Appendix 5.14
Waste-to-Energy Design Basis and Business Case Analysis
(Morrison Hershfield 2012)

November 13, 2015

Yukon Energy Corporation
2 Miles Canyon Road
Whitehorse, Yukon Y1A 6S7

Attention: Shannon Mallory, Environmental Coordinator

Dear Shannon:

Re: 5160120 - Review of Waste to Energy Business Case Analysis

Introduction

Morrison Hershfield completed a business case analysis for Yukon Energy Corporation (YEC) in 2012 exploring the feasibility of developing a Waste to Energy facility in Whitehorse ("Waste to Energy Updated Design Basis and Business Case Analysis", April 24, 2012). The primary purpose of the proposed facility was to increase firm electrical generation capacity in Yukon (1.6 MW capacity; 9,975 MWh generated annually).

We understand that YEC may be including "Waste to Energy" among the options to be considered in an updated Resource Plan and would like to determine if the results of Morrison Hershfield's 2012 business case analysis ("MH 2012") require revisions or updating. This memo includes a brief discussion of the key business case variables and provides an assessment of whether the business case results remain applicable for YEC's current planning initiative.

Review of Key Business Case Variables:

A brief discussion of the key business case variables determined in MH 2012 is provided below:

Feedstock Availability

The design basis for the 2012 business case was predicated on optimizing the use of available City of Whitehorse Municipal Solid Waste (MSW) feedstock and augmenting the MSW with higher cost biomass (wood) feedstock during the winter period when waste volumes decrease. The business case analysis assumed that available MSW volumes would decrease significantly by 2015 coinciding with the City's policy direction of achieving a 50% waste diversion target by 2015. The business case also included a number of sensitivity analyses that examined alternative waste diversion scenarios.

We understand the City of Whitehorse has not yet achieved its 50% diversion target and higher volumes of MSW are currently being disposed in landfill than predicted in the business case analysis. However, since the City is continuing to implement their Zero Waste programs outlined in the Solid Waste Action Plan (City of Whitehorse, 2013) the assumption of reduced future MSW volumes (used in the business case analysis) remains valid.

It was assumed that biomass (to augment the MSW feedstock) would be obtained from a variety of sources including spruce beetle-killed wood, local brushing and clearing, and Construction & Demolition waste. We are not aware of any significant changes in either the availability or competitive end uses for these biomass sources.

Technology and Conversion Efficiency

In the RFI process used to support the 2012 business case, seven vendors provided technical and price information. Some of these vendors are no longer active in the marketplace. However, one vendor, namely EcoWaste Solutions, has been expanding its operations and added additional capabilities. Since this was also one of the highest rated vendors in our assessment, we can confirm that the standard module size originally chosen is still valid.

There have been no new technologies for energy from waste that have reached maturity in this size range to the best of our knowledge in the past 4 years. From other recent projects and technology reviews we can confirm that controlled-air two-stage technology is still the most appropriate technology for this size range, fuel type and location.

The conversion efficiency of waste into heat and power depends on the heating value of the feedstock and the efficiency of the technology. Since neither have changed, the conversion efficiency will also not have changed.

Capital Cost Estimates

The major variables in the capital cost estimates are:

- Chute to stack combustion and energy recovery technology
- Site costs
- Installation and commissioning costs
- Interest rates

Given that the technology assumptions have not changed, the facility size is the same, and inflation has been minimal we estimate that the original cost used in the financial analysis is still valid.

Since it is premature to select a site for this facility (at this planning stage) there is no basis for updating estimated site costs.

Inflation rates have been low (or even negative) in Yukon over the past few years indicating that there is no basis for updating installation and commissioning costs.

Interest rates have actually dropped since the business case analysis was conducted, but only minimally. Since they are expected to rise again, we suggest that the 5.5% annual rate used in the business case analysis is still valid.

In summary, capital costs can be expected to be in the same range as projected in the original financial analysis.

Operating Costs

The most significant operating costs accounted for in the 2012 business case analysis were labour, variable O&M costs, and cost of biomass (wood) supply. Similar to the discussion of capital cost estimates (above), it is assumed that labour and variable O&M costs have not changed significantly as a result of low inflation experienced in Yukon (Whitehorse). We are also not aware of any reason that costs for procuring local biomass (wood) will have changed significantly over the past 4 years.

Revenues

The 2012 business case analysis is highly dependent on revenues from both MSW tipping fees and the sale of heat to a future District Energy System (DES) in Whitehorse. The business case analysis assumed a tipping fee rate of $108 per tonne of MSW received. Since the current (2015) City of Whitehorse Landfill tipping fees range between $94/tonne for sorted waste to $250 for unsorted waste, the estimate used in the business case analysis is still considered reasonable.

Estimated revenue from heat sales to a future DES were based on heating loads and district energy system capital and operating costs derived from a recent DES study completed for YEC in 2013 ("Whitehorse Community Energy Project: Community Energy System Feasibility Study Report", FVB Energy Inc). This is currently the best available information for assessing District heating opportunities and costs in downtown Whitehorse.

Conclusion

Based on the discussion provided in this letter, the Waste to Energy business case analysis results completed for YEC in 2012 are suitable for the purpose of YEC's current high-level resource options assessment.

Yours truly,
Morrison Hershfield Limited

Don McCallum, MASc., P.Eng.
Vice President, Environment

Morrison Hershfield Limited

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Global Waste Practice Leader

REPORT

Waste to Energy Updated Design Basis and Business Case Analysis

Presented to:
Yukon Energy Corporation
2 Miles Canyon Road
Whitehorse, Yukon
Y1A 6S7

Project No. 510404502 April 24, 2012

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April 24, 2012

Yukon Energy Corporation
2 Miles Canyon Road
Whitehorse, Yukon Y1A 6S7

Attention: David Morrison, President and CEO

Dear Mr. Morrison:

Re: Waste to Energy Updated Design Basis and Business Case Analysis

Morrison Hershfield is pleased to submit this final report to Yukon Energy Corporation to assist the Corporation in their evaluation of waste to energy opportunities in Whitehorse.

We look forward to continuing to support the Corporation in the evaluation and implementation of future energy opportunities in the territory.

Yours truly,

Morrison Hershfield Limited

Don McCallum, MASc., P.Eng.
Director, Environmental Services

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EXECUTIVE SUMMARY

Yukon Energy is considering increasing firm electrical generation capacity in Yukon using municipal solid waste (MSW) as a fuel source in a waste to energy (WTE) process. A preliminary business case analysis completed by Morrison Hershfield in 2011 indicated that WTE could provide firm, dependable electricity at significantly lower cost than diesel-generated electricity, provided waste heat from the process could be utilized and sold in a District Energy System (DES). This report updates the WTE business case analysis incorporating feedback received from key stakeholders, updated facility design, performance and cost information, preliminary District Energy System feasibility results, and a preliminary analysis of siting, environmental and approval considerations.

Several meetings and discussions have been held between Yukon Energy, their consultant team, and key stakeholders including City of Whitehorse, Government of Yukon Community Services Department, Raven Recycling, P&M Recycling, and the Yukon Conservation Society. Issues identified during these meetings included potential impact on City landfill operations and costs, air emissions, ash management, and concerns that WTE would harm and limit recycling opportunities. Yukon Energy organized a half-day workshop and public meeting on October 18, 2011 for the purpose of identifying issues and opportunities and outlining a plan for moving forward. A key theme identified at the workshop and public meeting was support for locally derived energy sources. There was a strong desire expressed to ensure that WTE is part of an integrated waste management system and does not compete with recycling. There was also strong support for increased diversion of materials away from the landfill and future WTE, with discussion of the territory and City potentially establishing a 50% waste diversion target.

The WTE facility design capacity was decreased to 25,000 tonnes per year from 30,000 tonnes per year in response to the desire of the City of Whitehorse to establish and achieve a 50% waste diversion goal. Approximately 7,700 tonnes per year of wood biomass would be required initially to ensure the WTE facility operates at full utilization, assuming the waste diversion target was achieved at plant startup. The amount of wood biomass required would decrease over time based on continued population and waste growth and maintaining a 50% waste diversion target.

A call for Expressions of Interest (EOI) yielded technical responses from seven vendors potentially interested in providing a WTE process. The response confirmed the technical basis of the business case analysis (conventional combustion utilizing either a small mass burn system or different forms of close-coupled gasification), provided expected energy recovery efficiencies, and outlined capital and operating cost estimates.

A preliminary siting assessment, informed by the results obtained from a separate Whitehorse District Energy feasibility study, identified potential site locations in the Marwell Industrial area and along Robert Service Way south of the downtown area. While a more detailed siting assessment and consultation will be required prior to final site selection, the business case analysis assumes siting in the Marwell area because of proximity to potential heat customers, access to municipal services and compatibility with adjacent land uses.

Air emissions have been estimated for a WTE facility and compared to emissions from diesel combustion in electrical generators and furnace oil combustion in space heating applications. Assuming the electricity produced from WTE displaces diesel-generated

electricity, and waste heat is utilized in a DES displacing furnace oil, WTE is expected to result in a net reduction of nitrogen oxide, particulate matter and carbon monoxide emissions and a net increase in sulphur dioxide emissions.

The estimated cost to produce 10,000 MWh per year of electricity from MSW and biomass in the "base case" is $0.31 per kWh. This estimate is similar to the cost of diesel-generated electricity and does not provide a clear incentive to pursue a WTE project. This cost estimate is higher than reported in the September 2011 preliminary business case analysis ($0.16 per kWh) largely as a result of two key factors: (1) requirements for additional biomass (higher cost) feedstock during initial operations, assuming that the waste diversion target of 50% is achieved in 2015; and (2) reduced electricity generation efficiencies reported by vendors when operating in a combined heat and power mode, while meeting the heat quality requirements specified in the initial results of the FVB Energy Whitehorse district energy study.

A sensitivity analysis identified two key areas of uncertainty that have the ability to significantly affect business case viability, as follows:

- An application for federal grant funding has been made under the NRCan ECO II program. If this funding request is successful, the electricity production costs could be reduced to $0.21/kWh.

- The base case analysis assumes an almost immediate drop (by 2015) in residual waste volumes to meet a 50% diversion target. The actual implementation schedule for achieving the diversion target is not yet known. If the diversion target was achieved in seven years (instead of two), the cost to produce electricity using WTE is $0.21 per kWh in 2015.

Based on the study results, it is recommended to determine if project feasibility can be improved through further examination of two key project uncertainties: capital funding grant availability and confirmation of waste diversion strategy implementation.

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1. INTRODUCTION

1.1 Overview

Yukon Energy is assessing a range of potential alternatives for increasing firm electrical generation capacity in Yukon. This report examines the social, environmental, technical and economic considerations associated with the development of a waste to energy (WTE) facility located in Whitehorse utilizing municipal solid waste (MSW) as the primary fuel source.

A preliminary WTE business case analysis completed in 2011 (Morrison Hershfield 2011) examined three facility scenarios, with capacities ranging between 20,000 and 30,000 tonnes per year and electricity generation between 14,000 and 17,000 MWh per year. The analysis examined the impact of utilizing wood biomass to augment MSW feedstock during periods of lower waste generation rates and the impact of utilizing low-grade waste heat in a potential District Energy System (DES). Utilizing preliminary facility cost and revenue assumptions, the estimated cost of electricity production ranged between \$0.16 and \$0.18 per kWh which increased to over \$0.27 per kWh if no district energy revenue was available. The most cost-effective and flexible facility scenario incorporated wood biomass as a supplementary feedstock source. The preliminary business case analysis incorporated a number of recommendations for proceeding with the project evaluation including:

- Confirm feedstock (MSW and wood biomass) quantity, quality and costs;
- Refine facility cost estimates;
- Undertake detailed feasibility study of a Whitehorse DES;
- Secure agreements for feedstock supply;
- Select a site for the WTE facility
- Confirm facility permitting and approval requirements
- Prepare a request for proposal (RFP) for the design and construction of a WTE facility.

The specific objectives and study scope addressed in this report is outlined in the following section.

1.2 Study Scope and Objective

The objective of this report is to refine the WTE business case analysis, allowing Yukon Energy and key project stakeholders to determine whether to proceed into more detailed siting, engineering and approval investigations and activities. The study scope incorporates the following elements:

1. *Incorporate stakeholder and public input*

   A one-day WTE stakeholder workshop, public meeting and focused stakeholder meetings have been undertaken for the purpose of communicating preliminary results and obtaining input into the future project direction. The results of these activities are documented and have been used to update the facility design basis and environmental considerations.

2. *Refine assessment of heat utilization opportunities*

   Since the completion of the preliminary business case analysis, a Whitehorse DES feasibility study conducted by FVB Energy has been initiated by Yukon Energy in partnership with the City of Whitehorse, Yukon Cold Climate Innovation Centre, and Yukon Government. The preliminary results of this separate study are incorporated into this report to determine the potential heat utilization opportunities of a WTE facility.

3. *Update design basis*

   The WTE facility design basis has been updated to incorporate more detailed assessments of feedstock and plant. The MSW feedstock assessment is revised to incorporate stakeholder input on future diversion targets and strategies for addressing seasonal waste generation variability. Sources and volumes of local wood biomass have been assessed for use as supplementary feedstock.

   A call for Expressions of Interest (EOI) provides a basis for updated facility process details, Combined Heat and Power (CHP) efficiencies and facility costs.

4. *Assess siting, environmental and approval considerations*

   Two siting potential areas for siting are identified and described incorporating considerations for waste utilization, transportation impacts, environmental considerations, land availability and compatibility with adjacent land uses. Potential environmental issues, described in the earlier Morrison Hershfield (2011) report are updated, and the project approval process outlined.

5. *Refine WTE business case analysis*

   The WTE business case analysis incorporates updated analyses of facility costs and revenues to determine an estimated cost of electricity production. Key financial inputs include:

   - Potential MSW tipping fee revenue based on an assessment of Whitehorse Landfill life cycle costs;
   - Wood biomass costs based on local supply assessment;
   - Facility capital and operating costs informed by industry responses to the call for EOI;
   - Allowance for land, servicing, and electrical tie-in costs;
   - Heat revenue using results of preliminary Whitehorse DES feasibility study.

   A sensitivity analysis illustrates the impacts to the business case if a capital funding grant is obtained (application has been filed) or if key assumptions are varied for critical project variables.

2. ENERGY DEMAND

2.1 Electricity

Yukon Energy is the primary generator of electricity in Yukon, with the capacity to generate electricity from both hydro and diesel combustion sources. At present almost all of the territory's electricity is generated from hydro sources[1].

The demand for electricity has been steadily rising since 2000 as a result of commercial and residential growth. More recently, increased mining activity in the territory has resulted in an additional industrial load, which is forecasted to continue to grow in the near-term. The result of this forecasted growth in electricity demand is that there is expected to be a shortfall in the supply of clean energy to the grid by 2014 (Yukon Energy, 2011).

Until new electricity generation capacity is installed on Yukon Energy's grid, the shortfall of clean energy, relative to electricity demand, will be met through the combustion of diesel in existing generators. The cost of diesel generation is high (approximately $0.30 per kWh at current fuel prices) compared to the rates charged to Yukon customers in the past decade: $0.13 - $0.14 per kWh for residential customers and $0.15 - $0.16 per kWh for commercial customers (Yukon Energy, 2011). Waste to Energy provides the potential to generate electricity at a lower cost, emitting fewer greenhouse gas emissions, when compared to diesel generation.

2.2 Heat

2.2.1 Whitehorse DES Feasibility Study

Yukon Energy in partnership with the Yukon Government, the City of Whitehorse, and the Yukon Cold Climate Innovation Centre at Yukon College is leading a study aimed at providing an assessment of the technical and economic viability of establishing a DES in the City of Whitehorse. FVB Energy has been retained to conduct the study which is expected to be completed in May 2012.

The scope of this district energy study includes the assessment of a range of alternative system concepts, development of a recommended system and design basis, and definition of a business model. The final deliverables of the work are expected to provide a comprehensive evaluation of technical and business case viability, and a strong foundation for proceeding into more detailed engineering and design if the concept proves feasible.

