Edmonton Composting Facility Renewal

Business Case

City Operations Department | Waste Services Branch

City of Edmonton

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Change History

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1. Executive Summary

1.1. The ECF Renewal Project Business Case

The Edmonton Composting Facility (ECF) clearly requires renewal if it is to meet the City's existing and future organics processing needs. The building structure housing the composting aeration bays is compromised and unable to support a snow load safely. In its current condition, the facility cannot successfully operate year-round, resulting in a seasonal necessity to send compostable organics to landfill. While repairing the existing facility has been considered, this scenario offers only a temporary solution, as population growth will likely continue to increase the volume of compostable materials entering the ECF.

While an important component of the Edmonton Waste Management Centre (EWMC), the newly commissioned Anaerobic Digestion Facility (ADF) will not provide enough additional organics processing capacity to prevent the ECF from needing to expand.

Also, the planned implementation of Source Separated Organics (SSO) collection and other collection program changes will require the processing of SSO and Municipal Solid Waste (MSW) separately, a result that can only be achieved through major changes to the ECF process and facility configuration.

Importantly, the impacts of processing grass, leaf and yard waste have also been considered Because of the large volumes of this material over a relatively short season, accepting this material into a new processing facility will negatively impact capital and operating costs. The ECF Renewal Project has considered potential improvement options for the ECF facility and its equipment only. Potential changes to facilities other than the ECF are out of scope.

To determine the best path forward for the ECF, Waste Services and IIS have collaborated to develop this comprehensive Checkpoint 1 strategic level business case. This analysis has carefully considered the condition of the current facility and equipment, currently available technologies, and the current and projected market conditions. High-level cost estimates for potential solutions have been prepared and analyzed through a detailed financial model considering capital and operating costs, Net Present Value, and potential impacts to utility ratepayers in both the short and long-term. All of these factors have been considered along with intangible and tangible social and environmental benefits in a decision framework that incorporates a triple-bottom-line analysis.

Based on the results of this process, the project team and steering committee recommend that the City proceed to the next stage of planning for a new ECF that incorporates anaerobic digestion technology. Demolishing the existing ECF Aeration Hall and installing digestion technology will require the City to accept short-term costs. Along with an initial capital investment, demolishing the existing ECF Aeration Hall and constructing a new facility will require closure of the facility and a resulting inability to process all the compostable organics it receives for approximately three years. Once operational, however, digestion technology will produce renewable energy in the form of either electricity or renewable natural gas (RNG), resulting in the long-term benefits of reduced GHG emissions, increased GHG credits, and additional revenue generation through sales of these bi-products – particularly in the case of RNG.

2. Background

Waste Management in the City of Edmonton

The City of Edmonton (the City) provides waste collection for over 370,000 single and multi-unit homes. This is done by providing manual waste collection services to single unit homes and automated front-load-bin waste collection services to multi-unit homes and a small number of commercial customers. Both programs are two-stream (garbage and recyclables). The waste is then taken to the Edmonton Waste Management Centre (EWMC), a 233-hectare centre located in Edmonton's North East, for processing and disposal.

Established in 1995, the EWMC is a fully-integrated collection of advanced waste processing and research facilities that serve residents, institutions, and commercial businesses. The EWMC is managed and operated by the Waste Services Branch. Annually, over 500,000 tonnes of residential and commercial solid waste are received and processed at the EWMC.

The garbage collected through the curbside collection program and multi-unit bin collection program is transported to the tipping floor of the Integrated Processing and Transfer Facility (IPTF) located within the EWMC, where it is pre-processed (debagging, sorting and/or sizing). After pre-processing, the compostable waste is transferred to the Edmonton Composting Facility (ECF) for composting; non-compostable and non-recyclable waste will be transferred to the Refuse Derived Fuel Facility (RDF) for waste to biofuels processing. The residuals are transported to an offsite third-party landfill for ultimate disposal.

The City of Edmonton has a goal of 90 percent diversion of residential waste from the landfill. The average waste diversion rate in the City from 2012 to 2016 has been estimated at 47%. While this value is significantly less than the City's ultimate goal, it is significantly higher than both provincial and national averages from 2006-2014 – 20 percent and 36 percent respectively.

The Edmonton Composting Facility (ECF)

Located at the EWMC, the ECF was the largest municipal solid waste (MSW) and bio-solids co-composting facility in North America when it was built. At approximately 39,000 square metres, it is a key component of the City's waste diversion strategy. When in full operation, the ECF contributes to the City's overall diversion target of 90 percent by creating compost from the organic fraction of approximately 332,000 tonnes/year of MSW and varying amounts of digested sewage biosolids (treated sewage sludge) as capacity allows. Under full operation, the ECF produces approximately 65,000 tonnes of municipal solid waste compost product and 25,000 tonnes of digested biosolids compost product annually. This compost product is currently used by sports fields, garden centres, nurseries and construction projects, for farmland application, and as an absorbent and erosion control product. The operation of the ECF is contracted to a private operator.

In addition to the ECF and also located at the EWMC, a new Anaerobic Digestion Facility (ADF) is expected to be fully operational in early 2019. It is designed to process up to 40,000 tonnes/year of organic waste to help reduce the amount of organic waste sent to the landfill. The ADF will create renewable energy in the form of electricity and heat, as well as produce high quality compost.

As Edmonton's population continues to grow, the role of the ECF and ADF in diverting compostable fraction of MSW from landfills will continue to increase, as indicated by the potential compostable waste available summarized in the table below.

Table 1: Potential Fraction of City's MSW Going to the ECF

Year	City's Population (Forecast)	Fraction of MSW going to ECF	
		From Residential Waste Stream[2]	Potential Total Compostable Waste[1]
		(tonnes)	(tonnes)
2020	943,654	137,661	161,253
2025	1,016,157	135,493	158,714
2030	1,088.659	146,685	171,824
2035	1,161,162	158,801	186,017
2040	1,233,664	171,919	201,382

1. From City's Mass Balance Model
2. Numbers include both compostable and non-compostable waste going to the ECF

Current and Future Processes

Currently, the material going into the composting process is the organic waste derived commercial and residential municipal solid waste (MSW) that is collected at residences and business in a single stream with non-organic waste (i.e., not separated at the point of collection) and pre-processed upstream of the Composting Facility. Material entering the pre-processing system passes through bag openers and manual sorting to remove household hazardous waste, stringy material, and bulky material, and screening with the intent of removing as much non-compostable material as possible. Non-compostable material removed by the system goes to the Refuse Derived Fuel Facility (RDF), recycling, or landfill.

As detailed in the *Waste Services Business Plan 2019-2022*, Waste Services is planning to implement Source Separated Organics (SSO) collection for single unit residences, requiring homeowners to separate compostable material, such as food waste, prior to pick-up. This implementation is the first step in enacting an overall vision that sees diversion targets progress over time from 73 percent as referenced in *Waste Services 25 year Strategic Outlook*[1] when

[1] August 23, 2018, City Operations report CR_6216.

waste processing facilities are fully operational, to 90 percent when all waste diversion programs are fully implemented.

2.1. Problem / Opportunity

Problem

The ECF was at the leading edge of technology and waste management practice when it was constructed in 1999. As the facility has aged, critical structural issues have emerged that result in the requirement to shut down the Aeration Hall Building during the winter months, whenever there is any snow accumulation on the roof. This inability to operate contributes directly to a reduction in the waste diversion rate as material that would otherwise be compostable is instead diverted to landfill.

A number of changes have been made to the ECF since its original construction, however, including the following:

- The original finishing circuit design was modified due to ongoing operational issues with the equipment removing the heavy contaminants (heavies) in 2007.
- With the advent of the Integrated Processing and Transfer Facility (IPTF), where MSW is processed, the primary screening trommels were also taken out of service in 2011; and
- The five composting drums were taken out of service due to ongoing maintenance costs related to stress corrosion cracking in 2012. Two of the drums were retrofitted to permanent conveyors to transfer organics from the ECF tip floor to the aeration hall.

Despite this evolution, the main composting equipment will exceed its intended lifespan of 30 years by 2029.

Opportunity

At the same time that the need to address the Aeration Hall structural issues is emerging, the Anaerobic Digestion Facility (ADF) is being commissioned and Waste Services will implement the Source Separated Organics (SSO) collection for single unit residences. The fully operational ADF can be expected to absorb 59 percent of the SSO that is forecasted to result from this collection change in 2024. However, since the ADF capacity is fixed at 40,000 tonnes per year, by 2044 the percent of the collected SSO processed by the ADF will reduce to 36 percent, as waste from other segments is included and Edmonton’s population grows, and therefore, anticipated volume of SSO produced, continues to grow beyond this fixed capacity.

This combination of circumstances, along with the age of the equipment in the ECF, presents a unique opportunity for the City to review the overall short-term and long-term strategy for organics processing at the EWMC and determine the capital investment in facilities and/or equipment that will help the City achieve its goals over the next 30 years.

As a result, while investigating investment requirements to address the aeration hall structure so that ECF can be in operation continuously all year round, Waste Services is taking this opportunity to review potential technology that can process organic waste more efficiently and economically in order to help achieve the 90 percent diversion rate goal. Taking advantage of this opportunity will allow Waste Services to determine the most appropriate long-term strategy and investment for processing organics. The strategy will be driven by the City's stated vision to support a 90% waste diversion goal through beneficial processing, aided by source separation of residential waste. This will contribute to the City's ten-year strategic goals to preserve and sustain Edmonton's environment and ensure Edmonton's financial sustainability.

2.2. Current Situation

ECF Facility and Equipment

In its current state, the ECF faces serious structural and operational challenges that must be addressed for it to remain in full operation.

Most urgently, the roof structure and ceiling cladding on the Aeration Hall Building have physical deficiencies that currently make it structurally unsafe to operate when there is snow on its roof resulting in a complete shutdown of the facility during the winter of 2017-2018. This shutdown resulted in a 15-20 percentage point reduction in the overall diversion rate. Annual seasonal shutdowns resulting in a continued reduction of diversion are likely to continue until structural repairs or replacement to the Aeration Hall Building occurs. The building must either be repaired or replaced as it is impossible for the cycle of shutdowns to continue indefinitely because the building structure will continue to deteriorate.

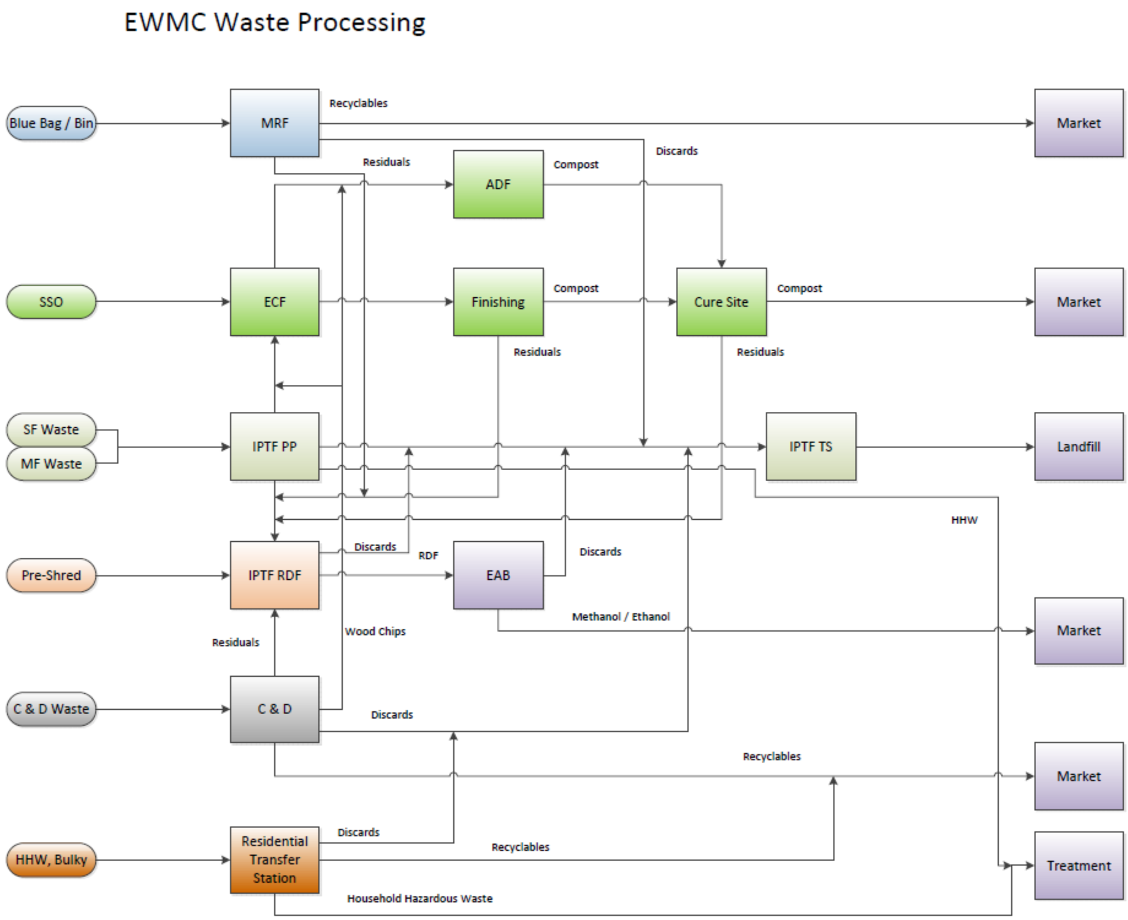
Other, less urgent physical deficiencies to the building envelope, mechanical systems, and electrical systems and equipment have also been identified. Detailed discussion of specific items and implications can be found in ONEC Engineering's Report entitled *ECF Aeration Hall Reinforcement Study – Site 500* (Appendix 1) and Stantec Consulting Ltd.'s Building Condition Assessment (Appendix 2).

In addition, the current ventilation system does not consistently remove dust and other contaminants from the aeration hall requiring workers to wear respirators inside the ECF. This reduces their overall productivity and comfort on the job.

EWMC System

Established in 1995, the EWMC is a collection of advanced waste processing and research facilities. The ECF is one component of this overall system. Figure 2-1 exhibits a snapshot of process flow for the waste received at the EWMC.

Figure 2-1 EWMC Process Flow



The MSW collected through the curbside collection program and multi-unit bin collection program is transported to the tipping floor of the Integrated Processing and Transfer Facility (IPTF) located inside the Edmonton Waste Management Center (EWMC) where it is pre-processed (sorting and/or sizing). After pre-processing, the organic waste is transferred to Edmonton Compost Facility (ECF) for composting, non- compostable and non-recyclable is transferred to Refuse Derived Fuel facility (RDF) and Waste to Biofuels. Facility, and the remaining rejects are transported to an offsite third-party landfill for disposal.

One important constraint on current ECF operations is the capacity of the current Cure Site. The Cure site also acts as product storage area and the overall capacity of the site is limited. The External Cure Site Project is currently in progress to create additional external cure site capacity. Bringing the ADF on line will not alleviate this issue since the SSO solids processed through the ADF eventually must go through the cure site before it becomes a marketable product.

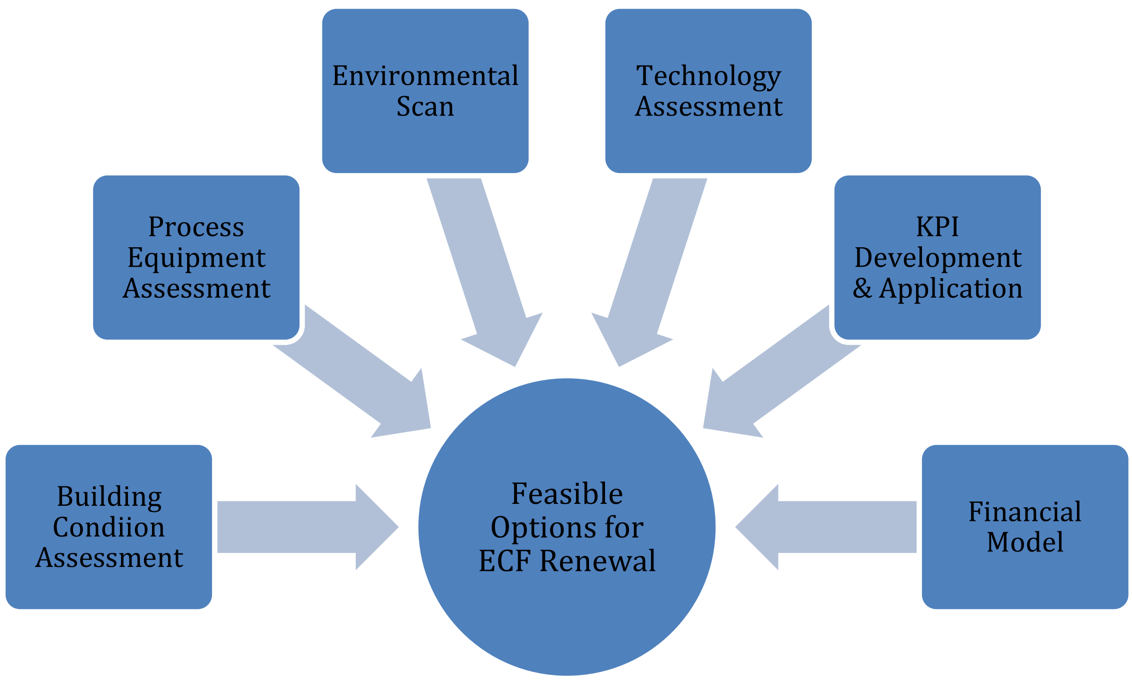
The combined impact of all of these challenges must be addressed to enable the City to reach its 90 percent diversion goal. While conducting the External Cure Site Expansion Project, Waste Services has also undertaken the Edmonton Composting Facility Renewal Strategy project to determine the best path forward for the ECF.

3. Initiative Description

3.1. Initiative Description

To develop the business case for the Edmonton Composting Facility Renewal project, Waste Services and Integrated Infrastructure Services have partnered with Stantec Consulting Ltd. to undertake an extensive review of the current state of the ECF and determine potential improvement options. This process (illustrated by Figure 3.1-1) has taken into account facility, equipment, social, environmental, technological, and financial analyses to arrive at a set of four feasible alternatives. These alternatives are presented for consideration in this strategic business case - corresponding to the Project Development and Delivery Model Checkpoint 1. Upon approval of this business case, the project team will proceed with initial planning for the selected alternative.

Figure 3.1-1 Process of Feasible ECF Renewal Options Development.



Current State Analysis

First, to ensure a comprehensive and contextualized understanding of the current state of the ECF facility, its equipment, and current operational outcomes, a series of professional assessments were undertaken.

- A Building Condition Assessment was completed by Stantec, providing a) an opinion of the general physical condition of the site's major facility systems; b) opinions of cost to address observed physical 'deficiencies'; and c) to renew base-building systems and exterior site components over a twenty-year period. The detailed report is attached as Appendix 2 of this document.

- A further assessment of the potential cost for refurbishment of the building structure was developed by ONEC, a specialized engineering firm hired by Waste Services, to investigate ECF structural issues. The detailed report is attached as Appendix 1 to this document.
- An assessment of the ECF's process equipment was also undertaken. This assessment provides an opinion of the general age of the site's major process equipment and current state observation and analysis related to process capability, capacity, throughput and remaining useful life. The detailed report is attached as Appendix 3 to this document.

An Environmental Scan was next conducted, providing a comprehensive picture of waste management in the context of the ECF and including the following:

- Snapshot of solid waste management and government initiatives on the national, provincial and regional fronts
- An overview of the City's solid waste management program and potential opportunities for collaboration in the Alberta Capital Region
- Assessment of future waste management needs for the City
- Regulatory framework and industry development
- SWOT analysis with focus on Waste Services

The complete Environmental Scan is included as Appendix 4 to this document.

This comprehensive program of analysis allowed the project team to look at the ECF facility and its operations from a holistic contextualized and thorough perspective.

Technology Assessment

Building on the current state analysis, the project team undertook a two-step process to develop the range of feasible options for renewal of the ECF.

First, a range of current technological options for organics processing were researched and evaluated by the ECF Renewal project team according to collaboratively determined criteria. This process is discussed further in Section 6 of this document and detailed in the report attached as Appendix 5.

Next, technology selection criteria were collaboratively developed and used to consult industry through a Request for Information (RFI) solicited from qualified vendors. The RFI, conducted by Stantec, allowed the project team to request advice directly from qualified vendors regarding appropriate available technologies, operating requirements, recommended contracting strategies for delivery, and indicative pricing for recommended options. It is attached as Appendix 6 to this document.

Key Performance Indicators

In parallel to the activities described above, the project team undertook a series of workshops to arrive a set of KPIs to be used in conjunction with the financial modeling to narrow the list of potential feasible technology alternatives resulting from the RFI. These KPIs are discussed in detail in Section 3.7 and in the memorandum attached as Appendix 7.

Financial Modeling

Costing data collected from the reports listed above, Waste Services, the RFI and other sources were then fed into the financial model developed by Stantec Consulting.

Feasible Renewal Options

The cumulative results of the process provide a set of four feasible alternatives for renewing the ECF. Each of these four alternatives are discussed in detail in Section 6 of this document. Their potential costs and the benefits associated with each are discussed in detail in Section 8.

Technologies that were deemed to be unfeasible include liquid digestion, and waste to energy (incineration) options.

Foundational Assumptions

Importantly, the following assumptions underpin every dimension of both the quantitative and qualitative analyses discussed above:

- Separated Source Organics (SSO) collection and will be implemented for single unit residences beginning in fall of 2020.
- The ADF facility is fully operational.
- The City’s goal to divert 90% of single unit residential waste from the landfill remains valid.

- The technologies considered for the business case are limited to proven emergent and current commercially-available technologies. Unproven emergent technologies were not assessed.
- A complete (non-phased) reduction of grass, leaf and yard waste in the refuse stream will be implemented by 2020. It has been assumed that yard, leaf and grass waste will be collected and processed separately from the ECF.
- The above changes result in the quantities of organic fraction of MSW and SSO to be processed at the ECF and ADF per the mass balance information issued on July 27, 2018.

3.2. Initiative Justification

The need for an initiative to determine the best way forward for the renewal of the ECF is apparent.

In its current physical condition, the ECF cannot process all of the organic waste it receives. Without remediation of the structural issues in the Aeration Hall, the facility is at a high risk of complete closure for several months each year. During these months, organic waste that could be composted will continue to be diverted to landfill. In addition, while shutting down the ECF on a seasonal basis provides a temporary work around strategy to support partial operation, this strategy cannot be used indefinitely, as the structural issues at its root must eventually be addressed.

In addition, Waste Services plans to implement changes in waste collection. The City is planning to collect Source Separated Organics (SSO) from single unit residences in an initial phase of implementation. Waste Services also plans to work with the multi-unit sector to advance source separation in this sector as part of the review. In order to support the business case for organics processing, public engagement data was collected while this project was underway with a goal being to ensure that public preferences and expectations and operational needs could be brought into alignment as necessary. This means there will be two organics streams of material to be processed. Separating the two materials will allow for improved compost product from the SSO, compared to the MSW. This will require major changes to the ECF process and facility configuration.

This business case provides the necessary first step to addressing both the immediate and long-term challenges with the current ECF and will be analyzed in conjunction with input from a multi-segment engagement process that ran concurrently. Work to date has thoroughly researched potential technology options, current market and industry conditions, and presents Class 5 (high-level) costing implications for viable options. Approval of the recommended technology strategy is needed to proceed to the next phase of planning.

3.3. Urgency of Need

As previously noted, the need to address the ECF structural issues is clear and immediate. Maintaining the status quo will continue to result in annual winter shutdowns that will continue to contribute to a declining annual waste diversion rate despite of the start-up of the Anaerobic Digestion Facility. As previously noted, the fully operational ADF can be expected to absorb 59 percent of the SSO that is forecasted to result from this collection change in 2024. However, since the ADF capacity is fixed at 40,000 tonnes per year, by 2044 the percent of the collected SSO processed by the ADF will reduce to 36 percent, due to population growth.

As a result, the ECF will remain operating at less than its full capacity, preventing progress toward the stated strategic targets of 73 percent[2] and eventually 90 percent waste diversion.

In addition to these critical structural issues, the move to SSO collection will result in a need to process the MSW and the SSO separately. This reduces the overall capacity of the existing ECF processing equipment. While the ADF, once commissioned, will have the ability to absorb some of the total material currently going to the ECF, it will not provide a complete long-term solution. Should the ECF's capacity not be sufficiently replaced to meet this additional demand, the surplus organic material received must be sent to landfill. This will serve as an additional hindrance to reaching the goal of 90 percent diversion.

Ultimately, maintaining the status quo does not support the City's stated goals to achieve 90% diversion of its residential waste stream and does not align with its long-term environmental or financial sustainability goals.

3.4. Anticipated Outcomes

Each of the four alternatives presented in Section 6 provide an avenue for addressing the urgent need expressed above. Regardless of the final option selected, remediation allowing for year-round operation of the ECF is essential for achieving full operation of waste processing facilities and a key milestone in the journey toward 90 percent waste diversion.

The following additional benefits are also expected to arise as result of improving the ECF:

- More efficient operation
- Improved worker conditions
- Improved quality of compost that results in increasing market value of finished product
- Increased diversion rate of organics (i.e. reduced amount of unprocessed organics to landfill)
- Improved processing availability, especially reducing planned and unplanned equipment downtime to 5 percent or less

Importantly, the long-term success of these benefits is closely tied to the success of three parallel initiatives currently being pursued by Waste Services. As a result, this business case assumes the following:

- Organics waste management project collection will be fully implemented before this project is completed
- The ADF facility will be fully operational
- The External Cure Site project will be completed.

[2] August 23, 2018, City Operations report CR_6216

Thus, while the ECF Renewal Project is a critical component, it is only by implementing this full program of initiatives that the ultimate goal of 90 percent diversion can eventually be achieved.

3.5. Scope

As previously noted, Section 6 of this document presents four possible alternatives for renewal of the ECF.

Alternative 1 represents the minimal feasible scope, including the following elements:

- Expand tipping floor sufficiently to allow the SSO collection trucks to discharge their loads. Expansion of the tip floor will remove existing parking space, resulting in the need to create new space on site for parking.
- Refurbish the existing Aeration Hall to ensure structural integrity and address lifecycle issues identified in the Building Condition Assessment.
- Maintain all existing equipment systems through ongoing maintenance or lifecycle replacement.
- Improve the finishing circuit to improve the quality of the Municipal Solid Waste compost product.
- Demolish the unsafe South Download building and remove the unused composting drums.

Alternative 2 - demolish the existing Aeration Hall and equipment, build new buildings and install new composting equipment – consists of the following:

- Expand tipping floor sufficiently to allow the SSO collection trucks to discharge their loads. This will require creation of new parking space to provide for parking space used for tip floor expansion.
- Construct a new Aeration Hall with new composting equipment sized to medium-term requirements but with room for expansion to meet long-term requirements.
- Improve the finishing circuit to improve the quality of the Municipal Solid Waste compost product.
- Demolish the unsafe South Download building and remove the unused composting drums

Alternative 3A - demolish existing Aeration Hall and equipment, build new digestion facility and produce electricity from biogas - includes the following:

- Demolish the existing Aeration Hall and equipment
- Demolish the unsafe South Download building and remove the unused composting drums

- Expand tipping floor sufficiently to allow the SSO collection trucks to discharge their loads. This will require creation of new parking space to provide for parking space used for tip floor expansion.
- Improve the finishing circuit to improve the quality of the Municipal Solid Waste compost product.
- Construct new Anaerobic Digestion facility on existing Aeration Hall site
- Replace all existing SSO and MSW processing equipment with new digestion technology
- Install new equipment to generate electricity from biogas

And, finally, Alternative 3B - demolish the existing Aeration Hall and equipment, build a new digestion facility and produce Renewable Natural Gas – includes the following:

- Demolish the existing Aeration Hall and equipment
- Demolish the unsafe South Download building and remove the unused composting drums
- Expand tipping floor sufficiently to allow the SSO collection trucks to discharge their loads. This will require creation of new parking space to provide for parking used for tip floor expansion.
- Improve the finishing circuit to improve the quality of the Municipal Solid Waste compost product.
- Construct new Anaerobic Digestion facility on existing Aeration Hall site
- Replace all existing SSO and MSW processing equipment with new technology
- Install new equipment to generate renewable natural gas (RNG) from biogas

The factor that will have the greatest impact on the overall scope (as well as associated costs, benefits and timelines) is whether or not composting or digestion technology is chosen. This is the key decision required as a result of this business case.

3.6. Out of Scope

Regardless of the specific alternative chosen, the ECF Renewal Project considers potential improvement options for the ECF facility and its equipment only. Potential changes to facilities other than the ECF are out of scope.

3.7. Critical Success Factors

Key Performance Indicators

Through a series of workshops, the project team also developed a series of KPIs. These KPIs were used evaluate the results of the RFI and further narrow the list of potential alternatives. They are summarized as follows:

Table 6-1: Key Performance Indicators

KPI	**What is being measured**	**Target Value (Specific to Technology Assessment)**
KPI-1 (ECF)	Operation Cost	Comparative Parameter
KPI-2 (ECF)	Market value of finished product (per tonnes)	Comparative value for assessment of technologies
KPI-3 (ECF)	Diversion Rate of Organics	System efficiency for organic waste processing
KPI-4 (ECF)	Proprietary and Non-Proprietary technology	Individual proprietary equipment is acceptable, but the overall system must be open sourced to several vendors
KPI-5 (ECF)	Emissions	Comparative value for reviewing technologies
KPI-6 (ECF)	Planned and unplanned Equipment downtime	5% or less

To achieve sustainable and strategically aligned success, the ECF Renewal project must result in changes to the ECF that, at minimum, enable the following:

- The ability to process all SSO and MSW organics reliably and at a reasonable cost.
- A facility that is sized to handle expected volume increases over next 30 years (and match with the Waste Services' estimation in the Mass Balance, attached in Appendix 8).
- The ability to accommodate the change of the collection programs that are either piloted, being developed or reviewed. Potential change of collection programs includes Source Separated Organics (SSO), separate grass, leaf and yard waste collection, and ban of organics bin top-up.
- The ability to reduce diversion of organic waste to landfill from current levels.

4. Strategic Alignment

2050 Vision

The Vision 2050 plan has four goals that are addressed by this project. By ensuring that solid organic waste is collected, processed responsibly, and the amount landfilled is minimized, Edmonton will be a healthy city, urban places will be clean, regional prosperity is increased by building a circular economy, and a low carbon future is assured.

The proposed project will extract some of the inherent energy in organic waste through the use of microbiology before the remaining solids are composted. The biogas generated will be collected and conditioned for use as renewable natural gas. This extracted energy can be used to power buildings and facilities or to provide renewable natural gas. The compost can be used to replenish carbon in the soil of local gardens and surrounding agricultural fields.

The generation of electricity or production of renewable natural gas from biogas will directly support a number of aligned objectives, including the following:

- That a significant and increasing proportion of Edmonton's energy comes from renewable sources, with as much as reasonably possible produced locally.
- That the energy generation infrastructure that Edmonton relies upon is increasingly decentralized and distributed.
- That Edmonton, the energy city, is a leader in studying, testing and adopting new energy technologies. With Waste Services as the adoption leader, commercial organizations can choose to utilize anaerobic digestion for their organic wastes, generating green electricity for their operations and exporting the excess to be used by other local entities; or producing renewable natural gas that can be distributed for local or regional use.

Finally, regardless of which option is chosen, renewing the ECF will allow the City to continue on its path towards diverting 90 percent of the waste collected from single unit residents away from landfill. While a renewed ECF will continue to generate greenhouse gas emissions, these emissions will be reduced compared to levels produced by the current ECF.

Waste Services Business Plan 2019-2022

Aligning with the long-term vision of *Vision 2050*, the *City of Edmonton Waste Services Business Plan 2019-2022* specifies that Waste Services is planning to implement Source Separated Organics (SSO) collection for single unit residences, requiring homeowners to separate compostable material, such as food waste, prior to pick-up. Public engagement examining four potential options began in Fall 2018. Final recommendation of a preferred source separated organics set out is targeted for June 2019, with an initial rollout implementation phase to follow.

This initial rollout, along with changes to curbside collection of grass, leaf and yard waste, is expected to improve compost quality, decrease infrastructure and operating costs and improve the single unit residential diversion rate by 11 percent.

This implementation is the first step in enacting an overall vision that sees diversion targets progress over time from 73 percent[3] when waste processing facilities are fully operational to 90 percent when all waste diversion programs are fully implemented.

Renewal of ECF is required to process the combination of source separated organics and organic fraction of municipal solid waste that the facility will receive as a result of this collection program change.

Greenhouse Gas Management Plan

Prepared by Energy Transition, City Environmental Strategies in May of 2018, the *City of Edmonton Greenhouse Gas Management Plan, 2019-2030 Civic Operations Report* examines three greenhouse gas reduction scenarios to identify ways that the City of Edmonton can reduce its greenhouse gas emissions from civic operations. As an integral component of reducing the City's GHG emissions, the report recommends that the City pursue a hierarchical investment approach, summarized as follows:

1. Avoid wasteful energy and carbon-intensive practices and/or purchasing or construction of new assets
2. Reduce emissions by improving energy efficiency
3. Replace high carbon energy sources with low carbon sources, and;
4. Offset by taking actions to reduce GHG emissions in one place by offsetting emissions that occur elsewhere

The ECF Renewal Project supports this approach. Renewing technology at the ECF, whether through composting or digestion will result in a reduction of the overall GHG emissions from the ECF. With their potential to generate renewable energy, Alternative 3A and 3B can provide the added benefit of producing renewable energy. In addition to being marketable, the potential exists for the City to use this energy to operate its own facilities. Importantly, the methodology used to consider ECF Renewal options aligns with the best practices recommended in this report – triple-bottom-line analyses, financial life cycle analyses and application of consistent, conservative methodologies for estimating future energy prices.

Related Initiatives

Finally, renewing the ECF is also strategically aligned with a number of other distinct but related initiatives that are currently underway. While these initiatives are outside the scope of this project, their outcomes will impact its overall success, and all will be important components of achieving the ultimate goal of 90 percent diversion.

- The Organics Waste Management report, being issued separately by Waste Services. This proposes phasing in collection of Separated Source Organics from single-unit households that will reduce the overall quantity of material requiring processing capacity at the ECF, but also create two separate streams that will reduce process flexibility

[3] August 23, 2018, City Operations report CR_6216.

- The External Cure Site Expansion Project, currently underway, which will provide the necessary creation of an external cure site to reduce bottlenecking under both current and future ECF scenarios.
- Commissioning of the new ADF, currently underway, which will temporarily reduce demand for organics processing at the ECF but will not eliminate the need for a refurbished ECF, as its total processing capacity is fixed and will eventually be outpaced by the forecasted demand.
- Implementation of SSO collection from single-unit residences, as separating SSO from MSW materials will require major changes to the ECF process and facility configuration.

5. Context Analysis

A detailed discussion of the National, Provincial and Regional contexts is provided in the Environmental Scan attached as Appendix 4 to this document. Highlights of this analysis are discussed in summary below.

National Context

A snapshot of the state of waste management in Canada and Alberta from 2006 to 2014 has been prepared based on information obtained from the Waste Management Industry Survey Report (2010) developed by Statistics Canada and relevant CANSIM tables[4]. This analysis is discussed in detail in Appendix 4. Based on the interpretation of this data, the average waste disposal rate in Canada exhibits a declining trend.

Nationwide, diversion rates are higher for the residential sector than for the non-residential sector. and the overall waste diversion rate has remained relatively static since 2002, increasing from 22 to 25 per cent by 2012[5].

Not surprisingly, the provinces that generate the least amount of un-diverted waste per capita (Nova Scotia and B.C.) also have the highest rates of waste diversion. Similarly, the provinces with the highest per capita waste generation (Alberta, Saskatchewan, and Manitoba) have the lowest rates of waste diversion across the provinces. This means that the worst-performing provinces can take two broad approaches to make improvements: reduce the generation of un-diverted waste and increase the amount and types of waste diverted[4].

Provincial Context

Based on information available in the Provincial Business Plan 2017-2020 (prepared by Alberta Environment and Parks, AEP), 661 kg per capita of waste was disposed in Alberta landfills in 2015. Information about the waste recycled or recovered or the provincial waste diversion rate is not available from the Government of Alberta database. Therefore, a trend analysis of waste generation rate was undertaken to estimate per capita waste generation rate in 2015.

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[4] http://www5.statcan.gc.ca/cansim/a47 accessed on Nov 24, 2017

[5] http://www.conferenceboard.ca/hcp/provincial/environment/waste.aspx?AspxAutoDetectCookieSupport accessed on Feb 22, 2018

It is estimated that in 2015, the waste generation rate in Alberta was approximately 964 kg per person which reduced to 946 kg/person in 2016. Using the interpreted waste generation rates and the waste disposed rates per capita of 661 kg in 2015, it would infer a provincial waste diversion rate of 31%. This diversion rate is significantly higher than that quoted by Statistics Canada. The 31% diversion rate seems reasonable in view of the current state of waste recycling and several other waste management initiatives in place in the Alberta Capital Region (ACR) and the larger municipalities like Cities of Edmonton, Calgary, Leduc, and Lethbridge. Currently, there is insufficient provincial legislation to encourage, enable and empower Alberta municipalities in their efforts to minimize waste and achieve reduction targets.

Regional Context

Founded in 1992, the Capital Region Waste Minimization Advisory Committee (CRWMAC) is a voluntary group of technical and political representatives from 24 municipalities in the ACR including the City of Edmonton with representation from Alberta Environment and Parks (Government of Alberta). The ACR covers approximately 11,500 square kilometers with a total population of 1,321,426 as per the 2016 Census (Statistics Canada)[6] of which almost 67% resides within the City of Edmonton. Other than the City of Edmonton, there exists three other established regional solid waste management systems in the ACR – the Leduc District Regional Waste Management Authority, the Roseridge Waste Services Commission, and the Lamont County Regional Solid Waste Commission. Besides these, the region is also serviced by private waste management entities like Waste Management Inc., Progressive Waste Solutions (previously BFI Canada), GFL Environmental and Evergreen Ecological Services Ltd. who are engaged in waste collection, disposal, composting and material recovery.

Most major municipalities in the ACR have an established waste collection system with a SSO collection program in place. However, based on the data from the ACR municipalities, only 25% of the organics generated were collected through the SSO program. It is assumed that the SSO collection program is currently available to only single-unit homes. No other information is available about the SSO collection program e.g. the level of contamination observed in the SSO waste stream and participation rate from tax payers in the ACR (excluding the City of Edmonton). Based on Four Seasons Waste Composition Study[7], the compostable waste in the City's residential waste stream constitutes an average approximately 58% (single unit homes) and 32% (multi-unit homes). Given that, it seems likely that a significant portion of organics remain disposed in landfill.

In 2011, the ACR's overall waste diversion rate was 49% (organics and recyclables combined)[8]. Approximately 90% of this waste diversion was contributed by Edmonton, Strathcona County and St. Albert municipalities. It is to be noted that this diversion rate only relates to residential waste and does not include any ICI and C&D waste generated in these communities.

Current Composting and Digestion Technologies

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[6] Statistics Canada- accessed November 24, 2017

[7] City of Edmonton Four-Seasons Waste Composition Study prepared by EWMC and Tetra Tech November 2016

[8] Alberta Capital Region Integrated Waste Management Plan, Phase I report – Integrated Waste Management Options prepared by EBA Tetra Tech April 2013

Examining the potential benefits and best suitability of particular composting and digestion technologies for renewing the ECF formed a significant portion of the analysis and for this business case. Details of the process used to perform that analysis are provided in Sections 3 and 6, and specific technologies are discussed in depth in Appendix 5. The following sub-section provides a brief overview of the current relevant technologies to contextualize Edmonton's current and potential future practices.

There are several types of composting systems available that successfully handle material similar to that being processed by the City. The current system is an agitated bay system, which is well-suited to processing the organic fraction of MSW. There are several other agitated bay systems that have been successfully used to process MSW in North America; the Sorain Cecchini system is used in Edmonton; and the ICS ™ system which is system used at the Delaware County Composting Facility in Walton, NY and Rapid City, South Dakota is the most common agitated bay system in North America.

In tunnel composting, the material is processed in an enclosed vessel with high rate aeration and a high degree of control of the temperature and moisture of the composting material. There are several tunnel composting systems in Canada, in Calgary, Hamilton, and London, and the new Anaerobic Digestion facility in Edmonton will have tunnel composting after digestion. All of the projects listed here process SSO. It is worth noting that these systems do not have agitation as part of the process but do successfully process SSO.

Extended aerated static pile (EASP) composting has been most commonly used for processing biosolids, but there are two facilities in North America processing MSW with EASP - in Marlborough and Nantucket, Massachusetts.

Finally, there are several large-scale, Fabric Covered aerated static pile (ASP) composting operations in North America, all handling SSO. Cedar Grove Composting in Washington State is the longest operating of these facilities. There are three in Ontario including the newest facilities in Belleville and in Thorold. There are several biosolids composting facilities using the covered ASP including Edmonton, which uses this technology for its outdoor biosolids composting operation, and a large facility in King County in California operated by the Los Angeles County Sanitation Districts (LACSD).

In general, anaerobic digestion technologies have been more focused on SSO rather than MSW. Even the plant being commissioned at the EWMC is slated to receive a cleaner waste stream than the existing composting operation. However, as more facilities accept post-consumer food waste, the levels of contamination in the feedstock are rising. The pre-processing system at Edmonton provides a high percentage organic feedstock that should be acceptable to high solids anaerobic digestion.

High solids digestion is really a combination of solids and liquid digestion. The solid material is loaded into concrete vessels with air tight doors similar to those used in tunnel composting systems. Liquid is sprayed over the material, collected, and sent to a tank for traditional liquid anaerobic digestion. Methane is collected from both the solids vessels and the liquid tank and burned in an engine driving a generator that makes electricity. Heat from the engine warms the liquid going to both the solids and liquid digesters.

High solids digestion, also known as dry fermentation, has been widely used in Europe. In North America there are at least five operating facilities excluding the new facility in Edmonton.

These are San Jose, CA; Surrey, BC; Oshkosh, WN; Richmond, BC (currently shutting down) and; Monterey, CA.

Conventional Thermal Treatment

Conventional Thermal Treatment is traditional waste-to-energy (WTE) via incineration of MSW. From a 2006 report to the Canadian Council of the Ministers of the Environment (CCME), there are seven large MSW incinerators in Canada, of which five are WTE facilities, with one 30-tonne-per-day facility located in Wainwright, Alberta.

6. Alternatives

6.1. Feasible Alternatives

The process outlined in Section 3 resulted in four feasible alternatives. Their proposed scope, estimated timelines, and key considerations are outlined in the tables below.

Alternative 1: Rehabilitate Aeration Hall Building and Maintain All Equipment		
Proposed Scope	**Estimated Timeline**	**Key Considerations**
• Refurbish the existing Aeration Hall to ensure structural integrity and address lifecycle issues identified in the Building Condition Assessment. • Expand tipping floor sufficiently to separate municipal solid waste and source separated organics. • Maintain all existing equipment systems through ongoing maintenance. • Improve finishing circuit to improve the quality of the	• Completion of planning and development design for PDDM checkpoint #3 business case in 2020 • Refurbishment of existing buildings, expansion of tipping floor and improvement of finishing circuit will take place between 2020-2023. • Existing equipment will be used until the end of life expected in 2028. • Install new composting equipment starting in 2029.	• May allow for partial operation (during non-winter months) of existing facility while upgrades are completed. • Will produce an improved quality of compost starting in 2024 due to the implementation of the SSO program and improved finishing. • No GHG credit between 2019-2023 (during construction period), credit assumed for 2024 – 2036. • The building size could limit the type of equipment that will be installed in 2029.

Municipal Solid Waste product.	• Expand drying area in 2029.	

Alternative 2: Demolish Existing Aeration Hall and Install New Composting Equipment on Existing Aeration Hall Site		
Proposed Scope	**Proposed Timeline**	**Key Considerations**
• Demolish existing Aeration Hall and equipment. • Expand tipping floor sufficiently to separate municipal solid waste and source separated organics. • Construct a new Aeration Hall with new composting equipment sized to medium-term requirements but with expandability to meet long-term requirements.	• Complete planning and development design for PDDM Checkpoint 3 Business Case in 2020 • Demolition and construction in 2020-2023. • Fully operational in 2024. • Expand composting process building in 2034 to accommodate additional demand.	• Will produce an improved quality of compost starting in 2024 due to the implementation of the SSO program and improved finishing. • Increase in GHG credits due to improved organics recovery. • The Aeration Hall is expected to be out of service during both demolition and construction phases. This will result in a temporary reduction in diversion rates. • New building with 30+ year lifespan • Equipment process designed to handle separate MSW and SSO waste streams • No GHG credit between 2020-2023 (during construction period)

Alternative 3A: Demolish Existing Aeration Hall, Construct New New Digestion Equipment & Facility on Existing Aeration Hall Site		
Proposed Scope	**Proposed Timeline**	**Key Considerations**
• Demolish the existing Aeration and South Download halls and and equipment • Expand tipping floor sufficiently to separate municipal solid waste and source separated organics • Construct new Anaerobic Digestion facility on existing Aeration Hall site • Replace all existing SSO and MSW processing equipment with new technology • Install new equipment to generate electricity from biogas	• Complete planning and development design for PDDM Checkpoint 3 Business Case in 2020 • Demolition and construction (phase 1 construction) 2020 - 2023 • Fully operational in 2024 • Install two Combined Heat and Power (CHP) units during construction • Phase 2 construction – 2034 – additional process equipment and facility and additional CHP unit to accommodate additional demand	• The Aeration Hall is expected to be out of service during both demolition and construction phases. This will result in a temporary reduction in diversion rates. • No GHG credit during construction period • Improves compost quality, but digestion technology does not produce as much compost • Biogas will be turned into electricity that will be sold into the power grid. • Digestion emits less CO2 equivalent than composting, and so may be eligible for more GHG credit

Alternative 3B: Demolish Existing ECF, Construct New ECF with New Digestion Equipment & Facility		
Proposed Scope	**Proposed Timeline**	**Key Considerations**
• Demolish the existing Aeration Hall and equipment • Expand tipping floor sufficiently to separate municipal solid waste and source separated organics • Construct new Anaerobic Digestion facility on existing Aeration Hall site • Replace all existing SSO and MSW processing equipment with new technology • Install new equipment to generate renewable natural gas (RNG) from biogas	• Complete planning and development design for PDDM Checkpoint 3 Business Case in 2020 • Demolition and construction (phase 1 construction) 2020 - 2023 • Fully operational in 2024 • Phase 2 construction – 2034 – additional process equipment and facility	• The Aeration Hall is expected to be out of service during both demolition and construction phases. This will likely result in a temporary reduction in diversion rates. • No GHG credit during construction period • Improves compost quality, but digestion technology does not produce as much compost • Biogas will be turned into Renewable Natural Gas (RNG) and sold into the pipeline system • Digestion emits less CO2 equivalent than composting, and so may be eligible for more GHG credit

6.2. Process and Metrics Used to Select Most Feasible Alternatives

The process and metrics used to arrive at the alternatives above is robust and sophisticated, involving multiple levels of assessment.

Technology Assessment

To arrive at the choice between composting and digestion technology, a two-step process was followed. First, a range of current technological options were researched and evaluated by the ECF Renewal project team according to the following criteria:

- Beneficial reuse of all end products
- Maximum use of existing infrastructure
- Process City staff can oversee

- Low overall energy consumption
- Low environmental impact
- Small footprint, capable of being sited at the existing site
- Availability of third-party vendors for operations and potential public-private partnership (P3)
- Sufficiently proven technologies

Next, detailed criteria were developed. These criteria, listed below, were included in the Request for Information solicited from qualified vendors:

- Process 30,000 Tonnes Per Year (TPY) of SSO utilizing composting or digestion followed by composting
- Process 20,000 TPY of MSW utilizing composting. Digestion will only be considered if the process is piloted and demonstrated effective with the Edmonton MSW waste stream
- MSW and SSO must be processed separately
- The process must fit into the space outlined in Appendix 11
- The existing biosolids dewatering operation exists within the designated space and must be left alone and operable
- The building housing the existing composting operation is structurally unsound and must be modified or replaced (this can be eliminated if further investigations find the structure to be sound)

The RFI process helped to validate the initial technology assessment results and allowed for the development of high-level capital and operating costs; and schedule parameters for each feasible alternative based on direct consultation with industry

7. Organizational Change Impact

The ECF is operated by a contracted firm. The organic waste management program, including management of the ECF, is overseen by a General Supervisor and a Supervisor. The Cure Site is operated and managed by City personnel; changes to the Cure Site operation associated with any program changes related to organic waste management, such as changes to collection of grass clippings and yard waste are described in the business cases for those initiatives.

No major change is anticipated with any of the four main ECF alternatives to the City's organization. Some of the alternatives will have different requirements for the contractor, however.

The following table illustrates the considerations to be made once the design has been finalized.

Table 7-1 Operational Impacts of ECF Renewal Options

Function	Alternative 1 Existing Composting	Alternative 2 New Composting	Alternative 3 New Anaerobic Digestion and CHP	Alternative 3B New Anaerobic Digestion and RNG
City Resources				
General Supervisor, Organics Program	No Change	No Change	No Change	No Change
Supervisor, Compost Operations	No Change	No Change	No Change	No Change
Contract Resources		Generally improved health and safety, and productivity due to improved working conditions	Generally improved health and safety, and productivity due to improved working conditions	Generally improved health and safety, and productivity due to improved working conditions
Management Personnel	No change	No change	No change	No change
Process Operators	No change	Reduced process operator complement due to higher level of automation	Require CHP Operator - Class 4 operating engineer. Reduced process operator complement due to reduction of process equipment	Reduced process operator complement due to higher level of automation and reduction of process equipment, some offset by additional RNG process
Equipment Operators	Increased equipment operator complement for expanded tip floor.	Increased equipment operator complement for expanded tip floor.	Increased equipment operator complement for expanded tip floor. Increased equipment operator complement for moving material between digesters,	Increased equipment operator complement for expanded tip floor. Increased equipment operator complement for moving material between digesters, composters and finishing circuit.

			composters and finishing circuit.	
Maintenance Personnel	No change	Reduced complement of millwrights due to newer equipment. Increased complement of instrument techs due to higher level of automation.	Reduced complement of millwrights due to reduction of processing equipment. increased complement of instrument techs due to higher level of automation.	Reduced complement of millwrights due to reduction of processing equipment. increased complement of instrument techs due to higher level of automation.
Laboratory Personnel	No change	No change	Increased complement of lab techs due to requirements for biogas testing.	Increased complement of lab techs due to requirements for biogas and RNG testing.

7.1. Stakeholder Impact

Key stakeholders and how they will be impacted by the ECF Renewal Project are summarized in the table below:

Table 7-1 Preliminary Stakeholder Impact Table

Stakeholder	City Relationship	Type of Impact	Impact
Sustainable Waste Processing Section	Internal	Direct	Will affect operation of the organics program and budgeting.
Waste Collections Section	Internal	Direct	Residential source separated collection trucks will be tipped at expanded ECF tipping floor.
Operating Contractor	External	Direct	Will provide better working conditions inside the ECF. Will affect the operation of the ECF, and the number and skills of personnel required.

