition of a brownfield developed by the City of Calgary is an “abandoned, vacant, or underutilized property where past actions have resulted in actual or perceived contamination and where there is an active potential for redevelopment” (“Brownfield Strategy” 3). The original meaning of the term ‘brownfield’ emerged in the United Kingdom, not as the encapsulation of any particular condition of the land, but rather as the opposite of ‘greenfield’ (De Sousa, “Brownfield Development” 79). The definition of a ‘greenfield’ is a “plot of land with no buildings, no infrastructure, or contamination risks (Bricker 4). De Sousa adds to this definition by defining greenfields as “clean, agricultural lands located in the periphery of cities” (De Sousa, “Brownfield Redevelopment” 4). Common characteristics of brownfield sites consist of residual contamination in groundwater and soil, allowing contamination to seep into the local environment, migrating both on and offsite.
Brownfields vary in size, from small parcels of land (half an acre) to large industrial areas encompassing numerous facilities (hundreds of acres). Examples of different types of brownfields include abandoned oil and gas facilities, manufacturing sites, landfills, and rail yards (De Sousa, “Turning Brownfields” 2). Contamination levels are unique to each site, and can vary considerably based on the historical background. Contamination can affect all components of the physical environment, including soil, water, and air. In relation to landfills, this primarily occurs through leachate percolating into the surrounding soil and water, while releases of methane gas contaminate the air.

One particular type of brownfield is a landfill. Landfills are of interest due to their size and potential for redevelopment. According to the Government of Ontario, the definition of a landfill is the “disposal of waste by depositing and covering the waste in pits” (“Watershed Based” 48). Two types of landfills are common in Ontario. Firstly, natural attenuation landfill sites (old and small facilities) are typically sited, designed and operated to rely on the natural hydrogeological setting to control the release of any contaminants (Ontario, “Watershed Based” 48). The second type of landfill consists of ‘new, large, and expanding landfills, equipped with engineered liners, a collection system to control leachate migration, and systems to control landfill gas emissions’ (Ontario, “Watershed Based” 48). New technologies and stricter regulations over the past thirty to forty years have helped contain contaminants, and have prevented it from migrating to adjacent properties (Capstone 1). These strategies and initiatives have helped protect people and the local environment.
In addition to environmental impacts, potentially high concentrations of methane can cause explosions on adjacent properties, posing serious safety risks to surrounding communities. Ontario’s Ministry of the Environment states:

“a mixture of 5% to 15% methane in air will explode if ignited. A concentration of 5% methane in air, is the ‘lower explosive limit’ (LEL), and concentrations equal to or greater than the LEL are considered hazardous…Therefore, methane concentrations greater than 5% LEL warn of conditions which could be potentially hazardous, and gas control systems should be designated to maintain concentrations below this level” (MOE, “Methane Hazards” 3).

As our population and consumption of goods and services continues to grow, Canadian landfills are quickly reaching their capacity, forcing closures and the development of new landfill sites. Once closed, many landfills have been transformed into recycling centers, parks and recreational areas, and other land uses. Instead of leaving a landfill site derelict and underutilized with no economic value, cities and municipalities have the opportunity to redevelop a site and create a community asset.

According to Aplet (1977), the creation of parks and recreational spaces is a popular end land use for closed landfills. Some examples include golf courses, parks, playgrounds, baseball diamonds, soccer fields and rugby fields. Green spaces are popular end land uses for three distinct reasons. Firstly, the Ministry of the Environment (MOE) recommends “that uses on lands previously used for waste disposal be limited to open-air activities associated with parks, recreation and open spaces, crop farming and similar uses for which the landfill end use is specifically designed” (Ontario, “Operational Guidance” 2).
The second relates to landfills being publicly owned properties. If local governments were faced with the additional burden of purchasing a property from a private owner, it would be very difficult for a green space redevelopment project to be economically viable. Lastly, as urban populations continue to climb, the need for green space and recreational activities is becoming increasingly more important for the health and well-being of surrounding inhabitants. Successful landfill to green space projects do exist across Canada, but for the purpose of this thesis, case studies within the Greater Toronto Area (GTA) will be the focus for two reasons. First, the GTA has successful projects, which provide good case studies. Secondly, it has an abundance of landfills and a shortage of green space per capita. The objective of this research project is to examine the issues, barriers and processes involved in transforming closed landfills to green spaces in the GTA, and to propose recommendations for overcoming the major obstacles.

In addition to examining the challenges of landfill redevelopment, a portion of this thesis will discuss the economic, social and environmental benefits of landfill to green space redevelopment, with the intention of encouraging sustainable initiatives in Canadian cities.

1.2 Justification for Research

The conversion of landfills for leisure and recreational purposes has become increasingly more important for cities and municipalities in recent years, due to increasing populations and the resulting demands for housing. Green space amenities are an important feature of any city, providing an escape for urban dwellers to enjoy a variety of leisure and recreational activities. The needs of growing urban populations can be met by providing
green space areas on closed landfills, when there is a significant deficiency in that community.

Additional research is needed on the landfill to green space conversion projects in Toronto in order to broaden the knowledge base of the factors inhibiting landfill redevelopment projects. With a better understanding of the barriers and limitations to landfill to green space conversions, strategies for overcoming these obstacles can be more achievable. The significant factors related to the transformation of landfills to parks and green spaces are: (a) the current landfill regulations, (b) population trends, (c) funding for parks and recreation areas, (d) increasing recreational needs, (e) alleviating the potential impacts from hazardous materials and contaminants, and (f) revitalizing surrounding communities. Academics and professionals have identified these significant factors (e.g. De Sousa, Doick, Wernstedt), but very little research has been done on overcoming the barriers to landfill to green space transformations. Once these brownfields reach their capacity, it is important that they remain productive through the supply of an alternative use. The key outcome of this research will be a tool for overcoming the common barriers to converting landfills into green spaces, which will be a useful guideline for all relevant stakeholders in the remediation and redevelopment process.

1.3 Major Challenges to Redeveloping Brownfields

There are four significant challenges identified in the literature to redeveloping brownfields into green spaces: they are (a) the purchase of the property, (b) remediation, (c) design, and (d) development. Since landfill sites are often city owned properties
(Breckenridge 1), the costs of purchasing property for green space are avoided. However, landfills to green space redevelopment projects are burdened with the remediation, design and development costs.

The environmental management of landfill contaminants has an abundance of social, environmental and economic challenges. These include liability, meeting environmental regulations, ensuring the health and safety of the surrounding communities and environment, and risk management initiatives. In regard to redeveloping brownfields, the high costs of remediation, risk management and development are often proclaimed as the most significant barriers to overcome (Gnanayudam 1). Fortunately, Ontario has implemented a number of financial opportunities from the federal, provincial and municipal governments to help support the redevelopment of brownfields. Some examples include Community Improvement Plans (CIP’s), Brownfield Financial Tax Incentive (BFTI) Programs, and Brownfield Remediation Tax Assistance (BRTA) (Harper 9).

A number of professionals have mentioned in the interviews, that the most popular types of landfill reuses include open spaces, parks and recreation areas (Gnanayudam, Breckenridge, O’Keefe). The least popular type of landfill redevelopment involves the construction of infrastructure and large buildings, accompanied by high levels of public use.
1.4 Current Landfill Standards

This section provides background knowledge on the current landfill standards in Ontario, in order to better understand the established guidelines and regulations provided by the MOE. Efforts by professionals to meet these designated standards are one of the many challenges to transforming landfills to green spaces. Regulatory requirements issued by the Environmental Protection Act (EPA) and the MOE, can potentially be difficult standards to meet depending on a site’s specific characteristics. Although the MOE continues to “emphasize the 3R’s (reduce, reuse, and recycle), land filling remains a necessary component of waste management – whether to manage 3R’s residuals or to dispose of wastes which are not amenable to reuse or recycling” (Ontario, “Landfill Standards” 8).

New standards were established in order to ensure Ontario landfills are state-of-the-art and fully protective of the environment. These standards include location restrictions, facility design and operating criteria for liner and leachate collection systems to prevent groundwater degradation, groundwater monitoring requirements, corrective action requirements, and closure and post-closure maintenance periods (Ontario, “New Landfill Standards” 1). In Ontario, the new standards include new and more specific requirements in a number of areas as follows:

- Mandatory air emissions control for sites larger than three million cubic meters
- Assessment of groundwater and surface water conditions
- Design specifications for groundwater protection
- Buffer areas, final cover design and surface water control
- Site monitoring, record keeping and reporting
• Contingency planning for leachate control
• Financial assurance requirements for private sector landfills (Ontario, “New Landfill Standards” 1).

Landfill standards across Canada can vary from province to province. The focus of the new landfill standards is facility design, financial assurance requirements, environmental monitoring, and closure and post-closure maintenance (Ontario, “New Landfill Standards” 3). Once a landfill has reached capacity, final closure must be completed in a manner that ensures the long-term protection of the environment.

1.5 Brownfield Redevelopment versus Greenfield Development

In cities throughout Canada, “the legacy of a negligent industrial past has left its’ scars on the urban landscape in the form of countless underused or abandoned industrial and commercial properties, commonly referred to as ‘brownfields’” (De Sousa 2). Many city planners and private developers are hesitant in putting brownfields back into productive use because of the fear that they may be contaminated (De Sousa 2). Even after remediation and redevelopment are completed, there are often additional significant concerns regarding the potential risks of future liabilities (De Sousa 2). These could materialize because of, for example, substandard remediation practices or the introduction of enhanced environmental regulations.

Since developers are often unwilling to invest in the redevelopment of brownfields, greenfield development continues to be the simplest option for residential and commercial growth. The reason why these lands are so appealing for new development is that greenfields have no remediation costs and minimal liability concerns (Gnanayudam
These two significant reasons are why a number of Canadian cities continue to expand their urban periphery, causing a number of economic, environmental and social issues. Lower consumption patterns, the redevelopment of brownfields and the preservation of greenfield sites, are pivotal strategies for ensuring the sustainability of growing city (Doick, “Brownfield III” 130).

Urban expansion has become a growing issue in Toronto due to the abundance of greenfields at the urban periphery and a lack of geographical restrictions. Vancouver for example, has the Pacific Ocean and Canadian Rockies limiting its urban expansion; while Toronto’s periphery consisted of agricultural lands, open fields and forests (e.g. the GTA green belt). The GTA is one of Canada’s most developed areas and continues to grow in both size and in population. Increased population growth results in high demand for both residential and commercial development, primarily supplied by the city’s urban periphery.

As Toronto attempts to balance the demand of its’ growing population with the pressures of urban sprawl, brownfield redevelopment provides a potential solution for both challenges. Toronto has a history of landfills within its city limits, which can potentially provide opportunities for new park and green space development. Harnik et al. reinforce this by emphasizing that “in a time of severe urban space and resource constraints, closed landfills present excellent new park sites for three reasons - size, location and cost” (2). As these opportunities arise, Harnik et al. state “communities from coast to coast have been jumping at the chance to convert them” (2). As older suburban areas become more
developed, communities and cities across Canada are beginning to witness the benefits of landfill redevelopment.

1.6 The Role and Importance of Urban Parks, Recreation and Green Space

Urban parks and open spaces are of significant importance for the quality of life in our increasingly urbanized society. Empirical evidence indicates that the presence of natural assets (e.g. urban parks and forests, green belts) and components (e.g. trees and water) in urban contexts contributes to the quality of life in a variety of ways (Chiesura 2). Apart from the obvious environmental benefits of natural areas; including air and water purification, wind and noise filtering, and microclimate stabilization; they provide social and psychological services, which are of crucial significance for the livability of urban dwellers (Chiesura 2). Nearby green spaces provide city residents with a variety of social and recreational opportunities that include meeting new people, relieving stress, enjoying nature, exercising and relaxing.

City residents have shown an increasing interest in living close to urban green spaces. Studies have been conducted on the ‘willingness to pay’ for people moving to an urban setting. One such study states that people are willing to pay a premium cost for a residential home close to a park, green space or open space of good quality (Hoffman 4). It was theorized that the reason people are willing to pay higher rent or take a more expensive mortgage, is because people tend to live healthier and more fulfilling lives when living closer to green spaces. Hoffman et al. state that “living near a green space can achieve many possibilities to do something for health and well-being and it allows the opportunity to socialize” (4). The role of urban parks and green spaces is essential in
providing balance between nature and the built form. People choose to live in, and businesses want to invest in, communities that are perceived to have a high quality of life. People want neighborhoods that are safe, abound in cultural amenities, and provide opportunities for the whole family (De Sousa, “Unearthing the Benefits” 22). Thus, parks and green spaces play a significant role in the livability and sustainability of a growing city while providing more opportunities for urban inhabitants to live a healthier and more active lifestyle.

A study in the Netherlands showed that green space has a positive influence on human health and well-being, which emphasized a view overlooking a green space significantly shortens the healing process of patients in hospitals (Hoffmann 4). Cohen supports Hoffman, by stating ‘public parks have an important role to play in facilitating physical activity, contributing to a healthier lifestyle’ (1). It is well documented that green space has a positive influence on human health and well being (Cohen 1), but the majority of urban brownfields remain idle for long periods of time with no specific intent (Adams et al., “Ownership Constraints” 20). This is due to a number of economic and environmental factors, which prohibit or stall the redevelopment process from moving to move forward.

It is vital for Canadian cities to maintain their current urban parks and green spaces and plan accordingly for the growing populations and the values of new urban dwellers. This section emphasizes the importance of urban green spaces, and that closed landfills can be ideal sites for developing new parks and recreational areas. These sites are ideal
candidates because they are usually city owned properties and are often large in size. There are a handful of Canadian examples that illustrate successful transformations of landfills into park and green space. More research is needed on the barriers and limitations to this type of redevelopment in order to ease the transition process. With adequate knowledge of the obstacles to landfill redevelopment, new strategies can be implemented to encourage more landfill revitalization projects in Canada.

1.7 Benefits of Transforming Landfills-to-Green Spaces

The benefits of risk managing landfills can contribute to a city in three distinct ways:

(a) Environmental benefits consist of restoring natural systems, re-introducing native ecosystems, enhancing biodiversity, regenerating plants and trees, improving air quality, and the removal and management of harmful contaminants (De Sousa, “Unearthing the Benefits” 6). The remediation of a nearby landfill regulates the existing hazardous material from migrating to adjacent properties, and transforms a once undesirable site into a mixed-use property that meets the existing and future social needs (Laing 17).

(b) The economic benefits of redeveloping landfills can include increased revenue to offset the costs of long term care of the former landfill, new job opportunities, a higher tax base, and indirect economic benefits for the surrounding neighborhoods (De Sousa, “Greening of Brownfields” 7).

(c) The social benefits of transforming landfills to green spaces can consist of ‘improved quality of life in neighborhoods (people can live closer to work and recreational areas),
removal of threats to human health and safety, and opportunities for social interactions among neighbors and co-workers (NRTEE, “Cleaning up the Past” 11). Many brownfields offer opportunities for urban revitalization that can achieve important social and environmental goals, at the same time as producing economic returns on public investments (McCarthy 9). Landfills are one of many types of brownfields that have significant potential for redevelopment, creating environmental, social, and economically sustainable communities for current and future generations.
2. Chapter 2: Methodology

The research methods used for this thesis consisted of three distinct research components: (a) a literature review, (b) three case studies of successfully converted brownfields, and (c) semi-structured interviews. All three components play a significant role in identifying the common barriers and benefits to landfills to green space transformation projects in the GTA. The primary research tool used in this thesis was the semi-structured interview, which provided this report with fundamental data on the barriers to transforming landfills to green spaces.

2.1 Literature Review

The literature review was an important component to this study because it provided a clear understanding of current barriers to brownfield redevelopment and their related definitions. The literature review provided valuable insight into the current issues relating to brownfield redevelopment. It also helped identify the research gaps, which helped guide this thesis. Yin expresses the importance of a literature review for any new research project by stating “a thorough literature review is the first step in establishing a ‘methodological path’ (“4th Edition” 3). The literature review helped support this thesis by presenting the ideas and concepts of past scholars on the challenges to both the redevelopment of brownfields and the development of green spaces. Secondly, the literature review supports the other two components of this thesis by presenting past analysis, patterns, and critiques of previous interview processes and case study strategies. Lastly, the literature review illustrated that the concept of transforming landfills to green spaces is not an original idea, but that this information will help shape the recommendations developed in this thesis. By building on past academic studies, this
thesis will inform a means to overcome the current and future barriers to landfill to green space redevelopment projects in the GTA.

The research process for this thesis consisted of collecting and analyzing a variety of information, including academic sources, grey literature and local newspaper articles. These resources proved to be the most accurate and informative. Examples of academic sources included in this report consist of online journals, books, and public reports, while examples of grey literature include consulting reports and community improvement plans. The grey literature related to the case studies in Chapter 4 provided specific information regarding a site’s environmental history, strategies for redevelopment, and green space development plans. An example of grey literature was a document (IGRS 1) on the Britannia Landfill, outlining the details of constructing and implementing a ‘gas-to-energy’ system on site. Consulting reports provided a scientific understanding of landfill contaminants, quantitative risk assessments, and remediation strategies for landfill related projects. Grey literature was pertinent to gaining insight into the objectives and strategies of professionals in the field of landfill redevelopment, providing better understanding of the planning process for redeveloping landfills in the GTA.

The grey literature was used in conjunction with the review of academic literature outlining current brownfield and landfill redevelopment strategies, to determine the need for this type of research and to identify the themes throughout this study. These themes consisted of understanding the challenges, benefits and strategies for overcoming the barriers to landfill to green space projects. The literature review familiarized the
researcher with an overview of past studies relating to redeveloping landfills, specifically relating to the common obstacles and benefits to additional urban green space. The review also summarized relevant issues central to the transformation of landfill to green spaces, including the types of green spaces, the current brownfield redevelopment strategies in Ontario, the growing need for green space in Ontario, and the benefits and barriers to redevelopment. Landfill to green space projects involve a variety of professionals at different stages of the redevelopment process, including environmental consultants, city planners, and city developers. These parties were interviewed for the purpose of gathering professional perspectives and information on this thesis topic.

Once the literature review was completed, the most relevant fifteen academic sources were selected to accurately depict the barriers to both redeveloping brownfields (10 sources) and green space development (5 sources) (e.g. see table 6 in Chapter 5). The fifteen sources were chosen based on the author, its published year, its Canadian context and on their previous research. Seminal authors comprised the majority of these fifteen sources, including De Sousa, the NRTEE, Doick and Wernstedt. These authors helped illustrate a consensus in the literature regarding the barriers to converting brownfields into green spaces, through their individual research and personal opinions.

2.2 Case Study Approach

A case study approach was employed for this research as a tool for testing the information found in the literature review and the semi-structured interviews. The case study approach is an effective way of complementing the theoretical research with
practical, real life examples. According to Hartley, case study research consists of a
detailed investigation, often with data collected over a period of time, of phenomena,
within their context” (2). This research strategy explored successful landfill to green
space projects in the GTA, for the purpose of understanding why these projects were able
to overcome the common barriers to redeveloping landfills. Yin emphasizes the
importance of the ‘case study approach’, by stating ‘case studies are often the chosen
approach when studying the underlying research, focusing mainly on “how” and “why”
questions (“4th Edition” 23). Furthermore, Yin distinguished the ‘case study approach’
from other research strategies by formulating a definition of the approach. He stated that
a case study is defined as an empirical inquiry that “investigates a contemporary
phenomenon within its real-life context; when the boundaries between phenomenon and
context are not clearly evident; and in which multiple sources of evidence are used” (Yin,
“1984 Edition” 23). This is an essential component because it expresses the importance
of connecting the literature with real-life examples. Case studies have provided a sound
balance to this research topic, which provides future landfill to green space researchers
with current examples in the GTA.

The case study approach was an appropriate strategy for this particular research, because
it provided concrete examples of landfill to green space projects in the GTA. Three
selected case studies, all situated in the GTA, were chosen based on specific criteria:
history (former/now closed landfill), location, current/future end land use (green space),
and whether the project was successful in achieving its’ designated goals. This strategy
helped provide depth and support to the literature review and semi-structured interviews.
Given the underlying questions; ‘what are the main barriers to transforming landfills to green spaces?’, and ‘how can we overcome these obstacles’?, a case study approach was implemented to find the answers. The case study approach solidified the identification of major barriers facing ‘landfill to green space’ professionals.