Key outcomes include:

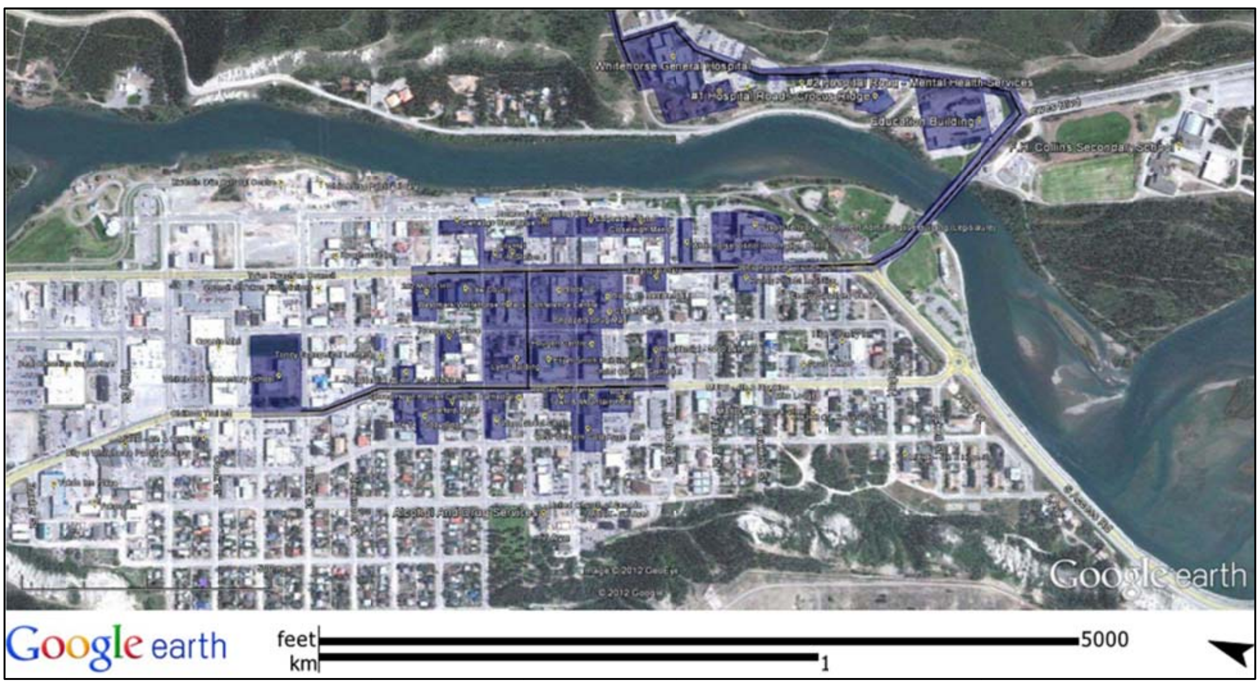
- A review of previous pre-feasibility work (Stantec, 2010), independently reassessing the district energy potential and developing business case scenarios of several alternative heating zones throughout the city.

[1]94% Hydro in 2009, as reported at the Yukon Energy Charrette in March, 2011

- Development of a DES Business concept and owner/operator models.
- Engagement with potential DES customers.
- Development of a technical concept.
- Development of a memorandum of understanding (MOU) and energy service agreements (ESA) with potential customers.
- Preparation of design basis document (DBD) that includes project definition and business plan.

Currently the project is at its midway point. FVB Energy has completed a high level technical and business case evaluation of seven district energy zones in nine separate scenarios. At this point in the assessment, the scenario including the hospital district and the downtown core area provides the highest heating demand and net revenues and the lowest payback period among the evaluated scenarios. As a result, this scenario has been recommended by FVB for further development and is adopted for the WTE business case. Figure 1 illustrates the potential layout for the Downtown and Hospital district energy scenario.

Figure 1: Potential Whitehorse DES distribution lines servicing the Downtown and Hospital area.



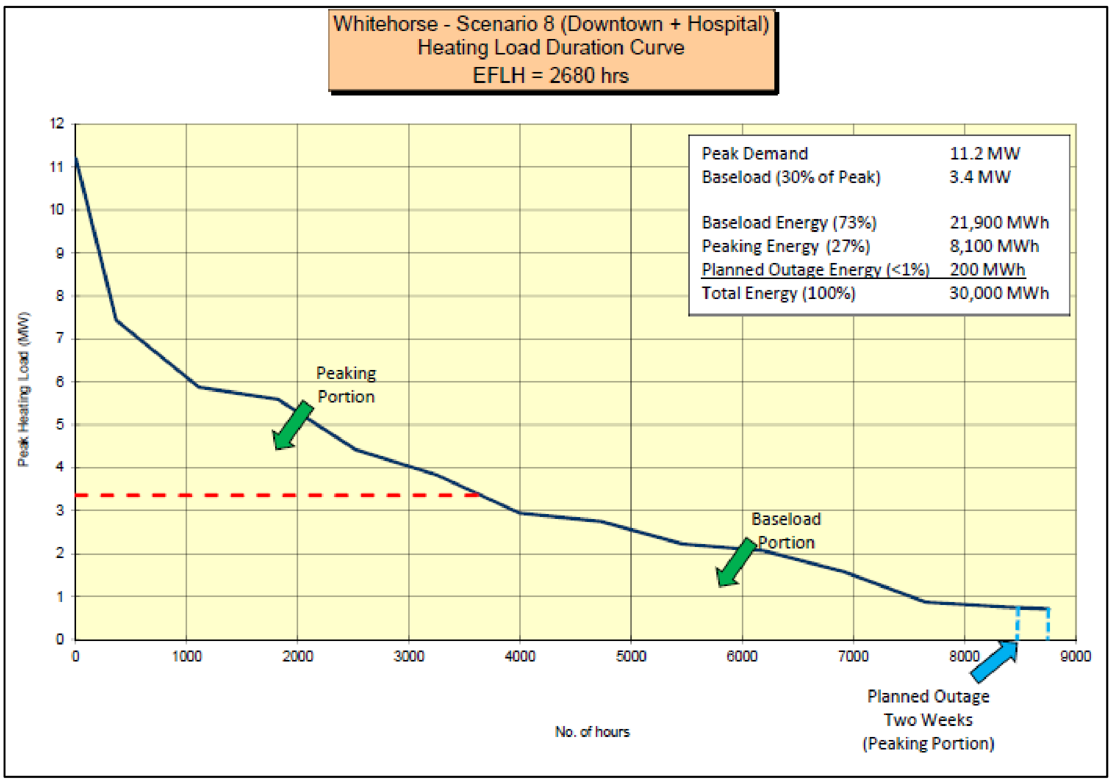
Source: FVB Energy Pre-Screening Scenarios Jan 25, 2012.

2.2.2 Heat Utilization Opportunities

Utilizing waste heat produced in the WTE facility in a future DES will significantly increase the overall energy efficiency of the WTE facility while also providing an additional revenue stream.

Based on the preliminary results of the district energy business case analysis by FVB, a feasible business case exists for implementing a DES in Whitehorse. Assuming a DES is constructed to service the hospital and downtown district (Scenario 8 as described in the FVB study), the DES would distribute 30,000 MWh of heating energy a year. Figure 2 illustrates the heat load-duration relationship for the hospital and downtown district, assuming a central DES biomass heating plant provides a base load heating supply with 3.4 MW capacity (73% of total annual heating demand). The remaining heating demand would be met through peaking boilers.

Figure 2: Heating load-duration curve for Whitehorse Downtown and Hospital District (FVB Energy, 2012)



A WTE plant constructed in Whitehorse would eliminate the need for a central biomass heating plant to service the DES. Assuming a design capacity of 25,000 tonnes per year, the WTE facility could generate up to 4 MW of usable heat energy (in addition to electrical power) that would meet 79% (23,700 MWh) of the total annual DES heating demand.

Total WTE facility energy efficiency increases dramatically if heat is utilized in addition to electrical power production. However, based on the expected heat quality required in a Whitehorse DES, heat utilization will result in some reduced electricity production, compared to an electricity-only process. Further discussion of CHP considerations in the WTE design basis is provided in Section 4.

3. PUBLIC ENGAGEMENT

A public meeting, one-day workshop, and a series of stakeholder meetings have been organized by Yukon Energy since the WTE project was initiated in 2010. The purpose of the public engagement has been to share information and identify the opportunities and issues.

Several meetings and discussions have been held between the Yukon Energy project team and City of Whitehorse senior staff for the purpose of understanding the City's waste management challenges and opportunities and potential impacts of a WTE facility on the City's landfill operations. The project team has made presentations to City Council at Council and Senior Management (CASM) meetings on June 9, 2010, May 18, 2011 and August 3, 2011. The purpose of these presentations has been to communicate project progress, understand City waste issues and priorities, identify joint opportunities, and hear project concerns.

Early in the project development, a project meeting was held on the evening of November 30, 2010 with representatives from Raven Recycling, P&M Recycling, Yukon Conservation Society and Government of Yukon Community Services. A follow-up meeting was held with representatives from the same organizations on August 9, 2011 to discuss the draft results of the Preliminary Business Case Analysis (Morrison Hershfield 2011). Key issues raised at these meetings included air emissions, ash management, and concerns that a WTE facility would harm and limit recycling efforts. Interest was also expressed for utilizing waste heat to increase the overall energy efficiency and displace fossil fuels used in space heating.

Waste to Energy was one of the potential energy sources discussed at the Yukon Energy Charrette in March 2011. Following up from the Charrette, Yukon Energy organized a half-day workshop and evening public meeting focused on WTE on October 18, 2011 (full workshop report included in ***Appendix A***). Over 70 invited participants attended the workshop session and 68 people attended the evening public meeting. Presentations were made by Yukon Energy and their consultant, a representative of Raven Recycling and P&M Recycling, and the City of Whitehorse. Following the presentations, workshop participants were organized into facilitated groups and asked to consider the following:

- Identify the opportunities and the challenges/issues around Waste to Energy
- Can the issues become opportunities? How?
- What does Yukon Energy need to make this project work?
- What does Raven Recycling and P&M Recycling need to make this work?
- What does the City of Whitehorse need to make this work?

A key theme identified during the workshop and public meeting was support for locally derived energy sources. However, there was a strong desire to ensure that WTE was part of an integrated waste management system and did not compete with recycling. There was also strong support for increased diversion of materials away from landfill and future WTE (50% by 2015 identified as a potential target) and strict air emission regulations.

4. UPDATED DESIGN BASIS

4.1 System Capacity

A system capacity of 30,000 tonnes per year was initially studied and used in the preliminary WTE business case analysis (Morrison Hershfield, 2011). This capacity was based on the known waste quantities with current recycling and composting activities in Whitehorse, plus waste coming to the Whitehorse landfill from outside communities.

Internal City of Whitehorse planning plus a Yukon Territorial Government study into waste diversion has resulted in more ambitious recycling goals in the community, with a target of 50% total diversion by 2015 currently being considered. In meetings with the City and local recycling groups, these figures were acknowledged as the new target that would henceforth be used for the planning basis of any energy recovery from residual, non-recycled waste.

As a first step it was necessary to get a thorough understanding of the waste volumes that would be generated with the new recycling targets, and how these might affect a WTE facility. City of Whitehorse Landfill Cost Assessment study was initiated to review the waste disposal situation at the Son of War Eagle landfill (Morrison Hershfield, 2012). The purpose of this study was two-fold: to estimate the future generation of waste that would need to be disposed at the landfill under a recycling only scenario as well as a recycling plus WTE scenario, and what would be the life cycle costs under each scenario. The residual waste volumes would help to determine a WTE facility size and also determine the life expectancy of the current landfill design under the 2002 Solid Waste Management Plan (Gartner Lee, 2003). The life cycle costs would determine unit costs for disposal of residuals and in the case of WTE, of ash and non-combustible residuals. The results of this study, completed as a landfill full cost accounting report is included as ***Appendix B***.

The landfill full cost accounting report was prepared in close consultation and cooperation with the City of Whitehorse. All available data and reports and projections available from the City were used and City staff were interviewed extensively. The study is based on the existing landfill plan from 2003 updated with current fill volumes and projections. The study examines the true cost of landfilling, focusing specifically on the disposal to landfill of the residues that are not recycled, composted or used for energy. The study does not include the cost of collection, recycling or composting in the calculations. These are separate items that need to be dealt with through an integrated zero waste management planning process led by the City of Whitehorse.

4.1.1 Waste Trends

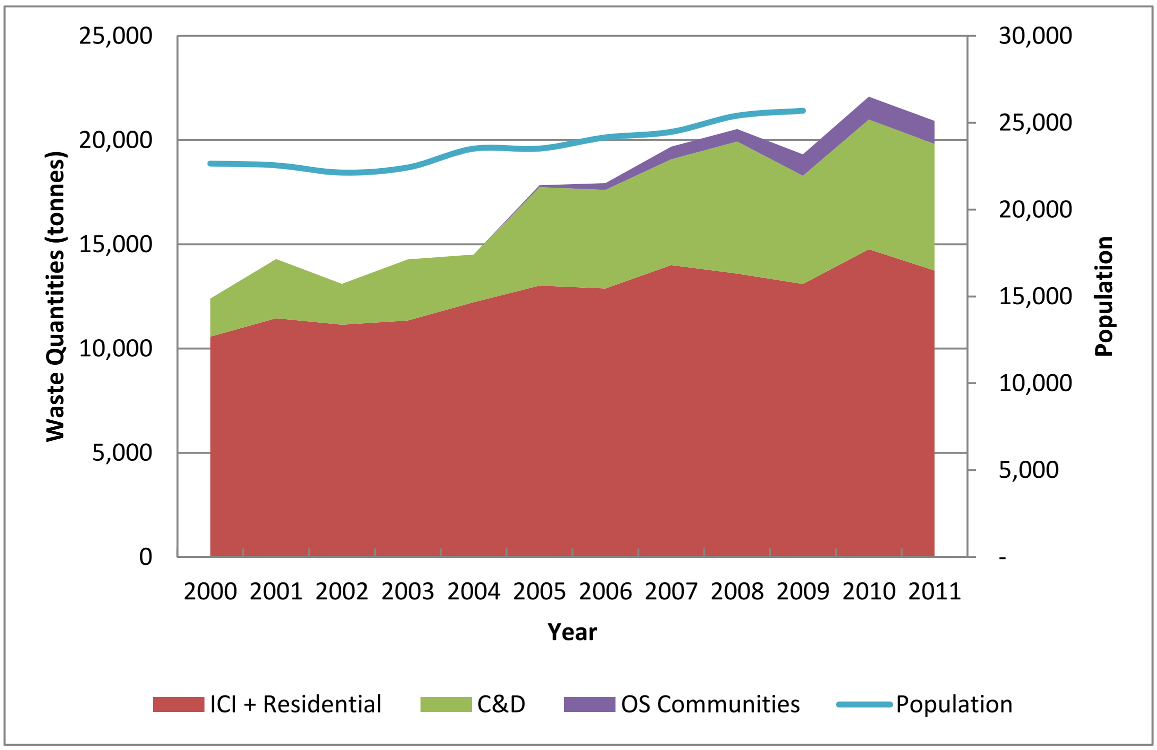
Waste generation quantities were forecast into the future based on historical tipping data obtained from the City for the years 2000 to the end of 2011. Only waste that is permanently disposed of in the landfill cells was included in the analysis. This comprised domestic curbside collected residential waste (RES); Industrial, Commercial, Institutional (ICI) waste including multi-family residential waste; waste from Outside Communities (OS); and, Construction and Demolition (C & D) waste. Excluded from the analysis were tires, white goods, grubbing, etc. which are not permanently disposed of in the landfill cells.

Figure 3 illustrates the quantities of waste managed at the city landfill over the last 11 years along with population statistics[2] over the same time period. It is apparent from this figure that waste growth rates have exceeded the rate of population growth.

Domestic waste (residential and IC&I) has consistently been the largest contributor of waste disposed at the landfill, although C & D waste has shown the largest increase in waste volumes over the past 11 years. In particular, C & D waste volumes exhibited a significant jump between 2004 and 2005 from 2,290 tonnes in 2004 to 4,723 tonnes in 2005.

Residential curbside waste is a relatively small portion (10-12%) of total domestic waste.

Figure 3: Recent Waste Growth in Whitehorse



The cause of the high rates of waste growth over the past decade and the volatility in waste volumes from year to year is likely related to a range of economic factors. Gross Domestic Product (GDP) in Yukon rose over 60% during this time period (6.2% per year on average) while by comparison Canada's GDP rose just 42% (Statistics Canada, 2010).

[2] Source: Population statistics obtained from the Yukon Bureau of Statistics 2009 Population Report

4.1.2 Disposal Quantities with Enhanced Diversion

This analysis provides an estimate of the amount of waste that would need to be disposed of at the Son of War Eagle Landfill assuming enhanced diversion, projected to 2060. It assumes for simplicity that 50% of waste would be diverted from landfill by 2015 and that this diversion rate could be maintained in spite of waste growth through increased population growth and economic activity. Wastes are broken down by domestic waste (residential, commercial and institutional sources), C&D waste (construction and demolition sources and generally of a different nature than domestic waste), and waste coming from outside communities, which is assumed to be only domestic.

Waste projections are shown in Figure 4 and Table 1. As can be seen from the figure, there is a sharp decrease of waste in 2015 when aggressive diversion programs are assumed to be implemented. After that time, volumes continue to increase in step with population growth. In reality, the transition will likely be more gradual and waste diversion is ultimately expected to exceed 50% as higher local awareness sets in and higher levels of government implement more rigorous product stewardship programs. Since these cannot be predicted at this time, the simplified model has been used for this study. However, a sensitivity analysis has been incorporated into the business case analysis assuming implementation of the diversion target is phased in between 2013 and 2020.