Residential Ratepayers	External	Direct	The capital cost of the project and the savings will affect the residential rate charged.
City Commercial Customers	External	Direct	Will affect the tipping fee charged to City commercial customers
Commercial Customers	External	Direct	Minimal impact
Commercial Haulers	External	Direct	Minimal impact, reduction of traffic in IPTF
EPCOR	External	Direct	May affect the operation of the biosolids dewatering program, and the amount of dewatered biosolids than can be composted.
Alberta Environment and Parks	External	Indirect	A permit application will need to be made to alter the permit to operate issued by AEP.
River Valley Development	Internal	Indirect	The planned changes will require review under the river valley bylaw.
Facility Planning & Design Section	Internal	Indirect	The development phase of the project will be led by FPD, and the delivery phase will be supported by FPD.
Facility Infrastructure Delivery	Internal	Indirect	The development phase of the project will be supported by FID, and the delivery phase will be led by FID.
The Capital Region Waste Minimization Advisory Committee (CRWMAC) municipalities (24) in the	External	Indirect	The new facility may be able to provide services to ACR communities that do not have contracts for processing organic waste

Alberta Capital Region			

7.2. Business and Operational Impact

The key business and operational impacts related to the four feasible alternatives are summarized in the table below.

Table 7-2 Business and Operational Impacts of Feasible Alternatives

Alternative	Interim Operational Strategy	Related Challenges	Related Benefits
Alternative 1	Partial operation (during non-winter months) of existing facility may be possible while upgrades are completed.	Facility will only be able to operate until 2034 before expansion is required. The existing site may not accommodate this expansion.	Following construction, the immediate structural issues will be addressed, allowing for year-round operation until maximum capacity is reached.
Alternative 2, 3A or 3B	Aeration Hall will be out of service during both demolition and construction phases.	SSO and MSW normally processed by the ECF in excess of what the ADF can process must be diverted to landfill for approximately 3 years	New ECF will operate year-round, divert more SSO and MSW from landfill, and produce higher quality compost. In the case of Alternative 3A or 3B, there is an added benefit in the production of electricity or RNG.

8. Cost Benefit

This section describes, in depth, the comprehensive analysis comparing the feasible alternatives for renewing the ECF. Assuming the selection of Composting technology, the following two alternatives are possible:

- Alternative 1: repair existing Aeration Hall building, use existing equipment until end-of-life, then replace it with new equipment. Expand the tip floor to accept SSO, improve the finishing circuit to improve compost quality. This alternative essentially forms the baseline for other analyses.
- Alternative 2: demolish the existing Aeration Hall and build new building and install new composting equipment. Expand the tip floor to accept SSO, improve the finishing circuit to improve compost quality.

Assuming the use of Digestion technology, two more alternatives remain:

- Alternative 3A: demolish existing Aeration Hall and build new digestion facility and produce electricity. Expand the tip floor to accept SSO, improve the finishing circuit to improve compost quality. This is NOT to be confused with the existing ADF.
- Alternative 3B: demolish existing Aeration Hall and build new digestion facility and produce RNG. Expand the tip floor to accept SSO, improve the finishing circuit to improve compost quality.

Examining each of these alternatives in depth, it quickly becomes apparent that the factor that will have the greatest overall and strategic impact on the cost and benefit of a given alternative is whether composting or digestion technology is selected. While there are differences between the costs and benefits associated with Alternatives 3A and 3B (both forms of digestion), these differences are not as great as the differences between either of these options as compared to Alternative 1 or Alternative 2 (each a form of composting). Between 3A and 3B, biogas-to-RNG is expected to yield significantly more financial benefit than biogas-to-electricity.

For these reasons, the cost benefit analysis that follows compares Alternatives 1, 2 and 3B. The detailed preliminary analysis showing the financial difference between biogas-to-electricity and biogas-to-RNG (3A and 3B) has been undertaken, with a summary of key results included in Appendix 9. It is understood that should digestion be the approved decision at Checkpoint 1, more detailed analysis to determine between biogas-to-electricity versus biogas-to-RNG will be further studied in the subsequent development phase.

Triple Bottom Line Approach

The cost benefit analysis uses a Triple Bottom Line (TBL) approach, evaluating the economic, environmental and social aspect of each of the alternative. The impacts are measured as described below:

Economic impact: capital cost (CapEx), operation and maintenance cost (OpEx), and revenue

Environmental impact: evaluated as tangible and intangible

Tangible impact: GHG emission, contribution from waste to energy

Intangible impact: quality of compost, impact of process residual

Social impact: evaluated as tangible and intangible

Tangible impact: impact to ratepayers

Intangible impact: innovation of technology

A detailed financial model (Appendix 10) was developed to quantify and analyze tangible impacts. Results are summarized and discussed in section 8.1 (Tangible benefit) and 8.3 (Cost). For impacts that are not feasible to quantify, a qualitative comparison is discussed in section 8.2.

When evaluating the economic impact of three alternatives, the impact is different depending on the time frame one uses. In order to thoroughly evaluate all four alternatives, two perspectives are taken:

Short-Term (2018-2022) Impact: Capital Cost

A comparison of capital investment between 2018 - 2022 has been completed to find the alternative with the least immediate impact on a potential utility rate increase. Given that the benefit of any alternative selected only realizes after completion of construction and operation, this perspective evaluates the capital investment only, among the three alternatives between 2018 - 2022.

Long-term (2018-2048) impact: Net Present Value (NPV)

This perspective takes a holistic view of the next 30 years on capital investment; O&M cost and benefits to compare the three alternatives.

Comparisons from both perspectives are presented in subsection 8.1 and 8.3, aiming to clarify potential trade-offs. Section 8.2 discusses and compares intangible benefits of all four alternatives. Section 8.4 lays out key assumptions, while section 8.5 summarizes the 30-year NPV analysis. Section 8.6 provides an in-depth discussion of sensitivity analyses on key assumptions made and investigates whether the economic preference of alternatives would change should key assumptions change.

8.1. Tangible Benefits

Tangible **Environmental** benefits include GHG emissions reduction and in some case, generation of renewable energy. GHG emission was determined by estimating the amount of CO_2 equivalent offset. Quantification of GHG offset from composting was based on the methodology from the report *2014 ECF Offset Project Report*, while estimation of GHG offset from digestion was based on approach used in the existing ADF updated business case. The form of waste-to-energy is different depending on the process technology (i.e.: composting vs. digestion) used. The type and amount of energy was quantified. Table 8.1-1 provides a summary of comparison for the four alternatives.

Table 8-1 Comparison of tangible environmental benefits

Benefit (Cumulative 2019-2048)	Alternative 1	Alternative 2	Alternative 3B
GHG emission offset (tonne CO2e)	2,999,710	2,740,000	4,403,571
Type of Energy export	N/A	N/A	RNG
Amount of Energy Produced GJ (RNG)	N/A	N/A	32,344,247

These tangible benefits when sold at market can generate revenue, quantifiable as **economic** benefits. Since either repair or construction and installment of new equipment will take place during this period, the revenue that will be generated for all four cases come from GHG credit that can be claimed and sold based on existing operation and GHG credit certification.

Revenue from GHG credit is a significant component of the revenue generated for all alternatives. In order to receive GHG credit, calculation of the amount of CO2e emitted must be verified and certified. The amount of GHG credit, or missions offset credit, is the difference between "baseline emissions" and "project emissions". "Base emissions" are GHG emission without the project, and "project emissions" are GHG emissions that are specific to the project. GHG emission can include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Methane and nitrous oxide are converted to CO_2 equivalent for calculation of emissions offset or GHG credit. Composting and digestion has different GHG emission.

- For composting (Alternative 1 and 2), "baseline emissions" are methane produced from organics being sent to landfill without any treatment; "project emissions" come from a few factors, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emitted from composting operations, material treatment, electricity usage, residual transportation and processing as well as fuel extraction and processing.

- For digestion with export of RNG (Alternative 3B), "baseline emissions" come from a few factors, including fuel extraction and processing, pipeline natural gas displaced in project, on-site heat and electricity generation displaced, as well as landfill decomposition; "project emissions" come from fuel extraction and processing, levied fossil fuel flaring, combustion of levied fossil fuels.

Appendix 13 provides the calculator developed for estimating GHG credit for the alternatives being evaluated in this business case.

All alternatives will receive GHG credit starting in 2024 when new facility is in operation. Once accredited, the GHG credit can be awarded for 8 years with a possible 5-year extension, allowing all alternatives to receive a total of 13 years of monetized GHG credit, ending in year 2036. After consultation with representatives from the Alberta Climate Change Office, it is understood that the refurbishment option (Alternative 1) may be eligible as a new project to obtain 8 years of GHG credits sales and another 5-year extension due to the significant investment starting in 2024. It is important to note that although after 2036, there may not be revenue from generated from selling GHG credit, the amount of GHG emission offset is still a tangible benefit presented in Table 8-1.

Given the significant contribution of GHG credit to revenue, it is worth further exploration to uncover whether or how the comparison of the alternatives will change should the price of CO2e change in the future or should the amount of GHG credit (i.e.: amount of CO2e) that can be verified and claimed change. A sensitivity analysis on this factor is discussed in section 8.5.

Revenue from compost, whether it is MSW or SSO compost, constitutes a minimal portion of the overall benefit, and so is not discussed in detail.

Installing a digestion facility and RNG equipment at the existing ECF site (Alternative 3B) provides the ability to generate more revenue than composting (Alternative 1 and 2). As it is understood that the revenue estimation is sensitive to market conditions for RNG in the future, a detailed sensitivity analysis and discussion of market assessment based on current knowledge and experience is provided in Section 8.5.

8.2. Intangible Benefits

There are two intangible **Environmental** benefits: quality of compost and impact of process on residuals. The compost quality is the same for all alternatives. In any case, the quality of both MSW and SSO will be improved sufficiently to allow for safe use and marketability.

Residuals from processing can currently be taken to the existing RDF to produce biofuel, which serves to reduce the amount diverted to landfill, providing an important contribution to the City's 90 percent diversion goal in all three cases.

Finally, these alternatives also have different intangible **social** impacts, compared in the table below.

Table 8-2 Comparison of intangible social benefits

Intangible Social Impact	Composting – Repair (Alt. 1)	Composting – New (Alt. 2)	Digestion (Alt. 3)
Better working conditions	Similar to current operation with improved aeration hall and a safer environment.	Improved working conditions with better odor control, sound structure, more efficient equipment and a safer overall environment. Familiarity from operation from existing ECF.	Improved working condition similar to Alt. 2. Familiarity from operation from existing ADF.
Innovation of technology	Same technology as used now until 2034.	More efficient equipment will be in operation in 2024. Proven technology similar to the one used now.	Production of renewable natural gas, which will help the City towards Net Zero.
Improved public perception of Edmonton waste management service	Limited potential benefit to public perception. Technology upgrade will be delayed and therefore more likely to be dated compared to other capitals in Canada or cities in	Meaningful potential benefit to public perception. Facility will be operational year-round, safety and working conditions will improve. Quality of compost	Meaningful potential benefit to public perception. Provides all benefits of Alternative 2, with the added capability of generating energy from waste. This provides multiple clear

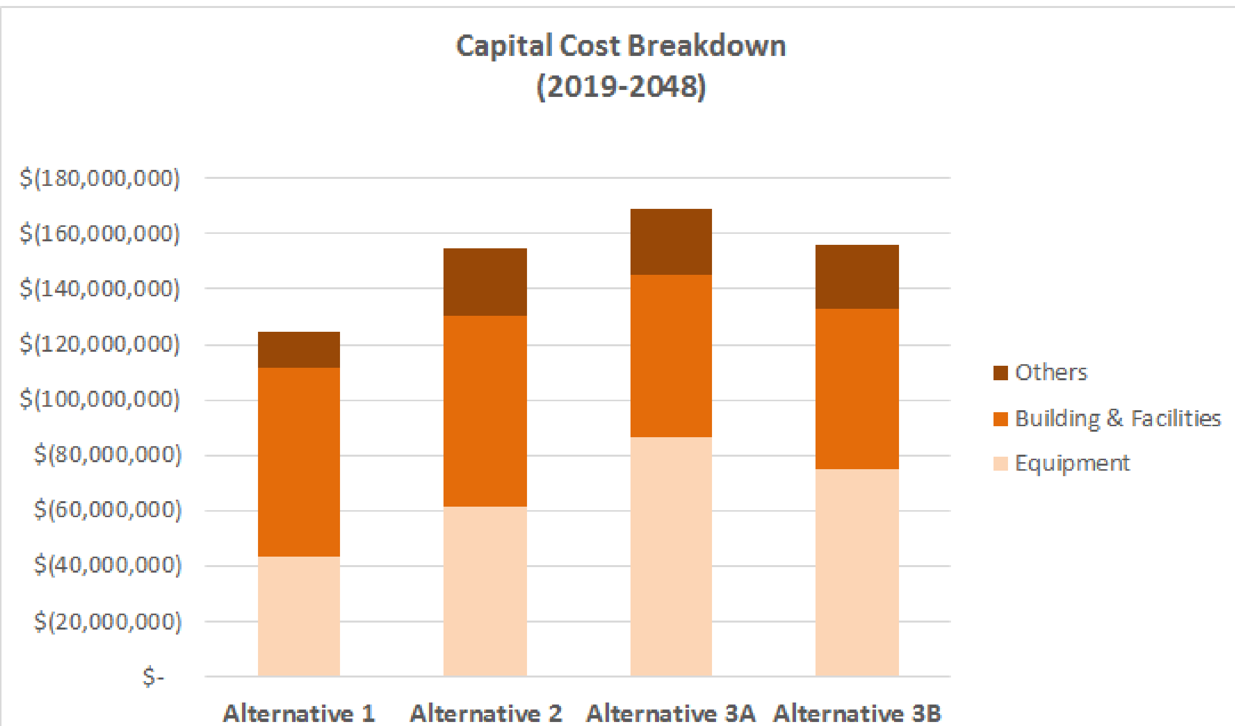
	the region.	produced will improve.	and tangible environmental and financial benefits.

8.3. Costs

Capital Cost

Capital cost includes costs associated with new equipment, repair or construction of buildings and facilities. Other costs such as engineering, construction management, etc. are also included. Figure 8-2 shows comparison of capital costs of alternatives as well as their breakdown.

Figure 8-2 Comparison of capital cost breakdown, 2019-2048



Although Alternative 1 has the lowest capital investment between 2019-2022, the 30-year evaluation takes into account the differences in life cycle of the existing asset versus the new equipment, as well as phased construction to accommodate growing capacity. Due to the significant capital investment, should the facility be constructed to accommodate the 2044 estimation of capacity, a phased construction approach is favourable. This approach can better align with other related initiatives, provides flexibility to accommodate uncertainty regarding the amount of material that will be processed, and controls the impact of capital spending. Appendix 11 presents conceptual level layout for each option with notation on construction phase of equipment and facility expansion.

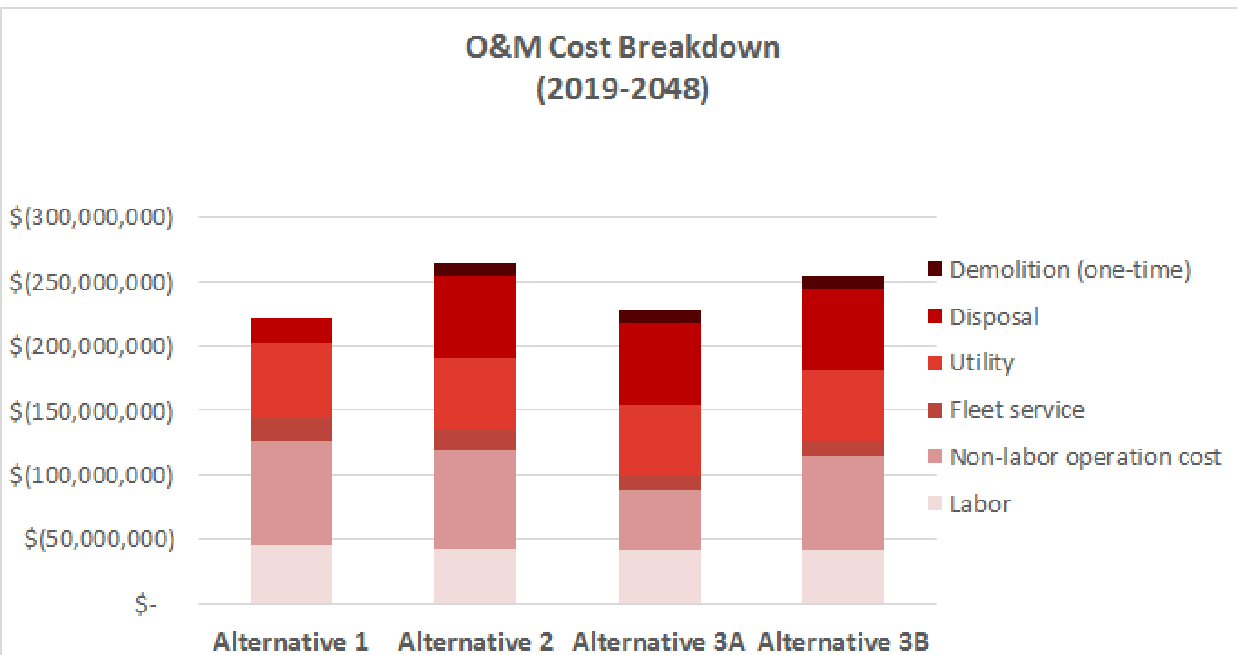
Evaluating cost breakdown, equipment cost accounts for a higher proportion of overall cost for digestion than for composting (Alternative 1 and 2). Alternative 1 has the highest building and facility cost because of the cost of refurbishing the existing building. As a result, digestion (Alternative 3) is the most capital-intensive option, while Alternative 1 remains the least capital cost intensive option.

Operations and Maintenance (O&M) Cost

O&M costs include costs of labor, material, non-labor operation and maintenance, fleet service, utility, disposal of residuals and one-time demolition of existing facilities and equipment. These are calculated from existing costs, from information obtained from the RFI, and from experience.

Figure 8-3 shows comparisons of cumulative O&M cost and breakdown for the long-term period.

Figure 8-3 O&M cost and breakdown, 2019-2048



During the period of 2019-2022, existing facility and equipment in Alternatives 2 and 3 is expected to be demolished, resulting in a one-time demolition cost. O&M cost for other categories are relatively the same across all three alternatives because operations during this period are assumed to be relatively similar while design and construction occurs.

Taking the 30-year perspective, as shown in the figure above, the alternatives with new facilities and equipment have slightly higher O&M costs than the repair option. This is a result of the one-time demolition cost for new facilities, which cannot be capitalized. Labor, non-labor operation, and utility are three major components of O&M costs for all alternatives.

Digestion has higher fleet service cost due to need for an additional rolling stock and vehicle for transporting material. Non-labor operation costs vary the most among alternatives. Notably, digestion has lower non-labor operation costs than composting. Nevertheless, O&M costs are relatively similar between composting and digestion.

8.4. Assumptions

This section lists all key assumptions used in the economic analysis. Assumptions listed here are referred to as "baseline" case in the sensitivity analysis and in section 8.6. A full list of assumptions used in the economic analysis is in Appendix 10 (tab *Assumptions*). Key assumptions are:

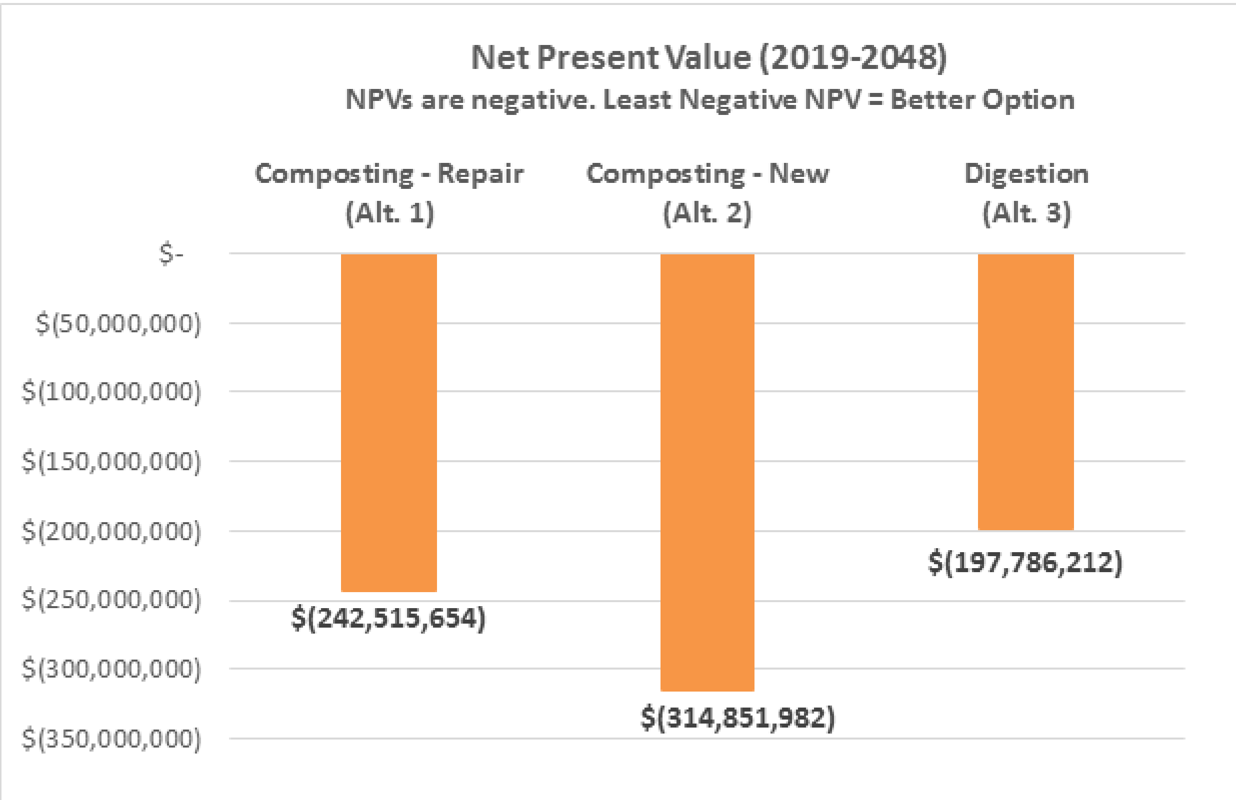
- Utility Weighted Average Cost of Capital (WACC) is 5.4%.
- Annually compounded inflation rate is 1.9% based on average 2019-2022 Corporate budget guidelines
- Mass balance amounts of 51,910 tonnes organic fraction of MSW and 68,085 tonnes of SSO will be generated in 2024 and will grow at an annual 1.6% growth factor through the project period.
- MSW compost selling price is $4.20 /tonne based on a composting market study of conducted by Waste Services Compost Marketing Supervisor. This is a conservative assumption. Market analysis suggests that compost price ranges from $6 - $14. All MSW compost is marketable and generating revenues.
- SSO compost selling price is $9.00/tonne based on a composting market study of conducted by Waste Services Compost Marketing Supervisor. This is a conservative assumption. Market analysis suggests that compost price ranges from $11.5 - $23. All SSO compost is marketable and generates revenue. Current compost sales cost an average of $17.59 / tonne (2017) in shipping costs.
- RNG selling price is $5.14/GJ based on paper *Technomic Comparison of Biogas-to-Energy Options for the Gold Bar WWTP*. This is a conservative assumption, consistent with current natural gas cost of $5.35/GJ. It is assumed that all RNG produced is marketable and generates revenue.
- Alberta CO_2e price for 2018 – 2020 is $30/tonne based on report *Estimated impacts of the Federal Carbon Pollution Pricing System*. Current carbon tax in Alberta in 2018 is $30/tonne. It is assumed that all GHG offset (estimated in the form of CO_2e) is marketable and generates revenue.
- Alberta CO_2e price for 2021 is $40/tonne. based on report *Estimated impacts of the Federal Carbon Pollution Pricing System*. It is assumed that all GHG offset (estimated in the form of CO_2e) is marketable and generates revenue.

- Alberta CO2e price for 2022 and beyond is $50/tonne. based on report *Estimated impacts of the Federal Carbon Pollution Pricing System*. It is assumed that all GHG offset (estimated in the form of CO2e) is marketable and generates revenue.

8.5. Comparison of Alternatives Under Baseline Assumptions

While the above sections show analyses of costs and benefits separately, this section compares cost and tangible benefits together for all alternatives in the form of Net Present Value (NPV). Note that NPVs are negative for all alternatives, meaning that the cumulative present value of revenue cannot recover cumulative present value of costs (both CapEx and OpEx). The smaller the NPV (i.e. the less the negative), the better is the alternative from the economic aspect. Figure 8-4 compares NPVs for the 30-year period. Appendix 10 (*Summary* tab) presents summary tables of NPV breakdown.

Figure 8-4 Comparison of NPV for all alternatives, 2019-2048



Digestion producing RNG has the best NPV for the 30 year project life and analysis, meaning that digestion producing RNG is more economical than composting in the long run. In addition to revenue generated from marketing GHG credit and compost, digestion produces biogas-to-energy product. Revenue generated from the biogas-to-energy product contributes significantly over the years to the overall revenue.

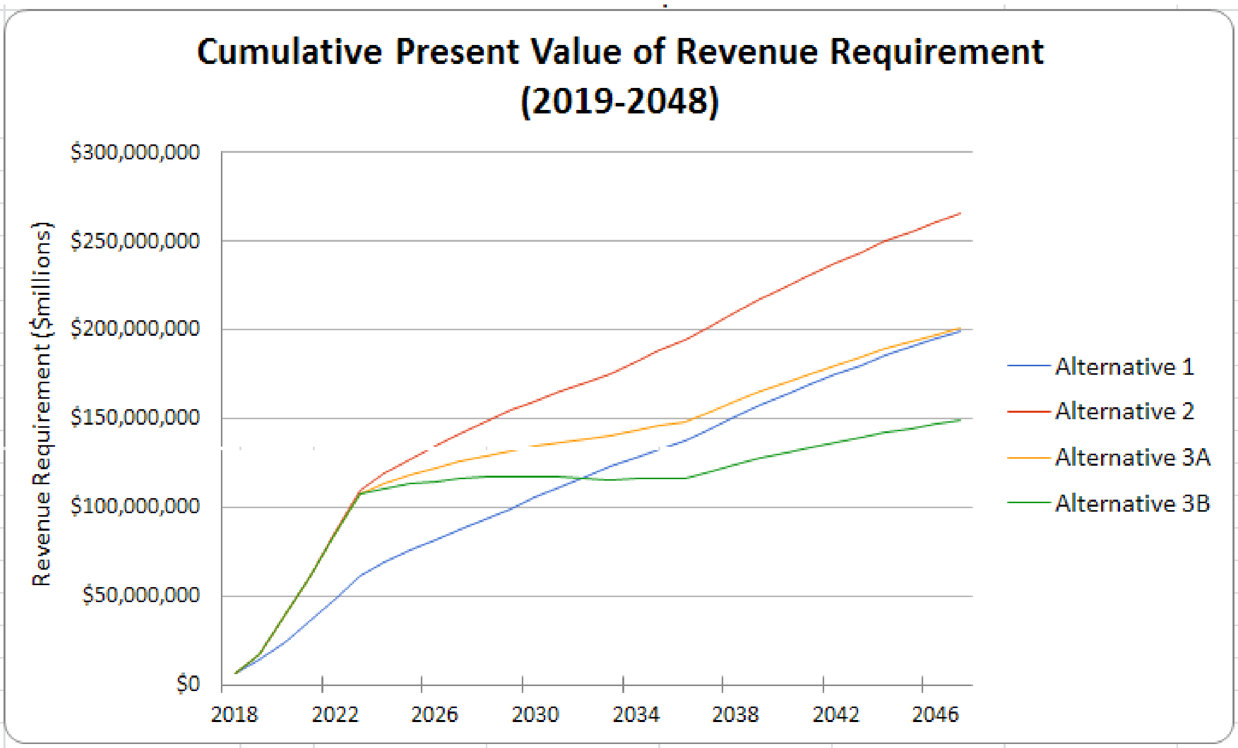
Impact on utility rates

Capital spending and the amount of revenue that can be generated from marketing processing and biogas-to-energy products directly impacts the utility rates, resulting in a direct and important **social impact** on the community. The magnitude of this impact can be evaluated by **the cumulative revenue that needs to be generated from utility rates (or rate revenue requirement)**. The higher the cumulative present value of this revenue requirement, the greater the need to raise the existing rate, and therefore, the greater negative impact on rate payers. Figure 8-5 presents different impacts on rate payers in the form of revenue requirement.

When evaluated for only the first 5-year period focusing on the least capital investment in the short-term, Alternative 1 has the lowest short-term negative impact on rate payers because it has the least capital cost during that period.

However, while Alternative 1 appears cheaper in the short term, Alternative 3 is superior overtime because of the non-rate revenue it generated by selling energy converted from biogas, and thus has the least negative impact on utility rates, as shown in Figure 8-5.

Figure 8-5 Comparison of impact on rate payers, 2019-2048



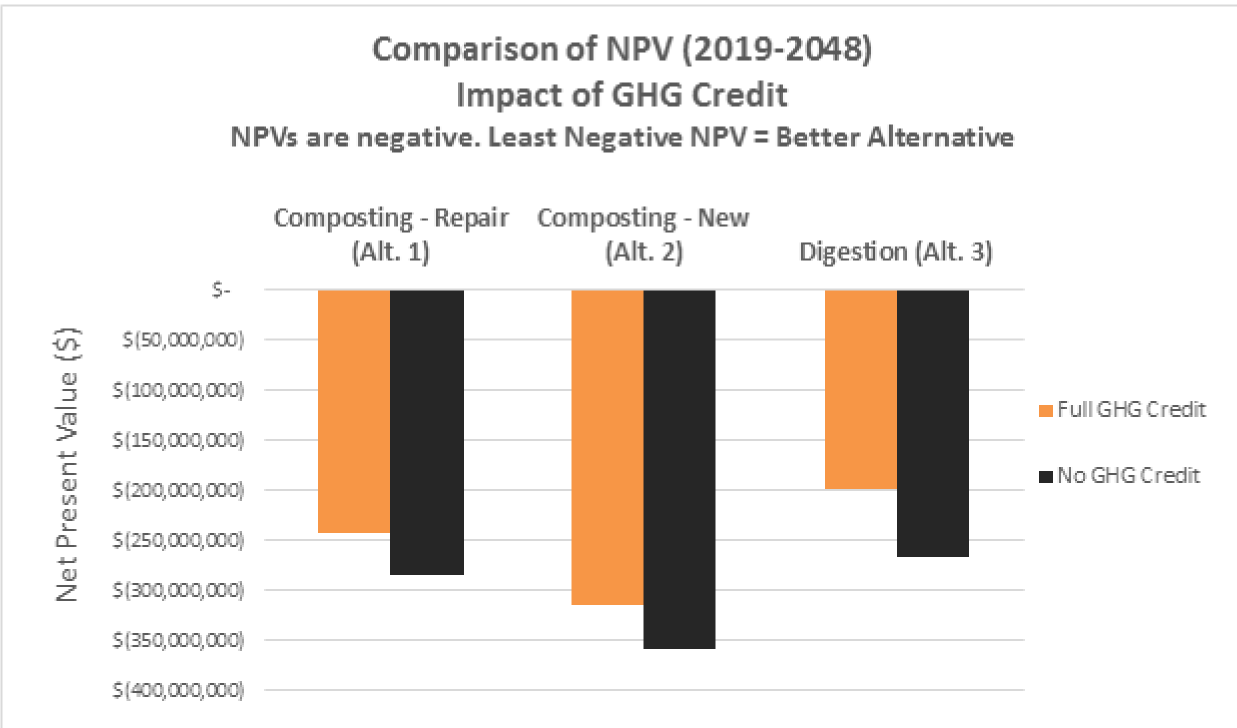
8.6. Sensitivity Analysis and Discussion of Impacts of Key Assumptions

Identified in earlier sections, revenue from GHG credit and selling of biogas-to-energy products are significant revenue contributors. Estimation of potential revenue is dependent on key assumptions such as carbon tax price (i.e. price of CO2e), market price of electricity, and market price of RNG. To evaluate the impact of the alternative comparison should these assumptions change, sensitivity analyses were conducted. Note that results using assumptions listed in 8.4 are referred to as the "baseline" scenario.

Impact of GHG Credit

Presented in Figure 8-1, revenue from GHG credit is a major contributor for all alternatives. Although unlikely, a worst-case scenario would be to assume no more GHG credit in the future, or that the carbon price becomes $0/tonne. Note that the project has not considered the impact of the new carbon levy on any of the alternatives. Figure 8-6 shows NPVs of alternatives and compares baseline scenario with the scenario of no GHG credit.

Figure 8-6 Comparison of alternatives (NPVs) under different GHG credit revenue scenarios



Under the scenario of **full GHG credit** (baseline scenario), the order of most economical alternative to least is as follows: Alternative 3 (digestion producing RNG), then Alternative 2 (composting - new), then Alternative 1 (composting – repair existing).

Under the scenario of **no GHG credit**, the order of most economical alternative to least is Alternative 3 (Digestion producing RNG), then Alternative 1 (composting – repair existing); and then Alternative 2 (composting – new).

This comparison demonstrates that **even in the very unlikely scenario of no GHG credit, the digestion alternative (3) still makes the most economic sense**.

Impact of market price of biogas-to-RNG

In the baseline scenario, Alternative 3B has the lowest NPV and makes the most economic sense. One of the key reasons is the revenue derived from selling RNG. It is therefore critical to test how NPV will change should the market price of RNG change.

The baseline scenario assumes market price of RNG at $5.14/GJ. This is the most conservative assumption because this cost is similar, even slightly lower than the current cost of natural gas of $5.35/GJ. It is extremely unlikely that market price of RNG will be below the price of natural gas.

An analysis of the NPV with varying RNG market price shows that as RNG market price increases, digestion becomes more favorable economically. When RNG can be sold at a market price at approximately $16.40/GJ, the NPV of digestion with RNG (Alt. 3B) becomes slightly positive. A positive NPV implies that not only all the capital investment can be repaid overtime, but also that that it may be possible to generate excess revenue, creating a positive impact on utility rates.

Preliminary market assessment suggests that RNG price has a higher range than baseline assumption, depending on different programs in the USA and Canada. For example, under British Columbia's FortisBC Biomethane Program, a fixed price contract typically provides a RNG price range of $18 - $22/GJ.

Impact of marketability of compost

Based on current operation and experience, marketing of compost can be challenging. It is not always possible to sell compost. As such, the worst-case scenario assumes there is no revenue from selling both MSW and SSO compost. Given that revenue from compost is a small component in revenue for alternatives, even under the worst-case scenario, digestion producing RNG (Alternative 3B) remains the most economical option.

Another aspect of marketability of compost relates to its quality. Compost produced by the current process contains glass and other materials that are not considered safe for handling and giving away. This results in a cost to the Waste Management service for hauling away compost at $17.85/tonne. Over a 30-year period from 2019-2048, this cost can amount to approximately $23 million dollars. Improving quality of the compost requires capital expenditure on new refining system and associated facility as well as new compost drying equipment and facility. The capital cost of improving compost quality is approximately $12.3 million dollars, which is accounted for in all alternatives. This comparison clearly shows that investing in the systems and facilities which improve compost quality is worthwhile, resulting in a cost saving of approximately $10.7 million dollars, even if all the compost is given away for free. Refer to Appendix 10 (*Summary* tab for calculation of cost saving).

Importantly, even after testing the individual and combined sensitivity of these key assumptions, Alternative 3B — digestion with biogas-to-RNG — remains the most economically attractive option.

ECF Decision Framework

To draw together both economic and non-financial aspects of the analyses in a quantifiable manner and arrive at a clear conclusion, the project team developed the ECF Decision Framework.

The framework uses a weighted score approach. Decision criteria, including sub-components for each criterion, and the weight of each criteria were developed by the project team and the Steering Committee. Table 8-2 describes the framework below.

Table 8-2 Decision framework description

Decision Criteria	Weight	Sub-Component of Criterion
Capital Cost	30	Not applicable
Net Present Value	25	Not applicable
Environmental	20	Diversion
		GHG Emissions
		Renewable Energy
Risks	15	Safety
		Safety Operating
		Operating Project
		Project Key Assumptions
		Key Assumptions Marketing
Accommodation	10	Capacity
		Scalability
		Flexibility

Evaluating each alternative along all of these dimensions, each received a total score out of 100 possible points.

Table 8-3 ECF Decision Criteria Scores for Options

Decision Criteria	Weight	Composting - Repair	Composting - New	Digestion
		Alternative 1	Alternative 2	Alternative 3
Environmental	20%	11	12	20
NPV	25%	20	16	25
Capital Cost	30%	30	24	24
Risks	15%	11	12	12
Accomodation	10%	5	6	6
Total	100%	77	70	87

Alternative 3B (Digestion producing RNG) received the highest overall score, as well as the highest score on almost all criterion with the exception of Capital Cost, noted in the table above. This means that considering all aspects, **building a new digestion facility at the existing site is the recommended option.**

Impact of allowing top-op of grass, leaf and yard waste (GL&YW)

A foundational assumption as mentioned earlier is that a program change for grass, leaf and yard waste (GL&YW) will be implemented before the project is ready to commission. **This means grass, leaf and yard waste will be collected and processed separately from the ECF.**

To test the impact on the ECF Business case should a top-up of green carts be allowed, a high-level analysis was conducted, comparing the impact of allowing up to 20,000 tonnes per year of GL&YW spread over five months with a 20 percent peaking factor in a month. The impact of this top-up was examined for Alternative 1 (composting) and Alternative 3 (digestion). The results of this analysis are summarized below. As this analysis is preliminary, should the decision be made to allow top-up, a more detailed economic analysis should be undertaken to determine more accurate costing.

Impact of top-op on composting (Alternative 1)

With GL&YW top-up, the existing site can accommodate the additional capacity with relocation of some existing facilities and equipment. Under this scenario, the aeration hall building would have to be expanded to add an additional compost bay around the year of 2032 compared to no expansion needed to 2044 in the base case.

Expansion will likely need to be to the North which will require relocation of the biofilter. Looking at the site plan for Attachment 1 (Appendix 11), this relocation is likely to be challenging, as room at the North end of the site is extremely limited. Relocation of the biofilter will also result in additional capital and O&M costs, with a capital cost in the order of $5 million. Expansion of the Aeration Hall to add one more compost bay will result in approximately $68 million capital cost around 2032. **Not accounting for any O&M cost, allowing grass, leaf and yard waste top-op could result in an additional $73 million capital cost.**

Impact of top-op on digestion (Alternative 3)

Assuming implementation of Alternative 3 with no GL&YW top-up, the plan is to initially construct 16 digestion tunnels and 10 composting tunnels for SSO and add 4 digestion and 3 composting tunnels by 2034 for future capacity (see Appendix 11 for site plan). With GL&YW top-up, the additional capacity requires 23 digestion and 19 composting tunnels for SSO in 2024 and additional 3 digestion and 2 composting tunnels by 2034. Estimating based on the current financial model and adjusting for more tunnels, **this means that approximately $45 million is required prior to 2024 period in addition to the $54 million in 2034 (as per the original estimate)**. This does not include the additional capital and O&M cost required to relocate the odour control system and the transformer and other electrical equipment in the area of the drum digester to utilize that space for the new facility. As is the case with Alternative 1, site limitations will also make this relocation challenging.

The impact of GL&YW on both composting and digestion are summarized in the table below.

Table 8-4 Summary of Impacts of Grass, Leaf & Yard Waste on Composting and Digestion

Alternative	Base Case Estimated Capital Cost (2019 – 2048)	Infrastructure Impacts of GYL Bin Top-Up	Estimated Capital Cost Impacts of GYL Top-Up
Alternative 1 (Composting)	$172M.	Relocation of biofilter, additional compost bay	Base Case + $73M for new total of $245M
Alternative 3 (Digestion)*	$216M	6 additional digesters and 14 additional composting tunnels; relocation of electrical and odor control systems	Base Case + $45M for new total of $261M

*Note: Digestion with RNG is assumed as base case for this purpose.

Additional Collections of Grass, Leaf and Yard Waste

As an alternative to the additional capital costs described above, the City could consider additional collections during the summer months to specifically collect GL&YW and deliver it to the cure site for composting. A single collection is estimated to cost approximately $500,000 per month. Thus for five or six months per year, the additional collections of GL&YW would result in an annual cost of $2.5 - $3.0 Million for avoiding $45 - $75 Million of capital costs.

9. Resourcing

Following the Project Development and Delivery Model (PDDM), the project will be led through Development and Delivery phases by Integrated Infrastructure Services (IIS), Facility Planning and Design (FPD) and Facility Infrastructure Delivery (FID) sections. A lead Project Manager will be assigned for the Development phase from FPD and a support Project Manager will be assigned from FID. After Checkpoint #3 and Council approval of the Delivery phase, the roles will switch, with FPD becoming support and FID leading. Other project personnel will be assigned to support the Project Managers as necessary. Program Managers and Supervisors from both sections will oversee the project and become involved as necessary. Project Managers will provide reporting through the Project Management Information System (PMIS) and through regular meetings through the design and construction periods.

Through each phase, the Strategy Business Partner (Waste Services Technical Services) and the Operate Business Partner (Waste Services Sustainable Waste Processing) will have representatives that are part of the project team. Other members of the project team may include other IIS or Waste Services representatives (including the Operating Contractor), or other stakeholders as necessary.

A Steering Committee for the project will consist of the Project Managers and leadership personnel from IIS and Waste Services and will meet regularly to review the status of the project and resolve any issues that cannot be resolved within the project team.

Special Resources

The following special resources are available to the project.

<u>IIS Engineering Services</u>:

Resources available to review engineering design associated with facility scope

Resources available to assist in review of geotechnical reports and possible risk management or environmental reports.

<u>Public Engagement Branch</u>:

Resources available to support in the development of the Public Engagement Charter as well as to introduce the City's new policy on engagement and how it may impact the project.

<u>Communications Branch</u>:

Market Research resources available to support internal and consultant team needs assessment surveys and interpretation of research. Also, 'Insight Survey' available to support internal and consultant team for needs assessment surveys.

Communications resources available to support communication plan and implementation of public engagement plan from a communications perspective.

<u>Facility and Maintenance Services and Park Operations</u>:

Provide field level expertise and input throughout project.

<u>Law Branch</u>

Law Branch resources will assist in the review of the Public-Private Partnership planning and options from both legal and risk management perspectives.

Operations Resourcing

Per the above, it is expected that Waste Services will provide resources to participate in the project team as well as the steering committee. The project team resources will come from both the Technical Services and Sustainable Waste Processing sections. The steering committee resources will be members of Waste Services leadership team.

It is expected that Waste Services will contract out the operation and maintenance of the new Edmonton Composting Facility, as has been done since the facility was taken over by the City. It is further expected that a General Supervisor of the Organics program will manage the operation through the contractor, and that a staff supervisor will manage the day-to-day details with the contractor. The compost cure site will continue to be managed and operated by Waste Services personnel.

10. Key Risk(s) and Mitigating Strategy

A comprehensive Risk Register was developed for this initiative, documenting conceptual stage project risks and alternative-specific (composting vs. digestion) risks in detail. This document is attached as Appendix 14. Key risks and their mitigation strategies are summarized here.

Key Conceptual Stage Risks (Applicable to Composting or Digestion Technology)

- The risk that the Organics Waste Program business case is not implemented, resulting in lower quality inputs and outputs (top-up option) for the ECF. This risk is being mitigated by aligning the Program Business Case approval as closely as possible with Project Business Case approval.

- The risk that the Mass Balance estimates are low, resulting in the demand for additional capacity in ECF that is not accounted for in this analysis. This risk is being mitigated in a number of ways, including by validating the mass balance numbers against other jurisdictions; continually reviewing mass balance calculations and adjusting during design; and by incorporating adequate organics volume contingencies into the design criteria.

- The risk that currency fluctuations change the value of project estimates. This risk will be mitigated by monitoring currency fluctuations during implementation, managing impacts using currency instruments or advance procurement, and negotiating contracts in Canadian dollars.

- The risk that current cost estimates are low resulting in budget or rate increases that are higher than announced to the Utility Committee and the Public. This risk is being managed by including contingencies appropriate to the project stage in the budget, as well as advancing design to Checkpoint 3, which requires more accurate cost estimates, prior to proceeding to final design and construction.

- The risk that Alberta Environment & Parks (AEP) approval is delayed which can cause schedule delay and changes to the design. This risk will be mitigated through early consultation and routine follow up AEP.

Key Risks Specific to Alternative 1 (Composting)

- The risk that ONEC repair cost estimates are low, resulting in increased project costs. This risk can be mitigated by determining the sensitivity of costs on the overall project analysis, and by developing the design to Checkpoint 3, which includes further design and investigation leading to updated cost estimates, prior to proceeding further.

- The risk that future equipment does not fit into the existing structure or impacts efficiency of operations. This risk is acceptable, as the existing structure is very large and likely will be acceptable for new technology.

Key Risks Specific to Alternative 3 (Digestion)

- The risk that the market for biogas by-products changes, resulting in decreased financial benefits to the City. This risk is being mitigated in a number of ways. First, a sensitivity analysis of these impacts was undertaken and worst-case price scenario utilized in business case. As the project progresses, it is also being discussed with local distribution companies, and Waste Services will continue to monitor market conditions. The City will also enter into appropriate sales contracts during the design phase to secure predictable revenue streams post-construction.

- The risk the quantity of biogas produced is lower than specified by the Vendor.This risk is being mitigated by using conservative estimates and by continually reviewing yield estimates and adjusting during design. Biogas quantity can also be made part of the performance requirements.

- The risk that the technology provider may request changes to City's general contract conditions and require a confidentiality agreement/policy.This risk will be mitigated in a number of ways: Law will be required to review changes and policy and provide recommendations in the City's best interest; negotiations or changes can be reviewed and accepted before a letter of intent is issued; and the City can require proposed changes to Terms and Conditions to be included in proposals.

- The risk that the maturity level of the digestate compost produced by the ECF will not be sufficient for curing. This risk will be mitigated by specifying a maturity level for the compost leaving the facility in the project specifications.

- The risk that the quality of biogas produced by the ECF is lower than specification or is variable. This risk will be mitigated by specifying a gas cleaning system to deal with variations and by specifying an RNG upgrading system to deal with low methane content or variations of quality.

11. Conclusion and Recommendations

11.1. Conclusion

This business case demonstrates that the ECF must be renewed in a timely manner. This facility must be upgraded to meet its current operational demands, as well as the changing demand expected in the next 10-20 years. As such, while repairing the existing structure (Alternative 1) is likely to have the lowest immediate impact to rate-payers, it is ultimately a short-term solution because the equipment replacement cannot be indefinitely avoided.

A number of opportunities exist to maximize the long-term benefits associated with each remaining renewal option. Which benefits the City will realize depends most directly on the selection of either composting or digestion technology. In the case of both Alternative 2 (Composting Technology) and Alternatives 3A and 3B (Digestion Technology), the City must be prepared to accept temporary inoperability of the ECF, potentially resulting in the diversion of organic waste to landfill during the demolition and construction phases. On the positive side, any of these alternatives will also increase the quality of the compost that the ECF produces, thereby potentially improving its marketability and providing additional cost avoidance for compost that is not marketable. None of these options is anticipated to result in major organizational change, and all, once completed, will serve to increase the City's overall diversion rate. Thus, each can be said to ultimately support the City's vision to be a customer driven world leader in sustainable and innovative waste management.

Alternatives 3A and 3B are distinguished from Alternative 2 chiefly by their potential to produce additional marketable by-products – either electricity (3A) or RNG (3B). While production of RNG (Alternative 3B) has the highest potential financial benefit, any option employing digestion rather than composting is clearly more beneficial, environmentally and holistically, than repairing or replacing existing composting equipment.

11.2. Recommendations

This business case corresponds to the Project Development and Delivery Model (PDDM) requirements for Checkpoint #1 - Authorization for Project Initiation. It is recommended that Alternative 3B be approved for project initiation and planning to PDDM Checkpoint #2 - Authorization for Design Expenditure.

Alternative 3B consists in demolishing the existing ECF and constructing a new ECF facility with new digestion equipment and new equipment to generate renewable natural gas from the biogas.

The size and scale of the facility is based on implementation of Separated Source Organics (SSO) collection for single unit residences with a small cart, as well as separate grass, leaf and yard waste collection.

Funding for planning, estimated at $2,000,000, will be used to advance the project to PDDM Checkpoint #2 - Authorization for Design Expenditure. This phase includes:

- Completing assessment of potential for Public-Private-Partnership per Policy C555. Results of the assessment will be submitted to Utility Committee and Council for approval.
- Determination of the delivery method and operating model for the facility.
- Continued research and environmental scan to support planning for design, construction, operation and maintenance of the facility.
- Procurement planning.

11.3. Project Responsibility and Accountability

Project Role	Name and Title	Roles and Responsibilities
Strategy and Operate Business Partner	Michael Labrecque, Branch Manager, Waste Services	Strategy Business Partner identifies and justifies a business need in alignment with the organization's strategic goals (defines the problem and measure of success). Strategy BP is responsible for developing a business case for the project and championing the project (any COE Section, Branch, Department, or Partner). A BP can include the role of both a Strategy and Operate BP for a project. ● Responsible for the development of the Strategy and business case that supports long-term needs, functional requirements, project goals and objectives ● Leads the completion of PDDM Checkpoint 1 with support from the IIS as outlined in Strategy Transition - Checkpoint 1 Overview ● Approval of significant changes to scope, budget and schedule in conjunction with the IIS Project Sponsor ● Participates in concept and design reviews to ensure the project meets the Strategy, project goals and objectives including operational requirements Operate Business Partner participates in identifying and justifying a business need with the Strategy BP in alignment with the organization's strategic goals. An Operate BP may also identify and justify a business need to provide on-going, day-to-day programs and service delivery (an "operational" strategy). The Operate BP will benefit from the output and receive the asset to operate, use and/or to maintain. A BP can include the role of both a Strategy and Operate BP for a project. ● Approval of significant changes to scope, budget and schedule in conjunction with the IIS Project Sponsor ● Participates in concept and design reviews to ensure the project meets the Strategy, project goals and objectives including operational

		requirements
IIS Project Sponsor	Pascale Ladouceur Director, Facility Planning and Design	A designated project role within IIS with the delegated authority to the project, by delegating the authority and accountability to the Project Manager. The IIS Project Sponsor provides direction, financial resources, and supports the project objectives. • Ensures objectives are achieved through the Project Development and Delivery Model (PDDM) for planning and design up to the end of Checkpoint 3 • Ensure changes to scope, budget and schedule are approved as required • Approves key deliverables (eg. Project Charter, Project Mgt Plan)
IIS Project Manager (Lead)	Project Manager	A designated project role given the delegated accountability, authority and responsibility to achieve the project objectives. The Project Manager is responsible for delivering the project, which includes the duties related to management, communications, reporting, review and approval. The Project Manager is the Agent of the IIS Project Sponsor and the Business Partners. • Accountable and responsible for all project management activities, acts as the project lead through the planning and design up to the end of checkpoint 3 • Leads the project team to accomplish the planned deliverables to fulfill the project requirements and ensures all reviews and approvals are completed • Manages, tracks and reports project budget and milestones through detailed plans and schedules to ensure the project is on budget, on schedule and within the defined scope and quality • Adheres to the Project Management methodology, policies, processes and core requirements, guiding the expectations for each project knowledge excellence • Responsible for the Public Engagement and Communication requirements, responding to citizen and stakeholder inquiries and following applicable

		policies, procedures and processes • Responsible to ensure Occupational Health and Safety requirements, procedures and objectives are integrated in all project activities and deliverables • Acts as Contract Manager and manages consultant(s) in conjunction with Project Architect, CPSS, and Law as required, following all procurement and contract management requirements, policies and procedures
Subject Matter Experts Engineer-ing Services, PRT Team, Law, etc	TBD	• Reviews designs to ensure planning and design meets functional requirements, project goals and objectives • Provides input and supports reviews of key deliverables • • Ensures all applicable policies, procedures and processes are followed based on Subject Matter Expertise •

12. Implementation Approach

Once this strategic business case is approved, a Project Manager will be assigned by IIS, and a development project team will be formed. Representatives from the Strategy Business Partner and the Operate Business Partner will be part of the project team. The project will be executed per the Capital Governance Policy (C591), the Project Design and Delivery Model and the Project Management Reference Guide.

