ANALYSIS OF THE FACILITY OPTIONS FOR THE VANCOUVER SOUTH TRANSFER STATION

by

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ABSTRACT

This thesis reviews five options for upgrading the Vancouver South Transfer Station ("VSTS") to meet Vancouver's solid waste management requirements over the next 15 years. Examining the role of the VSTS was based on Metro Vancouver's proposed changes to the existing 1999 Solid Waste Management Plan and resulting uncertainty related to garbage disposal in the Region.

This thesis consisted of reviewing operational requirements for VSTS. A base case financial model for each scenario was developed to assess financial impacts in terms of annual total costs to Vancouver and potential net revenues. The results of the base financial analysis was subjected to sensitivity analysis to determine which variables have the greatest impact on the financial outcomes. Based on the sensitivity analysis, a risk analysis was completed.

The results of the base case financial evaluation show that Vancouver's best financial alternative is to limit residential access to VSTS (Scenario 3). Further, based on the risk analysis restricting access to the VSTS remains the preferred financial alternative.

A qualitative analysis of the scenarios was conducted for factors that could not be expressed financially, but influence the overall conclusions and recommendations. Based on a comparison of the qualitative factors, closing the facility (Scenario 4) has the greatest negative impact. Comparatively, building a new facility would have the greatest positive impact (Scenario 1 (a) and Scenario 2).

Recommendations that arise from this thesis are that Vancouver should continue to dispose of Vancouver origin waste at the VSTS. Closing the facility would result in increased environmental impacts and financial costs of hauling waste to the Vancouver Landfill. Based on the ongoing uncertainty related to solid waste regional planning decisions related to upgrading the facility should not be finalized at this time.

Further, Vancouver should use VSTS to the maximum extent possible by restricting access to residential customers. Vancouver should also investigate the opportunity to provide large item

pickup to ratepayers. This would assist in reducing negative impacts resulting from restricting access and could also reduce the need for residents to use VSTS on a frequent basis.

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LISTS OF ABBREVIATIONS

"1995 SWMP"	The Metro Vancouver regional Solid Waste Management Plan currently in legislation at the time that this thesis was written.
"Base analysis"	The quantitative analysis of scenario costs and benefits, before adjusting key inputs for risk during the risk analysis.
"The City"	The municipal corporation, generally known as the City of Vancouver, as described under the Vancouver Charter.
"City collection"	Garbage collections by City of Vancouver Sanitation crews. This is almost exclusive from single family residents, with a few duplex and multi-family units.
"Commercial collection"	All Vancouver-origin garbage that is collected by commercial waste haulers, including multi-family residents and commercial business, along with waste delivered by residents directly to the VSTS.
"Delta"	The municipal corporation, generally know as the Corporation of Delta.
"Future SWMP"	The updated Solid Waste Management that Metro Vancouver is in the process of amending.
"Garbage"	Waste that remains after waste diversion and must be disposed of.
"GVS&DD"	The legal entity titled the Greater Vancouver Sewerage and Drainage District, in general referred to as Metro Vancouver.
"Large commercial loads"	Loads greater than 140 kilograms, used for the purpose of restricted access analysis as described in Section 6.1.1.

“Large loads”	Loads greater than 5,500 kilograms, used for the purpose of capacity analysis as described in Section 3.11.1.
“ICI Waste”	Industrial, Commercial and Institutional Waste.
“Metro Vancouver”	Formally GVRD means the regional district comprised of twenty-one member municipalities and one electoral area.
“NPV”	Net present value.
“Other MV Garbage”	Garbage originating outside of Vancouver.
“Ratepayers”	Vancouver single family residents who pay for waste collection and disposal through their municipal taxes (typically single family dwellings).
“Regional rate”	The rate charged for garbage disposal at Metro Vancouver waste facilities, including VL and VSTS. This rate is set by the Greater Vancouver Sewerage & Drainage District and reflects the costs for waste disposal based on the operation of all the region’s waste transfer and disposal facilities. This thesis contemplates increases to the regional rate, based on the proposed additional of waste to energy facilities.
“Risk-adjusted results”	The results of the quantitative analysis after the risk analysis, which makes adjustments for key inputs using Monte Carlo simulation.
“Small loads”	Loads less than or equal to 5,500 kilograms, used for the purpose of capacity analysis as described in Section 3.11.1.
“Small residential loads”	Loads less than or equal to 140 kilograms, used for the purpose of restricted access analysis as described in Section 6.1.1.

"SWMP"	Metro Vancouver's existing 1995 Solid Waste Management Plan.
"Tripartite Agreement"	The 1989 Tripartite Agreement between Vancouver, Delta and the Greater Vancouver Sewerage & Drainage District. This Agreement is valid until 2037. Among other things, it describes regional waste distributions, revenue distribution and transfer capacity.
"Vancouver garbage"	Garbage originating within the City of Vancouver.
"VL"	The Vancouver Landfill located at 5400-72nd Street in Delta, B.C.
"VSTS"	The Vancouver South Transfer Station located at 377 West Kent Avenue North in Vancouver, B.C.
"WTE"	Waste-to-Energy facilities.

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I would like to express my appreciation for support from the City of Vancouver. I have been so privileged to work with other passionate individuals in my career and research endeavors.

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I am incredibly grateful to my husband Keith, who always respects and supports my choices. His love and patience throughout my education has been unwavering. And to our new baby who is about to join our family. You have encouraged me to complete my educational pursuits for the time being and focus on new challenges that life will offer.

DEDICATION

This thesis is dedicated to my dad, for his continuous support and encouragement towards my educational endeavors

1.0 INTRODUCTION

1.1 Purpose

The purpose of this thesis is to provide a case study for upgrading the Vancouver South Transfer Station ("VSTS"). The objective of which is to review the options for upgrading the VSTS to meet Vancouver's solid waste management requirements over the next 15 years. The need to examine the role of the VSTS is based on Metro Vancouver's ("MV") proposed changes to the existing 1999 Solid Waste Management Plan ("SWMP") and resulting uncertainty related to garbage disposal in the Region.

This thesis represents an extension of the kind of analysis normally done by the City. The role of the author is and has been to generate insights over and above those possible from conventional analysis conducted in support of the City's decision making process.

1.2 Overview

The review of the upgrade options for the VSTS, contained in this thesis, were thoroughly examined and results were assessed based on the implications to Vancouver ratepayers. The preferred options were ranked based on the relative costs and potential net revenues. Sensitivity and risk analyses were used to determine whether the ranking of the options would change based on uncertainties in the variables.

This thesis consists of reviewing and understanding all regulatory and contractual constraints governing VSTS operations. This includes legal agreements, such as the Tripartite Agreement and Vancouver-Delta Agreement; as well as regulatory requirements such as the Ministry of Environment's Waste Management Act.

In addition, the operational requirements for VSTS were reviewed over a 15-year period. This includes waste flow quantities from residential (single and multi-family dwellings) and Industrial, Commercial and Institutional ("ICI") sources from Vancouver, Delta and other Metro Vancouver municipalities.

A review of solid waste programs in other municipalities was also performed to understand the different opportunities for transfer station facility operations. Based on the review, and information about the existing facility, scenarios representing various facility options were analyzed.

In order to analyze the various scenarios, all inputs and assumptions to be used in the financial/business analysis were identified and evaluated. Using the inputs and assumptions, financial models were developed for each scenario that project financial impacts in terms of annual total costs and potential net revenues for the base case.

The results of the base financial analysis were subjected to sensitivity analysis in order to determine which variables have the greatest impact on the financial outcomes among the various facility options. Based on the sensitivity analysis, a risk analysis was conducted associated with the various scenarios.

Further, a qualitative analysis of the various scenarios was conducted for the factors that could not be expressed financially, but have an overall effect on the conclusions and recommendations. These qualitative factors were divided by stakeholder groups, including Vancouver residents, regional residents, commercial customers and Owner/Operator.

In an ideal situation, weighting according to various criteria would be predetermined by decision makers. This would allow for the determination of the preferred option based upon quantitative and qualitative analyses. However, decision makers balance decisions based on personal subjectivity and stakeholders who make their perspectives known to the decision makers through public process.

Therefore, the options are ranked based on the results of the base case analysis. Sensitivity, risk and qualitative analyses are used to test the robustness of the option ranking to determine if the preferred option changes. Any noted changes will be drawn to the attention of the decision makers during the public process. This information can then be evaluated prior to finalizing a decision.

1.3 Description of Scenario Options

A written description for each of the evaluated scenarios is included below. A summary of the scenario options is also included in Table 1.1.

1.3.1. Scenario 1 (a) and (b) - Status Quo

This option uses the existing facility to its maximum capacity. Vancouver waste currently disposed of at other Metro Vancouver facilities will be accepted at the VSTS to the maximum capacity, and the remainder will continue to be disposed of at Metro Vancouver facilities.

Ongoing repairs as outlined in the "VSTS Inspection Report and Maintenance Management System" will be completed in order to maintain operations. Once Metro Vancouver's future Solid Waste Management Plan ("future SWMP") has been finalized, a decision related to building a new facility will be made. Two sub-scenarios are that:

- (a) A new facility is built once it is determined that waste to energy ("WTE") facilities will not proceed, or
- (b) A new facility is not built once it is determined that WTE facilities will proceed.

1.3.2. Scenario 2 - New Facility

This option would involve building a new facility starting construction in 2010. The new facility will be situated to the east of the existing facility, between the VSTS and Manitoba Street. Once the new facility is operational, the existing facility would be demolished.

1.3.3. Scenario 3 - Restricted Access

This option would involve restricting access to the existing building, in order to best accommodate residential collection vehicles and commercial customers whose net weights are over 20 times larger than residential customers. Residential customers would be accommodated during periods when operationally feasible (i.e. evenings and weekends). This could be done through changing the rate structures or bylaws. These types of restrictions are not uncommon in the waste management industry. The assumptions for this option will mirror actions taken in Toronto, Ontario.

Effective July 1, 2009, the City implemented new rates at the VSTS which include a 100 per cent surcharge on small loads during peak periods. Peak periods reflect the times when larger commercial vehicles need to use the VSTS. These times are Monday to Friday from 10:00am to 2:00pm.

1.3.4. Scenario 4 - Close Facility

This option involves closing down the transfer station and thereby forcing City's residential collection crews and other customers to drive to other transfer stations or directly to the Vancouver Landfill ("VL"). Although this scenario would not be contemplated by the City, it is meant for comparative purposes and to show the economics of operating the VSTS.

Table 1.1: Summary of Scenario Options

Scenario Description	Use Existing Facility	Regional WTE	Build New Facility	Restricted Access
***Scenario 1 (a)* -** Status Quo with WTE	Yes (Period 1 & 2)	Yes	No	No
***Scenario 1 (b)* -** Status Quo no WTE	Yes (Period 1)	No	Yes (Period 2)	No
***Scenario 2* -** Build New Facility	No	N/A	Yes (Period 1 & 2)	No
***Scenario 3* -** Existing with Restricted Access	Yes (Period 1 & 2)	N/A	No	Yes (Period 1 & 2)
***Scenario 4* -** Close Facility	No	N/A	No	N/A

2.0 METHODOLOGY

2.1 Municipal Government Traditional Methodology

Municipal governments use predefined procurement processes to obtain external resources such as contracted services, consulting services and supply management. The City of Vancouver has a Purchasing Policy[1] which defines the procurement process. The policy requires that procurement documents, such as Invitation to Tenders and Request for Proposals, are used for procurements over predefined values.

The detailed requirements and specifications used in the procurement documents are at least in part developed, overseen or reviewed by City staff. The requirements and specifications consider the work that is required to be completed, while also considering project schedule and budget constraints.

In the general procurement process, the analyses as described in this thesis would have developed as follows. Staff would have identified the public issue, in this case the aging transfer station infrastructure. Based on public sensitivity of this issue, staff would look to an outside consultant to complete the analysis. Although staff would provide guidance in terms of scope of work, the actual work would be completed by third party to show objectiveness in the process.

City staff would decide on the approach to procure the work. In this case, City staff would develop a Request for Proposals ("RFP") for consulting services. While developing the RFP document, City staff would identify a number of scenarios to be evaluated, while also considering the required project duration and budget (based on known project constraints).

Once finalized, the RFP would be issued into the public realm. Proponents would have the opportunity to participate in the bidding process, and ultimately would submit a Proposal. The evaluation of the Proposals would include both financial and non-financial considerations, with weightings assigned to both categories. For non-financial, a pre-developed non-financial evaluation criteria would be developed by staff. This would include key areas to evaluate along with weighting for each area. A pre-determined group of City staff would review the Proposals

[1] http://vancouver.ca/fs/bid/policy.htm

based on the evaluation criteria, without knowing the pricing. The financial and non-financial considerations would then be summarized to determine the best overall value to the City.

Once a successful Proponent has been retained, City staff would continue to work with the Consultant to provide required information, review work completed and evaluate the final recommendations. The level of detail to which the project is completed depends upon the requirements as set out in the RFP. Often times, the schedule or financial constraints make it necessary to make a number of assumptions in order to simplify the project to stay within the project constraints.

2.2 Thesis Methodology

This thesis takes a different approach to the process as described in Section 2.1. Based on schedule and budget constraints required in municipal government traditional methodology, it is highly likely that the options evaluated would have included theoretical options. Therefore, options such as Scenario 4 – Close Facility, would not have been evaluated in municipal government traditional methodology. The evaluation of this Scenario is included in this thesis and is important in order to analyze how municipal government makes decision. In particular, in understanding how qualitative factors influence decision making.

In the in municipal government traditional methodology approach, it is common to make a number of assumptions in order to reduce the scope. In this thesis, detailed analysis was performed on many of the input parameters that would have been subject to assumptions by a consultant. The author has a higher level of understanding of facility operations as a result of being intimately involved with the VSTS for over five years. The author also has accessibility to more resources for this thesis, including the ability to acquire additional data that allowed for a high level of input parameters analysis. This offers greater clarity on the financial costs, and provides detailed information that will be used to improve operations in the future.

Further this thesis provides a detailed sensitivity analysis and risk analysis, using Monte Carlo simulation. Sensitivity and risk analyses such as these would not have been performed in a typical consulting project. Instead, consulting analysis would focus on estimated costs with a

brief high level discussion around the limitation of the results. The addition of the risk analysis allows for a higher understanding as to the risk around the various scenarios, which may influence the decisions made regarding the long-term operations of this facility.

2.3 Importance of the Thesis Approach

Risk analysis has become an important methodology for companies in understanding their risk and planning risk mitigation strategies in advance of making decisions. The analysis is based on key parameters that quantify concepts of designing secure and safe investments.[2] Decisions related to the upgrading solid waste facilities have both short-term capital costs and long-term operating costs implications.

It is therefore important to not only analyze the costs and net revenues associated with upgrade options, but to also understand the variation of the costs and net revenues based on uncertain or undefined parameters. The use of risk analysis to create a greater understanding about the costs and net revenues will assist in planning for and reducing the overall long-term operating costs of the facility.

[2] Valasenko, Olga; Kozlov, Sergey (2009, May 4) Choosing the Risk Curve Type. Technological and Economic Development of Economy, 15(2): 341-351.

3.0 KEY BACKGROUND INFORMATION

3.1 Metro Vancouver Regional Solid Waste Management

Metro Vancouver is comprised of twenty-one member municipalities and one electoral area. As legislated by the Province through the Environmental Management Act, Metro Vancouver (also known as the Greater Vancouver Sewerage and Drainage District) is responsible for managing municipal solid waste ("MSW") in the region. The Environmental Management Act defines MSW to include Residential; Institutional, Commercial and light-Industrial ("ICI"); and Demolition Landclearing and Construction ("DLC") wastes.

In 2008, the Residential and ICI sector in the region contributed 1,346,400 tonnes of MSW to the regional solid waste management system. The majority of the Residential and ICI waste is collected at one of the Region's seven Transfer Stations before being directed to one of three disposal facilities supported by the 1999 SWMP. These facilities consist of Vancouver Landfill ("VL"), Cache Creek Landfill and Burnaby Waste to Energy Facility. Figure 3.1 shows the locations of the Transfer Stations and disposal facilities.

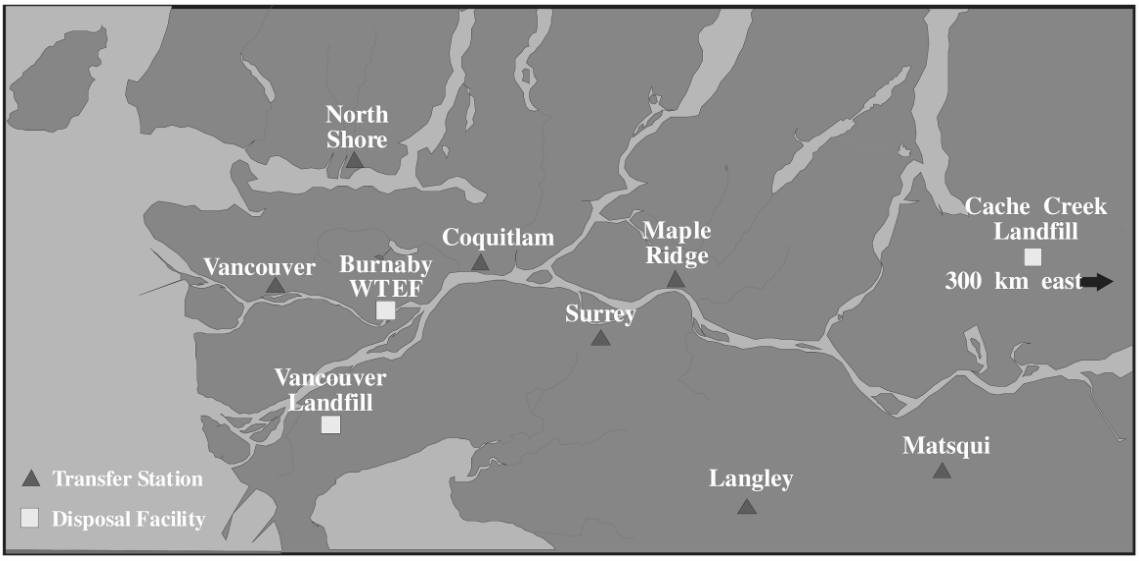

Figure 3.1: Map of Metro Vancouver Transfer Stations and Waste Disposal Facilities[3]

[3] Source: Metro Vancouver

3.2 Metro Vancouver Amendments to Regional Solid Waste Management

The Province of British Columbia's Waste Management Act (now Environmental Management Act) was amended in 1989 to require that all regional districts submit a solid waste management plan on or before December 31, 1995. A SWMP provides authorization for regional districts to manage MSW. Metro Vancouver currently operates under their 1999 Solid Waste Management Plan ("SWMP").

In January 2008, Metro Vancouver (formerly GVRD) began the process of amending the 1995 SWMP. At the same time, Metro Vancouver's GVS&DD Board approved their Commissioner's recommendations to abandon plans to replace Cache Creek Landfill with landfills located in the interior of British Columbia. Instead Metro Vancouver would focus its attention on the development of waste-to-energy ("WTE") facilities. Metro Vancouver's current plan is to build WTE facilities such that by 2020, no unprocessed waste will be disposed of in landfills.

At a special meeting of the Greater Vancouver Regional District's Waste Management Committee on May 20, 2009 a recommendation was passed to "direct staff to prepare a draft Solid Waste Management Plan that considers the feedback received during the consultation process on the Zero Waste Challenge and incorporates a waste diversion target of 70% by the year 2015."[4] Waste diversion means that waste is removed from the disposal stream. Several materials including wood, paper and food waste have been identified by Metro Vancouver as potential materials that should be targeted for diversion.

The remainder of the amendments to the Solid Waste Management Plan are ongoing and have not been finalized. It is anticipated that these amendments will be presented to the public in late 2009. Metro Vancouver needs to complete the public consultation process and receive stakeholder support ahead of approved by the Ministry of Environment.

A conceptual design plan to replace the VSTS was developed by EarthTech in 2007 as part of a high level Infrastructure Review. This included reviewing adequacy of the existing facility,

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[4] Greater Vancouver Regional District (May 20, 2009) Waste Management Committee Special Meeting Minutes. Retrieved June 16, 2009 from http://www.metrovancouver.org/boards/Pages/BoardsCommittees.aspx.

options for upgrades and a high level costs estimate for a new facility. Originally the conceptual design plan was scheduled for peer review and progress to detailed design in 2008. In light of the uncertainty related to MSW in the region, the City of Vancouver put on hold plans to replace the VSTS with a new facility. The decision was made to reduce the financial costs to Vancouver taxpayers, especially with the uncertainty related to MSW disposal.

3.3 Implementation of New Solid Waste Management Plan

There are components of the proposed future Solid Waste Management Plan ("future SWMP") which Metro Vancouver may not be able to implement within the suggested timeframes or at all. In particular, the proposed WTE facilities throughout the Region have caught the attention of many public interest groups and media. This has become a widely discussed topic, which has been criticized by several groups including the Fraser Valley Regional District, City of Abbotsford and Zero Waste Vancouver.

It is the author's opinion that developing WTE facilities can be difficult, if not nearly impossible. Many proposed WTE projects in North America have been cancelled as a result of lack of public support. The author anticipates the public opposition will continue to increase, in particular when the sites for the new WTE facilities are announced. The widely spread concept of not in my backyard reaction (or Nimbyism) will result in the formation of new public interest groups to oppose WTE facility developments in their communities.

In Metro Vancouver's initial proposal for the future SWMP, Waste-to-Energy Infrastructure will be expanded such that by 2020, no unprocessed waste will be disposed of in landfills. In other words, Metro Vancouver that would burn up to 1.5 million tonnes of garbage annually. The author believes that this timeframe is very optimistic and highly uncertain. The 10-year estimate is theoretical and could increase significantly based on the uncertain timelines for siting, permitting, and constructing new WTE facilities within Metro Vancouver.

Another source of the author's skepticism related the Metro Vancouver's future SWMP is the target for 70% waste diversion by 2015. Although the physical diversion of waste materials is possible, the salability and reuse of this material is questionable. The value or salability of the

diverted waste depends on a strong economy, as well as legislation requiring reuse or recycling of diverted waste materials. In order support the targeted waste diversion, there needs to be government support and infrastructure required to manage these materials. Since progress on this requires significant government efforts and funding it is the author's opinion that this will likely take more than the five years estimated by Metro Vancouver.

3.4 VSTS Site Description

VSTS is located within the City owned Manitoba Works Yard, as shown in Figure 3.2. The current VSTS facility is located on an approximately 1.9 hectare site (excluding the yard trimmings area). An additional 1.9 hectares of space is available directly east of VSTS, and a smaller amount of land is available directly north of VSTS.

The area east of VSTS is currently the centre for Sanitation Operations along with covered and uncovered truck and employee parking. The area north of VSTS is storage for the City's Central Stores branch.

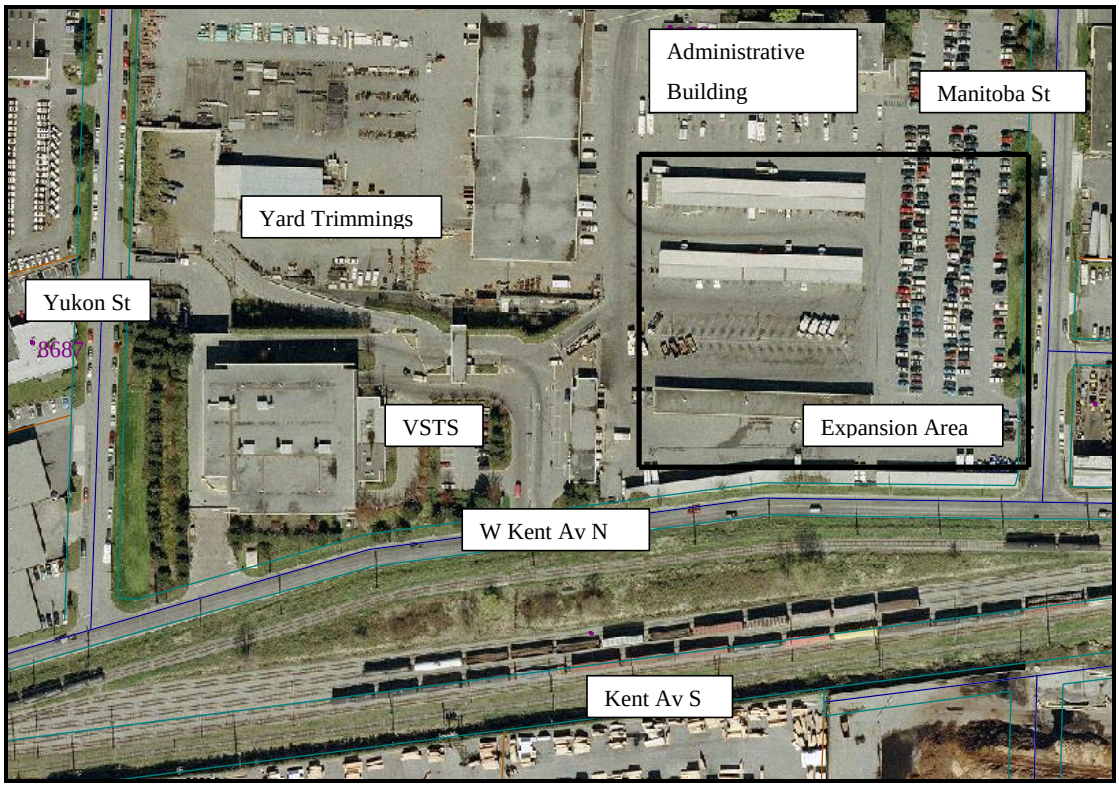

Figure 3.2: Aerial Map of Manitoba Works Yard

3.5 VSTS General Operations

VSTS, located at 377 West Kent Avenue North in Vancouver, BC, is owned and operated by the City of Vancouver. VSTS is an important part of the integrated waste management system in Metro Vancouver, serving as a convenient drop-off location and temporary storage facility for garbage and yard trimmings for Vancouver, UBC and parts of Richmond.

The VSTS is open seven days per week to receive garbage, yard trimmings and recyclable materials from City collection vehicles, commercial vehicles and residential customers. Municipal refuse is accepted at a rate of $71 per tonne, the same rate which is charged at all Metro Vancouver waste disposal facilities. Yard trimmings are accepted at a reduced rate of $56 per tonne and recyclable materials are accepted at no charge.

Both garbage and yard trimmings are subsequently transferred to the Vancouver Landfill. As approximately 80% of the traffic to the VSTS is small vehicle, there is up to 20:1 reduction in the amount of vehicle traffic to the Landfill, thereby reducing road congestion, air pollution and line-ups at the Landfill.

VSTS is one of the busiest waste disposal facilities in the Region. Approximately 250,000 tonnes per year or roughly 40% of the 600,000 tonnes of garbage that is disposed of at the Vancouver Landfill is initially received at VSTS. In addition, approximately 30,000 tonnes per year of yard trimmings are received at the VSTS and transferred to the Landfill for composting. The VSTS also has a multi-material recycling depot for residents located at the front entrance.