Figure 4: Projected landfill quantities under enhanced diversion

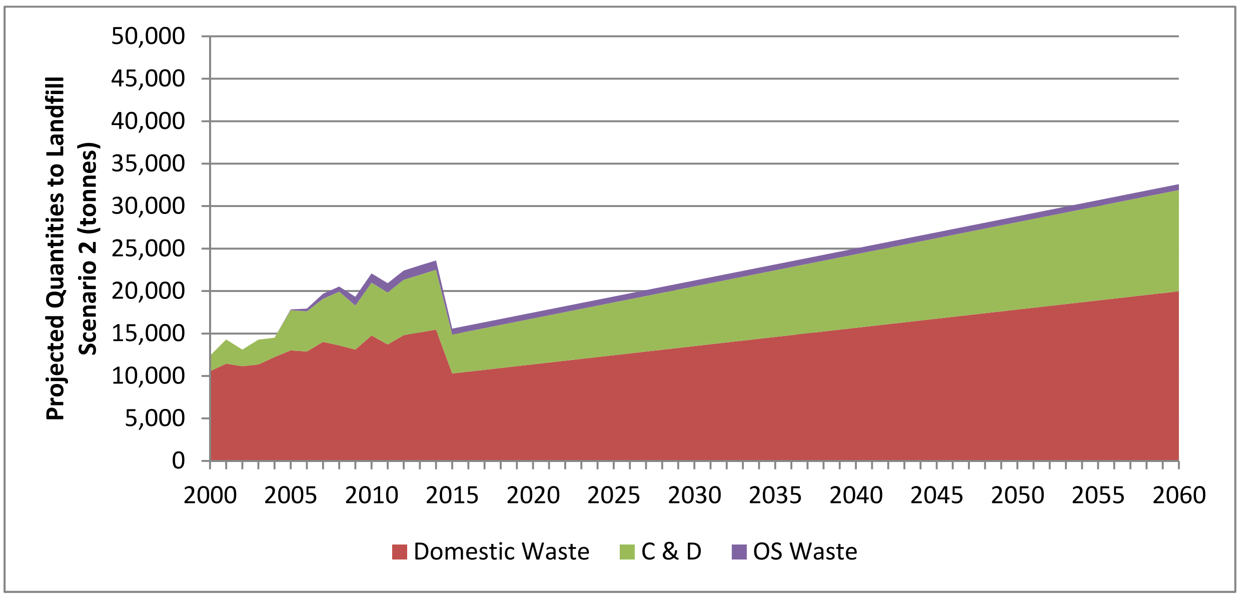


Table 1: Waste quantity projections based on enhanced diversion rate (tonnes)

	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
OS MSW	1,099	693	693	693	693	693	693	693	693	693	693
C & D	6,219	4,582	5,398	6,214	7,030	7,846	8,662	9,478	10,294	11,110	11,926
Domestic MSW	14,766	10,296	11,370	12,445	13,519	14,594	15,668	16,743	17,817	18,892	19,966
Total	**22,083**	**15,571**	**17,462**	**19,352**	**21,243**	**23,133**	**25,024**	**26,914**	**28,805**	**30,695**	**32,586**

4.1.3 Waste to Energy Facility Sizing

The residual feedstock available for waste to energy is calculated based on a 50% waste diversion target from the landfill being initiated in 2013 and achieved by 2015. This is a very aggressive schedule and as a sensitivity calculation, a more gradual phase-in of diversion programs from 2013 to 2020 was also considered (in the sensitivity analysis).

It is known from previous studies that there is a large variation in waste generation between summer (high) and winter (low) and that the peak summer monthly generation rate can be more than double of the monthly average for the year. Sizing of the WTE facility attempts to make the greatest use of the resource, while providing constant power and heat output. This is the rationale for choosing to supplement MSW with biomass when required: to capture as much of the MSW energy as reasonably possible.

Based on the enhanced diversion rate, the monthly average waste available in 2015 would be about 1,300 tonnes per year. For capacity selection, this has been increased by 50% to capture the higher waste volumes available in the summer months, without catering to the peak monthly generation (which is 100% higher than the average). During those months (e.g. in the winter) when there is insufficient MSW, biomass will be used to keep the facility operating at capacity.

For this analysis, a nominal design capacity WTE facility of 25,000 tonnes per year has been chosen. The actual annual throughput would be 95% of the total design capacity or 23,750 tonnes year. The projected loading of the WTE plant over time is shown in Figure 5 and Table 2. The biomass portion that needs to be used as fuel diminishes as MSW increases due to population and economic activity increases (while achieving 50% diversion). By 2035 the WTE facility would be using only MSW as feedstock.

Figure 5: Waste to Energy Feedstock Quantities

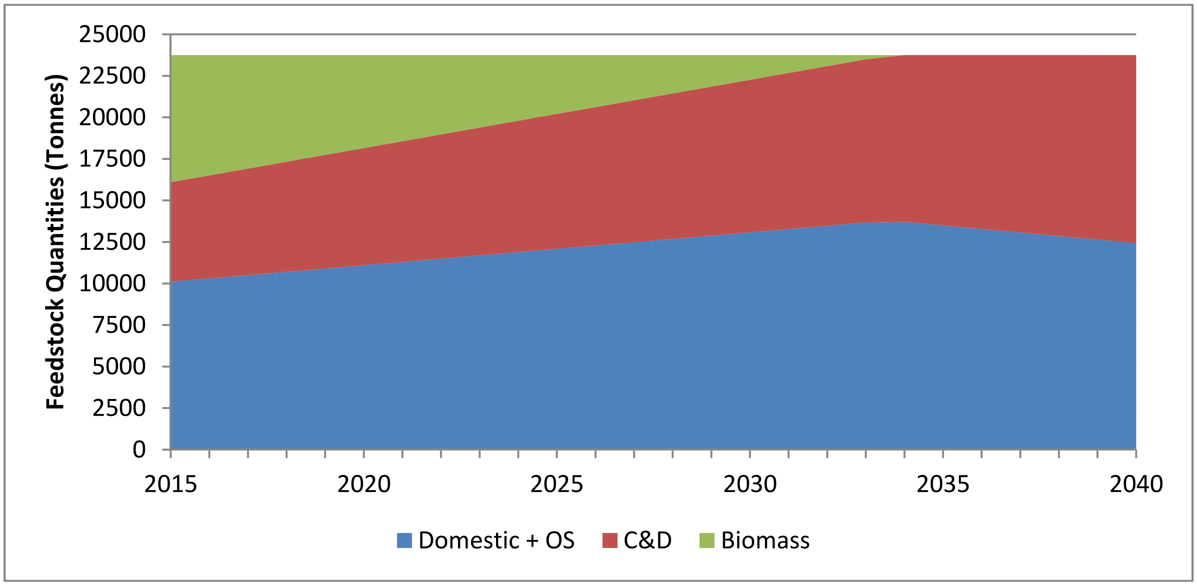


Table 2: Total Feedstock Quantities and Biomass Requirements (Tonnes)

	2015	2020	2025	2030	2035	2040
Domestic + OS	10,110	11,098	12,087	13,075	13,284	12,431
C&D	5,988	7,054	8,121	9,187	10,466	11,319
Biomass	7,652	5,598	3,543	1,488	0	0

4.1.4 Impact on Landfill with Enhanced Diversion and WTE

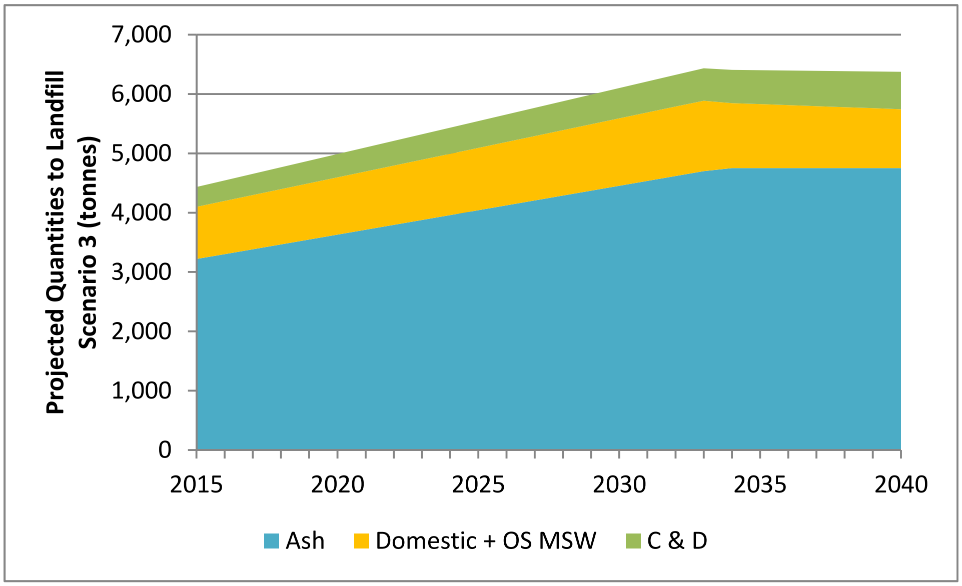
This analysis assumes that a Waste to Energy facility is constructed and commissioned by 2015. The design basis of the WTE facility maximizes utilization of remaining municipal solid waste after waste diversion (recycling and composting). It is assumed that the City achieves an enhanced waste diversion target of 50% by 2015. This is a simplification, as described above, but is used for modeling purposes.

It is assumed that solid waste growth beyond the WTE plant's capacity (which could use all of the MSW by 2035) would be accommodated through additional diversion programs. Using this assumption and projected waste growth rates, a total waste diversion rate of 57% would be required by 2040

The operating life of the WTE facility is assumed to be 25 years (to year 2040). It is likely that the WTE facility will operate longer (if there is waste still available), and the landfill will continue to accept waste/ash past 2040. Projecting waste quantities to the end of the landfill life is not considered practical for this analysis, since a WTE facility would extend the life of the current landfill well into the next century.

Projected waste and ash quantities going to the landfill until 2040 (25 year life of WTE plant) are shown in Figure 6. Wastes directed to landfill under this scenario would be primarily non-hazardous and stabilized ash resulting from the WTE process, plus some non-combustible C&D waste plus domestic waste when the WTE plant is undergoing maintenance.

Figure 6: Waste and Ash to Landfill



4.1.5 Biomass

As proposed in the preliminary business case analysis (Morrison Hershfield 2011), biomass, or wood waste, would be used as a supplementary fuel for the WTE facility if and when there is insufficient municipal waste available (e.g. during winter when waste generation rates are lower). Wood biomass therefore provides the flexibility to operate the facility at 100% capacity regardless of the available amounts of MSW.

Estimated annual biomass requirements are shown in Table 2. Initially, approximately 7,650 tonnes would be required with demand decreasing with waste growth.

The WTE facility could accept wood from multiple sources, which are discussed below. The cost of an on-site chipper and covered storage are incorporated in the facility cost estimates.

Potential sources investigated are:

1. Wood waste from mill residues;
2. Harvested spruce beetle kill and fire kill timber from Haines Junction;
3. Clearing and grubbing waste from construction activity within Whitehorse;

4. FireSmart wildfire management program;
5. Chipped wood waste from communities outside of Whitehorse;
6. Yukon Energy Right Of Way clearing; and,
7. Woody biomass from Yukon Highway maintenance.

4.1.5.1 Wood waste from mill residues

The closest source of mill residues to Whitehorse is the Dimok Timber mill in Haines Junction. Discussions with Dimok Timber determined that the estimated annual available mill residue is approximately 3000 oven dried tonnes (ODT) or approximately 3,500 green tonnes. Currently, there are no uses for the residues which are stockpiled and burned. Dimok Tiber provided Morrison Hershfield a quote for the delivered cost of the mill residues of $124/green tonne based on a maximum moisture content of 20% (Clunies-Ross, 2011). The quote includes costs for equipment to process, handle, store, and deliver biomass fuel. The most significant investment is a walking floor trailer which allows for self-unloading of the wood chips. Walking floor trailers are available in capacities ranging between 18 and 27 tonnes of biomass. This would result in between 111 and 167 loads annually depending on the trailer used.

According to Dimok Timber, the relatively low quantities provide a relatively low economy of scale and potential reductions in biomass volume requirements reduces the period in which capital costs can be amortized. The additional capital cost of the processing and handling equipment, and walking floor trailer over shipping raw logs means that utilization of mill residues results in no cost savings over using harvested timber.

4.1.5.2 Harvested spruce beetle kill and fire kill timber from Haines Junction

Spruce beetle killed wood is currently being harvested in the Haines Junction area, some of which is being shipped to Whitehorse primarily for use as firewood. Approximately 25,000 m3 of wood is currently allocated for firewood and forestry mill operations annually. The current annual allowable cut (ACC) is 100,000 m^3 or 45,000 tonnes per year, which could potentially yield a biomass supply that significantly exceeds the requirement for the WTE facility. The current price for delivered raw beetle kill logs from Haines Junction to Whitehorse at a commercial scale is approximately $115 per green tonne ($135 per ODT)[3].

[3] Based on $140 per cord of beetle kill spruce delivered to Whitehorse on a commercial scale, personal communication Clunie-Ross, Dimok Timber.

4.1.5.3 Clearing and grubbing waste from construction activity within Whitehorse

Historically, a significant portion of wood waste from land clearing for land development in Whitehorse was sent to the Son of War Eagle Landfill. In most cases this consists of non-merchantable timber, slashing, branches, and roots with intermingled topsoil.

Figure 7 indicates annual volumes between the year 2000 and 2005 were between 1,127 and 2,980 tonnes. The generation rates of clearing and grubbing waste is tied to land development activity in Whitehorse resulting in significant fluctuations over the years. In 2006 tipping fees for clearing and grubbing waste increased to $150 per tonne resulting in a sharp and sustained reduction in the volumes being sent to the landfill. As a result, clearing and grubbing waste over the last five years has been diverted primarily to landfill areas at MacLean Lake Road, near Copper Ridge subdivision off of Sandpiper Drive, and in smaller quantities on private lots that are close to job sites.

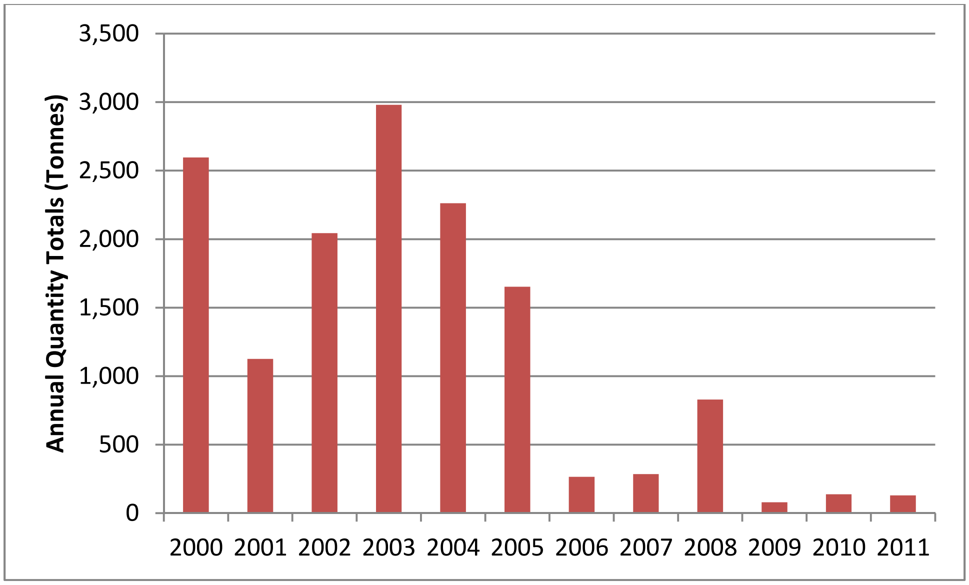
In absence of records of volumes that are currently being sent to site it is difficult to determine how much material exists in the stockpiles. Furthermore, loading and transportation costs and the likely contamination with topsoil and rocks would make extracting from existing stockpiles uneconomical.

The MacLean Lake Road site is an active site that is managed by the Yukon Contractors Association. Currently there is no charge to send waste to the site; however, introducing a $20 – $30 per load fee is currently being contemplated.

The hauling and disposal of clearing and grubbing waste is currently an onerous cost for contractors. This provides an opportunity for the WTE facility to obtain a potentially free to low cost biomass source provided careful loading and sorting of clearing and grubbing waste is undertaken to reduce soil contamination.

Based on the historical information available, it is difficult to predict what future clearing and grubbing biomass generation rates and what proportion of total material generated in Whitehorse could be obtained by a WTE facility. However, for preliminary estimation purposes, an assumption of 1000 tonnes is used. A modest financial incentive (such as $25) per tonne could be provided to capture a greater share of available clearing and grubbing waste and to encourage more careful separation of wood waste from contaminants such as soil and rocks in the waste brought to site. Separation would provide more efficient processing, reduce wear on the equipment and reduce the quantity of contaminants that would eventually have to be landfilled.

Figure 7: Historical Landfill Clearing and Grubbing Quantities disposed at City landfill



4.1.5.4 FireSmart Wildfire Management Program

The FireSmart program in the Yukon clears the equivalent of approximately 120 ha of land per year to reduce the wildfire exposure risk for Yukon Communities (pers comm. Jan, 2012 Fred Jennings, FireSmart Manager, YTG). Approximately half of the FireSmart work occurs in the Southern Lakes region which would result in a total volume of approximately 820 tonnes (680 ODT) of biomass annually[4]. Currently, most of the wood from the FireSmart program is taken by local people for firewood as costs are too high and volumes are too low to justify loading and hauling the material from a commercial perspective.