The details of the implementation approach will depend on the chosen delivery method which will be reviewed through the Public-Private-Partnership, per Policy C555.

13. Review and Approval Process

13.1. Business Case Sign-off

The business case has been developed as part of a strategy project led by Stantec. The project consisted of Stantec personnel, members from the Facility Planning and Design section of Integrated Infrastructure Services (IIS), and members from the Business Integration, Technical Services, and Sustainable Waste Processing sections of Waste Services. All project team members have participated in the project and have reviewed the documentation generated to develop the business case, as well as the business case itself.

Project Team Members

Name	Title	Section / Branch/Department
Ryan Kos	General Supervisor, Business Strategy	Business Integration/Waste Services/City Operations
Jane Ni	General Supervisor, Operational Planning and Project Delivery	Technical Services/Waste Services/City Operations
Jawad Farhad	General Supervisor, Organics Processing & Management	Sustainable Waste Processing/Waste Services/City Operations
Henry Maisonneuve	Project Manager	Facility Planning and Design /IPD/IIS
Gordon Derick	Supervisor, Project Management	Facility Planning and Design /IPD/IIS
Bruce Ferguson	Vice President, Programs & Project Management	Stantec
Manoj Singh	Senior Waste Management Engineer	Stantec
Charles Alix	Senior Associate	Stantec
Chengyan Zhang	Business Consultant	Stantec
Micaela Brown	Associate, Project Manager	Stantec
Courtney Newsham	Electrical Engineer, Assistant Project Manager	Stantec

In addition, a steering committee consisting of leadership personnel from IIS, Waste Services, and Finance have met regularly to review the project status and have reviewed the business case.

Steering Committee Members

Name	Title	Section/Branch/Department
Michael Labrecque	Branch Manager	Waste Services/ City Operations
Cameron Grayson	Director	Business Integration/Waste Services/City Operation
TBD	Director	Sustainable Waste Processing/Waste Services/City Operations
Ellen Tian	Director	Technical Services/Waste Services/City Operations
Keith Knoblauch	Operational Controller	Business Financial Analytics/Financial Strategies and Budget/Financial and Corporate Services
Pascale Ladouceur	Director	Facility Planning and Design/Infrastructure Planning and

		Design/ Integrated Infrastructure Services
Jason Meliefste	Branch Manager	Infrastructure Planning and Design/ Integrated Infrastructure Services

Approval of the business case has been provided by Gord Cebryk, Deputy City Manager of City Operations and Adam Laughlin, Deputy City Manager of Integrated Infrastructure Services.

14. Appendices

Appendix 1: ECF Aeration Hall Reinforcement Study – Site 500. ONEC.

Appendix 2: Building Condition Assessment – Edmonton Composting Facility. Stantec Consulting Ltd. February 12, 2018.

Appendix 3: Process Equipment Assessment – ECF. Stantec Consulting Ltd. December 12, 2017

Appendix 4: Environmental Scan. Stantec Consulting Ltd. March 2018.

Appendix 5: Technology Assessment Report – Organics Waste Processing. Stantec Consulting Ltd. April 2018.

Appendix 6: Organics Processing Facilities – Request for Information. Stantec Consulting Ltd. May 28, 2018.

Appendix 7: Memorandum Re: COE ECT/MRF Business Cases – Proposed KPIs for Technology Assessment. April 5, 2018.

Appendix 8: EWMC Mass Balance Model Summary, Forecasted to 2024. City of Edmonton, Waste Services.

Appendix 9: Supplemental Analysis – Impacts of Electricity vs RNG Production

Appendix 10: ECF Economic Analysis Version 11. December 12, 2018, 2018. Stantec Consulting Ltd.

Appendix 11: ECF Site Plans

Appendix 12: Impacts of Grass, Leaf, and Yard Waste Top-Up

Appendix 13: ECF GHG Credit Calculator

Appendix 14: ECF Business Case – Implementation Phase Risk Register – 13 Dec 2018

Appendix 1

ECF Aeration Hall Reinforcement Study – Site 500.
ONEC.

ECF AERATION HALL REINFORCEMENT STUDY - SITE 500

ONEC REFERENCE NO. E181722CP

PREPARED FOR:

INTEGRATED INFRASTRUCTURE SERVICES

CONFIDENTIAL

Abstract

This document outlines ONEC's Reinforcement Study Report for the Existing ECF Aeration Hall Building located in Site 500 of the EWMC Facility in Edmonton, Alberta

Revision	Date	Description	Prepared By
0	October 31, 2018	Issued for Use	Paul Spourghan, P.Eng.

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1 INTRODUCTION

The City of Edmonton (City) has engaged ONEC to determine if there are means of reinforcing the existing Aeration Hall building to meet building code requirements for safe use and occupancy for its intended purpose.

2 PROJECT BACKGROUND

2.1 ASSET DESCRIPTION AND BACKGROUND

The main Aeration Hall Building was designed in 1998 and constructed in 2000 and is located at Site 500 of the EWMC facility. The building measures approximately 117.600 m (386 feet) wide by 199.644 m (655 feet) long by 12.192 m (40 feet) high and covers about 23,478 square meters (252,830 square feet) of space. The building is a pre-engineered, frameless structure comprised of light gauge structural panels. The Aeration Hall has one annex to the west designated as the South Download Building, comprised of 1,192 square meters (12,832 square feet); and an annex to the south designated as the Finishing Circuit comprised of 1,142 square meters (12,290 square feet). The Aeration Hall building is bounded by a lagoon to the east and south, the Biofilters to the north, the Biosolids Loadout Building at the southwest corner, the North Download Building at the northwest corner and five conveying drums to the west.

The Aeration Hall building is constructed on continuous strip footings measuring 1,200 mm (4’-0”) to 1,500 mm (5’-0”) wide along the exterior walls. The Aeration Hall and annexes have a foundation wall that extends above a slab-on-grade structure measuring 1.8 m (6’-0”) and 305 mm (1’-0”) for the South Download Building and the Finishing Circuit, respectively. Two rows of interior spread footings measuring 2,750 mm (9’-0”) square are located approximately one-third the width of the Building in the east-west direction. Near mid-length of the Building, between gridlines 15 to 19, underground electrical conduits, mechanical piping, and tunnels run from the south side of the building in Bay 3 to the northern side of the building in Bay 1. The tunnels have a width of 965 mm (3’-2”) at the south end and widens to 8,331 mm (27’-4”) at the north end.

The existing roof has a gable shape with a slope of 1:82 (0.70°) on both sides. The roof structure measures 2,696 mm (8’-10”) deep and is comprised of light gauge 113 mm (4-1/2”) deep corrugated carbon steel panels at the exterior roof and 113 mm (4-1/2”) deep corrugated stainless steel panels in the interior (ceiling). Both the exterior roof and ceiling panels are connected with light gauge, galvanized hat-shaped web members to create a truss structure to support the roof loads. The trusses span in the north-south direction and are spaced at 1,041mm (3’-5”) on center.

The roof structure is supported by bearing walls comprised of 191 mm (7-1/2”) deep stainless steel corrugated panels. The interior portion of the roof is supported by two rows of 610 mm (24”) deep structural steel beams and 305 mm (12”) square hollow section columns laid out in the west-east direction. The exterior of the stainless steel bearing wall is skinned with cladding, girts and batt insulation. Based on a review of the architectural drawings, there were no requirements for providing eavestrough and downspouts along the eaves of the building’s roof. However, eavestrough and downspouts were installed at the south side of the Aeration Hall to control water flow onto the asphalt service access roads.

It is understood that the temperature inside the Aeration Hall when composting undergoes anaerobic state is approximately 30 degrees Celsius while the exterior can each reach temperatures of -40 degrees Celsius, resulting in a differential temperature of 70 degrees the roof structure will need to be designed to withstand for.

The facility as a whole is used for transformation waste into useful resources. TransAlta initially constructed and owned the facility until the City purchased it in 2003. The Aeration Hall was constructed to process screened organics from the collected waste, then combine with biosolids to create compost material that could be used as fertilizer. The Aeration Hall includes three compost bays, each equipped with an overhead machine / auger to aerate the material. The composting process produces a significant amount of heat, moisture, and gases. The odour is controlled by negatively pressuring the building and expelling the gases through underground tunnels into the biofilters located north of the building.

The City engaged ONEC in 2016 to conduct a building condition assessment on selected members of the Aeration Hall building to determine the extent of corrosion that may be present. During ONEC's inspection of the building, team members observed buckling of the stainless ceiling panels near the middle of the structure. Further investigation and research revealed that structural repairs had been conducted in 2003 and again in 2013. The repair in 2003 was performed on the two rows of the interior columns, located at one-third and two-thirds of the building's width. The repair consisted of reinforcing the bottom portion of the roof structure with a single 191 mm (7-1/2") deep light gauge channels and replacement of the buckled stainless steel ceiling panels. The 2013 repair was performed between the two rows of interior columns with the installation of two back-to-back 191 mm (7-1/2") deep channels. However, it is noted that the buckled stainless steel ceiling panels at those locations were not replaced with new ones. ONEC's inspection identified that the repairs had only been partially performed and not completed. All-in-all, the total reinforcement measures approximately 51.206 m (168 feet) in width for each of the 192 trusses and extends the whole length of the building.

Reports were prepared by ONEC outlining the issues observed of the roof structure, the continued structural deficiencies noted from the building's components, and the attempted repairs on them. Based on calculations conducted by ONEC, it was determined that the roof structure is not designed to support snow loads in accordance with the current Alberta Building Code (ABC 2014) requirements, making the building unsafe for occupancy during the winter season when snow accumulates on the roof. As such, the building cannot be operated during the winter seasons, resulting in reduced compost production and lost revenue for the City of Edmonton.

Further reports and documents prepared by ONEC and Behlen, appear to show that the structure was not adequately designed to support climatic loads indicated in the Alberta Building Code 1997 and to the design codes or guides available at the time of structure was initially designed.

2.2 Project Purpose and Scope

The primary objective of the project is to determine if the existing Aeration Hall Building can be reinforced to support dead loads and climatic design loads in accordance with the Alberta Building Code requirements. The National Research Council Canada (NRC) has indicated that buildings or components that have been in service for at least 30 years and demonstrate to be satisfactory may be considered to have sufficient capacity to resist loads unless there is evidence of significant damage, distress or deterioration noted. Due to the current condition state of the roof structure described in the previous section of this report, any reinforcements needed for the structure must be based on current codes at the time the reinforcements are designed for.

Following are the items that were performed:

a. Preliminary design of a new partial self-supporting truss system that will shelter the existing Aeration Hall roof.
b. Determine the additional dead load (self-weight of the reinforcements designed above) that will be added to the existing foundations. A self-weight allowance for a solar panel installation option has been included for possible future energy saving initiatives.
c. Determine the design capacity of the existing foundation system to verify that the added weight of the reinforcements will not overstress the existing foundation system.
d. Provide preliminary reinforcement details showing how it will be attached to the existing building.
e. Develop a methodology for construction.
f. Determine if the Finishing Circuit to the south and Biofilters to the north will impede construction.
g. Estimate the remaining service life of the existing system and how the reinforcements will extend the intended service life of the structure to the desired five to ten-year timeline or greater.
h. Prepare drawings to show a concept plan for the proposed reinforcements.
i. Prepare a Class 4 (-15% to +50%) as per AACE International.
j. Prepare a high level construction schedule for the project.

2.3 Original Design loads

Design drawings for the Aeration Hall from the original engineering consultant (GKO Engineering) and the original building vendor supplier (Behlen Industries) were provided to ONEC for review.

General Notes on drawing number 40-S-FDN-100, Rev.0, was prepared by GKO Engineering. The major design loads for the building are indicated as follows:

- Applicable Building Code: National Building Code 1995 (NBC 1995)
- Strip and spread footing **allowable** bearing capacity: 125 kPa
- Ground Snow Load (Ss): 1.6 kPa
- Associated Rain Load (Sr): 0.1 kPa

- Wind Load (q): 0.40 kPa
- Icing (northern part of the Aeration Hall Building): 0.39 kPa and 0.75 kPa (drawing 40-S-BDG-100 Rev.0)
- Superimposed Dead:
    - Roofing: 0.6 kPa
    - Electrical: 0.1 kPa
    - Mechanical: 0.15 kPa
    - Weight for cable trays and duct are also indicated on drawings:
        - 40-S-BDG-104
        - 40-S-BDG-105
        - 40-S-BDG-106
        - 40-S-BDG-107

Comparing the loads shown on Behlen Industries General Information and Conformance Drawing Sheet 1, Rev.1, to that shown by GKO Engineering, the major difference found in the design loads for the building are indicated below:

- The ice load on Behlen Industries'drawings only indicate 0.39 kPa is used for the calculations, rather than GKO's specified 0.75 kPa located at the northern part of the roof.
- Dead loads:
    - Weight of building system taken as 0.40 kPa, rather than 0.60 kPa as specified by GKO Engineering. It is assumed that the weight of the building as reported by the manufacturer is the accurate number as they should have more specific knowledge on the components used.
    - No direct indication on the drawing that additional cable trays, large ducts, or equipment loads were considered in the design of the building.

2.4 Proposed Design Loads

For the purpose of this study, the following design loads are proposed for the design of the reinforcements and for verifying the capacity of the existing foundations:

- Building Code: National Building Code 2015 (NBC 2015). The NBC 2015 was chosen for this study since the Alberta Building Code is soon due for a revision and that new relevant information can be found in the new code. Furthermore, at the time the building is proposed to be designed, a new building code may be in effect.
- Strip and spread footing **factored** bearing capacity: 150 kPa (Assumed value - existing Geotechnical report to be updated with new parameters based on new codes and standards)
- Snow Loads:

- Importance Factor (Is): 1.0
- Ground Snow Load (Ss): 1.7 kPa
- Associated Rain Load (Sr): 0.1 kPa
- Basic Snow Roof Factor (Cb): 0.92 (as per new building code requirements as specified in NBC Clauses 4.1.6.2(2)(a) and (b), to account for large roof structures)
- Wind Exposure Factor (Cw): 1.0
- Roof Slope Factor (Cs): 1.0
- Accumulation Factor (Ca): 1.0
- Calculated roof design snow load (S): 1.67 kPa
- Full and Partial Loading as addressed in NBC Article 4.1.6.10, has been considered on this roof structure due to multiple support spans along the width of the building.

- Wind Loads:
  - Importance Factor (Iw): 1.0
  - Wind (q): 0.45 kPa
  - Exposure Category: Open Terrain
  - Exposure Factor (Ce): 1.11
  - Internal Pressure Category: 2
- Icing (northern part of the Aeration Hall Building): 0.39 kPa and 0.75 kPa (drawing 40-S-BDG-100 Rev.0)
- Superimposed Dead:
  - Roofing:
    - Standing seam roofing system and purlins: 0.19 kPa
    - Pre-fabricated insulated panels (3” thick, R22 value): 0.14 kPa
    - Collateral Loads (Mechanical and Electrical): 0.40 kPa
    - Solar Panel complete with Rail Installation: 0.14 kPA
    - Existing Aeration Hall Roof Structure Self-Weight: 0.42 kPa
  - Walls:
    - Cladding and Girts: 0.14 kPa
    - Pre-fabricated insulated panels (3” thick, R22 value): 0.14 kPa
- Miscellaneous cable trays and large duct work has not been considered in the analysis as it does not provide a significant part of the overall design of the building components and its foundations with regards to this study only.

Since the adoption of the National Building Code 2005, the return periods for snow and wind have increased from 30 years to 50 years, resulting in climatic design load increases for snow and wind by approximately 6 percent and 13 percent, respectively.

3 Feasibility Assessment

3.1 Reinforcement Design

The study investigates the feasibility of two alternative reinforcement systems to the existing structure. Due to the severe extent of deterioration observed of the existing structural components of the South Download building, it is recommended that the structure be demolished. A report has been prepared to address the demo work and is located in Appendix C.

3.2 Proposed Design Approach Type I: (Structural Steel Trusses, Purlins/Girts and Cladding)

The first proposed design (Type I) will use new structural steel framing above the Aeration Hall Building to effectively cover the existing roof structure from accumulating snow during the winter seasons. The structural steel will consist of fabricating 3,353 mm (11'-0") deep trusses with a 1:24 (2.4°) roof slope, comprised of hollow section members spanning in the north-south direction over the entire 117.600 m (386'-0") width of the existing building. The trusses will be spaced at each gridline, approximately 7,290 mm (24'-0") on center, with the exception of the trusses near the end walls, where they will be spaced closer to suit existing conditions. The trusses will be supported at four locations; exterior sides of the existing building walls with 356 mm (14") square hollow section columns at full height, and in the interior with short columns consisting of 254 mm (10") hollow sections. The intermediate column supports will penetrate through the existing roof cladding into the attic space and bear directly onto the existing welded wide-flange beams measuring 610 mm (24") deep, which are in turn supported by existing building columns at each gridline. The new columns are located directly above the existing 305 mm (12") building columns, therefore, the existing welded wide flange beam will need minor reinforcing to allow for pass-through forces between the new and existing columns. The existing building columns will need to be reinforced with new angles installed at each corner of the hollow section member to increase its current capacity to withstand the new dead and snow loads imposed onto the structure.

There will be approximately three to four expansion joints incorporated within the building's structural framing, due to the long building length. The existing strip and spread footings will require reinforcement at each gridline to support the additional loads imposed on the system.

Below are a few reasons as to why the new steel columns are supported at the exterior side of the adjacent foundation walls:

- If the new columns are supported directly above the existing foundation wall, demolition and shoring work will be required to support a portion of the existing wall and roof trusses since the stainless steel corrugated wall cladding is load bearing. New supports will also be required for the existing skinned insulated walls at the exterior side of the corrugated panels. Special hoarding will be required during the construction of the reinforcement to prevent odour produced from the compost process from escaping to the exterior atmosphere and to fulfill requirements from Environment Canada.

- If new columns are supported adjacent to the foundation walls to the interior, the obstructions caused by constructing new reinforcing concrete pedestals may impede on operations. If new columns are supported adjacent to the foundation walls to the exterior, impact to operations, construction costs and schedule will be minimized.

The new roof system will be comprised of standing seam cladding and supporting cold-formed purlins. The wall will be comprised of cladding and supporting cold-form girts. The building's interior will retain heat, moisture, and gases by using 76mm (3") pre-fabricated insulated ceiling and wall panel system with an R-Value rating of 22. The exposed sides of the panels will be treated with 4-mil plastisol coating that will be suitable for the high humidity and corrosive environment. The additional benefits of the proposed insulated panel system are that the new structural framing will not be exposed to large temperature differentials between the interior and exterior temperatures, panels will be easier to replace when required and will also have the capability to support maintenance personnel when servicing the space between the trusses and panels. Refer to Appendix B, for additional information on the panels. Additional insulation can be added to the underside of the standing seam roof cladding (eg. blanket insulation) to help in reducing the induced temperature loads that the steel structure will need to withstand.

Design of new reinforcements should be done in a manner to minimize the need to shore the existing building during the construction of the structure, however, temporary bracing/shoring will most likely be required during the erection of the steel structure.

If the existing Aeration Hall roof structure was determined through continued monitoring of the facility, that it is no longer capable of supporting its self-weight, the new overhead trusses have been designed to carry the Aeration Hall roof by a suspended support system, comprised of HSS beams and rods spanning in the east-west direction of the ceiling. However, it will be problematic to wait until significant signs warrant the addition of the suspended roof structure as it adds safety concerns at the time of its install.

Refer to SK-1 through SK-4, in Appendix A, for conceptual reinforcement details.

3.3 Proposed Design Approach Type II: (Metal Deck and Open Web Steel Joist Roof System)

The second proposed design (Type II) the new roof will utilize a metal deck and open web steel joists supported on girders, and framed above the existing Aeration Hall building. The roof deck will have an SBS roofing membrane installed. The steel members will be erected in a stick-built manner on site, but could be possibly assembled in modules. The same reinforcements to existing steel columns and footings will need to be made, similarly to that described in Type I, above.

Refer to SK-7, in Appendix A, for a proposed roof framing plan.

3.4 Lateral Load Resisting System

The lateral load resisting system currently used for the Aeration Hall Building to resist both wind and seismic loads is by diaphragm action with the existing roof and wall panels. The proposed structural steel reinforcement design approach, Type I, will utilize horizontal trusses running in the east-west direction and located at the top chord of the vertical trusses and span the entire length of the building. For the design approach, Type II, the q-deck will be utilized for diaphragm action.

The lateral forces in the north-south direction will be supported by cross-braced frames and transmitted to the endwall foundations. The lateral forces in the east-west direction will be supported by cross bracing in between the new columns and transmitted to the perimeter north and south foundations.

An alternate form of providing lateral support in the north-south direction would be to design exterior struts at each of the 29 frames, extending diagonally downward onto supporting helical piles along the north side of the building, adjacent to the Biofilters. This system may provide cost savings over the lateral truss system indicated above but will also cause potential obstructions for service vehicles. Obstructions can be minimized as there is approximately 18,288 mm (60’-0”) of space available between the north side of the Aeration Hall wall and the south edge of the Biofilters and by strategically locating the bracing into the ground. Currently, the southwest corner of the Biofilter section is very close to the Aeration Hall wall; however, recent study and work completed on the HVAC project of the North Download building indicated that less capacity will be required for the use of the filters, thereby, reducing the amount of woodchips needed for the area, and leaving up to 18.288 m (60’-0”) of space available for optional diagonal braces.

3.5 FOUNDATIONS

The existing foundations supporting the Aeration Hall Building appear to be designed and constructed to accommodate the reactions provided by Behlen Industries (the building vendor) and provide very little surplus in capacity, especially for the spread footings. As such, additional foundation reinforcements will be required to support the new reinforcement system. Spread footings will need to be increased in size by a minimum of 350 mm (14”) on all sides and doweled into the existing foundation. The strip footing along the building perimeter will need new concrete pedestals and footing extensions adjacent to, and doweled into the existing foundation walls to suit the new columns. Refer to preliminary sketches in Appendix A for details. Furthermore, A small portion of the existing footings could be undermined to allow new concrete to extend underneath for a better connection where possible (this detail is not shown in the preliminary sketches found in Appendix A). A geotechnical engineer will be engaged during the design phase to explore cost-effective options for reinforcing the existing footings.

Generally, the reinforcement will be confined to areas where columns will be located. For example, at all gridlines in the north-south direction and at the endwalls, spaced at approximately 7,290 mm (24’-0”) on center.

The strip and spread footings located near underground tunnels and conduits between gridlines 16 to 19 pose a challenge for reinforcement and will require special consideration during the detailed design stage.

Locates for all services will need to be conducted prior to digging, or alternately, hydrovac can be utilized.

3.6 FIRE PROTECTION

It is understood that the existing building does not utilize a sprinkler system for fire protection. The review of building codes at the time of detailed reinforcement design will need to be performed to determine what requirements will need to be incorporated into the building.

Alternatively, pre-fabricated insulated wall and ceiling panels may be able to provide some fire protection but will require more investigation and design to confirm compliance with applicable building codes and standards.

3.7 Serviceability Criteria

Building sway, displacement, deflections, and other serviceability criteria will be in accordance with codes noted below:

The new reinforcing structure will need to be designed to minizine the effects of deflections – the building components should be designed to allow for sufficient movement without damage. Limitations as per CAN/CSA S16-14, Limit State Design of Steel Structures as follows:

- Roof Vertical Deflection due to Snow Load: L/180; Where L = Length or Span
- Wind Load lateral Deflection: h/200; Where h = Story Height

4 Project Delivery Strategy

Determining the project delivery strategy is one of the most important decisions for a successful project completion. Choosing the best strategy must start with a good understanding of choices available. For this Project, there are several potential delivery strategies available – Design-Bid-Build (DBB), Design-Build (DB), Construction Management (CM) or Integrated Project Delivery (IPD). Given the complex, intricate and unique needs of the Project, we recommend using an IPD project delivery process for the following reasons:

1. Early collaboration between all stakeholders (Owner and User Groups, Consultant, Contractor) will maximize efficiency through all phases of design, fabrication, and construction.
2. Innovations in design and construction methods could be explored and evaluated against the project goals and objectives pertaining to quality, sustainability, cost control and schedule management.
3. Key decisions are evaluated by key project participants, including design and construction professionals.
4. Risks can be managed effectively.
5. This delivery strategy may allow the project to be under construction in the Spring of 2021.

If a decision is made to proceed with the traditional Design-Bid-Build approach or the alternative Design-Build or Construction Management approach, ONEC will adjust the proposed work delivery plan to reflect the preferred strategy.

4.1 Methodology and Logistics

In order to reduce costs, expedite schedule and minimize impact to operations of the Aeration Hall and adjacent facilities, early procurement of the structural steel is recommended as there is over 1,000 tonnes of material to be fabricated.

Detailed engineering will be issued for the following construction activities upon City's review and approval:

- Foundation work (reinforcing the existing spread and strip footings).
- Items that may require minor modification to the existing equipment, cable trays and conduits to accommodate the installation of the new structural steel. The new steel would be designed in a way to minimize impact to existing construction where possible.
- Structural steel work (trusses, columns, braces, purlins, cladding, etc.) to allow for procurement and fabrication of the materials. Fabricated material will be stored at the vendor's yard until ready to ship to site for installation.

Upon the installation of columns and wall bracing, the roof trusses will be fabricated in three sections measuring approximately 39.014 m (128'-0") long, each complete with a splice at mid-point for transportation and assembled on site in modules in the following sequence prior to the crane lift:

- Two back-to-back adjacent truss frames spaced at 7.315m (24'-0").
- Roof bracing, as required.
- Purlins and/or girts and cladding.
- The average footprint of one module will measure approximately 7.315m (24'-0") wide by 39m (128'-0") to 39.7m (130'-3") long.

Each assembled module will have an approximate mass of 30 tonnes and will be lifted with the aid of an 80 ton and 600+ ton capacity mobile cranes. The modules may be installed starting from the east side of the Aeration Hall Building and progress towards the west side of the building. The modules will be erected in a manner where one gridline bay spacing (gridlines running in the east-west direction) 7.315m (24'-0") wide is skipped. For example, modules will be installed from the far east side and throughout the width of the building, followed by an empty gridline bay, followed by an installed module, followed by and empty gridline bay, and so forth. Due to the large size of the 600+ ton crane and its boom length, the crane will be situated along the service road north of the Biofilters and most likely encroach into the filters in order to allow for sufficient boom reach for the installation of the modules located on the north side of the building, directly above Compost Bay 1. The crane will be situated along the south side of the Aeration Hall for modules that will be installed directly above Compost Bays 2 and 3. The middle module will have columns pre-welded to the truss frames and will be erected directly above the existing W24 welded wide flange beam. The beam will be boxed in with reinforcing plates at those locations to allow the force to transfer directly to the existing square hollow section column below.

Wall cladding will be installed from the eave of the new roof structure and extend 305 mm (12") below the eave of the existing building. This will allow two things to happen:

- For the demolition of the Aeration Hall, there will be an opportunity for waste material to be brought to the exterior through the sides of the building for disposal, if desired.
- Deferred costs for cladding the rest of the building from the eave down to near grade level if funding is limited during the main reinforcing phase of the Aeration Hall building.

An additional added benefit of having a self-supporting overhead structure is that it is capable of supporting portions of the existing building during the demolition stage with minimal shoring work.

4.2 Construction Schedule

Below is a proposed high-level schedule outlining the design, procurement, construction and fit up.

Upon award of the project, detailed engineering design involving all four disciplines; geotechnical, structural, electrical and mechanical would be performed in approximately eight months in addition to the City's review cycles and any design changes that may need to be incorporated. Long lead items will be procured after the design development is completed to allow fabrication and delivery to site while the final design details are being completed.

The foundation work is proposed to be constructed during early spring and late fall seasons, prior to snowfall, approximately seven months in duration. New reinforcement and other building components can be fabricated at the shop until the following spring.

Structural steel and other building components will be brought to site in early spring the following year to be erected within seven months or until first snow fall occurs.

The total project duration is projected to be three years, depending on difficulties encountered during the design, approval cycle, fabrication, or construction phases of the project life cycle.

4.3 Construction Cost Estimate

The feasibility study estimate is intended to provide direct and indirect costs for the construction of the proposed reinforcing structure for the Aeration Hall facility.

Quantities of major elements were assessed and measured where possible and priced based on Means Publishing, contractor pricing and local experience gained by ONEC.

An allowance of 2.83% was added to account for inflation in 2019 to the anticipated bid date of the project in 2020. The rate is based on an average Municipal Price Index (MPI) for the years of 2019 and 2020.

An allowance of 25% contingency was added to cover design and pricing unknowns.

Cost estimate based on information presented on preliminary sketches SK-1, SK-2, SK-3, SK-4, and SK-7 and on the following components of the proposed Design Approach Type:

- **Design Approach Type I:**
  - Supply and install of structural steel columns, anchor rods, trusses, wall and roof bracing.
  - Primer coating where steel is not exposed to the elements.
  - Galvanizing where steel is exposed to the elements.
  - Standing seam roofing.
  - 600 ton and 80 ton mobile cranes. Budgeted for 800 hours on 600 ton crane.

- Supply and install standard wall cladding and girts. Wall cladding will extend 305mm below the existing building eave height. The remaining exposed wall will be cladded once the existing building is demolished.
- Future install of existing Aeration Hall roof supports if required (hanger type supports to the underside of the existing ceiling)
- Excavate / Backfill
- Cut & dispose existing slab at the interior column lines.
- Supply and place slab replacement at interior column lines.
- Reinforcing the existing interior column.
- Form / pour / strip concrete pads shown on SK-3 and SK-4.
- Reinforcing steel and dowels shown on SK-3 and SK-4.
- Ready mix supply shown on SK-3 and SK-4.
- Supply of lunch, office and washroom trailers.

- **Design Approach Type II:**
  - Supply and install columns, beams and wall bracing.
  - Supply and install of open web steel joists and q-deck.
  - Supply and install SBS roofing.
  - Galvanizing where steel is exposed to the elements.
  - Supply and install standard wall cladding and girts. Wall cladding will extend 305mm below the existing building eave height. The remaining exposed wall will be cladded once the existing building is demolished.
  - Future install of existing Aeration Hall roof supports if required (hanger type supports to the underside of the existing ceiling)
  - Excavate / Backfill
  - Cut & dispose existing slab at the interior column lines.
  - Supply and place slab replacement at interior column lines.
  - Reinforcing the existing interior column.
  - Form / pour / strip concrete pads shown on SK-3 and SK-4.
  - Reinforcing steel and dowels shown on SK-3 and SK-4.
  - Ready mix supply shown on SK-3 and SK-4.
  - Supply of lunch, office and washroom trailers.

Cost Summary:

DESCRIPTION	DESIGN APPROACH TYPE I (Structural Steel Trusses, Purlins and Standing Seam Roof System)	DESIGN APPROACH TYPE II (Metal roof Decking c/w OWSJ System)
Substructure: Reinforcements to the Existing Foundations	$4,659,900	$4,659,900
Superstructure: Reinforcement to the Existing Aeration Hall Building	$12,851,477	$21,348,878
Addition of new Aeration Hall roof support system (hanger type supports to the underside of the existing ceiling, as required)	$2,588,250 Note 1	$2,588,250 Note 1
Sub-total Costs	**$20,099,627**	**$28,597,028**
General Requirements and Consulting Fees (15%)	$3,014,944	$4,289,554
Construction Administration (10%)	$2,009,963	$2,859,703
Sub-total Costs Excluding Contingencies	**$25,124,534**	**$35,746,285**
Design and pricing unknowns (25%)	$6,281,133	$8,936,571
Inflation Allowance (2.83%) – 2 years, compounded annually	$1,442,171	$2,051,869
Total Construction Estimate	**$32,847,838**	**$46,734,725**
Unit Cost (Approximate Floor Area: 24,620 m^2 [265,120 ft^2])	**$1,334/m^2 ($124/ft^2)**	**$1,898/m^2 ($176/ft^2)**

Cost Summary of Differed Future Costs:

DESCRIPITION	DESIGN APPROACH TYPE I & II
Cladding the remaining wall from the eave to ground level.	$1,603,000
Pre-Fabricated Insulated Ceiling and Wall Panels (76mm thick)	$5,948,179
Sub-total Costs	**$7,551,179**
General Requirements and Consulting Fees (15%)	$1,132,677
Construction Administration (10%)	$755,118
Sub-total Costs Excluding Contingencies	**$9,438,974**
Design and pricing unknowns (25%)	$2,359,743
Inflation Allowance (2.83%) – 2 years, compounded annually	$541,805
Total Construction Estimate	**$12,340,523**
Unit Cost (Approximate Floor Area: 24,620 m^2 [265,120 ft^2])	**$501/m^2 ($47/ft^2)**

Note 1 – If the building is planned to be demolished in near future, the cost for directly supporting the roof may be subtracted from the Sub-total cost.

Note 2 – An allowance of approximately $750,000 should be added to the above costs to allow for repair of the Biofilters due to mobile crane access.

Exclusions:

- Special reinforcements for strip and spread footings adjacent to underground tunnels, conduits and piping.
- Reinforcements for underground tunnels.
- Mechanical and electrical work.
- Costs for altering the existing MCC.
- Price of steel based on current mill price. No allowance made for price changes due to tariff.
- Demolition work, unless noted otherwise.
- Cost of operations due to reduced capacity output and impact to adjacent facilities.

- Owner's staff and associated management costs.
- Relocation of existing facilities and services.
- Temporary service roads.
- Hoarding.
- Special safety considerations.
- Any new fire proofing protection.
- Environmental regulations.
- Cost of contaminated soil removal, if required.
- Legal fees and expenses.
- Building permits.
- Tax.

5 CONSTRUCTION IMPACTS TO OPERATIONS

Based on the proposed logistics and construction schedule, the following will impact SUEZ's operations:

- Limited use of the facility during the installation of the reinforced spread footing foundation for the interior columns of the building along Gridlines B and C.
- Limited use of the facility during the installation of the structural steel and other building components erected with a mobile crane. No personnel can be inside the building at areas where load is being lifted directly overhead by the mobile crane.
- Limited use of the facility during the installation of the reinforced strip footing foundation at the perimeter of the building. Most of the work will be performed at the exterior side of the foundation walls, with the possible exception where MCC 5 is located inside of the Finishing Circuit. To avoid moving the PLC panels and modifying the existing masonry constructed enclosure, the foundation reinforcement may be constructed inside the Aeration Hall at three locations, between Gridlines 15 to 18. Columns will need to penetrate through the existing stainless steel panel at these locations. To avoid gas from entering the attic space, a rubber boot seal type membrane will be used, similarly to the ones already used for the existing columns penetrating through the ceiling panels.
- Construction traffic will utilize the service roads immediately to the north, east and south side of the Aeration Hall Building. The access roads will need to be shared with the Integrated Processing and Transfer Facility (IPTF) and Biosolids Loadout Building at the southwest corner of the Aeration Hall Building and Global Electric Electronic Processing (GEEP) to the northeast. It is understood that the following activities currently occur around the facility:

- **IPTF:** Traffic flow of bin trucks every 60 minutes daily from the overhead doors located at the northeast corner of the IPTF. The facility operates approximately 16 hours over a five day week.
- **Biosolids Loadout Building:** Traffic flow of six to 12 trucks daily. The Biosolids Loadout Building is located at southwest corner of the Southdown Load Building. The facility operates approximately 12 hours over a five day week.
- **Compost Loadout Shelter:** Traffic flow of approximately 12 trucks daily from the shelter located about 21 m (70’-0”) southeast from the Finishing Circuit Building.
- **Residual Loadout Shelter:** Traffic flow of approximately three trucks daily from the conveyor located immediately east of the Finishing Circuit Building.
- **GEEP:** The service road prominently used by this facility is located north of the Biofilters and will be limited during the erection of the north module trusses. The facility operates approximately 16 hours over a five day week.
- **Biofilters at the Southwest Corner:** It is understood the southwest section of the Biofilter is currently not functioning as intended and is slated to be repaired in 2019. If the City decides that the Aeration Hall reinforcement project is to proceed, it will be prudent to hold off on the repairs of the Biofilter until the reinforcements for the building is complete since crane access may be required for area.

6 RISK AND RISK MITIGATION

The risk and risk mitigation measures on this project will include safety, schedule, cost and quality. We understand that the City of Edmonton would like the ECF facility to start functioning as early and consistently as possible, therefore, the following items are proposed:

a) **The City** determines the most appropriate project delivery method to pursue; DBB, DB, CM, or the recommended IPD to suit the facility’s needs.

b) **Procuring of material** will be critical to having it available in time for erection. Material for the project can be made through a number of manufactures in the Edmonton area. For example, cladding, liner, girts and purlins can be provided by at least three companies in Edmonton. For larger orders, they are subbed out to their larger manufacturing plants in other provinces, if required. As for structural steel, there is a manufacture in Edmonton along with its subsidiaries capable of delivering about 120,000 tons/year, which is more than this project will require. In addition, there are also at least two other large structural steel manufacturers that would be able to deliver on the project requirements. Coordinating the efforts for obtaining material will be important to reduce the risk of not having it readily available when needed on site.

   Once the size of the large mobile/crawler crane requirements have been established, booking for the equipment would require approximately a six month lead time. There are a few suppliers in Western Canada able to provide 600+ ton capacity cranes.

c) **Early procurement of structural steel** will follow shortly after the design development of the main trusses and other major building elements have been completed. The detailed design of the steel will occur after construction drawings for the reinforcement of the existing foundations has been completed.

d) **Reinforcing the foundation** will occur after detailed drawings have been completed. Reinforcement to the existing foundations immediately adjacent to the underground tunnels, conduits and piping will require special consideration due to the limited space available for constructing the reinforcements without negativity affecting the existing services. The issue of concern occurs between gridlines 15 to 19 and along gridline C, between gridlines 4 to 15. The condition of the existing foundation walls exposed above grade to view appear to be in fair to good condition. However, the condition of the concrete at the footing area and inside the tunnels are not currently known. It is recommended that further test locations be conducted by excavating at selected locations of the existing footing(s) to allow the concrete to be exposed for an inspection. Moreover, an inspection should also be conducted inside the tunnels, where possible, to determine its current condition. It is understood for the last 17 years of the building's service life, there was never eaves trough installed at the north side of the structure. Water would be allowed to drain from the eave unto the ground directly below. This is problematic as water could accumulate and infiltrate into the soil, reach the footing and potentially cause settlement to occur. A survey of the north foundation wall would be recommended to determine if settlement has occurred.

   By conducting the selected inspections, it will be possible to determine if additional work than originally anticipated by the proposed reinforcement plan would be required and to reduce unexpected costs during the construction phase.

   If it was found that the existing foundation is in good condition, the service life of the concrete could extend possibly 40 plus years and justify the costs for constructing new reinforcements and for installing solar panels.

e) **The water table** is known to be very high at this area. An inspection should also be conducted to determine whether it is required to pump out or drain the water. It is understood that the City has been exploring ways to dewater a portion of the site, and if this is the case, determine how this would be beneficial at the time of construction.

f) **Allowance of $750,000** should be included for Biofilter repair in the North-East and North-West sides of the building due to damage from the mobile crane(s).

g) **Potential problem might** exist with water circulation in foundation pipes.

h) **Schedule** for the construction of both the substructure and superstructure can only be completed during the spring and fall seasons of each year when snow accumulation is not present on the roof of the Aeration Hall building. To help facilitate these requirements, careful planning of the design stages will need to be developed to ensure procurement and fabrication of the materials can be completed at the scheduled dates.

i) **Disruption** to the operation of the Aeration Hall and adjacent facilities can be minimized by planning the erection sequence of the proposed reinforcement system. For foundation reinforcements, the intermediate spread and perimeter strip footings can be constructed while the facility is in operation, with minor disruptions scheduled in advance. Installation of the superstructure (columns, bracing and modular roof trusses) would ideally start at the east side of the Aeration Hall and progress towards the west side of the building. The main reason for starting to erect the steel at the east end of the building is due to the fact that composting material will be brought into the Aeration Hall at the west side of the building from the Tipping floor via conveyors running through two drums that connect the two faculties together. A portion of the Aeration Hall may be occupied where erection is not occurring directly overhead and within a pre-determined buffer zone. There will be a point at approximately 79 m (260’-0”) away from the west side of the building where erection of the roof trusses will impede on the operational process flow of the facility and will require the need to stop operation temporarily to allow the rest of the trusses to be installed. The time for erecting those portions of the trusses may take approximately one to three months.

   To the same effect, the adjacent buildings such as the IPTF and Biosolids building may also experience limited material removal temporarily while the crane at that location is in service. However, trucks transporting material from the facilities may resume operations between crane lifts. Refer to SK-6, in Appendix A, for road access limits.

   A temporary service road measuring approximately 114m (374’-0”) long may be constructed to allow personnel to enter the GEEP facility while the crane is in service at the north side of the Biofilters. Refer to SK-5, in Appendix A, for the proposed service road location.

   Ultimately, the City and operational management will need to determine the best path forward for the facility.

j) **If the Existing Aeration Hall roof** was found through continued monitoring to be deteriorating to a point where it is no longer able to support its own weight, reinforcements could be added to the underside of the existing ceiling and hung from the underside of the new truss chords at selected locations. The cost for these reinforcements will be differed future costs. However, waiting until significant signs warrant the addition of the suspended roof structure will be problematic as it adds additional safety concerns at the time of install and may no longer be feasible. To minimize risks, it is recommended to add the suspended system to support the existing Aeration Hall roof as soon as possible after the construction of the new roof trusses has been completed.

7 CONCLUSION

This report has been prepared to determine at a high-level if the existing Aeration Hall building can be reinforced to allow safe occupancy of the structure and meet Building Code requirements. Sections three and four of the report suggests that a Type I design approach would be a feasible option for reinforcing the existing building. However, there are other questions and assumptions made in the report that will require further investigation to confirm their validity as to whether reinforcing the Aeration Hall would be feasible. Some of the questions needed to be looked into further are as follows:

- What is the structural condition of the existing spread and strip footings?
- Will dewatering during the construction of reinforcements to the existing footings be problematic?
- What is the structural condition of the existing tunnels? Will repair work be required, if so, to what extent?
- Will the existing underground services within the Aertaion Hall play role as to whether any of these will require repair or replacement work in the near future?
- What real impact will the construction of the reinforcement play to other adjacent facilities? How will these be handled?
- How much space will the City provide for construction material laydown, and where?
- Can a portion of the existing Biofilters be taken out of service to allow for mobile crane access?
- How much disruptions to the ECF could be tolerated during the construction phase?
- How do future plans for the ECF effect what the Aeration Hall will play in the future, and to what extent?

There are still a number of other questions and concerns that will need to be addressed before deciding whether reinforcing the Aeration Hall would be a cost-effective option.

This report has only touched base on a few of the items that should be looked into, and to allow for further constructive dialog between the owner, operations and the consultant as the project progresses.

8 FEASIBILITY LEVEL STUDY

This is a feasibility level study and will need to be verified, refined and progressed during the design development stage as the solution proposed will require further development and to allow additional understanding of other potentially affected components such as electrical and mechanical equipment.

9 LIMITATIONS

This report including drafts or other relating documents associated with this report shall not be distributed to any third-party or to the public without written approval by both ONEC and its author, unless and until disclosure is required by law or regulations, and then, only to the extent of such requirement. The City of Edmonton may make copies of this report for its own use with the intended purposes of this report. ONEC and its author shall be informed in writing if any portion of the document(s) for mentioned above is distributed to any third-parties or to the public where required by law.

10 CLOSURE

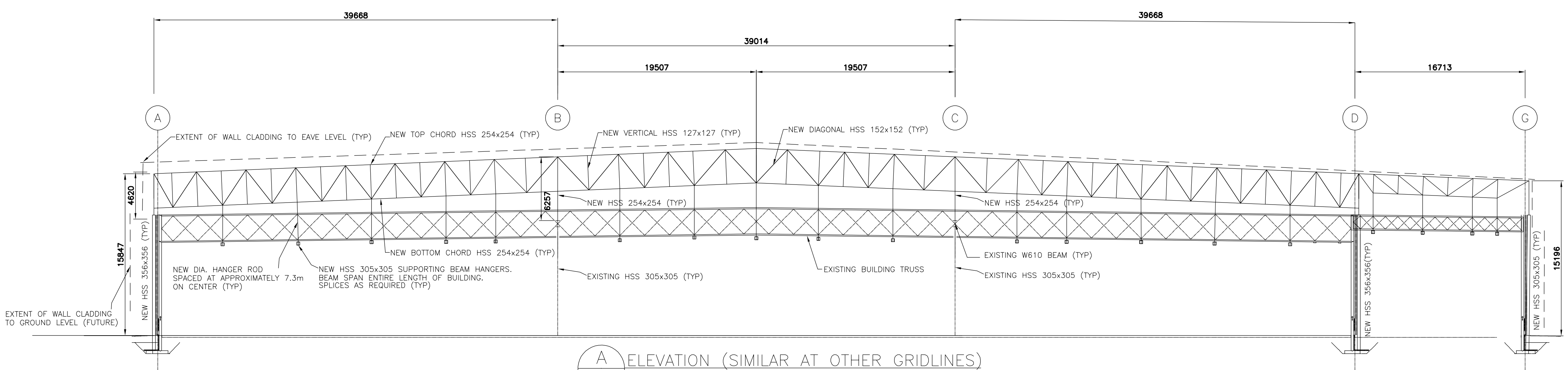
We trust that the information provided herein meet your requirements. If you have any questions or require additional information, please contact the undersigned.

Sincerely,

Paul Spourghan, P. Eng.
Senior Civil / Structural Engineer
ONEC Engineering, a Division of ONEC Construction Inc.
3821 - 78 Avenue Edmonton, AB T6B 3N8
paul.spourghan@onecgroup.com

APPENDIX A: CONCEPTUAL DESIGN SKETCHES

AERATION HALL REINFORCEMENT STUDY



A ELEVATION (SIMILAR AT OTHER GRIDLINES)
40-S-BDG-100

no.	description	date	checked
A	ISSUED FOR INFORMATION	2018/08/21	PS

revisions

issue data	date
Issue Description	0000/00/00

seal

seal

permit

consultants

ONEC

consultant project no. E181772P

THE CITY OF Edmonton FINANCIAL SERVICES AND UTILITIES

project

ECF FACILITY

location : 250 AURUM ROAD N.E., EDMONTON, AB

drawing title

AERATION HALL REINFORCEMENT STUDY– BUILDING SECTION

scale N.T.S

drawn by
date

drawing no.

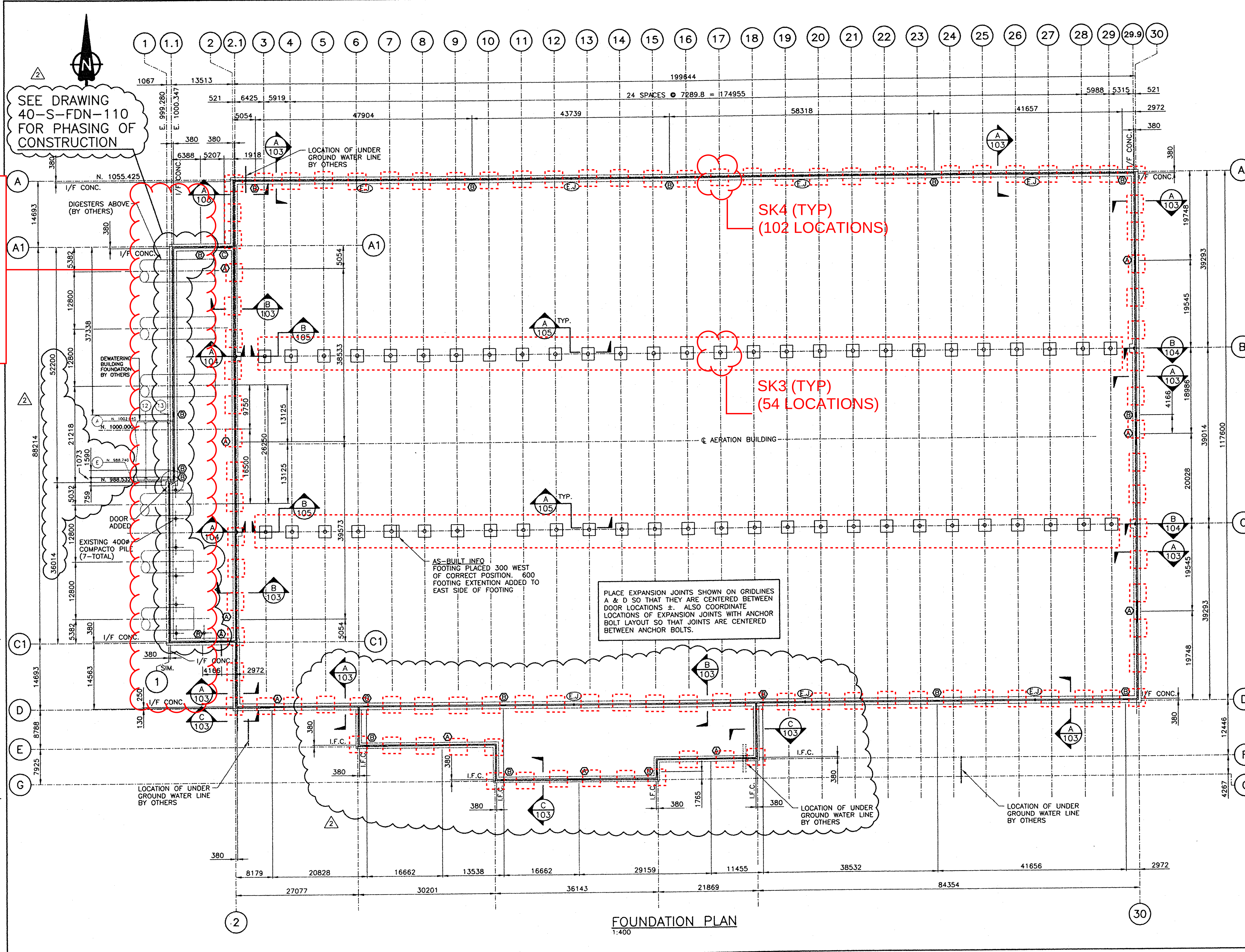
checked by
date

sheet no. 1 of 1

reviewed by
date

project no. E181772CP

CAD file name: SK–1



NOTES:

1. ALL FOOTING EXCAVATIONS MUST BE INSPECTED BY THE GEOTECHNICAL ENGINEER PRIOR TO FORMING.
2. ROUGH OPENING SIZE AND LOCATION IN WALLS CONFIRMED:
   - (A) 5130 WIDE OVERHEAD DOOR OPENING
   - (B) 1016 WIDE MANDOOR OPENING
   - (C) 3048 WIDE OVERHEAD DOOR OPENING
3. BIDDER TO ALLOW FOR SIX (6) 300ø OPENINGS THROUGH FOUNDATION WALLS, IN BUDGET.
4. UNEQUAL LATERAL EARTH PRESSURE ADJACENT TO FOUNDATION WALL SHALL BE MINIMIZED. BACKFILL ON ONE SIDE OF THE FOUNDATION SHALL NOT BE MORE THAN 600mm HIGHER THAN THAT ON THE OTHER SIDE, UNLESS OTHERWISE NOTED.
5. THESE FOUNDATIONS HAVE BEEN DESIGNED BASED ON THE FOLLOWING BUILDING LOADS PROVIDED BY "BEHLEN INDUSTRIES" OF MANITOBA, DATED JULY 6, 1998.