Once the criteria were determined, a variety of research tools were utilized to locate information on potential case study candidates. These included online databases, phone conversations with local municipality members, library archive research, City of Toronto archives, and discussions with relevant professionals. This research formulated a variety of exploratory questions regarding potential case studies, including “how many closed landfills are in the GTA?” and “how many of these landfills were converted into public green space or recreation?”. Three case studies met the case study criteria, which included the Keele Valley Landfill, the Britannia Landfill, and The Leslie Street Spit.

During the preliminary stages of research, the intended approach was to study two successful and two unsuccessful case studies to determine why certain projects were able to overcome obstacles, while others were not. However, after further research and discussions with professionals, defining and discovering ‘unsuccessful’ case studies turned out to be impractical. This was primarily due to the age of landfill sites in Ontario. Most of these ‘unsuccessful’ sites are decades old, creating difficulty in contacting professionals involved in those projects and reasons for their redevelopment failures. As a result, additional research was conducted, to identify one additional successful case study in the GTA. The process for finding case studies consisted of personal research and
discussions with professionals. Case studies were found through both strategies, but the discussions with professionals proved to be particularly valuable.

All three cases were researched regarding their history, end land use planning, description of operations and practices, benefits to redevelopment, and barriers to conversion. The data sources for these case studies derived from grey literature and the professional opinions of participants involved in each case study. Each participant was asked to fill out a ‘barriers’ table outlining the barriers to their associated case study. This data was then compiled and analyzed to determine the top five barriers in each case study.

2.3 Research Methods: Semi-Structured Interviews

2.3.1 Introduction to Semi-Structured Interviews

DiCicco-Bloom provides a definition of a semi-structured interview by stating that they are usually “scheduled in advance at a designated time and location outside of everyday events. They are generally organized around a set of predetermined open-ended questions, with other questions emerging from the dialogue between interviewer and interviewee/s” (DiCicco-Bloom 2).

The semi-structured interview method was chosen based on the freedom it provides for both interviewer and respondent. It allowed new ideas to surface during the interview based on the answers provided by the interviewee. In such an interview, a set of predetermined questions acts as a guide for the research. While the researcher will work to ensure that certain key questions are asked of every participant interviewed, the semi-
structured format allows and encourages the researcher to interject with additional questions that may arise. An important note, however, is that these questions are merely a guide to the session and the flow of the interview is meant to be primarily driven by the respondent. This type of interview method is particularly useful when the researcher wishes to explore a predetermined set of themes, but remains open to additional themes that may emerge throughout the interview (Cobetta 2). Having this flexibility was particularly important given the variation of professional experience and the likelihood that certain themes would only be relevant to some of the respondents.

Based on the interview questions and additional discussion, ‘barrier’ tables were filled out, outlining the top five barriers to transforming landfills-to-green spaces based on the participant’s professional opinion. The completed tables provided the necessary data to determine the major barriers in converting landfills to green spaces, which was then combined into summary tables. A series of summary tables were completed to determine the major barriers for the following categories: specific professions, all interviewees and case studies (see table 1).

<table>
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<th>Rating /5</th>
<th>Details on Barrier:</th>
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</thead>
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<tr>
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</tr>
</tbody>
</table>

Table 1: Example Barrier Table Matrix
2.3.2 Participant Recruitment

A targeted group of city planners, developers and environmental consultants were the focus for this thesis. As a screening process, participants were asked questions regarding their experience and knowledge in the field of landfill to green space redevelopment projects. Based on their answers, professional background and willingness to participate in the study, an interview was arranged. The interviewees included five environmental consultants from a variety of firms, including Franz Environmental Inc., Golder Associates Ltd., and Biophilia Inc.; city planners from both the City of Calgary and the City of Toronto; a representative from the Ministry of the Environment; environmental specialists; landfill monitoring and technical analysts; and landfill project managers (see appendix I for a detailed list of interviewees). The information generated from the interviews contributed the necessary level of understanding to determine the key barriers, benefits and strategies for converting landfills to green spaces.

The information obtained from these interviews was important to this study for several reasons. Firstly, the professional opinions relating to the barriers and benefits to landfill to green space projects were absent in the literature. Secondly, this information provided this study with concrete data on the specific barriers to each profession, the severity of the barriers, and an overall better understanding of the obstacles involved in converting landfills to green spaces. Lastly, the interviewees provided solutions and strategies for overcoming these barriers in order to improve the efficiency of landfill to green space projects (see table 1).
All interviews were conducted face-to-face at the location convenient to the interviewee. Most in-person interviews were conducted at the interviewee’s place of business, with only one interview being held outside of the office setting, in a nearby coffee shop. The length of the interviews ranged from thirty to sixty minutes, with the average interview lasting forty-five minutes. Some interviews were recorded using a digital recorder, although the majority of interviews involved note taking.

2.3.3 Questions and Data Collection Methods

Each professional was asked an average of ten questions, adapted to their individual professions and experience in landfill related projects. For example, city planners answered questions regarding the planning of landfill to green space projects, while environmental consultants were questioned regarding the technical and environmental issues. Questions were designed to identify:

1) key environmental, social and economic benefits to transforming landfills-to-green spaces;
2) specific barriers relative to each profession;
3) most common barriers to converting landfills into green spaces; and
4) strategies for overcoming these barriers.

Although the prepared questions guided the interview (e.g. see fig. 1 in Appendix), the semi-structured nature of the meetings allowed flexibility for follow-up questions and open discussions. Due to the nature of the semi-structured interviews and the tendency of the participants to discuss alternative topics, this additional information was utilized as background information throughout this thesis. Only the pertinent information deriving from the interview sessions were included in the ‘barrier’ tables.
Based on the questions and discussions, a ‘barrier’ table was completed to develop a clear understanding of the major barriers of landfill to green space projects. These tables constituted the data component of the research.

These questions were formulated in correspondence with the main research objectives listed in Chapter 1. The intention of these questions was to help determine the barriers involved in transforming closed landfills into green spaces and to provide recommendations for alleviating them. Additionally, these questions were specifically designed to identify the barriers facing three particular professions (environmental consultants, city planners and project developers).

2.3.4 Ethics Approval and Confidentiality

The interviews required approval from the Conjoint Faculties Research Ethics Board (CFREB) of the University of Calgary. Questions were submitted on October 21\textsuperscript{st}, 2012 and approved by October 30\textsuperscript{th}, 2012. Interviewees were sent a series of documentation upon agreement to participate, which provided an overview of the project and interview details. This documentation package included a recruitment letter, a consent form and a ‘barriers’ table. Interviewee’s indicated on the forms whether they permitted the recording of the interviews and whether quotes could be attributed to their names. Because some interviewee’s preferred not to be identified in the research, a coding system was used for those individuals. This ensured the confidentiality for those who requested anonymity. For the purpose of anonymity, interview respondents were identified in the research findings according to their affiliation and their involvement in
one or all of the cases. The following codes were used to identify the affiliations of the respondents (see table 2):

i. City of Calgary (CofC)
ii. Biophilia Inc. (Bio)
iii. Franz Environmental Inc. (Franz)
iv. Ministry of the Environment (MOE)
v. Brown & Associates Planning Group (BAPG)
vi. Keele Valley Landfill (KVL)
vii. Britannia Landfill (BL)
viii. Golder Associates (GAL)
ix. Calgary Municipal Land Corporation (CMLC)
x. Toronto Regional Conservation Area (TRCA)
xii. Friends of the Spit (FOTS)

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<thead>
<tr>
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<th>Type of Data</th>
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</tr>
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<td>Notes</td>
<td>September 15, 2013</td>
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</tr>
<tr>
<td>16</td>
<td>Notes</td>
<td>September 23, 2013</td>
<td>TRCA</td>
</tr>
</tbody>
</table>

Table 2: Affiliation Table
2.4 Limitations of Research Methods

Both the case study approach and the semi-structured interviews had their own unique limitations when attempting to discover the best case studies and the ideal participants. An equal distribution of stakeholder representation for each case study was intended but due to some cases having occurred too long ago, interviewing professionals from the environmental consulting side became impractical. This was due in part to the relevant consultants retiring or changing occupations. Consequently, interviews with Landfill Head Monitoring Supervisors, Technical Analysts and Project Managers from the case study sites were completed with secondary sources and grey literature filling in the information gaps.

As previously stated, the case studies were chosen based on certain criteria. Even though all three case studies met these basic criteria, the projects were significantly different in regard to their history and size. Consequently, this approach had limitations through the use of a multiple case design, resulting in more information, but fewer consistencies between cases.

A second limitation to the case study approach was the identification of ‘unsuccessful’ case studies. The original intent was to research both successful and unsuccessful case studies but after multiple discussions with project managers in the GTA, this intent was not longer feasible. Thus, a new case study approach was implemented to incorporate three successful case studies, to obtain additional examples of how the proponents of projects are able to overcome the barriers to redeveloping landfills in the GTA. The
rationale for choosing ‘companion cases’ (Yin, “4th Edition” 62), to both the KVL and the Britannia Landfill was to broaden the information base for this research.

Overall, the limitations to this research project posed challenges, but secondary information (i.e. literature review and grey literature) and the cooperation of key stakeholders allowed the necessary information to be collected and analyzed. The literature review, case study approach and semi-structured interviews provided the foundation for the recommendations in Chapter 7. These three types of research methods will more accurately identify the specific barriers to transforming landfills to green space. Once these obstacles are accurately identified, strategies for overcoming these barriers were provided.
3. Chapter 3: Literature Review on the Risk Management, Barriers and Benefits to Landfill Redevelopment in the Greater Toronto Areas

3.1 Introduction

The literature on brownfield redevelopment in Canada, specifically regarding the redevelopment of landfills, is rather scant. The few studies that do exist have focused primarily on the technical aspects of site remediation or, to a lesser extent on policy (De Sousa, “Brownfield Redevelopment” 6). Although Canadian research on brownfield redevelopment is limited, government agencies such the Canadian Council of Ministers for the Environment (CCME) and the National Round Table on the Environment and the Economy (NRTEE) have been more involved in this field through market research studies, to better understand the current barriers to redeveloping landfills. Specific international research relating to the conversion of landfills to greens spaces was limited or dated. Mackey’s study, ‘Three End-Uses for Closed Landfills and Their Impact on the Geosynthetic Design’ (United States) and Misgav’s report ‘Selecting a Compatible Open Space Use for a Closed Landfill’ (Israel), are two papers relevant to this study (Makey 2; Misgav 1).

3.2 Types of Green Spaces

The word ‘green’ has often appeared in brownfields discourse, but often refers to preserving greenfields in the urban periphery. This includes the creation of parks, public spaces and gardens, outdoor sports facilities, natural habitats, greenways, and children’s playgrounds. De Sousa emphasizes that there is no internationally or even nationally recognized typology of green space, but he does provide his own comprehensive typology of urban open space that contains various types of spaces. De Sousa’s definition
of green space will be the classification used throughout this thesis because of his expertise in this field. These definitions include:

- **Public/City/Central Park**: Publicly developed and managed open space as part of zoned open space system of a city;
- **Downtown Park**: Green parks with grass and trees located in downtown areas;
- **Neighborhood Park**: Open space developed in residential environments;
- **Pocket Park/Parkette**: Small urban parks that offer passive recreation amenities (e.g. sitting areas, walking paths, etc.);
- **Community Garden**: Neighborhood spaces designed, developed, or managed by local residents on vacant land; may include viewing gardens and play areas;
- **Greenways**: Interconnected recreational and natural areas connected by pedestrian and bicycle paths;
- **Urban Wilderness/Natural Areas**: Wild lands that contain historically significant and aesthetically important environmental features that require conservation and protection and;
- **Waterfronts**: Open space along waterways in cities. (De Sousa, “Quest for Sustainability” 156).

Duc Uy illustrates a second definition of a green space by stating “green spaces are outdoor places with significant amounts of vegetation, which exist mainly as semi-natural areas, or are viewed as last remnants of nature in urban areas” (1).

3.3 Definitions Relating to Landfills

Waste disposal facilities in Ontario, including landfill sites and waste transfer stations, can vary in regards to their design and management. Some landfills are designed to naturally degrade materials, while other landfill sites are engineered to contain harmful contaminants from impacting surrounding environments. The first important concept to identify is landfilling. In Ontario, Landfilling is defined as the disposal of waste by
dumping and covering in designated pits (“Watershed Based Source” 48). Two types of landfills are common in Ontario, Natural Attenuation Landfill (NAL) sites and new, expanding landfills with engineered liners and collection systems (Ontario, “Watershed Based Source” 48). These are two common examples of operating landfills, but closed and structurally engineered landfills will be the primary focus to this study.

Landfills are differentiated as operating (active) and non-operating (closed). Once a landfill reaches its ‘capacity’, which is the predicted lifespan of a given facility, it no longer accepts additional waste and is officially labeled as a ‘non-operating’ or ‘closed’ landfill site. The definition of a non-operating landfill means “a landfill that has completed final closure and has placed the final cover system including the soil and other materials that are used on the surface of the landfill” (Calgary, “City-Wide” 15). The definition of an operating landfill means “a landfill that has received or is receiving waste and has not completed the final cover system including the soil and other materials that are used on the surface of the landfill” (Calgary, “City-Wide” 15). It is important to distinguish between closed and non-operating landfills because in order for a site to be redeveloped, it must first be closed and properly capped in order to allow risk management and redevelopment strategies to begin. This is an essential step to limit the exposure of contaminants to the surrounding communities and to avoid additional complications and costs.

3.3.1 Types of Landfills in Ontario
NAL’s are a landfill process by “which a compound (i.e., leachate) is reduced in concentration over time through absorption, degradation, dilution and/or transformation”
(Ontario, “Specific Terms” 1). This natural attenuation process may play a valuable role in managing certain types of landfills with varying materials and conditions, but decisions must be made on a site-by-site basis. These decisions are made by the MOE and are assessed based on the landfill’s history and its on-site materials. According to Bishop, the natural attenuation process is described as a “complex mixture (1) of organic and inorganic nonhazardous and hazardous materials in landfills, which are slowly being degraded or transformed through natural attenuation (natural abiotic and micro-biotic processes (Bishop 1).

The second type of landfill in Ontario is a more sophisticated landfill, equipped with engineered liners and collection systems to contain landfill contaminants, which are called ‘leachate collection systems’. These modern landfills are constructed with new technologies in order to meet the new landfill standards issued by the MOE on August 1st, 1998. Contained in Regulations 232/98 under Part V of the Environmental Protection Act, new landfills in Ontario must meet the requirements for design, operation, closure, post-closure care and financial assurance (Ontario, “Landfill Standards” 8). These new landfill standards cover the following:

- Design specifications for groundwater protection including a site specific design option and two generic design options,
- Mandatory air emissions control for sites larger than 3 million cubic metres in size,
- The assessment of groundwater and surface water conditions;
- Design requirements for buffer areas, final cover design, surface water and landfill gas control, and the preparation of a site design report,
• Operation and monitoring requirements for site preparation, groundwater and surface water monitoring, daily cover, record keeping and reporting,
• Requirements for a leachate contingency plan,
• Site closure and post-closure care provisions, and
• Financial assurance requirements for private sector landfills (Ontario, “Landfill Standards” 10).

3.3.2 Management of Landfills

Several options exist for the treatment, management and redevelopment of landfill sites in Ontario. While a number of options are available, the preferred waste management option is incineration or landfill capping (MOE, “Environmental Risk” 1). Incinerators are used to burn hazardous waste primarily for waste destruction/treatment purposes. When performed properly, incineration destroys the toxic constituents in hazardous waste and reduces the volume of the waste (EPA, “Combustion” 1). Landfill capping involves placing a cover over the contaminated material. Such cover does not clean up the contaminated material but contains it, while minimizing the exposure to park users and reducing the impact on surrounding environments (EPA, “Combustion” 1). The reason these two options are at the top of the hierarchy of preferred waste management options is because of lower remediation and operational costs, compared to alternative options.

Both excavation and soil separation are two additional remediation strategies for landfills but are expensive methodologies in comparison and therefore less desirable. Lastly, the ongoing monitoring of leachate, groundwater and surface water is an integral component to ensuring the protection and containment of potential contaminants are met. To obtain approval for a landfill site, a detailed assessment of the site must be carried out to identify
any potential effects on the environment and to show how these potential effects can be satisfactorily addressed (Ontario, “Landfill Standards” 48). In addition to a Certificate of Approval (C of A), a contingency plan is required for the implementation of additional groundwater protection measures, and defines the landfill standards to reflect the particular setting and condition of each landfill (Ontario, “Landfill Standards” 49). The final C of A will define the design of the site, the types of waste to be accepted, and the requirements for site operation, monitoring, closure and post-closure care (Ontario, “Landfill Standards” 49).

Even though significant efforts are made to reduce, reuse and recycle waste, communities will continue to need landfills for the materials they cannot reuse. Since every landfill has its’ limited capacity, it is inevitable that sites will close and the pressures for redevelopment will present themselves.

3.4 The Need for New Green Space Development in the City of Toronto

The City of Toronto’s vision according to its Parks, Forestry and Recreation website is that Toronto will be known by the world as the ‘City within a Park’ - a rich fabric of parks, open spaces, rivers and streams that will connect our neighborhoods and join us with our clean, vibrant lakefront (Toronto 1). Currently, the City of Toronto has among the lowest hectares per 1000 people, compared to other major Canadian cities (see fig. 1). Data on Canada’s green space position has been compiled by Evergreen, a national nonprofit organization that promotes the greening of Canadian cities. This organization found it difficult to collect accurate and comparable data on urban green space due to the
variation in green space definitions from one municipality to another. Despite this, a figure was created using information compiled in 2002 showing mid-sized cities (e.g. Edmonton, Ottawa, and Winnipeg) having the highest green space to population ratios, while the populous urban areas of Toronto, Montreal and Vancouver were among those with the lowest ratios.

![Green Space in Canadian Cities](image)

**Fig. 1: Green Space in Canadian Cities, Source: (Evergreen 8)**

This figure illustrates that intensification pressures challenge large urban centers attempting to create new green spaces for their growing populations. These pressures include high land values, relatively low green space provision ratios for their current populations (five percent) and high urban migration rates. Canada’s largest cities face limited access to additional parkland, due to high land values and built-up surrounding areas, or due to geographical limits to the city’s growth (Evergreen 13). Larger urban centres have higher land values compared to rural locations due to its accessibility to a
variety of public needs and amenities such as public transportation, employment opportunities, cultural and entertainment districts, and international events.

The statistical evidence illustrating the shortage of green space in Toronto on a per capita basis emphasizes the importance of developing new parks and recreational areas for a growing population. The transformation of landfill to green spaces allows realistic opportunities for large Canadian urban centers to increase their recreational amenities and for the City of Toronto to meet its ‘City within a Park’ vision.

3.5 Current Brownfield Redevelopment Strategies in Toronto

Brownfield sites are often located in already built-up areas which can take advantage of existing infrastructure including schools, community facilities, and public transit. In many cases, closed landfills are located on the outskirts of towns, cities or counties. However, according to Mackey, as small towns or cities continue to grow, many of these landfill properties were enveloped by the expanding population of a given area (Mackey 410). These landfill areas represent undeveloped property in growing communities that are seeking additional parks and other recreational facilities.

Additionally, redeveloping brownfields also alleviates development pressure on surrounding green fields (Ontario, “A Practical Guide” 5). The desire for more open space within a community can be addressed by turning existing underutilized municipal land or abandoned contaminated sites into open spaces. Areas such as parks, boardwalks, or trails can strengthen the neighborhood, increase the value of adjacent properties and
make it a more attractive place to live, work and play (Ontario, “A Practical Guide” 8). Additionally, the redevelopment of landfills can lead to further neighborhood regeneration. As contaminated sites become redeveloped, adjacent properties become more attractive to public and private investors, while retaining current amenities.

The *Practical Guide to Brownfield Redevelopment in Ontario* (Ontario, “A Practical Guide” 1) touches on a number of key initiatives for the encouragement and success of redevelopment projects in Ontario. This report focuses on providing a basic understanding of key concepts, the importance and role of municipalities, incentives for redevelopment, environmental investigation and remediation and the benefits.