According to the FireSmart manager, there is the potential for a larger 1000 ha of fuel control work required in the Whitehorse area; however, no budget or timeframe has been established to implement such a program.

Based on the above information, current FireSmart volumes do not appear to be able to provide an economically significant and reliable supply of biomass.

4.1.5.5 Chipped wood waste from communities outside of Whitehorse

Wood construction and brush waste from outside communities is currently being chipped primarily in the spring to fall months at four sites located in Carcross, Tagish,

[4] 120 ha per season, approximately 25m^3 of wood available per ha, 2.2 m^3 per oven-dried tonne, assuming 20% moisture content.

Marsh Lake and Deep Creek. On average, there are 8 – 10 small gravel truckloads of wood chips being chipped at each site monthly for approximately 5 months of the year (pers. Comm. Jan 2012, Wes Wirth, Director, Operations and Programs Community Services Government of Yukon and Brian Buchannan, Contractor to YTG.) [5] As a result, it is estimated that approximately 650 tonnes of wood chips could be available per year from all four sites. With the cost of dump trucks between $120 and $130 per hour, the delivered cost of wood chips to Whitehorse is assumed to be approximately $25 per tonne.

4.1.5.6 Yukon Energy Right Of Way clearing

Power line right of way clearing is generally conducted by mowing with one hydro axe and a crew of two hand brushers. The material generally consists of poplar and willow and is left in the right of way. Encroachment of larger tree species such as spruce is generally not an issue in the right of way. However, where significant overgrowth exists it is typically in areas that are difficult to access and therefore would be difficult to export. Merchantable wood from new ROW development is used by the forestry sector while non-merchantable wood is left for salvage as firewood. There are no new major transmission lines planned in the near term.

Yukon Energy completed a vegetation audit in 2010 which provides an indication of the timing of when brush clearing is required to maintain right of ways. The schedule shows that between 140 and 240 ha per year would need to be maintained over the next ten years. The location of the clearing activities within a particular year would determine the feasibility of collecting and shipping the biomass to Whitehorse.

Biomass from power line right of way clearing cannot be relied upon as a reliable source of biomass; however, should vegetation control near Whitehorse be collected, it could potentially provide a supplemental source of biomass to costlier sources.

4.1.5.7 Woody biomass from Yukon Highway maintenance

Information from Yukon Government’s Vegetation Control Program from 2008 to 2011 was provided from the Yukon Government Transportation Maintenance branch. Currently highway vegetation control consists of three types of clearing:

1. Type A: ROW full width brushing covers the area from shoulder to old growth is between 10 and 30 m and primarily used to improve sightlines. This type of material could include trees and brush. Significant Type A work has occurred near Whitehorse in the past few years (between Teslin and Haines Junction has already been thinned) and new areas generally being worked on are increasingly further from Whitehorse (beyond Stewart Crossing.) Between 2008 and 2011, 60 to 300 km were covered. In 2011, 200 piles approximately 10 m wide by 3 m high were generated and burned.

[5] Assumed density of woodchips to be 400 kg/m3, volume of truck load 12 cubic yards or 9.17m^3 resulting in 3.6 t per truck.

2. Type B: Shoulder brushing / mowing covers the area of up to 5 – 6 m from edge of shoulder and generally consists of patchy areas of willows and small brush which provide marginal heating value. Areas are maintained every 6 to 8 years. Historically, the distance covered annually for shoulder brushing has been between 168 and 500 km.
3. Type C: Shoulder mowing usually covers a distance of 2.5 – 4 m from edge of shoulder and generally consists of willow, clover and grass which provide very low heating value. Between 250 and 300 km are mowed annually.

Based on the above information it appears that the only suitable sources of biomass would be from Type A maintenance activities; however, no new major maintenance works are planned for the Whitehorse area which makes availability to this source cost-prohibitive.

4.1.5.1 Wood biomass source summary

Numerous potential sources of biomass exist, although consistent availability and accessibility of many of those sources is difficult to predict and rely upon. For a source to provide a significant and sustained supply of biomass, both collection and delivery costs must be more competitive than alternatives such as spruce beetle kill wood from Haines Junction.

Table 3 summarizes potential biomass sources along with their estimated present and future costs.

Based on the above discussion, the main reliable sources of biomass could be from mill residues, spruce beetle kill wood from Haines Junction, and clearing and grubbing waste from land development within Whitehorse. Other minor sources such as wood waste from outside communities, FireSmart, and ROW clearing could be accepted as is at the WTE facility site at a modest financial incentive such as $25 per green tonne.

Table 3: Biomass Sources, Anticipated Annual Availability and Delivered Cost.

Source	Quantity (green t)	Cost ($ per tonne)[6]				
		2012 $	2015 $	2020 $	2025 $	2030 $
Mill Residues	3,500 tonnes	$124	$136	$157	$182	$211
Beetle Kill Wood Delivered from Haines Junction	10,000+ tonnes	$115	$126	$146	$169	$196
Clearing and Grubbing Waste from Whitehorse	1000 tonnes	-	$25	$29	$34	$39
Wood chips from outside communities	650 tonnes	$25	$29	$34	$39	$45
Other (ROW Clearing, FireSmart, Other)	Minor and variable	-	$25	$29	$34	$39

Whole logs delivered from Haines Junction appear to be more cost-effective for the relatively small scale biomass demand than mill residues because mill residues require the purchase of a wood chipper in Haines Junction and vehicles such as a walking floor trailer to transport the wood chips. On-site chipping, handling and processing facilities are accounted for in the WTE facility cost estimates. It is anticipated that as biomass requirements decrease, reliance would be shifted toward less expensive sources.

Table 4 shows the blended average biomass price including inflation[7] based on the quantity requirements. Initially, the average biomass cost is estimated at $104 per tonne with the majority of biomass sources from beetle kill wood from Haines Junction.

[6] Annual costs are escalated assuming 3% inflation to account for higher escalation transportation fuel costs.
[7] Inflation for delivered biomass costs is assumed to increase at a higher rate than the actual inflation rate due to reliance and to reflect a greater escalation in fuel costs. Thus, a 3% annual inflation rate is assumed.

Table 4: Annual Biomass Feedstock Requirements and Average Price

	2015	2020	2025	2030
Annual Biomass Requirements	7,600	5,600	3,500	1,500
Source Quantities (green tonnes)				
Beetle Kill Wood from Haines Junction	5,950 @ $126	3,950 @ $146	1,850 @ $169	0
Clearing and Grubbing Waste from Whitehorse	1,000 @ $25	1,000 @ $29	1,000 @ $34	1,000 @ $39
Wood Chips from Outside Communities	650 @ $29	650 @ $34	650 @ $39	500 @ $45
COST				
Average Biomass Price ($ / green tonne)	$104	$112	$106	$34

4.1.6 Capacity Summary

- A WTE design capacity of 25,000 tonnes per year has been selected for the updated business case analysis. The facility will be capable of burning biomass (waste wood) as well as MSW, so that any shortfall in waste feedstock can be made up with biomass.
- It is estimated that the WTE plant will be burning MSW without need for biomass by 2035 based on current projections (assuming 50% waste diversion is maintained from 2015 onwards). This is for calculation and comparative analysis only. The actual ratio of waste to biomass will be dictated by the amount of recycling and diversion that can be achieved and the actual rate of MSW growth.
- A WTE life of 25 years is projected, after which time a decision will have to be made on whether to upgrade the facility and continue operations or to decommission the facility for lack of feedstock or because newer, more effective technologies are available to replace it.
- The current lifespan of the Son of War Eagle landfill based on the existing Landfill Management Plan (Gartner Lee, 2003), is until 2057 based on 50% waste diversion implemented in 2015. If waste diversion and WTE are in place, the capacity of the landfill would extend well into the next century. According to the City of Whitehorse, there is additional land available at the landfill for future expansion, if needed.
- Biomass is available from a variety of sources. There is adequate biomass available from reliable sources at a cost of $115 to $124 per green tonne delivered. Additional sources of biomass are less reliable but can help to

offset the cost of biomass whenever these sources are available. The cost of biomass from other sources is low, since there is a saving in disposal costs and usually only transportation and some handling expenses need to be covered.

4.2 Process Technology

In the preliminary business case analysis (Morrison Hershfield Ltd. 2011), it was determined that controlled air conventional combustion, close coupled gasification and small scale mass burn met the necessary criteria for implementation at this time. The criteria for technology selection included ability to handle the small volumes of waste and biomass available at Whitehorse, capacity to produce both heat and electrical power, and commercially viable operating facilities of a similar size that could be visited and viewed.

The September 2011 business case was based on cost and performance data of smaller systems that are available in the literature and are in the public domain. Since there are very few smaller systems operating in North America, it was decided to enhance the confidence levels in the constant performance estimates by asking vendors to submit an expression of interest (EOI) in the project. Vendors (it was open to all who wished to respond) were given a detailed project scope and description, and a series of questionnaires to fill out. The original questionnaire was made available on November 8th, 2011. A copy of the questionnaire is in Appendix C.

Responses were received on 8 January 2012 from the following vendors:

- Aquilini Renewable Energy Ltd.
- EcoWaste Solutions Ltd
- EnEco Systems Inc
- Ketza Pacific Construction Ltd.
- Novo Energy LLC
- OE Gasification
- TPF Basse Sambre

Responses were reviewed, additional clarifications requested, and final information received February 8th, 2012.

Novo Energy and Ketza offered a small scale mass burn system, EcoWaste Solutions a conventional two-stage combustion system, EnEco,TPF and OE offered different forms of close coupled gasification and Aquilini was teaming up with EnEco.

Based on the submissions, the process technology that was proposed in the original September 2011 study was confirmed. Even though the EOI process was open to newer technologies, all respondents offered conventional technologies (close coupled gasification for the purposes of this study is considered similar to conventional combustion, except the process is separated into two or more closely connected physical components). The business case analysis will therefore proceed based on performance that can be reasonably expected from using conventional combustion technologies.

This was not a technology selection exercise for implementation but rather a choosing of appropriate technologies and performance data for business case evaluation purposes. Actual technology selection, should the project proceed, is expected to take place on a competitive basis. It is possible that advanced technologies could meet requirements in the future.

4.3 Technology performance

The key measurements of performance and those that have the most impact on the business model are net production of electricity and heat per tonne of feedstock. As expected, there was a trade-off between lower capital costs and energy production efficiency (for example higher steam conditions requiring better materials and equipment resulted in better efficiencies but also higher costs). There were also varying approaches to the recovery of heat and power, from using upfront steam extraction for heat with a condensing turbine for electricity, to using an extraction turbine for the most flexible system, to using a back-pressure turbine for steady-state heat output.

The information that was received from the vendors in response to the EOI was evaluated and compared. For electricity only production, net outputs ranged from 600 kWh/tonne to 650 kWh/tonne. With CHP electricity output ranges from 200 kWh/tonne to 420 kWh/tonne while providing 4 MW of heat.

The value chosen for the base case analysis is 420 kWh per tonne of waste, which represents about a 10% electrical efficiency and is typical for smaller CHP systems. This is consistent with the number quoted by one of the vendors that provided a fairly complete and credible submission. It includes the ability to provide up to 4MW of heat for district energy.

All of the vendors claimed to be able to meet the most stringent emission standards (Ontario A7 or the EU standards), therefore there was no difference or issue with emissions.

Staffing levels quoted varied between 14 and 26, but most of the vendors indicated 17 to 18 staff would be required. The business case analysis assumes a staffing level of 18 is required for the facility.

5. SITING, ENVIRONMENTAL & APPROVALS CONSIDERATIONS

5.1 Site Considerations

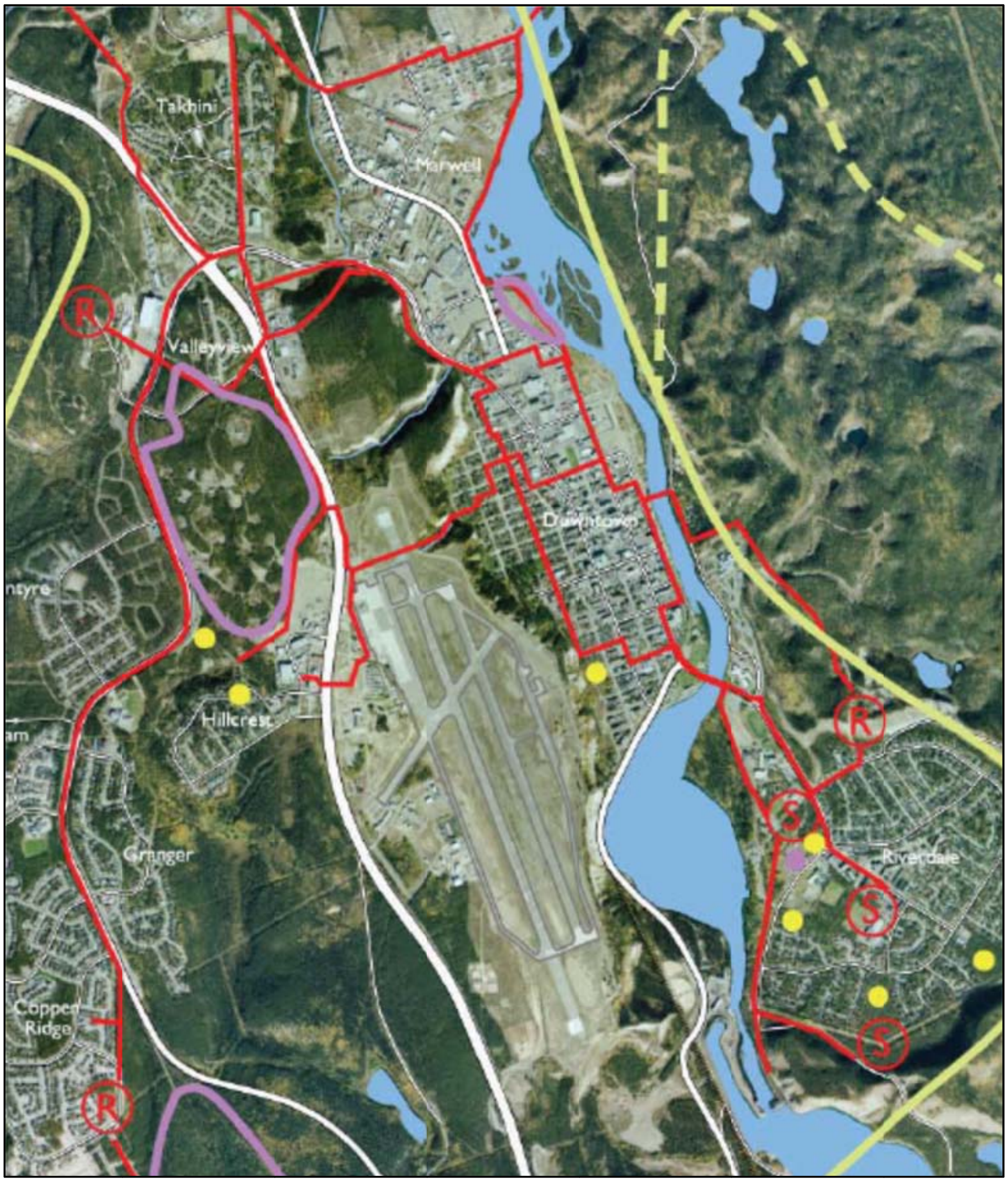
This section describes the site requirements for a Waste to Energy facility, potential economic, social and environmental impacts, and provides an assessment of two potential site areas.

5.1.1 Site and Infrastructure Requirements

A 25,000 tonne per year (70 tonnes per day) facility would require a site approximately 2 hectares in size that is relatively flat. The developed site would include buildings for the waste to energy plant, internal roads for truck access with room to turn around, scale, on-site storage of biomass and C&D waste, and a substation. The anticipated height of the stack would depend on the facility design and air dispersion requirements; however, 20 m – 30 m stack heights are common for smaller scale waste to energy facilities.

The site would require full servicing of electrical, water and sewer infrastructure. Electrical servicing will require access to a transmission line and the construction of a substation on site. Adequate water and sewer infrastructure would be required for the facility. Annual water demand of approximately 14,500,000 litres and 4,500,000 litres of wastewater are anticipated. Water demand can vary depending on the type of air pollution control systems used (dry or wet scrubbers), the cooling process employed in generating electricity and water recycling within the plant design. Figure 8 shows the location of major water and sewer lines in the City of Whitehorse. Generally, most developed areas of Whitehorse have access to sewer and water infrastructure. The area south of downtown near Yukon Energy's office and generation facilities is not serviced by municipal water or sewer. Yukon Energy is currently serviced by well water and uses a sewage holding tank where the effluent is pumped from and sent for treatment.

Figure 8: Major Water/Sewer Lines in Whitehorse



Source: City of Whitehorse OCP 2010 Map 5.

Zoning Bylaws

City of Whitehorse Zoning Bylaw 2006-01 permits public utilities in any zone under Section 1.6, Section 12.5 also applies to public utilities.

Key relevant aspects of Section 12.5 are the development regulations for siting that prescribe maximum building height of 20.0 m, minimum setbacks of 6 m, 3 m and 6 m for front yard, side yard and rear yard, respectively. Additionally, the design, siting, landscaping, screening, and buffering shall minimize and compensate for any objectionable aspects or potential incompatibility with development in abutting zones.