DESCRIPTION	NORTH (kN/m)	SOUTH (kN/m)	E&W (kN/m)	COLUMNS (kN)
DEAD	9.1	9.1	2.2	180
LIVE	40	28	1.3	639 *
WIND (UPLIFT)	-12.6	-12.6	N/A	-249
WIND (LATERAL)	±2.1	±2.1	±2.1	N/A
ICE LOAD ON NORTH WALL	3.8	N/A	N/A	N/A

* NORTH COLUMNS ONLY; 510kN FOR SOUTH COLUMNS.

NOTE TO CONTRACTOR

- WORK THIS DRAWING WITH THE ANCHOR BOLT PLAN BY "BEHLEN INDUSTRIES"

LEGEND

(E.J) EXPANSION JOINT (SEE TYPICAL DETAILS & NOTE ON PLAN)

DRAWING No.	DESCRIPTION

REFERENCE DRAWINGS

PROFESSIONAL ENGINEER PHILLIP WONG ALBERTA 98/03/15

PERMIT TO PRACTICE GKO ENGINEERING
Signature
Date 98/03/15
PERMIT NUMBER: P 05434
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PERMIT STAMPS

NO.	DATE	DESCRIPTION	BY	CHK	ENG	APP
2	14SEPT98	SOUTH & WEST ANNEX REVISIONS	DY	RZ	PW	
1	27AUG98	FINAL DOOR AND EXP. JOINT LOCATIONS	DY	RZ	PW	
0	12AUG98	ISSUED FOR CONSTRUCTION (PKG. 313)	DY	RZ	PW	
B	22JUL98	ISSUED FOR TENDER (PKG. 313)	DY	RZ	PW	
A	16JUL98	ISSUED FOR 90% CLIENT REVIEW	DY	RZ	PW	

REVISIONS

GKO Engineering
TransAlta

TITLE: EDMONTON CO-COMPOSTING FACILITY UNIT 40 - AERATION BUILDING FOUNDATION PLAN (PHASE 1)

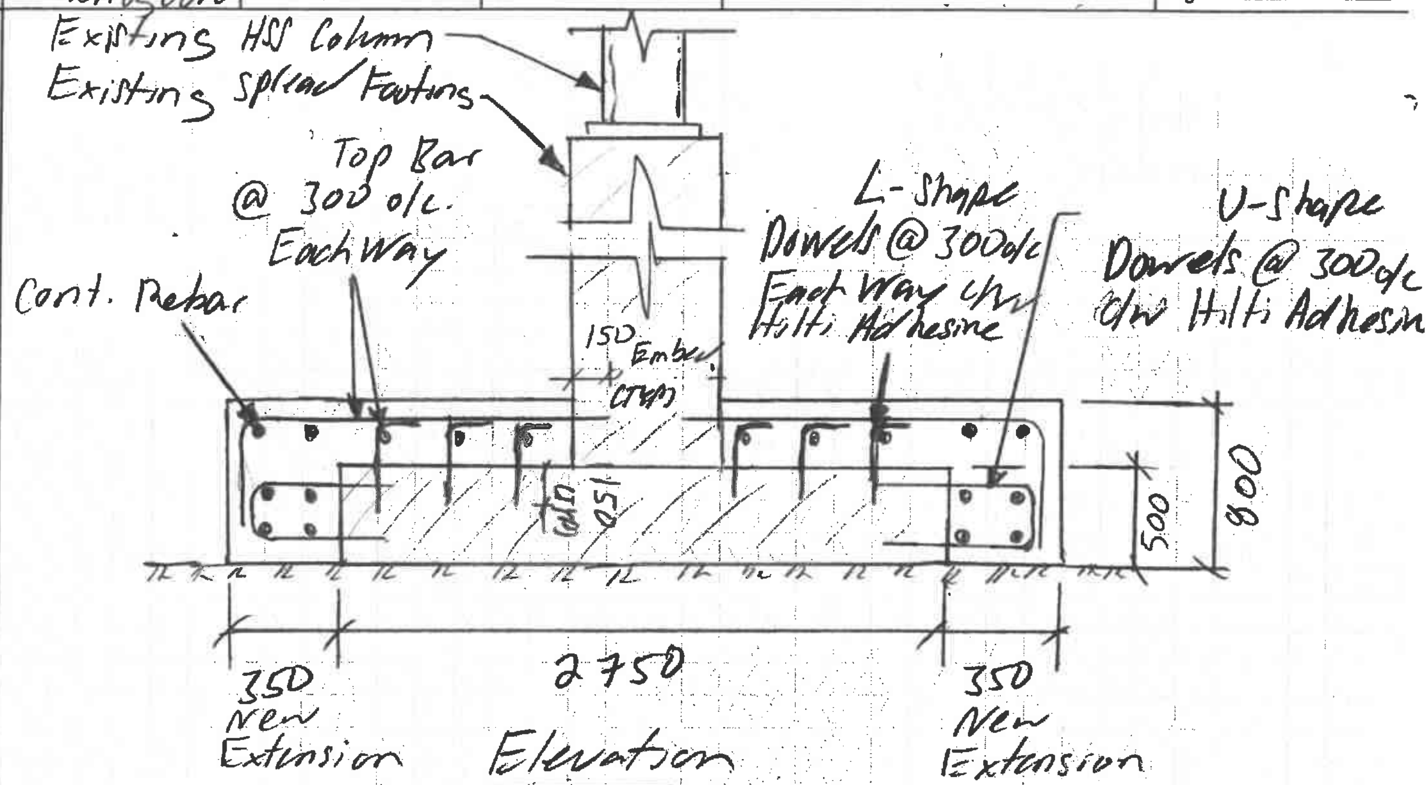
DRAWN BY: DY	DESIGNED BY: PW	DATE: JULY98
CHECKED BY: RZ	APPROVED BY:	SCALE: 1:400
JOB No.: E540	DRAWING No.: 40-S-FDN-102	REV. 2

SK-2

www.onecgroup.com

CLIENT: City of Edmonton
PROJECT: Aeration Hall Reinf. Study
JOB No.: E 181772CP-001
SUBJECT: Spread Footing Reinf.

DATE 10 Aug 2018 | BY P. S. | CHK | SKETCH NO. SK-3 | Pg NO. 1 of 2



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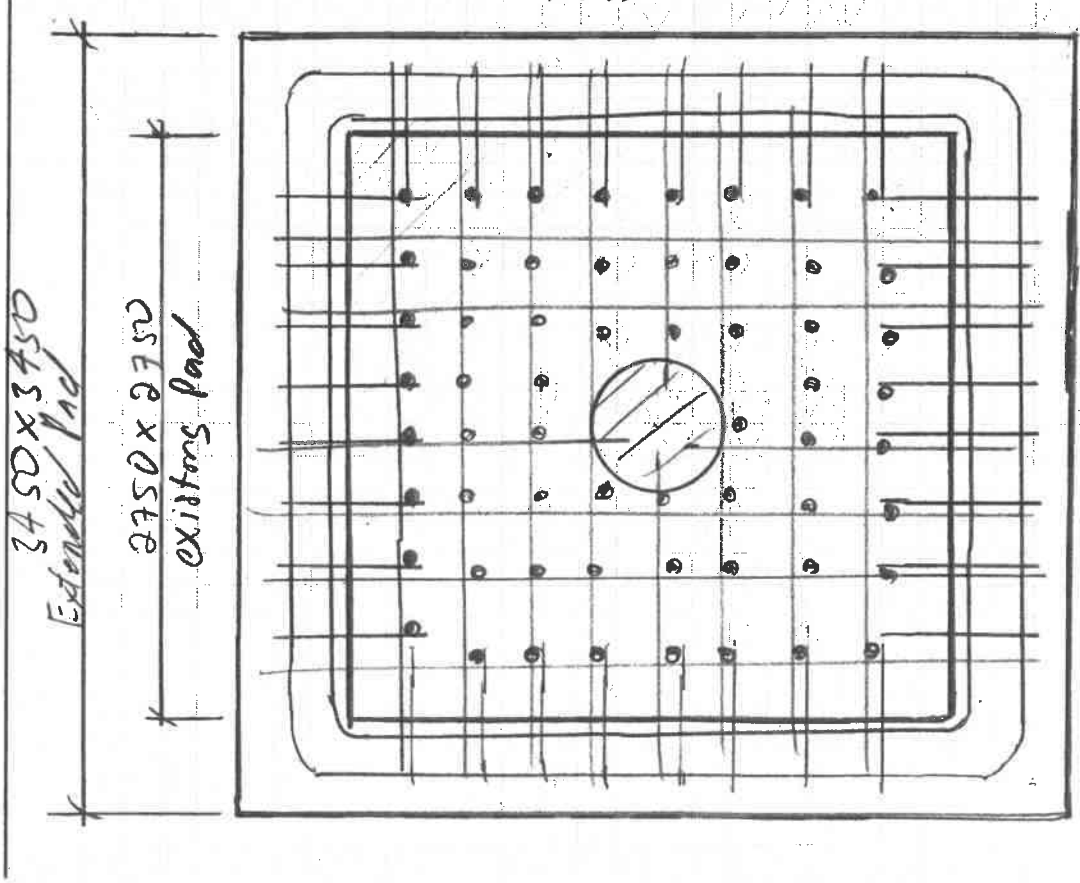
N.T.S.



(Refer to Drawing 40-S-FDN-103 for Elevations)

Roughen existing concrete Footing Pad

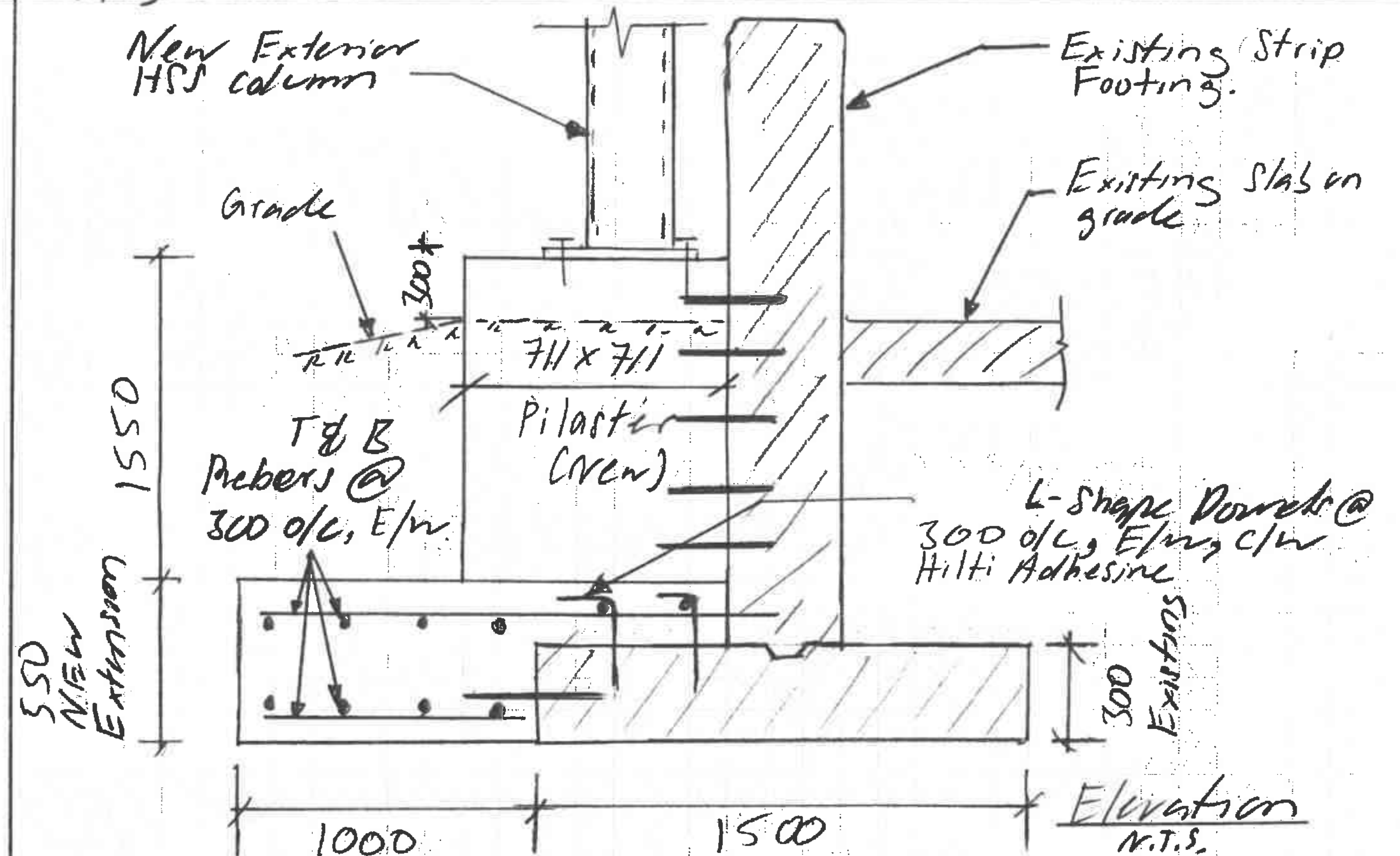
Plan
N.T.S.

ONEC

www.onecgroup.com

CLIENT: City of Edmonton
PROJECT: Aviation Hall Reinf. Stud
JOB No.: E181772CP-001
SUBJECT: Strip Footing Reinf.

DATE 10 Aug 2018	BY P.S.	CHK	SKETCH NO. SK-4	Pg NO. 2 of 2



Elevation
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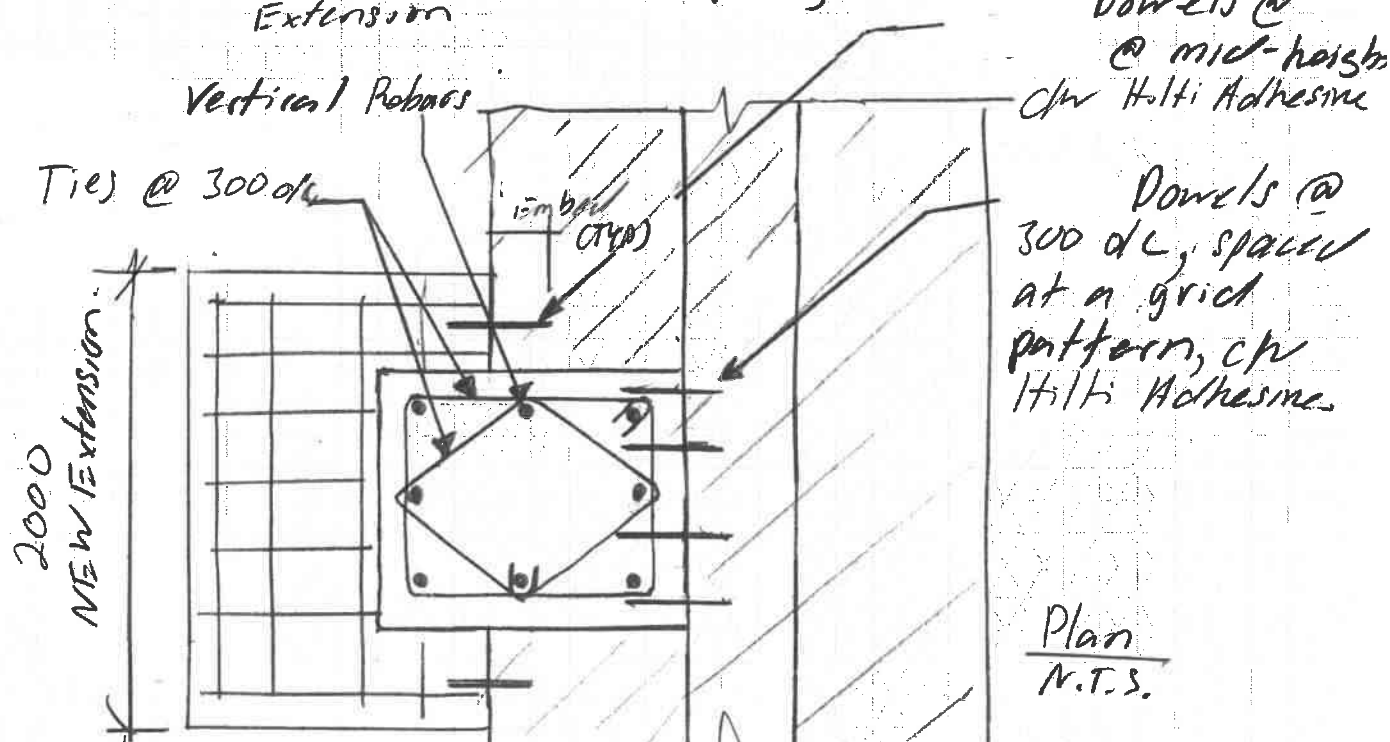

Plan
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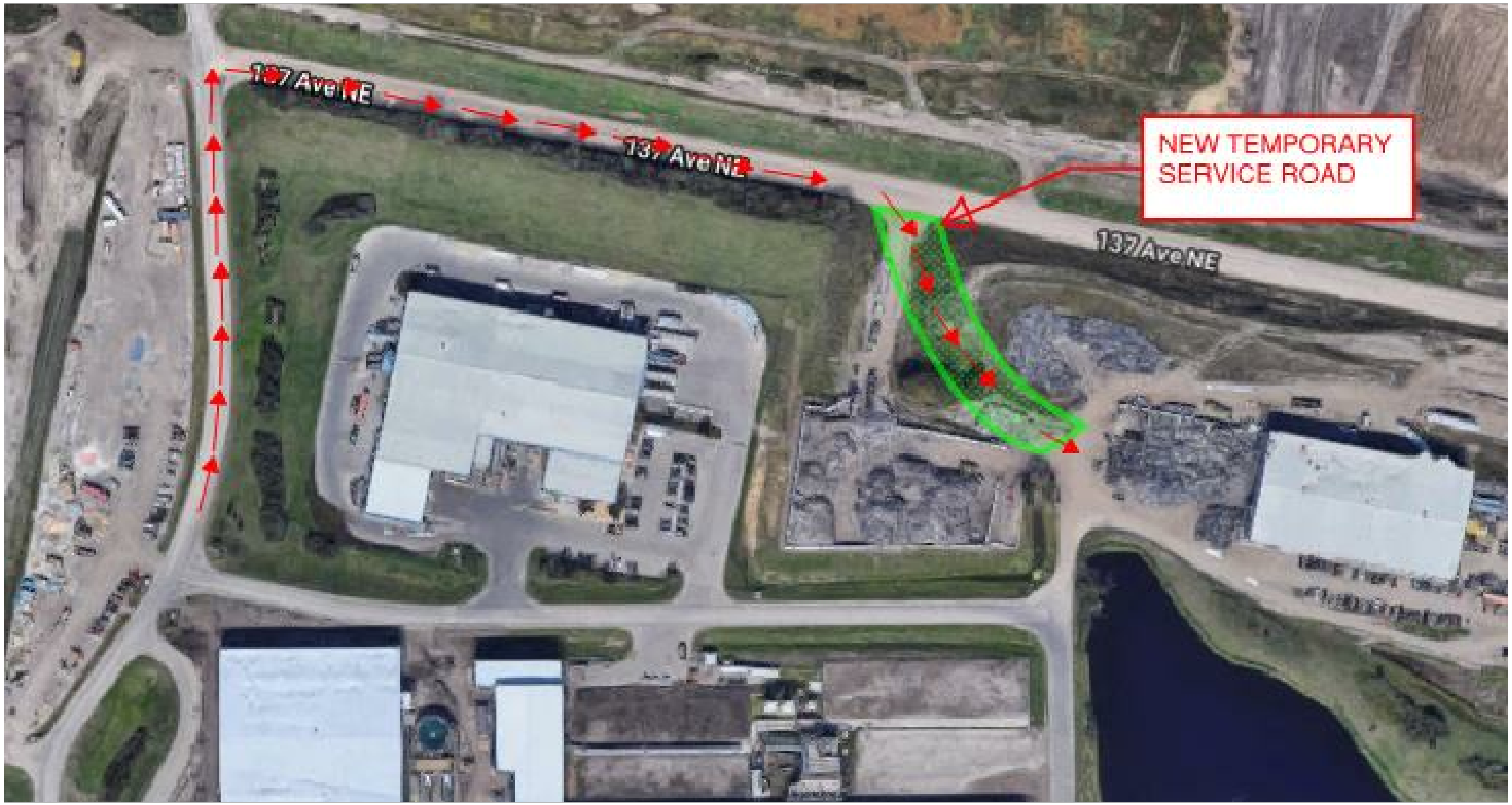

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issue data	date
Issue Description	0000/00/00

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consultants

ONEC

consultant project no. E181772CP

The City of Edmonton FINANCIAL SERVICES AND UTILITIES

project

ECF FACILITY

location : 250 AURUM ROAD N.E., EDMONTON, AB

drawing title

PROPOSED TEMPORARY ACCESS ROAD TO GEEP

scale N.T.S

drawn by
date

checked by
date

drawing no.

sheet no. 1 of 1

reviewed by
date

project no. E181772CP

CAD file name: SK-5

no.	description	date	checked
A	ISSUED FOR INFORMATION	2018/08/21	PS

revisions

issue data	date
Issue Description	0000/00/00

seal

seal

permit

consultants

ONEC

consultant project no. E181772P

THE CITY OF Edmonton FINANCIAL SERVICES AND UTILITIES

project

ECF FACILITY

location : 250 AURUM ROAD N.E., EDMONTON, AB

drawing title

PROPOSED AERATION HALL CRANE PLANNING AND ACCESS LIMITS

scale N.T.S

drawn by
date

drawing no.

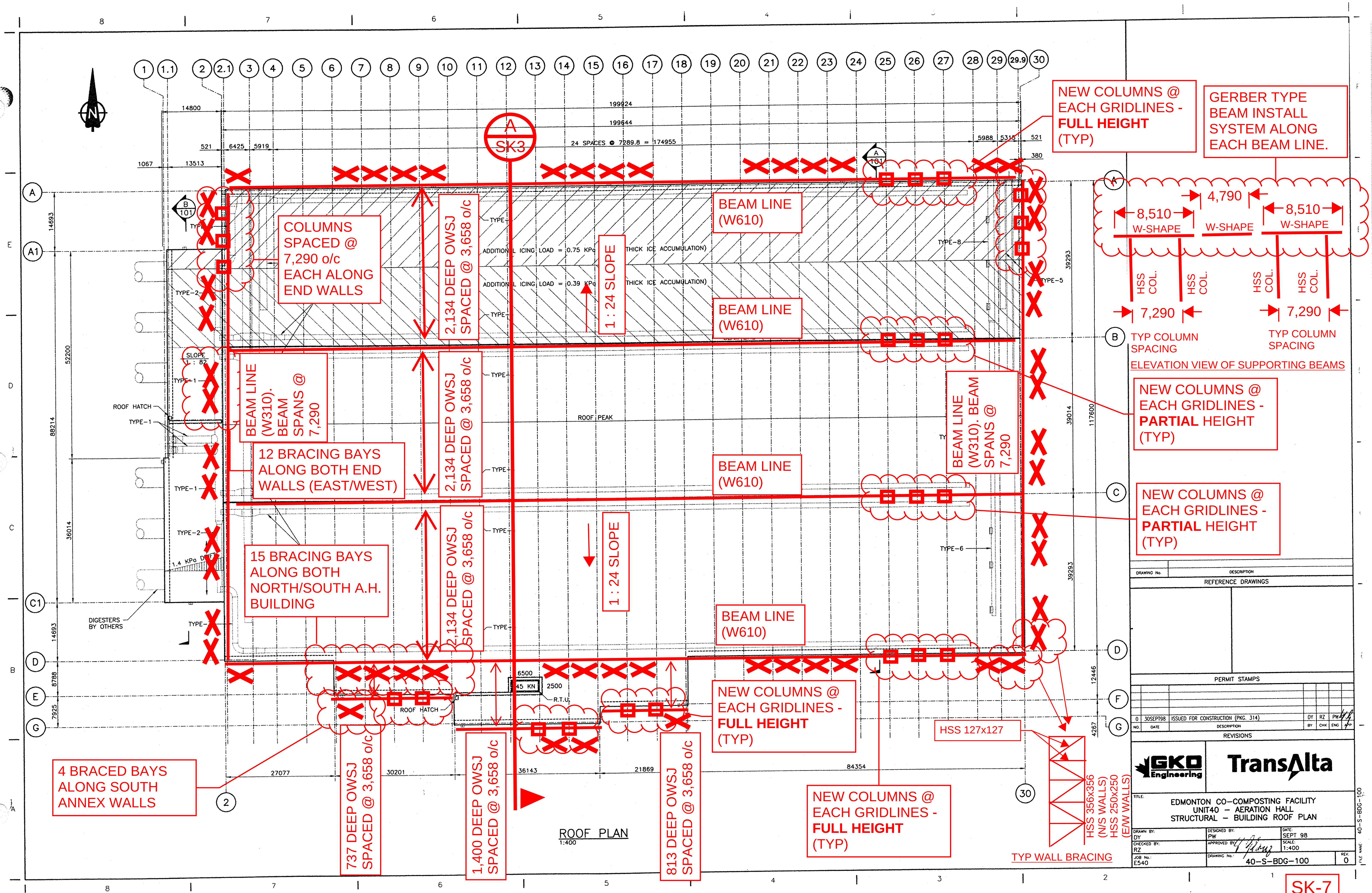
sheet no. 1 of 1

checked by
date

reviewed by
date

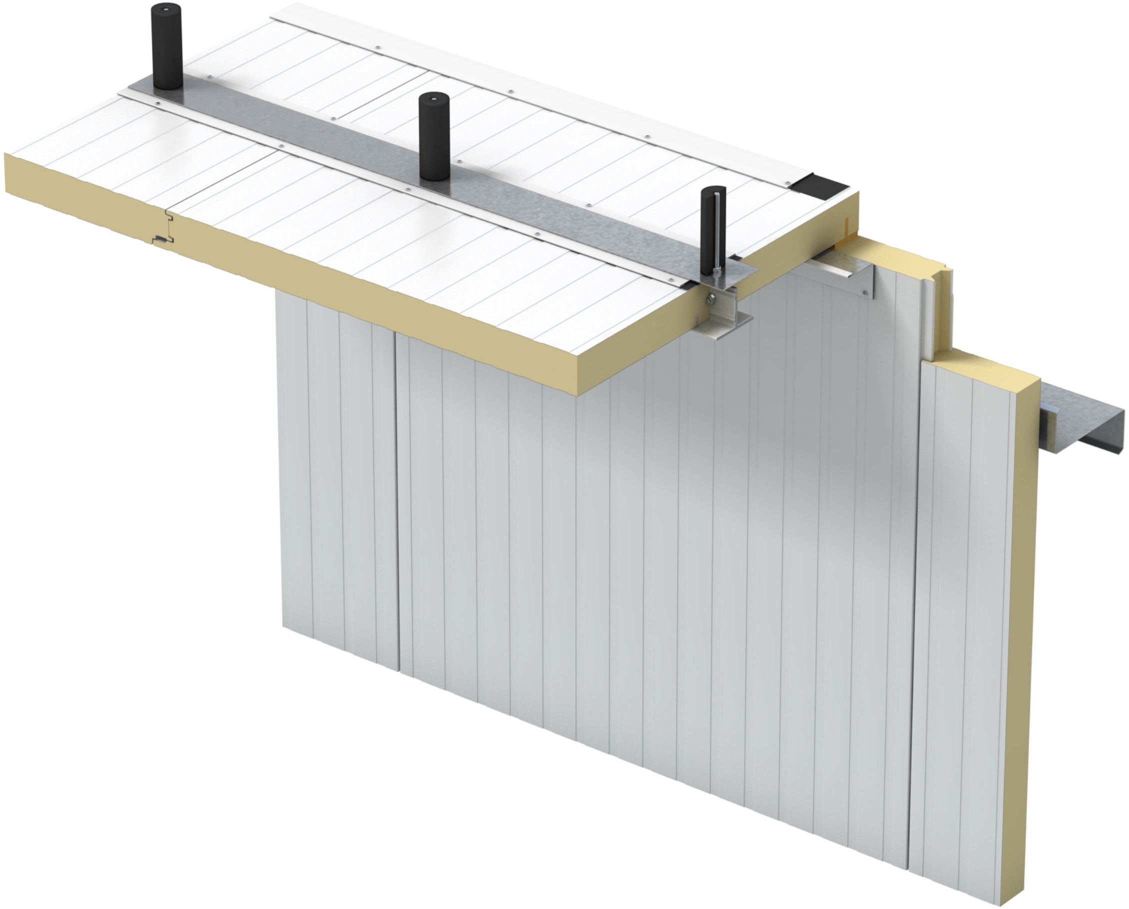
project no.
E181772CP

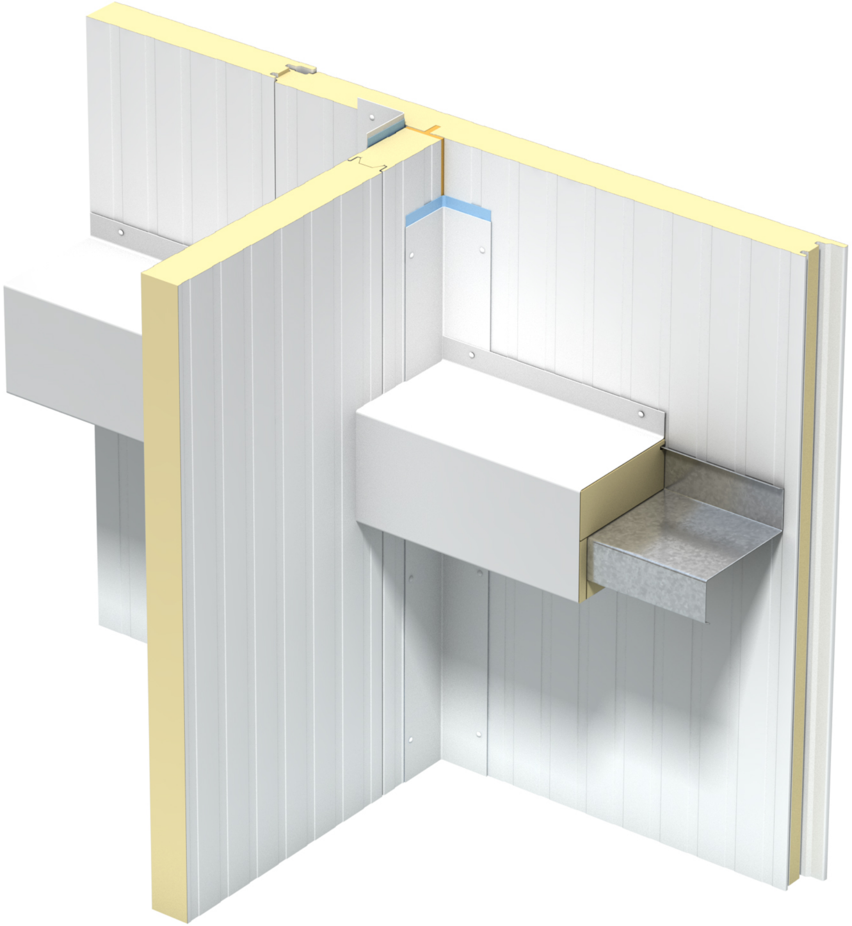
CAD file name: SK-6



NEW COLUMNS @ EACH GRIDLINES - FULL HEIGHT (TYP)
GERBER TYPE BEAM INSTALL SYSTEM ALONG EACH BEAM LINE.
4,790
8,510 W-SHAPE
W-SHAPE
8,510 W-SHAPE
HSS COL.
7,290
TYP COLUMN SPACING
ELEVATION VIEW OF SUPPORTING BEAMS
NEW COLUMNS @ EACH GRIDLINES - PARTIAL HEIGHT (TYP)
NEW COLUMNS @ EACH GRIDLINES - PARTIAL HEIGHT (TYP)
COLUMNS SPACED @ 7,290 o/c EACH ALONG END WALLS
2,134 DEEP OWSJ SPACED @ 3,658 o/c
BEAM LINE (W610)
1 : 24 SLOPE
ADDITIONAL ICING LOAD = 0.75 KPa THICK ICE ACCUMULATION)
ADDITIONAL ICING LOAD = 0.39 KPa THICK ICE ACCUMULATION)
BEAM LINE (W310). BEAM SPANS @ 7,290
12 BRACING BAYS ALONG BOTH END WALLS (EAST/WEST)
ROOF PEAK
15 BRACING BAYS ALONG BOTH NORTH/SOUTH A.H. BUILDING
4 BRACED BAYS ALONG SOUTH ANNEX WALLS
737 DEEP OWSJ SPACED @ 3,658 o/c
1,400 DEEP OWSJ SPACED @ 3,658 o/c
813 DEEP OWSJ SPACED @ 3,658 o/c
NEW COLUMNS @ EACH GRIDLINES - FULL HEIGHT (TYP)
HSS 127x127
HSS 356x356 (N/S WALLS)
HSS 250x250 (E/W WALLS)
TYP WALL BRACING
A SK3
24 SPACES @ 7289.8 = 174955
199924
199644
ROOF HATCH
DIGESTERS BY OTHERS
ROOF PLAN
1:400
REFERENCE DRAWINGS
PERMIT STAMPS
0 30SEPT98 ISSUED FOR CONSTRUCTION (PKG. 314)
REVISIONS
GKO Engineering
TransAlta
EDMONTON CO-COMPOSTING FACILITY
UNIT40 – AERATION HALL
STRUCTURAL – BUILDING ROOF PLAN
DRAWN BY: DY
DESIGNED BY: PW
CHECKED BY: RZ
DATE: SEPT 98
SCALE: 1:400
JOB No.: E540
DRAWING No.: 40-S-BDG-100
REV. 0
SK-7

APPENDIX B: PRE-FABRICATED INSULATED PANELS





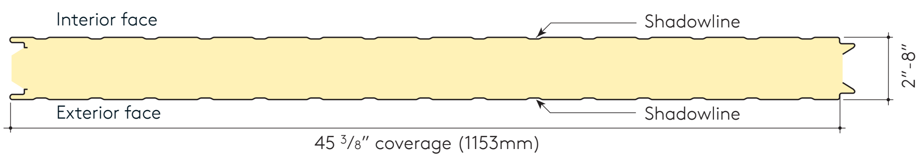
KS45 Shadowline Interior Data Sheet

Insulated Wall / Ceiling Panel System

Kingspan's single component systems can increase speed of build by up to 50%

Product Specification

Profile:	Exterior: Shadowline Interior: Shadowline
Embossing:	Exterior: Stucco or non-embossed Interior: Stucco or non-embossed
Gauge:	Exterior: 26, 24, 22 ga Interior: 26, 24, 22 ga
Width:	45 3/8"
Thickness:	2", 3", 4", 5", 6"*
Length:	8' - 53'
Reveal option:	N/A
Orientation:	Vertical
Post fabrication:	N/A
R-value:	≈ 7.2 per inch per ASTM C518 @ 75°F ≈ 8.25 per inch per ASTM C518 @ 35°F



A premium engineered wall/ceiling system for interior applications. Specially designed to meet today's high performance standards in a wide variety of environments. Features a non-CFC polyisocyanurate insulating core.

Applications

KS45 Shadowline Interior panels are ideal for interior walls and ceilings in cold storage buildings, food and meat processing plants, critical temperature and controlled environment areas as well as in medical or pharmaceutical facilities. The superior engineered joint assures a tight, well designed vapor barrier in enclosures of any size.

Design Features

KS45 Shadowline Interior panels utilize a superior joint design with a caulked seal provision that provides excellent air infiltration and water penetration test results. Panels are produced in the attractive Shadowline stucco embossed or smooth profiles on both the exterior and interior face. Panel coverage is available in standard 45 3/8" width.

Customer Options

Choose from 20 in-stock Fluropon colors or select a custom color to match your needs. For interior heavy wash down environments, plastisol (PVC) coatings as well as stainless steel facings are available.

*2.75" and 8" are also available, although only from our facility in Langley, BC, Canada

KS45 Shadowline Interior Data Sheet

Insulated Wall / Ceiling Panel System

Test	Procedure	Results
Fire	FM 4880	Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems
	ASTM E84	Flame Spread: 25 or Less Smoke Developed: 450 or Less
	CAN/ULC-S138	Fire growth of foamed plastic insulated building panels in a full scale room configuration
	CAN/ULC-S102	Flame spread: 20, Smoke developed: 350 for panel with facings
	CAN/ULC-S127	Flame spread <500 for foam core
	NFPA 259	Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
Thermal Transmission	ASTM C518	See thermal performance tables below
Fatigue	Subjected to 2 million alternate cycles of 20 PSF positive and negative wind loading	No metal / foam delamination or metal fatigue
Humidity	Sample subjected to 100% relative humidity at 140°F for 1000 hours	No evidence of metal primer corrosion
Autoclave	Sample placed in an autoclave device and pressurized to 2 PSI at 212°F for 2 1/2 hours	No evidence of delamination
Skin Delamination		No skin delamination with direct pull off pressure up to 1188 psf

Thermal Performance at 75˚			Thermal Performance at 35˚		
Thickness	K-Factor	R-Value	Thickness	K-Factor	R-Value
2	0.07	14.4	2	0.06	16
2.75	0.05	19.8	2.75	0.05	22
3	0.05	21.6	3	0.04	24
4	0.03	28.8	4	0.03	32
5	0.03	36	5	0.03	40
6	0.02	43.2	6	0.02	48
8	0.02	57.6	8	0.02	64

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VALSHIELD ™

END USES

Heavy film plastisol coil coating for use on building panels, siding trim, animal confinement buildings, and applications that require chemical resistance.

TONE PLASTI-SOL $$$

Valshield coating systems are based on high solids plastisol finished with PVC technology and a specially formulated corrosion resistant primer. Valshield gives aluminum, hot-dipped galvanized (HDG) steel, and zinc alloy substrates the extra corrosion resistance needed for metal buildings exposed to acid rain in industrial or chemical environments. It is a great product for animal confinement buildings.

Smooth, striated, or textured colors can be produced for metal building wall panels or roofing.

Valshield coil coatings are designed to resist abrasion and protect against common physical abuse caused during transportation and installation. Valshield may be formed into building panels without micro-cracking on the ribs.

Note: Protective strippable coatings may cause increased gloss level; therefore, are not recommended for surface protection on this product.

SUBSTRATE	PRIMER
HDG Steel, Galfan®, Aluminum, or Galvalume® All substrates must be properly cleaned and pretreated.	Primer (561Y007)

FIELD PERFORMANCE – Florida Exposure South of Latitude 27 Degrees

	Vertical (90° Angle)	**Non-vertical** (Angle >15° vertical)
Film Integrity	15 Yrs: no blistering, peeling, cracking	10 Yrs: no blistering, peeling, cracking
Chalk Resistance: ASTM D659	10 Yrs: rating no less than No. 8	10 Yrs: rating no less than No. 6
Color Change: ASTM D 2244	10 Yrs: no more than 6ΔE (Hunter) units	10 Yrs: no more than 8ΔE (Hunter) units

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APPLICATION CHARACTERISTICS	
Application Method:	Reverse roll coat
Viscosity: ASTM D 4212	Varies depending on finish desired
Solids by Volume: ASTM D 2697*	78% to 85%
Solids by Weight: ASTM D 2369*	85% to 95%
Reducing Thinner:	Aromatic
Clean-Up Solvent:	Aromatic
Peak Metal Temperature:	400°F to 420°F
VOC (Theoretical): ASTM D 3960*	Less than 1 pound per gallon
Flash Point: ASTM D 3278*	141°F
Contains Lubricant:	Yes
Top-Coat Dry Film Thickness:	2.0 to 10.0 mils
System Dry Film Thickness:	2.1 to 10.2 mils total
PHYSICAL PROPERTIES	
Gloss (60°): ASTM D 523	15 to 70
Pencil Hardness: ASTM D 3363	B to H
T-Bend:	0T to 1T, no loss of adhesion
Cross Hatch Adhesion:	No loss of adhesion
Reverse Impact: ASTM D 2794	HDG/Galvalume: 4x metal thickness in inch-lbs., no loss of adhesion Aluminum: 2x metal thickness in inch-pounds, no loss of adhesion
ACCELERATED TEST DATA	
Salt Spray 1,500 Hours: ASTM B117	HDG/Galvalume®: creep from scribe no more than 1/16" (2 mm), no blisters
Salt Spray 2,000 Hours: ASTM B117	Aluminum: creep from scribe no more than 1/16" (2mm), no blisters
Dry Heat 168 Hours, 180°F (82°C): (2T Bend)	No loss of adhesion
Humidity 100% RH 1,000 Hours: ASTM D 2247	HDG/Galvalume®: no field blisters
Humidity 100% RH 2,000 Hours: ASTM D 2247	Aluminum: no field blisters
Water Immersion 168 Hours 100°F (82°C): ASTM D 870	No field blisters with minimum color change
XWR Weatherometer 2000 Total Hours: ASTM D 3361	Color change: maximum of 6ΔE (Hunter) Units Chalk: rating no less than No. 7
Chemical Resistance 24 Hours: ASTM D 1308	
10% Hydrochloric Acid	Slight stain, no blisters
20% Sulfuric Acid	No visible change
10% Sodium Hydroxide	Slight stain, no blisters
28% Ammonium Hydroxide	No visible change

These numbers are to be used as a general indication of field performance. Field performance may vary with color and gloss.
For details on health, safety and handling information, Material Safety Data sheets are available at www.paintandcolor.com.

For more information, contact Valspar's Coil Coatings Division:

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APPENDIX C: SOUTH DOWNLOAD BUILDING DEMO REPORT

ENGINEER. CONSTRUCT. COMPLETE.

SOUTH DOWNLOAD BUILDING
DEMOLITION COST ESTIMATE - SITE 500
ONEC REFERENCE NO. E181722CP

PREPARED FOR:

INTEGRATED INFRASTRUCTURE SERVICES

CONFIDENTIAL

Abstract

This document outlines ONEC's Demolition Cost Estimate for the South Download Building located in Site 500 of the EWMC Facility in Edmonton, Alberta

Revision	Date	Description	Prepared By
0	October 31, 2018	Issued for Use	Paul Spourghan, P.Eng.

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1 INTRODUCTION

The City of Edmonton (City) has engaged ONEC to prepare a demolition cost estimate of the existing South Download Building attached to the west side of the Aeration Hall structure. Previous structural condition reports prepared by ONEC indicates a portion of the building is in disrepair and not safe to be occupied.

2 PROJECT BACKGROUND

2.1 ASSET DESCRIPTION AND BACKGROUND

The main Aeration Hall Building was designed in 1998 and constructed in 2000 and is located at Site 500 of the EWMC facility. The Aeration Hall has one annex to the west designated as the South Download Building, and has a footprint of 1,192 square meters (12,832 square feet). This building is a pre-engineered, lean-to, frameless structure comprised of light gauge structural panels that shares a common wall with the Aeration Hall to the east.

The South Download building is constructed on continuous strip footings along the exterior walls. The building has a foundation wall that extends 300mm (1'-0") above the slab-on-grade structure. Seven existing digester drums penetrate into the South Download building at the west side, however, two of the seven is only being used to convey material from the TIP floor to the Aeration Hall.

The existing roof has slight slope toward the west side and measures 1,324 mm (4'-4") deep and is comprised of light gauge 113 mm (4-1/2") deep corrugated galvanized steel panels at the exterior roof and interior ceiling. Both the exterior roof and ceiling panels are connected with light gauge, hat-shaped web members to create a truss structure to support the roof loads. The trusses span in the west-east direction and are spaced at 1,041mm (3'-5") on center. The roof structure is supported by bearing walls comprised of 191 mm (7-1/2") deep corrugated galvanized steel panels to the west and stainless steel panels to the east.

2.2 PROJECT PURPOSE AND SCOPE

The primary objective of the project is to provide a cost estimate for the demolition scope of the South Download Building. Following are the items that were performed:

a. Indicate items that are proposed to be demolished.

b. Provide a preliminary concept plan for the proposed new steel frames to support the existing rooftop HVAC ducts.

c. Provide a preliminary concept plan for the shelters that will cover a portion of the existing the digester drums that are currently in service to transfer material from one facility to the other.

d. Provide a preliminary concept plan for the proposed new interface wall between North and South Download buildings.

e. Provide a preliminary concept plan for retaining the existing foundation.

f. Prepare a Class 5 (-20% to +50%) as per AACE International.

g. Provide an approximate high-level schedule for the project.

3 METHODOLOGY

Building Demolition

The Superstructure of South Download Building will be completely demolished and disposed. The existing digester drums and overhead HVAC ducting will need to remain. We have assumed that the South Download Building mechanical and electrical systems can be isolated from the existing facility infrastructure. Terminations and modifications to isolate the system is not included in this estimate as items will need to be confirmed with the City and SUEZ. The mechanical and electrical systems of the South Download Building is understood to be shut-off to make it safe for demolition.

The existing substructure may be retained to allow the City of Edmonton to use. The existing footing has insulation placed over it at the Aeration Hall to South Download building interface. The South Download concrete slab-on-grade structure will be separated from the Aeration Hall foundation wall with a construction of a new bitumen impregnated fibreboard at the interface to ensure there is no uplift forces on the foundation wall when the slab heaves. A concrete topping will be added to the existing slab to allow the floor to slope toward the west side of the structure to drain water during a rain or snow melt events, which will then be collected by a pre-fabricated trench along that side.

Some of the risks associated with leaving the existing foundation in place is that the slab is no longer exposed to a heated space, therefore, there is a potential of heaving/settlement that may occur during seasonal temperature changes. If the City decides to demolish the substructure, an adder/optional price has been provided.

New Structural Steel Frames to Support the Existing HVAC Ducting Work above the South Downloading Building

ONEC proposes to use new structural steel frames below the roof as shown in Figure 1 to support the existing ductwork prior to demolishing the South Downloading Building. The supporting frames will consist of beams, columns, and cross-bracing. The frames will be supported on helical pile foundations installed to the required depth based on load requirements. The proposed steel structure will not be able to be founded on the existing slab as a foundation, due to the aforementioned issue with heaving.

New Shelters to Cover the Existing Two Digester Drums Currently Used to Transfer Material via Conveyers Inside the Drums

Currently, there are two existing shelters that are covering a gap between the west wall of the Aeration Hall and termination length of the digester drums to the east. It is unknown if the existing shelters are designed to withstand snow and wind loads when the South Downloading building gets demolished. Refer to Figure 1 and 2.

Until further investigation is conducted, it is assumed that the existing shelters are not designed to withstand snow and wind loads, therefore, additional shelters over the existing is proposed to be constructed. Each shelter will consist of structural steel moment-resisting frames complete with cross-bracing where required. The roof will comprise of cladding and purlins and the walls with standard cladding with supporting girts. The new shelters will be supported on a helical pile foundation system.

New Interface Wall between North and South Download Buildings

The interior wall between the North and South Download buildings will need to be removed, since it is not suitable to be used as an exterior wall. A new exterior wall at the interface between the North and South Download Buildings is proposed to be constructed and will comprise of cladding, insulated wall panels, and girts.

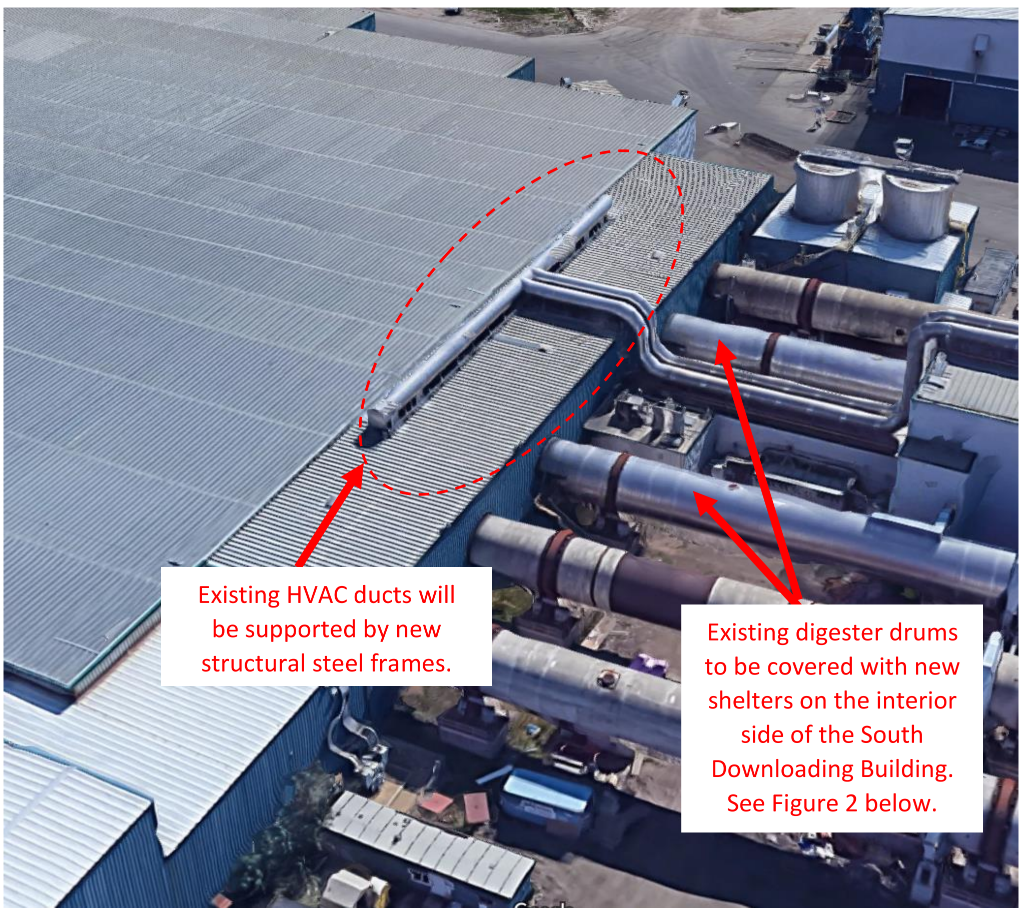

Figure 1: Concept plan for the proposed structural steel frames and shelters

Figure 2: Proposed location for new shelters to be built to cover over the existing.