VSTS was opened in 1989. Since then, there have been significant changes in waste management that have resulted in changes in service demand at VSTS. For instance, there has been more than a 50% increase in small vehicle traffic over the last five years. In addition, yard trimmings recycling along with several other materials have been added to VSTS. The provision of facilities for additional reusable or recyclable materials would be desirable. However, currently there are insufficiencies in the existing infrastructure, such as lack of weighscales and proper traffic control measures, to manage additional material streams. The current facilities are not adequate to facilitate increase waste diversion measures.

3.6 VSTS Facility Description

The VSTS was constructed at a cost of approximately $7,000,000 (1989$) with an additional $2,000,000 (1989$) for equipment. The design of the facility has a tipping floor located on the upper level where customers dump MSW and a main pit where the MSW is pushed into by a front-end loader. A bulldozer operating in the pit pushes the MSW into the top of a transfer trailer located on the lower level. The VSTS has a viewing gallery for the public, as well as staff facilities including washrooms, lunchroom, locker room and offices.

3.7 Legal Agreements

A legal agreement between the City of Vancouver, the Corporation of Delta and Greater Vancouver Regional District, known as the 1989 Tripartite Agreement, assigns operational and capital costs of the VSTS to all users of the VSTS, proportional to the amount of waste that they dispose of at the VSTS annually. Approximately 80% received at the VSTS originates from Vancouver, while the remaining 20% originates from other Metro Vancouver municipalities.

The Tripartite Agreement requires Vancouver to accept garbage from north Richmond and UBC/UEL at VSTS. It also allows for an open system, such that customers may dispose of garbage at any regional facility regardless of the origin. This results in the distribution of Vancouver's garbage disposal, as detailed in Table 3.1.

Table 3.1: Distribution of Vancouver's MSW Disposal in 2006

Facility	2006 Tonnage	Percentage
VSTS	193,182	56%
VL	11,482	3%
Burnaby WTE	28,736	8%
Coquitlam Resource Recovery Plant	29,232	8%
North Shore Transfer Station	83,794	24%
Total	**346,427**	**100%**

It is important to note the large proportion of leakage, defined as Vancouver waste which is not being disposed of at Vancouver own and operated facilities. Leakage is caused by a number of factors including a lack of capacity available at the VSTS, shorter haul routes to other regional facilities from certain areas of Vancouver and perceived longer wait times at the VSTS. Table

3.2 highlights the historical distribution of MSW originating from Vancouver residential and commercial sources.

Table 3.2: Historical Distribution of Vancouver's MSW Disposal

Year	Vancouver MSW to VSTS & VL		Vancouver MSW to Other MV Facilities	
	tonnes	%	tonnes	%
2002	199,823	64%	111,922	36%
2003	200,365	62%	120,439	38%
2004	212,506	61%	138,178	39%
2005	212,231	59%	145,342	41%
2006	204,664	59%	141,763	41%
2007*	158,886	49%	164,935	51%

* Civic strike in 2007 caused a 12-week shutdown of the VSTS and VL

3.8 Summary of VSTS User Fees and Revenues

There are four distinct groups that utilize the VSTS. These groups are Vancouver single family residential, Vancouver multi-family residential/commercial customers, Metro Vancouver residential/commercial and Delta commercial. The user fee charges, waste collection, user fee recovery and revenues remitted are summarized in Table 3.3.

Table 3.3: VSTS Summary of Fees and Revenues

Resident Group	Details
Vancouver Single Family Residential	User fees = Actual Operating Costs (Burns Bog Rate + VSTS Operating Cost) Garbage collected by City crews User fees recovered through municipal taxes No revenues, charged at cost
Vancouver Multi-family Residential & Commercial	User fees = Regional Rate + Hauler Overhead Garbage collected by private commercial haulers User fees recovered by private commercial haulers Revenues retained by Vancouver, placed into Solid Waste Capital Reserve
Metro Vancouver Residential & Commercial	User fees = Regional Rate + Hauler Overhead Garbage collected by private commercial haulers User fees recovered by private commercial haulers Revenues remitted to Metro Vancouver
Delta Commercial	User fees = Regional Rate + Hauler Overhead Garbage collected by private commercial haulers User fees recovered by private commercial haulers Revenues remitted to Delta

3.9 VSTS Operations Cost Recovery and Revenues

All Vancouver single family residential garbage is collected by the City of Vancouver Sanitation Department and disposed of exclusively at VSTS. This garbage is charged at cost for disposal meaning that there are no revenues from Vancouver single family residential garbage. All other sources of garbage, including Vancouver multi-family residential, are charged the regional tipping fee. The excess of the regional tipping fee less the cost of disposal (both transfer and disposal) is known as the potential revenue. Vancouver retains the potential revenue from Vancouver commercial waste in the Solid Waste Capital Reserve ("SWCR"), for use in VL closure and post-closure costs.

When waste from Metro Vancouver or Delta is received at the VSTS, the potential revenue is remitted to Metro Vancouver or Delta, respectively. A reciprocal relationship does not exist, meaning that when Vancouver commercial garbage is disposed of at other regional facilities (such as Burnaby WTE, Coquitlam Resource Recovery Plant and North Shore Transfer Station) Metro Vancouver retains the revenues and does not return any monies to Vancouver. Therefore, it is in Vancouver's best interest to have capacity available at the VSTS to dispose of all Vancouver commercial garbage including garbage currently disposed of at other regional facilities.

It is important to remember that the Regional rate charged at Metro Vancouver facilities is the average of the operating costs of all waste transfer and disposal facilities. Even if the legal agreements were modified to allow for revenue transfer from Metro Vancouver to Vancouver for leakage, it is currently Metro Vancouver's position that because the Regional rate is equal to the operating costs there would be no revenues to remit.

In 2006, approximately 40% of Vancouver's waste was leaked into other regional facilities, mainly the North South Transfer Station, Burnaby Waste-to-Energy facility and Coquitlam Resource Recovery Plant. This leakage resulted in lost revenues to the City of Vancouver in the amount of approximately $1,500,000. There is currently no mechanism to cost recovery any of these lost revenues.

3.10 Analysis Timeframe

One of Metro Vancouver's current strategies for updating the 1995 SWMP is to "build new WTE facilities within Metro Vancouver so that the disposal stream is treated locally in a sustainable manner that provides benefits in the form of energy and district heating to the region."[5]

Based on Metro Vancouver's plan to build WTE facilities such that by 2020, no unprocessed waste will be disposed of in landfills, they are planning to build between 3 and 6 WTE facilities starting in 2012. The uncertainty of where these facilities will be placed, along with the uncertainty around the timing makes it difficult for the member municipalities to make important decisions related to waste management; in particular the City of Vancouver which operate two of the regional waste disposal facilities (the VSTS and VL).

In addition to these plans, Metro Vancouver is also planning additional changes that will have significant effects on waste management in the next 15 years. This includes organics recycling, additional wood waste recycling, increasing diversion rates, and restrictions on packaging. These changes have made it difficult to forecast waste quantities. Therefore, the period of analysis for this thesis has been limited to a 15-year horizon based on the judgment of the author and discussions with colleagues. In order to verify this assumption, the analysis timeframe was varied between 10 to 20 years during the analysis process. Varying the analysis timeframe did not impact the ranking of the scenarios.

Within this 15-year time period, there are two defined periods for Scenario 1 (a) – Status Quo with WTE and Scenario 1 (b) – Status Quo no WTE. The first time period is between 2009 and the year that a decision is finalized related to the proposed WTE facilities. For Scenario 1 (b) – Status Quo no WTE, the time period ends when the decision is made not to proceed with WTE. At that point, Vancouver will continue with plans to replace VSTS with a new facility. For Scenario 1 (a) – Status Quo with WTE, the time period ends once the new WTE facilities are constructed and in operation such that Vancouver's waste is disposed of through the WTE facilities. The second time period for both Scenarios ends at the 15-year horizon in 2024.

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[5] http://www.metrovancouver.org/about/publications/Publications/DraftSWMPOutlineGoals.pdf

Figure 3.3 provides a timeline for each of the Scenarios using the base analysis assumptions.

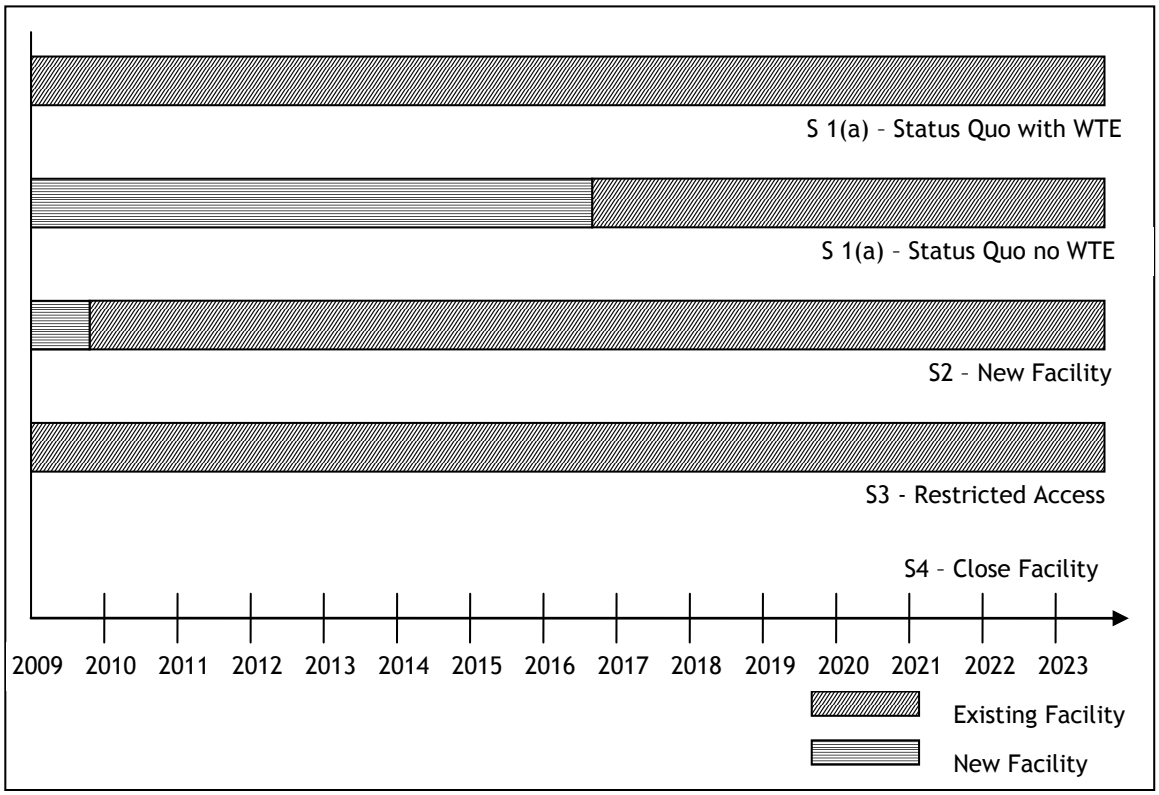


Figure 3.3: Scenarios Timelines under Base Analysis Assumptions

3.11 Capacity Analysis

Analyses were performed to evaluate the capacity of the existing facility, a new facility and the existing facility with limited access to residential customers. The existing facility capacity applies to Scenarios 1 (a) and 1 (b); the new facility capacity applies to Scenario 2 and the restricted access capacity applies to Scenario 3.

There are two ways in which the facility can be limited by capacity. It can be limited by that amount of MSW it is able to handle from incoming customers or by the outgoing amount of MSW it is able to remove from the facility. Based on the analyses described below, the ability to receive incoming MSW limits the capacity of the VSTS during normal operations.

3.11.1. Incoming Materials Capacity

For purposes of analyzing incoming materials there are two main types of customers: small vehicle transactions which are defined as those vehicles that have a gross vehicle weight less than 5,500kg; and large vehicle transactions which are defined as those vehicles that have a gross vehicle weight greater than 5,500kg.

On weekdays small vehicle customers represent 66% of the transactions, but only 6% of the incoming material weight. Figure 3.4 shows the existing facility weekday transaction volumes by time of day for small and large vehicles.

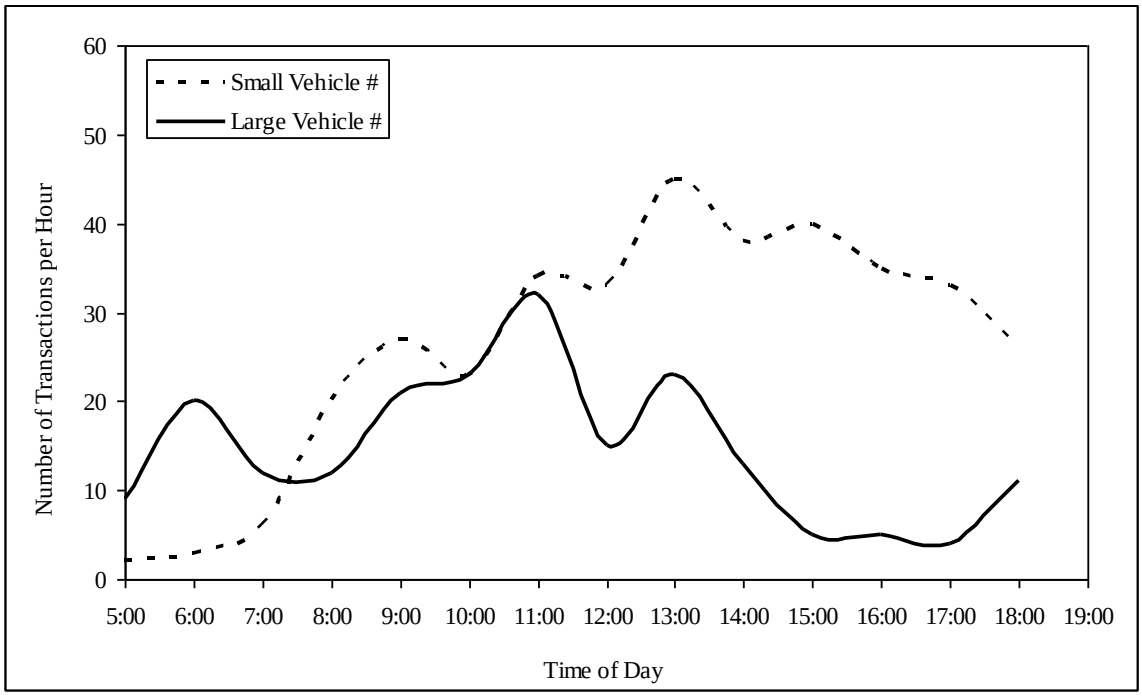


Figure 3.4: Existing Facility Weekday Transaction Volumes by Time of Day

On weekends small vehicle customers represent 86% of the transactions, but only 10% of the incoming material weight. Figure 3.5 shows the existing facility weekend transaction volumes by time of day for small and large vehicles.

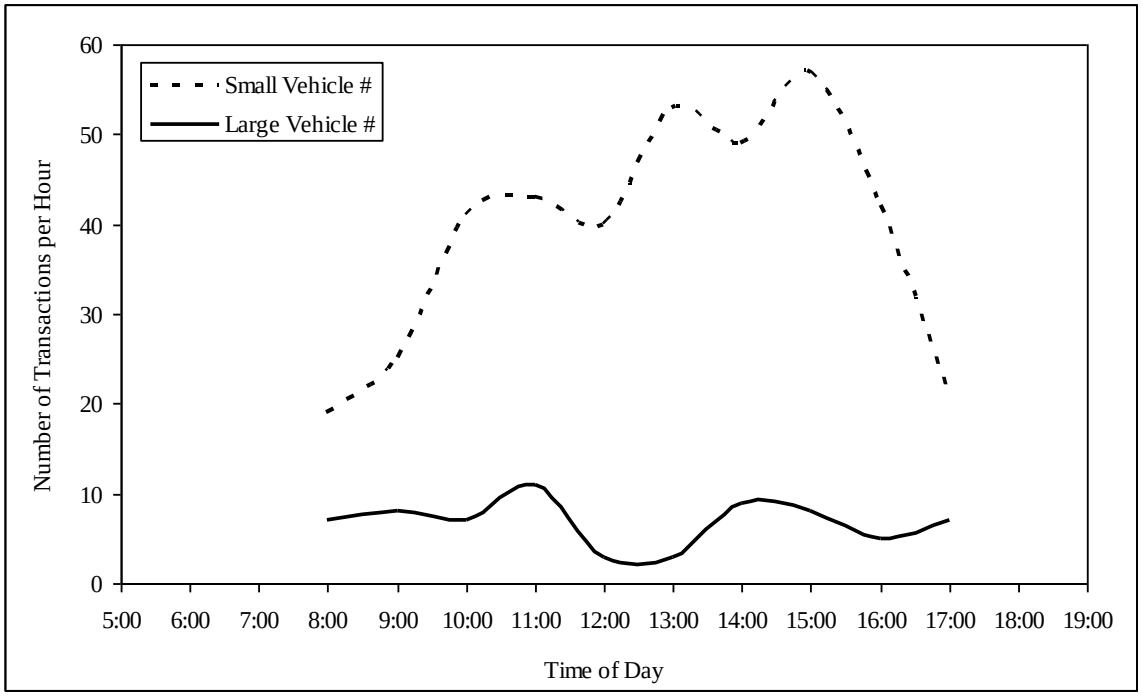


Figure 3.5: Current and Restricted Weekend Transaction Volumes by Time of Day

Small vehicle customers require a significant amount of resources including staff interactions and facility requirements. These customers dispose of small amount of MSW and are also slower to unload their vehicles, as the MSW must be hand unloaded. On average small vehicle customers have approximately 0.3 tonnes of MSW per load and unload at a rate of 0.03 to 0.12 tonnes per minute, as shown in Table 3.4.

Table 3.4: Unloading Rates and Average Load Weights based on Vehicle Types

Customer Type	Vehicle Type	Unloading Rate (tonnes/min)		Average Load Weight (tonnes)	
		Weekday	Weekend	Weekday	Weekend
Small Vehicles Transaction	Small Vehicle	0.12	0.07	0.25	0.22
	Vehicle with Trailer	0.03	0.02	0.41	0.32
Large Vehicles Transaction	Single axle Vehicle	6	7	1	1
	Double Axle Vehicle	89	68	6	7
	Packer Truck	145	71	7	5
	Roll-Off Truck & Box	0.4	0.5	2.9	3.8

In comparison large vehicle customers have larger volume loads (1 to 7 tonnes per load) and most have automatically unloading vehicles which results in quicker unloading rates (7 to 145 tonnes per minute). The exception is roll-off trucks with boxes, which require unloading two separate boxes. This results in maneuvering boxes outside the VSTS in a designated area. The unloading rate for roll-off trucks with boxes is approximately 0.5 tonnes per minute. This vehicle types is discouraged at the VSTS, as it requires significant space to unload and causes traffic congestion. During peak time periods, these trucks are diverted to the VL for disposal.

Based on the fact that small vehicle transactions are resource intensive and provide minimal waste quantities, a scenario was evaluated to determine the impact of imposing restrictions on small vehicles. Scenario 3 – Restricted Access has limited access for small vehicles during the weekday peak hours of 8:00am to 4:00pm. For the purposes of this scenario it is assumed that no small vehicles are allowed during the peak times. Figure 3.6 shows the results of this limited access scenario.

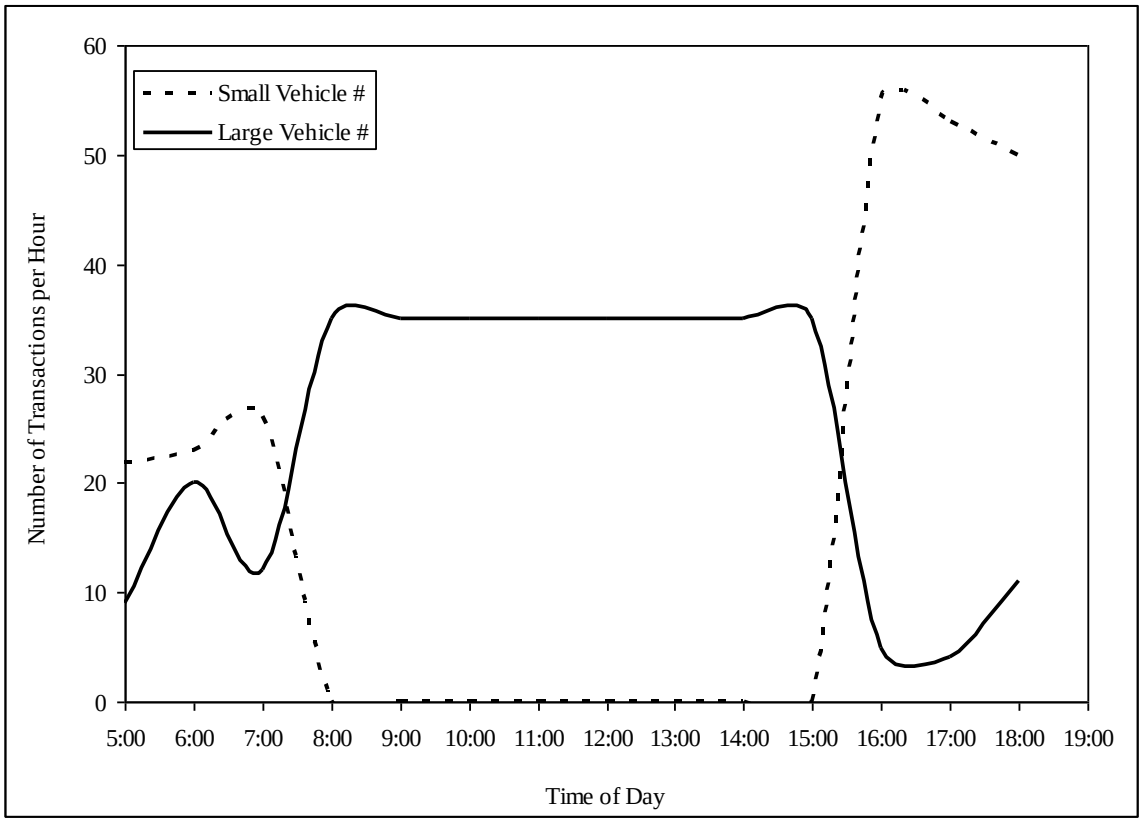


Figure 3.6: Restricted Weekday Transaction Volumes by Time of Day

The results of the analyses for the three facility capacities (existing facility, new facility and existing facility with limited access to residential customers) are shown in Table 3.5. The following assumptions were used to analyze the incoming waste capacity:

- Average net weight for small vehicle transactions (defined as vehicles with GVW less than 5500kg) is 0.2 tonnes per load;
- Average net weight for large vehicle transactions (defined as vehicles with GVW greater than 5500kg) is 3.4 tonnes per load;
- Maximum vehicle transactions per 12-hour day are 750 for the existing facility based on analysis by EarthTech as part of the VSTS Infrastructure Review; and
- Maximum vehicle transactions per 12-hour day are 1,800 for a new facility based on analysis by EarthTech as part of the VSTS Infrastructure Review.

Table 3.5: Incoming Waste Capacity Limits

Scenario	Maximum Capacity (tonnes)	% small vehicles		% large vehicles		Maximum Vehicles in 12 hrs[6]	Maximum Vehicles in 1 hr	
		WD	WE	WD	WE		WD	WE
Existing Building - Existing Access	281,705	66%	86%	34%	14%	750	79	38
Existing Building - Restrict Access	430,373	40%	86%	60%	14%	750	131	38
New Building	676,091	66%	86%	34%	14%	1,800	190	91

WD = weekday
WE = weekend

The analysis shows that restricting access of small vehicles during peak hours, as contemplated in Scenario 3, results in an increased capacity of approximately 150,000 tonnes per year compared to existing facility. A new facility, as contemplated in Scenario 2, would provide an additional 400,000 tonnes per year compared to existing facility.

[6] Memorandum titled "GPSS Model Output Analysis and Optimization Design Information", EarthTech, August 22, 2006.

3.11.2. Outgoing Materials Capacity

The following assumptions were used to analyze the outgoing waste capacity:

- Downtime for each transfer trailer is 30%, based on current levels of downtime experienced by the fleet. Downtime is defined as a period of time where the transfer trailer is unavailable due to servicing and/or repairs;
- The total driving time from VSTS to the Landfill including return time is approximately 2.3 hours. This includes time allotted for coffee/lunch breaks, pre/post trip logbooks, loading at VSTS, unloading at Landfill and cleaning time. The value is based on the current schedule where each drivers can complete 3 to 4 loads per 8 hour shift;
- Aluminum trailers have average MSW net weight of 24.6 tonnes per load;
- Steel trailers have average MSW net weight of 21.9 tonnes per load;
- Number of loads that are able to be loaded at the VSTS is approximately 2.5 per hour, based on existing performance levels; and
- Number of loads that are able to be unloaded at the Landfill is unlimited as transfer trailers are given first priority and operations are flexible in accommodating additional traffic.

Some methods to increase outgoing capacity without building a new facility are:

- Increase the number of hours that the transfer trailers operate (to a maximum of 24 hours per day);
- Increase the number of trailers, in particular add aluminum trailers which have a larger capacity per load compared to steel trailers;
- Increase the length of the drivers shifts by two hours to increase the number of loads each driver could transfer per shift while not increasing the number of required coffee and lunch breaks required; or
- Decrease the amount of fleet downtime, which as a result would increase efficiency of each trailer and may eliminate the need for additional trailers.

Based on the analysis completed in Table 3.6, the maximum outgoing waste capacity, the current facility would be able to haul 650,000 tonnes per year of waste to the Landfill if the above noted

methods were implemented. This is greater than the amount of waste that the VSTS is able to accept from incoming customers. Therefore, the incoming waste limits the capacity of the existing facility under all three scenario options.

Table 3.6: Outgoing Waste Capacity Limits

Max Capacity (tonnes)	Average tonnes per load	# of loads per yr	Operating hours		# of Trailers		Driver Shift Length
			per yr	per day	Aluminum	Steel	
300,000	22.5	13,333	5,808	16	2	7	8
350,000	22.5	15,556	6,171	17	2	7	8
400,000	23.4	17,094	6,534	18	5	4	10
450,000	24.6	18,293	6,897	19	9	0	10
500,000	24.6	20,325	6,897	19	10	0	10
550,000	24.6	22,358	7,260	20	10	0	10
600,000	24.6	24,390	7,986	22	10	0	10
650,000	24.6	26,423	8,712	24	10	0	10

3.12 Transfer Station Facility Capital Costs

A literature review was completed to provide additional confidence in the estimate of capital costs for a new transfer station facility, as shown in Table 3.7.