Development near the Whitehorse Airport could be subject to Regulations under Section 11.1 including:

> "No public utility or secondary use shall be permitted that attracts fauna or avifauna, generates electrical current or vibration that may affect the safe operation of aviation activities" and,
>
> "A development within the vicinity of the airport is subject to the obstacle clearance and electronic zoning requirements outlined in the Whitehorse Airport Zoning Plan."

Other development regulations that may apply but are unlikely to influence site selection include Section 5 (yards, projection into yards, accessory development, landscaping and screening); the parking regulations of Section 7; and the sign regulations of Section 8.

If rezoning is required, the process can take approximately 1.5 to 3 months and involves:[8]

- Determination if rezoning is required with the Planner/Development officer
- Submission of a complete rezoning application form plus supporting letters and documents and application fee of $900;
- Application is reviewed by the development review committee and recommendations are made to City Council;
- Introduction of the rezoning application to council;
- Public hearing process which includes public notification within 1 km of the site and notification in the newspaper and the development of a public hearing report;
- 2nd and 3rd reading by council.

Traffic Impacts

Based on the facility design capacity, 8 – 9 truckloads of waste per day would be transported to the facility assuming current capacity vehicles[9]. Truck traffic is only anticipated during daytime hours on waste collection days. Ash removal to the landfill from the waste to energy facility would likely result in one truckload every one or two days depending on the waste composition (ash content and inert materials of the waste stream); however, it would be possible to backhaul the ash on the incoming waste collection trucks resulting in no additional traffic impacts.

[8] Your Guide to the Rezoning Approval Process
http://ww3.whitehorse.ca/Planning/guides/rezoning%20approval%20process.pdf

[9] Assuming 2009 International Model SF62500 7400 SBA 6X4(Tandem) with GVWR 56000lbs and GAWR 20000lbs, payload of 8.6 tonnes.

District Energy Considerations

The utilization of waste heat from a WTE facility in a future DES would significantly improve the overall energy efficiency of the process and add an important additional revenue stream to the business case. Locating the WTE facility as near as possible to the heating demand reduces DES infrastructure costs and system energy losses.

A detailed district energy study is currently underway for the City of Whitehorse (described in Section 2). Preliminary study results indicate that the most cost-effective district energy scenario would supply heat to both the downtown and hospital district.

5.1.2 Air Quality Considerations

The prevailing wind in the downtown area is from the south-southwest, following the topography of the Yukon River Valley. Although air quality in the Whitehorse downtown area is generally very good, poor air quality periods can occur particularly on cold winter days when the winds are calm and dispersion is limited. Under such conditions a temperature inversion occurs trapping the colder air to the ground allowing for the temporary buildup of gaseous pollutants and fine particles in the air. Wood burning stoves, heating of commercial buildings and vehicle emissions have been identified as the primary contributors to periodic poor air quality in Whitehorse.

A CHP WTE facility would likely result in an overall improvement in air quality in the downtown area because multiple ground level point sources such as oil burning furnaces and diesel generators would be replaced with a centralized combustion facility equipped with stringent pollution controls and a stack that would elevate the emissions above the valley bottom. Further evaluation of air emissions is provided in Section 5.2.

Atmospheric dispersion modelling of facility air emissions is typically conducted after a site is selected and preliminary facility design conditions have been specified.

5.1.3 Access to Electrical Transmission System

Electrical power generated for export at the WTE facility would require an on-site substation and a 34.5 kV transmission line to connect to the existing substations in Whitehorse and the distribution system. In addition to the capital costs of constructing transmission lines and on-site substations, related considerations that would need to be confirmed and could have an impact on costs are:

- Space at existing substations for new equipment;
- Land easement;
- Permitting; and,

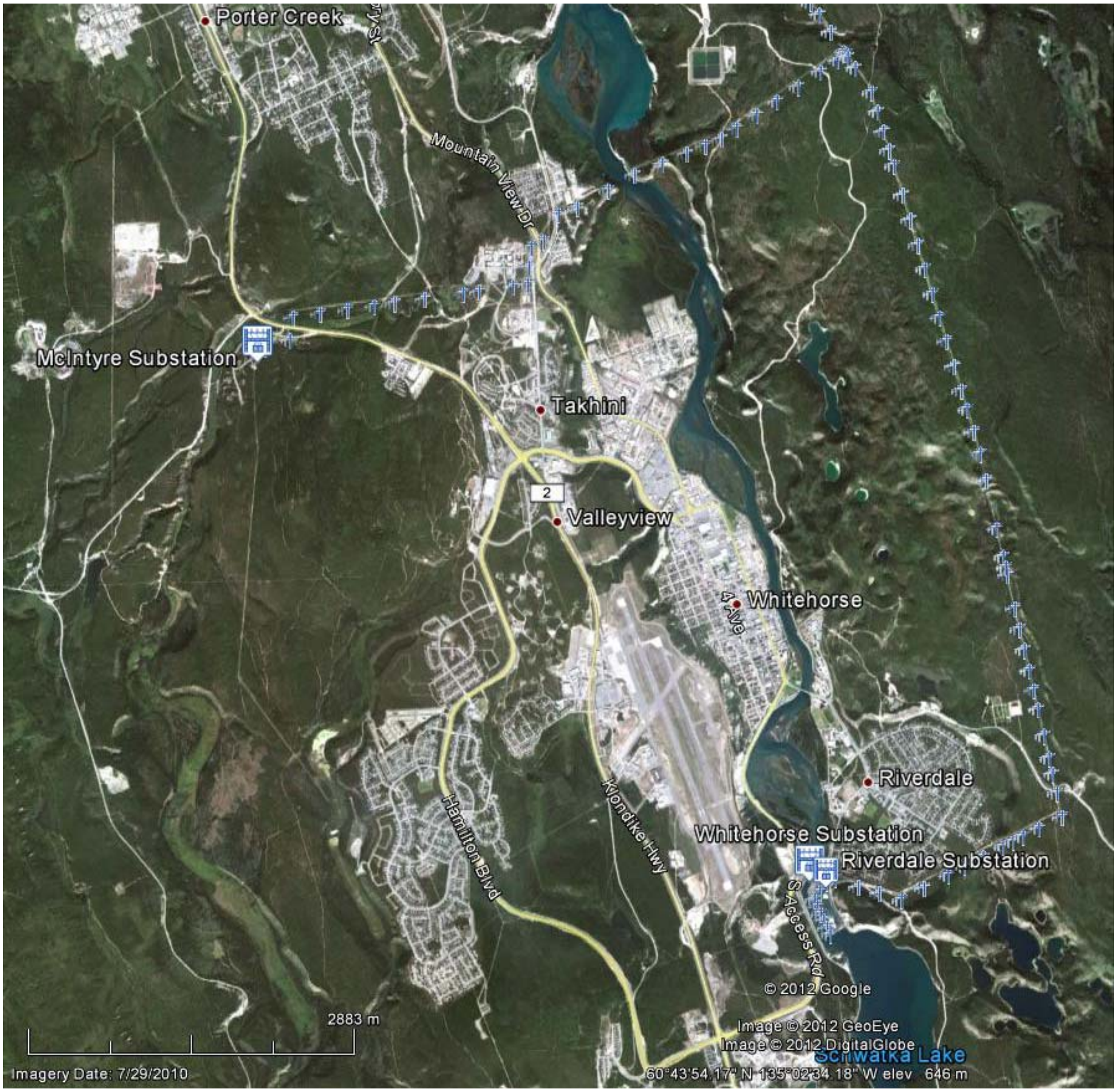
- Shut down of the bus for connecting the new supply.[10]

Four substations are currently located in Whitehorse, three of which are located within 5 km of the downtown area, as shown in Figure 9. The Whitehorse Substation on the west shore of the Yukon River and the Riverside Substation on the east shore of the Yukon River are located at the Whitehorse Hydro generation facility approximately 2.0 km southwest of the downtown along Robert Service Way. The McIntyre Substation is located approximately 5.0 km northwest of downtown Whitehorse off the Alaska Highway. The Takhini substation (not shown on the figure) is located 22 km north of the downtown on the Klondike Highway.

Major transmission lines originate at the Whitehorse Substation and border the southern end of Riverdale, then head north offset approximately 2 km along the eastern shore of the Yukon River (L172). This line is joined by a transmission line (L169) that connects to the McIntyre Substation approximately 3 km north of downtown Whitehorse near Range Road and Mountainview Drive.

[10] Person. Comm. Marc-Andre Lavigne, YEC, via. e-mail Feb 28, 2012.

Figure 9: Electrical infrastructure near downtown Whitehorse



Source: Google Earth

Noise, Odour, and Nuisance Considerations

Noise generation from the operations of a waste to energy facility could be an issue depending on its location. Sources of noise include trucks to bring waste to the facility, plant operations and fans. Assuming the facility is located in a commercial or industrial area, noise impacts associated from the anticipated truck volume and plant operations would be relatively minor.

The waste to energy facility would store any perishable waste within the facility which is under negative pressure preventing the migration of odours. The air is typically drawn from the waste receiving area into the combustion processes where high combustion temperatures eliminate any odours and dust associated with the waste.

Air emissions from a waste to energy facility depend on the pollution control system employed and the standards it is required to meet. Air emissions standards for waste to energy facilities are among the most stringent of all types of combustion processes and generally achieve lower emissions than the burning of wood or heating oil. The European Union, United States, and provinces such as Ontario and British Columbia have adopted best available technology standards which ensure that the standards achieved by the best performing similar facilities are adopted. Generally, emissions from WTE facilities are not visible except perhaps for a water vapour plume on cold days. Air pollution equipment can be configured to remove contaminants to well below the most stringent standards currently in use in Canada and Europe.

It is anticipated that Yukon would adopt WTE specific standards from either BC or Ontario.

5.1.4 Preliminary screening of siting options

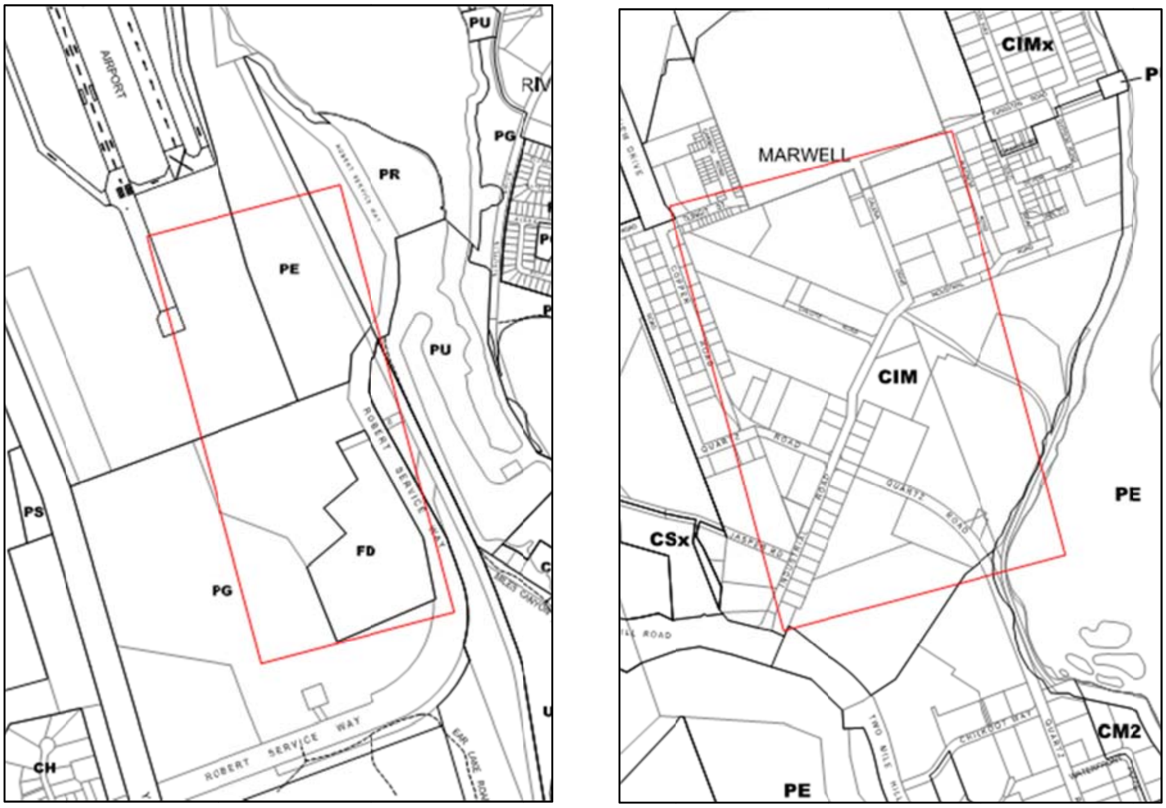
Site selection can have an important impact on project costs, additional revenue opportunities from district energy, environmental and nuisance impacts, and public acceptance. Proximity to district energy heat customers and compatibility with adjacent land uses have been used to screen potential site areas for further analysis.

The preliminary WTE business case analysis (Morrison Hershfield , 2011) indicated that heat sales to a future DES were critical to project feasibility. Accordingly, it is assumed that a future WTE plant must be sited in reasonable proximity to DES heat customers. As discussed in Section 2, preliminary results from the Whitehorse DES Feasibility Study indicate that the most promising DES option is one that serves the hospital and downtown core area.

Compatibility with adjacent land uses is critical to ensure that nuisance issues and traffic impacts are minimized. Based on land use compatibility, proximity to a future DES, and discussions with City of Whitehorse and Yukon Energy staff, two potential areas for siting a WTE facility have been identified. Those areas (illustrated in Figure 10) are:

1. South of downtown along Robert Service Way near Yukon Energy Headquarters;
2. Marwell Industrial Park, north of downtown area.

Figure 10: Siting areas Robert Service Way (Left) and Marwell Industrial Park (Right).



Robert Service Way South of Downtown

The area south of downtown near Yukon Energy head office includes several parcels of undeveloped land with good truck and electrical grid access that would easily meet the size requirements for a waste to energy facility. The haul distance to the Whitehorse landfill is approximately 16 km or 20 minutes. Depending on the parcel location, airport zoning restrictions may apply that could limit building heights and discharge of exhaust or steam from the facility that could affect air traffic. Since there is no residential development in this area and its proximity to the airport approach zone, noise and nuisance impacts to neighbouring sites would be very low. Air quality impacts however, may be of concern because of the location being upwind of downtown and the primarily residential Riverdale area which could be within 500 m of the site. Land in this area is currently zoned as either PG – Protected Green Space or PE – Environmental Protection, though based on the zoning by-law these designations may not prevent utility development, public concern may exist to development in those areas.

The close proximity to the Whitehorse substation means that electrical transmission line costs would be minimal; however, an on-site substation at the plant would still be required at an estimated capital cost of $1.5 million.[11]

A significant limiting factor to this area is the lack of water and sewer infrastructure. Currently, the City is contemplating the development of a 15 ha parcel for a new Municipal Services Building that fronts Robert Service Way and abuts the airport to the north (see figure 3). Such a development could bring water and sewer services to the area as well as a large heat consumer. As shown in Figure 8, currently the closest waste and sewer connections would be approximately 3 km from downtown. Based on the anticipated annual demand, a well could be developed to provide water to the site. Wastewater however, would require connection to the existing system. Water and sewer servicing costs are estimated to be $1.5 to $2.0 million.

Connection to a downtown DES would be between 2.0 and 3.0 km along Robert Service Way depending on the chosen site location. Current land use and topographical constraints along Robert Service Way appear to provide little opportunities for additional development for future connection along the district energy transmission route to downtown thus, constraining additional value that could be gained from the capital cost spent on district energy transmission pipe and water and sewer servicing. However, the WTE business case could improve significantly should the City construct their new Municipal Services Building at the parcel across from Yukon Energy and if further industrial and commercial development takes place in this area. This would provide new heat customers for the facility.

Marwell Industrial Park North of Downtown

Several large parcels of underutilized land (large areas exist that are only being used for surface storage of equipment) are located in Marwell area that would be of suitable size for a waste to energy facility. Marwell is well serviced with water and sewer infrastructure and has good truck access. The haul distance to the Whitehorse landfill is approximately 7 km or 10 minutes. The most accessible substation near Marwell is the McIntyre substation via transmission line L169 to the north. A substation would be required at the facility and a 34.5 KV transmission line to connect to L169 would be between 1.0 and 1.5 km in length depending on site location. The connection and substation costs are estimated to be $1.6 million[7].

Existing zoning CIM – Mixed Use Commercial/Industrial could be compatible with a Waste to Energy facility whose overall noise and nuisance impact would be no greater than other industries with such a designation. It is known that potentially contaminated lands exist in the Marwell area[12]. These sites may be suitable for a WTE facility since remediation requirements would likely be less stringent than for other land uses. Air quality impacts could be less than the location south of the downtown as a result of being downwind of the central downtown area.