3.1 Construction Schedule

The following is a proposed high-level schedule outlining the demolition, design, procurement, construction and fit up. Upon award of the project, detailed engineering design would be performed in three to four weeks in addition to the City's review cycles. The demolition period has been assessed as taking five to seven weeks from the start of work on site until substantial completion. Additional time may be required for the coordination and works of existing electrical and mechanical isolations and re-routing as required. The fabrication, procurement and installation of the new structural steel frames, shelters and other components can take approximately five to eight weeks. The total project duration is projected to be seventeen weeks, depending on difficulties encountered during the design, approval cycle, fabrication, or construction phases of the project life cycle.

3.2 Construction Cost Estimate

The estimate is intended to provide direct and indirect costs for the proposed scope of the work explained above. Quantities of major elements were assessed and measured where possible and priced based on Means Publishing, contractor pricing and local experience gained by ONEC.

An allowance of 2.83% was added to account for inflation in 2019 to the anticipated bid date of the project in 2020. The rate is based on an average Municipal Price Index (MPI) for the years of 2019 to 2020. An allowance of 25% contingency was added to cover design and pricing unknowns. Cost estimate based on information provided from available building drawings and on the following components:

- Excavation, demolition, and dispose of the superstructure of the South Downloading Building.
- Sawing and separation of the South Download concrete slab from the adjoining building.

- Supply and install of bitumen impregnated fibreboard for the Concrete Expansion Joints at the interface of the South Download and the adjoining building.
- Supply and install of trench.
- Form and pour ready mix concrete topping to allow the existing slab to be sloped.
- Minor backfill of the site.
- Supply and install of structural steel columns, beams and wall bracing for the HVAC ducting.
- SP3 steel prep, shop primer and final paint coat as required for the steel elements.
- Form and pour ready mix concrete for pile caps and grade beams, as required.
- Supply and install of cladding, wall panels, purlins and girts for shelters.
- Supply and install of cladding, wall panels and girts at the interface between the North and South Download Buildings.
- Supply and install of helical piles and anchors.
- Site expenses and fees for major general condition items such as:
    - Telephone & stationery
    - Temp. buildings & furniture
    - Project Manager as required
    - Superintendent as required
    - Travel & board
    - Insurance's
    - Safety & daily clean-up
    - Final clean-up
    - Photos
    - Temporary fencing
    - Hand tools
    - Fuel
    - Sign
    - Sanitation
    - Construction Management Fee Included

Cost Summary:

DESCRIPITION	Cost ($)
Superstructure: Demolition of the South Download Steel Building	$292,278
Substructure: Concrete slab sawing to separate the South Download from the foundation wall of the Aeration Hall. Supply and install of bitumen impregnated fiberboards, pour concrete topping for slopping existing floor into installed trenches.	$144,616
Supply and Install of new Structural Steel Frames for HVAC Ducting and Shelters	$266,719
Supply/Form/Pour Grade Beams, Pile Caps, Helical Piles, and Anchors	$190,961
Supply and install of Roofing, Purlins, Wall Cladding, Wall Girts, Standard Flashings	$151,035
Sub-total Costs	**$1,045,609**
General Requirements and Consulting Fees (15%)	$156,841
Construction Administration (10%)	$104,561
Sub-total Costs Excluding Contingencies	**$1,307,011**
Design and pricing unknowns (25%)	$326,753
Inflation Allowance (2.83%) – 2 years, compounded annually	$75,024
Total Cost Estimate	$ 1,708,788
Unit Cost (Approximate Floor Area: 1,192 m^2 [12,832 ft^2])	**$1,434/m^2 ($133/ft^2)**
Substructure (Optional) : Demolition of the South Download Foundation	$177,852

Budget Exclusions:

- Major mechanical and electrical work.
- Price of steel based on current mill price. No allowance made for price changes due to tariff.
- Existing structural steel pipe and cable tray racks. Location of racks to be demolished are to be confirmed at the time of design stage.
- Cost of operations due to reduced capacity output and impact to adjacent facilities.
- Owner's staff and associated management costs.
- Temporary service roads.
- Special safety considerations.

- Environmental regulations.
- Cost of contaminated soil or material removal.
- Legal fees and expenses.
- Building permits and development levies.
- Utility Connection Charges
- Bonding
- Testing and inspections.
- Offsite improvements.
- Tax.
- Winter conditions.
- Dewatering and discharge fees.
- Temporary utilities (power, gas and water)
- Cost to bring services to property line (storm, sanitary water, gas and hydro)
- Major shoring to the adjacent structure (Aeration Hall).
- Firewatch and site security (after hours)

4 LIMITATIONS

This report including drafts or other relating documents associated with this report shall not be distributed to any third-party or to the public without written approval by both ONEC and its author, unless and until disclosure is required by law or regulations, and then, only to the extent of such requirement. The City of Edmonton may make copies of this report for its own use with the intended purposes of this report. ONEC and its author shall be informed in writing if any portion of the document(s) for mentioned above is distributed to any third-parties or to the public where required by law.

5 CLOSURE

We trust that the information provided herein meet your requirements. If you have any questions or require additional information, please contact the undersigned.

Sincerely,

Paul Spourghan, P. Eng.
Senior Civil / Structural Engineer
ONEC Engineering, a Division of ONEC Construction Inc.
3821 - 78 Avenue Edmonton, AB T6B 3N8
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Appendix 2

Building Condition Assessment - Edmonton Composting Facility. Stantec Consulting Ltd. February 12, 2018.

BUILDING CONDITION ASSESSMENT

Edmonton Composting Facility (ECF)

250 Aurum Road NE, Site 500
Edmonton, Alberta

Final Report

Prepared for:

City of Edmonton Integrated Infrastructure Services
12th floor, Edmonton Tower
10111 – 104 Avenue NW
Edmonton, Alberta
T5J 0J4

Prepared by:

Stantec

Stantec Consulting Ltd.
200, 325 – 25th Street SE
Calgary, Alberta
T2A 7H8

Project No.: 110128016
February 12, 2018

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the City of Edmonton Integrated Infrastructure Services, (the "Client") to prepare a Building Condition Assessment (BCA) in support of a long-term Capital Replacement Plan for the facility referred to as the Edmonton Composting Facility, located at 250 Aurum Road NE, Site 500 in Edmonton, Alberta (referred to herein as the "site" or "property").

The purpose of the assessment is to visually review and obtain information relative to the current condition of two facilities located on the Edmonton Waste Management Centre (EWMC) namely the Edmonton Compositing Facility, and the Materials Recovery Facility (herein referred to as the "Site" or "Properties"), and to establish requirements with respect to a current state assessment including maintenance, repair, and capital replacement. The BCAs are reported separately. The following report is for the Edmonton Composting Facility (ECF).

The purpose of the BCA is to: (i) provide an opinion of the general physical condition of the site's major facility systems, and (ii) provide opinions of cost to address observed "physical deficiencies", and renew base-building systems and exterior site components over a twenty (20) year period.

We understand that the Client requires the BCA report in support of capital planning for infrastructure renewal purposes for the site.

The scope of our work, methodologies used, and limitations of this BCA report are presented in Section 2.0 of this report.

1.2 PROPERTY DESCRIPTION

We understand that Edmonton Composting Facility (ECF) is situated on the municipal Edmonton Waste Management Centre (EWMC) site. The facility is located at Aurum Road NE Site 500 in Edmonton, Alberta. The Site is accessed via several asphalt-paved driveways on the north, west and east boundaries of the property which connect to the roadways within the EWMC site.

The ECF, occupies a total area of approximately 416,500 ft2 (38,690 m2). For the purpose of this report, the ECF is comprised of six (6) buildings that are connected to form the Edmonton Composting Facility (ECF). The buildings included in the scope of this assessment are:

- North Download Building (unit 20)
- South Download Building (unit 30)
- Dewatering Building (unit 10)
- South Download Building (unit 30)
- Finishing Building (unit 50)
- Aeration Hall Building (unit 40)

An addition, referred to as the Biosolids Loadout Building was added to the south end of the South Download Building in 2015.

Refer to Appendix C, for a key plan drawing showing the locations of these major building sections.

The buildings are all steel-framed structures that are clad with pre-finished metal wall and roof panels and founded on cast-in-place concrete piers, footings, and piles.

Refer to section 6.1 for details on which areas of the ECF that were not accessible during the site visit or where limited is information was made available to conduct our assessment.

Salient Photographs

Aerial view of the site including the ECF and MRF (courtesy of Google Maps)

General view of the ECF from the west (courtesy of Google Maps)

General view of the ECF from the southeast (courtesy of Google Maps)

General view of the ECF from the northeast (courtesy of Google Maps)

1.3 PROPERTY CONDITION

A visual "walk-through" assessment of the site was carried out to conduct interviews with site representatives and to observe and document existing physical conditions at the property. The assessment was carried out by Stantec assessors on October 27, 2017.

Our assessment identified "physical deficiencies" that are considered "immediate" in nature, which require prompt action to prevent possible injury due to an unsafe condition and/or possible Code violation, or to address a system or component that was observed to have failed or is at risk of imminent failure. Items that are considered "immediate" in nature are described as follows:

Immediate Repairs

- Conduct repairs to the roof structure and roof cladding on Aeration Hall Building as per ONEC Engineering's structural report issued by ONEC Engineering as Project E171428CP-001 rev. B.

The assessment also identified the following actions that are not considered "immediate" in nature, but are recommended within the evaluation period to address "physical deficiencies" that are considered beyond normal routine maintenance, or to repair or replace systems or components due to age. The actions have been organized by major facility system.

4.2 Building Structure

Event Description	Event Cost (2017 Dollars)	Initial Event Year

4.3 Building Envelope

Event Description	Event Cost (2017 Dollars)	Initial Event Year

Event Description	Event Cost (2017 Dollars)	Initial Event Year
Allowance to replace damaged metal cladding on Tipping Building	$ 10,000	2018
Conduct repairs/replacement of corroded metal siding panels on Finishing Building. The cost to conduct this work is considered to be below the threshold and therefore part of routine maintenance	$ -	2020
Conduct replacement of joint sealants around doors, windows and wall penetrations. This work is considered to be below the threshold and part of routine maintenance. No cost has been provided.	$ -	2020
Replace damaged and inoperable overhead doors	$ 10,500	2017
Replace overhead door electric operators	$ 12,500	2019
Conduct replacement of overhead door electric operators	$ 12,500	2019

4.4 Building Interior

Event Description	Event Cost (2017 Dollars)	Initial Event Year
Conduct periodic repair/renewal of gypsum board walls. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	$ -	2019
Allowance to conduct renewal of paint finishes of interior walls and steel framing.	$ 30,000	2018
Allowance to conduct cleaning of interior walls, ceiling and limited floor areas in the Aeration Hall Building including inspection of liner and structure for corrosion/integrity.	$ 54,000	2018
Allowance to conduct cleaning of interior walls, ceiling and limited floor areas in the Tipping Building, including inspection of liner and structure for corrosion/integrity.	$ 11,600	2018
Allowance to conduct cleaning of interior walls, ceiling and limited floor areas in the North Download Building, including inspection of liner and structure for corrosion/integrity.	$ 6,400	2018
Allowance to conduct cleaning of interior walls, ceiling and limited floor areas in the South Download Building including inspection of liner and structure for corrosion/integrity.	$ 4,000	2018
Allowance to conduct cleaning of interior walls, ceiling and limited floor areas in the Finishing Building, including inspection of liner and structure for corrosion/integrity.	$ 4,000	2018
Conduct renewal of paint finishes in the control room. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	$ -	2018
Conduct periodic repair/renewal of gypsum board ceilings. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	$ -	2020
Install firestopping sealant on wall penetrations where missing. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	$ -	2020
Conduct replacement of washroom accessories. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	$ -	2018

4.5 Mechanical Systems

Event Description	Event Cost (2017 Dollars	Initial Event Year
Conduct study to determine air balancing issue with Aeration hall as both125hp exhaust fans cannot be run together as designed.	$ 10,000	2018
Conduct Study of MAU units 40-H-74A,40-H-74B, 10-H-3, 10-H-52, 10-H-58 are not being utilized to determine if replacement of units is required or not. The unit have been Flagged for Deletion on provided equipment.	$ 5,000	2018
Conduct Maintenance study of suspended natural gas fired unit heater 10-H-52 to determine course of action to repair or replace unit which has been flagged for deletion on equipment inventory list provided.	$ 2,500	2018
Conduct a study for the testing of the hoses in the stand- pipe cabinets throughout the process building	$ 6,000	-

4.6 Electrical Systems

Event Description	Event Cost (2017 Dollars	Initial Event Year
Conduct study to assess the support hangers on cable tray systems identified with heavy corrosion.	$ 15,000	2030
Conduct electrical equipment cleaning and infrared testing on a three year cycle.	$ 10,000	2018
Conduct a study of the different areas of the production building to determine areas where explosion proof equipment maybe required.	$ 8,000	2018
Conduct study to correct ground fault issues with fire alarm wiring in the facility.	$ 10,000	2018

Additional Considerations

No additional considerations have been identified

In addition to the aforementioned recommendations, the assessment identified actions beyond the next five (5) years that are recommended to repair or replace major facility systems and components that have reached, or may reach their Expected Useful Life (EUL) over the next twenty (20) years. These actions are presented in three (3) cost tables that are titled as follows:

- **Appendix A** – Component Listing and Event Costs
- **Appendix B** – Short-and Long-Term Component Event Costs Summary

A description of the cost tables is provided under Section 5.1 of this report.

1.4 OPINIONS OF COST SUMMARY

Opinions of cost were developed for the BCA based on information obtained from our visual assessment of the site to account for the current and future anticipated repair and/or replacement expenditures of systems and components. The expenditures include activities to investigate or address observed or reported "physical deficiencies", and to repair or replace systems or components that have already exceeded their EUL, or are anticipated to achieve or surpass their EUL over the next twenty (20) years.

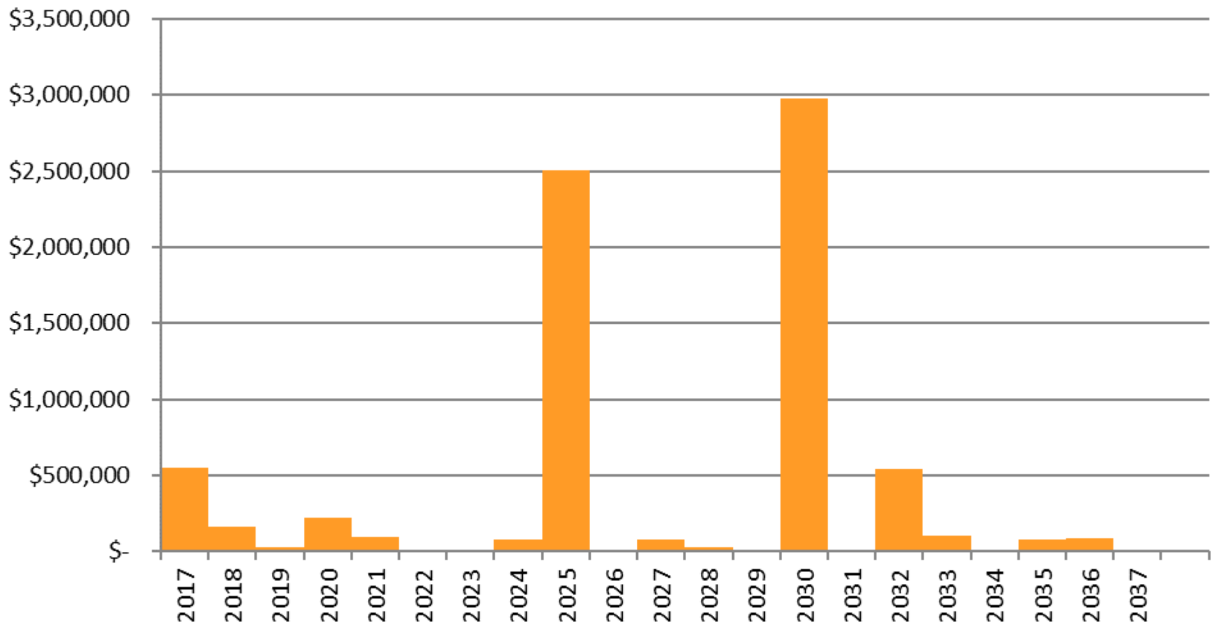
Only actions that are considered greater than $3,000 in value have been included in this report; however, actions relating to life safety or possible Code violations may also be included, regardless of cost.

Table 1-1 presented below indicates the total costs (in current dollar values) for major facility systems that are anticipated immediately (i.e., within the next year), over the Short-Term (i.e., years 1 to 5), and the Long-Term (i.e., years 6 to 20). Figure 1-1 provides a graphical representation of the total opinions of cost, spread out over the current year, and the next ten (20) years.

Table 1-1 – Total Cost by Major Facility System

Major Facility System	Immediate (2017)	Short-Term (2018 - 2022)	Long-Term (2023 - 2037)	Optional	Totals
Site Improvements	$ -	$ -	$ -	$ -	$ -
Building Structure	$ -	$ 5,000	$ -	$ -	$ 5,000
Building Envelope	$ 10,500	$ 95,500	$ 191,600	$ -	$ 297,600
Building Interior	$ 6,000	$ 190,000	$ 455,200	$ -	$ 651,200
Mechanical Systems	$ 484,800	$ 30,700	$ 2,605,800	$ -	$ 3,121,300
Electrical Systems	$ 47,500	$ 181,400	$ 3,217,600	$ -	$ 3,446,500
Conveying Systems	$ -	$ -	$ -	$ -	$ -
Additional Considerations	$ -	$ -	$ -	$ -	$ -
TOTALS	**$ 548,800**	**$ 502,600**	**$ 6,470,200**	**$ -**	**$ 7,521,600**

Figure 1-1 – Total Opinions of Cost by Year



1.5 CLOSURE

We have provided our opinion of the site's general physical condition based on: conditions observed at the property during our site visit; information provided to us by site representatives; estimates of life expectancy of the site's major facility systems and components; opinions of cost for repair and/or replacement of these components; and, the effects of assumed inflation. We believe this BCA report, and its recommendations, are accurate within the limitations inherent in the foregoing. However, due to numerous factors that can affect capital renewal requirements (such as actual inflation rates, actual costs/timing of work, etc.), we recommend that this report be reviewed annually to capture changes to the assumptions made herein.

This BCA was conducted, and this report was prepared by the Facilities Assessment team within Stantec's Buildings Engineering group. The qualifications of the team used for this project are included in this report as **Appendix D**.

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2.0 SCOPE, METHODOLOGY AND LIMITATIONS

2.1 SCOPE OF WORK

The scope of our work was based on the scope of services as outlined in Stantec's proposal letter dated September 18, 2017. The scope of our work included interviews with the site representative(s), a review of pertinent documentation (where provided by the Client or site representative(s)) and a generalist (i.e., non-specialist) visual "walk-through" assessment of major facility systems at the site to observe and document existing physical conditions. The assessment of major facility systems was generally based on the American Society for Testing and Materials (ASTM) Standard E2018-15, "*Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process*".

The major facility systems observed (where applicable) include the following:

- Site Improvements
- Building Structure
- Building Envelope
- Building Interior
- Mechanical Systems
- Electrical Systems
- Conveying Systems

The information obtained from our visual "walk-through" assessment formed the basis for establishing our opinion of the general physical condition of the major facility systems. The walk-through also formed the basis for developing costs and timing to investigate or address observed or reported "physical deficiencies", and to repair or replace systems and components that have already surpassed their EUL, or are anticipated to achieve or surpass their EUL over the next twenty (20) years.

The scope of our work performed is summarized as follows:

- Reviewed existing documentation, where provided by the Client or site representative(s). A summary of documentation reviewed is included in this report under Section 7.2.
- Conducted a visual "walk-through" assessment of major facility systems to check their general physical condition including the buildings.
- Conducted interviews with the site representative(s). A listing of personnel interviewed during the assessment is included in this report under Section 7.3.
- Identified and financially quantified our opinions of cost and timing to address observed or reported "physical deficiencies"; to repair or replace components that are anticipated to achieve (or have already achieved) their EUL over the next Twenty (20) years; and, to conduct further investigations (if required) and provide corresponding order-of-magnitude costs for work that may be required as a result of these investigations.
- Prepared a BCA report for the site that outlines findings, opinions, and recommendations, complete with photographs of salient observations and other pertinent information obtained during the "walk-through" assessment.

The assessment of the site was based on a visual "walk-through" review of the visible and accessible components of the property, building(s), and related structures. The roof surface(s), interior and exterior wall finishes, and floor and ceiling finishes of the building(s) were visually assessed to check their general physical condition and to identify "physical deficiencies", where observed. The assessment did not include an intrusive investigation of wall assemblies, ceiling cavities, or any other enclosures/assemblies. No physical tests were conducted, and no samples of building materials were collected to substantiate observations made, or for any other reason.

The review of mechanical, electrical, and conveying systems and components at the property (where present), including corresponding life safety systems, included discussions with the site representative(s), and a review of pertinent maintenance records that were made available by the Client and/or the site representative(s). The visual walk-through assessment was conducted to determine the type of systems and components present, age, and aesthetic condition. No physical tests were conducted.

An evaluation (detailed or otherwise) of the site's compliance with local Building Codes and Fire Codes, or with local ordinances, requirements, etc. (including those related to life safety and fire protection) is not part of the scope of this project. We have assumed that the existing property development was reviewed and approved by the local authorities having jurisdiction at the time of construction, and during any subsequent additions, renovations, and/or inspections. Compliance with ASTM E2018-15 does not warranty or guarantee Code compliance with any governmental entity, trade standard, or the insurance industry, and this effort should not be considered an in-depth code review.

The BCA includes an assessment of existing components that are currently in place at the site; however, the BCA does not include comments, recommendations or opinions of probable costs for potential "upgrades" or future installation of components that are not currently in existence at the site, or other extraneous amenities. However, recommendations for "Optional" work may be outlined in this report for certain building / site components (typically at the Client's request) and these have been labeled as such.

2.2 DEVIATIONS FROM THE GUIDE

No major deviations were made from our proposal letter dated May 12, 2017, during the completion of site visit activities and the preparation of this report.

The major deviations from ASTM Standard E2018-15 for this project were as follows:

- No reviews of municipal/public records for zoning, building, and/or fire & life safety code/regulatory compliances were conducted.
- Investigation of whether or not the property resides in a flood plain was not performed.
- Verification of the number of parking spaces was not conducted.
- Verification of gross and net usable areas of the site building(s) was not performed.
- Site services, parking area, site amenities, and process equipment
- Structural assessment of the building
- The Tipping building roof assessment was limited to viewing from roof catwalk only. All remaining roof surfaces (aside from the aforementioned) were not viewed due to not having safe access.

2.3 METHODOLOGY

2.3.1 Component Life Expectancy

The systems and components observed during the site visit have been assigned a value for their EUL. This value was used to determine an "event" year for renewal, based on the reported age or Remaining Service Life (RSL) of the system or component. Where this information was unavailable, the age and RSL were estimated based on the system or component's overall reported or observed physical condition. The values for EUL are based on information provided in manufacturer's literature, industry standards, our visual observations, and our experience with similar materials and systems. The values for EUL and RSL have been adjusted to suit our site observations. In certain instances, the EUL and RSL may not have a direct correlation due to circumstances such as the observed condition or nature in which a system or component is utilized, a recommended phased replacement of a system or component, a distribution of capital costs to alleviate "spikes" in certain planning years, etc.

The EUL of a system or component is a theoretical number that is arrived at with much estimation and is a function of the quality of materials used, manufacturing and installation, as well as the frequency and intensity of service, the degree of maintenance afforded to the system or component, and local weather conditions. Also, the realization of a system or component's EUL does not necessarily constitute its replacement. A detailed condition assessment or investigation may be a more prudent approach which may indicate a need for maintenance or refurbishment only, or may indicate adequate physical condition for an extended period.

Some systems or components have been assumed to have "indefinite" life expectancy as compared to the relative life of others. From time to time, localized repairs may be required due to deterioration or vandalism, which are assumed to be handled as part of ongoing maintenance. In some instances, a provisionary cost has been applied to a system or component in order to provide for foreseeable future repairs for which an actual cost cannot be applied at this time.

2.3.2 Component Condition Ratings

ASTM E2018-15 defines a "physical deficiency" as a conspicuous defect or significant deferred maintenance of a site's material systems, components, or equipment as observed during the site assessor's walk-through site visit. Included within this definition is material systems, components, or equipment that is approaching, has reached, or has exceeded its typical EUL or whose RSL should not be relied upon in view of actual or effective age, abuse, excessive wear and tear, exposure to the elements, lack of proper or routine maintenance, etc. This definition specifically excludes deficiencies that may be remedied with routine maintenance, miscellaneous minor repairs, normal operating maintenance, etc., and excludes conditions that generally do not constitute a material physical deficiency of the site.

The physical condition of a component/system is dependent on whether a physical deficiency is present, or whether action is anticipated within the next ten (10) years. The physical condition of components / systems noted in this report are often described as either "Excellent", "Good", "Fair", "Poor", or "Critical".

Definitions for condition ratings used in this report are provided in Table 2-1 on the next page.

Table 2-1 - Component Condition Ratings

Condition Rating	Description
Excellent	System or component is "like new" and/or functioning as intended with no deterioration observed.
Good	Functioning as intended with minimal deterioration observed. This rating implies that no action is anticipated within the next five (5) years.
Fair	Functioning as intended with normal deterioration and minor distress observed. Some evidence of deferred maintenance may be observed. This rating implies that action is anticipated within the next three (3) to five (5) years.
Poor	Not functioning as intended with significant deterioration as well as distress observed. Evidence of long-term deferred maintenance may be obvious. This rating implies that action is anticipated within the next two (2) years.
Critical	The component or system was observed to have failed or is at risk of imminent failure and/or the condition of the component or system presents a potential life safety concern or a possible Code infraction. This rating implies that action is required immediately (i.e., within the next year).

2.3.3 Event Types

Events (i.e., recommended actions) were developed for this report for components or systems where they are found to contain "physical deficiencies" that are considered beyond normal operational maintenance, to replace systems and components that have exceeded or will exceed their EUL over the next twenty (20) years. The event types used for this report, and their descriptions, are described below.

Table 2-2 - Event Types

Event Type	Description
Health & Safety	Actions required within the Immediate Term to prevent or minimize the risk of possible injury or impact due to an unsafe condition, or a possible violation of applicable Codes, standards, regulations, ordinances, requirements, etc. (Note that an evaluation of the site's compliance with local Building Codes and Fire Codes, or with local ordinances, requirements, etc. is not part of the scope of this project).
Deferred Maintenance	Actions required to address items pertaining to deferred maintenance, or to repair or replace a component or system due to a loss of function, reliability, and/or performance.
Study	Actions required to confirm the nature and/or extent of suspected "physical deficiencies" or to develop a cost estimate, schedule, and/or scope of work for repair/replacement activities that cannot be defined at the time of the assessment.
Lifecycle	Actions anticipated to repair or replace components or systems due to age or obsolescence, or to maintain function and/or performance.
Optional	Actions that may be performed to improve upon existing components or systems that are not related to age or physical condition.

2.3.4 Event Costing

Opinions of cost (in current dollar values) have been provided for events that are expected for systems and components over the next twenty (20) years, and are described in this report interchangeably as provisions, budgets or allowances. The costs are based on unit rates published by Means Publishing and/or Marshall & Swift Valuation Service, combined with local experience gained by Stantec, and are inclusive of "soft" costs such as contractor overhead and & profit, ancillary demolition/repairs, contingency allowance and consulting fees (i.e., design, inspection, testing, etc.), where these are warranted.

The quantities associated with each event have been roughly estimated during the walk-through site assessment and do not represent exact measurements or quantities. Furthermore, the accuracy of the cost estimates presented in this report is generally classified as Class 3, according to ASTM Standard E2516 "Standard Classification for Cost Estimate Classification System".

Only events with a total anticipated cost over $3,000 have been included in this report. Events below this cost threshold are assumed to be handled under the property's Operations and Maintenance budgets, although they may be mentioned in the report. There may also be events presented in this report that are currently being managed under the Operations and Maintenance budgets for the site. Events relating to life safety and possible Code infractions may be included in the report, regardless of cost.

At the time of repair or replacement, specific "scope of work" statements and quotations should be determined, and the budgetary allowances revised, where required, to reflect actual expenditures. Preliminary work may also be required in advance of the anticipated timeframe for events recommended in this report, which could also entail additional costs that are above and beyond the events' corresponding cost.

Stantec recommends that all maintenance contracts, operating costs and cost recovery information be reviewed in conjunction with the costs presented in this report. Furthermore, Stantec recommends that a defined set of parameters be agreed upon between the Client and other affected parties that pertain to classifying an event as an operating cost versus a capital expenditure cost, and for future projects. This may include criteria such as a cost threshold, frequency of asset replacement, nature of the work to be performed, asset insurability or mobility, etc.

2.4 LIMITING CONDITIONS

Exclusive Use

This report, including its information and opinions, has been prepared for the exclusive and sole use of the City of Edmonton Integrated Infrastructure Services (the "Client").

Reliance Purposes

This report shall not be relied upon for any purpose other than intended for the Client within the scope of services negotiated between Stantec Consulting Ltd. (Stantec) and the Client without the express prior written consent of Stantec.

Third Party Reliance

This report may not be relied upon by any other person or entity without the express written consent of Stantec and the Client. Any reliance on this report by a third party, any decisions that a third party makes based on this report, or any use at all of this report by a third party without the prior written consent of Stantec is the sole responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

Distribution

No party shall distribute this report, in its final form or in draft form, or any portion or copy thereof without the express written permission of Stantec, except that the Client may make copies of this report as are reasonable for its own use and consistent with the intended purposes of this report.

Opinions of Cost

Any opinions of cost expressed in this report are partially based on consultation with industry-recognized publications on costs for materials and labour. While Stantec uses information available to us combined with our judgment and past experience, the specific rationale and conditions forming the basis of contractors' bids, material or equipment pricing are beyond our knowledge and control. Stantec can therefore not be held responsible if the final costs vary from these opinions of cost.

As well, any opinions of cost are intended for global budgeting purposes only. The scope of work and the actual costs of the work recommended can only be determined after a detailed examination of the site element in question, understanding of the site restrictions, understanding of the effects on the ongoing operations of the site/building(s), definition of the construction schedule, and preparation of tender documents. Stantec expressly waives any responsibilities for the effects of any action taken as a result of these endeavors unless Stantec is specifically advised of prior to, and participate in the action, at which time, Stantec's responsibility will be negotiated.

Physical Limitations to Scope

Stantec's work did not include intrusive testing/investigation, destructive testing, testing of life safety systems or quantitative testing. As such, any recommendations and opinions of cost associated with these recommendations, as presented in this report, are based on walk-through non-invasive observations of the parts of the building(s) which were readily accessible during a visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report.

Opinions of cost presented in this report are also based on information received during interviews with site representatives, operations and/or maintenance staff. Stantec cannot be held responsible for incorrect information received during the interview process. Should additional information become available with respect to the condition of the building(s) and/or site elements, Stantec requests that this information be brought to our attention so that Stantec may reassess the conclusions presented herein.

Assessments

No legal surveys, soil tests, environmental assessments, geotechnical assessments, barrier-free compliance assessments, seismic assessments, detailed engineering calculations, or quantity surveying compilations have been made. No responsibility, therefore, is assumed concerning these matters. Stantec did not design or construct the building(s) or related structures and therefore will not be held responsible for the impact of any design or construction defects, whether or not described in this report. No guarantee or warranty, expressed or implied, with respect to the property, building components, building systems, property systems, or any other physical aspect of the property is made.

Standard of Care

The assessment outlined in this report generally captured conditions that existed at the time of the site visit. Stantec's opinions and recommendations presented in this report are rendered in accordance with generally accepted professional standards for like services under like circumstances for similar locales. The opinions and recommendations are not to be construed as a warranty or guarantee regarding existing or future physical conditions or regarding compliance of systems/components and procedures/operations with the various regulating codes, standards, regulations, ordinances, etc.

3.0 PROJECT TEAM

The following Stantec personnel were used for the completion of the BCA and CRRFS, and the preparation of this report. The qualifications of each Stantec team member are attached to this report in **Appendix E**.

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No sub-consultants or sub-contractors were used in the completion of the BCA or in the preparation of this report.

4.0 MAJOR FACILITY SYSTEMS ASSESSMENT

The following sub-sections describe the findings of our visual walk-through assessment of the property on August 16, 2017, and our discussions with the site representative(s).

4.1 SITE IMPROVEMENTS

4.1.1 Mechanical Utilities

Description

The evaluation of site mechanical utilities is limited to site drawings provided by City of Edmonton, Edmonton Waste Management Centre (EWMC). Services including water (Non- Potable), Sanitary/Storm sewer, and Natural gas services.

All utility services are located along the main road on the West and North side of the property housing the Compost Facilities Building (CFB). The Water service is a single source utility (non-metered) which distributes to the building sprinkler systems and to the potable water, in four locations on the property, one 200mm Potable water line enters the South-West edge of the property, into the SW main sprinkler room (service room #2) adjacent to Tipping floor mechanical warehouse which also provides service to a parking lot fire hydrant. The second location is at the North-West edge of the property where a second 200 mm water line enters the building to a second main sprinkler room (service room #1) and parking lot fire hydrant.

The third 200mm utility service enters the North Download Building on the NW corner. A 200mm utility service enters a separate pumping building located in the south west corner adjacent to Aeration Hall all other internal water distribution in the building is distributed Via the pump house. There are also 200mm water lines feeding sprinkler trees in the east end of the FC and in the south east and west corners of Aeration Hall.

The main gas service enters the property on the North-West edge of the property to the main gas utility meter and distribution header located in an open-air space adjacent to the tipping floor loading bay doors, behind main sprinkler room #1. Natural gas is distributed to the Dewatering Building and Aeration Hall via above ground piping over the Tipping Floor roof and underground piping distribution to the Administration Building.

There is no prevision for Sanitary or storm sewer to the plant processing site. Sanitary sewage is connected to septic tanks which are serviced weekly by a vacuum truck. All other building areas storm water drains via a ditch system located along the north and east sides of the facility and drains into the large storm water pond adjacent to Aeration Hall. It should also be noted that there is no storm water ditch along the south side of Aeration Hall.

Findings / Recommendations

Based on age, and an Expected Useful Life (EUL) of approximately 50 years, the underground utilities provided by the municipality which enter the property from below adjoining road ways there were no significant issues or deficiencies reported or observed during the site assessment. No significant capital expenditures apart from routine maintenance is anticipated within the evaluation period.

4.1.2 Electrical Utilities & Equipment

Description

The site is serviced by a 25KV Medium voltage underground electrical utility. The electrical utility follows the municipality road on the West side of the property and enters the property on the North-West corner between the Tipping Building and Aeration Hall to a third party owned sub-station switch yard (74-SWG01) located in front of the Dewater Building and under the South Download tunnels. The sub-station service is brought into the main electrical room (74-SWG03) adjacent to the Dewater Building. The site communications/telephone services also follow the site electrical utility service into the main electrical room (74-SWG03).

Findings / Recommendations

The underground utilities provided by third party venders which enter the property from below adjoining road ways there were no significant issues or deficiencies reported or observed during the site assessment. Maintenance of these services would be by the third-party venders as such no capital expenditures have been included in the cost tables.

4.2 BUILDING STRUCTURE

4.2.1 Foundations

Description

According to construction drawings provided by the client at the time of the site assessment, the building foundations are typically composed of cast-in-place concrete pier footings that are positioned below internal concrete columns, and cast-in-place concrete strip footings that are positioned below perimeter concrete foundation walls. Concrete slab-on-grade floors are constructed throughout the buildings. The slabs are underlain by a vapour barrier, and compacted, crushed gravel.

The perimeter of the foundation walls is provided with a rigid insulation board. The insulation is covered with a cementitious parging in areas where the foundation extends above grade.

Findings / Recommendations

Where visible, no significant deficiencies or deterioration associated with the building's foundation were observed during the site assessment. Building finishes were also observed for the presence of cracks or distress that might indicate foundation deficiencies and no significant deficiencies were observed or reported. Based on conditions observed and reported during the assessment, no significant capital expenditures related to the building’s structural framing are anticipated during the evaluation period.

The foundation insulation and parging on the southwest corner of the Tipping Building was observed to be damaged and displaced. It is recommended that repair of the foundation insulation and parging be conducted. The cost to conduct his work is considered to be below the threshold and part of routine maintenance. No cost is provided.

A concrete push-wall with a steel plate surface is provided on the sides of the tipping floor area in the Tipping Building.

A visual assessment of the concrete slab-on-grade floors was limited at the time of the site assessment due to debris and process materials. Where observed, the majority of the concrete slab-on-grade floors were noted to be in acceptable condition overall with minimal deficiencies, cracks, or displacement.

The concrete push-wall on the sides of the tipping floor area in the Tipping Building were observed to be intact. Several areas of the metal plate wear surface were observed to be damaged or torn. It is recommended that the damaged areas of metal plate be replaced to maintain functionality and mitigate damage to the underlying concrete push wall. An allowance to conduct replacement of damaged metal plating on concrete push wall has been provided in the cost table.

Salient Photographs

View of damaged foundation insulation and parging on the southwest corner of the Tipping Building

View of typical damaged and torn metal plating on the push wall in the tipping area.

4.2.2 Building Frame

Description

The facility consists of structural steel-framed buildings. Lateral loading of the building is resisted by diagonal cross bracing members installed at intervals along the perimeter of the structures.

Roof framing typically consists of metal decking supported by open web steel joists. Mezzanine floor levels are constructed of open web-steel joists supporting metal floor decks with concrete topping.

Findings / Recommendations

<u>Tipping Building, Dewatering Building, North Download Building, South Download Building, Finishing Building, and Biosolids Load-out Building.</u>

A visual assessment of the buildings' floor and structural frame was limited due to concealment by debris and process equipment at the time of the site visit. Where visible, no significant deficiencies or deterioration associated with the building's structural framing were observed during the site assessment. No evidence of widespread cracking, movement or other forms of structural distress were noted, or were reported by site personnel. Building finishes were also observed for the presence of cracks or distress that might indicate structural deficiencies and no significant deficiencies were observed or reported. Based on conditions observed and reported during the assessment, no significant capital expenditures related to the buildings' structural framing are anticipated during the evaluation period. Where visible the buildings' floor and roof structures were observed, and reported to be in good condition.

Aeration Hall Building

A structural assessment report of the Aeration Hall Building was provided by the client for review. The report, dated March 2, 2017, and authored by ONEC Engineering, indicated that ONEC Engineering was retained for a structural assessment of the Aeration Hall (building) in order to determine if structural steel, concrete and other critical structural elements were suffering from significant degradation/corrosion due to the harsh nature of the internal environment.

According to the report, initial inspections were conducted in December 2016, and identified areas of concern where the corrugated ceiling panels appeared to have buckled. Additional inspections of the general state of the roof joists and reinforced sections of all trusses within the attic spaces was performed between July 12, 2017 and September 8, 2017. ONEC also performed original capacity calculations and structural checks, in order to determine the current load carrying capacity of the roof truss and compare those results to the visual condition of the structure. ONEC was also asked to report on the results and provide recommendations for the continued service of the structure under the current design load and requirements of the Alberta Building Code.

Extensive deficiencies relating to the Aeration Hall Building's roof structure were reported by ONEC. Refer to the structural report issued by ONEC Engineering, Project E171428CP-001 rev. B. for further details.

Some of the observations recorded in the ONEC structural report referred to corrosion and the isolation of the celling structure from the process environment of the Aeration Hall. It is understood that when the frame is exposed to the environmental conditions of the Aeration Hall (humidity, ammonia combined with water form a corrosive mixture). These conditions could be contributing factors to a reduced EUL.

Section 4.4.1 of this report recommends periodic cleaning of the interior wall finish and structure. A structural review of the building frame and building envelope should be conducted in conjunction with the periodic cleaning. It is recommended that the re-occurring study include non-destructive testing to assess the impact of the liner and inspect random areas of the structure for corrosion to ensure that the structure can be in-service for the expected 50-year service life. A cost allowance for re-occurring structural/building envelope inspection of the liner and building frame have been provided in the cost table.

It was unknown at the time of the site assessment, what recommendations made in the structural assessment would be carried out and what was the cost for those corrections therefore no recommendations. Based on this fact, any remaining uncompleted structural repairs recommended in the structural report have not been included in the report at this time as making this recommendation may be speculative in nature. It is therefore recommended that a study be completed to determine what remaining structural recommendations should be completed and estimate the cost to complete them.

4.2.3 Stairs & Ramps

Description

The Dewatering Building includes one (1) interior stairs. The set of stairs is constructed in a stairwell at the building's north side. The stairs provide access to all building levels. The stairs are steel-framed with metal grate treads. Base or wall-mounted handrails of painted metal pipe construction border all stairs sections.

The Tipping Building includes one (1) metal framed stair. The set of stairs lead from the tipping floor to service tunnel located on the east side of the building. The stairs are steel-framed with metal grate treads. Base-mounted handrails of painted metal pipe construction border the stairs.

The North Download Building includes one set of interior stairs that provide access to a mezzanine level that contains an electrical room. The stairs are steel-framed with metal grate treads. The stairs are supported by steel posts at specific intervals. Base-mounted handrails of painted metal pipe construction border the stairs.

Exterior stairs with similar construction are proved on the exterior elevations of the Tipping Building, Dewatering Building, and Aeration Hall Building.

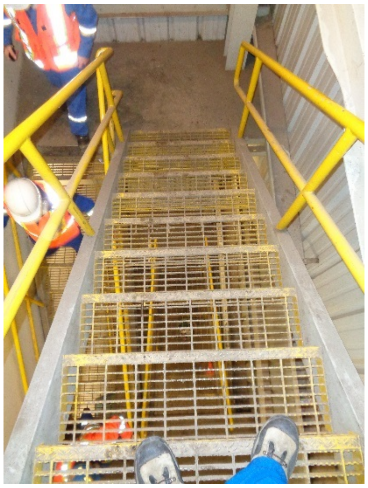
Findings / Recommendations

The interior stairs and handrails in the Dewatering Building and Tipping Building were observed to be in good condition and showed no signs of widespread damage or other deficiencies. Site personnel were also not aware of any known deficiencies. Based on age and observed condition, no major capital expenditures apart from routine maintenance is anticipated over the course of the evaluation period.

The stairs in the North Download Building that lead to the electrical room on the mezzanine level were observed to have temporary support posts. It is understood that renovation activities are underway in this area. It is recommended that repair of the stair support structure be completed in the immediate term. The cost to repair the stair supports is considered to be part of renovation activities and therefore not provided.

No significant issues or deficiencies apart from surface corrosion and chipped paint finish was observed on the exterior stairs. No significant capital expenditures apart from routine maintenance is anticipated within the evaluation period.

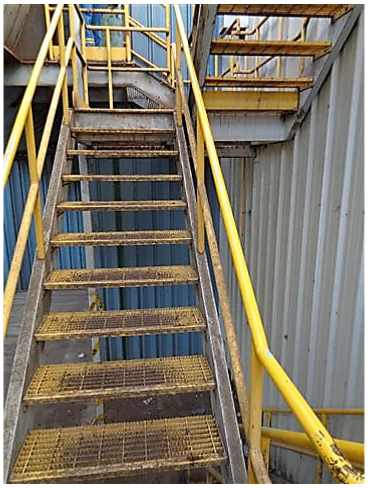
Salient Photographs


View of typical metal-framed stairs in Dewatering Building stairwell


View of metal-framed stairs in Tipping Building that lead from tipping floor to service tunnel


View of stairs leading to electrical room mezzanine within the North Download Building


View of metal-framed stairs leading to electrical room mezzanine within the North Download Building with temporary supports



View of typical exterior stairs on the Dewatering Building

View of exterior stairs on the Aeration Hall Building

4.3 BUILDING ENVELOPE

4.3.1 Exterior Walls

Description

According to construction drawings, provided at the time of the site assessment, the exterior walls of the Tipping Building are comprised of 38 mm pre-finished metal wall cladding, that Is installed on 100 mm galvanized steel 'Z' girts, with 100 mm rigid fiberglass (R-15) insulation, with a 38 mm galvanized metal liner panel and 200 mm galvanized steel main girts.

The exterior walls of the Dewatering Building are comprised of 38 mm pre-finished metal wall cladding, that Is installed on 150 mm galvanized steel 'C' girts, with 150 mm fiberglass (R-20) insulation, with a pre-finished metal liner panel and steel main girts.

The exterior walls of the North Download and South Download Buildings are comprised of 38 mm pre-finished metal wall cladding, that Is installed on 203 mm galvanized steel 'Z' girts, with R-15 WMP-F faced batt insulation.

The exterior walls of the Aeration Hall Building and Finishing Building are understood to be comprised of 40 mm pre-finished metal wall cladding, that Is installed on galvanized steel sub-girts, with 150 mm rigid fiberglass insulation, with a 150 mm horizontal steel girt, and a 190 mm corrugated stainless steel metal liner panel.

Construction drawings were not provided for the Biosolids Load-out Building; however, the exterior walls are understood to be of typical construction as the South Download Building.

Pre-finished metal flashing is provided on all of the buildings.

Joint sealant is also applied in construction joints, between dissimilar cladding materials, and around exterior wall openings (i.e., windows and doors).

Findings / Recommendations

Cladding materials and wall assembly components are original to their respective building construction circa 2000. The exception is the Load-out Building, which was constructed circa 2015.

Significant damage to the exterior cladding on the west elevation of the Tipping Building was noted at the time of the site assessment. The damage was observed to be primarily located around the overhead doors and may have been as a result of impact damage. Repair of damaged metal wall cladding, and flashing is recommended to maintain aesthetics and mitigate moisture intrusion in the building envelope. A cost allowance to conduct this work has been provided in the cost table.

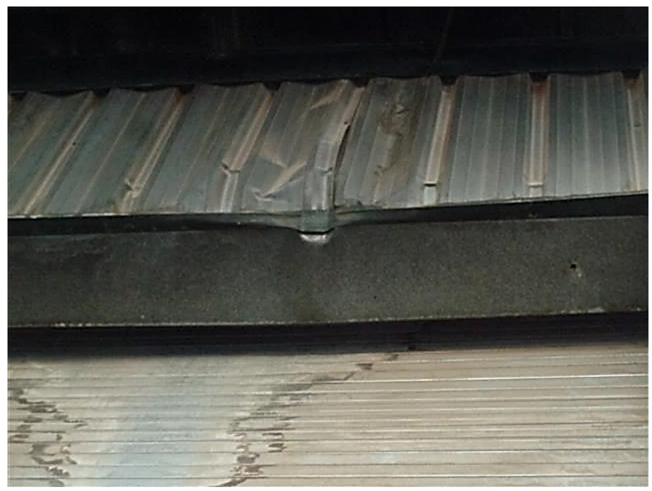
The majority of the exterior metal cladding on the buildings appeared to be in fair condition at the time of the site assessment. Localized impact damage was observed on the south corner of the Finishing Building, perforations from corrosion was noted on the south elevation of the Finishing Building and staining was observed below wall penetrations on the east elevation of the Tipping Building. it is recommended that the damaged metal cladding be repaired/replaced. The cost to conduct this work is considered to be below the threshold and therefore part of routine maintenance.

Based on the harsh environmental conditions under which the buildings operate, in particular the Aeration Hall (in high humidity, in the presence of ammonia (when combined with water form a corrosive mixture). We understand that the interior metal cladding is meant to isolate these conditions from the steel frame and the building envelope, however it is known that the interior metal cladding does leak and allow pollutants to enter this cavity (refer to ONEC Engineering structural report dated March 2, 2017). Under these conditions It is understood that when the frame and building envelop is exposed to these conditions it could be a contributing factor to a reduced EUL. Due to this risk periodic inspection and testing is recommended. The work for this inspection is included in the study located in Section 4.2.2.

Exterior sealants are understood to be original to the building's development and where visible were observed to be pliable and in overall good condition. Based on age and a EUL of 20 years, renewal of the sealants is anticipated over the course of the evaluation period to maintain the performance of the building envelope. This work is considered to be below the threshold and part of routine maintenance. No cost has been provided.

Salient Photographs


View of damaged metal cladding at overhead doors on the west elevation of the Tipping Building


View of damaged metal cladding at overhead doors on the west elevation of the Tipping Building

View of stained exterior metal cladding on east elevation of the Tipping Building

View of typical metal panel cladding on the southwest corner of the Aeration Hall Building adjacent to the Finishing Building

View of corrosion on metal cladding on the south elevation of the Finishing Building


View of typical metal panel liner on the interior of the Finishing Building

4.3.2 Exterior Windows

Description

Exterior windows are provided on the west elevation of the Tipping Building (Unit 20) and on the north elevation of the Dewatering Building (Unit 10). The windows consist of insulating glazing units (IGUs) set in a fixed aluminum frames.

Findings / Recommendations

The windows on the Tipping Building and Dewatering Building are understood to be original to the construction of the buildings circa 2000. No significant issues related to the windows were observed or reported during the site visit.

Based on a EUL of 40 years, lifecycle replacement of the exterior windows is not anticipated within the evaluation period. No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period.

Salient Photographs

View of typical exterior window on west elevation of the Tipping Building

4.3.3 Exterior Doors

Description

All exterior exit man doors on the building perimeters are painted, insulated metal pivot-type units that are hinge-mounted in painted, pressed steel frames. Exterior door hardware is typically composed of metal hand levers, exit devices, closers, weather stripping, and lock sets, where required.

The buildings are provided with various types and sizes of overhead doors. The doors are comprised of sectional wood panel, sectional metal panel and fabric panel. Some of the doors include a button controlled, electric operator.

Findings / Recommendations

All exterior exit man doors and components are understood to be original to the respective building's construction in 2000. The exterior doors were observed to be functioning as intended. However, the doors and related hardware exhibited wear, extensive deposits of debris and corrosion. The doors are considered to be in fair condition overall. The exit doors from the tipping floor on the north elevation of the Tipping Building were noted to be closed off due to construction activities on the north side of the building.

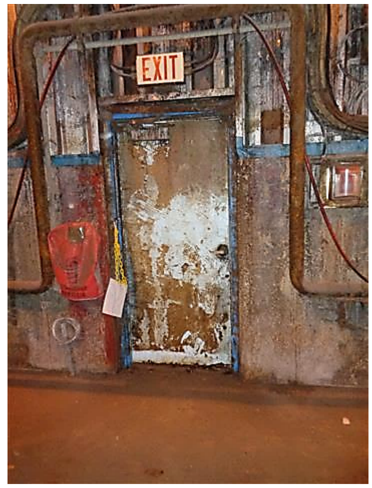
Based on a EUL of 35 years and conditions observed, the exterior exit man doors and components (with the exception of Biosolids Load Out Building) are expected to require replacement or refurbishment within the next ten (10) years to maintain the function and reliability. The repair or renewal of finishes, hardware, or other components may be required periodically to maintain performance and function. An allowance has been provided in the cost table.