Table 3.7: Transfer Station Capital Costs

Facility Name (Location)	Waste Transfer	Construction Completed	Capital Cost ($ CDN)	Cost per tonne
North Transfer Station & Material Recovery Facility (Phoenix, AZ)	1,300,000 tonnes/yr	January 2006	$40,000,000*	$31
Shoreline Recycling & Transfer Station (King County, WA)	400,000 tonnes/yr	February 2008	$24,000,000	$60
Surrey Transfer Station (Surrey, BC)	150,000 tonnes/yr	April 2004	$9,000,000	$60
Whistler Waste Transfer Station (Whistler, BC)	50,000 tonnes/yr	August 2007	$4,750,000**	$95

* includes administrative building, maintenance facility, scale houses & fueling station
** includes dismantling old transfer station and access road construction

EarthTech was retained by the City of Vancouver to complete a high level Infrastructure Review of the VSTS in 2006. This included reviewing adequacy of the existing facility, options for upgrades and a high level costs estimate for a new facility. According to their findings, the cost of a new 650,000 tonne transfer station was $23,288,000 (or $36 per tonne) in 2006 dollars including a 15% contingency. This estimate did not include the cost of demolishing the existing building. Based on the literature review, these costs are not out of line with other transfer station facilities that have been constructed within North America.

3.13 Industry Practices for Customer Restrictions in Other Jurisdictions

A literature review of industry standards was completed to determine opportunities to reduce residential traffic at the VSTS and mitigations measures required to minimize the effect of the restrictions on residents. New York, Toronto, Houston and Metro Vancouver have programs in place to reduce or eliminate residential traffic at transfer facilities, as detailed in the following sections.

The City of Vancouver does not offer large or bulky item collection for residents. Instead Vancouver runs a Keep Vancouver Spectacular event during the month of May each year. From May 1 to 31, Vancouver residents may dispose of household garbage free of charge at the Vancouver Landfill. Garbage must be transported by the residents in residential vehicles. Each resident must have proof of residency and is allowed up to 500 kilograms MSW disposal for free.

3.13.1. New York, New York

The Department of Sanitation for New York provides free curbside removal of large non-commercial "bulk" items (items that are too big to be discarded in a container or bag) from residential buildings. Sanitation will collect up six items per residential building for each normal garbage day and twelve bulk items per residential building on each recycling day (six regular bulk items plus six metal bulk items). Items must be placed on curbside on the regular garbage collection day. This eliminates the need for residents to use transfer stations for additional waste disposal.

3.13.2. Toronto, Ontario

In June 2003, Toronto City Council adopted modifications to the fees and hours of operation for small vehicles at Toronto's Waste Transfer Stations. Details on these restrictions are contained in Figure 3.7. In general, manual unloading vehicles are limited to hours when the transfer stations are not busy with commercial automated vehicles.

	Address	Directions	Automated Vehicles	Manual Unloading Vehicle [1]
Bermondsey (416) 392-3133 or (416) 392-3139	188 Bermondsey Road, North York	S. from Eglinton Ave. E.; 4th traffic light east of Don Valley Parkway	Sun 8:00 pm to Fri 11:59 pm	Mon 6:00 am to Midnight Tue–Fri 12:01 am to 8:00 am & 4:00 pm to Midnight
			Sat 12:00 am to 12:30 pm	**Sat 12:01 am to 12:30 pm**
Commissioners (416) 392-5890 or (416) 392-5894	400 Commissioners Street, Toronto	NE corner of Bouchette and Commissioners Sts.	Mon to Fri 6:00 am - 6:00 pm	Mon 6:00am to 6:00pm Tue–Fri 6:00 am to 8:00 am & 4:00 pm to 6:00 pm
			Sat - Closed	**Sat Closed**
Disco (416) 392-2292 or (416) 392-2376	120 Disco Road, Etobicoke	Corner of Disco Rd. and Carlingview Dr. N. of Dixon Rd. W. of Hwy. 27.	Mon to Fri 6:00 am - 6:00 pm	Mon 6:00 am to 6:00 pm Tue–Fri 6:00 am to 8:00 am & 4:00 pm to 6:00 pm
			Sat - Closed	**Sat - Closed**
Dufferin (416) 392-3161	35 Vanley Crescent, North York	E. of Chesswood Dr. (2nd St. W. of Dufferin), south of Finch Ave. W.	Mon to Fri 6:00 am to 6:00 pm Waste and Yard Waste	**Yard Waste** **Manual unloading of Tires only** Mon 6:00 am to 6:00 pm Tue–Fri 6:00 am to 8:00 am & 4:00 pm to 6:00 pm
			Sat - Closed	**Sat - Closed**
Ingram (416) 392-5592 or (416) 392-5837	50 Ingram Drive, North York	E. from Keele St., 6 st. N. of Eglinton Ave. W.	Sun 8:00 pm to Fri 7:00 pm	Mon 6:00 am to Midnight Tue–Thu 12:01 am to 8:00 am & 4:00 pm to Midnight Fri 12:01 am to 8:00 am & 4:00 pm to 7:00 pm
			Sat 7:00 am to 12:30 pm	**Sat 7:00am to 12:30 pm**
Scarborough (416) 392-3019 or (416) 397-1331	1 Transfer Station, Scarborough	N. on Markham Rd., left on Nugget Ave.; first left on Transfer Place	Sun 8:00 pm to Fri 6:00 pm (Closed Mon-Thu between 7:00 p.m. and 7:59 p.m.)	Mon 6:00 am to Midnight Tue–Thu 12:01 am to 8:00 am, 4:00 pm to 6:59 pm & 8:00 pm to Midnight Fri 12:01 am to 8:00 am & 4:00 pm to 6:00 pm (Closed Mon-Thu between 7:00 p.m. and 7:59 p.m.)
			Sat 7:00 am to 12:30 pm	**Sat 7:00am to 12:30 pm**
Victoria Park (416) 392-3025 or (416) 392-3027	3350 Victoria Park Avenue, North York	Corner of Victoria Park Ave. and McNicoll Ave.	Mon to Fri 6:00 am to 6:00 pm	Mon 6:00 am to 6:00 pm Tue–Fri 6:00 am to 8:00 am & 4:00 pm to 6:00 pm
			Sat - Closed	**Sat - Closed**

Figure 3.7: City of Toronto Transfer Stations Restrictions

3.13.3. Houston, Texas

In 2008, Houston offered four neighborhood depository sites. The purpose of these sites was to allow residents to discard heavy trash or drop off recycling before their scheduled once-per-month pickup. The depositories were used by the public free of charge. Each user provided proof of residency and could use this service up to four times per month. Neighborhood depositories did not accept household garbage, more than ten tires, large quantities of building materials, trash from commercial haulers or business/rented commercial vehicles.

In 2009, Houston changed their program to allow residents to dispose of Junk Waste and Tree Waste on alternating months. Tree Waste is defined as clean wood waste such as tree limbs, branches, and stumps but does not include lumber, furniture, and treated woods. Junk Waste is defined as furniture, appliances and other bulky materials. The purpose of the change in collecting large waste is to divert materials from landfills and save tax dollars.

3.13.4. Metro Vancouver

In past years it was common throughout Metro Vancouver for municipalities to offer free clean-up events. During these events residents could leave unwanted bulky items on their curbside. Other residents would then have the opportunity to collect items from their neighbours' curbsides, ahead of the garbage collection crews picking up these large items free of charge. The problem with these events is that they were quite costly to municipalities and created a large amount of left over debris.

Municipalities such as Surrey, Burnaby and Coquitlam now offer residents bulky item and appliance pick-up. Residents can contact their municipality to collect up to four items per year, which can be collected up to four separate days. The items are collected on the same day as the regular MSW collections.

4.0 QUANTITATIVE ANALYSIS

4.1 Base Cash Flow Model Description and Key Assumptions

The base cash flow model simulates the MSW flows through VSTS each year from 2009 until 2024. Specific policy targets currently contemplated in the future SWMP require that the base case analysis make use of targeted values. This includes the values for sustainable diversion rate and year that the diversion rate is achieved. These policy targets are highly aggressive given the complexity of actually achieving them. Achieving these targets is based on successfully changing the human and technical factors, as discussed in Section 3.3.

Some key assumptions and inputs in the model are as follows:

- Net revenues obtained by the City of Vancouver from MSW disposal are transferred to the SWCR to be used for closure and post closure costs at VL. Net revenues are considered in the VSTS financial analysis only in the context of potential to transfer additional revenues;
- Existing Vancouver MSW disposed of at VSTS, continues to be disposed of at VSTS;
- Vancouver MSW disposed of at regional facilities (also known as leakage), starts to be disposed of at VSTS as capacity becomes available;
- MSW from other Metro Vancouver municipalities currently deposited at VSTS will continue to be deposited at VSTS since over 98% of the MV waste deposited at VSTS is from Richmond or University Endowment Lands. Vancouver is obligated under the Tripartite Agreement to accept MSW from Richmond and UEL at the VSTS and both municipalities do not have another regional facility in closer proximity to dispose of their MSW);
- Capital costs for building a new transfer station will be directly attributed to the users of the transfer station through tipping fees over a 10-year period with accumulated interest (consistent with the City's current repayment terms for capital loans of this nature);
- Capital costs for building a new transfer station were determined using EarthTech's VSTS Infrastructure Review (January 2007) and assessed to be in the right order of magnitude during the literature review;

- Waste generation will occur as described in Appendix A. This is consistent with Deloitte & Touche's financial evaluation of VL (September 2008), using Statistics Canada data and Metro Vancouver population projections;
- Tonnages and waste flows are based on 2006 reported data, verified with 2008 data. Data from 2007 was not used, as a long Civic strike resulted in unrepresentative data;
- Site upgrades required to use the existing building were described in EarthTech's VSTS Infrastructure Review (December 2006). The schedule of required upgrades and costs will be incorporated into the model. Additional information was obtained from the VSTS Inspection Report and Maintenance Management System report (January 2009). Site upgrade costs have been conservatively estimated to be $300,000 in 2008 dollars;
- The existing site will remain a viable long-term location for the VSTS, and as such no additional costs will be considered to acquire new land and move the existing operation;
- Operating costs are based on 2007 reported data;
- The regional rate is based on a projection of Metro Vancouver's average garbage disposal costs (i.e. $100 per tonne), with the rate increasing from the current level ($71 per tonne) to $100 per tonne between 2008 and 2014;
- The regional diversion rate increases from the current rate of 52% to 70% by 2015, as stated in Metro Vancouver's proposed amendments to the 1995 Solid Waste Management Plan[7];
- A new WTE facility starts operating on January 1, 2014 and is able to accept 500,000 tonnes per year capacity (for scenarios where this is applicable);
- Operational costs are determined for each year (a combination of fixed and variable costs), and Vancouver's portion is determined based on its portion of the total annual tonnage to VSTS;

[7] Metro Vancouver Waste Management Committee Meeting, May 20, 2009, Reports from Staff on Zero Waste Challenge (Item 2.3)

- Inflation rate and capital costs escalation is assumed to be 2% per year, applied to all annual operating costs and capital costs, respectively;
- Discount rate is assumed to be 5.81% based on Municipal Finance Authority market rate for a 25-year bond as of April 30, 2009; and
- Additional information on assumptions for waste generation, fixed and variable operating costs and regional rate are available in Appendix A.

4.2 Approach

For each scenario, a detailed cash flow model was developed to determine the relative cost of the scenario to Vancouver single family residential ("SFR") ratepayers. The key comparison parameters for each of the scenarios were the operational costs (both fixed and variable), upgrade costs, capital costs and potential City of Vancouver net revenues. These parameters are expressed in terms of Net Present Value ("NPV"), calculated over the 15-year analysis period, as discuss in Section 3.10. Scenarios are ranked based on costs, in order to determine the preferred scenario.

The base results were subjected to sensitivity analysis to identify the variables that have the greatest influence on the base model results (in terms of effect on NPV). The sensitivity analysis is documented in Section 4.4 and Appendix B. Further, a risk analysis was performed to investigate the affects of estimated and highly sensitive variables on the model results. In particular, the risk analysis is used to determine if the relative ranking of the preferred scenario changes. The risk analysis is documented in Section 4.5 and Appendix C.

4.3 Base Case Results

Figure 4.1 illustrates the waste generation over time for Scenario 1 (a) – Status Quo with WTE, for each of the waste generation groups as detailed in Table 3.3. These groups include Vancouver SFR to VSTS, Vancouver commercial to VSTS, other Metro Vancouver garbage to VSTS and Vancouver commercial to other Metro Vancouver facilities. Vancouver Commercial (both to VSTS and to MV facilities) includes multi-family residential waste. The waste generation graphs for the remaining scenarios are located in Appendix A.

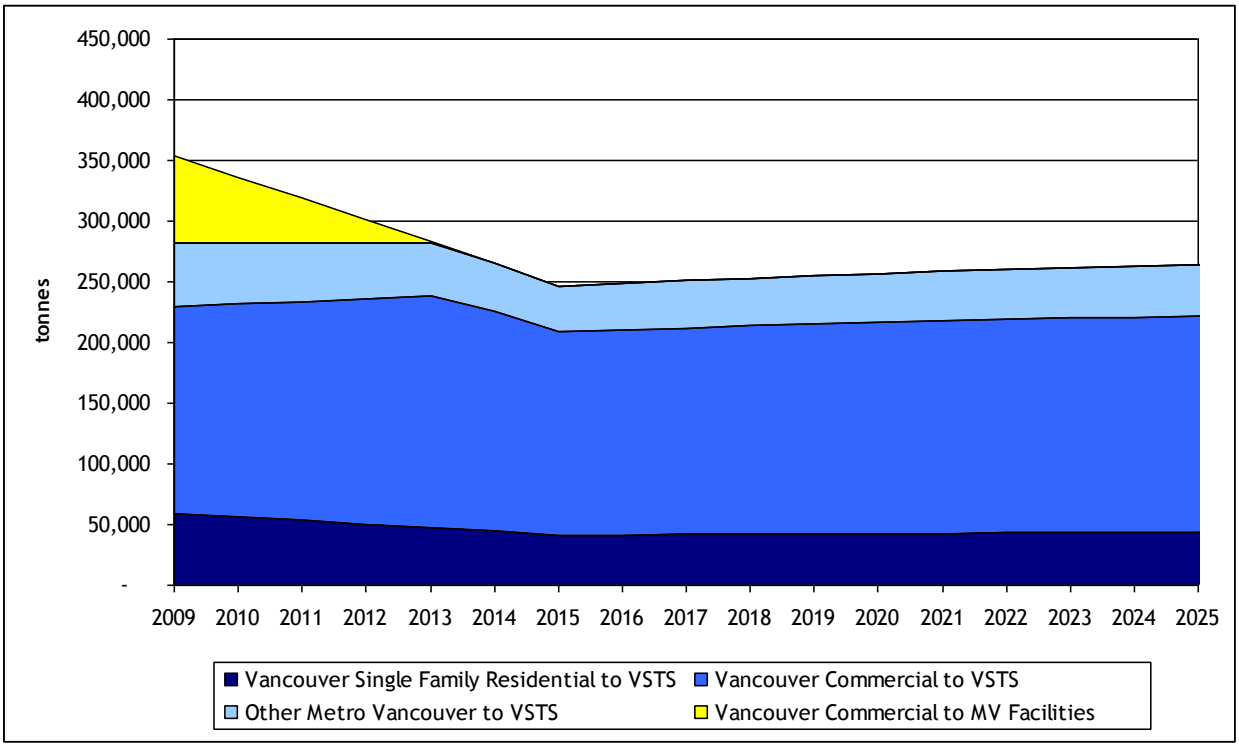


Figure 4.1: Waste Generation for Scenario 1 (a) – Status Quo with Waste-to-Energy

Table 4.1 shows the base case operating costs under Scenario 1 (a). Table 4.2 shows the allocation of the total VSTS costs based on the waste generation groups. It also shows the costs to Vancouver Commercial (including multi-family residential) for the leakage waste being disposed of at MV facilities other than VSTS and VL. The "Total Vancouver Costs" column shown in Table 4.2 is the summation of the Vancouver SFR Costs at VSTS, Vancouver Commercial Costs at VSTS and Vancouver Costs at other MV facilities. Table 4.3 shows the potential net revenues at the VSTS resulting from the disposal of Vancouver Commercial waste. Net Revenues is the total revenues collected from Vancouver Commercial less the allocated VSTS costs and the costs of disposal of the waste at VL (based on escalation of the 2006 VL operating cost of $23/tonne).

Similar output for all scenarios can be found in Appendix C. It should be noted that the base results incorporate Metro Vancouver's proposed future SWMP regarding timing of new WTE facilities, timing of achieving the targeted diversion rate and the regional rate ("tipping fee"). Changes to these assumptions are done in the sensitivity and risk analyses.

Table 4.1: Base Case Operating Costs Cash Flow Model - Scenario 1 (a)

Year	Waste Quantities (tonne)	Operating Costs		Upgrade Costs	Total VSTS Costs
		Fixed	Variable		
2009	281,705	$3,171,683	$3,902,113	$300,000	$7,373,796
2010	281,705	$3,171,683	$3,902,113	$306,000	$7,379,796
2011	281,705	$3,171,683	$3,902,113	$312,120	$7,385,916
2012	281,705	$3,171,683	$3,902,113	$318,362	$7,392,158
2013	281,705	$3,171,683	$3,902,113	$324,747	$7,398,543
2014	265,549	$3,171,683	$3,678,332	$331,242	$7,181,257
2015	246,682	$2,537,346	$3,416,985	$337,867	$6,292,198
2016	248,737	$2,537,346	$3,445,452	$344,624	$6,327,422
2017	250,765	$3,171,683	$3,473,547	$351,536	$6,996,766
2018	252,736	$3,171,683	$3,500,842	$358,567	$7,031,092
2019	254,671	$3,171,683	$3,527,644	$365,738	$7,065,065
2020	256,535	$3,171,683	$3,553,474	$373,053	$7,098,209
2021	258,353	$3,171,683	$3,578,655	$380,534	$7,130,873
2022	260,084	$3,171,683	$3,602,632	$388,145	$7,162,460
2023	261,718	$3,171,683	$3,625,257	$395,908	$7,192,848

Table 4.2: Allocation of Operating Costs for each Generation Group - Scenario 1 (a)

Year	VSTS Cost Allocation				Vancouver Costs at MV Facilities	Total Vancouver Costs
	Vancouver SFR	Vancouver Commercial	MV Other	Total		
2009	$1,553,730	$4,452,713	$1,367,353	$7,373,796	$5,086,298	$11,092,741
2010	$1,479,205	$4,589,594	$1,310,997	$7,379,796	$4,217,213	$10,286,012
2011	$1,403,589	$4,730,360	$1,251,967	$7,385,916	$3,121,464	$9,255,413
2012	$1,326,533	$4,874,670	$1,190,955	$7,392,158	$1,790,502	$7,991,705
2013	$1,247,896	$5,023,322	$1,127,325	$7,398,543	$215,616	$6,486,834
2014	$1,200,510	$4,889,317	$1,091,431	$7,181,257	$-	$6,089,827
2015	$1,050,856	$4,279,821	$961,522	$6,292,198	$-	$5,330,677
2016	$1,055,729	$4,299,667	$972,027	$6,327,422	$-	$5,355,396
2017	$1,166,315	$4,750,054	$1,080,397	$6,996,766	$-	$5,916,369
2018	$1,170,926	$4,768,831	$1,091,335	$7,031,092	$-	$5,939,757
2019	$1,175,490	$4,787,418	$1,102,158	$7,065,065	$-	$5,962,907
2020	$1,179,899	$4,805,377	$1,112,932	$7,098,209	$-	$5,985,277
2021	$1,184,230	$4,823,014	$1,123,629	$7,130,873	$-	$6,007,243
2022	$1,188,370	$4,839,874	$1,134,217	$7,162,460	$-	$6,028,244
2023	$1,192,290	$4,855,840	$1,144,719	$7,192,848	$-	$6,048,129

Table 4.3: Vancouver Commercial Potential Net Revenues at VSTS - Scenario 1 (a)

Year	Waste Quantities to VSTS (tonnes)	Allocation of VSTS Operating Costs	Cost for Waste Disposal at VL	Total Revenues	Net Revenues
2009	170,109	$4,622,822	$4,151,988	$12,077,752	$3,302,942
2010	175,196	$4,764,790	$4,361,668	$13,490,088	$4,363,630
2011	180,420	$4,910,780	$4,581,553	$14,974,838	$5,482,504
2012	185,767	$5,060,437	$4,811,683	$16,533,247	$6,661,127
2013	191,267	$5,214,588	$5,053,218	$18,361,586	$8,093,780
2014	180,798	$5,070,115	$4,872,168	$18,079,775	$8,137,492
2015	167,788	$4,447,609	$4,612,007	$17,114,365	$8,054,748
2016	169,024	$4,468,691	$4,738,906	$17,585,262	$8,377,666
2017	170,243	$4,920,297	$4,868,537	$18,066,301	$8,277,467
2018	171,418	$4,940,249	$5,000,183	$18,554,819	$8,614,387
2019	172,570	$4,959,987	$5,134,455	$19,053,077	$8,958,635
2020	173,671	$4,979,048	$5,270,555	$19,558,122	$9,308,519
2021	174,739	$4,997,753	$5,409,043	$20,072,026	$9,665,230
2022	175,746	$5,015,620	$5,549,025	$20,591,475	$10,026,830
2023	176,684	$5,032,524	$5,690,198	$21,115,344	$10,392,622

The base results for total cost from the cash flow model are summarized in Table 4.4. It can be seen that restricting residential customer access to the VSTS (Scenario 3 – Restricted Access) has the lowest cost and the highest potential net revenues. The key reason is that Vancouver is able to capture additional Vancouver commercial waste that is currently being disposed of at other Metro Vancouver facilities, thereby reducing overall costs and increasing potential net revenues. In addition, Vancouver does not incur any significant costs for disposal at the regional rate, and receives the net revenue benefit.

In comparison, the highest cost and lowest potential net revenues from the base analysis is when the City of Vancouver closes the VSTS and direct hauls the MSW to other MV waste disposal facilities (Scenario 4 – Close Facility). The key reason is that Vancouver incurs high cost for disposal at the regional rate, with zero potential net revenues as the City no longer operates the VSTS.

Table 4.4: Base Scenario Comparison for Costs and Net Revenues (NPV)

Scenario	Description	Total Vancouver Costs - 15 yrs	Potential Vancouver Net Revenues - 15 yrs	Ranking
S1a	Status Quo (a)	$77,943,642	$81,050,748	2
S1b	Status Quo (b)	$88,753,449	$81,050,748	3
S2	New Facility	$101,537,625	$81,050,748	4
S3	Restricted Access	$67,361,129	$85,125,880	1
S4	Close Facility	$137,906,845	$-	5

The net present value of costs are similar for Scenario 1 (a) – Status Quo with WTE and Scenario 1(b) – Status Quo without WTE with the given time period of 15 years. It is important to note that when the time period is increased to 20 years, the cost of Scenario 1(b) increases more than Scenario 1(a). This is due to the fact that there are increased capital costs associated with building a new facility in Scenario 1(b), that are not present in Scenario 1(a). As a result, Scenario 1(b) and Scenario 2 – New Facility become closer when comparing 20-year NPV of costs.

Figure 4.2 and Figure 4.3 graphically illustrate the base scenario comparison of total Vancouver costs and potential Vancouver net revenues, respectively.

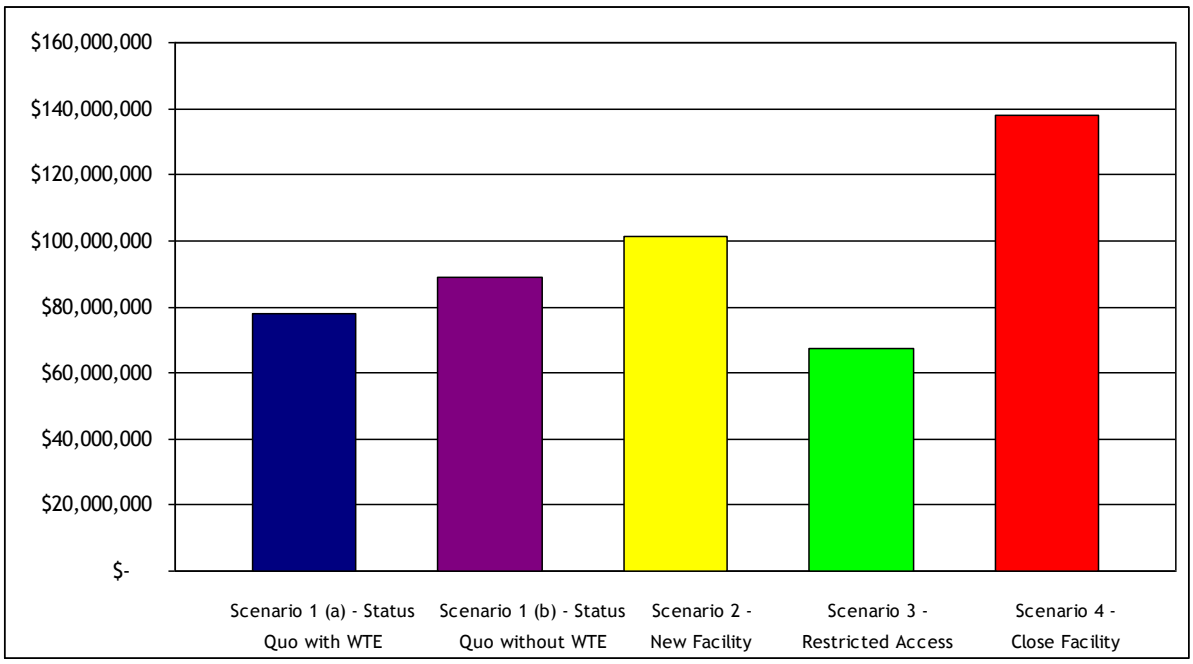


Figure 4.2: Base Scenario Comparison – Vancouver Total Cost (NPV)

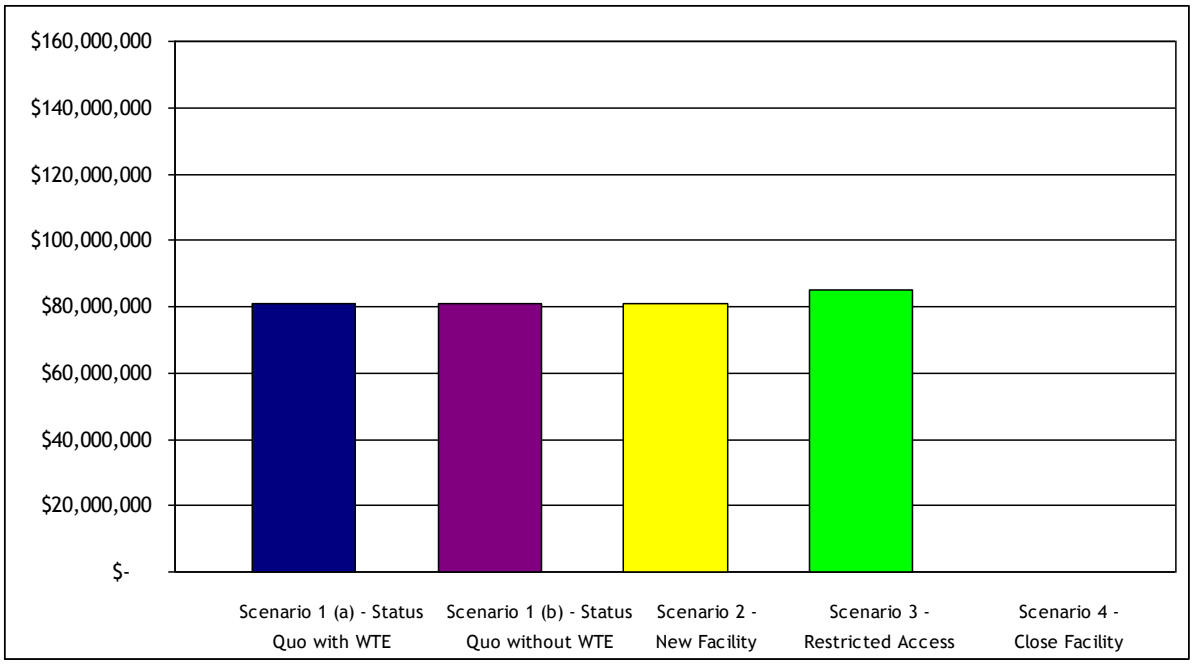


Figure 4.3: Base Scenario Comparison – Vancouver Potential Net Revenues (NPV)

4.4 Sensitivity Analysis

The purpose of the sensitivity analysis is to identify which variables or model inputs that have the most influence on the financial outcomes of the various scenarios. In conducting the sensitivity analysis, the base case values around which the analysis was conducted correspond to the deterministic analysis using the policy targets. It is important to note this assumption in relation to the results of the sensitivity analysis.