Connection to the downtown DES based on the current distribution system layout would require transmission piping between 1.5 and 2.0 km in length depending on

[11] Person. Comm. Marc-Andre Lavigne, YEC, via. e-mail Feb 27, 2012
[12] Person Comm. Pat Hogan YTG Feb 27, 2012

the site location. The transmission piping could provide opportunities for additional customers to be connected to the DES along the route. A WTE location in this area could also support a future extension of the DES to potential customers in the Range Road area.

5.1.5 Preliminary assessment overview

Siting a WTE facility in either the Marwell area or south of downtown along Robert Service Way appears to be technically feasible. Table 5 provides a comparative summary of the two siting options, highlighting relative advantages and disadvantages of each site area. On most criteria, the Marwell Industrial is preferable to the Robert Service Way location. The Robert Service Way location has the advantage of lower electrical tie-in costs; however, this cost advantage is reversed when the costs of water and sewer servicing are considered. While there would be few immediate neighbours to a facility located in the Robert Service Way area, the proximity to the airport could affect the facility design and operations.

For the purpose of updating the WTE business case analysis (Section 6) it is assumed that the WTE facility would be located in the Marwell Industrial area. A more detailed siting analysis, environmental assessment, and associated public consultation will be required before a final siting decision is made.

Table 5: Comparison of siting options

	Area 1: Robert Service Way South of Downtown	Area 2: Marwell Industrial Park North of Downtown
Land Availability	Yes	Potentially; however, no specific sites identified. Siting on contaminated land could result in lower land costs.
Distance to Landfill	Longer haul distance,16 km or 20 minutes	Shorter Haul distance, 7 km or 10 minutes
Compatibility with existing land uses and designations	Some restrictions, airport height and zoning restrictions and existing city zoning would need to be modified. Can be mitigated.	Yes
Access to water and sewer infrastructure	No, potentially mitigated if infrastructure is extended from Riverdale or MSB is constructed. Costs estimated between $1.5 and $2.0 million.	Yes
Access to electrical infrastructure	Yes – On-site substation still required, $1.5 million	No, may require connection to transmission line up to 1.5 km away and/or substation, $1.7 million
Connection to expanded DES in future	Limited, unless the City's new MSB (or other new commercial/industrial facilities) is constructed in this area.	Good potential for expanding DES into Range Road area.

	Area 1: Robert Service Way South of Downtown	Area 2: Marwell Industrial Park North of Downtown
Air quality limitations	Some limitations; need to ensure steam from the facility does not impact airport, close proximity to residential area and upwind of downtown. Detailed air study should determine if significant impacts exist.	Limited limitations, site location is in industrial/commercial area and downwind of downtown. Detailed air study should determine if significant impacts exist.
Noise and nuisance impacts	Minimal, site is located in an isolated area, truck traffic and operations should not have a significant impact to neighbouring properties. Nuisance impacts to Riverdale may be identified.	Minimal, site is located in a more central area, truck traffic and operations could have some impact to neighbouring properties; however, impacts could be mitigated and are minimal since operations are largely compatible with existing land use designations.

5.2 Air Emissions

Comparison of Air Quality Parameters

Waste to energy facilities, just like landfills and all combustion based energy sources, emit air pollutants. In the Whitehorse context, the net air emissions resulting from WTE include emissions associated with the combustion of waste minus avoided air emissions associated with landfilling of waste, displaced diesel-generated electricity, and displaced heating oil used in boilers (assuming implementation of a DES).

The air emissions from a WTE facility are dependent on the waste composition, the thermal conversion technology employed, combustion conditions, and the design of air pollution control system. Standards such as Ontario and BC's maximum achievable technology standards specific to municipal thermal waste treatment facilities are continuously becoming more stringent to ensure emissions are as low as technically feasible. Table 6 illustrates a comparison between the Ontario Guideline A-7: Combustion and Air Pollution Control Requirement for New Municipal Waste Incinerators and the average air emissions from the "top ten" Waste to Energy Research and Technology Council 2006 Industrial award finalists. (Psomopoulos, C.S., 2009). For all parameters, facilities demonstrated an ability to achieve significantly lower levels of emissions than the Ontario standards.

Table 6: Comparison of air emissions from WTE combustion technologies and Ontario Guideline A-7 Standard.

All concentrations are compared at 11% O_2

	Average of 10 Finalists	Ontario Guideline A-7 Standard 2010
Smog Precursors		
Total Particulate Matter (PM) mg/Rm3	3.1	14
Acid Gases		
Nitrogen Oxides (NOx) mg/Rm3	112	198
Hydrogen Chloride (HCL) mg/Rm3	8.5	27
Carbon Monoxide (CO) mg/Rm3	24	40
Total Organic Content (TOC) mg/Rm3	1.02	33
Sulphur Dioxide (SO2) mg/Rm3	2.96	21
Trace Air Contaminants		
Mercury (Hg) ug/Rm3	10	20
Dioxins (TEQ) ng/m3	0.02	0.08
Cadmium (Cd) ug/Rm3	4.9[13]	7
Lead (Pb) ug/Rm3	44.51	60

The government of Ontario conducted a detailed assessment[14] of the human health and ecological risks of a modern well run incinerator that complied with the A-7 Standard in conjunction with a similar study on their landfill standards. The study concluded that:

- No significant human health effects (those being cancer, lung disease, nerve damage or reproductive effects) are likely in a typical suburban community located near an incinerator or a landfill, however both cancer risks and non-cancer risks from incinerators were lower than those associated with landfill emissions[15];

[13] Source: (Psomopoulos, C.S., 2009)

[14] Environmental Risks of Municipal Non-Hazardous Waste Landfilling and Incineration (Ontario MoE, 1999)

[15] Total lifetime incremental cancer risk for a maximally exposed individual from long-term exposure to incinerator emissions range from 4.7x10-8 to 2.3X10-7 versus total combined cancer risk from long-term exposure to landfill emissions containing volatile chlorinated chemicals range from 4.0x10-6 to 1.0x10-5 for landfill emissions. (Ontario MoE, 1999)

- An ecological risk assessment predicts that water and sediment quality near an incinerator or landfill will meet Ministry guidelines for the protection of aquatic life;
- Direct or indirect impacts to the terrestrial environment, vegetation or wildlife resulting from incinerator or landfill emissions are not anticipated to be significant.

Similar conclusions from other comparative studies are summarized by Moy (2005). Most recently, an independent study commissioned by the Commissioner and Medical Officer of Health for Region of Durham, Ontario, determined that there is no conclusive evidence indicating negative impacts of modern incinerators on the health of people living in the vicinity, based on the epidemiologic literature from 2000 – 2007 (Smith, 2007).

Energy from the WTE facility is expected to displace approximately 10,200 MWh diesel generated power and 23,700 MWh of heat derived from burning 3,383,000 litres of heating oil annually. Table 7 illustrates air emissions for these energy sources per unit of energy generated.

Table 7: Comparison of air emission intensities from energy sources in Whitehorse with WTE

	Heating Oil[16] (kg/MWh)	Diesel Generator[17] (kg/MWh)	WTE (kg/MWh)[18]
Total Particulate Matter (PM)	0.042	0.183	0.0228
Nitrogen Oxides (NOx)	0.416	8.82	0.82
Carbon Monoxide (CO)	0.104	0.516	0.176
Sulphur Dioxide (SOx)	1.66e-7	0.014	0.022

Table 8 illustrates the total air emissions based on the anticipated WTE energy output and the emissions of heating oil and diesel that could be displaced as a result of a WTE facility. The results indicate that WTE would result in overall emission reductions of total particulate matter, nitrogen oxides and carbon monoxide and an increase in sulphur dioxide. It should be noted that the WTE emission estimate is based on an average of operating facilities. If the need was established to reduce sulphur dioxide emissions in the Whitehorse area,

[16] Source: Heating oil calculations adapted from emissions calculator by Illinois Environmental Protection Agency for #1 and #2 Fuel Oil http://www.epa.state.il.us/air/aer/calculate/boiler_oil.html . Sulphur content of oil supplied in Whitehorse is Ultra Low Sulphur Platinum 0.0005 ppm. Annual seasonal boiler efficiency is assumed to be 65% according to DES study by FVB Energy.
[17] Source: Diesel emissions data from Yukon Energy

[18] Source: Calculated based on air emissions from average 10 WTE finalists, 9,975 MWh electricity and 23,700 MWh of heat generated.

additional air emission controls limiting sulphur dioxide stack emissions are technically feasible.

Table 8: Total annual air emissions displaced by WTE

	Heating Oil (kg)	Diesel Generator (kg)	WTE (kg)	Air Emissions Displaced (kg)
Total Particulate Matter (PM)	985	1,825	767	(2,044)
Nitrogen Oxides (NOx)	9,854	88,019	27,720	(70,153)
Carbon Monoxide (CO)	2,464	5,147	5,940	(1,671)
Sulphur Dioxide	0.00394	140	733	593

Dioxins and furan compounds can be formed by a wide variety of combustion sources including cars, trucks, diesel generators, wood burning fireplaces and WTE facilities. The implementation of stringent air pollution standards and controls for WTE facilities over the previous decades has dramatically reduced dioxin and furan emissions. The German Ministry of Environment now considers dioxins and furans coming from WTE to be insignificant, since they make up less than 1% of the loading in Germany, even though 35% of the municipal waste in Germany is treated using WTE[19]. In Canada, we have Canada-Wide Standards for dioxins and furans which are the most stringent in the world.

Metals contained within MSW commonly include iron, copper, lead, zinc, cadmium and mercury. Within a WTE facility, most metals remain inert and appear in the bottom ash following combustion. Volatile metals however, particularly mercury and lead will be partially or fully volatized at high temperatures.

The emission of mercury and lead from WTE facilities is a function of the presence of these elements in the waste stream and the capabilities of the air pollution control system. The diversion of hazardous materials from disposal, such as thermostats, barometers and manometers, lighting and electrical appliances, major appliances, electronic waste, and batteries, can eliminate the source while air pollution control systems have been proven to be able to reduce volatile metal emissions to well below environmental regulations. Mercury emissions measured from the top ten North American WTE facilities are now less than 50% of the Ontario standard (see Table 6 above) while lead emissions are also consistently below the Ontario standard for these facilities. According to a German Ministry of Environment publication, lead and mercury emissions from incineration of household waste are no longer significant sources for human exposure to toxic substances, and emissions from all other sources are over 1,000 times greater than the emissions produced by WTE facilities (BMU, 2005).

[19] Germany, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2005). *Waste Incineration – A Potential Danger? Bidding Farewell to Dioxin Sprouting*. Accessed October 26, 2008. http://www.bmu.de/files/pdfs/allgemein/application/pdf/muellverbrennung_dioxin_en.pdf

Ultrafine particles (also referred to as “nano-particles”) are the subject of recent research and growing public interest. Ultrafine particles are generated directly by combustion from stationary sources (power plants, heating furnaces, WTE facilities) and mobile sources such as cars, trucks and industrial mobile equipment burning diesel, gas or gasoline. In order to put ultrafine sources into perspective, one study[20] in the literature compared the ultrafine emissions from vehicles with those coming from a WTE facility. Converted to the proposed size for the WTE plant in Whitehorse, about 100 vehicles traveling 3km would release about the same amount of ultrafine particles as a WTE facility in an hour. There is also recent evidence (briefly described below) that suggests that stringent air pollution control requirements for WTE facilities result in significantly fewer ultrafine particle emissions than from other combustion sources. One study conducted by a university in Switzerland on different types of pollution control equipment at WTE facilities found that a certain combination of scrubbers actually reduced ultrafine loadings from the stack to levels lower than in the ambient rural air (UMTEC, 2001). Further study and verification is required and would be addressed in an environmental assessment.

This section provided an overview of WTE air emissions in the context of emissions from displaced energy sources (diesel and furnace oil) and other emission sources. More detailed air quality analysis, including plume dispersion modelling is recommended once a potential site, process technology and air pollution controls have been specified.

5.3 Environmental Approvals and Permitting

Project-specific regulatory issues and requirements should be well understood as early in the life of a project as possible. A well thought out program for meeting these requirements that includes early engagement of relevant regulatory agencies, key stakeholders, and public can greatly reduce the risk of lengthy and costly project delays.

This section provides a brief summary of the expected federal, territorial and municipal regulatory requirements associated with the construction and operation of a WTE facility in Whitehorse, including undertaking an environmental assessment of the project, as well as obtaining all required permits and licenses as per territorial regulations and municipal by-laws. More details on the anticipated environmental assessment process are provided in ***Appendix D***.

5.3.1 Yukon Environmental and Socio-Economic Assessment Act Process Overview

It is anticipated that the construction of a WTE facility in Whitehorse will trigger the requirement to obtain approval under the *Yukon Environmental and Socio-Economic Assessment Act (*YESAA). Based on the type of facility proposed it is expected the assessment will involve a Designated Office evaluation (process used for the majority of assessments conducted in Yukon).

[20] *Buonanno, G., Ficco, G., & Stabile, L. (2009). Size distribution and number concentration of particles at the stack of a municipal waste incinerator.* Journal of Waste Management, *29, 749-755*

An assessment is initiated when a proponent submits a project proposal to the Yukon Environmental and Socio-economic Assessment Board. Project proposals typically contain environmental and socioeconomic information describing baseline conditions, potential project impacts, and mitigation strategies in some or all of the following areas:

- Air Quality
- Geology and Soil
- Water and Water Quality
- Fish and Fish Habitat
- Wildlife and Wildlife Habitat
- Vegetation Age, Composition, and Structure
- Cultural/Heritage Resources
- Recreation
- Health
- Employment
- Education/Knowledge
- Families

Following submission of the project proposal by the Proponent, a review process is coordinated (in this case) by the Designation Office. Following the evaluation phase, the Designated Office prepares a recommendation to applicable Decision Body(s)[21].

5.3.2 Territorial and Municipal Permitting & Licensing Requirements

A WTE facility in the Yukon will trigger permitting and licensing requirements at the territorial and municipal level. Project-specific issues linked to approvals requirements include air emissions, ash disposal, land acquisition needs, socio-economic implications, surface water / groundwater extraction and use, and potential for contaminant spills, amongst others. Table 9 lists the regulatory permits, leases and licenses likely to be associated with a WTE facility, along with information that should be included in environmental permit and approval applications.

Territorial permits and approvals can be issued by relevant regulatory agencies only after release of the YESAB Final Report recommendations and (if undue delay is to be avoided) only after each Decision Body has issued a Decision Document accepting the YESAB recommendations. However, permit application materials can be filed with relevant regulatory agencies prior to the issuance of a Decision Document to help expedite this process. Assuming no major issues arise during the review period, approvals could then be obtained shortly after the Decision Document is issued.

[21] A Decision Body is the federal government, territorial government or First Nation that responds to recommendations made to them by Designated Offices, the Executive Committee of YESAB or a Panel of the Board, and has the authority to determine whether a project may proceed.

Development activities in the Yukon often require additional federal permits or authorizations. Triggers for such permits include impacts to fish or fish habitat, or to navigable waters. It is assumed that no watercourses will be impacted as a result of construction of the WTE facility; as a result, an Authorization as per the *Fisheries Act* or Permit as per the *Navigable Waters Act* will not be required.

Table 9: Overview of Approvals Requirements for a Whitehorse Waste to Energy facility

Project Activity	Approval Requirement	Applicable Act / Regulation / By-Law	Information Requirements for Obtaining Approval (i.e. permit, license or lease)
Territorial Permit / Licensing Requirements			
Operation of incinerators capable of burning more than 5 kilograms of solid waste per day.	Air Emissions Permit	*Environment Act* / Air Emissions Regulations	▪ A description of the source of the contaminants that may be released into the air; ▪ The type and quantity of the contaminants that may be released into the air; ▪ One set of plans and drawings clearly showing the layout of the facility, location of individual equipment, and points of discharge, building dimensions and stack heights; ▪ A description of air quality control devices, including efficiency and other design criteria and photocopies of the manufacturer's specifications for the air quality control devices establishing that the equipment is capable of complying with applicable emission criteria in the permit; ▪ A map or aerial photograph, on a scale of 1:50,000 detailing the location of the facility, homes, buildings, roads and other adjacent facilities within a five kilometre radius of the facility; ▪ Specifications for any equipment, including incinerators, that may be used and a description of the mitigative measures planned to control air emissions and the disposal and handling of all types of ash; and, ▪ A description of any equipment or devices the applicant intends to use to monitor the release of contaminants into the air.
Constructing and operating a waste disposal facility	Permit for the Facility	*Environment Act* / Solid Waste Regulations	▪ The location and size of the proposed waste disposal facility or dump and a description of the type of solid waste to be handled or disposed of the site;
Disposal or handling of special waste[22]	Special Waste Permit	*Environment Act* / Special Waste Regulations	▪ The types of special waste and operations for which the application is made; ▪ Location of any proposed handling or disposal of special waste; ▪ The rate at which special waste will be generated; and

[22] Commonly known as hazardous waste.