Municipalities play a key role in the success of any brownfield redevelopment project when they have political and staff support. Municipalities have the potential to remove some of the barriers to redevelopment and create a brownfield vision for the community. This report outlines the importance of an ‘internal team’ to help reduce time delays by preventing the ‘cubicle shuffle’ where proposed projects are left in limbo while acquiring multiple municipal approvals (Ontario, “A Practical Guide” 7). These internal groups consist of the internal working group, the project lead and the political champion. Each of these will are defined as follows:

*Internal Working Group:* “Made up of representatives from various departments, which have a stake in the redevelopment of brownfields, this group receives every brownfield proposal and addresses the various strengths and weaknesses of a proposal. A group like
this eliminates delays by having all internal players come together early on and helps streamline the approval process” (Ontario, “A Practical Guide” 7).

Project Lead: “A brownfield coordinator or knowledgeable staff can be a valuable tool in helping developers and property owners through the redevelopment process. They can provide useful tips and act as a constant point of contact in case any questions or concerns are raised regarding the approval process or municipal incentives” (Ontario, “A Practical Guide” 7).

Political Champion: “A political representative can play a major role in promoting brownfield redevelopment within a community. They can start the dialogue about brownfields redevelopment within a community, help create public support for a brownfield vision, and create community excitement for potential redevelopment projects” (Ontario, “A Practical Guide” 7).

Municipal governments, internal working groups, brownfield coordinators, project leads and political champions all play an integral part in the promotion and development of strategies for redeveloping brownfields. Due to the re-occurring complexities of brownfield redevelopment projects, each working group plays an important role in the success of a given project. The stakeholders mentioned in this report by the government of Ontario, strongly correlate with the necessary type of professionals needed to transform landfills into green spaces. Without a strong support system, redevelopment projects simply couldn’t occur.
The land-use planning system in Ontario provides municipalities with a number of tools that allow them to take proactive approaches to promoting the revitalization of underutilized areas of a particular area. These tools include the development permit system, which provides flexibility in redeveloping situations by enabling municipalities to specify minimum and maximum development standards (Ontario, “A Practical Guide” 8). The collaboration of owners, developers and the public early in the remediation process, allows better communication between stakeholders and ensures an easier transition from a contaminated site to a productive one. Early communication can help save property owners’ time and money by providing greater certainty in the planning process and reducing the risk of future liabilities and appeals (Ontario, “A Practical Guide” 8).

In Ontario, many municipalities provide financial assistance to the private sector through a Community Improvement Plan (CIP). A CIP is an expression of a community’s intention to facilitate revitalization, and may include financial incentives to help stimulate investment and offset expensive redevelopment costs (Ontario, “A Practical Guide” 10). Additional opportunities are property tax assistance that may partially offset the remediation costs undertaken on an eligible brownfield property. The municipal portion of property taxes may be matched, if the Minister of Finance approves, on a proportional basis with a portion under the provincial Brownfields Financial Tax Incentive Program (BFTIP). For properties designated under the *Ontario Heritage Act*, municipalities may
also provide a 10% to 40% reduction in property taxes under the Heritage Property Tax Relief Measure (Ontario, “A Practical Guide” 10).

Ultimately, any contaminated property carries some degree of financial uncertainty and environmental liability. With good communication between stakeholders and the right information, those risks can often be avoided and the practice of redeveloping brownfields will continue to gain momentum in Ontario.

3.6 Benefits of Landfill to Green Space Conversions

The case for redeveloping landfills is strong but also complex. This complexity is due to a variety of obstacles and challenges (e.g. costs, liability, regulations, etc.) that arise when attempting to convert a landfill project into a green space or recreational amenity. However, the cleanup and remediation of a landfill site can generate a wide range of economic, environmental and social benefits (environmental, economic, and social), while transforming and improving the overall quality of life in older neighborhoods and communities.

3.6.1 Benefits to Redeveloping Landfill Sites

Old landfills are often situated in strategic core areas, near water or other transportation networks. Whether these properties stored waste or hazardous materials, they now represent missed opportunities for additional tax revenue and jobs. Utilizing pre-existing infrastructure and services ensures more urban density while creating accessible routes for green space users. Necessary upgrades tend to cost less than installing completely new infrastructure, which helps encourage and maximize the use of existing city and
The redevelopment of a landfill site within a municipality can potentially create economic benefits for local inhabitants, neighboring properties to the landfill site, and the municipality as a whole. The potential economic benefits of landfill redevelopment include the generation of revenues from the sale of recyclables. Recovered materials, such as metals, aluminum, plastic, and glass, can be sold in specific markets. An example is the District Municipality of Muskoka, Ontario, where collecting and selling recyclables found in the garbage is being converted into profit. “The district saw about $500,000 in revenue last year from the program, and in the process diverted a lot of recyclable goods back to the manufacturing of new products. Once it’s been processed, the goods can be turned into anything from water bottles to boxboard to roofing shingles” (CBC News 1). Additional revenues could come from the reuse of reclaimed soil, which can be used on site as daily cover material on other landfill cells, thus avoiding the cost of importing cover soil (EPA, “Landfill Reclamation” 2).
Depending on the volume of material on site, energy production is available through municipal waste combustors (MWC). Combustion is used for both energy production and to reduce waste volume. Local governments or private operators can implement a controlled burning process called combustion or incineration. In addition to reducing volume, combustors, when properly equipped, can convert water into steam to fuel heating systems or generate electricity (EPA, “Combustion” 1).

Electricity can also be generated from methane gas, which is a consistent source on landfill sites. An example of a ‘gas to energy’ project, situated in Mississauga, Ontario, outlines the profitability of these types of systems, which will be discussed in greater detail in chapter 4.

Both incineration and the collection of methane can be sold, creating additional revenue while the incineration of waste prolongs the capacity and lifespan of the landfill. These revenue driven strategies provide examples of the financial opportunities and benefits to redeveloping a closed landfill.

These strategies can provide significant sources of income to help combat the often difficult financial challenges needed to redevelop a landfill site. Aside from municipal and provincial funding, these secondary sources of income can alleviate remediation and redevelopment costs, if planning initiatives are organized. Knowing in advance the costs and potential lack of funding certain projects face, will allow professionals and stakeholders to adjust accordingly and implement a collection fund.
The Creation and Retention of Employment Opportunities

According to a study by the NRTEE in 2003, “several thousand contaminated sites have been cleaned up in Canada, creating tens of thousands of jobs” (“Cleaning up the Past” 10). Landfill redevelopment creates employment opportunities in the specialized areas of cleanup technology and development, in green space maintenance and in new businesses/services that have settled on recently remediated sites. Other examples of job opportunities include park construction, landscape architecture and design, recreational employment (e.g. golf course staff and sports referee’s, information centre’s, etc.), and ongoing landscape maintenance.

An example provided by the NRTEE, emphasizes the creation of job opportunities in Quebec City. An agenda called the Quebec’s Revi-Sols program has created an estimated “1,075 person-years of employment over the last five years in the areas of assessment and cleanup” (“Cleaning up the Past” 17). A second example of a small brownfield property in the West Harbourfront area of Hamilton, Ontario, involving the construction of 27 new housing units on land formerly used for rail yards and a gas station, “generated personal income of $720,000 from on-site remediation and construction jobs, and created 10 permanent jobs” (NRTEE, “Cleaning up the Past” 17). These two Canadian examples illustrate that short and long-term job opportunities arise due to brownfield redevelopment projects, and that this industry can be a reliable source of employment for Canadians.
Increased Tax Revenues

Landfill redevelopment increases the tax revenues at all levels of government through the creation of new economic bases to sustain property, income and capital taxes. At the municipal level, the NRTEE states that a remediated landfill site will bring increases in property tax revenues (“Cleaning up the Past” 18). Tax revenues could increase directly from the redevelopment project or indirectly through increases in property values of adjacent properties.

The NRTEE provides an example of a project in Dundas, Ontario called the Spencer Creek Village project. This redevelopment project involved the production of nearly 500 new housing units and 40,000 square feet of commercial space on a former steel site. It was estimated that “this project will generate $1.76 million a year in new property tax revenue for the municipality, $7.55 million in additional provincial sales tax, and $6.6 million in additional GST revenues” (NRTEE, “Cleaning up the Past” 18). Wernstedt supports green space development by stating “the benefits of green space, in contrast, frequently appear more invisible, qualitative and longer term” (“Turning Brownfields” 2).

The International Economic Development Council’s examination of the off-site impacts of a half-dozen brownfield to green space projects, estimates that property values in neighborhoods surrounding these projects have increased more than two times (Wernstedt, “Turning Brownfields” 3). Idle landfill properties can potentially cause a downward spiral of surrounding neighborhoods in which they are situated, due to unappealing and unsafe conditions. Studies show that residents and businesses tend to
move to other neighborhoods that are considered safer, cleaner, and more economically stable (Ontario, “Brownfields Showcase II” 2).

**Reduced Urban Sprawl**

The City of Calgary is one Canadian example where urban sprawl has become an issue of concern. Its industrial past has left an impact on the urban landscape in the form of countless underused or abandoned industrial and commercial properties (De Sousa, “Brownfield Redevelopment” 2). Understandably, developers and policy makers at all governmental levels in Canada, are interested in transforming brownfields sites into more productive uses. Urban sprawl primarily occurs because the cost of greenfield development is much cheaper compared to brownfield remediation and development. The costs of hiring environmental consultants, requesting environmental assessments and the eventual costs of remediation, make greenfield development more attractive for developers (Brown & Associates).

Landfill redevelopment can potentially reduce development pressures on greenfields in the City’s outlying areas, resulting in a decrease in both infrastructure and transportation costs (NRTEE, “Cleaning up the Past” 3). A statistical example provided by the NRTEE states that “every hectare of a brownfield redeveloped for residential purposes can save as much as $66,000 a year in transportation costs (relative to equivalent greenfield redevelopment” in Canada (“Cleaning up the Past” 18). Not only will cities see significant savings on both transportation and infrastructure expansion, but brownfields are often situated in central locations in well established areas, with existing infrastructure and transit access already in place. This issue continues to be a challenging
issue among many North American cities, but the benefits of urban renewal can outweigh those of greenfield development. It is essential for city planners and developers to continue tackling the cumbersome barriers to brownfield redevelopment, as it plays a key role in renewing and revitalizing the GTA.

3.6.3 Environmental Benefits

Depending on the history and method of operation, landfills can present a variety of health and safety concerns. Landfills can threaten water, air and land through releases of untreated hazardous materials (Ontario, “Watershed Based Source” 4). Redevelopment efforts include clean up and risk management strategies of landfill sites which helps protect people and the surrounding environment (Calgary, “Brownfield Strategy” 1).

Improved Air Quality

Increasing rates of air pollution are a significant concern for cities in Canada. One effective way of countering the increasing rates of carbon dioxide is the development of urban green spaces. Adams states that green spaces and natural amenities make an important contribution to removing particulates and cleansing the urban environment of carbon dioxide (Adams, “Greenfields” 70). As cities continue to expand and development is diverted to the urban periphery, commuters are forced to travel further distances to get to work, increasing levels of pollution. The outskirts of cities often lack sufficient public transportation, forcing commuters to take private transit. This causes significant increases in traffic, resulting in cars running longer and a rise in air pollution. Additional greenery will help create carbon sinks for absorbing carbon dioxide, while the conversion of ‘gas to energy’ will help combat high methane levels (Duc Uy et al. 8).
Methane collection systems are essential in reducing the impacts on surrounding neighborhoods and local environmental. The implementation of these systems is particularly important because of the long duration of methane production on landfill sites. Even when a landfill has been closed, emissions of landfill gas can last for decades, until all nutrients are depleted and both aerobic and anaerobic bacterial activities are negligible (Ofungwu 1). Additionally, Boltze and De Freitas illustrate the potential dangers of migrating gas by stating “methane gases can migrate into basements and similar enclosed spaces where they can present a latent hazard (476). This can potentially pose health risks to surrounding landfill homes, including the inhalation of carbon dioxide, methane, and ‘explosions under appropriate conditions’ (Boltze 476).

Restoration of Soil and Groundwater

A Canadian example, completed in Calgary, Alberta, called the ‘City Wide Variance Policy’ states “both operating and non-operating landfills have the potential to impact groundwater, surface water, air and soils through the decomposition of waste materials, including landfill gas and leachate” (Calgary, “City-Wide” 4). The protection of groundwater and soil resources is another important benefit to redeveloping contaminated sites. Migrating subsurface contamination often goes un-noticed for long periods of time unless a thorough testing program has been done.

Foo emphasizes the impacts of leachate by stating, “to date, the percolation of landfill leachate into the groundwater tables and aquifer systems pose a potential risk and potential hazards towards the public health and ecosystems” (54). The proper treatment
of landfill leachate can significantly reduce the impacts on the local environment and the surrounding neighborhoods. Foo emphasizes the impacts on the surrounding environment by stating “a couple 100 hazardous compounds have been identified in the heterogeneous landfill leachate, which present an accumulative, threatening and detrimental effect to the survival of aquatic life form, ecology and food chains” (65). Foo also outlined the potential impacts of leachate on humans by presenting a toxicity study that was conducted in 56 conventional municipal waste landfills. The results found that the different toxic chemicals found in leachate can cause cancer, birth defects and genetic damages (65).

Leachate refers to a “liquid that has been in contact with waste in the landfill cell and has undergone chemical or physical changes” (Alberta 9). Foo states that landfill leachate “is defined as any contaminated liquid effluent percolating through deposited waste and emitted within a landfill or dump site through external sources” (55). In Ontario, leachate treatment and disposal involves the discharge of leachate into a sewer or by hauling it to a sewage treatment plant (Ontario, “New Landfill Standards” 1). The management of landfill leachate has become one of the main focuses in remediating landfills and preventing harmful contaminants from migrating. A testing program may be carried out using a combination of observation and intrusive techniques. Observation techniques are used to quickly identify subsurface contamination that may be in solid, liquid or gas form, while intrusive techniques include a combination of test pitting and drilling procedures (Canada, “A Federal Approach” 12). Both the management of gas and
leachate are an integral task in the redevelopment of landfills, in order to protect the surrounding environment and the safety of adjacent communities.

3.6.4 Social Benefits

Neighboring landfill communities can potentially be tainted due to a variety of environmental and social stigmas. According to a government of Ontario document on brownfields, contaminated sites often “function without a sense of identity or social cohesion” (Ontario, “Brownfields Showcase II” 3). As residents and businesses begin to migrate away, remaining lands and buildings can potentially deteriorate over time. Victims of these trends are often the people who have the greatest need for social and health programs, community services, and housing. These victims are particularly vulnerable to deteriorating urban cores because of their lower incomes and lack of private transit. This causes a drain on municipal resources because the relatively high demand for programs and services, coupled with low property tax revenues, create program and budgetary pressures (Ontario, “Brownfields Showcase II” 3).

Revitalized Communities and Neighborhoods

The transformation of landfills to green spaces can be a very effective way of revitalizing communities, particularly ones with a deficiency in parks and green spaces. This type of redevelopment can mean an improved quality of life, by enabling residents to live closer to recreational facilities (NRTEE, “Cleaning up the Past” 1). In a study by Wernstedt he states “a majority of respondents viewed the green space as having a positive impact on their quality of life, through the provision of trails, access to recreational areas, and improvement in their personal health (“Turning Brownfields” 6). Additional benefits to
redeveloping landfills and neighborhood renewal are that they begin to attract new businesses. Businesses are attracted to newly developed sites, particularly green spaces, because people are naturally attracted to open and recreational spaces. This influx of people to urban green spaces can potentially increase sales for surrounding businesses. This domino effect stresses the importance of initial investments through all levels of government, private and public investors.

De Sousa is a major contributor to the theoretical side of ‘greening brownfields’. He expresses, that it is unfortunate that “greenspace is often perceived as an amenity for other forms of redevelopment, a nice side-dish, as opposed to a benefit in and of itself” (“Greening of Brownfields” 11). Many argue that the livability and sustainability of our urban centers is heavily dependent on the balance between urban form and natural amenities. Greening cities, particularly urban areas with greenery, is widely advocated as a key feature for the health and well being of our future cities (Jim 7). De Ridder supports Jim by reinforcing the importance of environmental quality in Canadian cities by stating “the quality of the urban environment is increasingly recognized to be a key ingredient of the economic regeneration of cities. High environmental quality has been a factor in attracting investment and building competitive advantage” (De Ridder 46). Green space development plays an important role for all three requirements for a healthy city. Environmentally it provides leisure and recreational opportunities, socially, people are safer and healthier, and economically, private and public investments are created.
Over the last decade, all levels of governments have developed policies or programs to encourage and support brownfield redevelopment projects. They recognize the economic, environmental and social benefits of transforming these no-longer operational sites into prosperous and more prolific uses (Calgary, “Brownfield Strategy” 1). Brownfields of all types offer opportunities for urban revitalization that can achieve important social and environmental goals, at the same time as producing potentially significant returns on private investments. ‘The stakes are high—in the long run, brownfield redevelopment can help create environmentally, socially and economically sustainable communities and urban areas for current and future generations” (McCarthy 1). Fig. 2, provides a summary of the economic, environmental and social benefits to converting landfills into green spaces.

![Fig. 2: A Summary of the Benefits to Converting Landfills into Green Spaces](image)

3.7 Barriers to Landfill to Green Space Conversions

The literature discussing the major barriers faced in redeveloping landfills is consistent in mentioning the variability of environmental conditions, the liability concerns, the financial burdens, and public perceptions of landfill redevelopment, as the key challenges that affect project viability. Landfill to green space projects offer a variety of
environmental, economic and social benefits, yet most landfill sites in Ontario take several years to be redeveloped. This is due to a number of impeding barriers that restrict and delay the redevelopment stages to begin. Although every landfill to green space project is different, the literature presents a strong correlation regarding the common barriers to landfill to green space projects.

3.7.1 Barriers to Landfill Redevelopment
The potential challenges professionals face when attempting to redevelop landfills, begin with the management and control of hazardous waste. When the remediation stages commence, site assessments are completed to determine the severity of the contamination. Based on a non-intrusive background review, a consultant can determine the type of landfill, how long it’s been in operation and potentially where the areas of concern are.

Older landfill projects tend to be more complicated due to more lenient environmental regulations in the past. As a result, landfills were established without the appropriate liner systems modern landfills require, allowing contaminants to seep into the surrounding soil and water systems. The containment of hazardous waste and the preservation of the surrounding environment is one of the many challenges faced in landfill reclamation.

Management of Contaminants
The management of hazardous materials, leachate and methane gas are three technically difficult challenges to combat when attempting to transform a landfill into safe and prosperous site. Both operating and non-operating landfills have the potential to impact
groundwater, surface water, air and soils. Through the decomposition of waste materials, methane gas and leachate may be produced, which may pose a concern for human health and safety (Calgary, “City-Wide” 4). Under certain circumstances landfill gas and leachate can migrate off-site via groundwater and soil gas movement. The accumulation of landfill gas containing methane in enclosed areas, can pose severe concerns for the adjacent properties due to the possibility of a fire or explosion (EPA, “Landfill Reclamation” 2).

Additionally, older landfills often lack records specifying where waste was deposited and what type of waste was accepted. The approving authorities of Canadian cities must ensure that land is suitable for its intended use in order to avoid post development liabilities.

**Potential Liabilities**

Liability is a reoccurring barrier to any type of brownfield redevelopment project. The difficulty often lies in determining the original ‘polluter’. The term ‘polluter’ refers to the original party responsible for the pollution. In some cases, the responsible person is clearly determined. In others, the person or party at fault may be difficult to identify or to locate (CCME 2). Additional complications arise when the responsible person is unable to pay. This occurs when an individual or company goes bankrupt and is unable to pay the remediation costs.

The major concern regarding liability for contaminated sites is unpredictability. “Unpredictability may lead to inaction or to inappropriate action on the part of the
commercial and industrial sectors. Future responsibilities are unclear and consequently future care of the environment is not assured” (CCME 2). Many developers avoid redeveloping contaminated sites for fear of future liability and because immediate cleanup costs may prove too high for the development project to be economically viable (Alberini 3). The challenge in redeveloping brownfields rests with local and provincial governments who are responsible for implementing environmental policies that deal with the liabilities relating to contaminated lands.