The sensitivity analysis uses a range of plausible values for each input and varies them individually. It records the model outputs and the ranking of the scenarios. The range of variables is based on discussions with industry professionals who are familiar with the VSTS, as well as the regional waste disposal system. Table 4.5 summarizes the variables used in the sensitivity analysis.

Table 4.5: Summary of Sensitivity Analysis Variables

Variable	Description
Timing of WTE	Represents which year WTE is determined to be feasible or infeasible
Regional Rate	Represents the rate per tonne charged for MSW at Metro

Variable	Description
	Vancouver waste disposal facilities from 2014 and beyond
Capital Cost Escalation	Represents the annual increase to capital costs
Maintenance Costs	Represents the annual costs to maintain/repair the existing facility
Annual Regional Rate Increase	Represents the annual increase to the Regional Rate
Inflation	Represents the annual increase to fixed and variable costs
Sustainable Diversion after 2015	Represents the diversion rate achieved from 2015 & beyond
Year 70% diversion is reached	Represents the year when 70% diversion is achieved
Population Growth	Represents the percent change in population growth
Discount Rate	Represents the change in discount rate
Variable Operating Cost	Represents changes to variable operating costs
Fixed Operating Cost	Represents changes to the fixed operating costs

Figure 4.4 shows the effects on the Total Vancouver Costs of varying the percentage of sustainable diversion after 2015 between 40.0% to 75.0%. Figures for the other sensitivity analysis variables are contained in Appendix B.

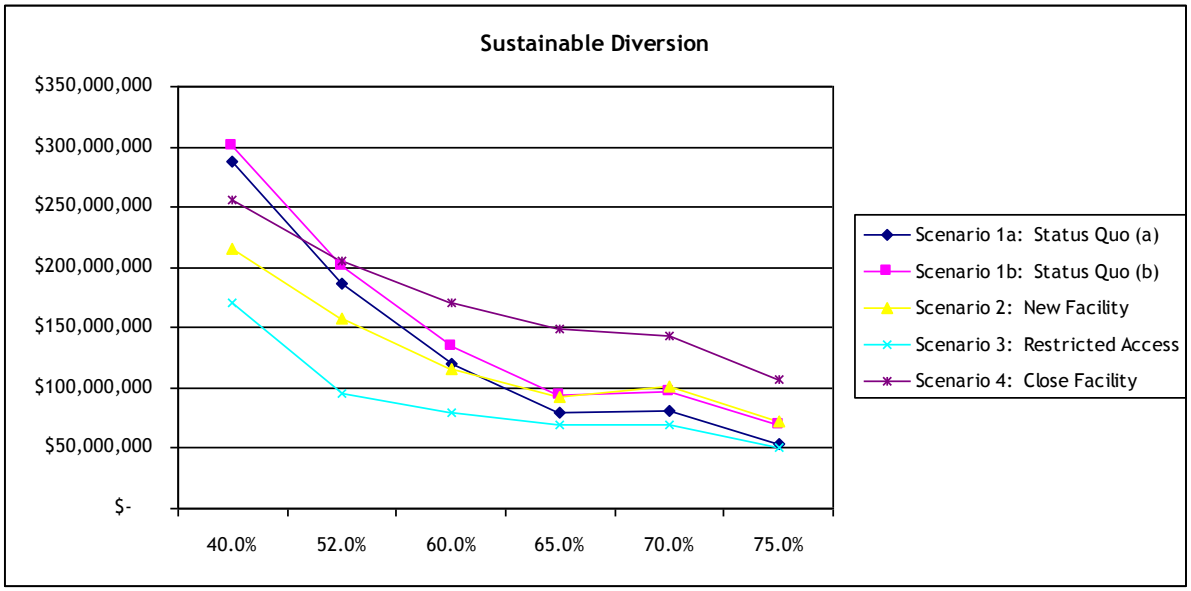


Figure 4.4: Change in Total Costs with varying Sustainable Diversion

Figure 4.5 is a tornado diagram for Scenario 1 (a) – Status Quo with WTE. This diagram shows the sensitivity of the total Vancouver costs on a percent basis in relation to the base total Vancouver costs. The larger the bars, the more sensitive the variable is to change. For Scenario 1 (a), the year 70% waste diversion is achieved and the sustainable diversion rate after 2015 have a significant affect on the total Vancouver costs. Annual maintenance costs and discount rate have a medium affect on the total Vancouver costs. Appendix B contains the tornado diagrams for the remaining scenarios.

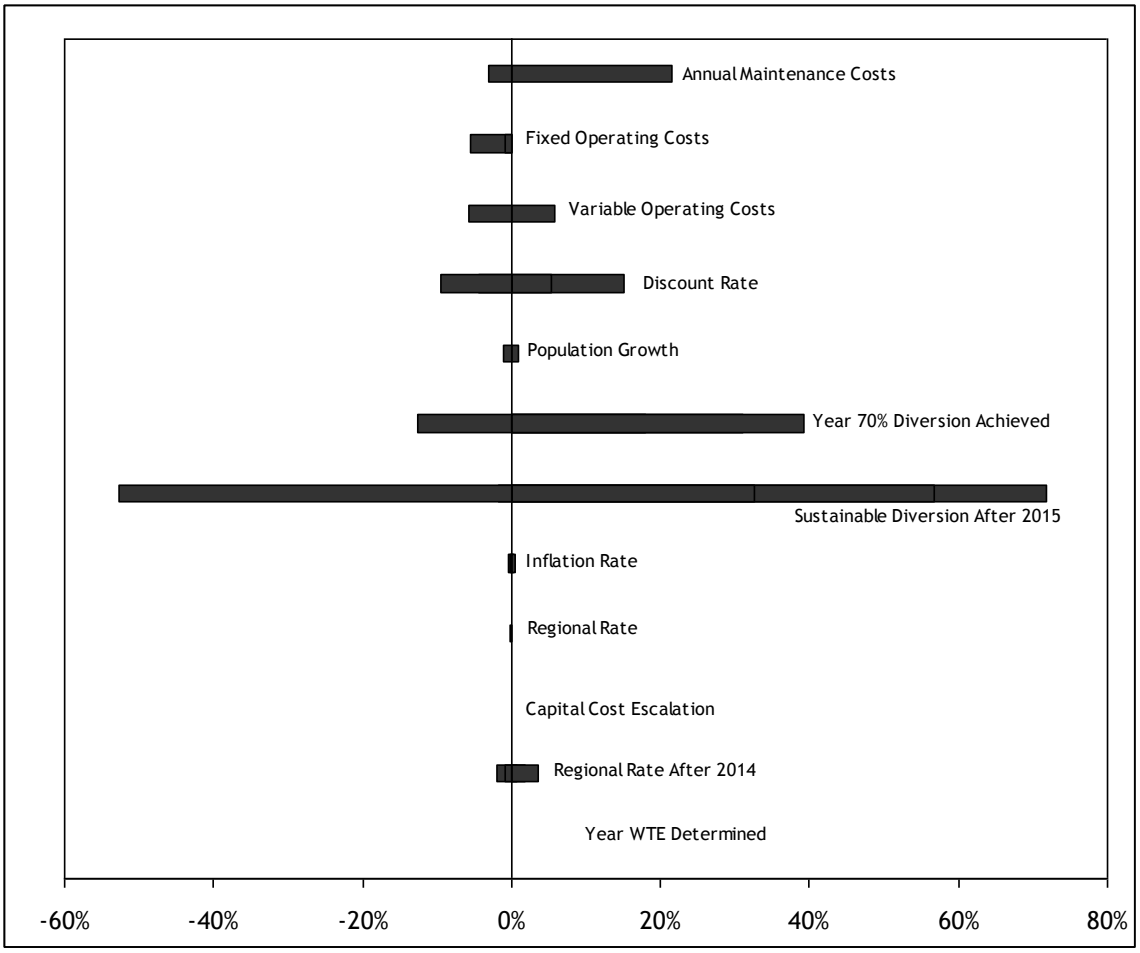


Figure 4.5: Scenario 1(a) Tornado Diagram

Table 4.6 summarizes the results of the sensitivity analysis. The degree of sensitivity to the change in the total Vancouver costs is measured in terms of high, medium or low based upon percentage change shown in the tornado diagrams. Sensitivity does not consider the total

potential net revenues to Vancouver, as these revenues are potential and theoretical in nature. The Risk Analysis column indicates whether or not further analysis was completed, using the probability distribution of the variable.

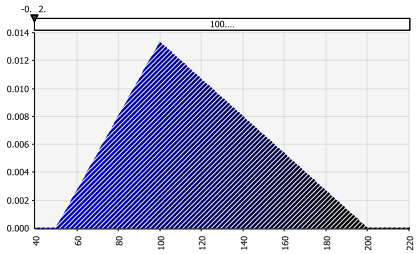
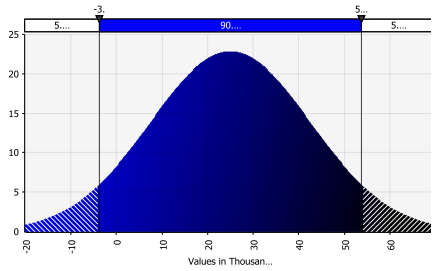
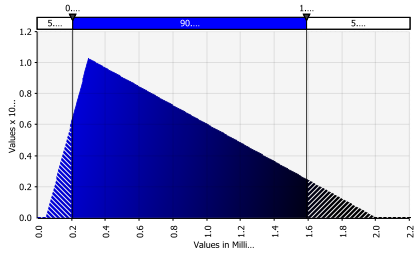
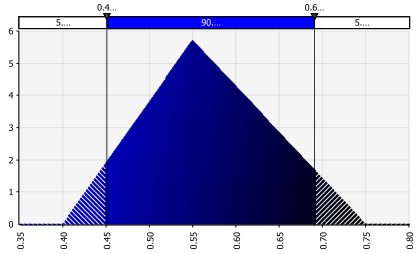
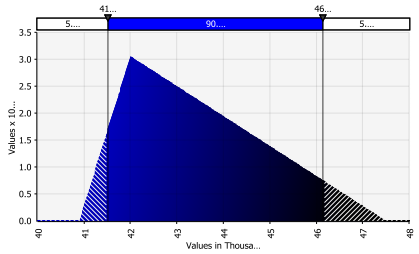
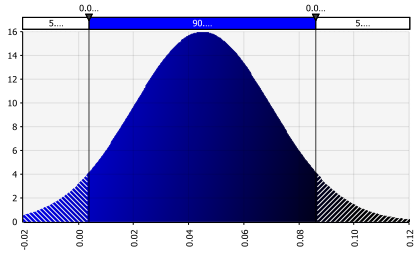
Table 4.6: Summary of Sensitivity Analysis Results

Variable	Base	Range	Sensitivity to NPV Change	Sensitivity to changing lowest cost scenario	Risk Analysis
Timing of WTE	Jan 2014	Jan 2014 to Jan 2034	Low	Low	No
Regional Rate	$100	$50 to $200	Medium	Low	Yes
Capital Cost Escalation	2.0%	0.5% to 10.0%	Low	Low	No
Maintenance Costs	$300,000 / year	$50,000 to $2,000,000 / year	Medium	Low	No
Annual Regional Rate Increase	2.0%	0.5% to 4.0%	Low	Low	No
Inflation	2.0%	0.5% to 4.0%	Medium	Low	Yes
Sustainable Diversion after 2015	70.0%	40.0% to 75.0%	High	High	Yes
Year 70% diversion is reached	2015	2012 to 2030	Medium	Low	Yes
Population Growth	Base	-10% to +10%	Low	Low	No
Discount Rate	5.1%	2.0% to 7.0%	High	Low	Yes
Variable Operating Cost	$13.85	$12.04 to $15.93	Low	Low	No
Fixed Operating Cost	Base	-15% to +15%	Low	Low	No

4.5 Risk Analysis

Based on the results of the base financial model and the sensitivity analysis, a risk analysis was completed to further investigate the effects of estimated variables on the results of the base model. Table 4.7 summarizes the variables that were assigned ranges (also known as probability distributions) and used in the Monte Carlo simulation. Full details on the Risk Analysis are available in Appendix C.

Table 4.7: Risk Analysis Variables

Variable	Description	Base	Range	Risk Curve
Regional Rate	Represents the per tonne rate at MV waste disposal facilities beyond 2014	$100	$50 to $200	
Inflation	Represents the annual increase to fixed and variable costs	2.0%	0.5% to 4.0%	
Annual Maintenance Costs	Represents the annual cost for maintaining the existing building	2.0%	0.5% to 4.0%	
Sustainable Diversion after 2015	Represents the diversion rate achieved in 2015 and beyond	70.0 %	40.0% to 75.0%	
Year 70% diversion is reached	Represents the year when 70% diversion is achieved	2015	2012 to 2030	
Discount Rate	Represents the change in discount rate	5.1%	2.0% to 7.0%	

The purpose of the risk analysis is to recognize that several of the estimated variables have a range of values, versus single point estimates that were used in the quantitative analysis. The result is a range of plausible total Vancouver costs and net potential revenues for each scenario, reflecting the uncertainty of the inputs. This provides additional information when comparing the ranking of the preferred scenario, which may improve the decision-making process.

The risk analysis will attempt to assist decision makers in understanding the scope of their decisions, in particular those relate to the future SWMP. Despite best efforts in trying to achieve policy targets as laid out in the draft future SWMP, there are challenges and uncertainties involved. For a few of the variables an attempt has been made to capture best judgment as to what could reasonably occur. These variables include the sustainable diversion rate and year the diversion rate is achieved. As decision makers often embed optimism in their policy decisions, an attempt is made in the risk analysis to capture the significance of setting optimistic targets.

The variables that were assigned a range of values were those that were shown to have a significant influence on the model during the sensitivity analysis. The Monte Carlo simulation selected random values for each of the inputs listed in Table 4.7 based on the ranges specified for 5,000 simulations. In addition, variables that could not be based on actual measurements and therefore were based on estimates were also assigned a range of plausible values in the risk analysis.

The shape of the probability distributions are based on judgment as to the likely shape of the distribution, based on experiences and knowledge of the author and colleagues. Although the distributions are based on judgment, the use of the distributions to represent an estimated variable is more robust than using a single point estimate. The shapes of the probability distributions were modified to reflect the judgment of the likely outcomes. A normal distribution was used for the inflation and discount rates.

The results of the base analysis are detailed in Section 4.3. The variables used for the base analysis were single value estimates. Comparatively, the results from the risk analysis (also known as Monte Carlo simulation) are probability density functions. These histograms summarize the range of potential outcomes for each of the scenarios and show the likelihood that the outcomes will occur.

The result of the estimation for the best case, expected case and worst case outcomes for the total Vancouver costs (15-year NPV) for each scenario is shown in Figure 4.6. The result of the estimation for the best case, expected case and worst case outcomes for the potential Vancouver net revenues (15-year NPV) for each scenario is shown in Figure 4.7.

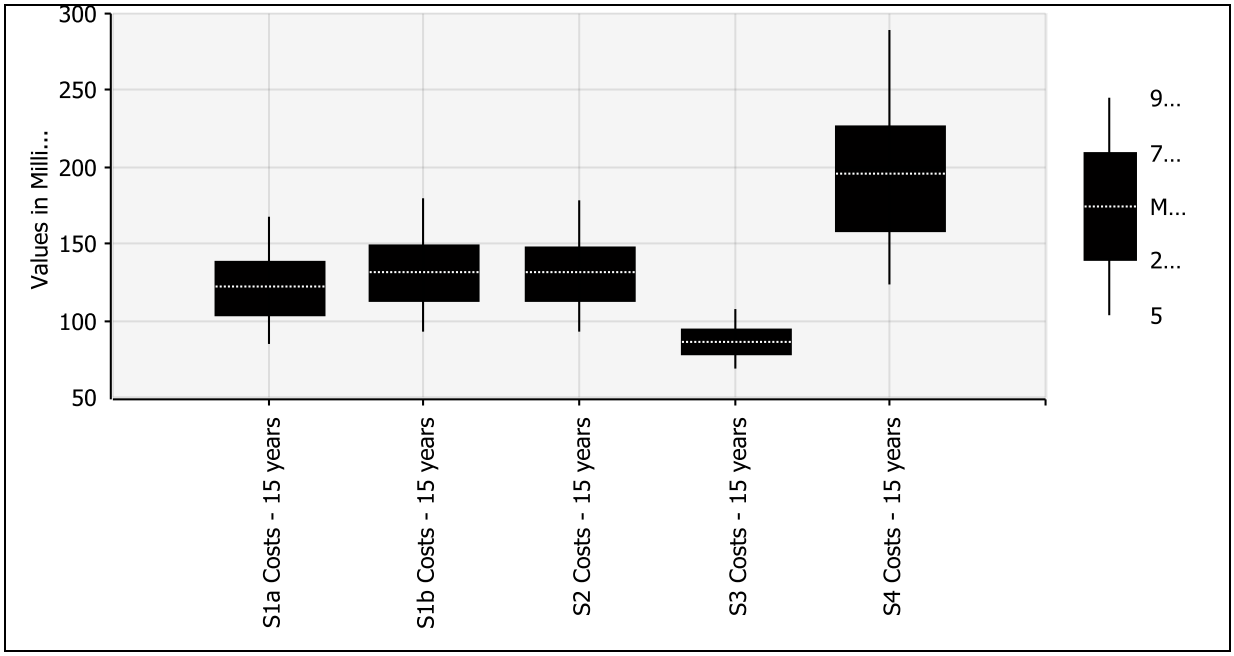


Figure 4.6: Risk Analysis Summary of Total Vancouver Costs (15-year NPV)

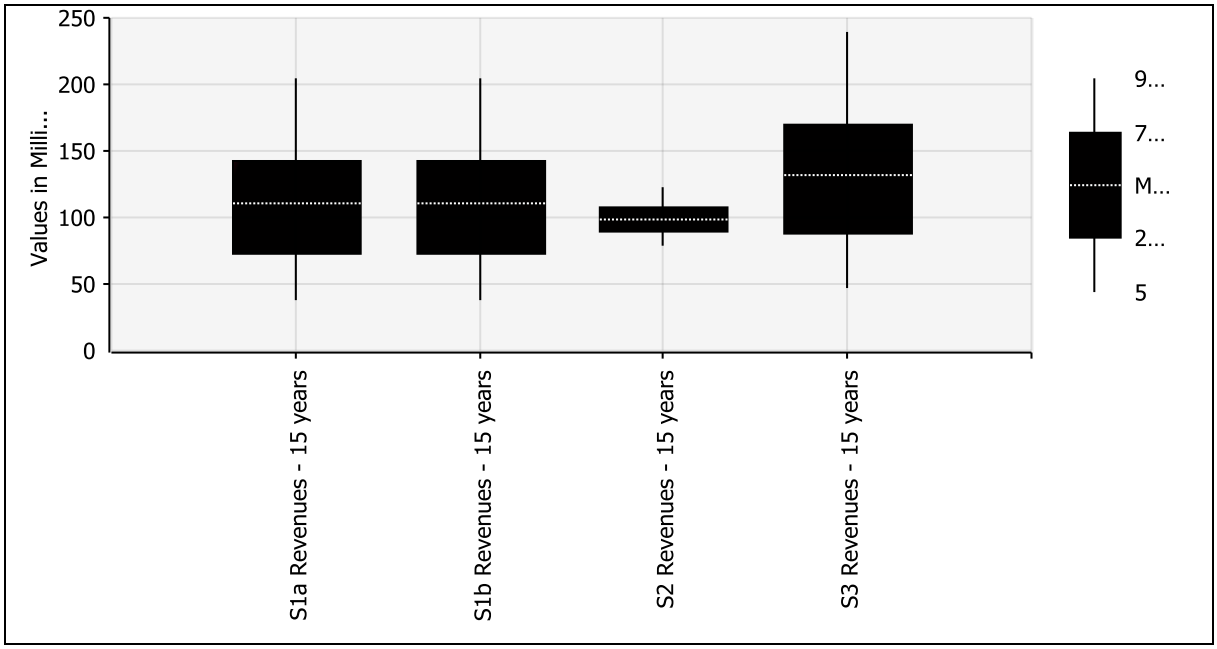


Figure 4.7: Risk Analysis Summary of Potential Net Revenues (15-year NPV)

In this analysis the best case outcome limit is the 5th percentile (indicated by the lowest bar on the figures), while the worst case outcome limit is the 95th percentile (indicated by the highest bar on the figures). The expected case is the mean of the probability density function, excluding the extreme outliers (indicated by the white dashed line on the figures).

The total cost and potential net revenue results of the risk analysis from the cash flow model are summarized in Table 4.8. It can be seen that Scenario 3 – Restricted Access has the lowest total Vancouver cost. The highest total Vancouver cost with no potential net revenues is Scenario 4 – Close Facility. These results are similar to the results from the base analysis, with the exception that Scenarios 1 (b) and 2 ranking.

Table 4.8: Risk Analysis Scenario Comparison (NPV)

Scenario	Description	Total Vancouver Costs - 15 yrs	Net Revenues - 15 yrs	Ranking
S1a	Status Quo (a)	$150,696,525	$146,585,843	2
S1b	Status Quo (b)	$164,969,791	$146,585,843	4
S2	New Facility	$162,984,470	$123,178,774	3
S3	Restricted Access	$105,847,873	$173,352,379	1
S4	Close Facility	$233,411,094	$-	5

Figure 4.8 and Figure 4.9 show that Scenario 3 – Restricted Access has the lowest expected total Vancouver cost, as indicated by the mean outcome. It also has the smallest range of possible total Vancouver costs. In other words, Scenario 3 is most likely to have the lowest total Vancouver costs with the greatest degree of certainty. In contrast, Scenario 4 – Close Facility has the highest total Vancouver costs with the greatest degree of uncertainty. The chance that the total Vancouver costs for Scenario 4 being within with the range of plausible costs for Scenario 3 is less than 2%, as shown in Figure 4.9.

Figure 4.10 shows that Scenario 2 has the lowest expected potential net revenues, as indicated by the mean outcome. It also has the smallest range of possible net potential revenues. In other words, Scenario 2 is most likely to have the least potential net revenues with the greatest degree of certainty. In contrast, Scenario 1a – Status Quo (a), Scenario 1(b) – Status Quo (b) and Scenario 3 – Restricted Access have the highest potential net revenues with the greatest degree

of uncertainty. Scenario 4 – Close Facility is not shown in Figure 4.10, as closing the facility would results in having no potential for net revenues.