Project Activity	Approval Requirement	Applicable Act / Regulation / By-Law	Information Requirements for Obtaining Approval (i.e. permit, license or lease)
			▪ Method of treatment or disposal.
Storage and handling of petroleum products	Storage Tank Systems Permit	*Environment Act* / Storage Tank Regulations	▪ Any plans related to the activity to be undertaken, including storage tank system design plans, safety and inspection plans and closure and reclamation plans; ▪ Identification of on-site and adjacent groundwater and surface water sources; and ▪ The proposed dates and timing of work to be undertaken in relation to the permitted activity.
Establishment of a solid waste disposal facility; **Fuel caches of more than 4000L or any single container of more than 2000L on Commissioner's Land**	Land Lease and Land Use Permit	*Territorial Lands (Yukon) Act, Lands Act* / Land Use Regulations	▪ A preliminary plan showing the lands proposed to be used and an estimate of their area, and the approximate location of all of the following: – existing lines, trails, rights-of-way, and cleared areas proposed to be used in the land use operation; – new lines, trails, rights-of-way, and cleared areas proposed to be used in the land use operation; – buildings, campsites, air landing strips, air navigation aids, fuel and supply storage sites, waste disposal sites, excavations, and other works and places proposed to be constructed or used during the land use operation; and – bridges, dams, ditches, railroads, highways and roads, transmission lines, pipelines, survey lines and monuments, air landing strips, streams, and all other features, structures or works that, in the opinion of the applicant, may be affected by the land use operation.
Water use or the potential deposition of waste materials in water	Water License	*Waters Act*	▪ Where the water is proposed to be used for an industrial, placer mining, or quartz mining undertaking, a description of the undertaking and of all wastes produced and chemicals used in the operation of the undertaking; and ▪ Where the proposed undertaking involves the handling or storage of petroleum products or hazardous materials, a plan for their safe handling, storage, and disposal, and a contingency plan for their containment and for cleaning them up in the event of a spill; and ▪ Plans for the abandonment, or any temporary closing, of the proposed undertaking.

Project Activity	Approval Requirement	Applicable Act / Regulation / By-Law	Information Requirements for Obtaining Approval (i.e. permit, license or lease)
Relevant Municipal Requirements			
Disposal of solid waste	Permit to Dispose of Solid Waste	Solid Waste By-Law	▪ Conditions that may be placed on the permit may include the requirement to provide information on the origin, type and amount of solid waste from outside the city, or laboratory analysis of the concentration of contaminants in the contaminated soil.
Release of waste water, storm water, subsurface water or clear-water waste into the sewer or drainage systems	Permit to Discharge	Sewer and Water By-Law	Information requirements associated with a permit to discharge not explicitly stated in the sewer and water by-law.
Establishment of a solid waste disposal facility	Development Permit	Zoning By-Law	▪ legal description and property address; ▪ statement of the current, proposed use and occupancy of all parts of the lot and buildings; ▪ description of the size of the proposed development with respect to gross floor area, lot coverage, building or structure height, amount and location of parking and loading areas; ▪ be accompanied by a site plan in duplicate, at an appropriate metric scale containing – a north arrow; – the legal property description; – lot dimensions and other reference features such as the location of easements, existing buildings, fences relative to property lines, and existing and proposed grades; – the location of all existing and proposed improvements on the lot including site access and egress, front, side and rear yard dimensions, location and size of required parking, loading and garbage collection areas; – the location of any trees, shrubbery or natural features to be retained; – the location of public sidewalks, hydro poles, light standards, boulevard trees, fire hydrants and other related features; – floor plans and elevation drawings of all proposed buildings, and

Project Activity	Approval Requirement	Applicable Act / Regulation / By-Law	Information Requirements for Obtaining Approval (i.e. permit, license or lease)
			structures including any additions; – the location, size, and placement of signs and future signs in all commercial, institutional and industrial zones; – the location of all existing and proposed services on the property; and – the location of all proposed structures to manage drainage including connections to existing storm mains, ditches, rock sumps and/or storm sewer interceptors for areas with high contamination potential.

5.3.3 Public Utilities Board Requirements

All energy projects proposed for development in the Yukon require an Energy Project Certificate (EPC) prior to construction. As per the *Public Utilities Act*, an energy project includes "… a facility for the generation of electricity from the motion of wind or water, or the combustion of natural gas, oil, petroleum products, coal, or plant products or geothermal energy".

The following is an outline of information that it is expected to be required in an EPC Application, primarily based on the information supplied in the YEC Application for the Mayo Hydro Enhancement Project (2009):

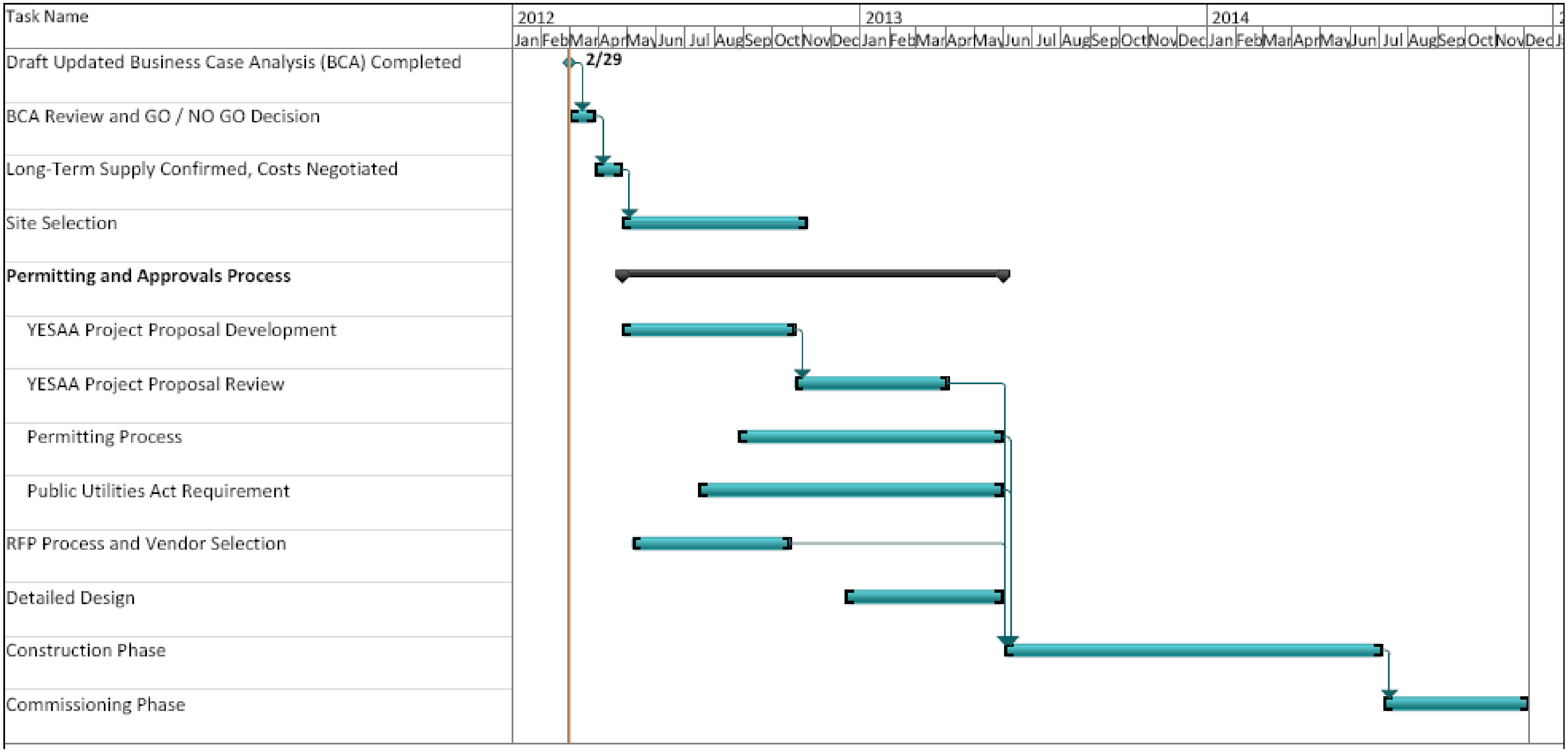
- Introduction and Applicant Information;
- Project Description, including a summary of anticipated environmental and socio-economic impacts;
- Project Justification, including project need, risks and effect on rate payers;
- Consultation Undertaken to Date; and
- Description of other Permitting Applications and Approvals.

5.3.4 Project Scheduling Implications

Figure 11 provides a preliminary schedule for getting a WTE project through the environmental assessment, permitting and approvals phase. The schedule incorporates regulated times associated with the adequacy, evaluation and recommendation stages of YESAA. However, the YESAA timelines have been intentionally structured to incorporate a great deal of flexibility such that both small-scale and large-scale projects can be accommodated. This results in some uncertainty for any particular project in exactly how long the approvals phase will take. To deal with this issue as well as other project uncertainties such as timing of when proposal development will begin, the schedule presented in Figure 11 incorporates the following assumptions:

- Decision whether to proceed with project based on updated Business Case Analysis made by end of March 2012.
- Project Energy Certificate Application and Permit Applications developed in parallel with YESAA Project Proposal Development and Review, requiring little additional time for regulatory decisions to be made (by the Yukon Utilities Board and territorial regulators such as the Yukon Ministry of Environment) following YESAA Decision Body approval.
- Six to 12 month commissioning phase.
- Detailed design phase completed in parallel with permitting review and approval phase.
- A relatively straightforward consultation process, with moderate public interest and few major issues and concerns identified, requiring 1 month for Seeking Views & Information, and an additional 2 weeks to respond to information requests

Figure 11: Preliminary Schedule for a Waste to Energy Project in the Yukon.



6. UPDATED BUSINESS CASE ANALYSIS

6.1 Approach and Key Assumptions

This analysis builds on the preliminary business case analysis, completed in September, 2011 (Morrison Hershfield, September 2011), and determines costs to produce additional power by utilizing municipal solid waste and biomass (wood) as fuel sources.

Research and analysis since the September 2011 study have resulted in the selection of a single scenario based on the most recent waste diversion initiatives and supported by research into residual waste availability, biomass supply, district energy heat needs and costs, technology types and costs (via an EOI) and other research as required. Key parameters and assumptions are presented in Table 10.

Table 10: Business Case Parameters and Assumptions

Business Case Parameter	Assumption	Comments
Nominal capacity of WTE plant	25,000 Tonnes Per Year	
Technology used	Conventional combustion	Two stage combustion, close coupled gasification or mass burn
Actual plant throughput at 95% availability	23,750 tonnes per year	
Feedstock used in in 2015	16,100 tonnes MSW 7,650 tonnes biomass	Based on 50% MSW diversion
Feedstock used in 2035	23,750 tonnes MSW	Based on expected population and waste growth
Tipping fee for waste received	$108 per tonne	Based on what it would cost to otherwise landfill that material
Tipping fee paid for ash disposed	$185 per tonne	Based on what it would cost to operate a smaller ash landfill
Average cost of biomass supply	$104 per tonne	As received wet wood
Net electricity production	9,975 MWh	Based on 470 kWh per tonne of waste
Net heat produced and sold	23,700 MWh	Based on supplying 79% of the heat for a future Whitehorse DES
Value of heat sold	$81/MWh	From separate district energy study
Minimum site size	2 ha	
Waste to energy facility life	25 years	With potential to extend
Remaining landfill capacity with expanded diversion (and no WTE)	Until 2057	Landfill expansion is possible
Remaining landfill capacity with expanded diversion and WTE	Well into next century	Landfill expansion likely not required
Contingency	10%	On capital and operating costs

6.2 Feedstock costs and revenues

6.2.1 Municipal solid waste

Revenues from tipping fees for the acceptance of MSW at the WTE facility are based on an analysis of the life cycle costs of operating the Whitehorse Landfill, Appendix B. The tipping fee will need to be discussed and confirmed with the City when this project moves forward.

The WTE tipping fees used in this analysis are the lifecycle costs of operating the Son of War Eagle Landfill assuming waste volumes are reduced/diverted from landfilling by a total of 50%. In this analysis, it is assumed that the residual waste would be taken to the WTE facility instead of the Son of War Eagle Landfill. The tipping fees paid to the WTE operator would be the same as the City's deferred cost to landfill the waste.

Costs of ash disposal, disposal of some non-burnable waste and small amounts of MSW when the WTE plant is being serviced were also assessed based on what it would cost the City to keep the landfill in operation for the lower volumes with WTE. While overall landfill costs go down when mostly ash is disposed, the unit costs per tonne actually go up because of the much lower volumes (units). For this analysis, it has been assumed that the WTE facility operator would pay the City the true cost of disposal for ash residue. This is substantially higher than the unit fee per tonne that would be paid to the WTE plant operator for acceptance of MSW.

Fly ash would require stabilization treatment prior to disposal into the landfill. An allowance of $30 per tonne has been included for ash stabilization.

6.2.2 Wood biomass

Wood biomass costs are dependent on the annual requirements and quantities available. Cheaper biomass source would be prioritized ahead of more expensive sources. Based on an assessment of the biomass availability near Whitehorse the initial cost is estimated at $104 per wet tonne delivered to the WTE facility. This is an average cost and may be less if greater quantities of cheaper sources of biomass become available. Since the volumes of MSW will increase along with population growth and commercial activity in the Yukon, the amount of biomass required should decrease to zero by about 2035 (more or less, depending on actual growth and actual recycling). Capital and operating cost estimates include provisions for biomass storage, handling and chipping.

6.2.3 Heat Revenues

The waste to energy facility would be able to provide a heat baseload of 23,700 MWh to a district heating system supplying the downtown and hospital district. When taking into consideration the additional capital and operating costs associated with the district energy, the potential net revenue from heat sales would be $81/MWh[23].

6.2.4 Metal Recycling

Recovered metals are expected to consist of 3% of the annual waste throughput. Revenues from recycled metals will fluctuate with world market demand for scrap. A value of $100 per tonne is used at this time to reflect an expected long term average.

6.3 Facility Capital and Operating costs

6.3.1 Scope included and excluded

At this stage of the project, where the technology has been defined, but a vendor not yet selected, and a site area defined, but a specific site not yet selected, there are some items that can be firmly defined and some that are accounted for with a cost allowance (for confirmation as the project develops).

Capital costs

Included in the capital cost estimates, which are supported by information received through the EOI and supplemented through other research and studies are:

- Purchased equipment to receive, process, combust waste;
- Equipment to recover energy in the form of heat and electricity;
- Air pollution control equipment;
- Ash removal and ash treatment as required;
- Biomass receiving, storage, processing/chipping and feeding;
- Buildings;
- Site work;
- Permits and approvals;
- Cost of land;
- Electrical tie-in and substations; and,
- Utility connections for water and sewer.

Interest during construction is not included.

[23] Calculations by FVB Energy for Whitehorse District Energy feasibility study provided by Robert Doyle February 29, 2012

Operating Costs

Operating costs include:

- labour costs;
- variable operating costs;
- maintenance costs;
- biomass processing;
- bottom ash disposal; and,
- fly ash treatment.

6.3.2 Estimated Costs

Capital costs were estimated using supporting information from vendor submissions, existing data from previous work, and new information from recent studies into the true cost of landfilling and into DESs. Vendor submissions provided a range of capital costs from $19.9 million to $42.8 million, with an average from 5 submissions calculated at about $31 million. The capital cost used in the business case analysis including 10% contingency was $34.6 million.

Operating costs, excluding feedstock costs and revenues, range from $3.3 million per year to $4.6 million per year based on vendor submissions. The higher number was for a technology from Europe, where prices are generally much higher than in North America. The other vendors' operating costs were within 20% of the lowest figure. The estimated operating costs for the business case analysis assume a staff requirement of 18 persons (vendors suggested between 7 and 39), variable operating costs supported by vendor submitted data, ash disposal costs derived from the landfill cost analysis, and an allowance for biomass processing and fly ash stabilization. Including a 10% contingency, the operating costs are estimated at $3.3 million per year and are within the range of operating costs provided by vendors in the EOI process.

A sensitivity analysis was used to account for the potential variability of some key costs.