Although there are a number of barriers inhibiting or delaying the remediation of contaminated sites, many professionals support the notion that liability is the primary barrier to overcome. Burnham-Howard states that the ‘primary among the barriers to brownfields redevelopment is the legal liability associated with hazardous waste contaminated sites’ (2). McCarthy supports Burnham-Howard by emphasizing the “concerns about legal liability for contamination is considered perhaps the greatest impediment to brownfield reuse (3).

Each landfill redevelopment project in Ontario has its own unique set of major and minor barriers. After an in-depth review of the available literature, ‘liability’ is consistently agreed upon as a major barrier to brownfield redevelopment.

**Financial Barriers/Costs**

High remediation costs for contaminated sites is one of the primary barriers inhibiting future redevelopment projects in every Canadian city. The costs associated with
environmental site assessment and clean up significantly increases the overall price of remediation. Redeveloping a contaminated site almost always costs more than developing a similar greenfield site due to remediation or risk management measures; special design or construction features and other mitigative measures; dealing with longer and more complex regulatory processes; and managing potential liability that could lead to future unquantified expenditures (Calgary, “Brownfield Strategy” 17). Site remediation and related preparation costs make many sites economically uncompetitive, thus developers are more comfortable with developing greenfields, causing trends of urban sprawl to continue in Canadian cities. Developers often have trouble putting together a complete financing package for brownfields, specifically in acquiring the capital to pay for the three activities unique to brownfield redevelopment: the site assessment, the site remediation plan, and the clean-up costs (Bartch 1). To emphasize the potential high costs of developing contaminated sites versus greenfield sites, McQueen provides a table illustrating a scenario for purchasing a contaminated site for $1 (McQueen 12).

<table>
<thead>
<tr>
<th>Item</th>
<th>Brownfield</th>
<th>Greenfield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Purchase</td>
<td>$1</td>
<td>$160,000</td>
</tr>
<tr>
<td>Building Construction</td>
<td>$1,800,000</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>Building Permit Fee</td>
<td>$23,600</td>
<td>$23,600</td>
</tr>
<tr>
<td>Site Plan Control Application</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>Parkland Dedication</td>
<td>$0</td>
<td>$3,200</td>
</tr>
<tr>
<td>Clean up of Property</td>
<td>$450,000</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$2,274,601</td>
<td>$1,987,800</td>
</tr>
<tr>
<td>Increase in Development Costs of BF over GF</td>
<td>$286,801</td>
<td>14.4%</td>
</tr>
</tbody>
</table>

Table 3: Brownfield versus Greenfield, (McQueen 9)

Table 3 demonstrates that a contaminated site, which was purchased for $1, can still be more expensive to develop due to the additional costs of clean up. Difrancesco’s table is based on four distinct assumptions, which include (1) a moderate level of contamination -
$450,000 in clean-up costs, (2) a property already serviced/zoned for industrial use, (3) no industrial development charges, and (4) no parkland dedication for brownfield site (Difrancesco 12). This generic scenario of an industrial manufacturing facility in Hamilton, Ontario, illustrates that the costs of a greenfield development project can be more than 14% lower than the brownfield option.

High remediation costs, liability concerns for developers, slow regulatory review processes, stringent remediation requirements and the public’s negative perceptions are significant challenges for any project. De Sousa provides a thorough analysis of the general barriers to brownfield projects shown in Table 4 De Sousa asked 18 interviewees to examine a list of obstacles to remediation and rank them according to a suggested scale. “As a non-obstacle (1 point), a moderate obstacle (3 points), or a severe obstacle (5 points) – with respect to how they were perceived to affect their own project costs and risks (“Brownfield Redevelopment” 11). It is also noted that the interviewees were asked to discuss the obstacles to remediation and redevelopment on the basis of their own experiences, rather than on the basis of a hypothetical redevelopment scenario. The opinions of the interviewees were compiled and given an average rating. Liability concerns, high remediation costs, and slow regulatory review processes were rated as the greatest obstacles to overcome, while a lack of information on the history of sites or a lack of remediation of disposal options were rated as ‘low’ obstacles.
<table>
<thead>
<tr>
<th>Category</th>
<th>Potential Obstacle</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate-Severe Obstacles</td>
<td>Liability Concerns</td>
<td>4.3</td>
</tr>
<tr>
<td>(Rounded to 4)</td>
<td>High Remediation Costs</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Slow Regulatory Review Process</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Complex Municipal Land-use Policies</td>
<td>3.6</td>
</tr>
<tr>
<td>Moderate Obstacles</td>
<td>Stringent Remediation Requirements</td>
<td>3.4</td>
</tr>
<tr>
<td>(Rounded to 3)</td>
<td>Uncertainty Related to the Site-specific Risk Assessment</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Lack of Government Incentives</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Obtaining Financing</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Lack of Knowledge/ Negative Attitude on the Part of the Public</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>Lack of Knowledge/ Negative Attitude on the Part of the Stakeholders</td>
<td>3.0</td>
</tr>
<tr>
<td>Low-Moderate Obstacles</td>
<td>More Contamination than Expected</td>
<td>2.4</td>
</tr>
<tr>
<td>(Rounded to 2)</td>
<td>Potential Impacts to Adjacent Properties</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>High Costs of Insurance</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>Lack of Information on the History of Sites</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>Lack of Remediation of Disposal Options</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Table 4: Barriers to Brownfield Projects in the GTA, (De Sousa, “Brownfield Redevelopment” 11)

Converting contaminated properties into green spaces offers a potential solution to both the remediation of hazardous sites and meeting neighborhood deficiencies through the development of new public amenities. This type of transformation would help improve the natural environment by addressing contamination, as well as helping revitalize distressed neighborhoods into healthier human environments that provide more venues for walking, recreation, and other physical activities (Wernstedt, “Turning Brownfields” 2). In order for potential brownfield to green space projects to gain momentum, the financial, regulatory and liability barriers, among others, must be overcome. Most revitalization projects are typically powered by the promise of housing opportunities or the economic gains – jobs, increased incomes, heightened tax revenues, for example – associated with commercial or industrial use (Wernstedt, “Turning Brownfields” 2), while the benefits of green space development often go unnoticed.
In summary, there is consensus throughout the literature on the major barriers to remediating brownfield sites. High remediation costs, liability concerns and uncertain regulatory requirements have all been mentioned as the top barriers to remediation. A variety of secondary and tertiary barriers are also present in the literature, but a high majority of professionals and academics have determined that costs, liability and regulatory concerns are the top barriers to remediating brownfields.

3.7.2 Barriers to Green Space Development

Accompanying the many barriers to brownfield remediation, are a variety of obstacles associated with green space development. According to the research on transforming brownfields to green spaces, the single most challenging barrier is a lack of financial resources. These resources are needed for planning, coordinating, and undertaking remediation and redevelopment for green space (De Sousa, “Quest for Sustainability” 186). The financial problem begins with the hiring of consultants, expensive environmental assessments, and the eventual remediation processes depending on the severity of the contamination. Additional costs relate to the design and development of the green space, which is accompanied by long-term maintenance costs. Thus, it is unlikely that cities have the budget to purchase privately owned land in order to develop new green spaces. In order for cities to transform contaminated lands into parks and open spaces, these lands must be publicly owned, in order to avoid the high costs of purchasing private lands.
Another economic obstacle working against the transformation of brownfields to green spaces is the lack of financial return. For privately owned lands, investors are looking for economic return on redevelopment projects. Residential, commercial or industrial development has a greater potential for economic return compared to green space development.

Landfills within city limits are primarily city owned properties, allowing greater flexibility regarding end land use options for these sites. This allows realistic recreational and open space opportunities to derive from landfill to green space projects. Furthermore, it is important for city planners to treat a city as one large entity. When planning for new parks and green spaces, it is essential to have a thorough understanding of what communities lack and have in abundance. City planners are not likely to transform a landfill site into a green space, if that landfill is situated in a community with an abundance of natural amenities. Thus, the location of a given landfill site can be a significant barrier to transforming a landfill into a park or green space. Wernstedt supports this notion by stating, “at any given site, other forces that may depress interest in a green space conversion may include the projects location and its surrounding land uses. Even if none of these constraints applies, demand for conversions also may be low if ample greenspace already exists” (“Turning Brownfields” 7). Wernstedt adds, “location of conversion projects appears to be a key factor for building local support. Projects that are part of larger area wide redevelopment – particularly ones that combine private and public funding – make it possible to access higher levels of financial commitments from
outside the greenspace arena and to generate revenue streams that can be capitalized to support greenspace investments (“Turning Brownfields” 14).

De Sousa outlined other factors impeding the conversion of brownfields to green spaces, in his study on ‘Brownfield Redevelopment and the Quest for Sustainability’ (“Quest for Sustainability” 1). He interviewed a number of professionals that were involved in greening projects to determine their views on the major barriers to brownfield-to-green space conversions. De Sousa’s approach to interviewing professionals with relevant experience in green space development projects is a sound approach to determining the key barriers and was the chosen approach for the recruiting interviewees for this thesis.

The barriers mentioned by the interviewees in the De Sousa study consisted of: concerns about the impacts of soil contamination on human health and the environment and of the appropriate scientific methods for dealing with such contamination; a lack of government leadership and poor coordination among governmental agencies; a lack of staff expertise with respect to green space planning; a lack of trust within governments and between them and other stakeholders to work together; alternative redevelopment priorities; limited examples of similar projects to provide guidance; and the long-term maintenance of the green space once it is developed (De Sousa “Quest for Sustainability” 186).

Very few studies have been completed on the specific barriers to ‘brownfield to green space’ projects, and even fewer relating to ‘landfill to green space’ projects. Limited studies have completed on these types of projects, but certain academics including De
Sousa and Wernstedt provide a strong foundation to understanding this topic. Additional data and research is needed on this topic in order to emphasize the potential of these types of projects. De Sousa mentions that “in many ways, people are still learning from these early ‘success’ projects, and about the benefits greening can bring about and how they can be carried out (De Sousa, “Quest for Sustainability” 187).

This section regarding the barriers to both brownfield reclamation and green space development provides a general but clear understanding of why many contaminated sites remain idle and undeveloped. In order for brownfield to green space conversions to gain momentum, these barriers must be overcome in order for a more sustainable city to exist.

Issues can arise with the transformation of landfill to green spaces, which was illustrated in a study done by Richard Laing, in ‘The Incorporation of Environmental Values in a Decision Support System’ (Laing 1). He assembled a group of stakeholders and led a discussion to identify the key issues to this type of redevelopment in urban settings. His issues were identified as a result of this process that included specific recreational issues, availability and condition of facilities, climatic concerns, housing developments and concerns over traffic (Laing 7). Potential barriers occur with every landfill to green space project but with proper planning, funding and communication between professionals, these challenges can be overcome.

3.8 Conclusion

This chapter outlines a variety of key benefits and barriers related to both landfill redevelopment and green space development, which support the understanding of
Ontario’s strategies for landfill to green space projects. Each section in this chapter helps frame the importance of enhancing our knowledge of the barriers to landfill to green space transformation, in order to re-utilize closed landfills and to provide additional amenities for the surrounding communities. With a better understanding of the obstacles to landfill to green space projects, these sites can have faster turnarounds and contribute to a community rather than be a hindrance.

The balancing forces between the barriers and benefits of landfill to green space transformations are an essential component to understand regarding the completion of a redevelopment project. The challenge relates to the uniqueness of every project, with each project having its own limitations and benefits. Understanding cities as one entity, rather than individual sections, allows developers and planners to locate green space deficiencies and plan accordingly to meet the needs of growing city populations.
4. Chapter 4: Case Studies

4.1 Introduction:

The GTA, Canada’s largest urban area (Canada 1), was selected as the primary study area for this thesis for two reasons. First, the GTA has had recent success with its landfill redevelopment projects, and secondly, there are growing needs for green space within the city limits. The GTA has a variety of successful landfill to green space examples to choose from, but for the purpose of this study, three case studies will be presented, which were narrowed down and selected based on specific criteria: (a) history (former/now closed landfill), (b) the location, current/future end land use (green space), and whether the case study was successful in achieving its designated goals.

The Keele Valley Landfill (KVL), The Britannia Landfill and the Leslie Street Spit were the chosen for study (see fig. 3). They were examined in terms of their historical background, their intended end use plan, current site operations, benefits, barriers to redevelopment and how they were able to overcome them.
A case study approach provides an additional research element to this thesis, and further clarifies the current barriers to redeveloping landfills in the GTA. The intention of this research element is to help identify the specific barriers encountered by projects within the GTA. Understanding the redevelopment process of these three successful case studies can potentially help the success of future projects in Ontario.

4.2 Keele Valley Landfill, Vaughan, Ontario

4.2.1 Overview

The Keele Valley Landfill (KVL) site is located in the City of Vaughan (Community of Maple), Ontario, approximately 10 kilometers north of the Metropolitan Toronto boundary and 5 kilometers east of Highway 400. The KVL was Canada’s largest landfill site, covering an area of about 376 hectares (Waste Management 28). This city owned
landfill received approximately 28 million tonnes of waste over its 19-year operating life (Chamberlain 38). The landfill was eventually shut down in 2002.

In August 1973, formal applications to establish the KVL were submitted to the Ministry of the Environment (MOE) by Crawford Allied Industries and Superior Sand, Gravel and Supplies Ltd. Four years of extensive hearings by the Environmental Appeal Board ultimately resulted in a Provisional Certificate of Approval by the MOE in September 1980. In 2002 after 19 years of operation, the City received approval from the MOE to refuse additional disposal and begin remediation efforts and plan the development of the site.

4.2.2 Future End Land Use

With the closure of the KVL, the City of Vaughan has been committed to leaving a positive legacy on the old landfill site. These sites include three landfills (KVL, Vaughan Landfill, and the Disposal Services Landfill), the former Avondale compost facility and cap soil excavation site and surrounding buffer zones. The total acreage of the NMRP is an estimated 200 acres (81 ha) and an estimated $31 million for construction (Vaughan 4). In September 1998, the City of Vaughan undertook the Maple Valley Parks and Open Space concept plan (CRA 6), with its main objectives consisting of:

- An open space/parkland and implementation strategy for the public holdings in North Maple, including KVL, the closed City of Vaughan Landfill, and the former Ministry of Natural Resources (MNR) lands;
- A preferred location for a major active park facility in North Vaughan;
- Future public open space of the ‘Avondale Lands’;
• A study process which maximizes opportunities for the public participation and input; and
• A disposition and use of adjacent private land holdings is considered in the development of the open space/parkland plan (CRA 6).

Given the significant limitations on future uses of the actual landfill area itself, the Maple Valley Plan (MVP) recommended a range of passive recreational uses. The possibility of a tobogganing and downhill ski center located on the eastern portion of the landfill was also contemplated. These slopes could provide a suitable terrain for downhill skiing and tobogganing due to their north-easterly orientation and adequate height of land (Vaughan 3).

Once completed, the new North Maple Regional Park (NMRP) will incorporate several properties that have been acquired over several years (e.g. see fig. 4).
4.2.3 Description of Operations and Practices

In accordance with the conditions contained in the Provisional Certificate of Approval, the KVL implemented two strategies for managing and containing both migrating leachate and methane gas: purge wells and a clay liner. The first strategy was the installation of purge wells by Waste Management of Canada Inc. along Teston Road. This was completed before any site preparation in an attempt to intercept and remove all subsurface contamination migrating from the former landfill properties to the north of the KVL. These additional landfills are Vaughan Landfill (directly north of Keele Valley).
and the Disposal Services Landfill (North-East of Keele Valley) (see fig. 4). The purge wells were connected to a force main, which discharged to the York-Durham sanitary sewer near the southwest corner of the waste disposal system (Toronto 3).

A second strategy was to install a clay liner at the base and sides of the landfill to prevent leachate from seeping down into the underlying soil. The liner is 1.2 metres (4 feet) thick, and is monitored using sensors on a semi-weekly basis (Toronto 1). Four devices are used which include ‘vibrating wire piezometers, which measure the height of the leachate on top of the liner within the landfill; lysimeters, which monitor the rate of leachate movement through the liner; conductivity sensors, which are placed at various depths in the liner and provide information about the depth of the leachate movement in the liner; and sub-liner water samplers, remotely operated devices that monitor the groundwater underneath the clay liner. In addition to these monitoring devices, a layer of coarse stone surrounding perforated pipes was constructed on top of the liner to drain off the collected leachate and discharge it into the York-Durham sewer system’ (Toronto 1).

In an attempt to manage migrating methane gas, a system of horizontal gas collection trenches and supplementary vertical gas wells was installed in the waste. “A vacuum is applied to these trenches by means of multi-stage blowers and header pipe system to draw the landfill gas out of the waste pile” (Toronto 3). The construction of this collection system was designed to primarily control odors from spreading, but the collection of methane can also be a source of energy. Once converted, this ‘gas to energy’ process is tied into the local grid system and supply energy to surrounding homes. The
on-site energy generation plant processes about 7.5 standard cubic metres per second of landfill gas (15,000 cubic feet per minute) containing about 46 percent methane (Toronto 3). When the utilization plant is down, the excess methane gas is burned in back-up incinerators to maintain odor control. Figure 5 illustrates the overall operational and geotechnical design of the KVL (see fig. 5).

![Design Features](image)

**Fig. 5**: Operational and Geotechnical Design of the Keele Valley Landfill (Toronto, “The Keele Valley Landfill”, 3)

### 4.2.4 Benefits to the City of Vaughan

With the landfill closure in 2002, the City of Vaughan has been planning to turn this site into a large green space, for passive and recreational use. Directed by the City of Vaughan’s city council, the MVP is a collaboration of many individual initiatives. The redevelopment of the KVL and the adjacent properties could potentially bring a variety of environmental, economic and social benefits to the City of Vaughan.
The environmental benefits associated with redeveloping the KVL and its surrounding properties are the management of leachate and greenhouse gas (GHG) emissions. In a report by JSW and associates, they state “the efficient consumption of the methane gas in the CAT Gensets and the refinement of CO$_2$ gas for the market place, will not release harmful gases from the KVL” (32).

The first social benefit of the MVP is that surrounding communities will be less exposed to dangerous areas, allowing safer and healthier communities. Minimizing the exposure to leachate and methane gas is important, so the construction of purge wells, monitoring wells and methane gas collections systems were pivotal to the overall well being of the surrounding communities. Secondly, the MVP presents new opportunities for outdoor recreation and exploration. From a closed landfill site, to a 245 acre green space, this redevelopment project can create new social and cultural opportunities for surrounding communities.

A variety of potential economic and financial incentives are present when redeveloping the KVL. These benefits include new employment opportunities during remediation stages, park development construction and ongoing park maintenance. Secondly, the transformation of a landfill to green space project can encourage additional private investments to surrounding streets, while retaining its current social amenities. An indirect benefit to the creation of urban green spaces, are increasing property values to residential homes and commercial buildings within walking distance of the newly development park.
4.2.5 Barriers to the Keele Valley Landfill

Due to a number of land use development restrictions on ‘fill’ portions of the landfill, the MVP recommends a range of passive recreational uses, including open space with limited infrastructure and no permanent structures. The proposed plans do include “bicycle and pedestrian trail development, look-outs, interpretive signage, open meadows for passive recreation such as kite flying, informal games and other similar activities” ( Vaughan 4).

Two separate interviews were completed regarding the KVL and its impeding barriers. Both interviews touched on a variety of topics relating to its’ history, obstacles it has overcome and the benefits this newly redeveloped site will bring to the City of Vaughan. The first interviewee outlined the five most significant barriers to transforming the KVL into a green space. These included costs, proper engineering, environmental control of contaminants, liability concerns, and regulatory requirements. Similarly, the second interviewee concluded his top five barriers to consist of costs, lack of communication between stakeholders, the environmental control of contaminants, liability concerns, and regulatory requirements.