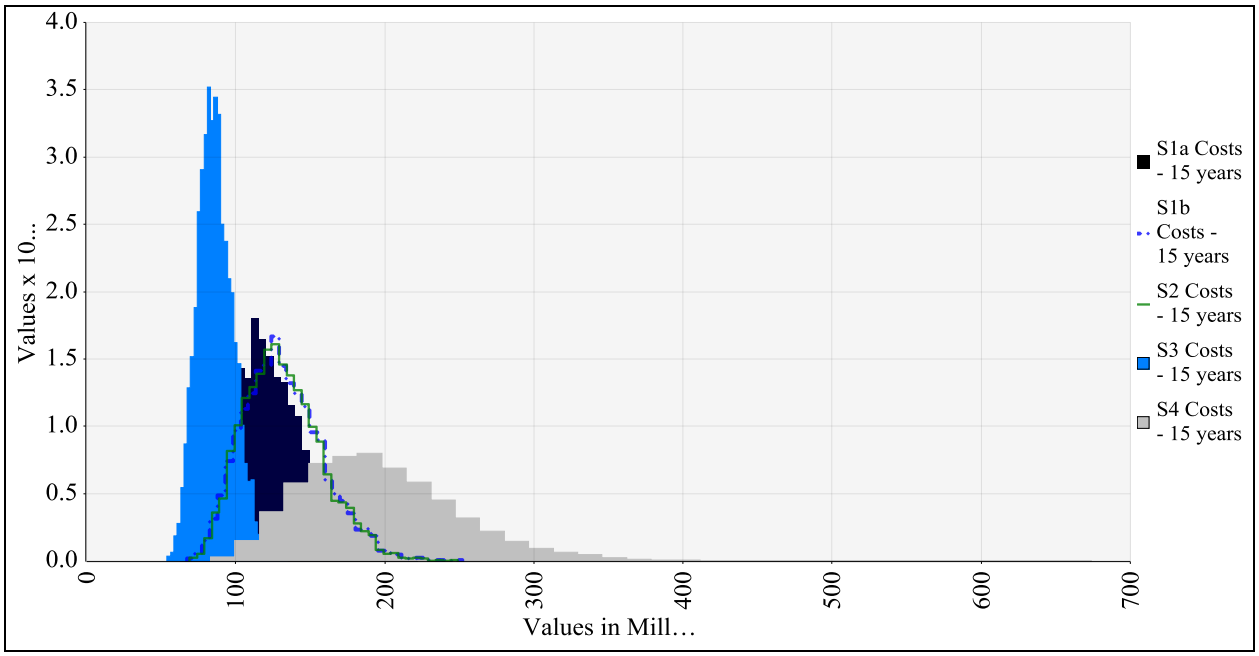


Figure 4.8: Comparison of Total Vancouver Costs (15-year NPV)

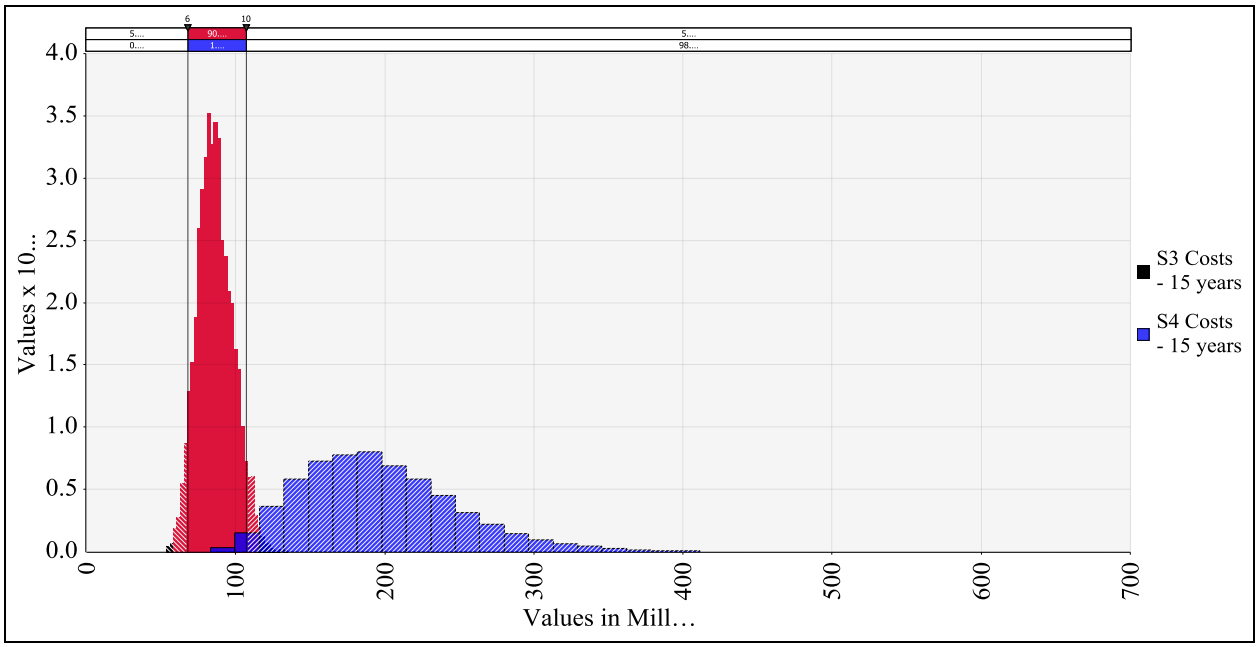


Figure 4.9: Comparison of Total Vancouver Costs - Scenario 3 & 4 (15-year NPV)

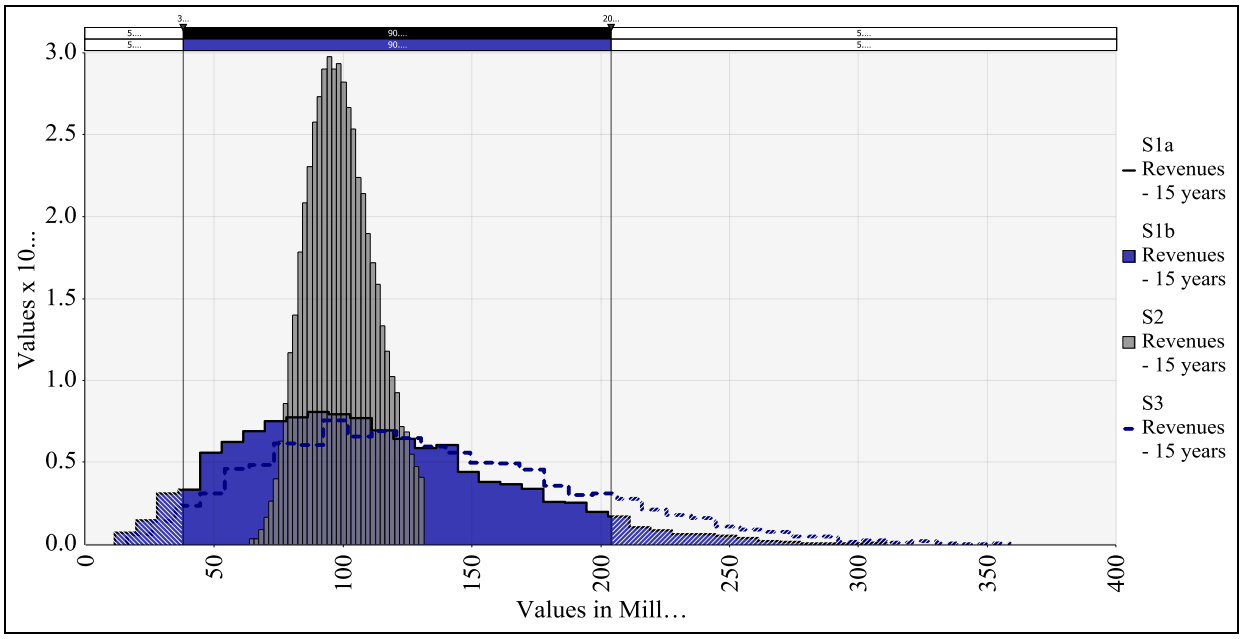


Figure 4.10: Comparison of Potential Net Revenues (15-year NPV)

The results of the risk analysis (Table 4.8) show significant increases in the net potential revenues for Scenarios 1 (a) to 3 and total Vancouver costs for Scenario 4 when compared to the base case analysis (Table 4.4). Not withstanding the significant differences in the NPV values, it is important to note that the rankings of the alternatives remain largely unchanged. These changes are caused by the range of values assigned to the regional rate, sustainable diversion rate after 2015 and year that the diversion rate is achieved.

The regional rate is the key variable that affects revenues. The greater the regional rate, the more money that will be gained as net potential revenues. On the contrary for Scenario 4 the larger the regional rate, the more money that Vancouver must pay to dispose of Vancouver's MSW at regional waste facilities, thereby increasing total Vancouver Costs.

The sustainable diversion rate and year that the diversion rate is achieved are the two key variables that affect the waste generation. The lower the diversion rate or the longer it takes to achieve, the more MSW that is generated in Vancouver. This results in larger volumes of waste receive at the VSTS, leading to additional net potential revenues.

The key parameters noted above have ranges that reflect the author's skepticism in the base case variable assumptions, as discussed in Section 3.3. The regional rate is varied between $50 and

$200 (base value of $100). While the sustainable diversion rate is varied between 40% and 75% (base value of 70%) and the year diversion is achieved is varied between 2012 and 2030 (base value of 2015). These ranges push the results in the direction of increased net potential revenues (or total Vancouver costs for Scenario 4).

5.0 QUALITATIVE ANALYSIS

5.1 Introduction

Waste management decisions, particularly related to facilities such as transfer stations, can create conflict between various stakeholder groups such as politicians, staff, regulators, facility users (including waste haulers) and residents (including local neighbours). These conflicts are related to the approach to long-term waste management, in terms of economic feasibility, facility services and potential or perceived impacts on stakeholder groups.

Based on the financial analysis in Section 4.1, restricting residential customer access to the VSTS (Scenario 3 - Restricted Access) is the best alternative based on expected monetary costs and potential net revenues. This Section compares the scenarios based on key qualitative factors, since certain impacts and benefits cannot be captured through a financial analysis. The qualitative analysis is based on a high-level comparison of the differences between the scenarios over a longer term period.

The following groups have been identified as stakeholders of VSTS operations for the qualitative analysis:

- Vancouver residents (facility users and neighbours), who are represented by Vancouver City Council;
- Metro Vancouver residents, who are represented by the Greater Vancouver Sewerage & Drainage District; and
- Waste haulers, who are represented by business organizations.

Based on the stakeholder groups, the factors are divided into five main categories as defined below:

- Vancouver factors: The impacts of these factors affect Vancouver residents only;
- Regional factors: The impacts of these factors are not limited to Vancouver, but instead affect the entire Region;
- Commercial factors: The impacts of these factors affect local and regional businesses;

- Owner/operator factors: The impacts of these factors affect the City of Vancouver as the owner and operator of the VSTS; and
- Legal and Regulatory factors: These impacts have legal or regulatory ramifications based on existing agreements, statues or acts.

5.2 Vancouver Factors

Vancouver City Council created a Vision Action Plan, which identifies key issues to Vancouver based on the value systems of the citizens they represent. The Plan identifies issues that Vancouver Council wants to address during their term in office.

The four key issues, as identified in December 2008, are:

- Homelessness and affordable housing;
- Improve the quality of life including building stronger, safer and inclusive communities;
- A green City from both an environment and sustainability perspective; and
- Creativity and innovation to create a capital and thriving economy. [8]

Of these key issues, the environment and sustainability is most relevant to the research on upgrades to the VSTS. The goal of this key issue is to make Vancouver the "greenest city in the world", by reducing greenhouse gas emissions and fighting climate change. In particular, the Plan states that:

> "The City will set strong waste diversion targets to reduce waste and improve recycling rates. We will work with residents and local businesses to reduce waste from packaging, including plastic bags and disposable containers, and develop a plan to improve recycling rates in apartments and condos."

Further detail on this key issue is contained within the Plan. Some key points from that are directly related to upgrading the VSTS include:

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[8] http://www.votevision.ca/sites/all/files/vision_platform_web.pdf

- Getting serious about reducing our waste with city-wide waste diversion and composting strategies;
- Making City-owned facilities models for recycling with a targeted diversion rate of 70%;
- Developing a city-wide curbside composting strategy for organic waste;
- Developing a plan to encourage recycling of construction and demolition debris; and
- Advocating for federal and provincial policies that support zero waste.

As part of Mayor Gregor Robertson's goal to make Vancouver the greenest city in the world and further to Council's Action Plan, on February 25, 2009 Mayor Gregor Robertson announced the Greenest City Action Team. The purpose of the team is to recommend immediate action steps to improve Vancouver's environmental performance and create strategies for advancing green economic initiatives.

The team has provided a report to Council as a Quick Start Guide[9] which outlines immediate actions the City can take that will have significant impacts. A further report anticipated to be completed in June 2009, will provide a comprehensive ten-year action plan to address Vancouver's environmental challenges and recommend targets, timelines, and actions. It will identify policy changes required regionally, provincially, and federally, as well as identify potential joint projects with businesses, non-government organizations, and other levels of government.

The scope of the team's mandate includes nine subjects, one of which is reducing pollution and waste. In the Quick Start Guide, increasing solid waste diversion, implementing organic waste composting, shifting to biweekly garbage collection, tackling waste packaging and advocating waste reduction were all identified as immediate action items.

Table 5.1 summarizes the key factors that affect Vancouver residents, based on the key points identified in the Vancouver Action Plan and factors noted during model analysis.

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[9] http://vancouver.ca/greenestcity/PDF/greenestcity-quickstart.pdf

Table 5.1: Summary of Vancouver Stakeholder Factors

Factors	Scenarios Differentiate?	Discussion
Facilitate recycling, including wood waste	No	Although a new facility would allow for additional recycling, the existing facility has a Recycling Depot.
Facilitate organics composting	No	Existing building has ability to accept residential collections and commercial loads. A new facility is needed to capture residential drop-offs (will be minimal volume due to residential collections).
Develop city-wide curbside organic waste composting	Yes	Closing the VSTS would require additional hauling distance for all waste types including organic waste.
Shift to biweekly garbage collection; advocate waste reduction	No	All scenarios would allow for less waste collection, although if bi-weekly collection was effective in reducing waste quantities a new larger facility may not be needed.
Promotes zero waste; Waste disposal system certainty/reliability	Yes	Closing the VSTS has the greatest effect on increasing steps towards Zero Waste and allows for the least amount of future control of waste management.
Local traffic	No	Closing the VSTS would reduce some traffic from the area; however residential collection vehicles will still be deployed from Manitoba Works Yard.
Regional role in waste disposal system	Yes	Closing the VSTS would reduce Vancouver's role in the regional waste disposal system.
Value of facility or land for future sale	No	Closing the VSTS could allow for the sale of the land, although the land is contained within an existing works yard. The City would prefer to retain the land for other City uses.
Possible Excess Contribution to SWCR	Yes	Closing the VSTS has the greatest effect on reducing contributions to the SWCR (i.e. potential net revenues).
Public works waste disposal	No	Closing the VSTS would make public works waste disposal longer haul further to VL.
Ease of waste disposal; control illegal dumping	Yes	Closing the VSTS or implementing restrictions could increase illegal dumping, if alternatives for waste disposal are not convenient.
Screen waste prior to disposal	No	Scenarios where a new facility is built will have improved waste screening, although the existing facility does have adequate waste screening.
Provide user convenience	Yes	Closing the VSTS results in user inconvenience, as does restricting access depending on the restrictions.

5.3 Regional Factors

As described in Section 3.2, Metro Vancouver is currently developing an updated regional SWMP. Once updated, the future SWMP will provide further information on the priorities for regional waste disposal. A summary of the regional factors is shown in Table 5.2, as determined through review of the strategic SWMP updating documents and base model analysis.

Table 5.2: Summary of Regional Factors

Factors	Scenarios Differentiate?	Discussion
Regional Traffic	Yes	Closing the VSTS has the greatest impact on additional traffic throughout the region.
Air Quality/Greenhouse Gas Emissions	Yes	Closing the VSTS has the greatest impact on additional regional traffic and increased greenhouse gas emissions.
Regional Waste Disposal System Certainty	Yes	Closing the VSTS would result in one less regional transfer station. Currently many of the transfer stations are at capacity. Closing a transfer station would put increase stress on the remaining facilities.
Regional Waste Tolerance to Disruption	No	VSTS has the most service disruptions. Other regional transfer stations operated by a third party experience fewer disruptions.

5.4 Commercial Factors

Waste haulers are concerned about the effect that a facility will have on the long-term viability of their business and how the facility will affect their competitive advantage. Decision makers can be affected by information provided by waste hauling associations. Often the information can be related to the economic effects, benefits to the community and environmental impacts. Table 5.3 contains a summary of the commercial factors.

Table 5.3: Summary of Commercial Factors

Factors	Scenarios Differentiate?	Discussion
Convenience of Disposal	Yes	Closing the VSTS has the less user convenience. It can be assumed that restrictions in Scenario 3 will not affect commercial haulers.
Ease of Facility Use	Yes	Scenarios that contemplate a new facility would have additional benefits, including increasing efficiency of services to customers.

5.5 Owner/Operator Factors

The City of Vancouver is a stakeholder as the owner and operator of the VSTS. In particular, issues related to general operations, health and safety and customer service are summarized in Table 5.4.

Table 5.4: Summary of Owner/Operator Factors

Factors	Scenarios Differentiate?	Discussion
Health and Safety	Yes	A new facility offers an opportunity to increase health & safety by incorporating changes in the facility design such as additional natural lighting, new dust suppression system and a flat floor design (versus the existing pit floor).
Customer Service	Yes	A new facility offers the opportunity to increase customer service through the addition of more inbound and outbound scales, the addition of a commercial automated scale, additional recycling, etc.
Staff Facilities	Yes	A new facility offers the opportunity to increase staff facilities, such as lunch room space, locker rooms, showering facilities, etc.
Facility Traffic Impacts	Yes	A new facility offers the opportunity to reduce traffic impacts, both onsite and on adjacent roadways (mainly Kent Avenue). The new design moves the facility entrance onto Manitoba Street offering further cue length onsite for vehicle traffic. Additional design features assist in better traffic flow within the facility.
Efficient Operations - personnel	No	An analysis by EarthTech (2005) of the new facility showed that the personnel requirements would remain relatively unchanged in a new facility compared to the existing facility.
Efficient Operations - resources	Yes	An analysis of the new facility showed that the resources (such as equipment, utilities, etc) requirements would stay relatively the same as the existing facility. Some equipment such as the crane would be replaced with a compactor (which is generally higher maintenance).
Change Management	Yes	A new facility would require change management for staff and customers. Change management can often be a time consuming process, but can be difficult to quantify.

5.6 Legal and Regulatory Factors

The City of Vancouver is bound to act within legal and regulatory obligations, created through the Tripartite Agreement, the 1995 SWMP and provincial environmental regulations. A summary of the legal and regulatory factors is shown in Table 5.5.

Table 5.5: Summary of Legal and Regulatory Factors

Factors	Scenarios Differentiate?	Discussion
Disposal Requirements	Unsure	The SWMP is currently under review; therefore it is unclear what additional issues may need to be addressed once the future SWMP is finalized. Modifications to the future SWMP would be required if Vancouver closed the VSTS.
Catchment Area	Yes	Closing the VSTS would require renegotiating the Tripartite Agreement.

5.7 Summary of Differentiating Factors

Of the twenty-eight factors identified, fifteen factors differentiate the scenarios. A summary of the factors that differentiate the scenarios is shown in Table 5.6. Included with the factor description is the stakeholder group affected by the factor. Also included is the least and/or most desirable scenario (as applicable), based on the identified factor.

Table 5.6: Summary of Differentiating Factors

Factors	Stakeholder	Affected Scenarios
Develop curbside organic waste composting strategy	Vancouver	Scenario 4 is least desirable with regards to impacting this factor.
Promotes Zero Waste	Vancouver	Scenario 4 is the most desirable with regards to impacting this factor.
Regional Role in Waste Disposal System	Vancouver	Scenario 4 is least desirable with regards to impacting this factor.
Possible Excess Contribution to SWCR	Vancouver	Scenario 4 is least desirable with regards to impacting this factor.
Ease of waste disposal; control illegal dumping	Vancouver	Scenario 4 is least desirable with regards to impacting this factor. Scenario 3 may also be undesirable depending on the types of restrictions. Scenarios 1 (a) and 2 are the most desirable with regards to ease of disposal.

Factors	Stakeholder	Affected Scenarios
Provide user convenience	Vancouver	Scenarios 3 and 4 are least desirable with regards to impacting this factor. Scenarios 1 (a) and 2 are the most desirable with regards to providing user convenience.
Regional Traffic	Regional	Scenario 4 is least desirable with regards to impacting this factor.
Air Quality/Greenhouse Gas Emissions	Regional	Scenario 4 is least desirable with regards to impacting this factor.
Regional Waste Disposal System Certainty	Regional	Scenario 4 is least desirable with regards to impacting this factor.
Convenience of Disposal	Commercial	Scenario 4 is least desirable with regards to impacting this factor. Scenarios 1 (a) and 2 are the most desirable with regards to convenience of disposal.
Ease of Facility Use and Customer Service	Commercial & Owner/ Operator	Scenario 1 (a), 2 and 3 are the most favourable in this regard for commercial customers. Scenarios 1 (a) and 2 are the most desirable with regards to ease of facility use and customer service.
Health & Safety, Staff Facilities	Owner/ Operator	Scenarios 1 (a) and 2 are the most desirable with regards to impacting this factor.
Facility Traffic Impacts	Owner/ Operator	Scenarios 1 (a) and 2 are the most desirable with regards to impacting this factor.
Change Management	Owner/ Operator	Scenarios 1 (a) and 2 are the least desirable with regards to impacting this factor.
Catchment Area (Tripartite Agreement)	Legal	Scenario 4 is least desirable with regards to impacting this factor.

5.8 Qualitative Analysis Summary

Based on the qualitative analysis, Scenario 4 – Close Facility has the greatest negative impacts. This was anticipated during the development of the scenarios. However for comparison purposes this scenario was evaluated to show that decisions related to the lowest cost option are not always considered the 'right' option. Instead decisions highly weigh the qualitative factors as they relate to various stakeholders. Decision makers must weigh additional costs with the beneficial qualitative factors, in order to make decisions.

Scenario 1 (a) – Status Quo without WTE and Scenario 2 – New Facility have the greatest positive impacts, in that building a new facility would increase the ability to offer additional recycling initiatives; and increase convenience and ease of use for customers (customer service).

Scenario 3 – Restricted Access would also provide these benefits to commercial customers, while decreasing these benefits for residential customers.

Scenario 1 (a) – Status Quo without WTE and Scenario 2 – New Facility also have positive impacts on increase health & safety; providing the opportunity to have additional staff facilities; and creating improvements to traffic management within the facility and on adjacent roadways.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the foregoing analyses, several conclusions can be made. These conclusions are divided into the following categories and discussed in the subsequent sections:

- Best financial alternatives;
- Strategies to minimize operating and capital costs;
- Impacts of future regional solid waste management planning;
- Benefits of ownership;
- Vancouver's role in regional solid waste management; and
- Preferable options for the City of Vancouver.

6.1.1. Preferred Scenario based on Financial Considerations

Based on a comparison of the Net Present Value of Costs and Net Potential Revenues for the five scenarios over a 15 year period, the City of Vancouver's best financial alternative is to limit residential access to the VSTS (Scenario 3 – Restricted Access). On June 2, 2009 Vancouver City Council passed a recommendation that:

> "the garbage disposal fee at the Vancouver Landfill and Vancouver South Transfer Station for loads less than 140 kg be increased from $6 - $7 to a $20 flat fee during peak hours (Monday to Friday 10:00AM to 2:00PM) and $10 flat fee during non-peak hours (all operating hours excluding Monday to Friday 10:00AM to 2:00PM) effective July 1, 2009".[10]

This recommendation will have a similar effect as implementing restrictions on small residential loads. Although residents are not restricted from using the VSTS at any time, the 50% surcharge during peak hours will result in a reduction in the number of small residential loads. As a result, the number of small residential loads will decrease during peak hours the number of large commercial loads transactions will start to increase. The increase in large commercial loads will

[10] http://vancouver.ca/ctyclerk/cclerk/20090602/documents/a2.pdf

not be as immediate as the decrease in small residential vehicle loads, and may take several months to increase.

Figure 6.1 shows the weekday and weekend small residential load transactions for the months of July 2008 and July 2009. For comparison purposes, Figure 6.2 shows the weekday and weekend large commercial load transactions for the months of July 2008 and July 2009.

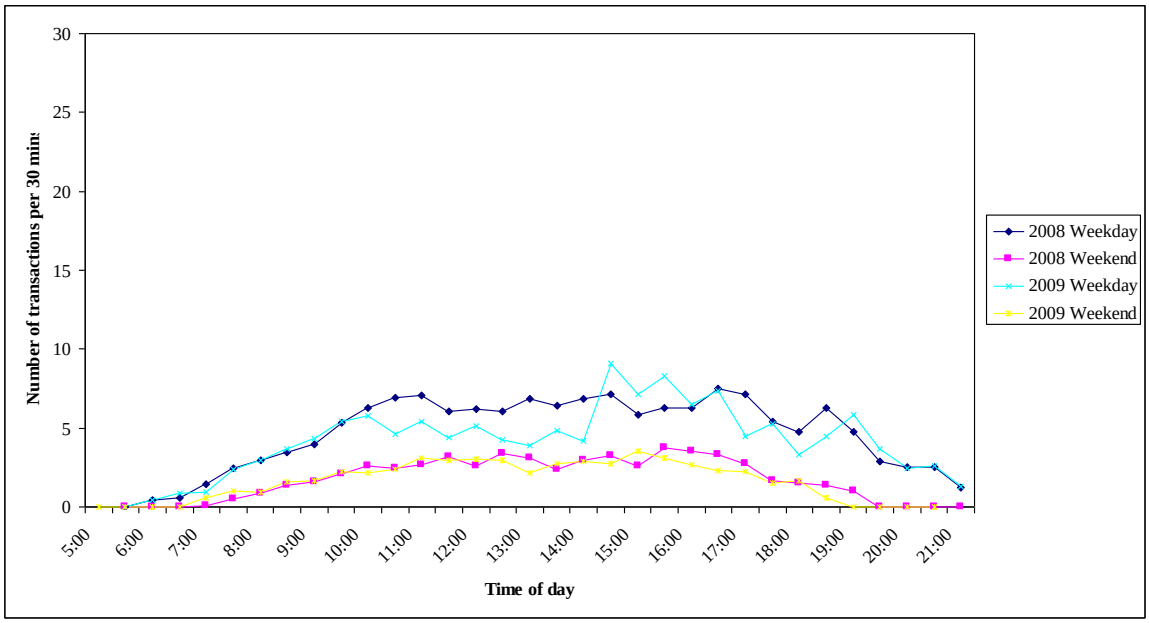

Figure 6.1: Weekday and Weekend Small Residential Load Transactions

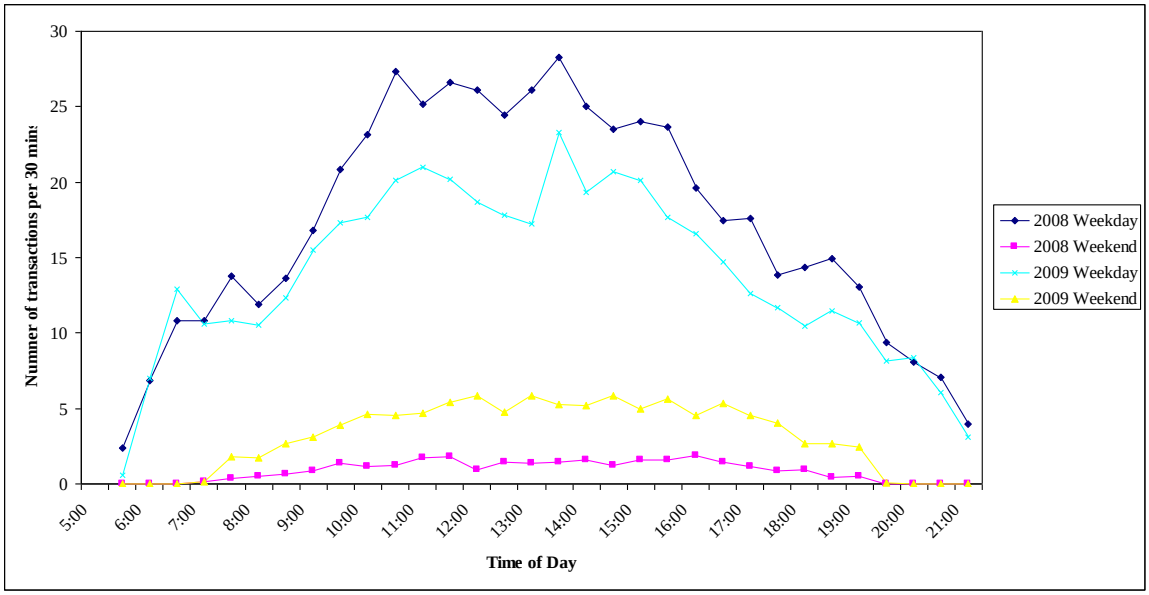

Figure 6.2: Weekday and Weekend Large Commercial Load Transactions

Data from July 2009 compared to July 2008 was analyzed to determine the initial customer response to the implemented rate increases for small residential loads (less than 140 kg) during peak hours. When comparing this data it is important to note that regionally there has been a 10% decrease in waste flow volumes in 2009 compared to 2008. This is in response to the recent economic downturn.

Table 6.1 shows the resulting small residential and large commercial load transactions during weekday peak versus non-peak hours. Table 6.2 shows the resulting small residential and large commercial load transactions during weekends, where peak hours do not apply.