The majority of overhead doors were observed to be operational. However, the overhead sectional metal doors on the west elevation of the Tipping Building were noted to be damaged beyond repair. It was reported that the doors are not being used in the operation of the Tipping Building. Several doors on the South Download Building, North Download Building and Finishing Building appeared to have impact damage and newer door sections. The overhead doors on the Aeration Hall Building appeared to be in acceptable condition with minimal deficiencies or impact damage.

Based on a EUL of 25 years, and conditions observed during the site assessment, replacement is anticipated within the evaluation term. Replacement costs for the overhead doors and related operators have been provided separately for each building in the cost table.

Salient Photographs

View of typical exterior door on west elevation of the Tipping Building



View of typical exterior door on the Aeration Hall Building

View of typical exterior door on north elevation of the Tipping Building

View of typical exterior door on north elevation of the Dewatering Building

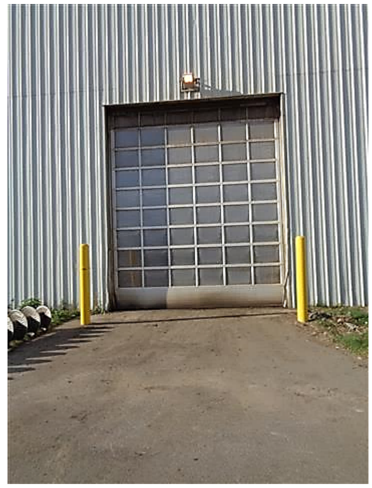
View of typical exterior door on south elevation of the South Download Building

View of non-functioning damage to overhead doors on the west elevation of the Tipping Building

View of overhead door and man door on the south elevation of the Tipping Building

View of typical overhead door on the south elevation of the Finishing Building

View of overhead door and man door on the west elevation of the Finishing Building



View of typical overhead door on the exterior of the Aeration Hall Building

4.3.4 Roofing & Accessories

Description

The buildings are provided with sloped roof sections that are clad with pre-finished metal standing-seam roof panels. According to construction drawings, the metal roof cladding is applied over R20 insulation that is complete with an air/vapor barrier. A metal panel liner is installed on the interior ceilings of most buildings.

Storm water runoff on the majority of the buildings is primarily collected in troughs and roof drains that are incorporated into the edge of the roof assemblies. The storm water is discharged via either internal rain leader piping or pre-finished metal downspouts onto paved surfaces. The downspouts are installed at strategic intervals along the perimeter of the building.

Fall protection guard rails and maintenance walkways constructed of galvanized metal pipe and grating, are provided on the Tipping Building and Dewatering Building.

Roof access on the Tipping Building and Dewatering Building are provided by wall-mounted, metal caged, ship ladders.

Pre-manufactured metal roof hatches are provided on the Tipping Building and Dewatering Building roofs. The roof hatches correspond to the ship ladder locations.

Findings / Recommendations

All roof components are original to the construction to their respective building sections circa 2000 and 2015. A visual inspection of the pitched roof sections was limited during the site assessment due to restrictions by the client and inaccessibility. Refer to section 6.1 for details on which areas of the facility were not accessible at the time of the assessment.

Based on an EUL of 50 years, a lifecycle replacement of the roof cladding is not anticipated within the evaluation period. However, it is recommended that periodic inspections be performed every 5 years to evaluate the condition and remaining service life of the roofing assemblies. The cost to conduct this work is considered to be below the threshold and part of routine maintenance. No active or recurring leaks were reported by site personnel. Based on an EUL of 50 years, a lifecycle replacement of the roof cladding on the majority of the building sections is not anticipated within the evaluation period. However, based on a structural condition assessment conducted by ONEC in March 2017, the Aeration Hall Building (unit 40) is recommended to have substantial work conducted in the short term. The cost to conduct this work which may include replacement of some of the roof cladding, is considered to be speculative and has not been provided at this time.

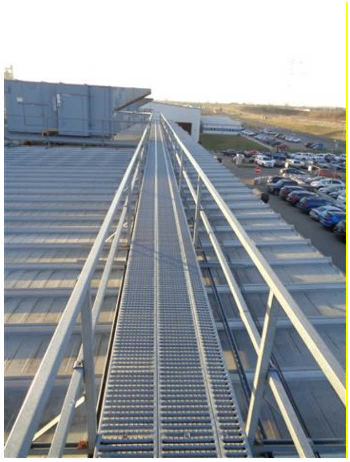
The rain leaders are understood to be original to the construction of the buildings. A visual assessment of the rain leaders was limited during the site visit due to concealment by interior finishes. No significant issues or deficiencies were reported by the site contact. However, a damaged rain leader on the east corner of the Tipping Building was observed. It is recommended that the damaged rain leader be repaired to maintain its functionality. The cost to conduct his work is considered to be below the threshold and therefore part of routine maintenance and therefore no cost has been provided.

No significant issues or deficiencies related to the fall protection guard rails, maintenance walkways, roof hatches and ship ladders were observed or reported at the time of the site visit. Based on a EUL of 50 years, no significant capital expenditure apart from routine maintenance is anticipated within the evaluation period.

Salient Photographs


View of roof access ship ladder on the northwest corner of the Tipping Building


View of typical roof hatch



View of typical Fall Protection guard rails and maintenance walkways on the roof of the Tipping Building

View of typical Fall Protection guard rails and maintenance walkways on the roof of the Tipping Building

View of typical metal roof cladding

View of damaged rain leader on the east corner of the Tipping Building

4.4 BUILDING INTERIOR

4.4.1 Wall Finishes

Description

Most interior wall finishes in the Aeration Hall Building, Dewatering Building, Tipping Building, Finishing Building and Load-out Building are provided with a prefinished or galvanized metal panel liner. The interior wall finishes in the North Download and South Download Buildings are exposed WMP-F faced batt insulation. The interior wall surfaces in the Control room at the South Download Building, the electrical room in the Finishing Building and the electrical room in the South Download Building are covered with a painted gypsum board.

The exposed steel structures of each building are provided with a paint finish.

Findings / Recommendations

A detailed visual assessment of the interior surface of the exterior walls of the buildings was not possible due to concealment by a heavy coating of debris understood to be from processing activities. Where visible the interior metal panel liner appeared to be in intact and serviceable.

The exterior walls of the buildings (North Download Building and South Download Building) that have an exposed WRF faced insulation also appeared to be laden with a coating of debris. It was reported that these areas are under renovation activities. It was unknown at the time of the site assessment whether these exterior walls will be renovated with an interior metal liner. Exposed insulation and metal substructure may be susceptible to damage from impact, debris and corrosive process environment that may result in a reduced service life.

Based on conditions observed during the site assessment, it is recommended that the interior surfaces be power washed/cleaned in the short term and subsequently every three (3) years to mitigate corrosion and ensure the wall components achieve their EUL of 50 years. A cost allowance to periodically conduct this work has been provided separately for each building in the cost table. It is also recommended that the interior wall surfaces be inspected after this work has been completed to determine its condition, correct deficiencies that require repair, and determine its remaining service life. This work is considered to be part of routine maintenance and therefore no cost has been provided. Refer also to Section 4.2.2, Building Frame for additional observations and recommendations regarding scope of the inspection of the metal wall liner and its importance to protect the building frame and building envelope from the indoor environmental conditions.

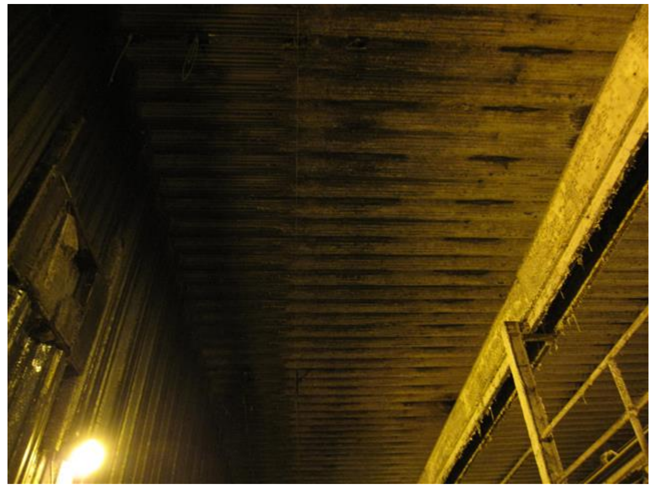
The interior wall finishes in the electrical rooms and control room generally appeared to be performing as intended, and exhibited only minor damage to gypsum wall board in localized areas due to ongoing building operations. The gypsum wall board and paint finish is expected to require periodic repair or partial replacement to address deficiencies as they occur, to restore aged or deteriorated wall surfaces, or in conjunction with future renovation activities. The cost is considered to be below the reporting threshold and part of routine maintenance.

Salient Photographs

View of typical interior surfaces in the South Download Building

View of typical interior surfaces in the North Download Building

View of interior wall and ceiling lining in Aeration Hall Building



View of interior wall and ceiling lining in Aeration Hall Building

4.4.2 Floor Finishes

Description

Floors throughout the buildings are generally left exposed to the concrete slab-on-grade.

Findings / Recommendations

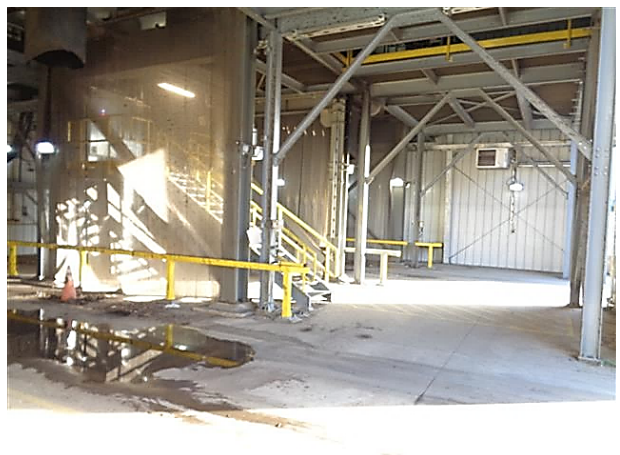
A visual assessment of the buildings' floor was limited due to concealment by debris and process equipment at the time of the site visit. Where visible, no significant deficiencies or deterioration associated with the building's concrete floors were observed during the site assessment. No evidence of widespread cracking, movement or other forms of structural distress were noted, or were reported by site personnel. Building finishes were also observed for the presence of cracks or distress that might indicate structural deficiencies and no significant deficiencies were observed or reported. Based on conditions observed and reported during the assessment, no significant capital expenditures related to the buildings' floor finish are anticipated during the evaluation period.

Salient Photographs

View of typical concrete floor in the Tipping Building

View of typical concrete floor in the Dewatering Building

View of typical concrete floor in the Aeration Hall Building



View of typical concrete floor in the Load-out Building

4.4.3 Ceiling Finishes

Description

Most interior ceiling finishes in the Aeration Hall Building, Tipping Building, Finishing Building, and Biosolids Load-out Building are provided with a prefinished or galvanized metal panel liner. The interior ceiling finishes in the North Download Building and South Download Buildings are typically exposed WMP-F faced batt insulation and steel roof structure.

The ceiling in the Control room at the South Download Building is provided with suspended metal T-bar grids with in-laid acoustic panels.

The exposed steel roof structures of each building are provided with a paint finish.

Findings / Recommendations

No significant amount of damage or deterioration related to the ceiling finishes was observed or reported during the assessment. Refer to section 4.4.1, for additional observations and recommendations related to the ceiling metal panel liners located in the Aeration Hall Building, Tipping Building, Finishing Building, and Load-out Building.

The suspended ceiling assembly in the control room is expected to require renewal over the course of the evaluation period as these finishes achieve or surpass their EUL. It is assumed that the suspended metal T-bar grid is left in place. A cost allowance to replace acoustic ceiling tiles has been provided in the cost table.

4.4.4 Interior Partitions

Description

Interior fixed partitions are provided at electrical rooms and the control room area are generally composed of gypsum-clad metal stud framework. Interior windows are installed in the control room area within the South Download Building and are typically composed of single-pane tempered glazing that is set within fixed and painted metal frames.

Fire-proof sealant or fire-proof cabling fixtures are provided at penetrations in interior partition fire separations.

Findings / Recommendations

Interior partition walls and windows are original to the construction of the buildings circa 2000.

No significant damage or deficiencies associated with interior fixed partitions or interior windows was observed during the site assessment. No significant capital expenditure related to the interior partitions and windows, apart from routine maintenance, is anticipated within the evaluation period.

No significant issues or deficiencies related to firestopping in fire separations located throughout the building were observed or reported. However, areas may have wall penetrations where fire stopping sealing is missing and were not viewed. It is recommended that firestopping sealant be applied on firewall penetrations where missing. The cost to conduct this work is considered to be below the threshold and part of routine maintenance.

4.4.5 Interior Doors

Description

Interior passage doors within the buildings are typically composed of painted hollow metal, pivot-type units that are set in painted, pressed steel frames. Door hardware is generally composed of metal hand levers or knobs, door closers, and lock sets, where required.

Findings / Recommendations

The interior doors are original to the construction of the buildings circa 2000. No issues or deficiencies related to the interior metal doors were reported. However, the doors are in good condition overall. Based on a EUL of 50 years, lifecycle replacement is not anticipated within the evaluation period.

The interior door hardware throughout the buildings was generally performing as intended. However, based on an EUL of 30 years, lifecycle replacement of pivot door hardware, locksets, and closers is anticipated during the evaluation period. A lifecycle replacement cost has been provided in the cost table.

Salient Photographs

View of typical interior door at stairwell

4.4.6 Fittings

Description

The washroom located in the control room area of the South Download Building has various accessories including soap dispensers, toilet paper dispensers, paper towel dispensers, waste containers, mirrors, grab bars, and other related accessories.

Fixed casework that is typically composed of floor-mounted cabinetry is installed in the control room area within the South Download Building. The casework is of wood construction and typically incorporates laminate-covered surfaces, along with laminate-surfaced counter tops of wood construction. The wall-mounted vanities in the washroom within the control room area are also of wood-frame construction and incorporate plastic laminate surfacing.

Findings / Recommendations

No significant issues or deficiencies related to the washroom accessories was observed or reported during the site assessment. Based on age, the washroom accessories will achieve their EUL within the 50-year evaluation period. We have assumed that washroom accessories may be repaired or partially renewed on an as-needed basis through the site's operations and maintenance budgets.

The fixed casework within the control room area of the South Download Building is understood to be original to the construction of the building circa 2000. Fixed cabinetry is understood to be serving its intended purpose and considered to be in good condition. Nonetheless, based on a EUL of 30 years, lifecycle replacement is anticipated within the evaluation period. Further assessment is recommended as the components reach their EULs to establish condition and replacement year. A cost allowance for fixed casework has been provided in the cost table.

4.5 MECHANICAL SYSTEMS

4.5.1 Domestic Water (Potable and Non-Potable systems)

Description

A water supply is provided to the Tipping buildings two sprinkler service rooms from a 200 mm (8") water service that originates from a City of Edmonton water main below Meridian Street NE on the west side of the property. Potable water is also distributed to two other building locations, the North Download building and pump house/Aeration Hall. The 200mm (8") utility lines enter each building to a backflow prevention device where the 200mm line is reduced to (100mm) sprinkler zones servicing their respective areas. The pump house is responsible for water distribution to Aeration hall and the Loadout building and to compost equipment processes.

Backflow prevention devices (200mm) are provided on the four-fire water sprinkler main lines to the building. A second backflow prevention device (100mm) serves individual zones off the main header. One additional sprinkler tree is in the Tipping building service room #2 which is a glycol system serving the loading bay door on the west side of the Tipping Building.

Domestic water supply is provided to the Dewater Building which supplies one electric water heater for bathroom, lab, and caretaker areas. Hot water tank is estimated to have a heating capacity of 3kW and storage capacity of approximately 30L (8 U.S. Gallon).

It was reported that a non-potable water distribution system is used for process water. This distribution system has been excluded from this assessment. It was not clear what the source of water is for the process water distribution system, however it was reported that the potable water system can be used as a source for the process water distribution if required.

Findings / Recommendations

The domestic water piping distribution system and equipment are original to the building's construction in 2000 and 2015 for the Load out building expansion. Water lines were observed to be in good condition. The backflow prevention devices were last certified by Tyco in March 2017. The domestic water distribution piping in the Dewater Building was reported to be performing as intended, as no active or recurring leakage was reported or observed.

Based on conditions observed and reported during the assessment, and an EUL of 50 years, renewal of the original domestic water distribution piping is not anticipated within the evaluation period. Replacement of the backflow prevention devices is anticipated in the medium term and a lifecycle cost has been provided in the cost table. The domestic water heaters were observed and reported to be functional. Nonetheless, based on an EUL of 15 years, cyclical replacement can be anticipated, and allowances are provided in the cost table.

Salient Photographs

Typical view Service room #2 sprinkler tree

Typical view of Back-Flow Prevention Device

4.5.2 Sanitary Waste

Description

Sanitary waste that is generated from the Dewater building's plumbing fixtures and building floor drains is collected in sanitary sewer piping and risers that appeared to be constructed of high density polyethylene (HDPE) with copper connections to plumbing fixtures. It was reported that there is no municipality sewer connection to the building. Sanitary waste water is collected in holding tanks and drained by a vacuum truck twice a year. There are several vent stacks on the roof of the Dewater building which vent sewage gases to atmosphere.

There are six (6) simplex sump pumps in the Tipping and North Download building (1) which discharge sanitary waste from the building to the site pump house. The pumps were observed to have fractional HP rating.

Findings / Recommendations

Sanitary waste and vent piping is original to the building's construction in 2000, was reported to be functional, and is in good condition. No major deficiencies were observed or reported during the assessment. No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period. Minor repairs to address periodic leaks or deficiencies, as they occur, will presumably be handled through CZUES the building's operations and maintenance budgets. Based on age, an EUL of approximately 20 years, and conditions observed during the assessment, the submersible sump pump and corresponding controls are expected to require replacement in the next 10 years of the evaluation period to maintain function and reliability.

Salient Photographs

Typical Sump Pump Dewater Building

Controller for Sump Pump in Pump Building to lagoon

4.5.3 Storm Drainage

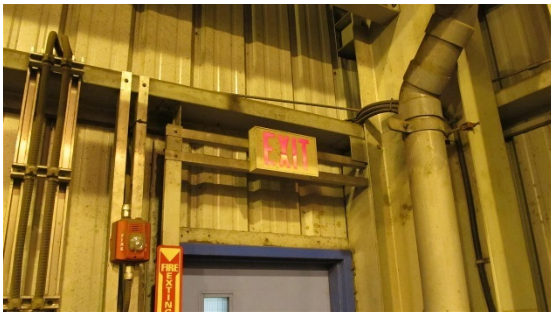
Description

There is no municipal storm drain connections to the site. Rain water from the building roof areas of the buildings are carried by interior rain leader which divert the water to ditch areas located on the North and east side of the facility and drain to the storm water lagoon and to splash pads in some areas over the ground.

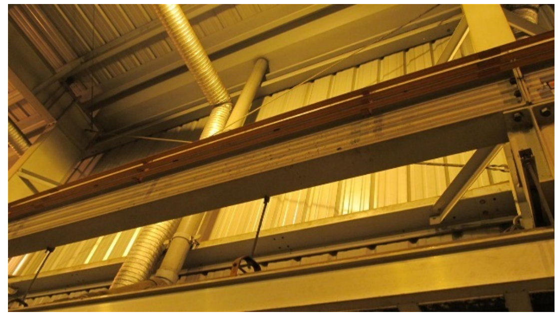
Findings / Recommendations

The building's storm water piping is original to its construction in 2000. The building's storm water piping is in good condition, there were no known concerns, and no major deficiencies or deterioration was encountered during the assessment. Based on conditions observed and reported during the assessment, no significant capital expenditures related to the buildings' storm drainage system is anticipated during the evaluation period. Refer to section 4.3.4 for finding and observations as it relates to building exterior rain water leaders.

Salient Photographs



View of Dewater Building, typical interior roof rain leaders



View of typical interior roof rain leaders

4.5.4 Plumbing Fixtures

Description

Plumbing fixtures in the building are provided in washroom and lab in the Dewater Building. The washrooms include floor mounted vitreous china water closets with tank style flush and wall mounted vitreous lavatory with center mount faucet.

Stainless steel double basin sink is surface-mounted in counter top in lab area. Floor-mounted mop sinks of acrylic construction are located in the custodial room.

Findings / Recommendations

The building's plumbing fixtures are considered to be in good condition, there were no known concerns, and no major deficiencies or deterioration was encountered during the assessment. Based on age, the building's plumbing fixtures, are anticipated to require lifecycle replacement during the evaluation period, and therefore an allowance has been provided in the cost table.

4.5.5 Energy Supply

Description

A Natural gas supply is provided to the site from a local utility provider. The natural gas main connects with an external wall-mounted meter and pressure regulator and gas distribution header that is installed on the building's northwest elevation of the Tipping Building behind service room #1. Natural gas is then distributed from the gas distribution header to the South-West corner of Aeration Hall Building and to the East side of the pump house. The natural gas service subsequently enters the various building sections and is distributed to the natural gas-fired projection heaters, radiant tube heaters and makeup air units. The delivery of natural gas in the buildings appears to be made via black iron piping.

Findings / Recommendations

Natural gas distribution piping is original to the building's construction and was extended to the North Download Building Unit 30 in 2015. The natural gas piping was observed to be in good condition with no deficiencies observed or reported. Based on the natural gas piping no significant capital expenditure apart from routine maintenance is anticipated within the evaluation period.

Salient Photographs

Typical view Utility gas distribution Tipping Building

4.5.6 Heating Systems

Description

The building's primary source of heating is different depending on the section of the process plant you reference. The Tipping Building main floor heating is made up of nine rows of radiant tube heaters distributed to cover the tipping floor area. Line voltage thermostats and contactors control the operation of the radiant tube heaters. The maintenance warehouse connected to the tipping building is heated by two rows of suspended gas fired radiant tube heaters. Smaller independent spaces like sprinkler rooms, stair wells and man door vestibules in the building are heated by wall mounted electric heaters manufactured by Chromalux estimated to be12kw output with integral thermostats. In smaller corridors and adjoining Ares where the tipping building connects to the South Download tunnels, suspended gas fired Rezor unit heaters are utilized.

It was reported that the primary floor heating (Radiant Tube) in the Tipping Building has never been used. It was reported that the way the process building operates, the temperature level never gets cold enough to warrant the heaters to be turned on.

The Finishing Building's primary heating source is provided by one Heating, Ventilation and Air Conditioning (HVAC) unit 10-H1025 (heating only). Secondary heating of the Loadout truck bays is provided by six (6) suspended gas fired Reznor unit heaters. Additional space heating throughout the process building Tipping, North Download, Loadout, finishing building areas is provided by natural gas fired unit heater manufactured by Reznor with an estimated heating capacity of 80 to 100 kW (272 to 341MBH) which direct vent out of the building and are controlled by local line voltage thermostats. Heating in the Main process areas are provided by four (4) gas fired Rezor heaters on the main floor and three on second floor. Unit control is provided local line voltage thermostat. Units are direct vented out of the building by exhaust piping through the side or roof area of the building it serves.

Sprinkler service room, stairwells and exit man door areas, are heated by electric baseboard heaters, manufactured by Chromalux, with estimated heating rating of 9kW each.

Findings / Recommendations

The Tipping building, South Download, North Download and Dewater building heating units are all expected to require replacement during the evaluation period as they achieve their EUL. Based on age and observations made during the assessment there were no reported concerns by the site contacts. It was reported that the gas fired radiant tube heaters over the tipping floor are not utilized as part of the building heating. It is recommended that a study is performed to determine why these units are not used as designed, as such an allowance has been provided in the cost table under section 4.5.7, Air Balance Study.

The heating equipment (both gas fired and electric heat type units) is expected to require lifecycle replacement during the evaluation period to maintain a reliable source of heating for the building and its occupants. An allowance has been provided in the cost table. The newer construction of the Finishing building no significant capital expenditure apart from routine maintenance is anticipated within the evaluation period, so no cost has been included in the cost tables for this portion of the process building.

4.5.7 Ventilation Equipment

Description

The Tipping Building ventilation is made up of two independent systems. Three main roof mounted Make-up Air (MUA) units manufactured by Engineered Air with air supply fan gas fired heating section, mixed air section and filters have outputs of (16,990l/s) located on the west side of the Tipping Building above the delivery doors and two other MUA units which supplement the tipping building primary heating. The South Download/North Download tunnels each have an individual built-up air handling unit with estimated air flow capacities of (3820L/s). Units have an air flow capacity of (3820L/s) each. Primary ventilation for the finishing building is by two MUA units 50-C122 and 50-C-123 and one MUA unit for the South annex building 50-C-ZZ. with estimated air flow capacity of (3820L/s). It was reported that the ventilation equipment serving the Tipping building is not operated year-round and is only used during cold outdoor air conditions.

The Tipping building is interconnected with the North Download building by 5 tunnel connections know as South Downloads. In the original design the South Downloads tunnels would spin and transfer the garbage from the Tipping Building to the North Download Building for sorting. The South Download tunnels are reported to be no longer in service; three have been decommissioned and two South Downloads #3 and #4 have been retrofitted with conveyor belts to transfer the garbage between buildings. Primary ventilation of the North Download building South Download tunnels 3 and 4 is provided by an individual Make-up Air (MUA) unit (30-HM30,30-HM40). Each tunnel area is exhausted by individual exhaust fans. The Tipping floor MUA air supply is reported to be drawn through the building and South Downloads tunnels to Aeration Hall.

The North Download Buildings, main electrical room is ventilated by an independent roof mounted MUA unit 30-H3, manufactured Engineered Air, with an estimated output capacity of (1802 l/s) and exhausted by one exhaust fan 3-C-10 Manufactured by Engineered Air, which has an estimated output of (9438 l/s).

A lab area is provided within the Dewatering building. The lab area has an independent MUA unit 10-H-58, manufactured by Engineered Air, with and output capacity of (1003L/S) which is interlocked with two exhaust fans 10-C48/10C-55, which have an estimated capacity of (4250L/S). The control room, bathroom and caretaker areas are ventilated by a ceiling mounted exhaust 10-C-11 with an estimated output of (47l/s). The process equipment area in the Dewater building has a separate MAU unit 10H-3, manufactured by Engineered Air with any output of (3820L/S) which is exhausted by a wall mounted exhaust fan 10-C-11 with an output of (4250 l/s).

The Aeration Hall Building is ventilated by two grade mounted MUA units, manufactured by Engineered Air, each with a capacity of (9438l/s). It was reported that the units were not used, because of the anaerobic heat produced during the breakdown of the compost material is sufficient to heat the building and therefore the units are not utilized. Ventilation of the overall processing building is provided by two roof mounted 125hp exhaust fans located on the Dewatering building, it was reported that only one of the two fans can operate at one time in order to maintain the negative air pressure required in Aeration Hall building. It was reported that when both units are running, the building air balance changes to a positive pressure in Aeration Hall Building allowing process odors to escape from the building without going through the Bio-filter. Roof and wall mounted exhaust fans provide ventilation to South Download tunnels, North Download building, loadout and finishing buildings. The fans were typically manufactured by GreenHeck, and all have factional HP ratings. The Aeration Hall Building is also equipped with five (5) attic fans, which are located above the stainless-steel liner, that ventilate the attic air space surrounding the Aeration Hall roof structure.

Not included in this assessment are the Aeration Hall Building process exhaust fans, which draw air from the Aeration Building. It was reported that only five out of the six exhaust fans can operate at once. This ventilation process reportedly pulls makeup air through the process building from the tipping building.

Findings / Recommendations

The Tipping building, North Download, Dewater and Aeration Hall heating made up units (MAU) and exhaust fans were observed and reported to be in good condition, and are original to the building's construction the equipment is understood to be maintained on a periodic basis as part of the ongoing Suez's maintenance program. Details of Suez's maintenance program were not provided during the assessment. Based on the EUL of 30 years, the MUA units are expected to require replacement during the evaluation period and an allowance has been provided in the cost table. There were no reported or observed concerns with the ventilation equipment or systems in the Finishing building and therefore no significant capital expenditure apart from routine maintenance is anticipated within the evaluation period, so no cost has been included in the cost tables for this portion of the building.

Based on the reported manual operation or non-operation of the MUA units and exhaust fans and how this impacts the process ventilation systems and it effect on the Aeration Hall pressurization, it is recommended that an air balance study be completed to assess current site operations of the ventilation systems in conjunction with the process design parameters/requirements. An allowance has also been provided to complete an air balance study to evaluate the reported issues occurring in the Aeration Hall during our assessment.

Salient Photographs

Tipping Building Typical MAU

Finishing Building MAU Ground level

4.5.8 Distribution Systems

Description

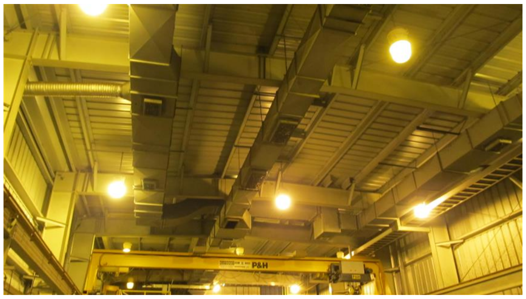
Conditioned air is delivered through the compost facility from the MAU units which supply the main Tipping building. Ventilation design was intended to re-use air for the Tip Floor Building in the Download and Aeration Hall Buildings, to minimize the volume for odor treatment. Tempered air is delivered via low velocity sheet metal ductwork located in ceiling building structures and other areas include ceiling mounted ductwork for lab bathroom, caretaker utility room, bathroom, and main electrical rooms. Air is delivered to the spaces, through a mix of ceiling mounted ducts, louvres. Air is ventilated form the different process areas of the building by a mix of ceiling mounted exhaust fan throughout the building to temper the delivered air, which range in capacity from (1004/s to 9,439 l/s). It should be noted that all buildings are kept at a negative pressure to contain odors as much as possible.

Exhaust air is expelled from the different process areas in the building via sheet metal ductwork that is in ceiling spaces and from the Aeration Hall Building compost ventilation process. Due to the environment in Aeration Hall the air distribution ducting has been replaces a number of times over the years. Residential style kitchen hood exhaust fans are provided in lab bathroom and caretaker closet for removal of unwanted odors.

Findings / Recommendations

All distribution systems and equipment in the process building are generally original to its construction and Finishing Building areas. Based on an EUL of 55 years, no replacement of the air distribution ductwork (supply air and exhaust systems) is anticipated during the evaluation period, while lifecycle replacement of lab and bathroom areas in the Dewater Building exhaust hoods is anticipated in the medium term. Allowance have been provided in the cost table for the replacement of these systems.

Salient Photographs



Dewater Building duct distribution system

Roof mounted exhaust ducting Tipping Building

4.5.9 Packaged and Terminal Systems

Description

The Dewater Building Lab receives a tempered air supply from a packaged, roof-mounted Heating, Ventilation, and Air Conditioning (HVAC) unit that is manufactured by Engineered Air. The HVAC unit has a nominal estimated cooling capacity of 10.5 kW (3.0 tons

Findings / Recommendations

All packaged and terminal systems and equipment are original to the building's construction in 2002 and Loadout building. The systems and equipment appeared to be functional, and performing as intended.

The AC Lab room type air conditioning unit was not observed during the assessment, as access to the roof was not permitted. However, based on age, and an EUL of 20 years, lifecycle replacement of the AC unit can be anticipated in the evaluation period.

4.5.10 Control Systems

Description

Control of all the Heating, Ventilation, and Air Conditioning (HVAC) equipment in the s building is provided by a combination of local controllers/switches and thermostats and plant HMI system. It is our understanding the SCADA controls used for the process equipment does not control or monitor the HVAC systems, The standalone gas detection system equipment is not included in this assessment. Standalone gas detection monitor (ODO Watch) monitors odors generated at the Tip Floor and biofilters.

Separate sensors are interconnected to the process Scada system are located throughout the compost facility to monitor CO2, H2S, NH3 and other process gases. Both independent systems are for the safety of the employees and to monitor odor levels from escaping the site to reduce complaints from the surround neighborhoods. The system works in conjunction with the Alarm beacon which also monitors different areas of the plant and provides audible and visual alarms when set detection levels are reached.

Findings / Recommendations

The standalone controllers, switches and thermostats are all original to the construction of the facility and were reported to be functioning as intended. Based on an EUL of 15 years, lifecycle replacement of the controls systems can be anticipated during the evaluation period, and an allowance has been provided in the cost table with the replacement of individual MUA, exhaust and heating units. The standalone gas detection system equipment is not included in the Buildings system assessment.

Salient Photographs

Typical Air Monitor Alarm Beacon

Typical Air Monitor system

4.5.11 Fire Suppression Systems

Description

The building is protected by a wet type sprinkler system throughout the process plant. Over overhead door area, which are subject to freezing, utilize glycol filled sprinkler zones. Stand pipe systems with hose cabinets were observed were observed on the Tipping floor and other areas throughout the plant. The stand pipe and sprinkler systems provide fire protection for the various building areas. Zone valves are in the fire suppression rooms. The sprinkler tree serves approximately 10 sprinkler zones in the building. Pressure is maintained in the wet sprinkler systems by a small reciprocating air compressor manufactured by General Air Products and is in the fire suppression room (service room 2).

Additional fire suppression for the building is provided by portable ABC-type fire extinguishers, which are typically installed within surface-mounted metal cabinets or on wall mounted brackets throughout the building areas.

Findings / Recommendations

The building's sprinkler system and components are understood to be original to its construction in 2000 and Loadout Building in 2015. Stand cabinets were observed throughout the process plant. A testing label was not present on the stand pipe and therefore a cost has been included in the cost table to conduct this test. The Portable fire extinguishers are likely replaced on an as-needed basis through local service contractors.

The fire protection systems were in overall good condition, as no major deficiencies or deterioration were observed or reported during the assessment. According to inspection tags reviewed during the assessment, the portable fire extinguishers were last certified in March of 2017 by Tyco Integrated Fire & Security Ltd.

Based on age and an EUL of 50 years, the wet/ glycol-pipe sprinkler system is not anticipated to require replacement during the evaluation period to maintain the reliability of this equipment. The air compressor, with an EUL of 20 years is anticipated to require replacement in the evaluation term, however, the replacement cost of the air compressor expected to fall below the assessment reporting threshold, and has therefore been excluded from herein. The replacement of portable fire extinguishers is also expected to continue an as-needed basis through local service contractors as part of routine maintenance and therefore the costs to replace the fire extinguishers has been excluded from this report.

4.6 ELECTRICAL SYSTEMS

4.6.1 Service & Distribution

Description

An underground 25KV utility service supplies the site. The service enters the property on the North-West corner of the property and extends underground on the East side of the Tipping Building in to an electrical medium voltage Substation. The substation is owned and maintained by a third-party utility provider.

The substation distribution switch gear is made up of a 25KV 3 Phase 400 Amp distribution buss which feed five internal 25kv to 600V step down transformers. One transformer supplies a 600V 3000Amp Buss Duct which supplies six 400hp VFD drives which powers fans used in the Aeration process. The second transformer provides power to a second 600V, 2000Amp bus duct which feed the main switch gear 74-SWG-02 (600v,3200Amp distribution buss) located in the Dewater building, Unit 10. The third transformer feed goes to switch gear 74-SWG-03 (600V,3000amp buss) located in South Download Building, Unit 30 and the forth transformer feeds switch gear 74-SWG-04 (600V, 2000Amp) located in North Download building, Unit 30. The fifth and final feed is distributed to motor control center 74-MCC-05 (600V,1600Amp buss) feeds Aeration Hall Building.

Because of the large motor loads in the facility power factor correction units have been incorporated in the power distribution. The buss duct feeding the Aeration Building Hall process fans, and the power distribution feeding switch gear 74-SWG-02, 74-SWG-04, and 74-swg-05 all have a 75KVAR power factor correction units.

There are Seven (7) motor Control Centre's throughout the facility, 74- MCC-02 (3200Amp Buss),74- MCC-03 (3000Amp buss), MCC-04 (2000Amp Buss), and MCC -05 (600V,600Amp Buss), 74-MCC-06(600V,600Amp buss, and 74-MCC07(600V, 600Amp buss). The MCCs include the motor starters for exhaust fans, the main air handling unit, heating, and process equipment throughout the facility. It should be noted that currently the entire power distribution system is 600 V three phase, there is no provisions for the distribution of 4160 Volts for the larger motor loads. The major loads for the power distribution include the five South Download motors (500hp each), these units are currently disconnected.

There are twelve (12) dry type stepdown transformers which step the voltage for 600V down to 120/208V. The transformers are manufactured by Square "D" and range from 45KVA to 150KVA, Units are located in electrical rooms and new the process equipment they service.

There are sixteen (16) secondary distribution panelboards located throughout the facility. There are:

- Seven (7) panelboards are supplied by switch gear #2
- Five (5) panelboards by switch gear #4
- Five (4) panelboards by switch gear #5

One secondary distribution panel in each switch gear is dedicated to 347/600V lighting and 600V motor/ specialty loads. The other panels are 120/208V which serve general plug loads throughout the facility. The 120/208V panels, which were manufactured by Eaton/Cutler Hammer, are typically rated for 225 Amp, and are fed by 100 to125 Amp feeders and include between 42 and 84 circuits.

Findings / Recommendations

The electrical distribution equipment in the building appeared to be original to its development in 2000 and the Load Out Building expansion in 2015.The electrical equipment appeared to be performing as intended and no signs of arcing or blackened surfaces were observed. Substantial dust build-up on the exterior of the electrical equipment was observed in many locations. Examples of locations were this was observed:

- On the tipping floor that electrical Panel 20-PNL-2B and step-down transformer 20-XFMR – 1 exterior cabinets.
- Panel 10-PNL-2D and transformer 10-XFMR-05

This dust build-up would affect the cooling of the transformer and has the potential for arch flash should this build up also occur on the interior of the electrical equipment. Infrared scan labels were not observed on electrical distribution equipment. Electrical panel boards within main electrical rooms were also observed to have arch fault incident energy level posted labeling with the required level of personal protective equipment to work on that type of equipment. Based on these observations, we have included a recommendation of cleaning the electrical equipment and infra-red testing on a three-year cycle. Cost for this work has been included in the cost table.

No known or observed concerns were reported with respect to the operation of the electrical equipment, CDP distribution panelboards and Sub-panels feeding process equipment. Most electrical equipment appeared to have future breaker capacity. Electrical panels feeding fire alarm panels were observed to have the breaker lock off installed on the fire alarm breakers.

The Motor Control Centre's, motor starter compartments, power factor correction units and power distribution unit all appeared to be in good condition. Electrical heat trace utilized on the sprinkler lines over the loading bay doors and down spouts had no observed or reported issues, it will require replacement midway through the evaluation period for which a cost has been included in the cost table.

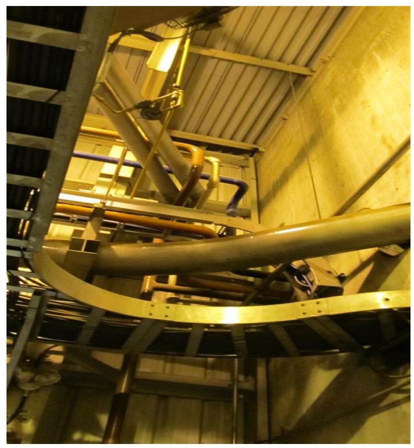
No significant issues or deficiencies related to the building's electrical distribution equipment were observed or reported at the time of the site visit. Based on a EUL of 40 years, no significant capital expenditure apart from routine maintenance is anticipated within the evaluation period for the electrical distribution except for the power factor correction units, which are anticipated to require replacement in the mid latter part of the evaluation period. Allowances have been provided in the cost table for the above-mentioned items of equipment.

Salient Photographs

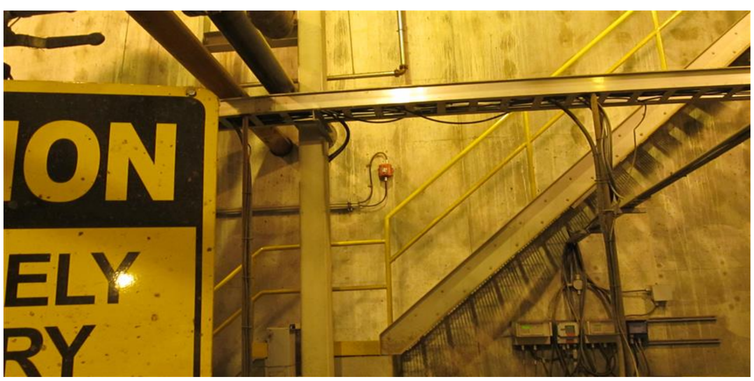
Transformer 20-XFMR - 01 Tipping Floor

Panelboard 20-PNL-2B Tipping Floor

Dewater Building cable tray system



Dewater second floor cable tray system



Typical process area cable tray

4.6.2 Lighting and Branch Wiring

Description

Electrical distribution wiring in the building is assumed to be copper. The wiring is typically enclosed in Electrical Metallic Tubing (EMT) or armored conduit (Teck cable). Armored cabling is distributed through the processing plant via suspended open cable tray (ladder duct style) which serves lighting, plug, data systems, and mechanical loads in the building and roof mounted mechanical ventilation equipment.

Interior lighting in the process building the Tipping floor were originally Hight Pressure Sodium (HPS) and were upgraded to LED in 2016. The mechanical warehouse adjacent to the Tipping Building have High Intensity Discharge(HID) high bay warehouse fixtures which employ high pressure sodium lamps. The North Download building, Aeration Hall Building, and Dewater building also utilize HID high bay fixtures with sodium lamps. It was observed that in some areas there is also a mixture of metal halide lamped HID fixtures. The interior and exterior lighting is controlled by lighting control panels which also employ manual control of the lighting. These units are located in the main electrical rooms in the areas that they serve. Exterior lighting is also controlled by photo cells and timers.

Exterior surface-mounted HID light wall packs that employ high pressure sodium lamps are installed below the perimeter of the roof along the exterior walls of the processing building to illuminate the surrounding parking and drive isle areas. It was noted by the site electrical contact Dave Rogers, that above the overhead delivery doors on the west side of the Tipping building, traffic signals were originally used to direct deliveries to the tipping building. These lights are no longer utilized on the building. Man, doors on the exterior of the building are illuminated by single wall pack above the access door to the roof access on the main building. South Download tunnels and walkways are illuminated by surface mounted two lamp fluorescent strip fixtures with T8 lamps housed in a moisture/dust proof fiberglass housing.

Findings / Recommendations

All electrical distribution wiring, interior, and exterior lighting fixtures are typically original to the building's construction in 2002 and Outbuilding extension in 2015. Cable tray systems are distributed throughout the process building. The cable tray systems are made up of open style aluminum ladder duct. The cable tray systems are suspended from the ceiling and steel columns and structural beams located over the procession equipment, ceiling and roof mounted mechanical equipment that they serve.

It was indicated in the structural report, because of the high levels of corrosive vapors present in the building, the cable tray supporting rods are showing corrosion which may compromise the support provided to the cable tray systems. It was observed that conduit systems, Teck cables located in the cable trays have high levels of dust collection on the conduits and cable tray wiring. Electrical distribution wiring was observed and reported to be in good condition however It was observed that wiring and lighting are subjected to high levels of dust buildup.

Based on an EUL of 50 years, electrical branch wiring in the building was observed and reported to be in good condition and is not anticipated to require replacement only minor maintenance during the evaluation period. Based on age, the building's interior and exterior light fixtures are expected to require replacement in the medium term of the evaluation period to maintain their function and reliability. Allowances have been provided for the different interior/exterior types of lighting in the cost table. Base on site observations and issues presented in the past structural report, a cost allowance has been provided in the cost table to conduct a study to evaluate the support hangers on the building cable tray system.

Salient Photographs

Typical exterior fixture with HID sodium Lamp

Typical dust proof fluorescent two lamp T8 fixture

4.6.3 Emergency Lighting and Power Supply

Description

Emergency lighting throughout the plant is provided by wall-mounted battery-pack light fixtures that incorporate integral or remote lighting heads.

Wall or ceiling-mounted "Exit" lights that are understood to incorporate incandescent lamps and integral battery back-up power are installed near or above points of egress. Egress door areas employ combination exit and dual emergency lighting heads.

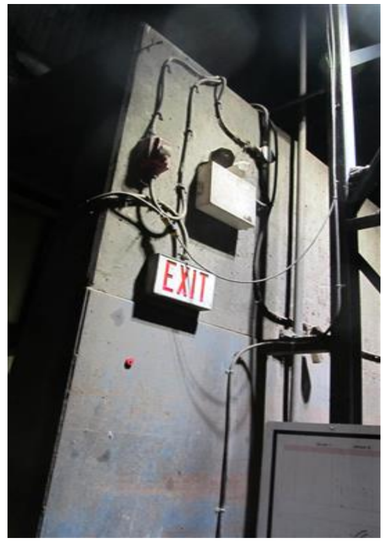
Findings / Recommendations

Emergency battery packs are original to the building's construction in 2000 and the Biosolids Load Out Building in 2015. The fixtures were observed and reported to be functional, and are considered to be in good condition. Nonetheless, the emergency battery packs are expected to require replacement over the next ten (10) years as they achieve their EUL of 20 years and are expected to require replacement in the evaluation period to maintain their function and reliability and a cost has been included in the cost table.

The Exit lights throughout the compost facility were all observed to be in good condition and functional. In some areas, it is recommended unit cleaning be implemented as part of routine maintenance. Based on an EUL of 30 years, and installation in 2000, the Exit lights and are expected to require replacement in the evaluation period to maintain their function and reliability and a cost has been included in the cost table.

Salient Photographs

Typical Exit/EM light over egress exit



Typical Emergency Battery pack

4.6.4 Fire Alarm Systems

Description

The Compost facility is equipped with an a fully addressable fire alarm system manufactures by Notifier that is in the main electrical room of the Dewater building it includes two annunciator panels one in the Administration building and one in the Load Out Building (South) 2015 (10-FPL-1101). The fire alarm system is distributed throughout the facility via Notification Appliance Circuit units know as (NAC panels).

All the fire alarm control panels are manufactured by Notifier. The main fire alarm control panel monitors the activity of sensory devices installed throughout the building and networked Annunciators and NAC Panels, including hard-wired heat/smoke detectors, pull stations, Piezo strobes, and sprinkler/standpipe flow switches and tamper valves. Heat detection devices are typically installed in mechanical/electrical rooms. The fire alarm system is remotely monitored by a third party.

Findings / Recommendations

The fire alarm system, including the annunciator panels and NAC Panels, main fire control panel, sensory/actuating devices, were installed during the building's construction in 2000 and 2015. The system is reported to be monitored remotely by Vipond and maintained by Fire Protection INC, and was last re-certified in March 2017.

The building's fire alarm system was reported to have continuous trouble alarms (ground fault issues) and requires high maintenance. It was reported that an independent company was hired to access and fix the recurring trouble issues. It was reported that the contractor was able to reduce ground fault trouble signals from an estimated 45 down to 9 issues. Because of the high humidity conditions in which the system operates and the location of conduit and wiring distributions systems the system is prone to ongoing ground fault issues. As a result, an allowance has been included for a study to access the ground fault issues further in the cost tables.

Nonetheless, lifecycle replacement of the field wiring and sensory/actuating devices are anticipated in the medium term as they achieve their EUL of 25 years, while replacement of the fire alarm and annunciator panels is anticipated in the shorter term, as they achieve their EUL of 15 years. Allowances have been provided in the cost table for this purpose.

Salient Photographs

South Download Pull-station requiring cleaning

Finishing Building typical exit sign requiring cleaning

4.6.5 Security Systems

Description

The building is equipped with a video surveillance system which is monitored remotely from this site, there is no on-site access equipment. The cameras are installed both internally and externally to the facility.

Findings / Recommendations

Security systems in the building are understood to be largely original to the building's construction in 2000, and were observed to be in good condition. Nonetheless, these systems are expected to require replacement over the next fifteen (30) years to maintain their function and reliability. Allowances have been provided in the cost table for the lifecycle replacement of security system. The video surveillance system is operated and managed by others, so a replacement cost has not been included in the cost table.

4.6.6 Communication Systems

Description

The underground telephone utility service is delivered to the communication demark location in the main electrical room located in the Dewater building, via a multi-pair copper cable where connects with the communications infrastructure installed on a painted plywood panel backboard. It was observed that standard "Plain old Telephone system" (POTS) is still in place, the phone system has been upgraded to VOIP system.

A local area network composed of hubs, voice/data switches, and Cat6 copper cabling is installed in the main electrical room. The voice/data lines are subsequently delivered to data jacks installed in maintenance shop office, larger electrical rooms and process control devices requiring network access are located throughout the main building.

Findings / Recommendations

All communication systems and equipment are understood to be original to the site's development in 2000, and was observed to be in good condition and functioning as intended. Based on an EUL of 50 years, lifecycle replacement of the telephone system and cabling no significant capital expenditures are anticipated during the evaluation period.

4.7 CONVEYING SYSTEMS

4.7.1 Elevators

Description

No elevators, apart from process conveying systems, are present on site.

5.0 OPINIONS OF COST SUMMARY

5.1 COST TABLES

Opinions of cost were developed for the BCA to reflect our assessment findings and recommendations, as presented under the applicable headings of Section 4.0. The recommendations presented under Section 4.0, and their corresponding opinions of cost, are summarized and tabulated in two (2) cost tables, which are attached to this report as Appendix A and C, and are described as follows:

- **Table A – Component Listing and Event Costs** - Provides a breakdown of the major building/site systems and components that were observed during our "walk-through" review of the site, their assumed age, and corresponding opinions of cost (in current dollar values), and timing to perform recommended actions.
- **Table B – Long-Term Component Event Costs Summary** - Provides a listing of major building/site systems and components, and corresponding opinions of cost (in current and future dollar values) for repair/replacement expenditures that are anticipated over years 6 to 20 of the twenty (20) year evaluation period.

5.2 COST SUMMARY

The total costs (in current dollar values) for major facility systems that are anticipated immediately (i.e., within the next year), over the Short-Term (i.e., years 1 to 5), and the Long-Term (i.e., years 6 to 20) are presented in Table 1-1 in the Executive Summary of this report, along with Figure 1-1 that graphically illustrates the annual total costs over the next twenty (20) years.

Table 5-1 below presents the total cost (in current dollar values) for Event Types that are anticipated immediately, over the Short-Term (i.e., years 1 to 5), and the Long-Term (i.e., years 6 to 20).

Table 5-1 – Total Costs by Event Type

Event Type	Immediate (2017)	Short-Term (2018 - 2022)	Long-Term (2023 - 2037)	Totals
Health & Safety	$ -	$ -	$ 3,015,700	$ 3,015,700
Maintenance	$ 10,500	$ 194,000	$ 557,000	$ 761,500
Study	$ 6,000	$ 25,000	$ 31,000	$ 62,000
Lifecycle	$ 124,700	$ 229,800	$ 3,030,100	$ 3,384,600
Optional	$ -	$ 7,000	$ -	$ 7,000
TOTALS	**$ 141,200**	**$ 455,800**	**$ 6,633,800**	**$ 7,230,800**

6.0 DOCUMENTS REVIEWED AND INTERVIEWS

6.1 SITE REVIEW

A visual walk-through review of the site was conducted by Mike Just, C.E.T. and Brad Herst, C.E.T., of Stantec on October 27, 2017. The Stantec staff were accompanied by Mr. Dave Rodgers, Electrical Supervisor, with Suez.