Although the KVL has encountered many redevelopment barriers, the site continues to make progress since its closure in 2002 and is partially redeveloped. The actual site of the landfill is not suitable for redevelopment until 2028, but portions of the property have been utilized. Eagles Nest Golf Course was built in 2006, while soccer and baseball diamonds were built on the north end of the site in 2005 (Beam 1).
The professionals involved in this project, included city planners, environmental consultants, project managers, and the surrounding Public have helped implement a variety of strategies to combat the many obstacles to redeveloping this site. According to both KVL interviewees, the project’s overall costs were the most significant barrier to surmount. Methods for dealing with the costs of risk management, development and ongoing monitoring derived from multiple strategies. The first method for overcoming the high costs of the KVL project included significant contributions from the local municipality. The local government provided funding for this project in an effort to progress the remediation and redevelopment stages, and help turn this site into more productive uses.

A second strategy included the collection and dumping of clean-fill on site. During the first ten months of 1999, the KVL received 41,532 clean fill loads, which is approximately 50,000 loads per year prorated to an annual rate (Toronto 1). With a service charge of $10.00 per load, the annual revenue collected from the dumping of clean-fill was approximately $500,000 per year. The KVL has more recently reduced its acceptance rate for clean-fill due to limited capacity, which has reduced its total revenue.

A third strategy for generating revenue was the collection and conversion of methane gas to energy. In 1985, a system to collect flare gas was installed, which constituted 47% of the landfill gases on site (Environment Canada 1). Eastern Power Developers won the bid to develop electricity generation station, which was built in 1994 and began its operation in 1995. On-site methane gas is collected through a series of underground pipelines to a
gas-to-energy plant, which is then converted to electricity, sold locally and tied to the regional grid. Due to confidentiality agreements, the total and annual revenues generated from the methane to energy process was not provided.

The second most significant barrier was liability. Professionals are concerned about the potential exposure of methane and leachate to park users and adjacent properties once the park is officially opened. The City of Vaughan is legally responsible for containing the onsite contamination from impacting park users and surrounding properties, while committing to the issued C of A’s for this site. Ongoing monitoring of potential contaminants reduces these risks and the associated redevelopment liabilities, allowing this project to move forward. Liability risks will always be present when redeveloping brownfields in Ontario, but these risks are significantly reduced with the implementation on monitoring systems, and new legislative and regulatory amendments.

The management and control of contaminants was also mentioned as a secondary barrier to transforming the KVL into a passive, recreational area. Both methane gas and leachate pose significant health risks to park users, neighboring properties and the surrounding environment. Monthly monitoring of groundwater and purge wells, and weekly monitoring of methane consumptions, provides the staff with a clear understanding of the contamination situation. Based on the data collected, the KVL monitoring staff is able to react accordingly to limit the environmental and social damage.
Although the KVL has faced a variety of obstacles since its closure in 2002, it has been able to redevelop certain portions of the site and provide a variety of recreational and passive opportunities.

4.3 Britannia Landfill, Mississauga, Ontario

4.3.1 Overview

The City of Mississauga is located on the shore of Lake Ontario, part of the largest system of freshwater in the world (Mississauga 1). As the city continues to grow, it is imperative that the growth does not compromise the natural environment. There are a number of opportunities for all lands within the city limits to contribute to the natural environment, but finding ways to overcome the barriers of brownfield redevelopment can be a difficult task for any city.

The Britannia Sanitary Landfill Site (BSLS) is located in Mississauga, Ontario (see fig. 3 and e.g. see Appendix III for site photos). The landfill, which was established in 1980 and closed in 2002, received over 10 million tonnes of waste (IGRS 1). The Region of Peel wanted to utilize the GHG emissions produced at the landfill and convert it to electricity. The Regional of Peel owns and operates the site and will be bearing the costs of the project. The estimated cost of the project, including the pilot plant study, facility design, equipment and installation was an estimated $1,500,000 (Dillon 6).
The site occupies 206 acres, of which 150 acres is comprised as a landfill (Peel 1). Once the site was closed, final cover was added, and the site began its transformation from a landfill to a golf course. In 2005, the Braeben Golf Course opened an 18-hole Championship Course and 9-hole par 3 Academy course for kids. Landfill gas wells were placed in perimeter areas along the fairways and cart paths to avoid interfering with the golf course.

Partial reasoning for the redeveloping the Britannia Sanitary Landfill Site into the Braeben Golf Course was due to excessive leachate discharge into the local sanitary sewer systems. Disposal of the leachate in this manner is the source of two problems. First, “the level of organic compounds in the landfill leachate being discharged into the
sewer systems exceeds the Region’s sewer use by laws, and secondly, the hydrogen sulphide gas evolving from the leachate is the cause of a significant odor problem in the areas surrounding the discharge point” (Dillon 2). The odor problem in the area of the receiving sanitary sewer line was first identified during the summer of 1985, which was eventually pinpointed to the neighboring landfill site after inspections of the sewer line and interviews with affected residents. To alleviate the odor problems, the leachate flow to the sanitary sewers was valved off in the fall of 1985 to avoid further impacts. The current methods for managing the on-site contamination problems are thoroughly outlined in the section 4.3.2.

4.3.2 End Land Use Planning

The current end use for the BSLS is a public 18-hole championship golf course, accompanied by a 9-hole par three course, complete with a driving range, clubhouse, locker room, maintenance building and dining facilities. The difference between the Braeben Golf Course and the Eagles Nest Golf Course, located on the southeast corner of KVL, was that the Braeben Golf Course is situated directly on the ‘fill’ portion of the landfill. This raised additional precautions for the Braeben Golf Course, requiring specific engineering to limit sinkholes from occurring through strategic ‘filling’ practices. These engineering strategies included dividing the BSLS into eight operational cells, which were filled one at a time (see fig. 7). Operating cells were prepared prior to receiving waste by excavating five metres below the original grade. The delivered wastes were dumped into a cell, compacted and then covered with 15 cm of clean fill at the conclusion of each day (Dillon 3). Once the cell is completely filled with waste, it is
covered with a minimum of 1 to 1.5 metres of clean fill, 15 centimeters of compacted topsoil, and then re-vegetated (Dillon 3).

Dan Labrecque, Commissioner of Public Works for the Region of Peel stated, “the former landfill site was always intended to be turned into a golf course upon its closure to serve the residents of the City of Mississauga and the Region of Peel” (2). This allowed the remediation and development of the landfill site to be very efficient and avoid unnecessary delays in determining its future end land use. Different proposals for a particular site can significantly delay a project from progressing, often increasing the costs of the project, while testing the patience of many developers and city planners.
4.3.3 Description of Operations and Practices

In an attempt to manage and contain harmful contaminants from migrating onto adjacent properties, the consultants and site developers of the Britannia Landfill implemented a number of environmental strategies. Firstly, 21 groundwater monitoring wells were installed around the perimeter of the site. This groundwater monitoring program generally consisted of quarterly water level measurements and semi-annual groundwater sampling for chemical analysis (Peel 21). The collected water samples are analyzed for metals and volatile organic compounds (VOCs). The results of the groundwater monitoring program are used to evaluate background levels of groundwater quality in the vicinity of the Site and to estimate any impacts, which may be occurring due to the buried waste.

Secondly, regarding run-off and potential surface water contamination, the Site has installed ditches and drains, which funnel the excess run-off into a nearby storm water management pond. Surface water accumulated in the pond is released through a controlled outlet structure and deposited into the nearby watershed of Carolyn Creek. Surface water monitoring is performed on a monthly basis to measure the suspended solids content of the discharged water to ensure there is no significant impact on the Carolyn Creek water quality. The surface water is sampled quarterly for chemical analysis for metals and VOC’s (Peel 21).

Thirdly, a surface emission-monitoring program was initiated to contain and utilize the landfill gas (LFG) emissions. It consists of 45 vertical wells, but has undergone an
expansion as the landfill ages, totally 55 wells (Peel 1). This program was undertaken at the BSLS to monitor LFG emissions and assess air quality at the surface. The primary objective of this program consisted of identifying areas of the site that require action to limit LFG emissions and secondly, to provide and indicate any trends in the LFG emissions over time (Peel 21).

The landfill gas collected has an average concentration of 50 percent methane and is sent beneath the roadway via an 800 m pipeline to the energy facility located on an adjacent property. The methane gas is collected and converted into electricity through three Cooper Superior reciprocating engines with the ability to power 5000 homes with 5.5 megawatts (MW) of electricity (Peel 1). A flare is located at the golf course to serve as a back up for the gas to energy facility during routine maintenance and potential engine breakdowns. In regard to maintaining water quality on and off site, semi-annual testing is completed through 55 groundwater-monitoring wells and leachate collection systems. The water is then treated at the Lakeview Waste Water Treatment Plant (Peel 1).

The LFG emissions are collected through a series of vertical and horizontal wells, which were drilled into the landfill. The wells are constructed of plastic pipe, perforated at depth, similar to water wells. The pipes extend to the surface and are connected to several valves, to control flow and allow flexibility to gathering pipes, to accommodate differential settlements from the landfill surface. The gathering pipes are typically buried at least one meter below the surface of the landfill (IGRS 1). The gas is collected in the pipe system by exerting a vacuum in the wells using a blower or compressor. Prior to
injecting the gas into an engine or turbine, the gas is cooled to ‘the dew point’ to allow the quantities of moisture to condense out of the gas (IGRS 1). Once the gas is filtered and reheated, it is fed into the generator, which creates the electricity and connects to the municipal power grid.

The well-field is designed to avoid the fairways of the golf course, while maximizing the collection of landfill gas. The wells are strategically located along the driving ranges, cart paths and on the perimeters of the fairways. Mike Watt, co-CEO of Integrated Gas Recovery Services Inc., stated that the “system includes approximately 55 wells, and is designed to collect approximately 2,500 cubic feet per minute of landfill gas” (21). Watt continues to state that the total generating capacity of the plant is 5.5 MW, which is enough to power more than 5,000 homes, and will generate electricity from 2005 until 2025 (Watt 21).

4.3.4 Benefits to City of Mississauga
The benefits of redeveloping the BSLS from a hazardous landfill to a thriving public golf course are environmentally, economically, and socially evident. Environmentally, the BSLS now has the appropriate monitoring systems for tracking migrating leachate and methane gas from impacting the adjacent residential properties. The installation of groundwater monitoring wells, liners, surface water monitoring programs, surface emission monitoring programs, and the construction of a landfill gas compression and electrical generation facility have all helped contain and treat the migrating contaminants from impacting local residents. Neighboring residents are now fully protected from the potential environmental impacts of leachate and methane gas, due to the daily and
quarterly monitoring of landfill contaminants. Furthermore, the contamination of the BSLS is treated on site, avoiding further environmental damage to adjacent sites. Lastly, the collection and conversion of LFG to energy has taken a significant source of carbon dioxide from entering the atmosphere and turned it into a useful form of energy. Environment Canada states that a key importance to the collection and treatment of LFG is to lower Canada’s ecological footprint by converting methane gas to energy. Statistically, Environment Canada estimates that “half of all landfill gas produced in Canada was combusted, it would mean a greenhouse gas (GHG) reduction equivalent to six million tonnes of carbon dioxide annually” (Watt 3). With the process ofcombusting and converting LFG to energy, Canadian landfill sites can become more environmentally friendly and even provide significant financial benefits.

This conversion of LFG to energy is at the forefront for making an economic argument for the redevelopment of landfill sites and the collection of methane gas. The Integrated Gas Recovery Services (IGRS) Inc. provided the Region of Peel with a solution that addressed all of the challenges of this project with the proposal to utilize the LFG for the generation of electricity. The incentive for IGRS to install a methane collection system and an energy production system is to receive significant economic returns for their investments. The annual revenue from the ‘gas to energy conversion’ is confidential and was not released by the IGRS.

The cooperation between the Region of Peel and private investments has been proven to be a very successful strategy in dealing with LFG in Ontario, benefiting all parties
involved in the redevelopment of the BSLS. The ‘costs’ of a given project were determined by many interviewees as the number one impeding barrier to transforming landfill sites to green spaces, and this site illustrates a key strategy in overcoming the financial burdens to redeveloping these types of sites.

The social benefits of redeveloping a contaminated site into a prosperous urban green space are easily recognizable. Surrounding residents and families can breathe easier knowing the harmful contaminants of a local landfill are monitored daily and treated, if levels exceed the appropriate standards issued by the MOE and EPA. Secondly, the transformation of the BSLS to a golf course, converts a once undesirable site into a popular destination for golfers and green space lovers alike. The Braeben Golf Course (BGC) is open for a variety of social events, including fundraisers, weddings, business conferences and community gatherings. Lastly, the introduction of the Braeben Golf course has the potential to revitalize the surrounding community, by retaining its current amenities and attracting new investments to the City of Mississauga.

4.3.5 Barriers to the Britannia Landfill

The transformation of the BSLS to the BGC has had a variety of challenges to overcome before this site could be re-introduced into the Mississauga community.

The costs associated with transforming this landfill into a green space was stated to be the most difficult barrier to overcome. This is primarily due to the heavy upfront costs of risk management. The excavation of on-site waste and debris, up to 5 metres below the original grade, combined with the hauling and dumping of waste to another landfill are
expensive. Transportation costs and dumping fees can also significantly cut into a projects’ budget. The installation of necessary infrastructure to manage, contain and monitor the levels of leachate and methane on landfill sites are very expensive and often need private sector investments.

The development and facility design costs of turning a closed landfill site into a golf course are very costly. Golf course development compared to the development of a green space or open space can be far more expensive in terms of initial development costs and maintenance costs. An example of the high costs of golf course development, the Region of Peel funded $13 million in capital costs for the development of the site as part of the closure process, while maintenance equipment will require replacement after four years at an estimated cost of $940,000 (Labrecque 2). Lastly, the ongoing monitoring of groundwater wells and methane levels, combined with landfill maintenance (e.g. repairing sink holes) are additional costs that occur over the duration of the green space lifespan.

The Region of Peel and the City of Mississauga have been successful in overcoming the cumbersome ‘cost’ challenges through a number of financial strategies. The first strategy consisted of implementing a reserve fund, which was a collection of funds from ‘dumping fees’ on the BSLS. Every ton of garbage from 1980 to 2002 contributed to the reserve fund, which was then fed back into the project to cover the risk management and development costs. A second strategy for overcoming the costs of landfill to green space development was to convert methane gas to energy, and sell it to the local municipality.
The IGRS Company provided the necessary private investment needed for the conversion of gas to energy. The IGRS saw the potential in this property and began constructing a gas-to-energy plant, with promising economic returns within five years.

Two final strategies for overcoming the financial burdens of the BSLS consisted of both private and public investment. As previously mentioned, the Region of Peel funded $13 million in capital costs, which can significantly help the viability of a redevelopment project. Secondly, private investment companies have opportunities to invest in closed landfills and develop ‘landfill gas to energy’ projects. Municipalities that have successfully undertaken landfill gas to energy projects either take on the projects themselves, hire consultants to provide assistance or enter into public-private partnerships, whereby a private company assumes part or all of the responsibilities of the landfill gas project. Services offered by private companies range from simply providing expert consultation to actually financing, building, and operating the plant, with royalties paid back to the municipality. The landfill gas to energy plant was designed, constructed, and operated in a public-private partnership with the Region of Peel.

Secondary barriers to the transformation of the Britannia Landfill were proper engineering, environmental control of contaminants and liability issues. In regard to proper engineering, the installation of appropriate liners, wells and soil cover can be significant challenges if they’re not installed properly or do not meet the environmental standards issued by the EPA and MOE. This project was able to avoid the engineering challenges by organized planning and development by all relevant stakeholders.
Knowing well in advance that this site was destined to be a golf course, consultants, developers and planners were able to plan accordingly and redevelop the BSLS without additional planning complications.

4.4 Leslie Street Spit, Toronto, Ontario

4.4.1 Overview

The Leslie Street Spit is a man made peninsula extending five kilometers into Lake Ontario and is over five hundred hectares in size (Conservation 1) (e.g. see Appendix III for a site photo). Initiated in 1959 by the Toronto Harbor Commission (THC) (now Toronto Port Authority (TPA)), it has been the disposal site for dredged material from the Outer Harbour and surplus fill from development sites within Toronto (Kavanagh 1). The Toronto and Region Conservation Authority (TRCA) currently owns the land and surrounding water bodies. Those areas still under construction are owned by the Ministry of Natural Resources (MNR) and are leased to the TPA. The TRCA is responsible for the development and implementation of the Master Plan and the annual operating program, which includes both biological and public interest activities (Conservation 1).

Tommy Thompson Park (TTP) is situated within the Leslie Street Spit, and represents some of the largest existing natural habitat on the Toronto waterfront (Conservation 1) (see fig. 8). Its land base was drastically increased from 1974 to 1983, with approximately 6,500,000 cubic metres of sand and silt, dredged from the Outer Harbour and place at the Spit (Conservation 1). This resulted in the formation of the lagoons and sand peninsulas, which account for a significant proportion of the land base of TTP. Currently, the TTP has a variety of habitats including wildflower meadows, cottonwood
forests, coastal marshes, cobble beaches and sand dunes (Conservation 2). This urban wilderness is also home to a variety of wildlife, especially birds, providing one of the best nature watching areas in the GTA. Additionally, this park also provides a variety of recreational opportunities including hiking, cycling, rollerblading and fishing. The TRCA currently owns 247 ha of the land and water included in TTP (TRCA 1). Those areas still under construction are owned by the Ministry of Natural Resources and are leased to the THC. This urban wilderness park has been managed by the TRCA since the early 1970’s, attracting well over 300,000 visitors annually (Conservation 2).

Fig. 8: Map of the Leslie Street Spit and Tommy Thompson Park (Kavanagh 2)
4.4.2 End Land Use Planning

With the mandate to co-ordinate recreational planning of the central Toronto waterfront, the TRCA developed a tentative plan for an ‘aquatic park’ on the Leslie Street Spit. Since then, however, “natural processes have transformed the Spit into a biologically diverse and rapidly evolving complex of significant shoreline communities, thereby creating the potential for a new set of recreational uses not considered or even envisioned in the original plan” (Kavanagh 1). As a result, many competing proposals emerged as potential options for the Spit’s future development. During the late 1970’s, as competing public interests grew more vocal, the TRCA attempted to resolve the future fate of the Spit by developing a master plan through an information gathering process that was to emphasize public participation and to reflect public opinion (Kavanagh 1). This planning process was initiated in 1984, and by 1987 the production of the TTP master plan was completed.

Through the process of dumping earth, brick and large rubble into Lake Ontario, the THC followed a three-phase design in the creation of TTP. The three phases consisted of the Eastern Headland, the peninsulas and the endikement. The three cells contained with the endikement area have been designed as a Confined Disposal Facility (CDF) for the disposal of dredged material (e.g. see fig. 8). Cell #1 covers 8.2 ha, Cell #2 covers 9.3 ha and Cell #3 covers 32.1 ha (TRCA v).

The biophysical conditions of TTP are quite diverse. This site has become well known as a significant nesting and staging area, and is an important component of one of the major
migrational corridors through the Toronto region. TTP currently has five species of colonial water birds that nest in significant numbers on site. These include ring-billed gull, common tern, herring gull, black-crowned night heron and the double-crested cormorant (TRCA vi). The environmental significance of the wildlife features of the site have been determined by applying the environmentally significant areas (ESA) selection criteria, and monitoring the wildlife species and habitat features that are present. The wildlife significance of the site includes the presence of migrant bird staging areas, significant nesting areas and nationally, provincially and regionally rare plant species (TRCA vi).

According to the TRCA, TTP will primarily be classified as a ‘natural area’ (TRCA, 1992). This concept is based on a natural succession or ecological approach, augmented by minimal intervention and management to achieve:

(1) the preservation of significant species such as the Common Tern, Black-Crowned Night Heron and Double-crested Cormorant;
(2) the protection of environmentally significant areas realizing their dynamic biological nature over time;
(3) the creation of significant marsh/wetland habitat; and
(4) surface/site preparation in the “natural area” to allow natural succession to achieve a vegetative community over time such as a willow/aspen/cottonwood community given the existing adjacent plant communities (TRCA 2).

To complement the ‘natural areas’ of the park, an interpretive Centre was developed to incorporate an educational program on site for school boards and the general public. A separate major/minor pedestrian path system in excess of 12 km and a separate 7 km
bicycle pathway were created for recreational opportunities, including running, rollerblading and biking.