Table 6.1: Small Residential and Large Commercial Load Transactions during Weekdays

Customer Type	# of Transactions July 2008		# of Transactions July 2009		Change between 2008 and 2009	
	Peak	Non-peak	Peak	Non-peak	Peak	Non-peak
Small Vehicles	1,191	2,255	882	2,231	-26%	-1%
Large Vehicles	4,767	7,898	3,589	6,654	-25%	-16%

Table 6.2: Small Residential and Large Commercial Load Transactions during Weekends

Customer Type	# of Transactions July 2008	# of Transactions July 2009	Change between 2008 and 2009
Small Vehicles	1,305	1,215	-7%
Large Vehicles	652	2,354	261%

The data shows a decrease of 26% in small residential loads (less than 140 kg) during peak hours in 2009 compared to 2008. This resulted in 309 fewer transactions for small residential loads during peak hours. Comparatively, there was only a 1% decrease in small residential loads during non-peak hours at the VSTS in 2009 compared to 2008. This is due to the fact that small vehicle traffic is shifting use at the VSTS to non-peak hours.

It is also interesting to note that there is an increase in large commercial load transactions (greater than 140 kg) on weekends. Data shows an overall increase on weekends of 260% (or 1,702 transactions) in 2009 compared to 2008. This may indicate that residents are disposing of larger loads of waste less frequently. This can be achieved by storing waste at the residence until

a larger volume accumulates, or by combining waste loads with neighbours. The larger loads result in fewer trips to waste disposal facilities and a reduction in greenhouse gas emissions.

6.1.2. Preferred Scenario based on Non-Financial Considerations

Based on a comparison of the qualitative factors for the five scenarios over a 15-year period, closing the facility (Scenario 4 – Close Facility) has the greatest negative impacts. Decision makers must weigh the additional costs of operating the VSTS with the beneficial qualitative factors before making a decision to close the facility.

Building a new facility would have the greatest positive impacts (Scenario 1 (a) – Status Quo without WTE and Scenario 2 – New Facility). A new facility offers the opportunity to increase recycling programs, in terms of quantities, types of materials and ease of access. A new facility would also offer the opportunity to improve health and safety, with upgrades such as the installation of more natural lighting, provision of additional staff facilities (such as a clean room between the locker room and lunch room) and site improvements to provide better traffic management.

6.1.3. Strategies for Minimizing Costs

Based on the capital costs of building a new transfer station facility, the best strategy to minimize costs is to use the existing facility. Based on implementing restrictions on residential customers transactions, the existing facility will provide waste disposal needs greater than the amount of waste generated by Vancouver over the 15-year analysis period. As diversion rates increase, the transfer station should provide additional capacity to remove residential customer transaction restrictions or to increase space for diversion programs.

Further, based on the risk analysis restricting access is still lower in costs compared to building a new facility. This was determined by varying the annual maintenance costs of the existing facility between $50,000 and $2,000,000 (with a mean value of $300,000).

6.1.4. Future Solid Waste Management Planning

Regional solid waste management planning is still ongoing. However, current planning strongly favours WTE facilities. The purpose of the June 28, 2009 Metro Vancouver Council of Councils meeting was to provide information to assist in deciding how to treat post diversion residual

waste within the region[11]. There were several presentations at the meeting on the merits and benefits of WTE.

One of these presentation was on the results of the Management of Municipal Solid Waste in Metro Vancouver – A Comparative Analysis of Options for Managing Waste After Recycling Study (June 12, 2009). This report was commissioned as a result of discussions with the Province which led to the conclusion that the broad 'strategic directions' type of plan being contemplated by Metro Vancouver in June 2008 would not "contain enough detail to allow the degree of community consultation the province required"[12].

As a result, Metro Vancouver employed AECOM to document and assess the relative characteristics and merits of landfills and waste to energy technologies as means to process or dispose of the remaining residual waste. The conclusions presented at the Council of Councils meeting included:

- Both WTE or landfilling will have loading on the Fraser Valley airshed;
- Landfill has the lowest net NOx emissions, while WTE has the highest net NOx emissions unless WTE is able to provide district heating (at which point WTE has lower emissions); and
- From a financial perspective scenarios with WTE and landfilling have similar costs, however WTE is higher in costs until at least half of the district energy is sold as modeled.

Based on the ongoing uncertainty related to the regional solid waste management planning and Metro Vancouver's favoritism towards WTE, it is in Vancouver's best interest to keep plans to upgrade the VSTS on hold. Any decisions related to upgrading the VSTS should only occur after Metro Vancouver has finalized the future SWMP and the Ministry of Environment has

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[11] Council of Councils June 27, 2009 Meeting Agenda (Metro Vancouver). Retrieved on June 28, 2009 from http://www.metrovancouver.org/boards/Council%20of%20Councils/Council_of_Councils-June_27_2009-Agenda.pdf.

[12] GVS&DD July 18, 2008 Regular Board Meeting (Metro Vancouver). Retrieved on June 28, 2009 from http://www.metrovancouver.org/boards/GVSDD%20Board/GVSDD_Board-July_18_2008-Additional_Items.pdf.

approved this Plan. Therefore, Scenario 2 – New Facility is not recommended until such at time as solid waste management planning is completed.

6.1.5. Benefits of Ownership

There are several benefits to the City of Vancouver related to ownership of the VSTS. Primarily the VSTS provides lower costs to Vancouver single family ratepayers. Ratepayers pay the actual cost for garbage disposal compared to the remainder of the region who are charged the regional disposal rate.

The VSTS provides a convenient location for garbage disposal for Vancouver garbage collection crews, commercial customers and residents. This assists in reducing greenhouse gas emissions and costs related to longer hauling distances. In addition, the VSTS provides residential customers with the opportunity to recycle materials at the VSTS Recycling Depot. Further, owning the VSTS allows Vancouver to implement new initiatives such as organics and wood recycling for residents.

The above noted benefits would not be realized if Vancouver implemented Scenario 4 – Close Facility.

6.1.6. Role of VSTS in Regional Waste Management System

Vancouver has legal obligations related to the operation of the VSTS. Closing the facility (Scenario 4 – Close Facility) would require additional analysis of the legal agreements and discussions with Metro Vancouver. Depending on the situation related to shutdown, additional agreements with Metro Vancouver may be required if Vancouver waste needs to be accepted in the regional system.

Restricting access to residential customers (Scenario 3 – Restricted Access) can be done at the discretion of Vancouver. However, Vancouver must provide Metro Vancouver with reasonable written notice, unless it is done at the request of Metro Vancouver. The remaining scenarios would not impact the existing legal agreements.

6.1.7. Preferable Option for City of Vancouver

The preferable option from Vancouver's perspective is to restrict residential customer transaction access at the VSTS (Scenario 3 – Restricting Access). This is based on the quantitative and risk analyses as described in Section 4. Further, the qualitative analysis (as described in Section 5) found that there were no distinguishing non-financial factors that would result in changing the preferred option.

The least preferable option from Vancouver's perspective is to close the VSTS (Scenario 4 – Close Facility). This is based on the quantitative analysis and is further supported by several qualitative factors which negatively affect Vancouver ratepayers.

6.2 Recommendations

Based on the foregoing analyses and conclusions, several recommendations can be made. These recommendations are divided into the following categories and discussed in the subsequent sections:

- Disposal of Vancouver's garbage;
- Operational efficiencies at the VSTS.

6.2.1. Disposal of Vancouver's Waste

Vancouver should continue to dispose of their garbage at the VSTS. Closing the facility would result in increased environmental and financial costs of hauling waste to the Vancouver Landfill. These costs could be increased up to the regional rate, which is currently set at $71 per tonne and is estimated to increase to $100 per tonne by 2015.

6.2.2. Operational Efficiencies

To use VSTS to the maximum extent possible, restrict access to residential vehicle transactions. Further, Vancouver should investigate the opportunity to provide large item pickup to ratepayers. This could assist in reducing negative impacts resulting from the restricted access and could also reduce the need for residents to use the VSTS on a regular basis.

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APPENDICES

APPENDIX A: BASE ANALYSIS RESULTS

This appendix describes the development and results of the base cash flow model. In developing the model, waste generation, operating costs and the regional rate were modeled or estimated as detailed below.

A.1. Waste Generation

Figure A. 1 to Figure A. 4 illustrate the waste generation models for each of the scenarios (Figure 4.1 shows the waste generation for Scenario 1 (a)). It is important to note that the waste shown as Vancouver Commercial to MV Facilities is leakage from the Vancouver origin. This waste is disposed of in Metro Vancouver's waste disposal system.

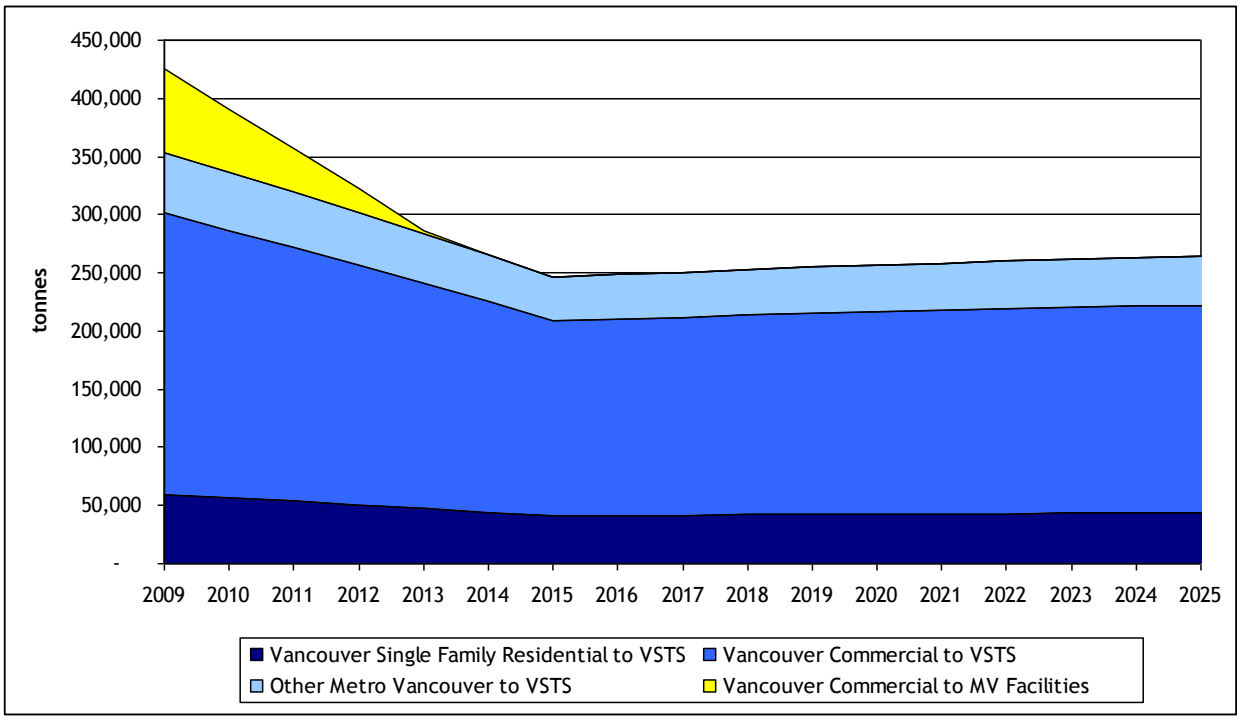

Figure A. 1: Waste Generation for Scenario 1 (b) – Status Quo without WTE

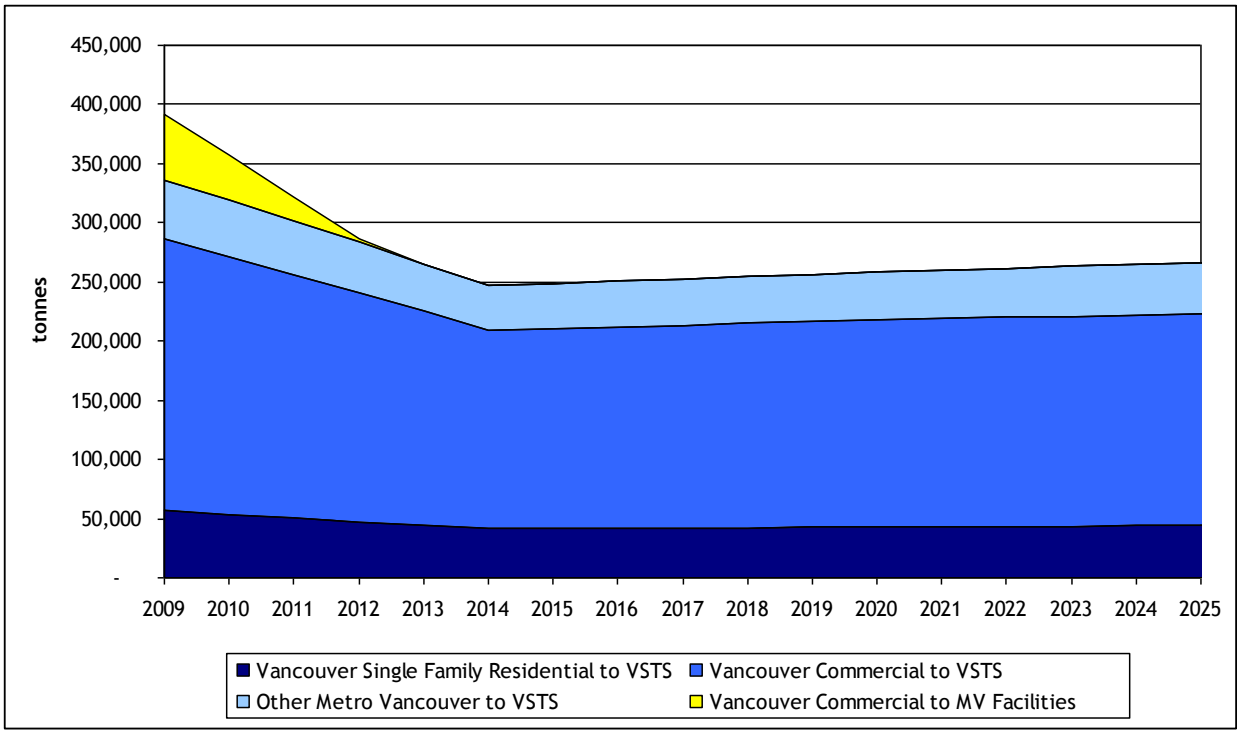

Figure A. 2: Waste Generation for Scenario 2 – New Facility

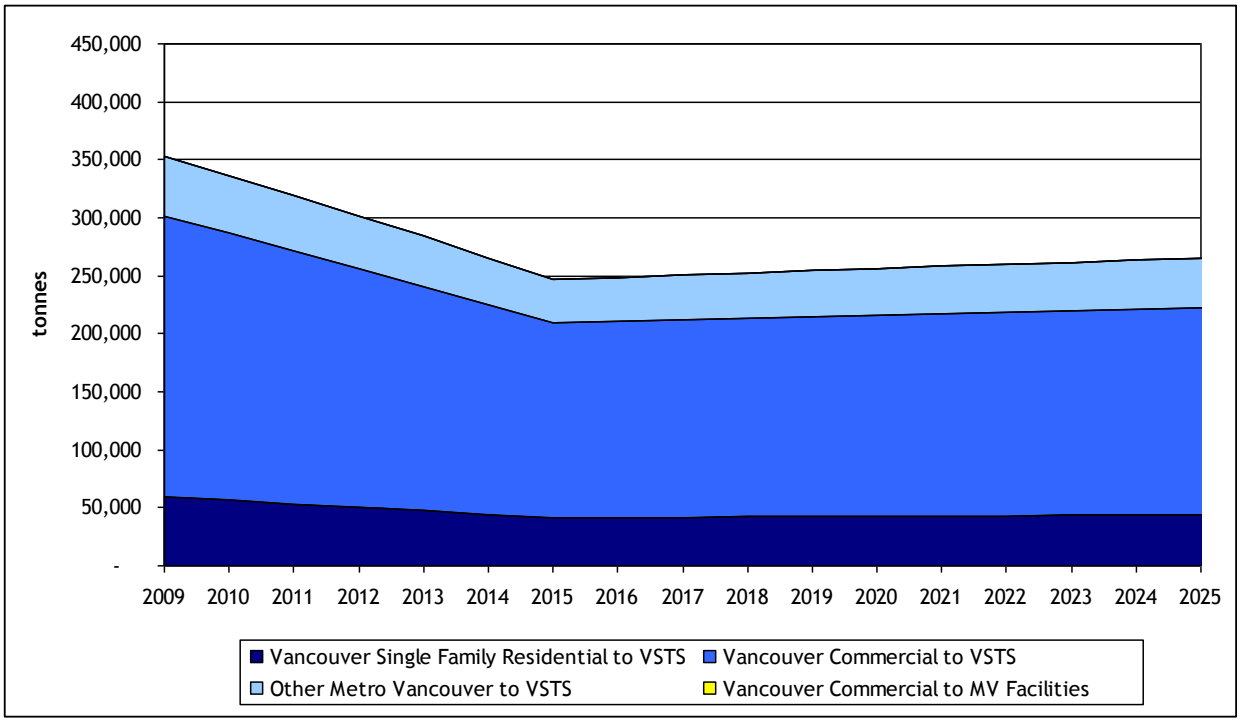

Figure A. 3: Waste Generation for Scenario 3 – Restricted Access

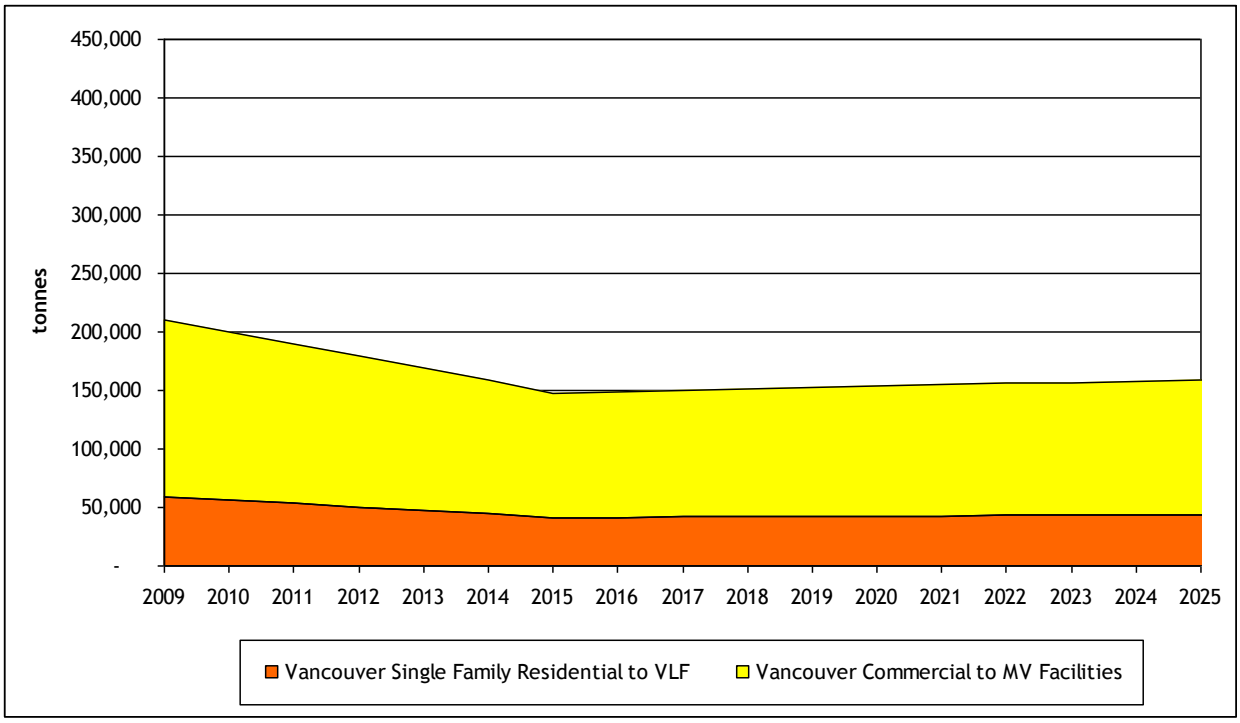

Figure A. 4: Waste Generation for Scenario 4 – Close Facility

A.2 Fixed Operating Costs

Fixed costs are those costs that do not fluctuate within a certain range of tonnage. For example, weighscale and building costs do not increase or decrease with a small increase or decrease in waste quantities. For the purpose this analysis, the fixed operating costs are set at $12.69 per tonne in 2006$.

A.3 Variable Operating Costs

Variable costs are those costs that do fluctuate with tonnage changes. For example, the revenues from recycling or the rental of equipment is able to easily change to adjust to waste flows as shown in Table A.1.

Table A.1: Variable Operating Costs with Varying Tonnages

Variable Operating Costs	Cost per tonne
Recycling	$(0.19)
Transfer Trailers	$10.10
Vehicle & Equipment Rental, Traffic Control	$3.94
Variable Operating Costs Total	**$13.85**

A.4 Regional Rate

The regional rate is the cost per tonne for disposal of municipal solid waste at any Metro Vancouver waste transfer or disposal facility. The City of Vancouver, as described in the Tripartite Agreement, must charge at least the regional rate for garbage disposal at the VSTS and VL. The regional rate is highly dependent upon the method of garbage disposal and subsidies for other programs such as recycling initiatives.

For the purpose of the base model analysis, the regional rate was assumed to escalate to $100 per tonne by 2014, as described in Metro Vancouver's SWMP updating strategies. For the purposes of the base model a linear increase from $71 per tonne in 2007 to $100 per tonne in 2014 was used, remaining at $100 per tonne after 2015.

A.5 Base Model Scenario Result Tables

The base case operating costs cash flow models for Scenarios 1(b) to 3 are shown in Table A.2 to Table A.4, respectively. Scenario 4 does not have a base case operating costs cash flow, as this scenario closes the VSTS and as a result has no operating costs.

Allocation of VSTS operating costs for each Generation Group under Scenario 1 (b) to 4 are shown in Table A.5 to Table A.8, respectively. Vancouver Commercial Potential Net Revenues at VSTS under Scenario 1(b) to 3 are shown in Table A.9 to Table A.11, respectively. Scenario 4 does not allocate net potential revenues, as this scenario closes the VSTS and as a result will not generate revenues.

Table A.2: Base Case Operating Costs Cash Flow Model - Scenario 1 (b)

Year	Waste Quantities (tonne)	Operating Costs		Upgrade Costs	Capital Costs	Total VSTS Costs
		Fixed	Variable			
2009	281,705	$3,171,683	$3,902,113	$300,000	$-	$7,373,796
2010	281,705	$3,171,683	$3,902,113	$306,000	$-	$7,379,796
2011	281,705	$3,171,683	$3,902,113	$312,120	$-	$7,385,916
2012	281,705	$3,171,683	$3,902,113	$318,362	$-	$7,392,158
2013	281,705	$3,171,683	$3,902,113	$324,747	$-	$7,398,543
2014	265,549	$3,171,683	$3,678,332	$331,242	$-	$7,181,257
2015	246,682	$2,537,346	$3,416,985	$337,867	$-	$6,292,198
2016	248,737	$2,537,346	$3,445,452	$-	$-	$5,982,798
2017	250,765	$3,171,683	$3,473,547	$-	$8,511,165	$15,156,395
2018	252,736	$3,171,683	$3,500,842	$-	$3,101,660	$9,774,185
2019	254,671	$3,171,683	$3,527,644	$-	$3,256,743	$9,956,070
2020	256,535	$3,171,683	$3,553,474	$-	$3,419,581	$10,144,737
2021	258,353	$3,171,683	$3,578,655	$-	$3,590,560	$10,340,898
2022	260,084	$3,171,683	$3,602,632	$-	$3,770,088	$10,544,403
2023	261,718	$3,171,683	$3,625,257	$-	$3,958,592	$10,755,532

Table A.3: Base Case Operating Costs Cash Flow Model - Scenario 2

Year	Waste Quantities (tonne)	Operating Costs		Capital Costs	Total VSTS Costs
		Fixed	Variable		
2009	281,705	$3,171,683	$3,902,113	$-	$7,073,796
2010	281,705	$3,171,683	$3,902,113	$5,263,801	$12,337,597
2011	281,705	$3,171,683	$3,902,113	$3,282,171	$10,355,966
2012	281,705	$3,171,683	$3,902,113	$3,446,279	$10,520,075
2013	281,705	$3,171,683	$3,902,113	$3,618,593	$10,692,389
2014	265,549	$3,171,683	$3,678,332	$3,799,523	$10,649,538
2015	246,682	$2,537,346	$3,416,985	$3,989,499	$9,943,830
2016	248,737	$2,537,346	$3,445,452	$4,188,974	$10,171,772
2017	250,765	$3,171,683	$3,473,547	$4,398,423	$11,043,653
2018	252,736	$3,171,683	$3,500,842	$4,618,344	$11,290,869
2019	254,671	$3,171,683	$3,527,644	$4,849,261	$11,548,588
2020	256,535	$3,171,683	$3,553,474	$5,091,724	$11,816,880
2021	258,353	$3,171,683	$3,578,655	$5,263,801	$6,750,338
2022	260,084	$3,171,683	$3,602,632	$3,282,171	$6,774,315
2023	261,718	$3,171,683	$3,625,257	$3,446,279	$6,796,940

Table A.4: Base Case Operating Costs Cash Flow Model - Scenario 3

Year	Waste Quantities (tonne)	Operating Costs		Capital Costs	Total VSTS Costs
		Fixed	Variable		
2009	353,343	$4,440,356	$4,894,424	$300,000	$9,634,780
2010	336,473	$3,806,019	$4,660,754	$306,000	$8,772,774
2011	319,313	$3,806,019	$4,423,054	$312,120	$8,541,193
2012	301,822	$3,806,019	$4,180,777	$318,362	$8,305,158
2013	283,951	$3,171,683	$3,933,224	$324,747	$7,429,654
2014	265,549	$3,171,683	$3,678,332	$331,242	$7,181,257
2015	246,682	$2,537,346	$3,416,985	$337,867	$6,292,198
2016	248,737	$2,537,346	$3,445,452	$344,624	$6,327,422
2017	250,765	$3,171,683	$3,473,547	$351,536	$6,996,766
2018	252,736	$3,171,683	$3,500,842	$358,567	$7,031,092
2019	254,671	$3,171,683	$3,527,644	$365,738	$7,065,065
2020	256,535	$3,171,683	$3,553,474	$373,053	$7,098,209
2021	258,353	$3,171,683	$3,578,655	$380,534	$7,130,873
2022	260,084	$3,171,683	$3,602,632	$388,145	$7,162,460
2023	261,718	$3,171,683	$3,625,257	$395,908	$7,192,848

Table A.5: Allocation of Operating Costs for each Generation Group - Scenario 1 (b)