6.4 Financial Analysis Base Case

Table 11: Base Case WTE Cost Model

MAXIMUM PRODUCTION OF ELECTRICITY (MSW and Biomass)

Combined Heat and Power, 1.6 MW (Electricity)

Base Case

Plant design capacity		25,000	Tonnes per year
Plant feedstock usage		16,098	Tonnes per year MSW
		7,652	Tonnes per year biomass
Complete facility installed and commissioned	$25,500,000	1,020	$ per tonne of installed annual capacity
Additional costs for wood handing, storage & chipping	$ 1,000,000		
Land Costs	$ 1,000,000		
Site work	$ 2,000,000		
AC Connection Costs	$ 1,600,000		
Permits and approvals	$ 50,000		
Total capital cost	***$31,450,000***		
Contingency	*$ 3,145,000*	10%	
Total capital cost + Contingency	***$34,595,000***		
Assumed average cost of capital		5.5	% annual interest rate
Amortization period		25	Years
Annual capital costs	***$ 2,611,923***	$ 110	capital expense per tonne of feedstock
Annual labor costs	$ 1,440,000	18	Assume average staff cost of $80k per year
Variable operation and maintenance costs	$ 900,000	$ 36	$ per tonne of installed annual capacity
Biomass Processing	$ 45,914	$ 6	$per tonne allowance
Bottom ash disposal (17% of MSW, 1% of biomass)	$ 519,113	$ 185	$ per tonne to landfill
Fly ash treatment and disposal (3% of feedstock	$ 145,730	$ 205	$ per tonne to treat and landfill
Total Operating Costs	**$ 3,050,757**		
Contingency	*$ 305,076*	*10%*	
Total Heat Sales		*23,700*	*MWh*
Net Revenue from DE	($1,914,960)	*$ 81*	*$ per MWh heat sold*
Cost of wood supply	$ 795,846	$ 104	$ per wet tonne
Revenue from tipping fees	($1,736,356)	$ 108	$ per tonne of MSW received
Revenue from sale of recyclables (3% of MSW)	($ 48,293)	$ 100	$ per tonne
Net annual cost	***$ 3,063,992***		
Total electricity produced in MWh	9,975	420	kWh per tonne of MSW and tonne biomass
Cost per kWh of electricity generated	**$ 0.31**		

The costs per kWh of electricity generated are higher than in the Preliminary Business Case Analysis (Morrison Hershfield, 2011) of $0.16 - $0.18 per kWh. The changes in the business case include the following:

- Capital costs are lower by about 10% due to a small reduction in capacity, more precise vendor information, and a reduction in contingency. Actual scope of capital items increased and now includes electrical substation and land cost allowances.
- Non-feedstock related operating costs are higher by about 15%. This is due to higher estimated ash disposal costs (arising from the landfill cost assessment) and a better understanding of some of the operating components through vendor input.
- Electricity production is 30% less than originally indicated due to electricity generation efficiency losses resulting from the amount of heat that will be removed for the DES (as indicated by vendors in EOI process). It is expected that vendors would optimize their CHP systems in a competitive bidding situation and may be able to improve on the electricity generation efficiencies quoted under the EOI.
- The amount of biomass required to augment the MSW feedstock in the near-term is substantially higher since we have assumed a 50% MSW diversion target is achieved in 2015. The additional biomass requirements and reduction in MSW tipping fee revenues significantly increase operating costs.

The base case analysis is appropriately conservative for the current stage of project evaluation. The impacts of varying key project variables are discussed in the sensitivity analysis section below.

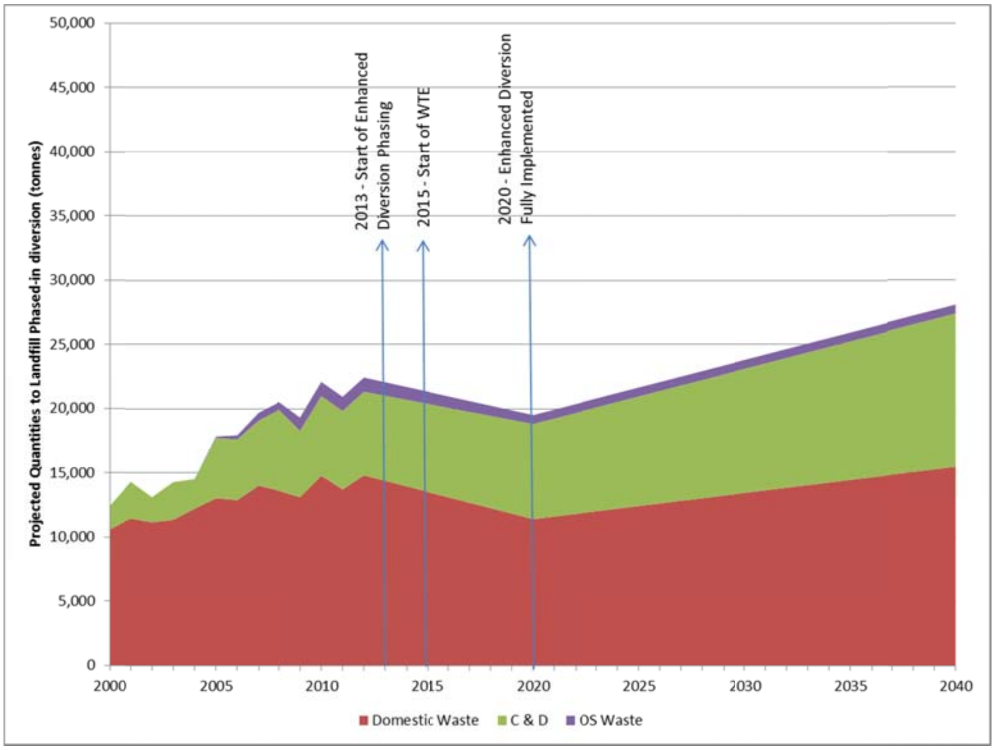
6.5 Sensitivity Analysis

The base case has a higher level of confidence than the preliminary business case analysis completed in September 2011. However, several key areas of uncertainty remain that can have a major bearing on project feasibility. A sensitivity analysis of the business case has been conducted for these key project variables and is described in the sections below.

6.5.1 Sensitivity #1 - Potential for Phased-in Waste Diversion

The base analysis assumes an almost immediate drop in waste generation due to very aggressive recycling efforts. This sensitivity looks at the economics of the WTE facility if the diversion programs are phased in between 2013 and 2020, achieving a diversion of 50% by 2020. The impacts on MSW residual waste volumes are illustrated in Figure 12.

Figure 12: Phased-In Enhanced Diversion Sensitivity



Assuming the 50% waste diversion measures are phased in between 2013 and 2020, additional MSW would be available initially. Waste quantities would continue to increase due to population growth and economic activity while progress was being made towards the 50% diversion goal. With this sensitivity, the cost to produce electricity using WTE is $0.21 per kWh in 2015.

6.5.2 Sensitivity #2 - Federal Grant Funding under the ECO II NRCan program

An application for federal grant funding toward capital costs has been made under the NRCan ECO II program, ***Appendix E***. Since the result of this funding application is not yet known, this funding is not reflected in the base case analysis. Should the grant application be successful, the total capital funds required would be reduced to $21.7 million improving the business case. This case was evaluated based on two scenarios:

- Sensitivity #2a, assumes that the ECO II funding is granted and 50% waste diversion is achieved in 2015. This results in a cost to produce electricity using WTE of $0.21 per kWh in 2015.
- Sensitivity #2b, assumes that the ECO II funding is granted and 50% waste diversion is phase-in as described in sensitivity #1. This results in a cost to produce electricity using WTE of $0.11 per kWh in 2015

6.5.3 Sensitivity #3 - Reduction in landfill costs.

With this sensitivity, the possibility of reduced landfill costs is explored. Should the City of Whitehorse find that estimated costs to operate the landfill can be reduced by, say 20%, then this could reduce the tipping fee revenue for accepting waste at the WTE facility by 20% and also reduce the cost to dispose of ash by 20%. In this case, the cost to produce electricity would rise to $0.34 per kWh because of reduced tipping fee revenues.

6.5.4 Sensitivity #4 - Electricity only

This sensitivity analysis examines the impact of designing the WTE facility for highest electrical generation efficiency and with no possibility of excess heat being available for district energy in any substantial amount. Even though the electricity generation would increase to 625 kWh for each tonne of feedstock consumed, the total energy that can be sold is lower, thus cost to produce electricity would rise to $0.34 per kWh.

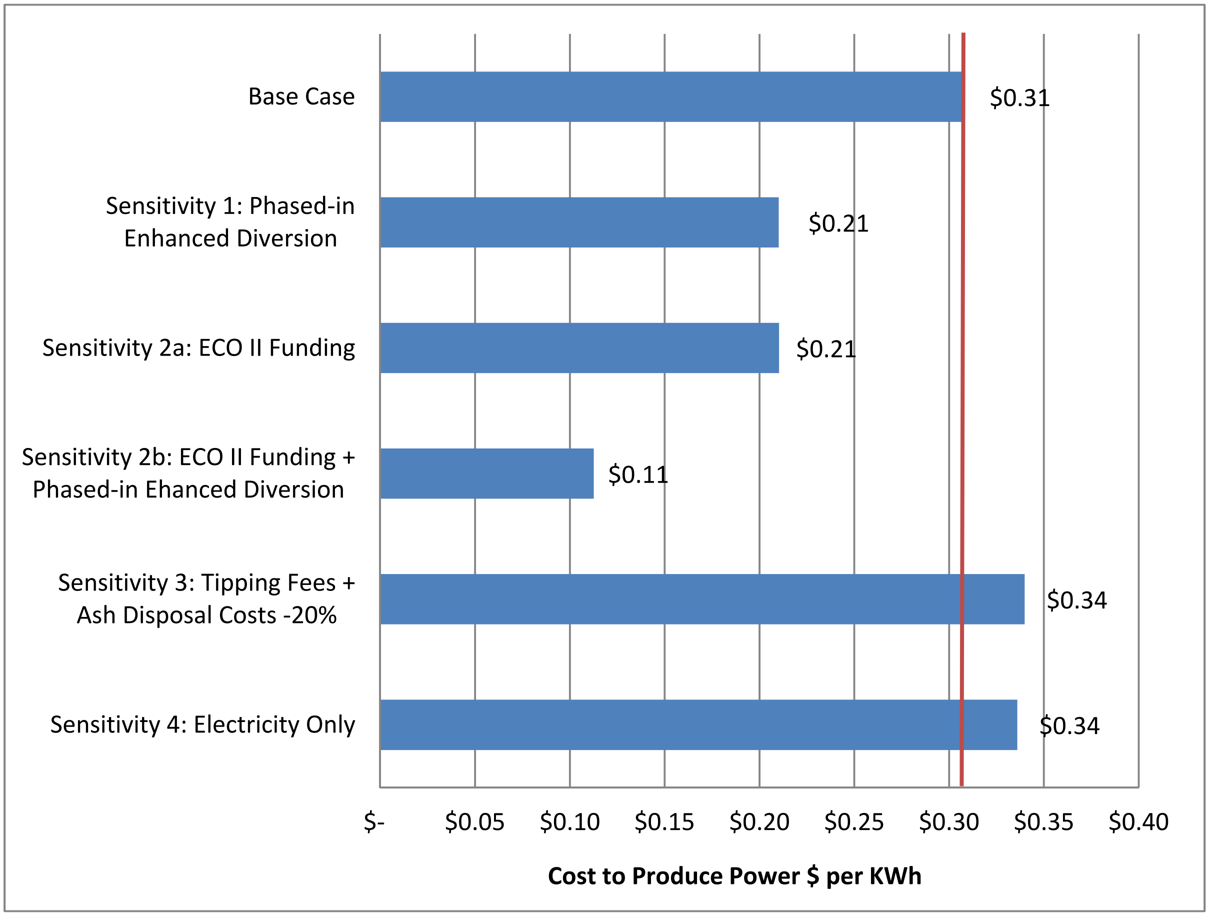
6.5.5 Sensitivity Analysis Summary

A summary of the sensitivity analyses is provided in Table 12. Figure 13 provides a graphical illustration of the electricity production cost for the base case and each sensitivity analysis.

Table 12: Sensitivity Analysis Summary

	Total Capital Cost $	Electrical Capacity MW	Annual Net Electricity Produced MWh/yr	Annual Heat Sales MWh/yr	Cost of Electricity Generated $/kWh
Base Case	34,595,000	1.6	9,975	23,700	0.31
Sensitivity #1 – Phased-in Diversion	34,595,000	1.6	9,975	23,700	0.21
Sensitivity #2a – ECOII Funding	21,700,000	1.6	9,975	23,700	0.21
Sensitivity #2b – ECOII Funding + Phased-in Diversion	21,700,000	1.6	9,975	23,700	0.11
Sensitivity #3 – Reduced Tipping Fees & Ash Disposal Costs	34,595,000	1.6	9,975	23,700	0.34
Sensitivity #4 - Electricity Only	34,595,000	2.0	14,844	0	0.34

Figure 13: Cost of Electricity Production Comparison



7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Several meetings and discussions have been held between Yukon Energy, their consultant team, and key stakeholders including City of Whitehorse, Government of Yukon Community Services Department, Raven Recycling, P&M Recycling, and the Yukon Conservation Society. Yukon Energy organized a half-day workshop and public meeting on October 18, 2011 for the purpose of identifying issues and opportunities and outlining a plan for moving forward. A key theme identified at the workshop and public meeting was support for locally derived energy sources. There was a strong desire expressed to ensure that WTE is part of an integrated waste management system and does not compete with recycling. There was also strong support for increased diversion of materials away from landfill and future WTE, with discussion of the territory and City potentially establishing a 50% waste diversion target.

A WTE design capacity of 25,000 tonnes per year has been selected for the updated business case analysis. This capacity has been reduced from an earlier analysis in response to the desire of key stakeholders to aggressively pursue a 50% waste diversion target. The facility will be capable of burning biomass (waste wood) as well as MSW, so that any shortfall in waste feedstock can be made up with biomass. There is adequate biomass available from reliable sources for the foreseeable future. It is estimated that the WTE plant will be burning MSW without need for biomass by 2035 based on current projections.

A WTE life of 25 years is projected, after which time a decision will have to be made on whether to upgrade the facility and continue operations or to decommission the facility for lack of feedstock or because newer, more effective technologies are available to replace it.

An expression of interest was issued to vendors of WTE equipment in November 2011 and 7 vendors responded in January 2012. All of the vendors offered information on conventional combustion or close-coupled gasification. Technical, performance, operational and cost information provided by the vendors was used to increase confidence in estimates for the business case analysis.

A preliminary siting assessment, informed by the results obtained from a separate Whitehorse District Energy feasibility study, identified potential site locations in the Marwell Industrial area and along Robert Service Way south of the downtown area. While a more detailed siting assessment and consultations will be required prior to final site selection, the business case analysis assumes siting in the Marwell area because of proximity to potential heat customers, access to municipal services and compatibility with adjacent land uses.

Air emissions have been estimated for a WTE facility and compared to emissions from diesel combustion in electrical generators and furnace oil combustion in space heating applications. Assuming the electricity produced from WTE displaces diesel-generated electricity, and waste heat is utilized in a district energy system displacing furnace oil, WTE is expected to result in a net reduction of nitrogen oxide, particulate matter and carbon monoxide emissions and a net increase in sulphur dioxide emissions.

A single business case was reviewed. Cost and revenue estimate uncertainty has been reduced due to separate studies that have been conducted into landfill life cycle costs, district energy requirements and costs, and biomass supply and costs. Greater certainty in WTE facility capital and operating costs and energy recovery efficiencies have been obtained through submissions received from technology vendors in an EOI process.

The estimated cost to produce electricity from MSW and biomass in the "base case" is $0.31 per kWh. This estimate is similar to the cost of diesel-generated electricity and does not provide a clear incentive to pursue a WTE project. This cost estimate is higher than reported in the September 2011 preliminary business case analysis ($0.16 per kWh) largely as a result of two key factors: (1) requirements for additional biomass (higher cost) feedstock during initial operations, assuming that the waste diversion target of 50% is achieved in 2015; and (2) reduced electricity generation efficiencies reported by vendors when operating in a CHP mode, while meeting the heat quality requirements specified in the separate District Energy study.

Evaluation of the business case identified several areas where there is still considerable uncertainty associated with "base case" assumptions and potential changes in circumstances could beneficially affect the viability of WTE. These areas of uncertainty were investigated using a sensitivity analysis. The following have the potential to significantly improve project economics:

- An application for federal grant funding has been made under the NRCan ECO II program. If awarded, the grant amount that could reduce the required plant capital costs to $21.7 million. Under this scenario the cost to generate electricity would be reduced to between $0.11/kWh and $0.21/kWh.
- The base case analysis assumes an almost immediate drop (by 2015) in residual waste volumes due to very aggressive recycling efforts. A sensitivity calculation examined the economics of the WTE facility if the diversion programs are phased in over 7 years instead of two years, achieving a diversion of 50% by 2020. With a phased-in diversion, there would be a need to manage more residual (non-recycled) MSW initially and until the diversion program is fully implemented. In the meantime, waste quantities continue to increase due to population growth and economic activity. With this sensitivity, the cost to produce electricity using WTE is $0.21 per kWh in 2015.

7.2 Recommendations and Next Steps

Based on the analysis in this report, it is recommended that the following two key project uncertainties be examined further to determine if the project feasibility can be improved:

1. Capital funding grants: Defer any final decisions on feasibility of WTE until the results of the NRCan ECO II application are known. The potential grant has the ability to substantially improve project economics.

2. Waste diversion implementation: The rate of waste diversion implementation is unknown and has a large bearing on project economics. Most aggressive diversion projects require extensive planning and funding, and there is a reasonable chance that achievement of a 50% diversion target would occur sometime after 2015 (potential commissioning date of a WTE facility). It is recommended that Yukon Energy initiate discussions with the City of Whitehorse and Yukon Government to understand diversion strategy implementation plans and schedule. Revise base case business case analysis taking into account waste diversion strategy implementation plans.

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APPENDIX A: YUKON ENERGY WASTE TO ENERGY WORKSHOP REPORT

APPENDIX B: LANDFILL FULL COST ACCOUNTING REPORT (DRAFT)

APPENDIX C: EOI QUESTIONNAIRE

APPENDIX D: ENVIRONMENTAL ASSESSMENT PROCESS

APPENDIX E: NRCAN ECOII FUNDING APPLICATION