TTP is currently 247 ha, but future plans have been discussed to expand the park by an additional 224 ha. Once the Ministry of National Resources’ lease to the THC expires, the park could be extended to incorporate more green space and recreational opportunities. This additional 224 ha of potential green space would include the southern portion of the Spit still under construction (e.g. see fig. 8).

4.4.3 Description of Operations and Practices

TTP’s history, biological diversity and location make it an ideal place to conduct research and monitoring. Research initiatives have been conducted by various agencies like the Department of Fisheries and Oceans and the Canadian Wildlife Service, as well as Toronto’s strong academic community (Conservation 1). Internationally, TTP has garnered interest relating to converting “waste” land to green space and habitat creation. Along with collaborative research, TRCA conducts its own monitoring in various areas related to the success of restoration and wildlife management endeavors.

A long list of annual and on-going research and monitoring projects have been initiated by the TRCA. A list of the annual research and monitoring projects include bio-monitoring using fresh water clams, aquatic vegetation surveys, marsh bird and amphibian monitoring, tree health in bird colonies, and a variety of bird monitoring (Conservation 1). The on-going research and monitoring projects include water sampling, sediment sampling, aquatic thermal monitoring, benthic community
assessment, fish community assessment, and an urban coyote study with the Ontario MNR (Conservation 1).

The TRCA has developed an effective strategy for determining the health of TTP, through on-going and annual monitoring/research programs. These programs create an abundance of data, which can be analyzed to determine the long-term and short-term health of on-site species. They also allow environmental specialists to react accordingly if potential biodiversity concerns do arise.

4.4.4 Benefits to the City of Toronto

Multiple environmental, social and economic benefits have occurred with the development of TTP. The redevelopment of the Leslie Street Spit is an important component to the overall revitalization of Toronto’s waterfront and plays a pivotal role in providing natural habitat within the downtown core.

The development of TTP brings a variety of environmental benefits to the City of Toronto. Firstly, it conserves and manages unique natural resources and environmentally sensitive areas. Secondly, it is a nesting area for many different types of bird species, which attract bird enthusiasts to the City of Toronto. Lastly, it provides recreational opportunities for Torontonians, including hiking, cycling, rollerblading and fishing.

The social benefits of TTP derive from increased opportunities for recreational use. This ‘urban wilderness’ (Conservation 2) allow urban inhabitants to escape the skyscrapers of Toronto’s business district and take a walk or bike ride through a naturalized setting.
Natural getaways have been proven to reduce stress and improve the health of local inhabitants, by encouraging more physical activity. Wernstedt supports this by stating “the most frequently noted personal benefit of green spaces by the users was an increase in their physical activity” (“Turning Brownfields” 6).

Lastly, TTP provides learning opportunities for students and the general public. The proximity of the park to the city and the variety of habitats and wildlife present provide an excellent opportunity for student to learn about our environment. There are currently two main education programs at TTP – the Aquatic Plants Program and Winged Migration Bird Studies (Conservation 2). The Aquatic Plants Program allows students to get hands-on experience of growing and caring for aquatic plants starting with the germination of a seed. In the spring, the class takes a field trip to plant their stock while learning about the ecology of a wetland. Conducted by the TRCA, the Winged Migration program allows students the opportunity to observe bird research techniques and bird banding, develop bird observation and data collection skills, and participate in fun and informative experiential learning activities (Conservation 2).

Economically, the redevelopment of TTP can potentially increase tourism for the City of Toronto, while increasing the land value of surrounding properties, which are in close proximity to the park. Studies have outlined that brownfield redevelopment; particularly the development of green space can increase surrounding land values. Waterfront businesses along the Lakeshore increase in value and attract more people to those areas, increasing sales and revenue. Avid fish and bird enthusiasts will be attracted to TTP for
its biodiversity and quantity of fish and bird species. According to De Sousa, this could potentially cause a tourism influx in Toronto. He states “greening projects tend to reduce costs related to urban sprawl and infrastructure provision; attract investment, raise property values and invigorate local economies; boost tourism; preserve farmland; prevent flood damage; and safeguard environmental quality generally” (De Sousa, “Turning Brownfields” 4).

4.4.5 Barriers to Redeveloping the Leslie Street Spit

Unlike the Braeben Golf Course and the MVP, TTP began its’ transformation by natural succession. Local vegetation and migrating bird species began to inhabit the western points of the Spit, peaking interests among local and environmental advocacy groups. The eventual transformation of the Leslie Street Spit to TTP did encounter its own unique set of barriers. Two participants involved in the protection and management of TTP identified these barriers, which were supported by background documents and relevant grey literature.

‘Costs' was outlined by Gaffney as one of two major barriers to transforming the northern portion of the Leslie Street Spit into TTP. Although both the federal and municipal government funded the development of TTP, additional funding is needed for monitoring, ongoing maintenance and staff salaries (Gaffney 1). Gaffney stated that the federal government provided the TRCA with 8 million dollars in upfront funding, and small amounts of additional funding are provided by the City of Toronto for maintenance (Gaffney 1). Unlike the previous two case studies, TTP contains large areas of untouched
land. These areas are not groomed and therefore do not consume portions of the annual funding provided by the City of Toronto.

During the development stages of the Spit in the late 1950’s (Conservation 2), regulatory requirements issued by the MOE did not exist. Additionally, environmental assessments did not exist until the 1980’s and thus, dumping and dredging occurred without environmental regulation. This allowed a variety of potentially harmful materials (e.g. oil drums and gas tanks) to be dumped on site. This has caused the occasional removal and treatment of certain materials, and a potential increase in exposure of harmful materials to park users. To date, new regulatory requirements have been implemented by the TRCA and approved by the MOE, to regulate all dumped and dredged materials into the Leslie Street Spit (Gaffney 1).

Costs and a lack of regulatory requirements were considered the top two barriers to transforming the Leslie Street Spit into TTP, but additional challenges also occurred during its conversion (Gaffney 1). Liability, time, and public involvement were considered as the secondary challenges to the development of TTP (Gaffney 1). With any landfill to green space conversion project, liability concerns are often present due to the potential exposure of harmful materials to park users. ‘Time’ was outlined as a challenge for this project due to the often-delayed approval processes, meeting MOE deadlines, and public involvement. Public involvement was declared as its own unique challenge but also contributed to delays in the development of TTP. Due to TTP’s unique ‘natural’ state and location, environmental advocates including a group called ‘the
Friends of the Spit’, remain heavily involved in this project to preserve TTP’s natural condition and avoid boating privatization of the harbor. The Ontario Sailing Association, a lobbying group partially funded with public money, lobbied to establish extensive boating facilities on the Spit (Carley 1). Planning challenges continue to arise due to the different perspectives between public and private organizations. Each group lobbies for very different end land uses, which results in drawn out council meetings and planning initiatives. Overall, TTP had similar barriers to both the KVL and the Britannia Landfill. Costs, liability, a lack of regulatory requirements during operation, and public involvement are all reoccurring challenges facing many landfill redevelopment projects in the GTA.

4.5 Conclusion

This chapter outlined three specific landfill to green space projects in the GTA - the Keele Valley Landfill, the Britannia Landfill and the Leslie Street Spit. Case studies provided an additional component to this thesis, which helped identify the current barriers and obstacles to converting landfills to green spaces. Each case study presented a history of the site, its end land use plan, a description of its current operations, and the benefits and barriers to its redevelopment. Additionally, the information gathered from these case studies supports the barriers outlined in the literature review (e.g. costs, liability, regulatory requirements, lack of communication and uncertain cleanup standards). Table 5 provides a background summary of these case studies.

These case studies were chosen based on specific criteria: history (former/now closed landfill), location, current/future end land use (green space), and whether the project was
successful in achieving its’ designated goals. These projects also had a variety of differences. Each case study varied in size, end land use, and in their challenges for redevelopment. The implications of this are that although these three sites have similarities, no two projects are alike, and the barriers change based on the varying landfill characteristics. For example, the Leslie Street Spit had a significant challenge in regards to managing the public. The public had no impact on either the KVL or the BL, but because the Leslie Street Spit became a green space through natural processes, no organized plan was implemented which created an intense competition for the land. The solution to this unique problem was to hold numerous city council meetings and maintain ongoing communication with all stakeholders.

Landfill to green space projects have a variety of challenges, but through this detailed review of case studies in the GTA, the primary and secondary barriers were evident. The primary barriers included the costs of a given project and the liability concerns involved in redeveloping landfills. The secondary barriers consisted of complicated regulatory requirements, and the containment and management of on-site hazardous material. A summary table outlining the barriers to these case studies is presented in Chapter 5.
<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Operation Start:</th>
<th>Size:</th>
<th>Current State:</th>
<th>Main Objectives:</th>
<th>Barriers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keele Valley Landfill, Vaughan, Ontario</td>
<td>Closed 2002</td>
<td>376 hectares</td>
<td>-Covered with fill -Ongoing Monitoring -Land settling</td>
<td>Range of passive and recreational activities</td>
<td>Costs, lack of communication, environmental control of contaminants, liability, and regulatory requirements</td>
</tr>
<tr>
<td>Britannia Landfill, Mississauga, Ontario</td>
<td>Closed 2002</td>
<td>206 Acres</td>
<td>Braeben Golf Course</td>
<td>To develop a public 18 hole championship golf course</td>
<td>Costs, liability, regulatory requirements, environmental control of contaminants, and operational design.</td>
</tr>
<tr>
<td>Leslie Street Spit, Toronto, Ontario</td>
<td>-Initiated in 1959 -Portions of the site are still open for dumping</td>
<td>-TRCA owns 247 hectares -Plans are to expand TTP by an additional 224 ha</td>
<td>Tommy Thompson Park and active landfill dumping</td>
<td>Public Park and Wilderness in the downtown core of Toronto</td>
<td>Regulatory requirements, costs, time, public perception/interference, and liability.</td>
</tr>
</tbody>
</table>

Table 5: Summary of Case Studies
5. Chapter 5: Data Collection

5.1 Introduction

Chapter 5 presents a series of tables, which illustrate the data collected throughout this research project. Seven tables were created to accurately depict the barriers outlined in the literature, the three case studies, and the personal perspectives of the interviewee’s. Accompanying the seven tables are brief summaries identifying the key information in each table.

5.2 Interviewees Summary Tables

Sixteen professionals and stakeholders were interviewed to improve the level of understanding of current barriers to transforming landfills to green spaces in the GTA. The focus was on city planners, developers and environmental consultants due to their involvement and experience in brownfield/landfill redevelopment projects. Each participant was asked to state the top five barriers to converting brownfields/landfills to green spaces.

5.2.1 City Planners

City planners are heavily involved in landfill to green space projects, allocating public amenities where deficiencies exist. For example, a city planner will not recommend a new green space development project in a ‘green space’ rich area or if that property has high market value. In an interview with Keath Parker from the City of Calgary, he emphasizes from a planning perspective, that ‘if there is marketability for an alternative use, and it’s a private owner, there’s much less of a chance it becomes a park and a
stronger chance the developers are going to want to get some economic yield out of the site” (Parker 1). The City of Toronto has incorporated brownfield remediation and redevelopment into its official plan using Section 28 of the provincial Planning Act (GMF 1). This section authorizes municipalities to create community improvement project areas (CIPAs) and develop community improvement plans (CIPs). In Toronto, CIPs allow the creation of financial tools that support the rehabilitation of contaminated properties with designated areas (GMF 1).

Participants were asked to rank the severity of each barrier by providing a ranking out of five (5 = high, 1 = low). This ranking process was utilized for all interviewee and case study tables. The responses from the six city planners were analyzed and presented in Table 6.

<table>
<thead>
<tr>
<th>Barrier:</th>
<th>Total Votes:</th>
<th>Total Score:</th>
<th>Average:</th>
<th>Ranking:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>6</td>
<td>27/30</td>
<td>4.5</td>
<td>1</td>
</tr>
<tr>
<td>Liability</td>
<td>5</td>
<td>17/25</td>
<td>3.4</td>
<td>4</td>
</tr>
<tr>
<td>Regulatory Requirements</td>
<td>3</td>
<td>13/15</td>
<td>4.25</td>
<td>2</td>
</tr>
<tr>
<td>Public Perception/ Involvement</td>
<td>4</td>
<td>9/20</td>
<td>2.25</td>
<td>6</td>
</tr>
<tr>
<td>Operational/Geotechnical Design</td>
<td>1</td>
<td>4/5</td>
<td>4.5</td>
<td>-</td>
</tr>
<tr>
<td>Control of Contaminants/Waste</td>
<td>2</td>
<td>7/10</td>
<td>3.5</td>
<td>-</td>
</tr>
<tr>
<td>Political Will</td>
<td>1</td>
<td>5/5</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Location</td>
<td>4</td>
<td>14/20</td>
<td>3.5</td>
<td>3</td>
</tr>
<tr>
<td>Ownership</td>
<td>3</td>
<td>10/15</td>
<td>3.25</td>
<td>5</td>
</tr>
<tr>
<td>Time (Delays)</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6: Common Barriers for City Planners

5.2.2 Developers

In general, private developers have avoided brownfield redevelopment opportunities because of a number of key impediments that can easily increase costs. In a report provided by the Government of British Columbia, these challenges include “the additional costs of funding required for environmental studies and site cleanup; difficulty
obtaining project financing from traditional sources of development capital; demolition and infrastructure costs; additional time; complexities and process uncertainty and limited information of a given project” (Columbia 7).

Due to limited involvement in landfill redevelopment projects, developer participants were difficult to locate. The responses from the two participants were analyzed and presented in Table 7.

<table>
<thead>
<tr>
<th>Barrier:</th>
<th>Total Votes:</th>
<th>Total Score:</th>
<th>Average:</th>
<th>Ranking:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>2</td>
<td>10/10</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Liability</td>
<td>2</td>
<td>9/10</td>
<td>4.5</td>
<td>2</td>
</tr>
<tr>
<td>Regulatory Requirements</td>
<td>1</td>
<td>5/5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Public Perception</td>
<td>2</td>
<td>6/10</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Operational/Geotechnical Design</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Control of Contaminants/ Waste</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Lack of Communication</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 7: Common Barriers for Developers

5.2.3 Environmental Consultants

The preliminary stages of any brownfield redevelopment project starts with a series of environmental assessments. Environmental consultants are hired to determine the potential on-site contamination and to recommend solutions for managing the impacts. Four environmental consultants were interviewed for the purpose of this thesis. According to this sample of consultants, the major barriers to converting landfills to green space included the (1) costs, (2) liability concerns, (3) operational design and geotechnical construction of the landfill infrastructure, (4) a lack of communication and understanding between professionals, (5a) meeting regulatory requirements and (5b) public perception and negative stigmas to developing on landfills. Participants were asked to rank the severity of each barrier by providing a ranking out of five (5 = high, 1 =
low). Cost associated with environmental assessments and remediation was emphasized as the primary barrier to redeveloping brownfields and landfills (see table 8).

<table>
<thead>
<tr>
<th>Barrier:</th>
<th>Total Votes:</th>
<th>Total Score:</th>
<th>Average:</th>
<th>Ranking:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>4</td>
<td>18/20</td>
<td>4.5</td>
<td>1</td>
</tr>
<tr>
<td>Liability</td>
<td>4</td>
<td>16/20</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Regulatory Requirements</td>
<td>3</td>
<td>11/15</td>
<td>3.65</td>
<td>3</td>
</tr>
<tr>
<td>Location/ Marketability</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Public Perception/ Involvement</td>
<td>2</td>
<td>5/10</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>Operational/Geotechnical Design</td>
<td>3</td>
<td>12/15</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Control of Contaminants/ Waste</td>
<td>1</td>
<td>2/5</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Lack of Communication</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Lack of Understanding</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 8: Common Barriers for Environmental Consultants

5.2.4 Case Studies

The five case study participants represent varied professional expertise in GTA landfill redevelopment projects. These participants were involved in the transformation of these case studies, which included a project manager, a waste management analyst, a waterfront specialist, a waste management technical analyst and an environmental advocacy group co-chair. All five participants, with their varied backgrounds, had a detailed and historical understanding of their specific project. Their responses are summarized in Table 9.

<table>
<thead>
<tr>
<th>Barrier:</th>
<th>Total Votes:</th>
<th>Total Score:</th>
<th>Average:</th>
<th>Ranking:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>5</td>
<td>20/25</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Liability</td>
<td>5</td>
<td>20/25</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Technical/Geotechnical Design</td>
<td>2</td>
<td>8/10</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Control of Contaminants/ Waste</td>
<td>3</td>
<td>11/15</td>
<td>3.65</td>
<td>2</td>
</tr>
<tr>
<td>Regulatory Requirements</td>
<td>5</td>
<td>18/25</td>
<td>3.6</td>
<td>3</td>
</tr>
<tr>
<td>Public Perception/Involvement</td>
<td>2</td>
<td>6/10</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Communication (Lack of)</td>
<td>1</td>
<td>2/5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Maintaining ‘Raw’ Lands</td>
<td>1</td>
<td>3/5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 9: Case Study Participants Table
5.2.5 Summary of Interviews

Table 10 summarizes the perspectives and personal opinions of these participants.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Planners</th>
<th>Developers</th>
<th>Consultants</th>
<th>Case Study Participants</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Operational/Geotechnical Design</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Control of Contaminants/ Waste</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Liability</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Regulatory Requirements</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Public Perception/Involvement</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Political Will</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Location/ Marketability</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Ownership/Acquisition</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Lack of Communication</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Lack of Understanding</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Time (Delays)</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Maintaining ‘Raw’ Lands</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Professionals Surveyed:</strong></td>
<td><strong>6</strong></td>
<td><strong>2</strong></td>
<td><strong>4</strong></td>
<td><strong>5</strong></td>
<td><strong>17</strong></td>
</tr>
<tr>
<td><strong>Total Votes:</strong></td>
<td><strong>30</strong></td>
<td><strong>10</strong></td>
<td><strong>20</strong></td>
<td><strong>25</strong></td>
<td><strong>85</strong></td>
</tr>
</tbody>
</table>

Table 10: Interviewee Summary Table

The ‘barrier’ column in Table 10 presents the ten barriers put forward by the participants. This column represents a general consensus among professionals involved in brownfield and landfill redevelopment projects. A strong correlation between the common barriers outlined in Table 5 and the common barriers mentioned by the participants in Table 11 is evident (see table 12).

5.3 Literature Summary Table

With regard to the barriers to brownfield redevelopment and green space development, Table 11 summarizes the academic opinions of scholars and researchers throughout the literature.
The chosen literature sources for this summary table were selected for the following reasons: (a) Canadian sources provided the Canadian context of this thesis, (b) research projects and theses summarized and added depth to a variety of academic sources on the barriers to brownfield redevelopment; and (c) seminal authors and government organizations, including Christopher De Sousa and the National Round Table on the Environment and the Economy (NRTEE) provided valuable insight on the common barriers to brownfield redevelopment projects. These sources were of particular interest because of their involvement in Canadian research in discussing brownfield to green spaces projects.

Fig. 9 provides a visual representation of the barriers mentioned in Table 10. This figure clearly illustrates the severity of each barrier (Y-axis) and the number of votes given by each professional (X-axis).
5.4 Summary

Table 12 summarizes the results found in both the literature review and the responses of current professionals in the field of converting brownfields to green spaces. Thirty-two scholars and professionals comprised the surveyed sample, totaling 160 votes (one sample = five votes). Fifteen academic studies derived from the current literature and seventeen professional perspectives involved in landfill to green space transformation projects. Totaling these votes successfully identifies the primary and secondary barriers facing professionals in Canadian cities to date.
Table 12: Summary Table (Literature and Participants)

Fig. 10 provides a visual representation of the barriers mentioned in Table 12. This figure clearly illustrates the severity of each barrier (Y-axis) and the number of votes issued by each professional (X-axis).
Fig. 10: Cluster Bar Graph of Table 12
6. Chapter 6: Discussion

6.1 Introduction

In reviewing the data, there was consensus regarding the five major barriers to converting landfills into green spaces. The voting system summarized in Table 12 (page 102) clearly illustrates that the costs, liability concerns, regulatory requirements and public perception/ involvement, are the significant barriers limiting landfill redevelopment projects (five votes each). The voting system presented in Table 11 provides a current representation of the primary barriers facing current projects in the GTA, existing brownfield/landfill redevelopment professionals and the findings of relevant academics. The data collected in chapters 3, 4, 5 provides the foundation for Chapter 6, which analyzes this data to determine the key findings of this research.