Year	VSTS Cost Allocation				Vancouver Costs at MV Facilities	Total Vancouver Costs
	Vancouver SFR	Vancouver Commercial	MV Other	Total		
2009	$1,238,722	$5,044,943	$1,090,131	$7,373,796	$5,086,298	$11,369,962
2010	$1,238,431	$5,043,761	$1,097,603	$7,379,796	$4,217,213	$10,499,406
2011	$1,238,276	$5,043,128	$1,104,512	$7,385,916	$3,121,464	$9,402,868
2012	$1,238,114	$5,042,470	$1,111,574	$7,392,158	$1,790,502	$8,071,086
2013	$1,238,026	$5,042,109	$1,118,408	$7,398,543	$215,616	$6,495,751
2014	$1,200,510	$4,889,317	$1,091,431	$7,181,257	$-	$6,089,827
2015	$1,050,856	$4,279,821	$961,522	$6,292,198	$-	$5,330,677
2016	$998,228	$4,065,485	$919,085	$5,982,798	$-	$5,063,713
2017	$2,526,472	$10,289,567	$2,340,355	$15,156,395	$-	$12,816,040
2018	$1,627,748	$6,629,332	$1,517,105	$9,774,185	$-	$8,257,080
2019	$1,656,497	$6,746,416	$1,553,158	$9,956,070	$-	$8,402,913
2020	$1,686,308	$6,867,829	$1,590,599	$10,144,737	$-	$8,554,138
2021	$1,717,321	$6,994,136	$1,629,441	$10,340,898	$-	$8,711,457
2022	$1,749,489	$7,125,147	$1,669,767	$10,544,403	$-	$8,874,636
2023	$1,782,842	$7,260,982	$1,711,708	$10,755,532	$-	$9,043,824

Table A.6: Allocation of Operating Costs for each Generation Group - Scenario 2

Year	VSTS Cost Allocation				Vancouver Costs at MV Facilities	Total Vancouver Costs
	Vancouver SFR	Vancouver Commercial	MV Other	Total		
2009	$1,188,325	$4,839,691	$1,045,780	$7,073,796	$5,086,298	$11,114,314
2010	$2,070,419	$8,432,197	$1,834,981	$12,337,597	$4,217,213	$14,719,829
2011	$1,736,216	$7,071,088	$1,548,662	$10,355,966	$3,121,464	$11,928,768
2012	$1,762,010	$7,176,140	$1,581,925	$10,520,075	$1,790,502	$10,728,652
2013	$1,789,197	$7,286,866	$1,616,325	$10,692,389	$215,616	$9,291,680
2014	$1,780,311	$7,250,676	$1,618,551	$10,649,538	$-	$9,030,987
2015	$1,660,712	$6,763,584	$1,519,534	$9,943,830	$-	$8,424,296
2016	$1,697,157	$6,912,014	$1,562,600	$10,171,772	$-	$8,609,171
2017	$1,840,905	$7,497,456	$1,705,292	$11,043,653	$-	$9,338,361
2018	$1,880,330	$7,658,021	$1,752,518	$11,290,869	$-	$9,538,350
2019	$1,921,461	$7,825,535	$1,801,592	$11,548,588	$-	$9,746,996
2020	$1,964,260	$7,999,845	$1,852,776	$11,816,880	$-	$9,964,105
2021	$1,121,034	$4,565,637	$1,063,667	$6,750,338	$-	$5,686,671
2022	$1,123,970	$4,577,594	$1,072,752	$6,774,315	$-	$5,701,563
2023	$1,126,664	$4,588,565	$1,081,711	$6,796,940	$-	$5,715,229

Table A.7: Allocation of Operating Costs for each Generation Group - Scenario 3

Year	VSTS Cost Allocation				Vancouver Costs at MV Facilities	Total Vancouver Costs
	Vancouver SFR	Vancouver Commercial	MV Other	Total		
2009	$1,618,544	$6,591,844	$1,424,392	$9,634,780	$-	$8,210,388
2010	$1,472,192	$5,995,800	$1,304,782	$8,772,774	$-	$7,467,992
2011	$1,431,962	$5,831,955	$1,277,275	$8,541,193	$-	$7,263,918
2012	$1,391,033	$5,665,262	$1,248,864	$8,305,158	$-	$7,056,295
2013	$1,243,232	$5,063,311	$1,123,111	$7,429,654	$-	$6,306,543
2014	$1,200,510	$4,889,317	$1,091,431	$7,181,257	$-	$6,089,827
2015	$1,050,856	$4,279,821	$961,522	$6,292,198	$-	$5,330,677
2016	$1,055,729	$4,299,667	$972,027	$6,327,422	$-	$5,355,396
2017	$1,166,315	$4,750,054	$1,080,397	$6,996,766	$-	$5,916,369
2018	$1,170,926	$4,768,831	$1,091,335	$7,031,092	$-	$5,939,757
2019	$1,175,490	$4,787,418	$1,102,158	$7,065,065	$-	$5,962,907
2020	$1,179,899	$4,805,377	$1,112,932	$7,098,209	$-	$5,985,277
2021	$1,184,230	$4,823,014	$1,123,629	$7,130,873	$-	$6,007,243
2022	$1,188,370	$4,839,874	$1,134,217	$7,162,460	$-	$6,028,244
2023	$1,192,290	$4,855,840	$1,144,719	$7,192,848	$-	$6,048,129

Table A.8: Allocation of Operating Costs for each Generation Group - Scenario 4

Year	Vancouver Costs at MV Facilities		Total Vancouver Costs
	Vancouver SFR	Vancouver Commercial	
2009	$1,887,460	$10,698,252	$12,585,712
2010	$1,831,377	$11,063,970	$12,895,347
2011	$1,771,044	$11,332,349	$13,103,392
2012	$1,705,849	$11,500,931	$13,206,780
2013	$1,635,409	$11,685,507	$13,320,916
2014	$1,558,514	$11,398,182	$12,956,696
2015	$1,446,366	$10,814,135	$12,260,501
2016	$1,457,022	$11,136,411	$12,593,433
2017	$1,467,528	$11,465,960	$12,933,487
2018	$1,477,657	$11,801,943	$13,279,600
2019	$1,487,585	$12,145,010	$13,632,595
2020	$1,497,076	$12,493,966	$13,991,041
2021	$1,506,287	$12,849,772	$14,356,059
2022	$1,514,969	$13,210,647	$14,725,616
2023	$1,523,050	$13,576,137	$15,099,187

Table A.9: Vancouver Commercial Potential Net Revenues at VSTS - Scenario 1 (b)

Year	Waste Quantities to VSTS (tonnes)	Allocation of VSTS Operating Costs	Cost for Waste Disposal at VL	Total Revenues	Net Revenues
2009	170,109	$4,622,822	$4,151,988	$12,077,752	$3,302,942
2010	175,196	$4,764,790	$4,361,668	$13,490,088	$4,363,630
2011	180,420	$4,910,780	$4,581,553	$14,974,838	$5,482,504
2012	185,767	$5,060,437	$4,811,683	$16,533,247	$6,661,127
2013	191,267	$5,214,588	$5,053,218	$18,361,586	$8,093,780
2014	180,798	$5,070,115	$4,872,168	$18,079,775	$8,137,492
2015	167,788	$4,447,609	$4,612,007	$17,114,365	$8,054,748
2016	169,024	$4,468,691	$4,738,906	$17,585,262	$8,377,666
2017	170,243	$4,920,297	$4,868,537	$18,066,301	$8,277,467
2018	171,418	$4,940,249	$5,000,183	$18,554,819	$8,614,387
2019	172,570	$4,959,987	$5,134,455	$19,053,077	$8,958,635
2020	173,671	$4,979,048	$5,270,555	$19,558,122	$9,308,519
2021	174,739	$4,997,753	$5,409,043	$20,072,026	$9,665,230
2022	175,746	$5,015,620	$5,549,025	$20,591,475	$10,026,830
2023	176,684	$5,032,524	$5,690,198	$21,115,344	$10,392,622

Table A.10: Vancouver Commercial Potential Net Revenues at VSTS - Scenario 2

Year	Waste Quantities to VSTS (tonnes)	Allocation of VSTS Operating Costs	Cost for Waste Disposal at VL	Total Revenues	Net Revenues
2009	170,109	$4,622,822	$4,151,988	$12,077,752	$3,302,942
2010	175,196	$4,764,790	$4,361,668	$13,490,088	$4,363,630
2011	180,420	$4,910,780	$4,581,553	$14,974,838	$5,482,504
2012	185,767	$5,060,437	$4,811,683	$16,533,247	$6,661,127
2013	191,267	$5,214,588	$5,053,218	$18,361,586	$8,093,780
2014	180,798	$5,070,115	$4,872,168	$18,079,775	$8,137,492
2015	167,788	$4,447,609	$4,612,007	$17,114,365	$8,054,748
2016	169,024	$4,468,691	$4,738,906	$17,585,262	$8,377,666
2017	170,243	$4,920,297	$4,868,537	$18,066,301	$8,277,467
2018	171,418	$4,940,249	$5,000,183	$18,554,819	$8,614,387
2019	172,570	$4,959,987	$5,134,455	$19,053,077	$8,958,635
2020	173,671	$4,979,048	$5,270,555	$19,558,122	$9,308,519
2021	174,739	$4,997,753	$5,409,043	$20,072,026	$9,665,230
2022	175,746	$5,015,620	$5,549,025	$20,591,475	$10,026,830
2023	176,684	$5,032,524	$5,690,198	$21,115,344	$10,392,622

Table A.11: Vancouver Commercial Potential Net Revenues at VSTS - Scenario 3

Year	Waste Quantities to VSTS (tonnes)	Allocation of VSTS Operating Costs	Cost for Waste Disposal at VL	Total Revenues	Net Revenues
2009	241,747	$4,622,822	$5,900,508	$17,164,035	$6,640,705
2010	229,964	$4,764,790	$5,725,181	$17,707,264	$7,217,292
2011	218,028	$4,910,780	$5,536,571	$18,096,320	$7,648,969
2012	205,884	$5,060,437	$5,332,762	$18,323,708	$7,930,509
2013	193,512	$5,214,588	$5,112,556	$18,577,199	$8,250,056
2014	180,798	$5,070,115	$4,872,168	$18,079,775	$8,137,492
2015	167,788	$4,447,609	$4,612,007	$17,114,365	$8,054,748
2016	169,024	$4,468,691	$4,738,906	$17,585,262	$8,377,666
2017	170,243	$4,920,297	$4,868,537	$18,066,301	$8,277,467
2018	171,418	$4,940,249	$5,000,183	$18,554,819	$8,614,387
2019	172,570	$4,959,987	$5,134,455	$19,053,077	$8,958,635
2020	173,671	$4,979,048	$5,270,555	$19,558,122	$9,308,519
2021	174,739	$4,997,753	$5,409,043	$20,072,026	$9,665,230
2022	175,746	$5,015,620	$5,549,025	$20,591,475	$10,026,830
2023	176,684	$5,032,524	$5,690,198	$21,115,344	$10,392,622