The data collected for this thesis derived from three distinct research components - a literature review, interviews and case studies. The literature review consisted of scholarly research papers and government documents that identify the barriers to both brownfield redevelopment and green space development. Interviews were conducted with professionals involved in brownfield and landfill redevelopment projects. These professionals consisted of environmental consultants, brownfield developers and city planners. Data from the interviewees was divided into three separate tables to outline the specific barriers and challenges to each profession. Additionally, a case study summary table was compiled to outline the common barriers encountered by the Keele Valley Landfill, Britannia Landfill, and the Leslie Street Spit. The information for this table was gathered from the participant’s responses, grey literature, and case study documentation.
Table 9 (page 97) summarizes the completed questionnaires that outlined the common barriers to all interviewees who participated in this study.

Lastly, Table 10 (page 98) presents the data collected from all three-research components. This table provides a current and clearer understanding of the key barriers to transforming landfills-to-green spaces in the Greater Toronto Area (GTA).

6.2 Analysis of Data Tables

Table 11 (page 99) was separated into two categories - the barriers to brownfield redevelopment and the barriers to green space development, because of the different nature of both types of projects. The key difference between brownfield redevelopment and green space development projects is potential on-site contamination. Brownfield sites are often forced to take additional precautions when redeveloping a site, whereas the literature on green space development is the introduction of new greenery on ‘clean’ lands.

In Table 11, the top three barriers in each category are highlighted in bold, with liability concerns and high costs as the top two barriers. Overall, the top five common barriers based on a fifteen-source sample of the literature were (1) liability concerns, (2) the high costs of brownfield redevelopment projects, (3) complicated regulatory requirements, (4) a lack of understanding/communication between professionals and stakeholders and (5a) uncertain cleanup standards and (5b) a projects location. Table 6 provides a sound base with regard to the significant barriers outlined in Canadian literature.
Table 6 outlines the most significant barriers currently facing city planners, based on a sample size of six professionals. These participants have helped identify these challenges by voting and providing a rating out of five, based on the severity of the barrier. Ten barriers were mentioned, but the focus of Table 6 (page 95) includes barriers with a minimum of three votes.

The cost associated with converting a landfill to a green space was determined as the number one impeding barrier. With an average ranking of 4.5/5, all six planners mentioned ‘cost’ and emphasized it as the most significant challenge delaying landfill redevelopment projects. The consensus for this barrier derives largely from the expensive up-front costs of remediation, development, ongoing monitoring and continuous maintenance.

Table 7 outlined the common barriers facing developers. Based on this sample, the two main barriers for developers consisted of costs and liability. Both barriers received two votes each and were given a high average rating of 4.5/5 and 5/5. Acquiring sufficient funding for landfill redevelopment projects is challenging for developers, due to the average size of landfills, remediation strategies and required infrastructure. Liability concerns arise with every brownfield redevelopment due to risks involved in exposing harmful materials or contaminants to site users. Sites must be properly remediated and implemented with the appropriate monitoring infrastructure to ensure that a site is safe.
Table 8 outlined the responses of four environmental consultants. The ‘costs’ of a given project was mentioned by all four consultants and was given the highest overall rating. It’s important to note, that it is difficult to generalize the upfront costs of a given landfill project due the varying degrees of contamination and property size. An example provided by the Toronto Regional Conservation Authority (TRCA) outlined the high costs of remediation, restoration and site preparation for Tommy Thompson Park (TTP), which was estimated at $1,000,000 (TRCA 88). Liability and regulatory requirements were stated as the key secondary barriers to converting landfill into green spaces. With respect to environmental liability, consultants are concerned with migrating contamination and its’ potential exposure to park users. Golf destinations like Braeben Golf Course (formally Britannia Landfill) have high usage rates during the warmer months of the year, emphasizing the importance of daily groundwater and methane monitoring.

Table 9 illustrates the data on the five case study participants, which were divided among three case studies - the Keele Valley Landfill (KVL) (two interviewees), the Britannia Landfill (one interviewee) and the Leslie Street Spit (two interviewees). Although all three studies fit the criteria of a ‘landfill to green space’ project, all three end land uses are different. Once completed, the KVL will become a multi-use park with a variety of recreational opportunities. The Britannia Landfill completed its transformation in 2005, turning this municipal landfill into a public golf course. Lastly, through natural succession, TTP began its’ evolution on the Leslie Street Spit in the early 1970’s. This site was eventually managed by TRCA to preserve its wildlife and natural ecosystems.
Even with different end land uses, these projects encountered similar challenges in their transformation from a landfill to a green space.

The five participants emphasized the costs of a given project, liability concerns and meeting regulatory requirements as the top three redevelopment challenges. All three barriers were given an average rating of 4/5. The uniqueness of each case study results in a variety of secondary and tertiary barriers. Public perception, a lack of public involvement and communication, time and maintaining raw lands are all examples of additional challenges to overcome when attempting to transform a landfill into a green space.

6.3 Summary of Table 12:

Table 12 provided this research project with a current and better understanding of the common barriers to transforming landfills to green spaces in the GTA. The cost involved in any landfill to green space project was outlined as the number one barrier, with a total of 32 votes out of 32 surveyed. Planners and developers have ‘difficulty acquiring the capital to pay for three activities unique to brownfield redevelopment - the site assessments, the site remediation plan and the actual site cleanup’ (Bartsch 26).

Fortunately, the majority of landfills in Canadian cities are city-owned properties and don’t require the additional costs of purchasing land for new green space projects. As a result, municipal and/or federal governments primarily provide the funding necessary to support landfill redevelopment projects in the GTA. Even though purchasing costs are avoided, government budgets are often utilized for a variety of city projects needing
similar funding and financial support. Additionally, parks and green space create minimal economic return for investors, which can deter planners and developers from initiating green space development projects on landfills.

Concerns relating to liability were voted the second most significant barrier to converting landfills to green spaces. A quote from the Canadian Institute for Environmental Law and Policy, states that liability “…has been one of the major impediments to brownfield redevelopment in Canada. The parties involved in a brownfield transaction or development project can potentially be exposed to risks of liability that are infinite as to quantum and time” (CIELAP 2). With a total of 31 votes out of a potential 32, liability is a major concern for all stakeholders involved in landfill redevelopment projects.

First, “long forgotten activities of the past can come back suddenly to create an environmental problem when least expected” (CCME 1). Both the private and public sectors are concerned about increased exposure to liability, resulting in “significant unforeseen expenditures” (CCME 1). Secondly, governments want to ensure that taxpayers are not burdened with costs associated with poor environmental practices of the past. Lastly, liability concerns arise due to potential migrating contamination and leachate to neighboring sites. Sometimes, contamination is contained and stays on-site, while other times it spreads and pollutes soil and water including groundwater, which may be the source of drinking water.
Complicated regulatory requirements and cumbersome approval processes were determined as the third most significant barrier to overcome. With 21 out of 32 potential votes, this challenge has the potential to impact all stakeholders involved in transforming landfills-to-green spaces. Obtaining timely development clearances, delays in approval processes and stringent environmental regulations outlined by the MOE and EPA, all cause this barrier to be a significant challenge to overcome.

In regard to the public, both their involvement and potential negative perception can be a significant barrier for landfill redevelopment projects. Although public involvement is important for determining a suitable end land use for a given landfill project, their involvement can cause redevelopment delays to occur. Council meetings, aggressive community members and neighboring residents can potentially delay projects from starting. With any new project, addressing public concerns over health and safety are important details to communicate.

Both communication and location both received eleven votes each. Although these barriers ranked fifth in Table 12, consistent communication amongst all stakeholders is a crucial barrier to overcome for any landfill redevelopment project. These barriers should not be underestimated and should be strongly considered when attempting to convert a landfill into a new green space.

Although there was general consensus on the main barriers to transforming landfills-to-green spaces, some differences are evident between the literature data and the
participant’s data. The literature review (e.g. see table 11) strongly emphasized uncertain cleanup standards, a lack of available funding and a lack of government involvement as three distinct challenges. The participant’s data did not mention any of these, but instead emphasized the control of contaminants and operational/ geotechnical design as significant barriers. A visual of these differences is evident in Fig. 11.

Fig. 11: Differences in Data

6.4 Key Findings

All landfill sites in Ontario are given a lifespan or dumping capacity. Once their limits are reached, the appropriate planning and development initiatives are imperative for the success of a given redevelopment project. Developing a better understanding of the current barriers limiting landfill redevelopment projects is the first step to increasing the success rate, and reducing the time needed to complete these initiatives.

Although the barriers are significant for all professionals involved, the numerous social, environmental and economic benefits should raise landfill redevelopment projects on a
city’s priority list. The economic benefits include a creation and retention of employment opportunities, increased tax revenue sources and reduced urban sprawl. Landfill redevelopment can utilize existing properties to fulfill green space deficiencies, while reducing development pressures on greenfields in a city’s outlying areas.

Landfill redevelopment can also drastically improve its surrounding environment. With the construction of ‘gas to energy’ systems, air quality is significantly improved due the collection and conversion of methane. The restoration of soil and groundwater are also improved with the assembly of monitoring and collection systems. Socially, landfill redevelopment transforms a once hazardous site into potential passive and recreational green space. These types of projects help revitalize surrounding neighborhoods by attracting new families and businesses, while improving the health and livelihood of those close by.

There is a significant difference between the management of landfills and all other brownfields. Landfills have their own unique challenges when attempting to manage contaminants, remediation, redevelopment and development. The different challenges facing landfill redevelopment projects compared to most brownfields are its (1) unstable lands, (2) methane production, (3) leachate, (4) development restrictions, and (5) magnitude. Unstable lands create both development restrictions for future end land uses, and cause redevelopment delays due to the slow decomposition of waste. The production of methane, carbon dioxide and leachate is a unique challenge to landfills. Brownfields have a variety of contaminants impacting the surrounding soil and water, but landfills
have an additional challenge in assuring the air quality is also protected. Lastly, landfills are often very large properties. This creates additional challenges compared to most brownfields in that larger redevelopment projects have more variables. Larger brownfields (i.e. landfills) have higher costs, more stakeholders involved, and are generally more complicated.

With the completion of my literature review and the supportive data from my interviews and case studies, the results from my finding were similar to my predictions. The difference between my predictions and the final results was that ‘operational / geotechnical design’ was not considered a major barrier (see table 12). This was an unexpected result because compared to most brownfields, landfills have additional operational challenges when attempting to remediate and redevelop. Due to its unstable lands, often large in magnitude, and high degree of environmental and social impacts (air, water and soil contamination), landfills pose significant challenges for all stakeholders. The significance of this is that technologies and strategies for managing landfill contaminants have advanced considerably, to the point where it is no longer a major challenge. The collection and conversion of gas to energy has made these types of redevelopment projects profitable, while the advancements in leachate containment and monitoring, ensure a site is being properly managed. Another interesting and relatable observation from Table 12, is that the fifteen sources from the literature review did not mention operational / geotechnical design as a barrier, while every type of professional mentioned this as an obstacle. My conclusion to this is that landfill redevelopment
projects are more complicated in regards to geotechnical design compared to other types of brownfields.

A second unexpected result was the heavy emphasis on ‘uncertain cleanup standards’ throughout the literature review (six total votes), versus zero votes in the interviews. When grouping brownfields together, confusion can potentially occur in regards to which standards apply to which type of brownfield. Whereas asking knowledgeable professionals in the field of landfill redevelopment about the applicable standards for landfills, they are generally fully informed. Government authorities and the MOE have are improving in regards to outlining current landfill standards for all professionals and stakeholders involved in a landfill redevelopment project.

It has been mentioned sparingly throughout this thesis, but there is a hierarchy of end land uses that is recommended when building on landfill sites. Although any type of development is possible, professionals have recommended that green spaces are the ideal alternative use for landfills. Green spaces are the ideal uses for former landfills by default. Due to a landfills condition, heavy infrastructure and built form are not smart development choices. Unstable lands, the collection of gases, and underground contaminants is not a place where residents should be permanently residing. Thus, the hierarchy of end land uses for landfills would consist of (1) parks and recreational spaces, (2) industrial, (3) commercial, and (4) residential. The type of green space that should be determined is case dependant and relates to the public deficiencies of a given community.
Both the case study and semi-structured interviews had their own unique limitations when attempting to select the ideal case studies and interviewees. Due to the often-long history of landfills in Ontario, identifying and contacting the relevant professionals involved in these projects became unrealistic. Thus, the information from the semi-structured interviews was sometimes passed down from previous employees, emphasizing the importance of grey literature to fill in any information gaps.

6.5 Conclusion

Chapter 6 provided a summary and an analysis of the three major research components in this thesis – a literature reviews, three successfully redeveloped case studies in the GTA, and seventeen professional interviews. A clear consensus of the top five barriers to transforming landfills to green space was evident in Table 1. The associated costs, liability concerns, unclear regulatory requirements, public perception/involvement, a site’s location, and a lack of communication were identified as the primary barriers.
7. Chapter 7: Conclusions and Recommendations

7.1 Introduction

The goal of this research was to clearly identify the five major barriers to transforming landfills to green spaces and to provide recommendations to help alleviate these obstacles for future redevelopment projects. Numerous challenges were identified throughout the literature, case studies and interviews. Identification of the key barriers (top 5) is the first step toward successfully redeveloping landfills into green spaces.

The need for this research derives from three key components. First, there is a lack of information on the specific barriers to redeveloping landfills throughout the literature. Secondly, the City of Toronto has among the lowest green space per 1000 people in Canada (Evergreen 8) and thirdly, closed landfills have limited options for potential end land uses. This research provided justification for why green spaces are a good land use for closed landfills, the need for additional green space in the GTA, and the multitude of social, environmental and economic benefits these projects can offer to a surrounding community.

There are a variety of key elements that should be assessed, in order to determine whether a closed landfill is a suitable site for future green space. These elements consist of (1) location, (2) size, (3) slope/terrain, (4) the type waste, and (5) the political will. The location of a landfill can strongly influence the type of future end land use that will occur. For example, if a landfill is situated in a highly residential / sub-urban area with minimal public green space, this landfill property becomes an ideal site to alleviate community
deficiencies. If a landfill is located in a highly profitable area, developers and city planners will be more inclined to excavate and build commercial or residential condominiums. Both the size and the slope / terrain can restrict the type of future end land use that occurs on a landfill site. Smaller landfills with large slopes are often limited to passive recreational green space (i.e. open fields), while large and flat landfill sites have more opportunities for organized recreational activities (i.e. golf courses, baseball diamonds, soccer fields, etc.). The type of waste can also impact the future end land use of landfill site. Construction fill, consisting of primarily rock and dirt is far more stable relative to human induced garbage (MOE 1). Human waste needs time to decompose in order for development stages to commence, whereas construction fill is easily compactable and more stable to build on. Lastly, political will plays a large role in the future end land use of a landfill site. Government authorities and city planners need incentive to designate lands for future green space. Without it, closed landfills will remain idle and underutilized.

In Ontario, landfills were originally situated in remote areas to avoid community disturbances, such as noise and smell. Over the past few decades, urban sprawl has reached the locations of these once remote landfills. This has created a stronger necessity for landfill redevelopment strategies to return these sites to productive uses.

7.2 Summary of Approach and Main Findings

The approach for this report included a literature review, an assessment of three case studies and interviews. These three research components have identified a variety of landfill to green space obstacles, including a consensus on the top five barriers. As
outlined in Table 12, the main findings (barriers) include the costs of a given redevelopment project, liability concerns, unclear regulatory requirements, public perception/involvement, and the location of a given landfill site. The costs and liability concerns were identified as the top two barriers, while unclear regulatory requirements, public perception/involvement and location were ranked 3, 4, 5 (see table 12).

Chapter 1 provided an introduction to the topic of brownfield redevelopment, by outlining the need for research, current landfill standards in Ontario, and the importance of urban green spaces. Chapter 2 outlined the methodology to this thesis.

Chapter 3 outlined the significant background research and academic perspectives relating to both brownfield redevelopment and green space development. This chapter helps identify the barriers identified in the literature, while providing a strong base for understanding the current context regarding landfill to green space transformations in Canada.

Chapter 4 provided this study with three successful redevelopment examples situated in the GTA. These case studies presented specific strategies for overcoming the challenges to each redevelopment project. Chapter 5 summarized the opinions of sixteen professional participants, helping to identify the specific barriers to each profession, the five most common barriers to converting landfills to green spaces and strategies for overcoming them. Chapter 6 discussed and analyzed the data collected from chapters 3, 4, 5 and summarized the key findings of this thesis.
7.3 Recommendations for Overcoming the Financial Barriers

Although each landfill redevelopment project will have their own unique challenges, this research has identified the most common barriers to converting landfills into green spaces. This chapter will provide solutions and recommendations to overcome the most common barriers to converting landfills into green spaces.

The costs associated with converting a landfill into a green space was outlined as the most significant barrier to overcome. This is due to a variety of factors, including:

- The costs of hiring professionals
- Required environmental assessments (EAs)
- Developing remediation strategies
- Construction of methane and groundwater monitoring systems
- Installation of liners to prevent leachate from migrating
- The dumping and compaction of clean fill
- The potential removal and hauling of on-site material
- Funding for ongoing methane and groundwater monitoring
- Additional small structure developments and infrastructure
- Funding for ongoing maintenance
- Staff Salaries

These combining factors often delay or deter landfill to green space projects from occurring. This section will outline the recommended strategies for overcoming the high costs of remediation, redevelopment, and ongoing maintenance.
7.3.1 Recommendations

The main financial barriers are the costs of hiring professionals, developing remediation strategies, the construction of monitoring systems and the development of the green space or recreational area.

(1) Government funding is the first effective method to overcoming the high costs of redeveloping landfills. Since the majority of landfills are municipally owned, local governments are responsible for the remediation and redevelopment of these sites once a landfill reaches its’ capacity. Municipalities have available funding for new green space development projects and brownfield redevelopment projects. The Ontario government has empowered municipalities with the ability to offer financial assistance to promote community planning goals, including brownfield redevelopment (Ontario 4). Community Improvement Plans (CIPs) made under the Planning Act have been used by municipalities to offer such financial assistance. Under Section 28 of the Planning Act, all or part of a municipality can be designated as a Community Improvement Project Area (CIPA). A municipality may then prepare a CIP for the CIPA. The Ontario Ministry of Municipal Affairs and Housing have stated that “in recent years, an increasing number of Ontario municipalities have been providing financial incentives to promote brownfield redevelopment within the context of a municipal CIP (“Brownfields Showcase II” 5). Municipally owned landfills can be considered as CIPs and thus can receive funding from the provincial government for landfill redevelopment projects.

(2) A second opportunity to reduce the economic and financial burdens of landfill to green space projects include private investments. Gas collection and energy generating
companies can partner with local municipalities to implement electricity generation plants and well systems on a landfill. A private investment example, which was discussed in Chapter 4, is the Integrated Gas Recovery Services (IGRS) investment in the Britannia Landfill. This private company invested in the necessary infrastructure and machinery to collect and convert methane into energy. This private-public partnership was successful for a variety of reasons. First, the municipality avoids the costs of implementing a landfill gas collection system, because the IGRS paid for all the capital and operating costs. Secondly, the municipality receives royalties for landfill gas, while collecting greenhouse gas (GHG) emission reduction credits for the project. These GHG credits can be sold to other polluters to raise additional revenue. IGRS was also satisfied with the arrangement because they profit from selling the converted energy to the surrounding municipalities.

(3) A third opportunity to reducing the impacts of high costs is a reserve fund. While in operation, a landfill can collect its ‘dumping fees’ and place that money in a reserve fund. With the eventual closure of a landfill, this money can then be put towards project redevelopment efforts and help reduce the high financial impacts. For example, the Keele Valley Landfill (KVL) averaged 1.4 million tonnes of Toronto’s waste every year (Yuen 1). The dumping prices at the KVL fluctuated during its’ operation, but in 1988 the cost of dumping one ton of garbage was $18 dollars Canadian (Royson 1). Thus, in one year of operation, the KVL accumulated $25,200,000 dollars in dumping revenues. An employee working at the KVL stated that operating a landfill has its own set of costs, but portions of this ‘dumping’ revenue could be placed in a reserve fund and set aside for future redevelopment initiatives (City of Vaughan 1).
A fourth strategy for overcoming the costs of a landfill to green space redevelopment project is phased or ‘cell-by-cell’ development. This strategy allows landfill cells to be redeveloped in stages, rather than all at once. This increases flexibility for a landfill owner to redevelop certain cells, while continuing to collect revenue from operating cells. Larger landfill sites such as the Leslie Street Spit, can predominantly benefit from this type of strategy. This site has gone through a series of phase developments over time, consisting of cell closures and new green space expansions.

Recovered materials, including metals, plastic, rubber and glass can provide additional income for landfill sites by selling recycled materials to specific markets and buyers. For example, the municipality of Muskoka, Ontario, raised an estimated $500,000 in revenue in 2010, and in the process diverted recyclable goods back to the manufacturing of new products (CBC 1). This strategy can provide additional profits to help alleviate the costs associated with redeveloping landfills.

The costs associated with landfill to green space transformation projects were outlined as the number one impeding factor. Overall, a number of financial opportunities exist for alleviating the high costs of remediation, redevelopment and ongoing maintenance. In summary, government funding, private-public partnerships, reserve funds and phase developments can all contribute to the successful redevelopment of a given landfill.
7.4 Recommendations for Overcoming Liability Concerns

Liability was determined the second most difficult barrier to overcome when converting a landfill into a green space in the Greater Toronto Area (GTA). Liability is a major concern for all professionals involved, including landfill owners, site developers, city planners and environmental consultants.

Professionals are concerned about remediating landfills for three distinct reasons.

(a) Ensuring a safe and hazardous-free green space for park users.

(b) Potential lawsuits if an incident do occur.

(c) Retrospective environmental costs

7.4.1 Recommendations

(1) The first recommendation for ensuring the liability risks associated with landfill redevelopment are mitigated is the proper installation of monitoring systems and liners. The construction of this monitoring infrastructure plays a pivotal role in providing ongoing information on methane levels, on-site water quality and any potential migrating leachate. Multiple interviewees emphasized the importance of these monitoring systems.

A technical analysts from the Britannia Landfill stated that strategies from reducing liability concerns would consist of ‘monthly monitoring of perimeter gas probes, daily monitoring of pressure levels with the gas collection system to prevent odors and gas migration and the appropriate liners during the redevelopment process’ (Britannia Landfill 1). A second interviewee stated that ‘the demonstration of past monitoring data and compliance can help reduce liability risks associated with landfill redevelopment’ (Gnanayudam 1). The installation of monitoring systems is not only required for
redeveloping landfills, but it ensures the safety of a given site and limits potential negative impacts on park users. Secondly, the proper construction of monitoring systems and properly maintained site records can provide valuable information and documentation to defend against a lawsuit.

(2) Public involvement is another important strategy for the development of environmental policies. The Canadian Council of Ministers of the Environment (CCME) emphasizes that contaminated site remediation should incorporate ‘openness, accessibility and participation’ (CCME 4). Furthermore, “accessible information and opportunity for public input are considered fundamental to the development and operation of policy and legislation related to contaminated site liability” (CCME 4). Recommendations by individual interviewees in this study, believe that both the regulatory authorities and the surrounding public be invested in the decisions making process. Anne Breckenridge from the City of Calgary, stated that it is recommended ‘that both regulatory and civil parties should participate in the development of appropriate mechanisms to adequately address liability concerns’ relating to redeveloping landfills (Breckenridge 1). Proper communication and agreement between all stakeholders provides everyone with a better understanding of the risks involved in redeveloping landfills, thus avoiding accidents and potential lawsuits.

(3) Government agencies, including the Ministry of the Environment (MOE), the Canadian Environmental Protection Act (CEPA) and the Canadian Council of Ministers for the Environment (CCME), need to clearly provide environmental regulations and
policies for landfills. Developing a clearer understanding of these regulations, landfill owners and developers will more efficiently remediate sites to meet the contamination standards provided by the Government of Ontario.

(4) In regard to potential retrospective environmental costs, reserve funds should be created during the preliminary landfill planning stages.

Landfill owners and developers must feel adequately protected from environmental liability in order for redevelopment projects to proceed. Without relief from liability risks, Burnham-Howard states “brownfields will remain abandoned and contaminated, communities, mayors, developers, environmental groups and in fact everyone, loses” (1). In summary, ensuring proper monitoring systems are installed, more public involvement, and clearer environmental regulations are recommended strategies for overcoming the challenges associated with liability.

7.5 **Recommendations for Overcoming the Regulatory Requirements**

New legislative and regulatory requirements have been put in place to help encourage the cleanup and redevelopment of landfill sites while ensuring the environment is protected. “These new requirements establish clear rules for site assessment and cleanup, ensure only qualified people undertake this work and provide for the filing of a record of site condition in a public registry” (Ontario, “Records of Site Condition” 1). When redeveloping landfills in Ontario, the results have demonstrated that regulatory requirements were outlined as the third most significant barrier. This occurs for a variety of reasons including:
(a) A lack of communication between stakeholders regarding regulations for landfill redevelopment projects

(b) Obtaining regulatory approvals / timely clearances for development

(c) Land use restrictions for landfills

(d) Non-existent regulatory requirements in the 70’s

(e) Lack of availability of data and information on site conditions

7.5.1 Recommendations

(1) The first recommendation to combating landfill regulatory requirements is good communication. Constant communication between all parties, including regulatory agencies, administration, site developers, city planners and landfill owners, is an important concept to avoid misunderstandings regarding to the required regulations.

Anne Breckenridge from the City of Calgary, states “good communication and cooperation between green space developers and landfill operators on site conditions, and a clear understanding of the roles and responsibilities of both parties is an important recommendation to avoid unnecessary complications” (Breckenridge 1). Thomas Gnanayudam from Franz Environmental Inc, supports the opinions outlined by Breckenridge by stating, “communication with local officials, the public and significant stakeholders is a key strategy in meeting the regulatory requirements outlined by the MOE and EPA” (Gnanayudam 1).

Proper communication during all stages of the redevelopment process is also beneficial for gathering information on a specific site’s condition. A thorough Phase I
environmental site assessment and communication between site owners and consultants can help develop a better understanding of a site’s condition. This is an important step for all professionals involved, because it provides the basis for a Phase II ESA.

Accompanying improved communication is ensuring that all stakeholders have a clear understanding of any ongoing new regulatory requirements. Multiple regulation approvals are required, so maintaining a thorough understanding of the steps involved in converting landfills-to-green spaces is highly recommended.

(2) A second recommendation is determining the end land use of a given landfill site during the preliminary planning stages. Designing a ‘site appropriate end use plan’ for a specific landfill project helps clarify and eliminate the irrelevant regulations. This is an important step due to the varying and unique characteristics of landfills in Ontario. A participant from the MOE supports this claim by stating “all sites are case dependent, causing standardization of landfill regulations to be difficult” (MOE 1). When the end use plans are determined, landfill projects can react accordingly to meet the necessary remediation and redevelopment regulations.

(3) In order to obtain the necessary risk management, closure and post closure approvals, project stakeholders must first understand the required procedures. Site closure involves completing the final cover, landscaping and construction of a site’s monitoring and control works. Post-closure care activities typically involve site inspection, monitoring and maintenance activities, and the construction or replacement of any monitoring or
control works (Ontario, “Landfill Standards” 66). Understanding these regulatory requirements and their associated deadlines during the early stages of a redevelopment project, are essential for avoiding project delays, obtaining development permits and making more projects efficient.

(4) In regards to land use restrictions on landfills, strategies for overcoming this obstacle are unfortunately very expensive. A solutions would be to collect and transport landfill materials to another location. This strategy may be cost prohibitive, but is a possible solution to landfill development restrictions.

Additional recommendations are encouraged, including the proper installation of monitoring systems, a thorough phase I & II site assessment and developing a clear approach to a given project. These secondary recommendations will help transition landfill projects into green space or recreational uses more efficiently. In summary, communication among all stakeholders, determining a site’s end land use in the preliminary stages and meeting designated deadlines are all highly recommended strategies to avoid complications relating to regulatory requirements.

7.6 Recommendations for Overcoming Public Perception/ Involvement

Public involvement is important for every landfill redevelopment project for two distinct reasons. First, the local knowledge and experience of surrounding community members can provide valuable insight on the history of a given landfill site and its nearby public
amenities. Project professionals, municipal governments and the public can discuss ideas to best utilize a newly redeveloped landfill to resolve any potential public deficiencies a community may have. Secondly, it is an important strategy for project planners to keep the surrounding public involved in local redevelopment initiatives. This could potentially save time and avoid future confrontations with the surrounding community.

7.6.1 Recommendations
(1) City council meetings are an ideal place for all stakeholders to communicate on a given redevelopment project. There are a variety of benefits to holding city council meetings. First, these are ideal opportunities for local residents to express their views and opinions on a particular matter. Secondly, it is a very productive way to obtain accurate information regarding the redevelopment process, planning initiatives and timeframes on a given project.

(2) Upfront and ongoing communication should accompany city council meetings. Surrounding neighborhoods and communities of a landfill site have vested interests in the planning and redevelopment process. Keeping the public informed in an organized manner, can save time and money during all stages of the project.

7.7 Recommendations for Overcoming Location and Communication
The location of a landfill and a lack of communication between relevant professionals tied for the fifth most significant barrier when attempting to transform a landfill into a green space (e.g. see table 11).
The one landfill characteristic that cannot be changed is its location. The location of a landfill could potentially be its most attractive feature, or it could be the one deterrent trait that discontinues any discussion of a redevelopment project. In order for new green space initiatives to be considered, a planning committee first determines the demand for this type of public amenity. Chris Wolfe from the City of Calgary, states “if a former landfill is not located where there is a demand for open space, there will simply be no incentive for such purposes” (Wolfe 1).

Communication is an important concept for any partnership. When attempting to redevelop a closed landfill, proper communication amongst all parties is critical to avoid unnecessary project delays and complications. A variety of professionals are involved in any landfill redevelopment project, including city planners, site developers, environmental consultants, government authorities, the Ministry of the Environment (MOE), and the public. Information can potentially be miss-communicated amongst all parties, leading to a variety of unnecessary challenges (e.g. greater time delays and higher costs).

7.7.1 Recommendations

(1) When redeveloping a closed landfill, one recommendation is long-term planning during the early stages of developing a landfill. Cooperation and communication between landfill developers and planning departments can help simplify the redevelopment process once a landfill reaches its designated capacity. Con O’Keefe from the City of Calgary reinforces this concept by stating, “work with planning agencies, so that
strategies can be developed to incorporate the location into the long-term further developments” (O’Keefe 1). Unfortunately, the location of a landfill is one feature that cannot be changed, but long-term planning can improve a site’s future redevelopment.

(2) Recommendations for improving communication between relevant professionals, government authority and the public are to hold regular meetings. Constant communication on the required regulatory requirements, planning restrictions, and development constraints all need to be communicated regularly to successfully redevelop any brownfield site.

7.8 Summary and Future Research

When summarizing the recommendations for approaching the barriers to transforming landfills to green spaces, two distinct observations were evident. The first was a clear interrelated connection between the five major barriers. The costs, liability concerns, regulations, public perception/ involvement, location and communication, all intertwine with each other (see fig. 12).
The first example illustrates the relationship between costs and liabilities. Without the proper construction of monitoring and collection systems (costs), the associated liability risks increase. These systems ensure a site’s safety by regulating its air and groundwater quality, thus reducing the exposure of contaminants to park uses (potential lawsuits) and retrospective environmental costs. Although the development and ongoing costs of monitoring systems are high, it could potentially be saving a landfill owner from future expenses. A second example illustrates the relationship between costs, liability and regulations. In order for a development approval, a certified environmental consultant is required to complete an ESA. This is a requirement issued by government authorities, which increases the overall redevelopment costs and reduces the potential liability risks. These are two examples on how the top five barriers are interrelated, emphasizing a clear approach to transforming a landfill into a green space. It is recommended that the associated barriers be addressed simultaneously to maximize efficiency and potential success.
The second observation relates to importance of communication. Communication was mentioned by all interviewee participants as a strategy for overcoming numerous challenges including the regulatory requirements, collaborating with the general public, ensuring minimal liability risks, and developing an accurate understanding of the potential costs. Any successful partnership must establish accurate and ongoing communication to overcome the common barriers and to achieve their goals.

In regard to future research, the topic of transforming landfills to green spaces still requires a variety of in-depth exploration. This thesis focuses on identifying the precise barriers associated with landfill to green space projects, but further research is needed on the specific details of each barrier. An in-depth look into the financial, liability, and regulations related to landfill redevelopment projects would provide professionals with more strategies and information on how to overcome each obstacle. For example, a lack of communication was mentioned as a significant barrier to transforming landfills to green spaces. Several interviewees also mentioned communication as a key strategy for overcoming these obstacles. An interesting and beneficial research project could explore the importance of communication between professionals and stakeholders. Based on the research, there is a disconnect between both parties, which could potentially create an interesting research project for future students.

Due to the varying redevelopment factors in Canadian cities, including policies and regulations, additional research would be beneficial on a city-by-city basis. It is difficult
to generalize the common barriers to converting landfills to green spaces across Canada, because of the uniqueness of project; therefore additional research for specific Canadian cities could clarify whether barriers differ across Canada. Lastly, further research is needed on successful versus unsuccessful landfill to green space conversion projects. Developing a better understanding of why certain projects are successful while others fail to overcome their specific barriers would be a beneficial case study approach. Overall, a variety of new and more specific research projects are needed to further understand the challenges facing professionals.

Although a variety of barriers are present when transforming landfills to green spaces in the GTA, strategies are available to alleviate these obstacles and guide more successful redevelopment projects. The three cases studies located in the GTA have achieved encouraging success in redeveloping their specific landfills. Their success has an inevitable association with government’s persistent commitment, various financial incentives and good public-private partnerships. The researcher regards these issues as successful municipal projects based on a common-sense assumption that all municipal programs/approaches are considered “successful” if the redevelopment transpires as opposed to the corresponding option of not being redeveloped at all.

Closed landfills exist throughout every Canadian province. However, while many municipalities have considerable experience with landfill policies and regulations, others are newer to the landfill policy arena. Information sharing and learning from past successes and challenges are key to the development of future landfill projects. It is
hoped that this report will further assist upcoming landfill to green space projects and transform a once hazardous site into a new amenity for all to enjoy.
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NRTEE, National Round Table of the Environment and the Economy. Removing Barriers: Redeveloping Contaminated Sites for Housing. Ottawa: National Round Table of the Environment and the


Appendix I:

**Consultants:**

1) In your past experience, have you worked on a landfill redevelopment project in Ontario?
   a. What was the end land use for that/those project/s? Any Green space?
   b. Were any of these projects successful?
   c. What specifically allowed this project to be successful? Reasons/Key Characteristics?
2) Do you know of any ‘landfill to green space’ redevelopment projects in the GTA?
3) In your opinion, are parks and green spaces the best end land uses for closed landfill sites?
4) What are the benefits of transforming landfills to green spaces?
   a. Economic?
   b. Environmental?
   c. Social?
5) Generally, what are barriers to landfill redevelopment?
6) What specific challenges have you faced as a Consultant, in regard to transforming landfills to green spaces?
7) What strategies did you implement to overcome these obstacles?

**Planners:**

1) In your past experience, have you worked on a landfill redevelopment project in Ontario?
   a. What was the end land use for that/those project/s? Any Green space?
   b. Were any of these projects successful?
   c. What specifically allowed this project to be successful? Reasons/Key Characteristics?
2) Do you know of any ‘landfill to green space’ redevelopment projects in the GTA?
3) In your opinion, are parks and green spaces the best end land uses for closed landfill sites?
4) What are the benefits of transforming landfills to green spaces?
   a. Economic?
   b. Environmental?
   c. Social?
5) Generally, what are barriers to landfill redevelopment?
6) What specific challenges have you faced as a Planner, in regard to transforming landfills to green spaces?
7) What strategies did you implement to overcome these obstacles?

**Developers:**

1) In your past experience, have you worked on a landfill redevelopment project in Ontario?
   a. What was the end land use for that/those project/s? Any Green space?
   b. Were any of these projects successful?
   c. What specifically allowed this project to be successful? Reasons/Key Characteristics?
2) Do you know of any ‘landfill to green space’ redevelopment projects in the GTA?
3) In your opinion, are parks and green spaces the best end land uses for closed landfill sites?
4) What are the benefits of transforming landfills to green spaces?
   a. Economic?
   b. Environmental?
   c. Social?
5) Generally, what are barriers to landfill redevelopment?
6) What specific challenges have you faced as a Developer, in regard to transforming landfills to green spaces?
7) What strategies did you implement to overcome these obstacles?

**Case Studies:**
1) When did this landfill open?
2) Who originally owned the property? Was it sold to the City?
3) How long was the landfill operational?
   a. When did it close?
   b. How many months did it sit idle before remediation/ redevelopment began?
   c. How long did the site sit idle (X months)? What delayed the redevelopment?
4) Who owned this landfill when it was in operation?
   a. Who led the redevelopment? Public or Private?
   b. How was the contamination on site managed?
5) What is the current use of this landfill site? Site details, layout?
   a. Why did this landfill become a green space?
   b. Who initiated the redevelopment? Public or private?
   c. What type of upkeep or ongoing monitoring is necessary? Who funds this (costs)?
6) Are green spaces/recreational spaces a good end land use for landfills? Why, Why not?
7) What were the benefits of transforming this landfill into a green space/open space?
   a. Economic?
   b. Social?
   c. Environmental?
8) If any, what were the main barriers to redeveloping this site into a green space?
   a. How were these barriers overcome? Details?
9) What specifically allowed this project to be successful? Reasons/Key Characteristics?
Appendix II:

Frank Barone, Principle Geotechnical Engineer, Golder Associates Ltd., Mississauga, Ontario

Eugene Benda, Landfill Monitoring Head Supervisor, Keele Valley Landfill, City of Vaughan, Ontario

Anne Breckenridge, Environmental Specialist, Environmental Assessment & Liabilities, Environmental & Safety Management, The City of Calgary

John Carley, Co-Chair, Friends of the Spit, Advocacy group Leader for the Preservation of Tommy Thompson Park (TTP)

Lou Ciardullo, Manager, Keele Valley Landfill, City of Vaughan

Nancy Gaffney, B.Sc., Waterfront Specialist (Planner), Toronto and Region Conservation Authority

Tricia Grieef, B.Sc., M.E.Des., Natural Areas Project Coordinator, The City of Calgary Parks, The City of Calgary

Jim Haraishi, Senior Engineer, Non-Hazardous Waste Policy Section, Waste Management Policy Branch, Ministry of the Environment (MOE) The City of Toronto

Thomas Gnanayudam, Geotechnical Engineer, Manager, Franz Environment Inc., Mississauga, Ontario

Neil P. Mackimmie, MBA, Development Manager, Calgary Municipal Land Corporation (CMLC), The City of Calgary

Rick Maj, Technical Analyst, Waste Management Division, Remediation and Environmental Solutions, Region of Peel

Angeles Mendoza, Environmental Consultant, Biophilia Inc., Calgary

Doug McDonald, Senior Planner, Brown and Associates, The City of Calgary

Con O’Keefe, Environmental Specialist, The City of Calgary

Keath Parker, Parks Development,
The City of Calgary

**Chris Wolfe**, Planner,
New Community Planning, Land Use Planning & Policy,
City of Calgary
Appendix III:

Braeben Golf Course, formerly Britannia Landfill

(http://www.reliableplant.com/Read/18574/energy-efficient-automation-helps-generate-electricity-from-landfill)

Britannia Landfill: Gas to Energy Plant (IGRS, 2007).
Leslie Street Spit (http://www.friendsofthespit.ca/)