APPENDIX B: SENSITIVITY ANALYSIS RESULTS

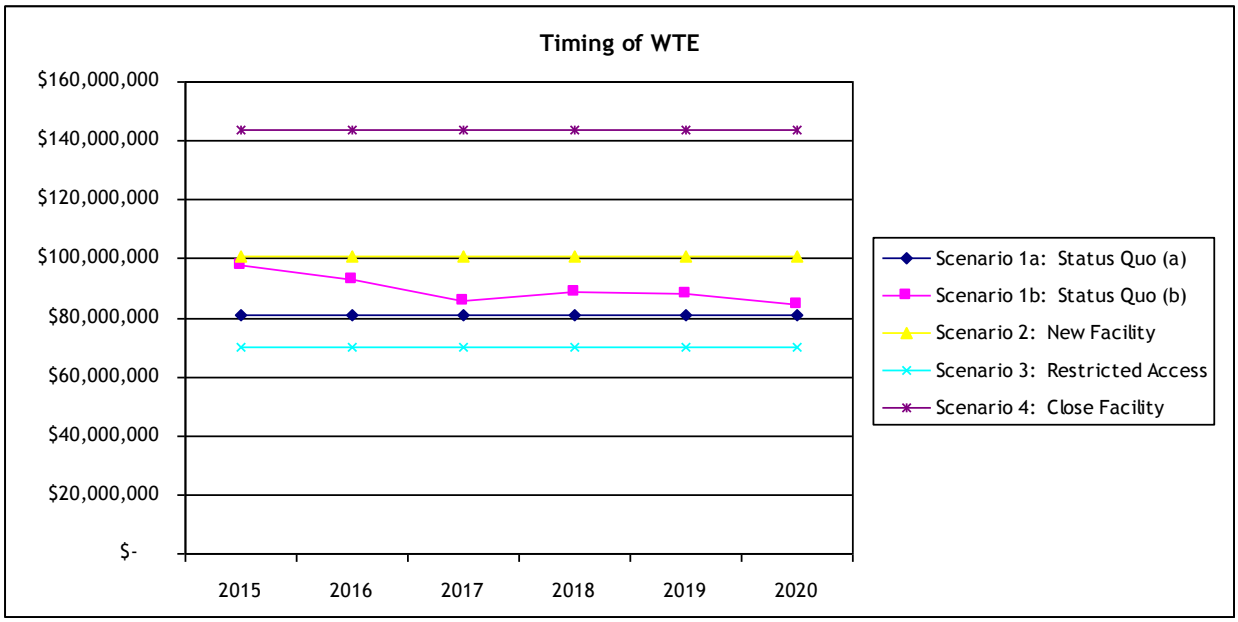

Figure B.1: Change in Vancouver Total Costs with varying WTE Year

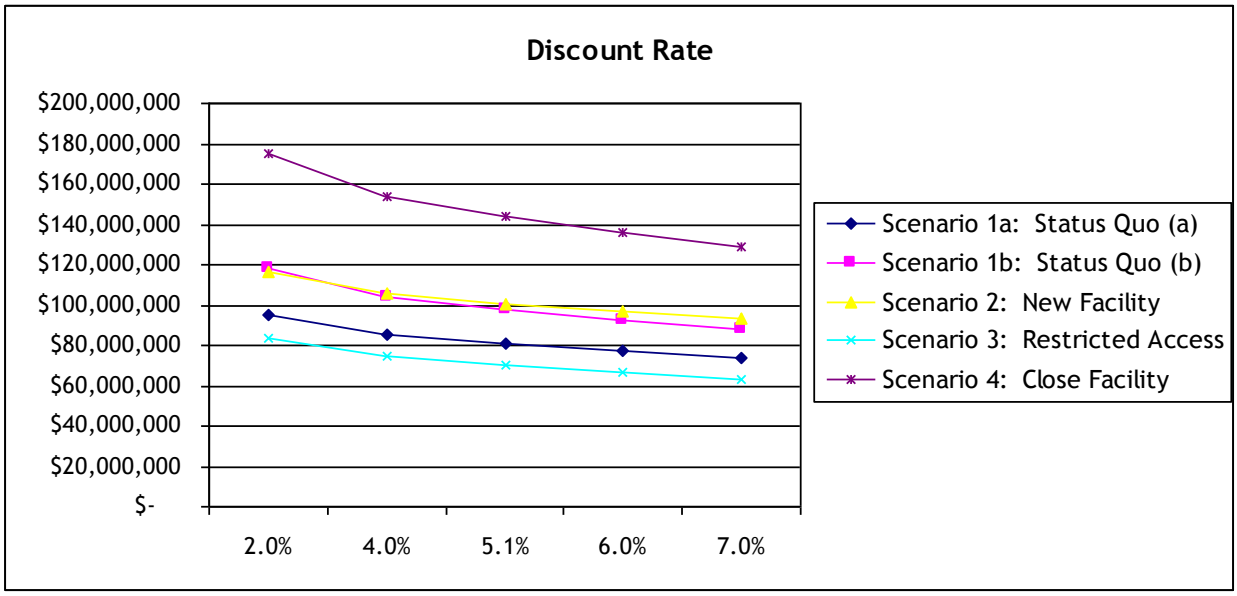

Figure B.2: Change in Vancouver Total Costs with varying Discount Rate

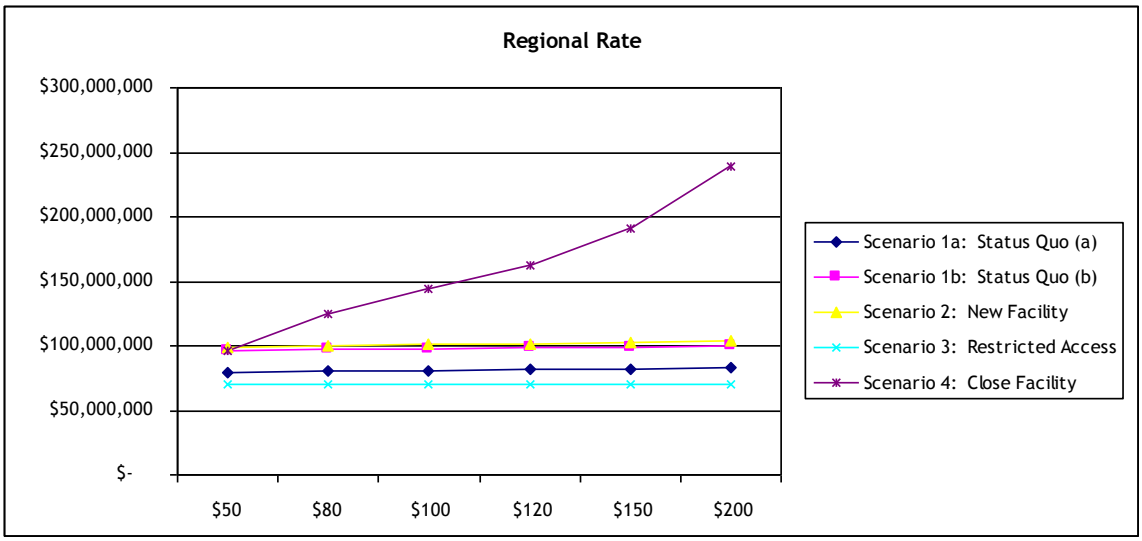

Figure B.3: Change in Vancouver Total Costs varying Regional Rate

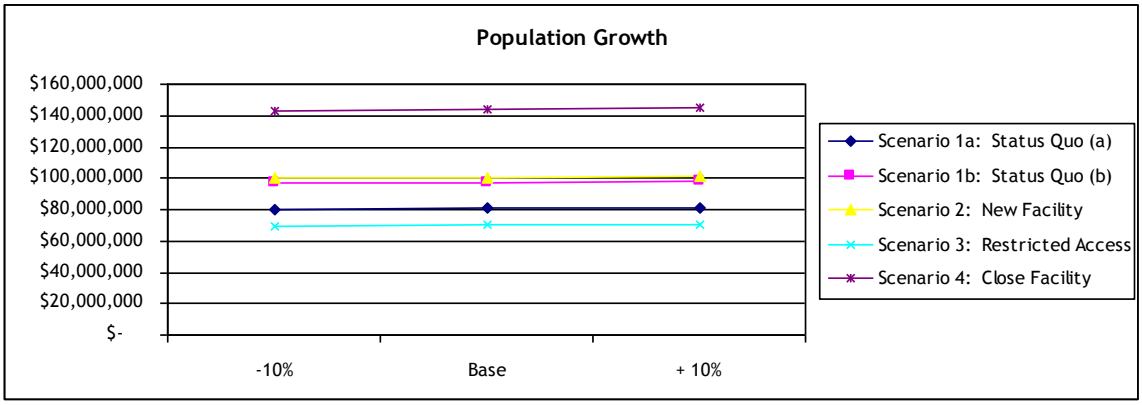

Figure B.4: Change in Vancouver Total Costs varying Population Growth

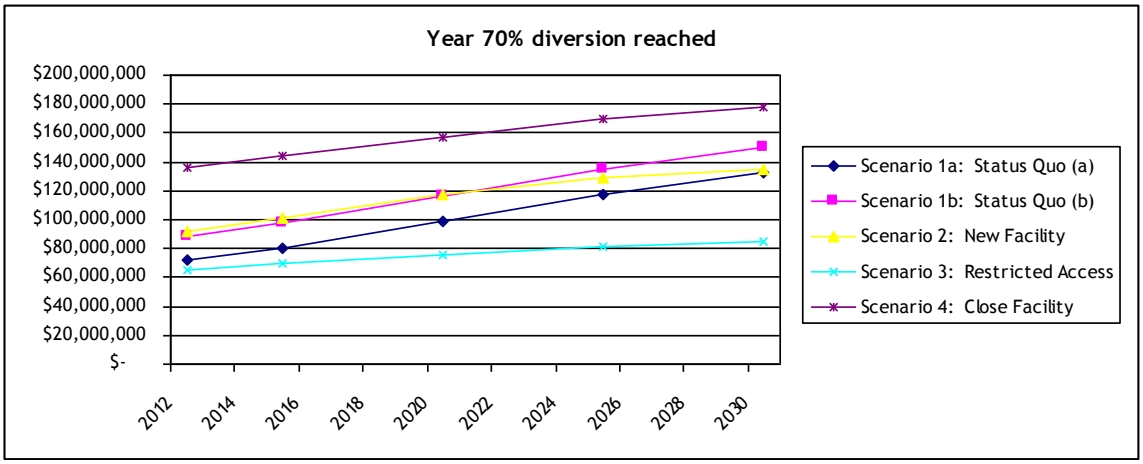

Figure B.5: Change in Vancouver Total Costs varying Year Diversion Achieved

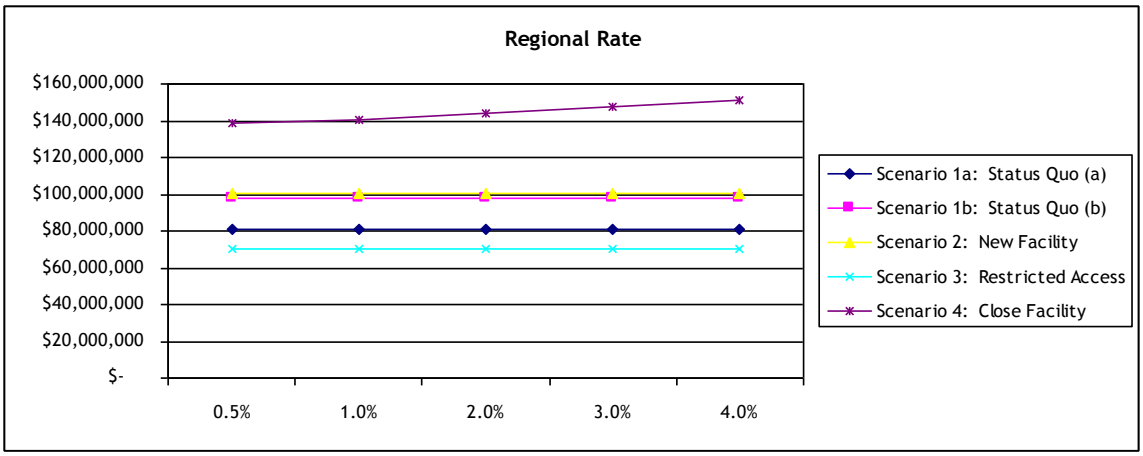

Figure B.6: Change in Vancouver Total Costs varying Regional Rate

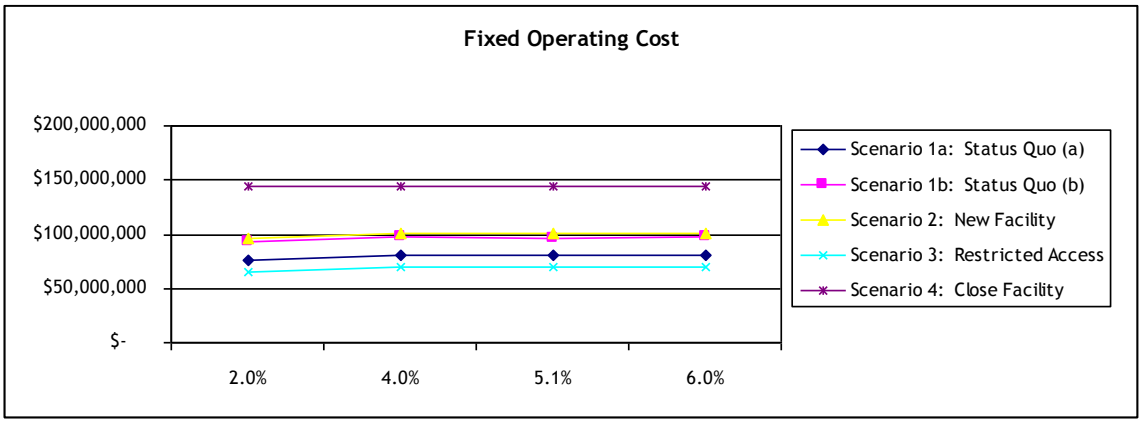

Figure B.7: Change in Vancouver Total Costs varying Fixed Operating Costs

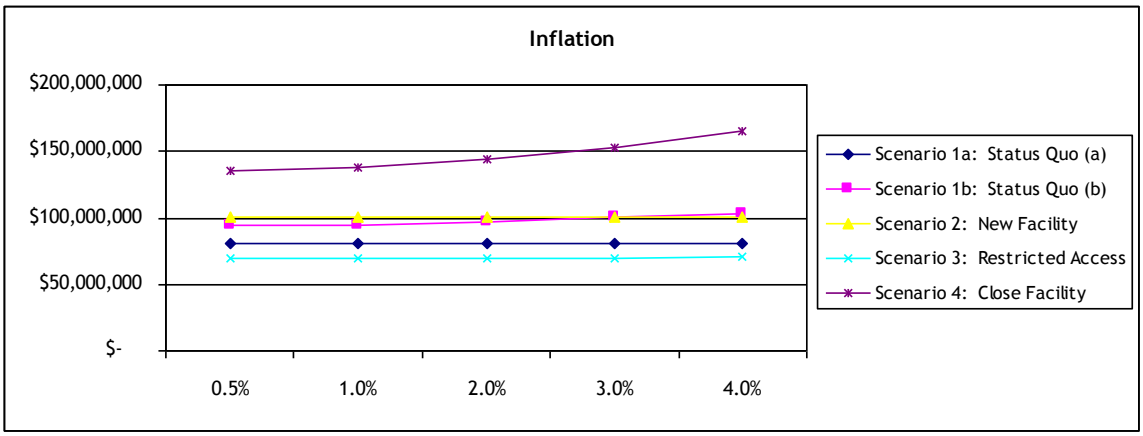

Figure B.8: Change in Vancouver Total Costs varying Inflation Rate

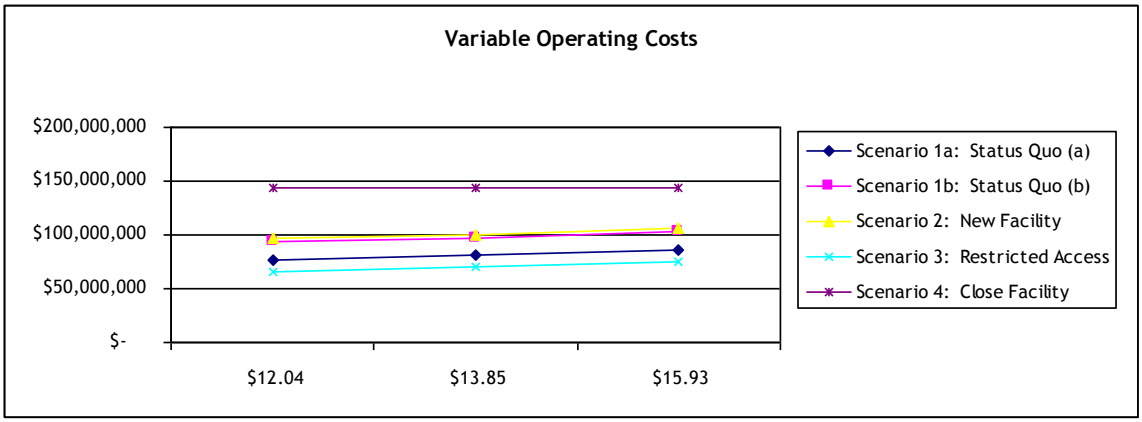

Figure B.9: Change in Vancouver Total Costs varying Variable Operating Costs

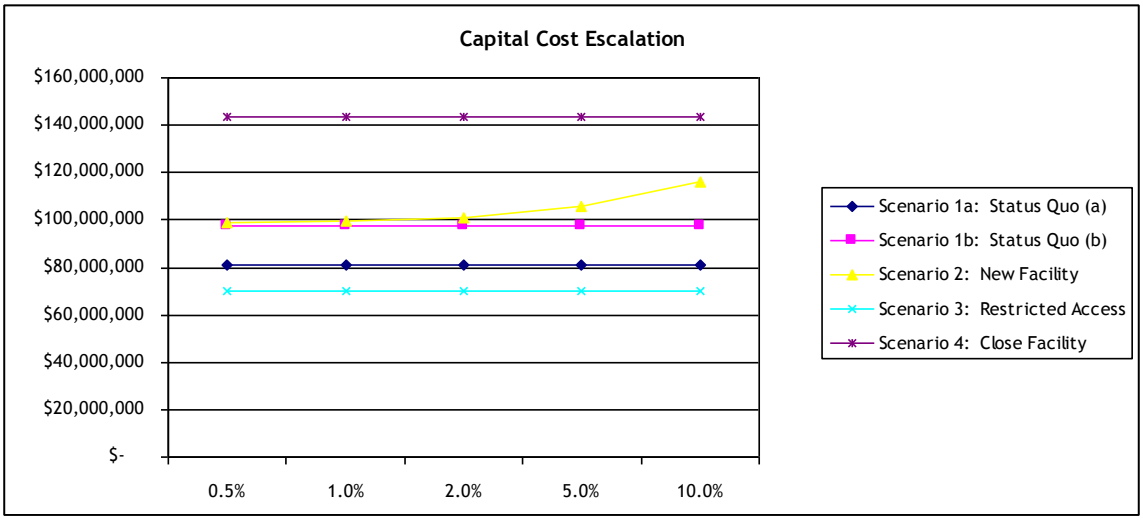

Figure B.10: Change in Vancouver Total Costs varying Capital Cost Escalation

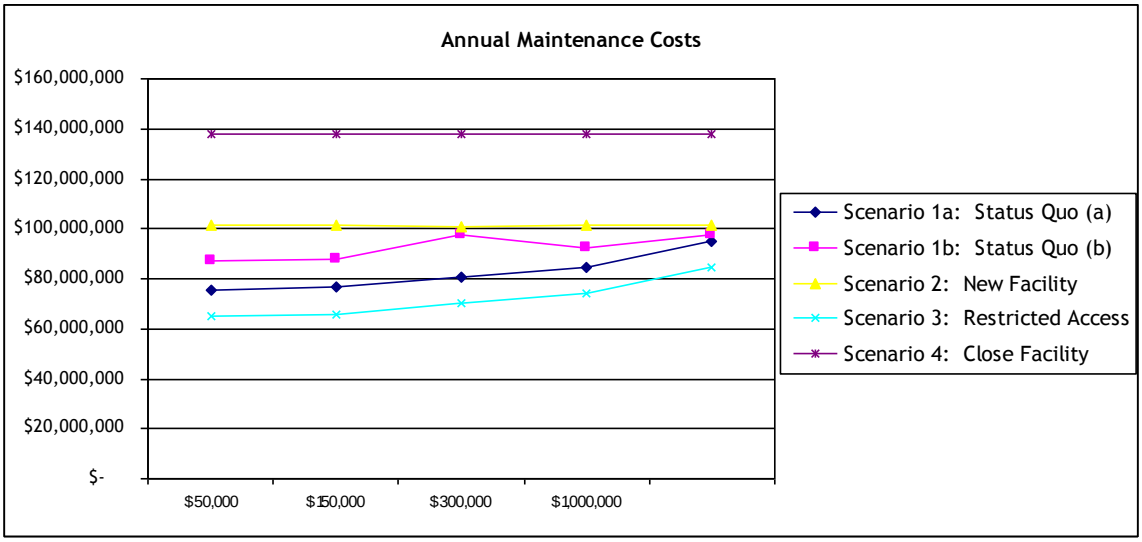

Figure B.11: Change in Vancouver Total Costs varying Maintenance Costs

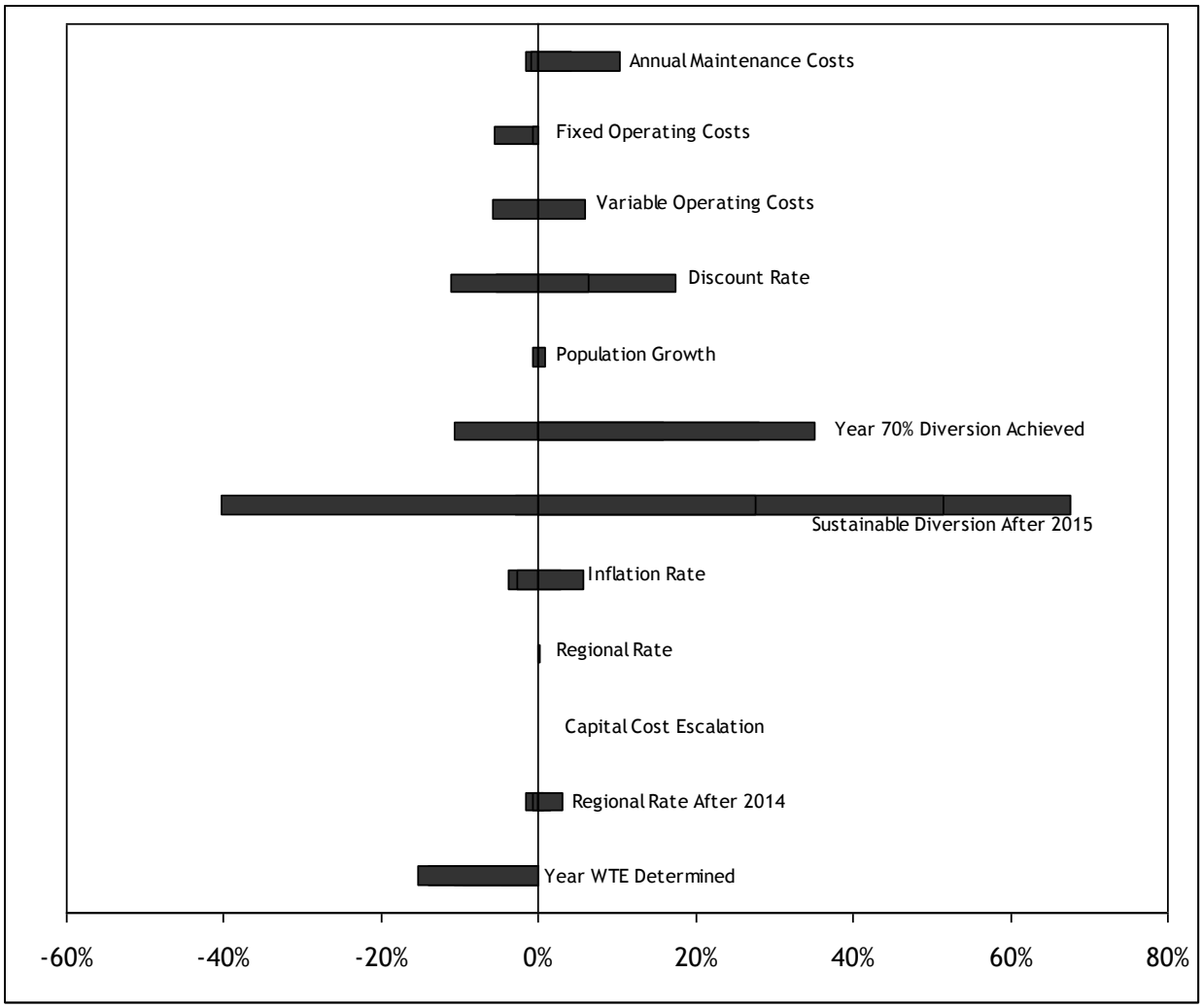

Figure B.12: Scenario 1(b) Tornado Diagram

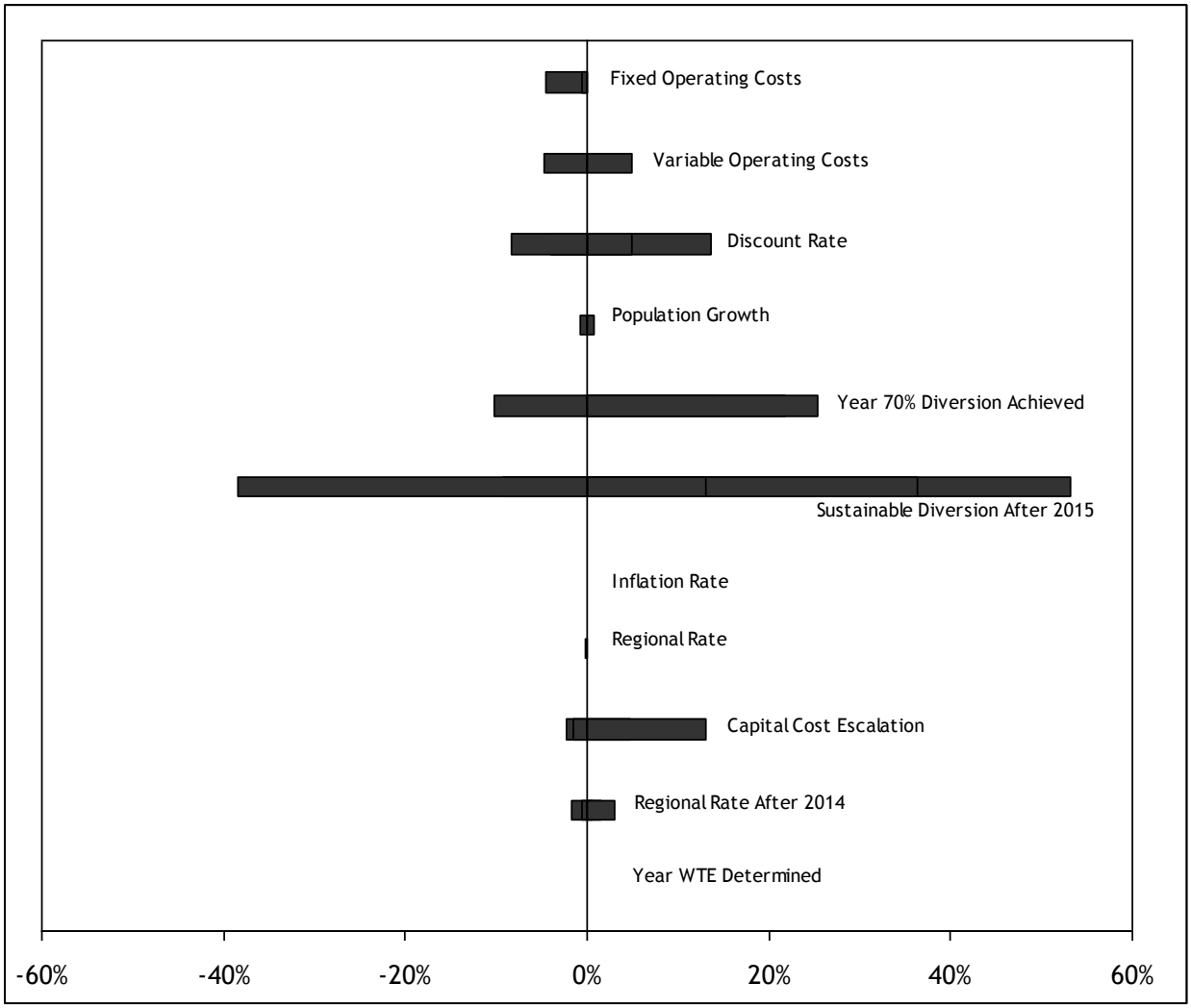

Figure B.13: Scenario 2 Tornado Diagram

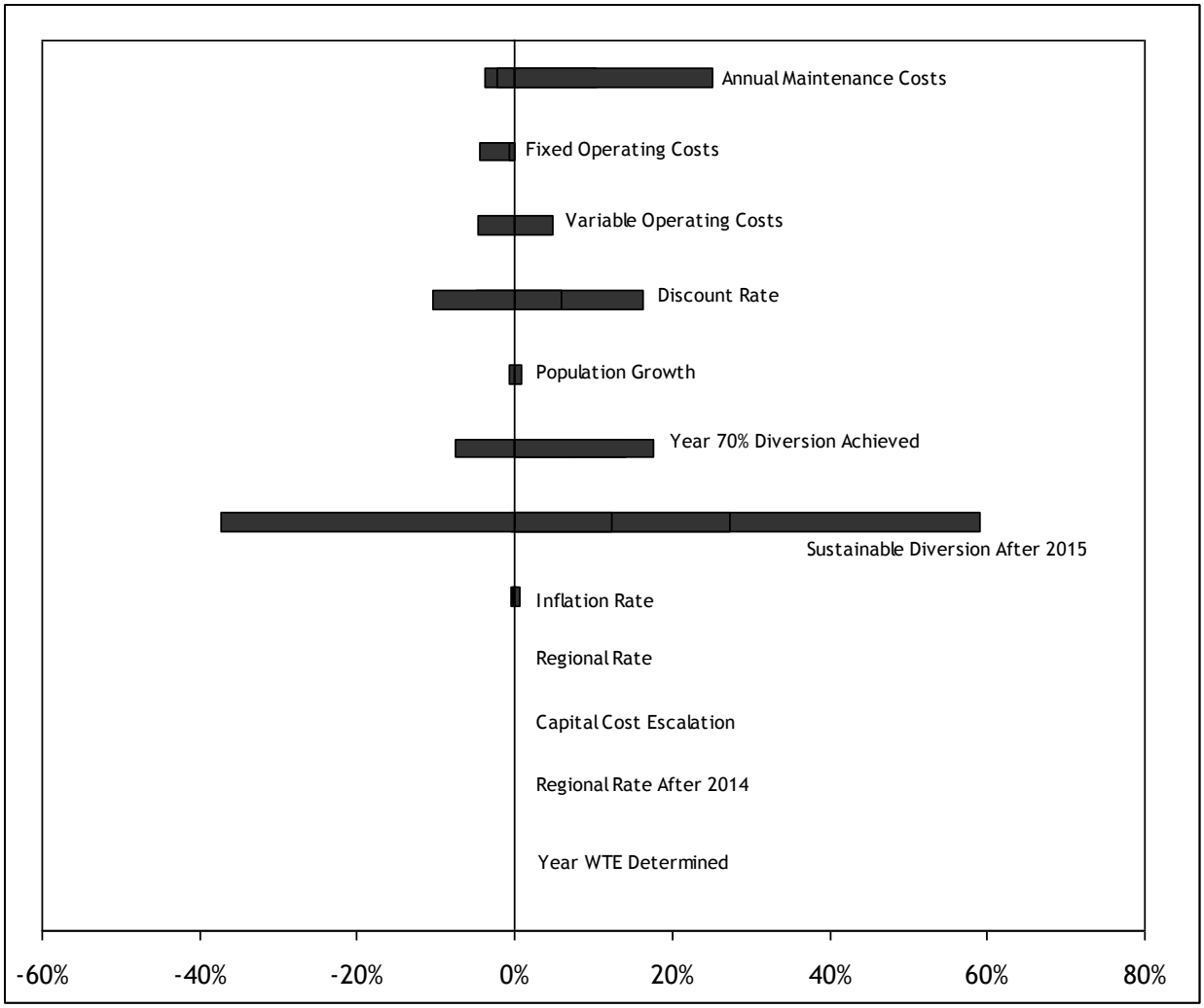

Figure B.14: Scenario 3 Tornado Diagram

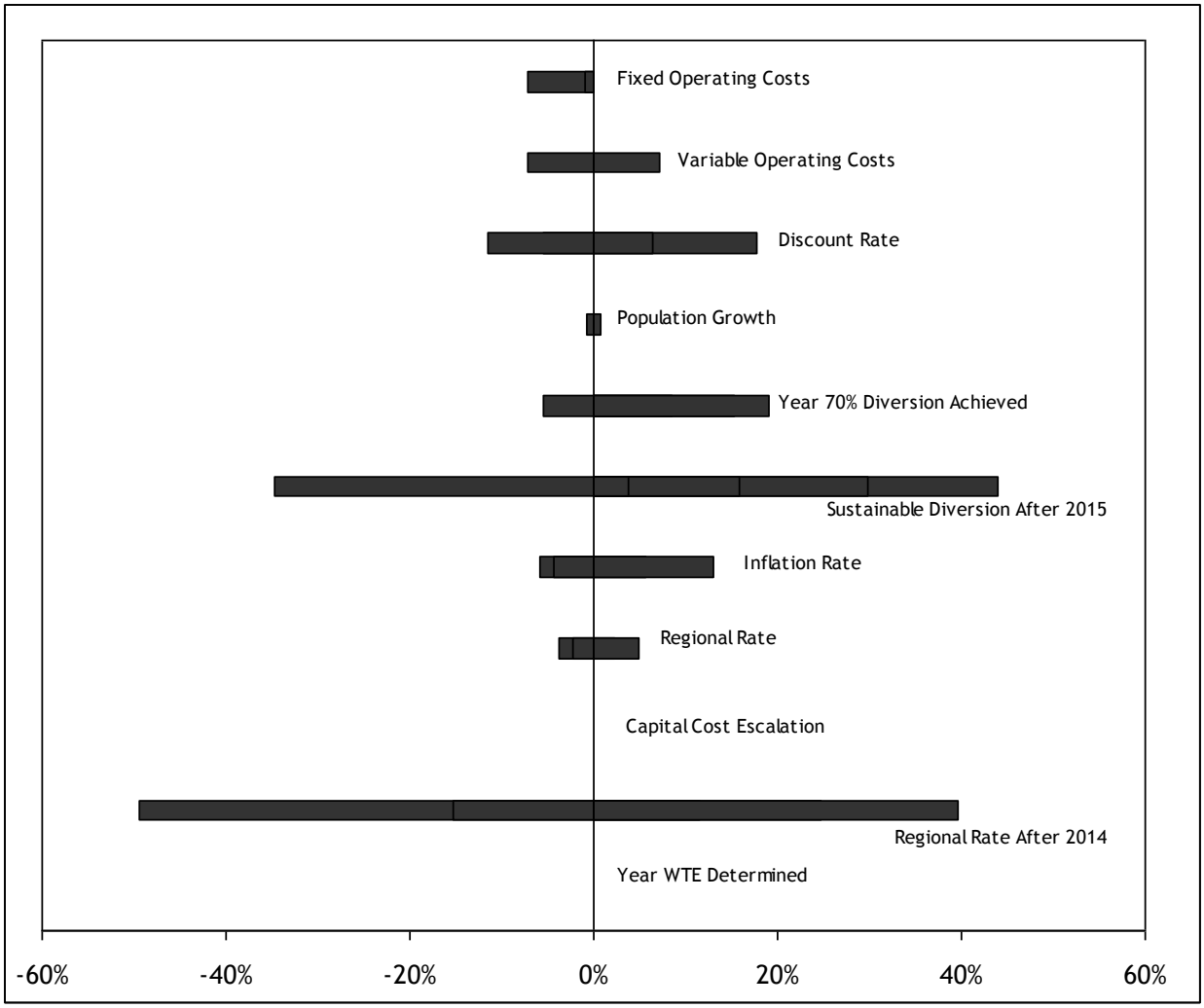

Figure B.15: Scenario 4 Tornado Diagram

APPENDIX C: RISK ANALYSIS RESULTS

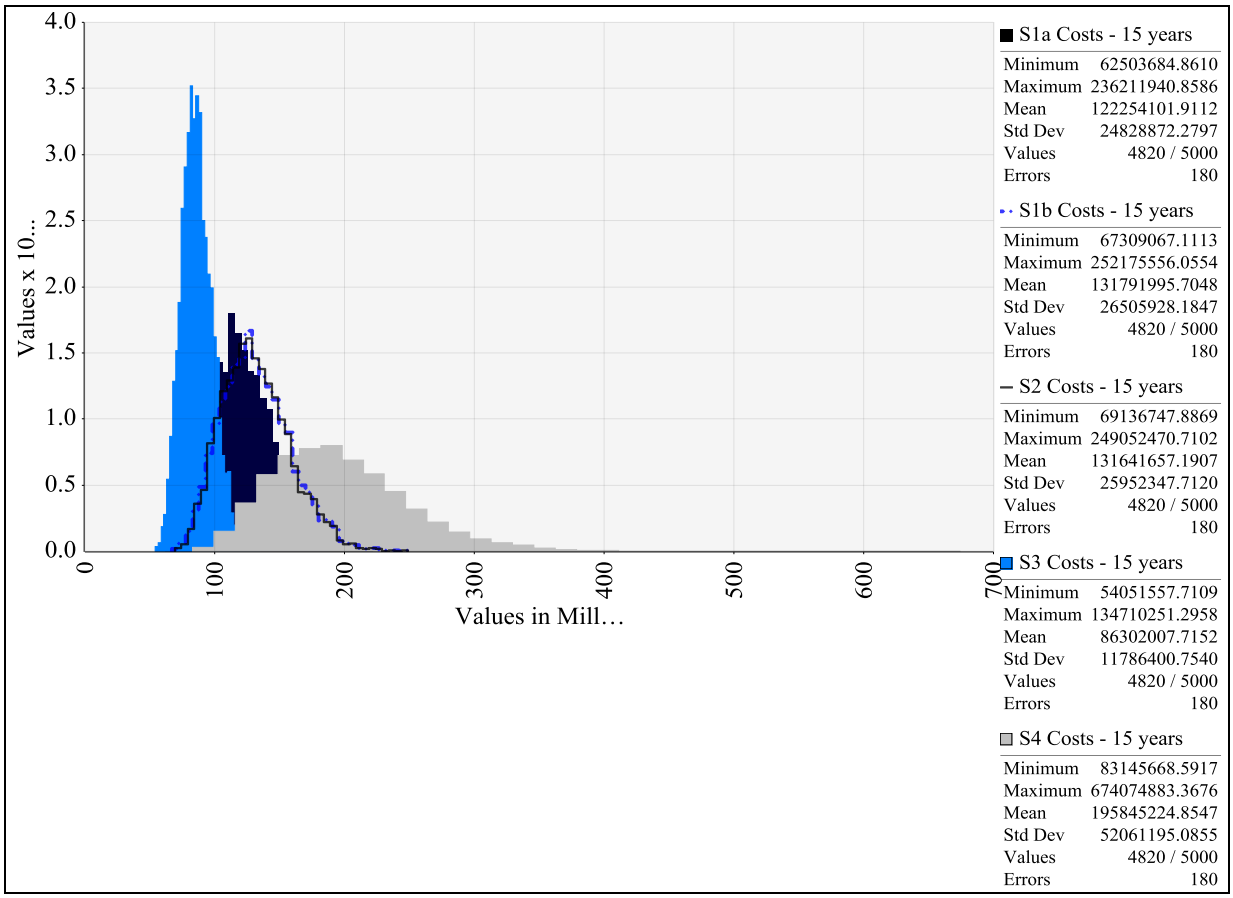

Figure C.1: Probability of Scenario Outcomes – Total Costs

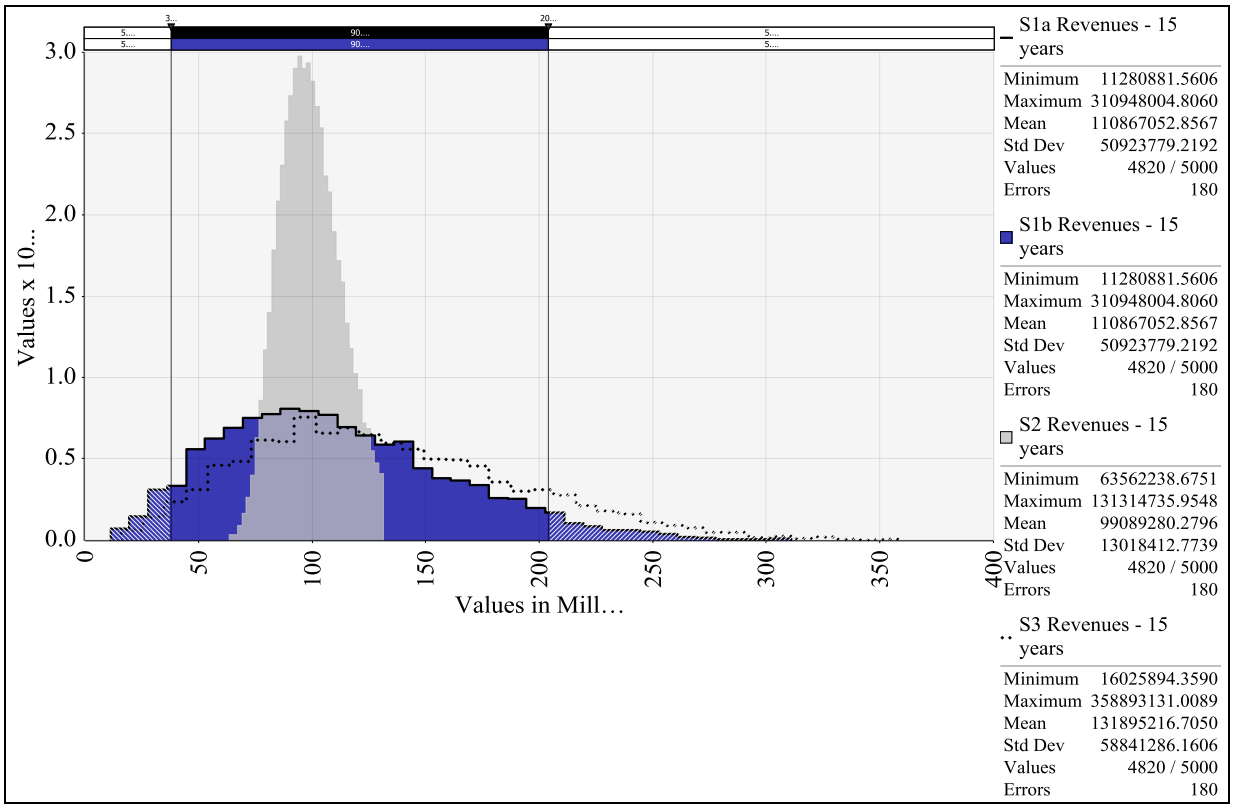

Figure C.2: Probability of Scenario Outcomes – Potential Net Revenues