The weather at the time of the assessment was clear, with ambient air temperatures that generally ranged between 0 and 9 degrees Celsius.

During the site evaluation, the follow areas were not viewed or had limited access to viewing due to not having safe access:

1) Dewater building lab/control room and bathroom facilities.

2) The North Download building was limited due to demolition/decommissioning of process equipment. A temporary stair access was setup in the North Download building for access to the main electrical room.

3) The Aeration Hall building was limited due to the presence of high H2S buildup within the building.

4) The Aeration Hall building attic space was not viewed due to restricted access of structural work being conducted by ONEC workers.

5) The Tipping building roof assessment was limited to viewing from roof catwalk only. All remaining roof surfaces (aside from the aforementioned) were not viewed due to not having safe access.

6) Finishing Building access was limited due to the high levels of dust suspension in the air limiting time spent in this area of the building.

6.2 DOCUMENTATION REVIEW

Stantec requested relevant documentation from the Client and/or site representative(s) that could provide knowledge of the property's physical improvements, extent, and type of use, and/or assist in identifying material discrepancies between reported information and observed conditions. Stantec's review of documents provided does not include commenting on the accuracy of such documents or their preparation, methodology, or protocol.

The following documents were reviewed and information derived from these documents was included in the preparation of this report.

Table 6-1 - Documentation Reviewed

Document Title	Date	Author	Type of Document
Construction Drawings	January 1999	Behlen Industries	Various construction drawing for Aeration Building
Construction Drawings	September, 1998	GKO Engineering TransAlta	Various Site, Architectural, Structural, Mechanical and Electrical drawings for various unit # buildings (such as units 10, 20, 30, 40, and 50)
ECF Equipment List Various Buildings	Unknown	Crystal Decisions	Equipment schedule
ECF Aeration Hall Structural Condition Assessment Report E161281CP rev A	March 02, 2017	ONEC Engineering	Structural Condition Assessment Report of Aeration Hall Building
ECF Aeration Hall Building – Attic Space Inspection Assessment	October 25, 2017	ONEC Engineering	Structural Condition Assessment Report of Aeration Hall Building
EWMC North Downloading Struct Assessment – North Downloading Review for Continued Safe Use	October 24, 2017	ONEC Engineering	Letter with regards to the safe continued use of the North Downloading Building
EWMC Remedial Study of Existing ECF Aeration Hall Bldg. – Biosolids Storage Silo Safety Review for Continued Safe Use	November 1, 2017	ONEC Engineering	Letter regards to the safe continued use of Biosolids Storage Silo
EWMC Remedial Study of Existing ECF Aeration Hall Bldg. – Anaerobic South Download Damage Potential in Collapse Event	November 16, 2017	ONEC Engineering	Letter with regards to the potential outcomes of collapse of the Aeration Hal and South Download Building

6.3 INTERVIEWS

The following personnel were interviewed or contributed information that was used in the process of preparing this BCA report:

- Dave Rodgers, Suez Electrical Supervisor,
- Martin Brewster, Suez Maintenance Manager

An interview was requested, but not provided with the facility's HVAC maintenance contractor to discuss maintenance on the HVAC equipment and systems including gaining an understanding of operational or maintenance concerns.

7.0 CLOSURE

Stantec has completed a BCA for the site at the request of the Client utilizing methods and procedures that are consistent with customary commercial practice and industry standards. The independent conclusions represent Stantec's professional judgments based on conditions that existed and information and data made available to Stantec during the course of the assessment. Factual information received has been assumed to be correct and complete.

Stantec recommends that this report be reviewed annually so that adjustments may be made to reflect actual costs of work, changes to timing and cost of work expected for coming years.

Should any clarification be required regarding the content or conclusions of this report, please contact the undersigned at the contact information provided below.

Respectfully submitted,

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Appendix A Component Listing and Event Costs

TABLE A - COMPONENT LISTING AND EVENT COSTS

Item No.	Major Facility System	Report Reference No.	Component Name	Component Detail or Location	Year of Install	Age (Years)	EUL (Years)	Condition Rating	Event Description	Event Type	Time to First Event (Years)	Initial Event Year	Frequency to Repeat (Years)	Quantity	Unit	Unit Cost (2017 Dollars)	Event Cost (2017 Dollars)	Total Opinion of Cost (20 Years)
1	Building Structure	4.2.1	Foundations	All Building Sections	2000	17	100	Good	No significant capital expenditure is anticipated within the evaluation period		83	-	-				$ -	$ -
2	Building Structure	4.2.1	Foundations	Foundation Insulation and Parging Tipping Building Unit 20	2000	17	100	Poor	Conduct repairs to foundation insulation and parging. The cost to conduct his work is considered to be below the threshold and part of routine maintenance. No cost is provided	Maintenance	1	2018	100				$ -	$ -
3	Building Structure	4.2.1	Slab on Grade	All Building Sections	2000	17	75	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		58	-	-				$ -	$ -
4	Building Structure	4.2.1	Basement Walls / Crawl Space	Basement Dewatering Building Unit 10	2000	17	75	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		1	2018	75				$ -	$ -
5	Building Structure	4.2.1	Basement Walls / Crawl Space	Concrete Push Walls Tipping Building Unit 20	2000	17	75	Poor	Allowance to conduct replacement of damaged steel plating on concrete push wall	Maintenance	1	2018	75	1	Lump Sum	$ 5,000	$ 5,000	$ 5,000
6	Building Structure	4.2.2	Floor Construction	Floor Decks All Buildings	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
7	Building Structure	4.2.2	Roof Construction	Roof Structure Aeration Hall Unit 40	2000	17	75	Critical	Refer to ONEC Structural Report. No cost is provided	Health & Safety	0	2017	75				$ -	$ -
8	Building Structure	4.2.2	Roof Construction	Roof Structure Aeration Hall Unit 40	2000	17	75	Critical	Conduct a study to determine what remaining structural recommendations related to the Aeration Hall Building's structure should be completed and estimate the cost to complete them.	Study	0	2017	75	1	Lump Sum	$ 6,000	$ 6,000	$ 6,000
9	Building Structure	4.2.2	Roof Construction	Roof Structure Tipping Building Unit 20	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
10	Building Structure	4.2.2	Roof Construction	Roof Structure Trommel Building Unit 30	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
11	Building Structure	4.2.2	Roof Construction	Roof Structure Digester Building Unit 30	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
12	Building Structure	4.2.2	Roof Construction	Roof Structure Dewatering Building Unit 10	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
13	Building Structure	4.2.2	Roof Construction	Roof Structure Finishing Building Unit 50	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
14	Building Structure	4.2.2	Roof Construction	Roof Structure Load Out Building	2015	2	75	Good	No significant capital expenditure is anticipated within the evaluation period		73	-	-				$ -	$ -
15	Building Structure	4.2.3	Stair Construction	Interior Stairs Metal-framed Trommel Buildings Unit 30	2000	17	75	Critical	Conduct repair of interior metal-framed stairs to electrical room within the Trommel building. The cost to repair is considered part of renovation activities underway	Health & Safety	0	2017	75				$ -	$ -
16	Building Structure	4.2.3	Stair Construction	Interior Stairs Metal-framed Dewatering Buildings Unit 10	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		0	2017	75				$ -	$ -
17	Building Structure	4.2.3	Exterior Stairs	Exterior Stairs Metal-framed All Building Sections	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
18	Building Envelope	4.3.1	Metal Siding	Exterior Walls All Building Sections	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-				$ -	$ -
19	Building Envelope	4.3.1	Metal Siding	East Exterior Wall Tipping Building Unit 20	2000	17	50	Poor	Allowance to replace damaged metal cladding on Tipping Building	Maintenance	1	2018	50	1	Lump Sum	$ 10,000	$ 10,000	$ 10,000
20	Building Envelope	4.3.1	Metal Siding	South Exterior Wall Finishing Building Unit 75	2000	17	50	Fair	Conduct repairs/replacement of corroded metal siding panels on Finishing Building. The cost to conduct this work is considered to be below the threshold and therefore part of routine maintenance	Maintenance	3	2020	50				$ -	$ -

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21	Building Envelope	4.3.1	Metal Siding	Exterior Walls Load Out Building Unit 75	2015	2	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		48	-	-				$ -	$ -
22	Building Envelope	4.3.1	Joint Sealers (Caulking)	Building Perimeter Main Building	2000	17	20	Fair	Conduct replacement of joint sealants around doors, windows and wall penetrations. This work is considered to be below the threshold and part of routine maintenance. No cost has been provided.	Maintenance	3	2020	20				$ -	$ -
23	Building Envelope	4.3.1	Exterior Wall Vapor Retarders, Air Barriers, and Insulation	Exterior Walls All Building Sections	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
24	Building Envelope	4.3.2	Aluminum Windows (Glass & Frame)	Window Exterior Warehouse Receiving Tipping Building Unit 20	2000	17	40	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	2	M²		$ -	$ -
25	Building Envelope	4.3.2	Aluminum Windows (Glass & Frame)	Windows Exterior Dewatering Building Unit 10	2000	17	40	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	5	M²		$ -	$ -
26	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Aeration Hall Unit 40	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	11	Each	$ 1,100	$ 12,100	$ 12,100
27	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Tipping Building Unit 20	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	9	Each	$ 1,100	$ 9,900	$ 9,900
28	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Trommel Building Unit 30	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	6	Each	$ 1,100	$ 6,600	$ 6,600
29	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man doors Digester Building Unit 30	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	2	Each	$ 1,100	$ 2,200	$ 2,200
30	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Dewatering Building Unit 10	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	10	Each	$ 1,100	$ 11,000	$ 11,000
31	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Finishing Building Unit 50	2000	17	35	Fair	Conduct lifecycle replacement of exterior doors	Lifecycle	5	2022	35	3	Each	$ 1,100	$ 3,300	$ 3,300
32	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Man Doors Load Out Building	2015	2	35	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-				$ -	$ -
33	Building Envelope	4.3.3	Steel-Framed Doors	Exterior Door Hardware All Building Sections	2000	17	15	Fair	Conduct lifecycle replacement of door hardware on exterior man doors.	Lifecycle	1	2018	15	41	Each	$ 500	$ 20,500	$ 41,000
34	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Aeration Hall Unit 40	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	7	Each	$ 3,500	$ 24,500	$ 24,500
35	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Tipping Building Unit 20	2000	17	25	Critical	Replace damaged and inoperable overhead doors	Maintenance	0	2017	25	3	Each	$ 3,500	$ 10,500	$ 10,500
36	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Tipping Building Unit 20	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	2	Each	$ 3,500	$ 7,000	$ 7,000
37	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Trommel Building Unit 30	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	5	Each	$ 3,500	$ 17,500	$ 17,500
38	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Digester Building Unit 30	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	1	Each	$ 3,500	$ 3,500	$ 3,500
39	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Dewatering Building Unit 10	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	2	Each	$ 3,500	$ 7,000	$ 7,000

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40	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Finishing Building Unit 50	2000	17	25	Good	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	4	Each	$ 3,500	$ 14,000	$ 14,000
41	Building Envelope	4.3.3	Overhead Doors	Overhead Doors Load Out Building	2015	2	25	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	2	Each		$ -	$ -
42	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Aeration Hall Unit 40	2000	17	25	Fair	Conduct lifecycle replacement of overhead doors	Lifecycle	3	2020	25	10	Each	$ 2,500	$ 25,000	$ 25,000
43	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Tipping Building Unit 20	2000	17	25	Poor	Replace overhead door electric operators	Maintenance	2	2019	25	5	Each	$ 2,500	$ 12,500	$ 12,500
44	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Trommel Building Unit 30	2000	17	25	Fair	Conduct lifecycle replacement of overhead doors	Lifecycle	4	2021	25	5	Each	$ 2,500	$ 12,500	$ 12,500
45	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Digester Building Unit 30	2000	17	25	Fair	Conduct lifecycle replacement of overhead doors	Lifecycle	4	2021	25	1	Each	$ 2,500	$ 2,500	$ 2,500
46	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Dewatering Building Unit 10	2000	17	25	Fair	Conduct lifecycle replacement of overhead doors	Lifecycle	8	2025	25	1	Each	$ 2,500	$ 2,500	$ 2,500
47	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Finishing Building Unit 50	2000	17	25	Poor	Conduct replacement of overhead door electric operators	Maintenance	2	2019	25	5	Each	$ 2,500	$ 12,500	$ 12,500
48	Building Envelope	4.3.3	Overhead Doors	Electric Operators Overhead Doors Load Out Building	2015	2	25	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	2	Each		$ -	$ -
49	Building Envelope	4.3.4	Roof Vapor Retarder and Insulation	Roof All Buildings	2000	17	75	Good	No significant capital expenditure is anticipated within the evaluation period		58	-	-				$ -	$ -
50	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Aeration Hall Unit 40	2000	17	50	Critical	ONEC Structural Report for recommendations and costing	Health & Safety	0	2017	50	23,327	M²		$ -	$ -
51	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Tipping Building Unit 20	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	5,143	M²		$ -	$ -
52	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Trommel Building Unit 30	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1,880	M²		$ -	$ -
53	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Digester Building Unit 30	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1,230	M²		$ -	$ -
54	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Dewatering Building Unit 10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	704	M²		$ -	$ -
55	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Finishing Building Unit 50	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1,288	M²		$ -	$ -

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56	Building Envelope	4.3.4	Sheet Metal Roofing	Standing-seam Metal Roofing Load Out Building	2015	2	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		48	-	-	1,288	M²		$ -	$ -
57	Building Envelope	4.3.4	Gutters and Downspouts	Rain Leaders & Downspouts All Building Sections	2015	2	30	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		28	-	-		Metre		$ -	$ -
58	Building Envelope	4.3.4	Other Roof Components	Fall Protection Guard Rails Roof Tipping Building Unit 20	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Lump Sum		$ -	$ -
59	Building Envelope	4.3.4	Other Roof Components	Roof Access Ship Ladder Tipping Building Unit 20	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Lump Sum		$ -	$ -
60	Building Envelope	4.3.4	Other Roof Components	Fall Protection Guard Rails Roof Dewatering Building Unit 10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Lump Sum		$ -	$ -
61	Building Envelope	4.3.4	Other Roof Components	Roof Access Ship Ladder Dewatering Building Unit 10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Lump Sum		$ -	$ -
62	Building Envelope	4.3.4	Other Roof Components	Roof Hatch Tipping & Dewatering Building Units 20 & 10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	2	Each		$ -	$ -
63	Building Interior	4.4.1	Gypsum Wall Board	Interior Control Room Finishing Building Unit 50	2000	17	50	Fair	Conduct periodic repair/renewal of gypsum board walls. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	Maintenance	3	2020	50				$ -	$ -
64	Building Interior	4.4.1	Other Wall Finishes	Throughout All Building Sections	2000	17	10	Poor	Allowance to conduct renewal of paint finishes of interior walls and steel framing.	Maintenance	1	2018	10	1	Lump Sum	$ 30,000	$ 30,000	$ 60,000
65	Building Interior	4.4.1	Other Wall Finishes	Power Wash Interior Surfaces Aeration Hall Unit 40	2000	17	3	Poor	Allowance to conduct cleaning of interior walls, ceiling and floor in the Aeration Hall Building including inspection of liner and structure for corrosion/integrity.	Maintenance	1	2018	3	33,000	M²	$ 1	$ 28,400	$ 198,800
66	Building Interior	4.4.1	Other Wall Finishes	Power Wash Interior Surfaces Tipping Building Unit 20	2000	17	3	Poor	Allowance to conduct cleaning of interior walls, ceiling and floor in the Tipping Building, including inspection of liner and structure for corrosion/integrity.	Maintenance	1	2018	3	11,600	M²	$ 1	$ 11,600	$ 81,200
67	Building Interior	4.4.1	Other Wall Finishes	Power Wash Interior Surfaces Trommel Building Unit 30	2000	17	3	Poor	Allowance to conduct cleaning of interior walls, ceiling and floor in the Trommel Building, including inspection of liner and structure for corrosion/integrity.	Maintenance	1	2018	3	4,000	M²	$ 1	$ 4,000	$ 28,000
68	Building Interior	4.4.1	Other Wall Finishes	Power Wash Interior Surfaces Digester Building Unit 30	2000	17	3	Poor	Allowance to conduct cleaning of interior walls, ceiling and floor in the Digester Building including inspection of liner and structure for corrosion/integrity.	Maintenance	1	2018	3	4,000	M²	$ 1	$ 4,000	$ 28,000
69	Building Interior	4.4.1	Other Wall Finishes	Power Wash Interior Surfaces Finishing Building Unit 50	2000	17	3	Poor	Allowance to conduct cleaning of interior walls, ceiling and floor in the Finishing Building, including inspection of liner and structure for corrosion/integrity.	Maintenance	1	2018	3	4,000	M²	$ 1	$ 4,000	$ 28,000
70	Building Interior	4.4.1	Interior Wall Painting	Control Room Dewatering Building Unit 10	2000	17	10	Fair	Conduct renewal of paint finishes. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	Maintenance	1	2018	10				$ -	$ -
71	Building Interior	4.4.3	Gypsum Board Ceilings	Control Room Dewatering Building Unit 10	2000	17	15	Fair	Conduct periodic repair/renewal of gypsum board ceilings. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	Maintenance	5	2022	15	98	M²		$ -	$ -

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72	Building Interior	4.4.3	Suspended Ceilings	Control Room Dewatering Building Unit 10	2000	17	30	Good	Conduct lifecycle replacement of acoustical ceiling tile (existing T-bar grid to be left in place)	Lifecycle	13	2030	30	118	M²	$ 35	$ 4,200	$ 4,200
73	Building Interior	4.4.4	Fixed Partitions	Control Room and Electrical Room Dewatering Building Unit 10	2000	17	100	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		83	-	-				$ -	$ -
74	Building Interior	4.4.4	Interior Windows	Interior Windows Control Room Dewatering Building Unit 10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
75	Building Interior	4.4.4	Interior Firestopping	Throughout All Buildings	2000	17	50	Fair	Install firestopping sealant on wall penetrations where missing. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	Maintenance	3	2020	50				$ -	$ -
76	Building Interior	4.4.5	Swinging Doors & Hardware	Interior Doors All Building Sections	2000	17	50	Fair	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-				$ -	$ -
77	Building Interior	4.4.5	Swinging Doors & Hardware	Hardware Interior Doors All Building Sections	2000	17	15	Fair	Allowance to conduct lifecycle replacement of interior door hardware	Lifecycle	3	2020	15	1	Lump Sum	$ 6,000	$ 6,000	$ 12,000
78	Building Interior	4.4.6	Toilet, Bath, and Laundry Accessories	Washroom Control Room/ Laboratory Dewatering Building Unit 9	2000	17	15	Fair	Conduct replacement of washroom accessories. The cost to conduct this work is considered to be below the threshold and part of routine maintenance	Maintenance	1	2018	15				$ -	$ -
79	Building Interior	4.4.6	Fixed Casework	Control Room/ Laboratory Dewatering Building Unit 10	2000	17	35	Good	Conduct lifecycle replacement of fixed casework including countertops in laboratory	Lifecycle	18	2035	35	1	Lump Sum	$ 15,000	$ 15,000	$ 15,000
80	Mechanical Systems	4.5.1	Water Supply Piping Systems	Dewater Building Unit10	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period it was noted by Martin Brewster that utility water supplied to site is Non-potable water.		33	-	-	704	M²		$ -	$ -
81	Mechanical Systems	4.5.1	Water Supply Piping Systems	Aeration Building Unit 40	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period it was noted by Martin Brewster that utility water supplied to site is Non-potable water.		33	-	-		M²		$ -	$ -
82	Mechanical Systems	4.5.1	Backflow Preventors	Dewater Building Unit 10	2000	17	30	Good	Conduct lifecycle replacement of the back flow prevention devices on Domestic water piping (2.5") Inspected March 29, 2017	Lifecycle	13	2030	30	1	Lump Sum	$ 3,500	$ 3,500	$ 3,500
83	Mechanical Systems	4.5.1	Backflow Preventors	Aeration Hall Unit 40	2000	17	30	Good	Conduct lifecycle replacement of the back flow prevention devices on fire water piping (6") SW Aeration Hall, (4") South Aeration Hall, (2.5") SE Aeration Hall and (3") Aeration Hall Inspected March 29, 2017	Lifecycle	13	2030	30	1	Lump Sum	$ 16,000	$ 16,000	$ 16,000
84	Mechanical Systems	4.5.1	Backflow Preventors	North Download Building Unit 30	2000	17	30	Good	Conduct lifecycle replacement of the back flow prevention devices on fire water piping (6") and (2.5") (Trommel Building) and (6") in Finishing Building	Lifecycle	13	2030	30	1	Lump Sum	$17,500	$ 17,500	$ 17,500
85	Mechanical Systems	4.5.1	Backflow Preventors	Tipping Building Unit 20	2000	17	30	Good	Conduct lifecycle replacement of the back flow prevention devices on fire water piping (8") North Floor and (4") North floor and (8") South floor, Inspected March 29, 2017	Lifecycle	13	2030	30	1	Lump Sum	$ 17,500	$ 17,500	$ 17,500
86	Mechanical Systems	4.5.1	Domestic Water Heaters	Dewater Building Lab/washroom Unit 10	2000	17	15	Good	Conduct lifecycle replacement of the DHW heater (Dewater Building LAB, 3kW)	Lifecycle	5	2022	15	1	Lump Sum	$ 1,500	$ 1,500	$ 3,000
87	Mechanical Systems	4.5.2	Waste and Vent Piping	All Building Sections	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Each		$ -	$ -
88	Mechanical Systems	4.5.2	Waste Pumps	Tipping Building Unit 20 North Download Building Unit 30	2000	17	20	Good	Conduct lifecycle replacement of Tipping building sump	Lifecycle	3	2020	20	7	Each	$ 2,000	$ 14,000	$ 14,000

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89	Mechanical Systems	4.5.3	Rain Water Drainage Piping Systems	All Building Sections	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-	1	Each	$ 3,000	$ 3,000	$ -
90	Mechanical Systems	4.5.4	Water Closets	Dewater building Unit 10 washroom	2000	17	35	Good	Conduct lifecycle replacement of the floor mounted tank style vitreous china water closet	Lifecycle	18	2035	35	1	Each	$ 2,000	$ 2,000	$ 2,000
91	Mechanical Systems	4.5.4	Lavatories	Dewater building Unit 10 washroom	2000	17	35	Good	Conduct lifecycle replacement of wall mounted vitreous china lavatories with centre set faucets	Lifecycle	18	2035	35	1	Each	$ 1,200	$ 1,200	$ 1,200
92	Mechanical Systems	4.5.4	Sinks	Dewater Building Unit 10 Lab area	2000	17	35	Good	Conduct lifecycle replacement of the stainless steel sink	Lifecycle	18	2035	35	1	Each	$ 1,500	$ 1,500	$ 1,500
93	Mechanical Systems	4.5.4	Sinks	Maintenance Warehouse	2000	17	35	Good	Conduct lifecycle replacement of the stainless steel sink	Lifecycle	18	2035	35	1	Each	$ 1,500	$ 1,500	$ 1,500
94	Mechanical Systems	4.5.4	Sinks	Dewater Building Unit 10 Janitorial Closets	2000	17	35	Good	Conduct lifecycle replacement of the acrylic mop sinks	Lifecycle	18	2035	35	1	Each	$ 1,500	$ 1,500	$ 1,500
95	Mechanical Systems	4.5.4	Drinking Fountains / Coolers	Dewater building Unit 10	2000	17	25	Good	Conduct lifecycle replacement of wall mounted water cooler	Lifecycle	8	2025	25	1	Each	$ 1,650	$ 1,700	$ 1,700
96	Mechanical Systems	4.5.4	Showers	Dewater Building Unit 10 Washroom	2000	17	35	Good	Conduct lifecycle replacement of the shower complete with flow valves, shower head and acrylic surround	Lifecycle	18	2035	35	1	Each	$ 2,500	$ 2,500	$ 2,500
97	Mechanical Systems	4.5.5	Gas Supply Systems	All Building Sections Building constructed in 2000/2015	2000	17	50	Good	No significant capital expenditure a part from routine maintenance is anticipated within the evaluation period		33	-	-	704	M²		$ -	
98	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Natural Gas Fired Radiant Tube Heaters Maintenance building/mechanical shop Unit 20,30	2000	17	30	Good	Conduct lifecycle replacement of Gas fired radiant tube heaters 30-H-4 N,30-H-5 SE,30-H-6SW,30-H-7 Electrical Shop and 20-H--8/9/10/12/14/15/16/18/19	Lifecycle	13	2030	30	15	Each	$ 5,000	$ 75,000	$ 75,000
99	Mechanical Systems	4.5.7	Air Handling Units	Tipping Building Unit 20 MUA Units	2000	17	30	Good	Conduct Lifecycle replacement of roof mounted MAU - 20-H-3/11/13/17/55	Lifecycle	13	2030	30	5	Each	$ 90,000	$ 450,000	$ 450,000
100	Mechanical Systems	4.5.7	Air Handling Units	Dewater Building Unit 10	2000	17	30	Good	Conduct lifecycle replacement of MAU - 10-H-3, 10-H-52, 10-H-58 (main area 3820L/s) Units to determine repair or replacement of equipment flagged for deletion based on provided equipment inventory lists. Refer to line item 109 for additional recommendations.	Lifecycle	13	2030	30	3	Each	$ 71,500	$ 214,500	$ 214,500
101	Mechanical Systems	4.5.7	Air Handling Units	Dewater Building LAB Unit 10	2000	17	30	Good	Conduct Lifecycle replacement of LAB MAU - 10-H-58 (1103L/s)	Lifecycle	13	2030	30	1	Each	$ 71,500	$ 71,500	$ 71,500
102	Mechanical Systems	4.5.7	Exhaust Fans	Dewater Building LAB Unit 10	2000	17	30	Good	Conduct lifecycle replacement of the roof mounted LAB exhaust unit (10-C-48East roof, 10-C-11 NW roof,10-C-55W roof,	Lifecycle	13	2030	30	4	Each	$ 5,000	$ 20,000	$ 20,000
103	Building Envelope	4.5.7	Exhaust Fans	Tipping Building Unit 20	2000	17	30	Good	Conduct lifecycle replacement of the roof mounted Tunnel & tipping floor exhaust 125hp 20-CC-12A/12B	Lifecycle	13	2030	30	2	Lump Sum	$ 25,000	$ 50,000	$ 50,000
104	Mechanical Systems	4.5.7	Exhaust Fans	Aeration Building Unit 40	2000	17	30	Poor	Conduct study to determine air balancing issue with Aeration hall as both125hp exhaust fans cannot be run together as designed.	Study	1	2018	30	1	Lump Sum	$ 10,000	$ 10,000	$ 10,000
105	Mechanical Systems	4.5.7	Exhaust Fans	Dewater Building Unit 10	2000	17	30	Good	Conduct lifecycle replacement of wall mounted exhaust fan 10-C-11 (4250 L/s)	Lifecycle	13	2030	30	1	Each	$ 2,500	$ 2,500	$ 2,500
106	Mechanical Systems	4.5.7	Air Handling Units	North Download Building Unit 30 Electrical Room	2000	17	30	Good	Conduct Lifecycle replacement of roof mounted 30-H3	Lifecycle	13	2030	30	1	Lump Sum	$ 71,500	$ 71,500	$ 71,500

TABLE A - COMPONENT LISTING AND EVENT COSTS

Item No.	Major Facility System	Report Reference No.	Component Name	Component Detail or Location	Year of Install	Age (Years)	EUL (Years)	Condition Rating	Event Description	Event Type	Time to First Event (Years)	Initial Event Year	Frequency to Repeat (Years)	Quantity	Unit	Unit Cost (2017 Dollars)	Event Cost (2017 Dollars)	Total Opinion of Cost (20 Years)
107	Mechanical Systems	4.5.7	Air Handling Units	North Download Building Unit 30 Conveyor Tunnels	2000	17	30	Good	Conduct Lifecycle replacement of roof mounted makeup air units 30-HM-30 Drum 3 and Makeup Air unit 30-HM-40 Drum 4	Lifecycle	13	2030	30	2	Lump Sum	$ 71,500	$ 143,000	$ 143,000
108	Mechanical Systems	4.5.7	Air Handling Units	Aeration Hall Unit 40	2000	17	30	Good	Conduct lifecycle replacement of ground level makeup air units 40-H-74A,40-H-74B unit 40-H--74-A to determine repair or replacement of units. The unit have been Flagged for Deletion on provided equipment inventory list. Refer to line item 109 for additional recommendations.	Lifecycle	13	2030	30	2	Lump Sum	$ 71,500	$ 143,000	$ 143,000
109	Mechanical Systems	4.5.7	Air Handling Units	Aeration Hall Unit 40 Dewater Building Unit 10	2006	11	30	Poor	Conduct Study of MAU units 40-H-74A,40-H-74B, 10-H-3, 10-H-52, 10-H-58 are not being utilized to determine if replacement of units is required or not. The unit have been Flagged for Deletion on provided equipment.	Study	1	2018	30	1	Lump Sum	$ 5,000	$ 5,000	$ 5,000
110	Mechanical Systems	4.5.7	Air Handling Units	Finishing Building Unit 50	2000	17	30	Good	Conduct Lifecycle replacement of roof mounted MAU - 50-C-122 S Annex Building W,50-C-123 South Annex Building E-50-C-ZZ Electrical room S wall	Lifecycle	13	2030	30	3	Each	$ 71,500	$ 214,500	$ 214,500
111	Mechanical Systems	4.5.7	Exhaust Fans	North Download Building Unit 30 Conveyor tunnels	2000	17	30	Good	Conduct lifecycle replacement of exhaust fan 30-CM62 Drum 3 and 30-CM72 Drum 4	Lifecycle	13	2030	30	2	Lump Sum	$ 25,000	$ 50,000	$ 50,000
112	Mechanical Systems	4.5.7	Exhaust Fans	Aeration Hall Building Unit 40	2000	17	30	Good	Conduct lifecycle replacement of attic mounted exhaust fans.	Lifecycle	13	2030	30	5	Each	$ 5,000	$ 25,000	$ 25,000
113	Mechanical Systems	4.5.7	Air Handling Units	Aeration Building Unit 40	2000	17	30	Good	Conduct Lifecycle replacement of exterior MAU Units 40-H-74A and 40-H-74B	Lifecycle	13	2030	30	2	Lump Sum	$ 100,000	$ 200,000	$ 200,000
114	Mechanical Systems	4.5.7	Air Handling Units	Finishing Building Unit 50	2000	17	30	Good	Conduct Lifecycle replacement of MUA unit 1 (West end) 50-C-122/ 50-c-123	Lifecycle	13	2030	30	2	Lump Sum	$ 71,500	$ 143,000	$ 143,000
115	Mechanical Systems	4.5.7	Air Handling Units	Finishing Building Unit 50	2015	2	30	Good	No significant capital expenditure apart from routine maintenance of 1-H-1025 is anticipated within the evaluation period		28	-	-	1	Lump Sum		$ -	$ -
116	Mechanical Systems	4.5.8	Air Distribution Ductwork	Buildings Unit10,20,30,40,50	2000	17	55	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		38	-	-	13,700	M²		$ -	$ -
117	Mechanical Systems	4.5.8	Exhaust Ductwork	Buildings Unit 10,20,30,40,50	2000	17	55	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		38	-	-	7,880	M²		$ -	$ -
118	Mechanical Systems	4.5.9	Unit Air Conditioners	Dewater Building LAB Unit 10	2000	17	25	Good	Conduct lifecycle replacement of the roof mounted ac unit 10-ACU-1	Lifecycle	8	2025	25	1	Each	$ 5,000	$ 5,000	$ 5,000
119	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Tipping Building Unit 20	2000	17	30	Good	Conduct lifecycle replacement of unit heaters(Tip floor tunnel (2) and MSS building (7). (20-4,5,6,7,52,53,54,56,57)The cost to conduct this work is considered to be below the threshold and part of routine maintenance		13	2030	30	9	Each		$ -	$ -
120	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Finishing Building Unit 50	2015	2	30	Good	No significant capital expenditure apart from routine maintenance of unit heaters 50-H68 NE,50-H-69 SE,50-H--70-S-Center,50-h-71SW The cost to conduct this work is considered to be below the threshold and part of routine maintenance		28	-	-	4	Each		$ -	$ -
121	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Dewater Building Unit 10 Suspended type natural gas unit heater	2000	17	30	Fair	Conduct Maintenance study of suspended natural gas fired unit heater 10-H-52 to determine course of action to repair or replace unit which has been flagged for deletion on equipment inventory list provided.	Study	1	2018	30	1	Each	$ 2,500	$ 2,500	$ 2,500
122	Mechanical Systems	4.5.9	Humidifiers	Dewater Building Unit 10 Lab Area	2000	17	25	Good	Conduct lifecycle replacement of lab Humidifiers 10-Y-53 and 10-Y-54	Lifecycle	8	2025	25	2	Each	$ 3,500	$ 7,000	$ 7,000

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TABLE A - COMPONENT LISTING AND EVENT COSTS

Item No.	Major Facility System	Report Reference No.	Component Name	Component Detail or Location	Year of Install	Age (Years)	EUL (Years)	Condition Rating	Event Description	Event Type	Time to First Event (Years)	Initial Event Year	Frequency to Repeat (Years)	Quantity	Unit	Unit Cost (2017 Dollars)	Event Cost (2017 Dollars)	Total Opinion of Cost (20 Years)
123	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Buildings Unit10,30,50 Suspended type natural gas unit heater	2000	17	30	Good	Conduct lifecycle replacement of the suspended natural gas fired unit heaters (10-H-4/5/6/7,53,54,55),(30-H-60/61/62/63/63A/63B),(50-H-68/69/70/71)	Lifecycle	13	2030	30	18	Each	$ 2,500	$ 45,000	$ 45,000
124	Mechanical Systems	4.5.6	Fuel-Fired Heaters	Finishing Building Unit 30 Suspended type natural gas unit heater	2015	2	30	Good	No significant capital expenditure apart from routine maintenance 0f 30-H77,78 units is anticipated within the evaluation period		28	-	-	2	Each		$ -	$ -
125	Mechanical Systems	4.5.6	Unit Heaters	Electric blower heater for Sprinkler rooms/ electrical room	2000	17	20	Good	Conduct lifecycle replacement of the 3kW electric blower heater in sprinkler room and electrical room and closed stairwells.	Lifecycle	3	2020	20	6	Each	$ 1,700	$ 10,200	$ 10,200
126	Mechanical Systems	4.5.10	Building Management Systems Controls	Tipping Building Unit 20	2000	17	15	Good	Conduct lifecycle replacement of the building automation system, Scada	Lifecycle	0	2017	15	5,143	M²	$ 15	$ 77,200	$ 154,400
127	Mechanical Systems	4.5.11	Standpipes	Buildings Unit 10,20,30,40	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
128	Mechanical Systems	4.5.11	Standpipes	Finishing Building Unit 50	2015	2	50	Fair	Conduct a study for the testing of the hoses in the stand- pipe cabinets throughout the process building	Study	48	-	-	1	Lump Sum	$ 6,000	$ 6,000	$ -
129	Mechanical Systems	4.5.11	Sprinklers	Tipping Building Unit 20 main floor/glycol loop	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
130	Mechanical Systems	4.5.11	Sprinklers	North Download Building Unit 10,20,30,40	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
131	Mechanical Systems	4.5.11	Sprinklers	Tipping Sprinkler Room#2 Air Compressor	2000	17	20	Good	Conduct lifecycle sprinkler system air compressor, cost below reporting threshold		3	2020	20	1	Each		$ -	$ -
132	Mechanical Systems	4.5.11	Fire Extinguisher, Cabinets and Accessories	Buildings Unit 10,20,50	2000	17	12	Good	Conduct lifecycle replacement of the fire extinguishers, cost below reporting threshold	Lifecycle	0	2017	12	8			$ -	$ -
133	Mechanical Systems	4.5.11	Fire Extinguisher, Cabinets and Accessories	Finishing Building Unit 30	2015	2	12	Good	Conduct lifecycle replacement of the fire extinguishers, cost below reporting threshold	Lifecycle	10	2027	12	4			$ -	$ -
134	Electrical Systems	4.6.1	Main Electrical Switchboards	Exterior sub-station 25KV 74-SWG01	2015	2	40	Good	Medium Voltage Sub-station owned and maintained by third party Utility Provider		38	-	-	1			$ -	$ -
135	Electrical Systems	4.6.1	Secondary Electrical Transformers	Exterior sub-station 25KV Transformers 74-XFMR2/74-XFMR3	2000	17	40	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	1	Lump Sum		$ -	$ -
136	Electrical Systems	4.6.1	Main Electrical Switchboards	Main Electrical Rooms: North Download Building, Unit 30 Dewater Building, Unit 10 Digester Building, Unit 30	2000	17	40	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	1	Each		$ -	$ -
137	Electrical Systems	4.6.1	Electrical Branch Circuit Panel Boards	Dewater Building Unit10,20 East Electrical	2000	17	40	Good	Conduct lifecycle replacement of the 600V, 400 Amp Central Distribution Panelboards 10-PLN-2B/10-PNL-2B2,10-PLN-6B(600V400Amp)		23	-	-	1	Lump Sum	$ 15,000	$ 15,000	$ -
138	Electrical Systems	4.6.1	Electrical Branch Circuit Panel Boards	Digester Building Unit 20,30	2000	17	40	Good	Conduct lifecycle replacement of the 120/208V 225 Amp Panelboards 10-PNL-2D,20-PNL-6A,20-PNL-2A,		23	-	-	2	Lump Sum	$ 17,000	$ 34,000	$ -
139	Electrical Systems	4.6.1	Main Electrical Transformers	Stepdown Transformers	2000	17	40	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		23	-	-	1	Lump Sum		$ -	$ -
140	Electrical Systems	4.6.1	Motor Control Centers	All building Sections	2000	17	30	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		13	2030	30	1	Each		$ -	$ -

Item No.	Major Facility System	Report Reference No.	Component Name	Component Detail or Location	Year of Install	Age (Years)	EUL (Years)	Condition Rating	Event Description	Event Type	Time to First Event (Years)	Initial Event Year	Frequency to Repeat (Years)	Quantity	Unit	Unit Cost (2017 Dollars)	Event Cost (2017 Dollars)	Total Opinion of Cost (20 Years)
141	Electrical Systems	4.6.1	Other Electrical Systems	Building, Electrical Rooms Power Factor Correction equipment	2000	17	30	Good	Conduct lifecycle replacement of the Elctrotek Power Factor Correction Control 74-KVAR-02 (700KVR), 74-KVAR-04, 74-KVAR-05 and 74-KVAR-06.	Lifecycle	13	2030	30	1	Lump Sum	$ 100,000	$ 100,000	$ 400,000
142	Electrical Systems	4.6.1	Other Electrical Systems	Power Distribution Buss Duct	2000	17	30	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		13	2030	30				$ -	$ -
143	Electrical Systems	4.6.2	Electrical Branch Wiring	Buildings Unit10,20,30,40,50	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
144	Electrical Systems	4.6.2	Electrical Branch Wiring	Buildings Unit10,20,30,40,50	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
145	Electrical Systems	4.6.1	Other Electrical Systems	All Building Areas	2000	17	30	Poor	Conduct study to assess the support hangers on cable tray systems identified with heavy corrosion.	Study	13	2030	30	1	Lump Sum	$ 15,000	$ 15,000	$ 15,000
146	Electrical Systems	4.6.1	Other Electrical Systems	All Building Areas	2000	17	30	Fair	Conduct electrical equipment cleaning and infrared testing on a three year cycle.	Maintenance	1	2018	3	1	Lump Sum	$ 10,000	$ 10,000	$ 70,000
147	Electrical Systems	4.6.6	Telephone Systems	Finishing Building Unit 50	2000	17	50	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		33	-	-		M²		$ -	$ -
148	Electrical Systems	4.6.2	Interior Fluorescent Fixtures	Buildings Unit 20,30,50	2000	17	30	Good	Conduct lifecycle replacement of the interior chain suspended metal shade fluorescent lighting fixtures.	Lifecycle	13	2030	30	157	Each	$ 250	$ 39,300	$ 39,300
149	Electrical Systems	4.6.2	Interior Metal Halide Fixtures	Finishing Building Unit 50	2015	2	30	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		28	-	-	6	Each		$ -	$ -
150	Electrical Systems	4.6.2	Interior LED fixtures	Tipping Building Unit 10	2016	1	30	Good	No significant capital expenditure apart from routine maintenance is anticipated within the evaluation period		29	-	-		Each		$ -	$ -
150	Electrical Systems	4.6.2	Interior Metal Halide Fixtures	Buildings Unit ,20 30, 40,50	2000	17	30	Good	Conduct lifecycle replacement of the interior high bay metal Halide fixtures	Lifecycle	13	2030	30	649	Each	$ 1,250	$ 811,300	$ 811,300
151	Electrical Systems	4.6.2	Lighting Accessories and Controls	Composter Facility Unit 80 Lighting photocell/controller System	2000	17	30	Good	Conduct lifecycle replacement Photo cells/ timers	Lifecycle	13	2030	30	1	Lump Sum	$ 15,000	$ 15,000	$ 15,000
152	Electrical Systems	4.6.2	Interior Metal Halide Fixtures	Buildings Unit 10,20 30, 40,50	2000	17	30	Good	Conduct lifecycle replacement Photo cells/ timers	Lifecycle	13	2030	30	1	Lump Sum	$ 8,000	$ 8,000	$ 8,000
153	Electrical Systems	4.6.2	Exterior Metal Halide Fixtures	Buildings Unit 10,20,30, 40 HID wall packs	2000	17	20	Good	Conduct lifecycle replacement of the metal halide light fixture above doorway, along building	Lifecycle	3	2020	20	91	Each	$ 650	$ 59,200	$ 59,200
154	Electrical Systems	4.6.2	Interior Special Purpose Lighting	Buildings Unit 10,20,30, 40 HID wall packs	2000	17	30	Critical	Conduct a study of the different areas of the production building to determine areas where explosion proof equipment maybe required.	Study	1	2018	30	1	Each	$ 8,000	$ 8,000	$ 8,000
155	Electrical Systems	4.6.2	Exterior Metal Halide Fixtures	Finishing Buildings Unit 30 HID wall packs	2015	2	20	Good	Conduct lifecycle replacement of the metal halide light fixture above doorway, along building	Lifecycle	18	2035	20	9	Each	$ 650	$ 5,900	$ 5,900
156	Electrical Systems	4.6.2	Other Exterior Fixtures	Tipping Building Unit 20 Roof mounted traffic lights	2000	17	20	Good	Loading bay doors decommissioned roof mounted traffic lightings and remove from building	Optional	3	2020	20	7	Each	$ 1,000	$ 7,000	$ 7,000
157	Electrical Systems	4.6.3	Emergency Lighting Battery Packs	All Building Sections	2000	17	20	Good	Conduct lifecycle replacement of the interior emergency battery packs, cost below reporting threshold	Lifecycle	3	2020	20	80	Each	$ 200	$ 13,300	$ 13,300

TABLE A - COMPONENT LISTING AND EVENT COSTS

Item No.	Major Facility System	Report Reference No.	Component Name	Component Detail or Location	Year of Install	Age (Years)	EUL (Years)	Condition Rating	Event Description	Event Type	Time to First Event (Years)	Initial Event Year	Frequency to Repeat (Years)	Quantity	Unit	Unit Cost (2017 Dollars)	Event Cost (2017 Dollars)	Total Opinion of Cost (20 Years)
158	Electrical Systems	4.6.3	Exit Signs	All Building Sections	2000	17	30	Good	Conduct lifecycle replacement of the interior Exit/ combination EM Lighting signs	Lifecycle	13	2030	30	38	Each	$ 350	$ 13,300	$ 13,300
159	Electrical Systems	4.6.1	Other Electrical Systems	Tipping Building Unit 20	2000	17	30	Good	Conduct lifecycle replacement of electric heat trace of the sprinkler lines and eavestrough	Lifecycle	13	2030	30	1	Lump Sum	$ 10,000	$ 10,000	$ 10,000
160	Electrical Systems	4.6.3	Uninterruptible Power Supply Systems	Alert Management Controller Unit 10	2000	17	30	Good	Conduct lifecycle replacement of the Eaton 9130 UPS for Alert management controller	Lifecycle	13	2030	30	1	Lump Sum	$ 5,000	$ 5,000	$ 5,000
161	Electrical Systems	4.6.5	Other Security Systems	ODO WATCH	2000	17	20	Good	ODO Watch gas detection systems has been noted as an existing system within the building but is outside of the scope of the Building assessment.		3	2020	20				$ -	
161	Electrical Systems	4.6.5	Other Security Systems	Scada/gas sensors	2000	17	20	Good	Scada gas detection systems has been noted as an existing system within the building but is outside of the scope of the Building assessment.		3	2020	20				$ -	
162	Electrical Systems	4.6.5	Other Security Systems	Beacon Alarm	2000	17	20	Good	Beacon gas detection systems has been noted as an existing system within the building but is outside of the scope of the Building assessment.		3	2020	20				$ -	
163	Electrical Systems	4.6.5	Intrusion Detection Systems	All building sections	2000	17	20	Good	Conduct lifecycle replacement of the Eaton 9130 UPS for Alert management controller	Lifecycle	3	2020	20	1	Lump Sum	$ 20,000	$ 20,000	$ 20,000
164	Electrical Systems	4.6.4	Fire Detection and Alarm	Trommel Building Unit 30	2000	17	25	Poor	Conduct study to correct ground fault issues with fire alarm wiring in the facility.	Study	1	2018	25	1	Each	$ 10,000	$ 10,000	$ 10,000
165	Electrical Systems	4.6.4	Fire Detection and Alarm	Finishing Building Unit 50	2015	2	25	Good	No significant capital expenditure is anticipated within the evaluation period		23	-	-	1,288	M²		$ -	$ -
166	Electrical Systems	4.6.4	Fire Detection and Alarm	Buildings Unit20,30,40,50	2000	17	25	Poor	Conduct lifecycle replacement of the Notifier fire alarm and detection system including all wiring and field devices, but excluding fire alarm panels and annunciator panels	Health & Safety	8	2025	25	50,261	M²	$ 60	$ 3,015,700	$ 3,015,700
167	Electrical Systems	4.6.4	Fire Detection and Alarm	Finishing Building Unit 50	2015	2	15	Good	No significant capital expenditure is anticipated within the evaluation period of the Notifier fire alarm panel (excluding field devices) tied to main fire alarm system		13	2030	15	1	Lump Sum		$ -	$ -
168	Electrical Systems	4.6.4	Fire Detection and Alarm	Dewater Building Unit 10	2000	17	15	Good	Main panel located in Dewater building and main fire alarm annunciator in Administration Building, Conduct lifecycle replacement of the main Notifier panel and , five fire alarm NAC panels (Notification Appliance Circuit), excluding field devices	Lifecycle	0	2017	15	1	Lump Sum	$ 47,500	$ 47,500	$ 95,000

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Appendix B Long-Term Component Event Costs Summary

TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS) SHORT-TERM (2017 - 2022) Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	LONG-TERM (2023 - 2037) Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	Total Opinion of Cost (20 Years)
1	Foundations	All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	Foundations	Foundation Insulation and Parging Tipping Building Unit 20	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	Slab on Grade	All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	Basement Walls / Crawl Space	Basement Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Basement Walls / Crawl Space	Concrete Push Walls Tipping Building Unit 20	Maintenance	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000
6	Floor Construction	Floor Decks All Buildings		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	Roof Construction	Roof Structure Aeration Hall Unit 40	Health & Safety	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	Roof Construction	Roof Structure Aeration Hall Unit 40	Study	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,000
9	Roof Construction	Roof Structure Tipping Building Unit 20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10	Roof Construction	Roof Structure Trommel Building Unit 30		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Roof Construction	Roof Structure Digester Building Unit 30		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	Roof Construction	Roof Structure Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
13	Roof Construction	Roof Structure Finishing Building Unit 50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
14	Roof Construction	Roof Structure Load Out Building		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
15	Stair Construction	Interior Stairs Metal-framed Trommel Buildings Unit 30	Health & Safety	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
16	Stair Construction	Interior Stairs Metal-framed Dewatering Buildings Unit 10	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17	Exterior Stairs	Exterior Stairs Metal-framed All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
18	Metal Siding	Exterior Walls All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	Metal Siding	East Exterior Wall Tipping Building Unit 20	Maintenance	$ -	$ 10,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000
20	Metal Siding	South Exterior Wall Finishing Building Unit 75	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21	Metal Siding	Exterior Walls Load Out Building Unit 75		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
22	Joint Sealers (Caulking)	Building Perimeter Main Building	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
23	Exterior Wall Vapor Retarders, Air Barriers, and Insulation	Exterior Walls All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
24	Aluminum Windows (Glass & Frame)	Window Exterior Warehouse Receiving Tipping Building Unit 20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25	Aluminum Windows (Glass & Frame)	Windows Exterior Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
26	Steel-Framed Doors	Exterior Man Doors Aeration Hall Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 12,100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,100
27	Steel-Framed Doors	Exterior Man Doors Tipping Building Unit 20	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 9,900	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,900

TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS)																					Total Opinion of Cost (20 Years)
				SHORT-TERM (2017 - 2022)						LONG-TERM (2023 - 2037)															
				Immediate	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	
				2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	
28	Steel-Framed Doors	Exterior Man Doors Trommel Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 6,600	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,600
29	Steel-Framed Doors	Exterior Man doors Digester Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 2,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,200
30	Steel-Framed Doors	Exterior Man Doors Dewatering Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 11,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,000
31	Steel-Framed Doors	Exterior Man Doors Finishing Building Unit 50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 3,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,300
32	Steel-Framed Doors	Exterior Man Doors Load Out Building		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
33	Steel-Framed Doors	Exterior Door Hardware All Building Sections	Lifecycle	$ -	$ 20,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,500	$ -	$ -	$ -	$ -	$ 41,000
34	Overhead Doors	Overhead Doors Aeration Hall Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 24,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 24,500
35	Overhead Doors	Overhead Doors Tipping Building Unit 20	Maintenance	$ 10,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,500
36	Overhead Doors	Overhead Doors Tipping Building Unit 20	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000
37	Overhead Doors	Overhead Doors Trommel Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500
38	Overhead Doors	Overhead Doors Digester Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,500
39	Overhead Doors	Overhead Doors Dewatering Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000
40	Overhead Doors	Overhead Doors Finishing Building Unit 50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,000
41	Overhead Doors	Overhead Doors Load Out Building		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
42	Overhead Doors	Electric Operators Overhead Doors Aeration Hall Unit 40	Lifecycle	$ -	$ -	$ -	$ 25,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 25,000
43	Overhead Doors	Electric Operators Overhead Doors Tipping Building Unit 20	Maintenance	$ -	$ -	$ 12,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,500
44	Overhead Doors	Electric Operators Overhead Doors Trommel Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ 12,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,500
45	Overhead Doors	Electric Operators Overhead Doors Digester Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500
46	Overhead Doors	Electric Operators Overhead Doors Dewatering Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500
47	Overhead Doors	Electric Operators Overhead Doors Finishing Building Unit 50	Maintenance	$ -	$ -	$ 12,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,500
48	Overhead Doors	Electric Operators Overhead Doors Load Out Building		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
49	Roof Vapor Retarder and Insulation	Roof All Buildings		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
50	Sheet Metal Roofing	Standing-seam Metal Roofing Aeration Hall Unit 40	Health & Safety	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
51	Sheet Metal Roofing	Standing-seam Metal Roofing Tipping Building Unit 20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
52	Sheet Metal Roofing	Standing-seam Metal Roofing Trommel Building Unit 30		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS)																					Total Opinion of Cost (20 Years)
				SHORT-TERM (2017 - 2022)						LONG-TERM (2023 - 2037)															
				Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	
53	Sheet Metal Roofing	Standing-seam Metal Roofing Digester Building Unit 30		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
54	Sheet Metal Roofing	Standing-seam Metal Roofing Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
55	Sheet Metal Roofing	Standing-seam Metal Roofing Finishing Building Unit 50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
56	Sheet Metal Roofing	Standing-seam Metal Roofing Load Out Building		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
57	Gutters and Downspouts	Rain Leaders & Downspouts All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
58	Other Roof Components	Fall Protection Guard Rails Roof Tipping Building Unit 20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
59	Other Roof Components	Roof Access Ship Ladder Tipping Building Unit 20		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
60	Other Roof Components	Fall Protection Guard Rails Roof Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
61	Other Roof Components	Roof Access Ship Ladder Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
62	Other Roof Components	Roof Hatch Tipping & Dewatering Building Units 20 & 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
63	Gypsum Wall Board	Interior Control Room Finishing Building Unit 50	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
64	Other Wall Finishes	Throughout All Building Sections	Maintenance	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 30,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 60,000
65	Other Wall Finishes	Power Wash Interior Surfaces Aeration Hall Unit 40	Maintenance	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ -	$ 28,400	$ -	$ 198,800
66	Other Wall Finishes	Power Wash Interior Surfaces Tipping Building Unit 20	Maintenance	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ -	$ 11,600	$ -	$ 81,200
67	Other Wall Finishes	Power Wash Interior Surfaces Trommel Building Unit 30	Maintenance	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ 28,000
68	Other Wall Finishes	Power Wash Interior Surfaces Digester Building Unit 30	Maintenance	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ 28,000
69	Other Wall Finishes	Power Wash Interior Surfaces Finishing Building Unit 50	Maintenance	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ -	$ 4,000	$ -	$ 28,000
70	Interior Wall Painting	Control Room Dewatering Building Unit 10	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
71	Gypsum Board Ceilings	Control Room Dewatering Building Unit 10	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
72	Suspended Ceilings	Control Room Dewatering Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,200
73	Fixed Partitions	Control Room and Electrical Room Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

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TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS)																					Total Opinion of Cost (20 Years)
				SHORT-TERM (2017 - 2022)						LONG-TERM (2023 - 2037)															
				Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	
74	Interior Windows	Interior Windows Control Room Dewatering Building Unit 10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
75	Interior Firestopping	Throughout All Buildings	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
76	Swinging Doors & Hardware	Interior Doors All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
77	Swinging Doors & Hardware	Hardware Interior Doors All Building Sections	Lifecycle	$ -	$ -	$ -	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,000	$ -	$ -	$ 12,000
78	Toilet, Bath, and Laundry Accessories	Washroom Control Room/ Laboratory Dewatering Building Unit 9	Maintenance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
79	Fixed Casework	Control Room/ Laboratory Dewatering Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,000	$ -	$ -	$ 15,000
80	Water Supply Piping Systems	Dewater Building Unit10		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
81	Water Supply Piping Systems	Aeration Building Unit 40		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
82	Backflow Preventors	Dewater Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,500
83	Backflow Preventors	Aeration Hall Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,000
84	Backflow Preventors	North Download Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500
85	Backflow Preventors	Tipping Building Unit 20	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,500
86	Domestic Water Heaters	Dewater Building Lab/washroom Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ 1,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500	$ 3,000
87	Waste and Vent Piping	All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
88	Waste Pumps	Tipping Building Unit 20 North Download Building Unit 30	Lifecycle	$ -	$ -	$ -	$ 14,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,000
89	Rain Water Drainage Piping Systems	All Building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
90	Water Closets	Dewater building Unit 10 washroom	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000	$ -	$ -	$ 2,000
91	Lavatories	Dewater building Unit 10 washroom	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,200	$ -	$ -	$ 1,200
92	Sinks	Dewater Building Unit 10 Lab area	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500	$ -	$ -	$ 1,500
93	Sinks	Maintenance Warehouse	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500	$ -	$ -	$ 1,500
94	Sinks	Dewater Building Unit 10 Janitorial Closets	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,500	$ -	$ -	$ 1,500
95	Drinking Fountains / Coolers	Dewater building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,700	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,700
96	Showers	Dewater Building Unit 10 Washroom	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500	$ -	$ -	$ 2,500
97	Gas Supply Systems	All Building Sections Building constructed in 2000/2015		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
98	Fuel-Fired Heaters	Natural Gas Fired Radiant Tube Heaters Maintenance building/mechanical shop Unit 20,30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 75,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 75,000
99	Air Handling Units	Tipping Building Unit 20 MUA Units	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 450,000
100	Air Handling Units	Dewater Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 214,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 214,500
101	Air Handling Units	Dewater Building LAB Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 71,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 71,500

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TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS) SHORT-TERM (2017 - 2022) Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	LONG-TERM (2023 - 2037) Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	Total Opinion of Cost (20 Years)
102	Exhaust Fans	Dewater Building LAB Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,000
103	Exhaust Fans	Tipping Building Unit 20	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000
104	Exhaust Fans	Aeration Building Unit 40	Study	$ -	$ 10,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000
105	Exhaust Fans	Dewater Building Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500
106	Air Handling Units	North Download Building Unit 30 Electrical Room	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 71,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 71,500
107	Air Handling Units	North Download Building Unit 30 Conveyor Tunnels	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000
108	Air Handling Units	Aeration Hall Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000
109	Air Handling Units	Aeration Hall Unit 40 Dewater Building Unit 10	Study	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000
110	Air Handling Units	Finishing Building Unit 50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 214,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 214,500
111	Exhaust Fans	North Download Building Unit 30 Conveyor tunnels	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000
112	Exhaust Fans	Aeration Hall Building Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 25,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 25,000
113	Air Handling Units	Aeration Building Unit 40	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,000
114	Air Handling Units	Finishing Building Unit 50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,000
115	Air Handling Units	Finishing Building Unit 50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
116	Air Distribution Ductwork	Buildings Unit10,20,30,40,50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
117	Exhaust Ductwork	Buildings Unit 10,20,30,40,50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
118	Unit Air Conditioners	Dewater Building LAB Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000
119	Fuel-Fired Heaters	Tipping Building Unit 20	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
120	Fuel-Fired Heaters	Finishing Building Unit 50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
121	Fuel-Fired Heaters	Dewater Building Unit 10 Suspended type natural gas unit heater	Study	$ -	$ 2,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,500
122	Humidifiers	Dewater Building Unit 10 Lab Area	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000
123	Fuel-Fired Heaters	Buildings Unit10,30,50 Suspended type natural gas unit heater	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 45,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 45,000
124	Fuel-Fired Heaters	Finishing Building Unit 30 Suspended type natural gas unit heater	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
125	Unit Heaters	Electric blower heater for Sprinkler rooms/ electrical room	Lifecycle	$ -	$ -	$ -	$ 10,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,200
126	Building Management Systems Controls	Tipping Building Unit 20	Lifecycle	$ 77,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 77,200	$ -	$ -	$ -	$ -	$ -	$ 154,400
127	Standpipes	Buildings Unit 10,20,30,40	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

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TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS)																					Total Opinion of Cost (20 Years)
				SHORT-TERM (2017 - 2022)						LONG-TERM (2023 - 2037)															
				Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	
128	Standpipes	Finishing Building Unit 50	Study	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
129	Sprinklers	Tipping Building Unit 20 main floor/glycol loop		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
130	Sprinklers	North Download Building Unit 10,20,30,40		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
131	Sprinklers	Tipping Sprinkler Room#2 Air Compressor	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
132	Fire Extinguisher, Cabinets and Accessories	Buildings Unit 10,20,50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
133	Fire Extinguisher, Cabinets and Accessories	Finishing Building Unit 30	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
134	Main Electrical Switchboards	Exterior sub-station 25KV 74-SWG01		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
135	Secondary Electrical Transformers	Exterior sub-station 25KV Transformers 74-XFMR2/74-XFMR3		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
136	Main Electrical Switchboards	Main Electrical Rooms: North Download Building, Unit 30 Dewater Building, Unit 10 Digester Building, Unit 30		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
137	Electrical Branch Circuit Panel Boards	Dewater Building Unit10,20 East Electrical	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
138	Electrical Branch Circuit Panel Boards	Digester Building Unit 20,30	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
139	Main Electrical Transformers	Stepdown Transformers		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
140	Motor Control Centers	All building Sections		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
141	Other Electrical Systems	Building, Electrical Rooms Power Factor Correction equipment	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 100,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 100,000
142	Other Electrical Systems	Power Distribution Buss Duct		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
143	Electrical Branch Wiring	Buildings Unit10,20,30,40,50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
144	Electrical Branch Wiring	Buildings Unit10,20,30,40,50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
145	Other Electrical Systems	All Building Areas	Study	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,000
146	Other Electrical Systems	All Building Areas	Maintenance	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ -	$ 10,000	$ -	$ 70,000
147	Telephone Systems	Finishing Building Unit 50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
148	Interior Fluorescent Fixtures	Buildings Unit 20,30,50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 39,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 39,300
149	Interior Metal Halide Fixtures	Finishing Building Unit 50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
150	Interior Metal Halide Fixtures	Buildings Unit ,20 30, 40,50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 811,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 811,300
151	Lighting Accessories and Controls	Composter Facility Unit 80 Lighting photocell/controller System	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,000
152	Interior Metal Halide Fixtures	Buildings Unit 10,20 30, 40,50	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,000

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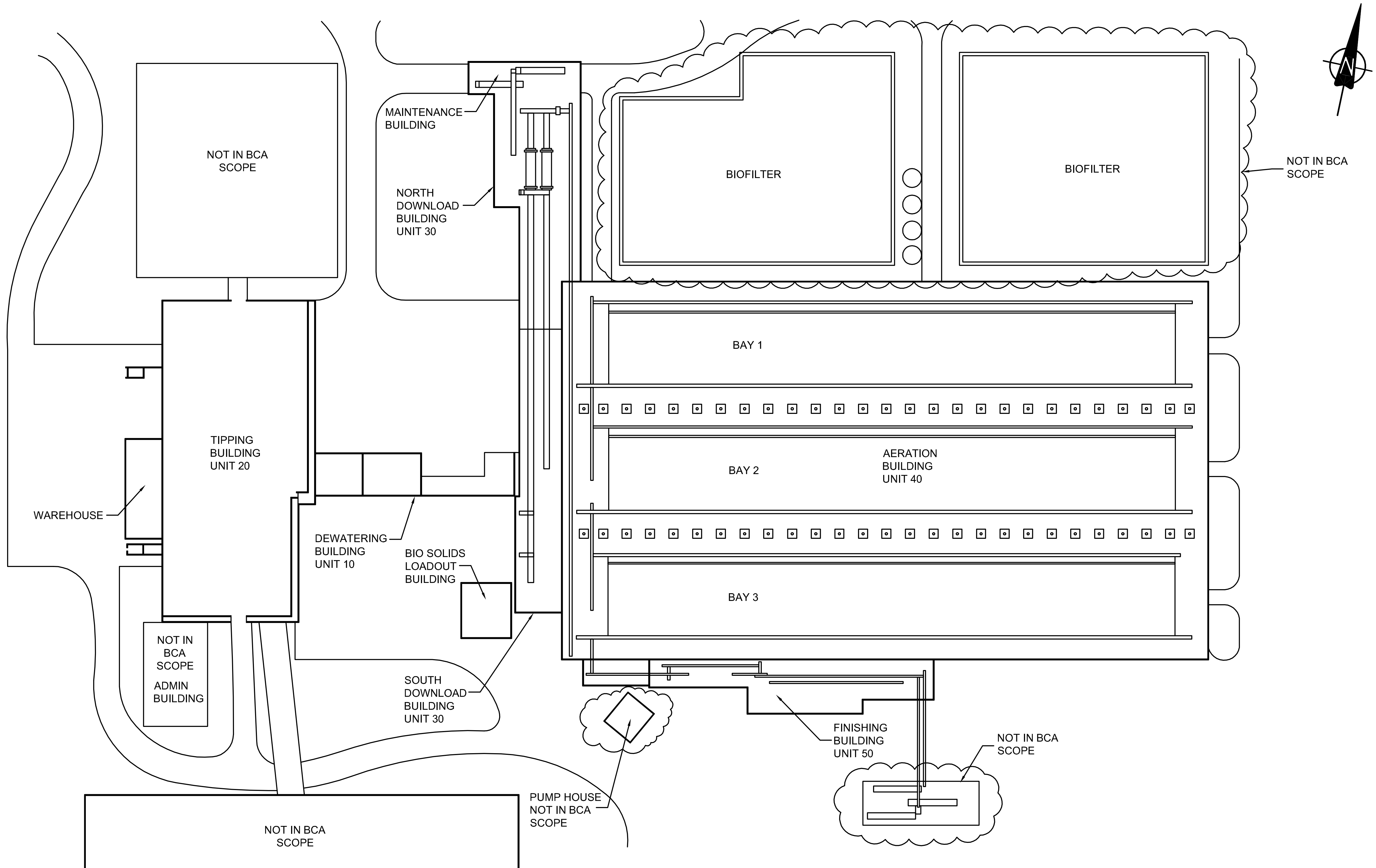
TABLE B - COMPONENT EVENT COSTS SUMMARY

Item No.	Component Name	Component Detail or Location	Event Type	EVENT COSTS (2017 DOLLARS) SHORT-TERM (2017 - 2022)						LONG-TERM (2023 - 2037)															Total Opinion of Cost (20 Years)
				Immediate 2017	Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022	Year 6 2023	Year 7 2024	Year 8 2025	Year 9 2026	Year 10 2027	Year 11 2028	Year 12 2029	Year 13 2030	Year 14 2031	Year 15 2032	Year 16 2033	Year 17 2034	Year 18 2035	Year 19 2036	Year 20 2037	
153	Exterior Metal Halide Fixtures	Buildings Unit 10,20,30, 40 HID wall packs	Lifecycle	$ -	$ -	$ -	$ 59,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 59,200
154	Interior Special Purpose Lighting	Buildings Unit 10,20,30, 40 HID wall packs	Study	$ -	$ 8,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,000
155	Exterior Metal Halide Fixtures	Finishing Buildings Unit 30 HID wall packs	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,900	$ -	$ -	$ 5,900
156	Other Exterior Fixtures	Tipping Building Unit 20 Roof mounted traffic lights	Optional	$ -	$ -	$ -	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,000
157	Emergency Lighting Battery Packs	All Building Sections	Lifecycle	$ -	$ -	$ -	$ 13,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,300
158	Exit Signs	All Building Sections	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,300
159	Other Electrical Systems	Tipping Building Unit 20	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000
160	Uninterruptible Power Supply Systems	Alert Management Controller Unit 10	Lifecycle	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000
161	Other Security Systems	ODO WATCH	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
162	Other Security Systems	Beacon Alarm	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
163	Intrusion Detection Systems	All building sections	Lifecycle	$ -	$ -	$ -	$ 20,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,000
164	Fire Detection and Alarm	Trommel Building Unit 30	Study	$ -	$ 10,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000
165	Fire Detection and Alarm	Finishing Building Unit 50		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
166	Fire Detection and Alarm	Buildings Unit20,30,40,50	Health & Safety	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,015,700	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,015,700
167	Fire Detection and Alarm	Finishing Building Unit 50	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
168	Fire Detection and Alarm	Dewater Building Unit 10	Lifecycle	$ 47,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 47,500	$ -	$ -	$ -	$ -	$ -	$ 95,000

Appendix C Key Plan



KEY PLAN

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:	**Project No.:**	110128016
	Scale:	N.T.S.
	Date:	18/02/10
	Dwn. By:	CD DM SL2018020197
	App'd By:	MJ

Client: CITY OF EDMONTON

Site Address 1311 MERIDIAN STREET NE, EDMONTON, ALBERTA

EDMONTON COMPOSTING FACILITY - BCA

Dwg. No.: ECF-001

Stantec

Appendix D Equipment list

Client provided Equipment list - Dated 12-1-2017

Functional Loc.	Description	Planning plant	Sort field
C-WM-ECF-HVACS-BIOSOL	BIOSOLIDS - SILO BUILDING	3300	UNIT 10
C-WM-ECF-HVACS-BIOSOL-AH1025	AIR MAKE UP, UNIT 1025, ROOF,SILO BLD.	3300	10-H-1025
C-WM-ECF-HVACS-BIOSOL-AM1025	FLAGGED FOR DELETION	3300	10-MAU-1/10-H-1025
C-WM-ECF-HVACS-BIOSOL-FN1026A	EXHAUST FAN 1026A, SILO BLD SOUTH WALL W	3300	10-C-1026A
C-WM-ECF-HVACS-BIOSOL-FN1026B	EXHAUST FAN 1026B,SILO BLD S WALL UP MID	3300	10-C-1026B
C-WM-ECF-HVACS-BIOSOL-FN1026C	EXHAUST FAN 1026C,SILO BLD S WALL LW MID	3300	10-C-1026C
C-WM-ECF-HVACS-BIOSOL-FN1026D	EXHAUST FAN 1026D,SILO BLD SOUTH WALL E	3300	10-C-1026D
C-WM-ECF-HVACS-BIOSOL-HT1	UNIT HEATER 1, EAST, SILO BUILDING	3300	10-H-1026
C-WM-ECF-HVACS-BIOSOL-HT2	UNIT HEATER 2, WEST, SILO BUILDING	3300	10-H-1027
C-WM-ECF-HVACS-BIOSOL-MT1	MOTOR, UNIT HEATER 1, EAST, SILO BLD	3300	10-HM-1
C-WM-ECF-HVACS-BIOSOL-MT1025	MOTOR, AIR MAKE UP UNIT 1025, ROOF	3300	
C-WM-ECF-HVACS-BIOSOL-MT1026A	MOTOR,EXHAUST FAN 1026A,SILO BLD S WALL	3300	
C-WM-ECF-HVACS-BIOSOL-MT1026B	MOTOR,EXHAUST FAN 1026B,SILO BLD S WALL	3300	
C-WM-ECF-HVACS-BIOSOL-MT1026C	MOTOR,EXHAUST FAN 1026C,SILO BLD S WALL	3300	
C-WM-ECF-HVACS-BIOSOL-MT1026D	MOTOR,EXHAUST FAN 1026D,SILO BLD S WALL	3300	
C-WM-ECF-HVACS-BIOSOL-MT2	MOTOR, UNIT HEATER 2, WEST, SILO BLD	3300	10-HM-2
C-WM-ECF-HVACS-BIOSOL-VF1025	VFD, AIR MAKE UP UNIT 1025, ROOF	3300	
C-WM-ECF-HVACS-DWNBLD	DOWNLOAD BUILDING	3300	UNIT 30
C-WM-ECF-HVACS-DWNBLD-AH30	AIR MAKE UP UNIT,DRUM 3 CONVEYOR GALLERY	3300	30-H-30
C-WM-ECF-HVACS-DWNBLD-AH40	AIR MAKE UP UNIT,DRUM 4 CONVEYOR GALLERY	3300	30-H-40
C-WM-ECF-HVACS-DWNBLD-AM30	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-DWNBLD-AM40	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-DWNBLD-BL61	BLOWER 61,SOURCE CAPTURE EXHAUST	3300	30-C-61
C-WM-ECF-HVACS-DWNBLD-FN62	EXHAUST FAN 62, DRUM 3	3300	30-C-62
C-WM-ECF-HVACS-DWNBLD-FN64	FAN 64, VACUUM SYSTEM	3300	30-C-64
C-WM-ECF-HVACS-DWNBLD-FN72	EXHAUST FAN 72, DRUM 4	3300	30-C-72
C-WM-ECF-HVACS-DWNBLD-MT30	MOTOR, AIR MAKE UP UNIT 30, DRUM 3	3300	30-HM-30
C-WM-ECF-HVACS-DWNBLD-MT40	MOTOR, AIR MAKE UP UNIT 40 , DRUM 4	3300	30-HM-40
C-WM-ECF-HVACS-DWNBLD-MT61	MOTOR , BLOWER 61,SOURCE CAPTURE EXHAUST	3300	30-CM-61
C-WM-ECF-HVACS-DWNBLD-MT62	MOTOR , EXHAUST FAN 62, DRUM 3	3300	30-CM-62
C-WM-ECF-HVACS-DWNBLD-MT64	MOTOR,FAN 64, VACUUM SYSTEM	3300	30-CM-64
C-WM-ECF-HVACS-DWNBLD-MT72	MOTOR , EXHAUST FAN 72, DRUM 4	3300	30-CM-72
C-WM-ECF-HVACS-DWTBLD	DEWATER BUILDING	3300	UNIT 10
C-WM-ECF-HVACS-DWTBLD-AC1	AIR CONDITIONING, UNIT 1, TOP OF LAB	3300	10-ACU-1
C-WM-ECF-HVACS-DWTBLD-AH3	AIR MAKE UP, UNIT 3, NORTH ROOFTOP BLDG	3300	10-H-3
C-WM-ECF-HVACS-DWTBLD-AH52	AIR MAKE UP, UNIT 52, EAST ROOFTOP BLDG	3300	10-H-52
C-WM-ECF-HVACS-DWTBLD-AH58	AIR MAKE UP, UNIT 58, CONTROL RM ROOFTOP	3300	10-H-58
C-WM-ECF-HVACS-DWTBLD-AM3	FLAGGED FOR DELETION	3300	10-H-3
C-WM-ECF-HVACS-DWTBLD-AM52	FLAGGED FOR DELETION	3300	10-H-52
C-WM-ECF-HVACS-DWTBLD-AM58	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-DWTBLD-FN11	EXHAUST FAN 11, NW CORNER SECOND FLOOR	3300	10-C-11
C-WM-ECF-HVACS-DWTBLD-FN48	EXHAUST FAN 48, EAST ROOFMOUNT LAB OVENS	3300	10-C-48
C-WM-ECF-HVACS-DWTBLD-FN55	EXHAUST FAN 55, W ROOFMOUNT LAB COUNTER	3300	10-C-55
C-WM-ECF-HVACS-DWTBLD-HT4	UNIT HEATER 4, NW ROOFTOP CEILING	3300	10-H-4
C-WM-ECF-HVACS-DWTBLD-HT5	UNIT HEATER 5, SW CORNER ROOFTOP CEILING	3300	10-H-5
C-WM-ECF-HVACS-DWTBLD-HT53	UNIT HEATER 53, SE LOWER FLOOR	3300	10-H-53
C-WM-ECF-HVACS-DWTBLD-HT54	UNIT HEATER 54, NE LOWER FLOOR	3300	10-H-54
C-WM-ECF-HVACS-DWTBLD-HT6	UNIT HEATER 6, SW LOWER FLOOR CEILING	3300	10-H-6
C-WM-ECF-HVACS-DWTBLD-HT7	UNIT HEATER 7, NW LOWER FLOOR CEILING	3300	10-H-7
C-WM-ECF-HVACS-DWTBLD-HU53	HUMIDIFIER 53, LAB	3300	10-Y-53
C-WM-ECF-HVACS-DWTBLD-HU54	HUMIDIFIER 54, LAB	3300	10-Y-54
C-WM-ECF-HVACS-DWTBLD-MT1	MOTOR, AIR CONDITIONING UNIT 1	3300	
C-WM-ECF-HVACS-DWTBLD-MT11	MOTOR, EXHAUST FAN 11	3300	10-CM-11
C-WM-ECF-HVACS-DWTBLD-MT3	MOTOR, AIR MAKE UP UNIT 3	3300	10-HM-3
C-WM-ECF-HVACS-DWTBLD-MT4	MOTOR , UNIT HEATER 4	3300	10-HM-4
C-WM-ECF-HVACS-DWTBLD-MT48	MOTOR , EXHAUST FAN 48	3300	10-CM-48
C-WM-ECF-HVACS-DWTBLD-MT5	MOTOR , UNIT HEATER 5	3300	10-HM-5
C-WM-ECF-HVACS-DWTBLD-MT52	MOTOR, AIR MAKE UP UNIT 52	3300	10-HM-52
C-WM-ECF-HVACS-DWTBLD-MT53	MOTOR , UNIT HEATER 53	3300	10-HM-53
C-WM-ECF-HVACS-DWTBLD-MT54	MOTOR , UNIT HEATER 54	3300	10-HM-54
C-WM-ECF-HVACS-DWTBLD-MT55	MOTOR , EXHAUST FAN 55	3300	10-CM-55

Client provided Equipment list - Dated 12-1-2017

Functional Loc.	Description	Planning plant	Sort field
C-WM-ECF-HVACS-DWTBLD-MT58	MOTOR, AIR MAKE UP UNIT 58	3300	10-HM-58
C-WM-ECF-HVACS-DWTBLD-MT6	MOTOR , UNIT HEATER 6	3300	10-HM-6
C-WM-ECF-HVACS-DWTBLD-MT7	MOTOR , UNIT HEATER 7	3300	10-HM-7
C-WM-ECF-HVACS-FINCRT	FINISHING CIRCUIT BUILDING	3300	UNIT 50
C-WM-ECF-HVACS-FINCRT-AH122	AIR MAKE UP, UNIT 122, SOUTH ANNEX BLD W	3300	50-C-122
C-WM-ECF-HVACS-FINCRT-AH123	AIR MAKE UP, UNIT 123, SOUTH ANNEX BLD E	3300	50-C-123
C-WM-ECF-HVACS-FINCRT-AHZZ	AIR MAKE UP, UNIT ZZ, ELECT. ROOM S WALL	3300	50-C-ZZ
C-WM-ECF-HVACS-FINCRT-AM122	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-FINCRT-AM123	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-FINCRT-AMZZ	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-FINCRT-FN117	EXHAUST FAN 117, SOUTH ANNEX BLD. E WALL	3300	50-C-117
C-WM-ECF-HVACS-FINCRT-FN118	EXHAUST FAN 118, SOUTH ANNEX BLD. E WALL	3300	50-C-118
C-WM-ECF-HVACS-FINCRT-FN119	EXHAUST FAN 119, SOUTH ANNEX BLD. W WALL	3300	50-C-119
C-WM-ECF-HVACS-FINCRT-FN120	EXHAUST FAN 120, SOUTH ANNEX BLD. W WALL	3300	50-C-120
C-WM-ECF-HVACS-FINCRT-HT01	HEATER, 01	3300	50-HE-01
C-WM-ECF-HVACS-FINCRT-HT68	UNIT HEATER, 68, PRODUCT BLD. NORTHEAST	3300	50-H-68
C-WM-ECF-HVACS-FINCRT-HT69	UNIT HEATER, 69, PRODUCT BLD. SOUTHEAST	3300	50-H-69
C-WM-ECF-HVACS-FINCRT-HT70	UNIT HEATER, 70, PRODUCT BLD SOUTH CNTR	3300	50-H-70
C-WM-ECF-HVACS-FINCRT-HT71	UNIT HEATER, 71, PRODUCT BLD. SOUTH WEST	3300	50-H-71
C-WM-ECF-HVACS-FINCRT-MT01	MOTOR, HEATER 01	3300	50-CM-01
C-WM-ECF-HVACS-FINCRT-MT117	MOTOR, EXHAUST FAN 117	3300	50-CM-117
C-WM-ECF-HVACS-FINCRT-MT118	MOTOR, EXHAUST FAN 118	3300	50-CM-118
C-WM-ECF-HVACS-FINCRT-MT119	MOTOR, EXHAUST FAN 119	3300	50-CM-119
C-WM-ECF-HVACS-FINCRT-MT120	MOTOR, EXHAUST FAN 120	3300	50-CM-120
C-WM-ECF-HVACS-FINCRT-MT122	MOTOR, AIR MAKE UP UNIT 122	3300	50-CM-122
C-WM-ECF-HVACS-FINCRT-MT123	MOTOR, AIR MAKE UP UNIT 123	3300	50-CM-123
C-WM-ECF-HVACS-FINCRT-MT68	MOTOR, UNIT HEATER 68	3300	50-CM-68
C-WM-ECF-HVACS-FINCRT-MT69	MOTOR, UNIT HEATER 69	3300	50-CM-69
C-WM-ECF-HVACS-FINCRT-MT70	MOTOR, UNIT HEATER 70	3300	50-CM-70
C-WM-ECF-HVACS-FINCRT-MT71	MOTOR, UNIT HEATER 71	3300	50-CM-71
C-WM-ECF-HVACS-FINCRT-MTZZ	MOTOR, AIR MAKE UP UNIT ZZ	3300	50-CM-ZZ
C-WM-ECF-HVACS-LGNSYS	LAGOON PUMPHOUSE	3300	UNIT 10
C-WM-ECF-HVACS-LGNSYS-HT1	UNIT HEATER 1, EAST	3300	
C-WM-ECF-HVACS-LGNSYS-HT2	UNIT HEATER 2, WEST	3300	
C-WM-ECF-HVACS-LGNSYS-MT1	MOTOR, UNIT HEATER 1	3300	
C-WM-ECF-HVACS-LGNSYS-MT2	MOTOR, UNIT HEATER 2	3300	
C-WM-ECF-HVACS-MAINTS	MAINTENANCE/MECHANICAL SHOP	3300	UNIT 30
C-WM-ECF-HVACS-MAINTS-HT1	HEATER 1, SOUTH WEST RADIANT UNIT	3300	30-H-6
C-WM-ECF-HVACS-MAINTS-HT2	HEATER 2, SOUTH EAST RADIANT UNIT	3300	30-H-5
C-WM-ECF-HVACS-MAINTS-HT3	HEATER 3, NORTH RADIANT UNIT	3300	30-H-4
C-WM-ECF-HVACS-MAINTS-HT4	HEATER 4, GAS FIRED, ELECTRICAL SHOP	3300	30-H-7
C-WM-ECF-HVACS-MAINTS-MT4	MOTOR, HEATER 4	3300	
C-WM-ECF-HVACS-TIPFLR	TIP FLOOR BUILDING	3300	UNIT 20
C-WM-ECF-HVACS-TIPFLR-AH11	AIR MAKE UP UNIT 11, N TIP FLOOR ROOFTOP	3300	20-H-11
C-WM-ECF-HVACS-TIPFLR-AH13	AIR MAKE UP UNIT 13, TIP FLOOR ROOFTOP	3300	20-H-13
C-WM-ECF-HVACS-TIPFLR-AH17	AIR MAKE UP UNIT 17, S TIP FLOOR ROOFTOP	3300	20-H-17
C-WM-ECF-HVACS-TIPFLR-AH3	AIR MAKE UP, UNIT 3, TIP FLOOR	3300	20-H-3
C-WM-ECF-HVACS-TIPFLR-AH55	AIR MAKE UP UNIT 55, TUNNEL ROOFTOP	3300	20-H-55
C-WM-ECF-HVACS-TIPFLR-AM11	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TIPFLR-AM13	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TIPFLR-AM17	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TIPFLR-AM3	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TIPFLR-AM55	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TIPFLR-FN12A	EXHAUST FAN 12A, NW CORNER 2ND FL INLINE	3300	20-C-12A
C-WM-ECF-HVACS-TIPFLR-FN12B	EXHAUST FAN 12B, SW CORNER 2ND FL INLINE	3300	20-C-12B
C-WM-ECF-HVACS-TIPFLR-HT10	HEATER 10, GAS FIRED RADIANT IN CEILING	3300	20-H-10
C-WM-ECF-HVACS-TIPFLR-HT12	HEATER 12, GAS FIRED RADIANT IN CEILING	3300	20-H-12
C-WM-ECF-HVACS-TIPFLR-HT14	HEATER 14, GAS FIRED RADIANT IN CEILING	3300	20-H-14
C-WM-ECF-HVACS-TIPFLR-HT15	HEATER 15, GAS FIRED RADIANT IN CEILING	3300	20-H-15
C-WM-ECF-HVACS-TIPFLR-HT16	HEATER 16, GAS FIRED RADIANT IN CEILING	3300	20-H-16
C-WM-ECF-HVACS-TIPFLR-HT18	HEATER 18, GAS FIRED RADIANT IN CEILING	3300	20-H-18

Client provided Equipment list - Dated 12-1-2017

Functional Loc.	Description	Planning plant	Sort field
C-WM-ECF-HVACS-TIPFLR-HT19	HEATER 19,S GAS FIRED RADIANT IN CEILING	3300	20-H-19
C-WM-ECF-HVACS-TIPFLR-HT4	UNIT HEATER 4, TIP FLOOR	3300	20-H-4
C-WM-ECF-HVACS-TIPFLR-HT5	UNIT HEATER 5, TIP FLOOR	3300	20-H-5
C-WM-ECF-HVACS-TIPFLR-HT52	UNIT HEATER 52, TIP FLOOR	3300	20-H-52
C-WM-ECF-HVACS-TIPFLR-HT53	UNIT HEATER 53, TIP FLOOR	3300	20-H-53
C-WM-ECF-HVACS-TIPFLR-HT54	UNIT HEATER 54, TIP FLOOR	3300	20-H-54
C-WM-ECF-HVACS-TIPFLR-HT56	UNIT HEATER 56, N TUNNEL CEILING MOUNT	3300	20-H-56
C-WM-ECF-HVACS-TIPFLR-HT57	UNIT HEATER 57, N TUNNEL CEILING MOUNT	3300	20-H-57
C-WM-ECF-HVACS-TIPFLR-HT6	UNIT HEATER 6, TIP FLOOR TUNNEL	3300	20-H-6
C-WM-ECF-HVACS-TIPFLR-HT7	UNIT HEATER 7, TIP FLOOR TUNNEL	3300	20-H-7
C-WM-ECF-HVACS-TIPFLR-HT8	HEATER 8, N GAS FIRED RADIANT IN CEILING	3300	20-H-8
C-WM-ECF-HVACS-TIPFLR-HT9	HEATER 9, GAS FIRED RADIANT IN CEILING	3300	20-H-9
C-WM-ECF-HVACS-TIPFLR-MT11	MOTOR , AIR MAKE UP UNIT 11	3300	20-HM-11
C-WM-ECF-HVACS-TIPFLR-MT12A	MOTOR, EXHAUST FAN 12A	3300	20-CM-12A
C-WM-ECF-HVACS-TIPFLR-MT12B	MOTOR, EXHAUST FAN 12B	3300	20-CM-12B
C-WM-ECF-HVACS-TIPFLR-MT13	MOTOR , AIR MAKE UP UNIT 13	3300	20-HM-13
C-WM-ECF-HVACS-TIPFLR-MT17	MOTOR , AIR MAKE UP UNIT 17	3300	20-HM-17
C-WM-ECF-HVACS-TIPFLR-MT3	MOTOR , AIR MAKE UP UNIT 3	3300	20-HM-3
C-WM-ECF-HVACS-TIPFLR-MT4	MOTOR, UNIT HEATER 4	3300	20-HM-4
C-WM-ECF-HVACS-TIPFLR-MT5	MOTOR, UNIT HEATER 5	3300	20-HM-5
C-WM-ECF-HVACS-TIPFLR-MT52	MOTOR, UNIT HEATER 52	3300	20-HM-52
C-WM-ECF-HVACS-TIPFLR-MT53	MOTOR, UNIT HEATER 53	3300	20-HM-53
C-WM-ECF-HVACS-TIPFLR-MT54	MOTOR, UNIT HEATER 54	3300	20-HM-54
C-WM-ECF-HVACS-TIPFLR-MT55	MOTOR , AIR MAKE UP UNIT 55	3300	20-HM-55
C-WM-ECF-HVACS-TIPFLR-MT56	MOTOR, UNIT HEATER 56	3300	20-HM-56
C-WM-ECF-HVACS-TIPFLR-MT57	MOTOR, UNIT HEATER 57	3300	20-HM-57
C-WM-ECF-HVACS-TIPFLR-MT6	MOTOR, UNIT HEATER 6	3300	20-HM-6
C-WM-ECF-HVACS-TIPFLR-MT7	MOTOR, UNIT HEATER 7	3300	20-HM-7
C-WM-ECF-HVACS-TIPFLR-VF12A	VFD, EXHAUST FAN 12A	3300	
C-WM-ECF-HVACS-TIPFLR-VF12B	VFD, EXHAUST FAN 12B	3300	
C-WM-ECF-HVACS-TRMBLD	TROMMEL BUILDING	3300	UNIT 30
C-WM-ECF-HVACS-TRMBLD-AH3	AIR MAKE UP, UNIT 3, TROMMEL BLD	3300	30-H-3
C-WM-ECF-HVACS-TRMBLD-AM3	FLAGGED FOR DELETION	3300	
C-WM-ECF-HVACS-TRMBLD-HT60	UNIT HEATER 60, NORTH EAST WALL MOUNT	3300	30-H-60
C-WM-ECF-HVACS-TRMBLD-HT61	UNIT HEATER 61, NORTH WEST WALL MOUNT	3300	30-H-61
C-WM-ECF-HVACS-TRMBLD-HT62	UNIT HEATER 62	3300	30-H-62
C-WM-ECF-HVACS-TRMBLD-HT63	UNIT HEATER 63, WEST WALL MOUNT	3300	30-H-63
C-WM-ECF-HVACS-TRMBLD-HT63A	UNIT HEATER 63A	3300	30-H-63A
C-WM-ECF-HVACS-TRMBLD-HT63B	UNIT HEATER 63B, SOUTH WALL MOUNT	3300	30-H-63B
C-WM-ECF-HVACS-TRMBLD-HT77	UNIT HEATER 77,REJECTS LOADOUT BUILDING	3300	30-H-77
C-WM-ECF-HVACS-TRMBLD-HT78	UNIT HEATER 78,REJECTS LOADOUT BUILDING	3300	30-H-78
C-WM-ECF-HVACS-TRMBLD-MT3	MOTOR, AIR MAKE UP UNIT 3	3300	30-HM-3
C-WM-ECF-HVACS-WAREHS	WAREHOUSE BUILDING	3300	UNIT 20
C-WM-ECF-HVACS-WAREHS-HT20	HEATER 20, GAS FIRED, RADIANT,CEILING	3300	20-H-20
C-WM-ECF-HVACS-WAREHS-HT21	HEATER 21, GAS FIRED, RADIANT,CEILING	3300	20-H-21

Appendix E Assessor Qualifications

Michael Just C.E.T

Project Manager / Facility Assessor

Stantec

Michael has over 19 years of experience in Facility operation management of high performance sport facilities and 7 years of consulting experience in the fields of facility assessment, capital planning, technical writing, assessment input and project management. While at Stantec he has been working as a Project Manager and Field Assessor focusing on the physical assessment of commercial, residential and industrial properties for various clienteles, including financial institutions, property owners/developers, real estate investment trusts, government-related entities, and other clients for mortgage financing, acquisition/disposition due diligence, and capital renewal purposes. His projects have provided physical assessment of capital components for over 500 properties. Michael is also a Level 1 Certified Building Investigations Thermographer utilizing Infrared technology to analyze building envelope assemblies.

EDUCATION

Diploma, Engineering Technology, Southern Alberta Institute of Technology (SAIT), Calgary, Alberta, 1981

R-2000 Energy Audit Certification, Calgary, Alberta, 2003

EDR Parcel Platform, Property Due Diligence software training, Calgary, Alberta, 2010

ReCAPP Certified Data Validator, V2.0, Altus Capital Planning, Capital Planning Solutions, Markham, Ontario, 2010

Roof Technology & Science, RCI Roofing Contractors Institute, Calgary, Alberta, 2010

CERTIFICATIONS & TRAINING

Building Investigations Thermographer Level 1, Infrared Training Centre, FLIR Canada, Burlington, Ontario, 2014

AIP: Fall Protection Compliance CSA Z259-16T04, Calgary, Alberta, 2014

Enform: H2S Alive, Calgary, Alberta, 2014

Oil Sands Safety Training Association (OSSA): Confined Space Entry and Monitor, Calgary, Alberta, 2015

Oil Sands Safety Training Association (OSSA): Fall Protection, Calgary, Alberta, 2015

Oil Sands Safety Training Association (OSSA): Regional Orientation Program, Calgary, Alberta, 2014

Alberta Construction Safety Association: Construction Safety Training System CSTS-09, Calgary, Alberta, 2014

St. John Ambulance Standard First Aid: CPR and AED, Calgary, Alberta, 2014

REGISTRATIONS

Certified Engineering Technologist, The Association of Science and Engineering Technology Professionals of Alberta

MEMBERSHIPS

Associate Member, Building Owners Manufacturers Association (Calgary)

Corporate Member, RCI, Inc.

Corporate Member, Alberta Building Envelope Council South

Professional Member, The Association of Science and Engineering Technology Professionals of Alberta

Michael Just C.E.T

Project Manager / Facility Assessor

PROJECT EXPERIENCE

Building Condition Assessments

Agropur, Diamond City, Alberta (Field Assessor/Building Envelope Thermographer)

Stantec was retained to conduct a building envelope investigation of a commercial cheese production facility, to determine the performance of the building envelope and determine the cause(s) of condensation occurring during production operations. The time sensitive assessment entailed interviews with management and production staff, review of building HVAC systems and components, testing of indoor environment conditions and using infrared thermography to analyze the structures building envelope assemblies. The findings and recommendations were presented to Agropur's senior management for potential implementation.

WestJet Airlines, Calgary, Alberta (Field Assessor)

Stantec was commissioned by WestJet to conduct a capital renewal plan for the WestJet Campus facility located in Calgary, Alberta. The property is developed with a 315,000 square foot office building used as the company's corporate headquarters and a 195,000 square foot hangar which supports the airlines flight operations and maintenance. The purpose of the assessment was to visually review and obtain information relative to the current condition of the campus buildings and related site components, as part of their annual business planning in order to set aside funds for infrastructure renewal projects

CIBC, Lethbridge, Alberta (Field Assessor)

Stantec was retained by CIBC to conduct a building envelope investigation of two CIBC buildings to determine corrective action to prevent water intrusion from reoccurring and provide general recommendation. Stantec coordinated with the client's representative and their contractor for the planned on-site activities which included destructive investigation, corrective repairs and water flood testing. Infra-red Thermography was also used to evaluate the facilities' building envelope performance in the areas related to the moisture intrusion.

Property Condition Assessments, Various Cities, Alberta, British Columbia, Saskatchewan (Project Coordinator / Field Assessor)

Stantec has been retained by various investment management groups to complete property condition assessments (PCAs) of commercial, light industrial and institutional properties in Alberta, British Columbia, and Saskatchewan. Types of properties included strip and enclosed shopping malls, warehouses, light industrial operations. These assessments are carried out for the purpose of refinancing and corporate acquisitions. Potential liability issues identified include replacement requirements, deferred maintenance and repairs of structural, site, building envelope, mechanical and electrical and life safety components. Reviews of building components and site improvements were conducted, and findings/recommendations are presented using PARCEL® Asset Validation Survey software.

Education Centre, Calgary, Alberta (Field Assessor / Building Envelope Thermographer)

Stantec was retained in 2012 by GWL Realty Advisors Inc. to conduct a property condition assessment of a commercial building in downtown Calgary, Alberta, for acquisition due diligence purposes. The assessment entailed a review of building systems and components by a team of internal specialists. Infrared Thermography was also performed by Mr. Just to analyze the condition of the structures building envelope assemblies under the direction of a building envelope specialist.

Enbridge Pipelines Inc., Various Sites, Alberta, Manitoba, Saskatchewan (Field Assessor)

Stantec was commissioned by Enbridge to conduct property Condition Assessment at five remote sites situated throughout Alberta, Saskatchewan and Manitoba. The properties are used to support the pipeline terminal operations. The purpose of the assessment was to visually review and obtain information relative to the current condition of the terminal buildings and related site components, and to establish requirements with respect to capital replacement of the buildings and related systems.

** denotes projects completed with other firms*

Michael Just C.E.T

Project Manager / Facility Assessor

Shell Energy, Albian Sands, Fort McMurray, Alberta (Field Assessor/Building Envelope Thermographer)

Stantec was commissioned by Shell to conduct a property Condition Assessment at the Shell Albian Sands Village facility situated 23 km east of Fort Mackay. The Albian Village is a hotel-type facility that contains 2460 accommodation units, a kitchen and dining facility and support services for operations staff for the Shell Albian Sands Project. The purpose of the assessment was to visually review and obtain information relative to the current condition of the Albian Sands Village Core building, Dormitories and related site components, and to establish requirements with respect to maintenance, repair, and capital replacement. Infra-red Thermography was also used to evaluate the facilities' building envelope performance.

Suncor Energy Services, Various Locations near Fort McMurray, Alberta (Field Assessor/Building Envelope Thermographer)

Stantec was commissioned by Suncor Energy to conduct property Condition Assessments at the Borealis Lodge, Mackay River Lodge, Firebag Village and Pioneer Lodge situated near Fort McMurray. The Lodges are hotel-type facilities that contain between 200 and 2300 accommodation units, a kitchen and dining facility and support services for operations staff for the Suncor Energy Project. The purpose of the assessment was to visually review and obtain information relative to the current condition of the lodges and related site components, and to establish requirements with respect to maintenance, repair, and capital replacement. Infra-red Thermography was also used to evaluate the facilities' building envelope performance.

City of Calgary – Recreation Facilities, Calgary, Alberta (Field Assessor/Building Envelope Thermographer)

Stantec is retained by The City of Calgary Recreation Department in Calgary, Alberta, to prepare Capital Renewal Plan reports of their Recreation facilities which included Sportsplexes, Ice Arenas, and Pools. The reports are prepared using internal templates and assist the City of Calgary with planning for future major repairs or replacements to the complexes' infrastructure. Infrared Thermography was used to assist with evaluation of the building envelope components.

City of St. Albert – Building Condition Assessments, St. Albert, Alberta (Field Assessor/Building Envelope Thermographer)

Stantec was retained by The City of St. Albert in St. Albert, Alberta, to perform a Building Condition Assessments (BCA) of the city owned Fountain Park Recreation Centre. The BCA was used to provide the City with information relative to building systems and their general physical condition, as well as recommendations and corresponding costs to address deferred maintenance needs, preventative maintenance requirements and future anticipated capital renewal work. Infrared Thermography was used to assist with evaluation of the building envelope components.

City of Red Deer – Building Condition Assessment, Red Deer, Alberta (Field Assessor)

Stantec was retained by The City of Red Deer in Red Deer, Alberta, to prepare a Building Condition Assessment (BCA) report of specific properties purchased by the City. The purpose of the BCA was to provide an opinion of the physical condition of the site's major facility systems, opinion of costs to address physical deficiencies, and renewal of base building systems and exterior site components over a 25-year period. Additional opinions for potential upgrades, including costs, to meet current code requirements, standards, and regulations were also provided. The BCA was used to assist the City in developing a Capital Repair Plan for the Sites.

City of St. Albert – Roof Assessments for Potential Solar Panel Installation, St. Albert, Alberta (Field Assessor)

Stantec was retained by The City of St. Albert in St. Albert, Alberta, as part of a solar panel project, to provide roof condition assessments and estimates of expected remaining service life (RSL) based on year of installation and current conditions observed of roofs on three (3) of the city owned buildings. The buildings include Fountain Park Recreation Centre, Servus Place Leisure Centre and the St. Albert Transit Garage. The roof condition assessment was part of a proposal which includes structural engineering services to determine the feasibility of placing solar panels on the previously mentioned building's roofs.

** denotes projects completed with other firms*

Michael Just C.E.T

Project Manager / Facility Assessor

City of Calgary - Community Association Capital Renewal Plans, Calgary, Alberta (Field Assessor)

Stantec is retained by community associations in Calgary, Alberta, to prepare Capital Renewal Plan reports of their building and site assets. The reports are prepared using internal templates and assist the community associations to understand the condition of their assets, and to apply for infrastructure renewal grants through the City of Calgary's Capital Conservation Grant program

City of Spruce Grove – TransAlta Tri Leisure Facility Maintenance and Lifecycle Plan Development, Spruce Grove, Alberta (Field Assessor)

Stantec was retained by The City of Spruce Grove in Spruce Grove, Alberta, to prepare a Maintenance and Lifecycle Plan strategy for the TransAlta Tri Leisure Facility (TLC) focused on preventative maintenance and lifecycle cost and strategy to assure all assets achieve the maximum life expectancy. The key stakeholders in this project not only included the city, but the TLC administration, Board, Parkland County, and the Town of Stony Plain.

City of Calgary, 2013 Flood, Building Condition Assessments, Calgary, Alberta (Field Assessor)

Stantec was retained by the City of Calgary to assess the damages caused to Municipally owned buildings, by a significant river flood event in the city of Calgary. Some of the properties assessed consisted of The City of Calgary Old Town Hall, Municipal and Administration office complex, and the City of Calgary Trade Centre. The assessments provided the City of Calgary an understanding of the general condition and capital replacement requirements. The BCAs were used to assist the City in developing a Capital Repair Plan for the Sites

Town of Okotoks, Construction Observation, Inspections and Reporting, Okotoks, Alberta (Field Assessor)

Stantec was retained by The Town of Okotoks in multiple years to conduct a pre and post-construction survey of a historical heritage residential building in Okotoks, Alberta as result of utility construction activities being completed adjacent to the property. The purpose of the Survey was to document a general visual overview and pictorial recording of the pre-construction and post-construction conditions of the building's structural and building envelope components.

Government of Alberta, Alberta Infrastructure Facility Evaluations, Various Locations, Alberta (Field Assessor/Task Manager)

Stantec has been retained by Alberta Infrastructure annually since 2004 to act as a Prime Consultant for their facility evaluation program, which includes the assessment of various government-owned and operated properties located across Alberta for capital planning purposes. Facilities included Schools, Universities, Hospitals, Seniors Care Facilities and Lodges, Government Administration Buildings, Court Houses, and Maintenance facilities. Facility Evaluation reports are prepared using ReCAPP® & VFA Validation Survey software.

City of Edmonton Building Condition Assessment, Edmonton, Alberta (Field Assessor)

Stantec was retained by the City of Edmonton to provide detailed a Building Condition Assessment of a City-owned and tenant operated property at the Edmonton Municipal Recycling Facility to provide an understanding of the general condition and capital requirements over the next ten years.

AgeCare Facilities, Various Cities, Alberta (Field Assessor)

Stantec was commissioned by AgeCare Investments Ltd. To prepare a Capital Renewal Plan for six long-term and retirement residence facilities.

Royal Alexandra Hospital, Edmonton, Alberta (Field Assessor)

Stantec was commissioned by Alberta Infrastructure to perform an assessment of the Royal Alexandra Hospital Complex in Edmonton for capital planning purposes. Facility Evaluation reports are prepared using ReCAPP® Validation Survey software.

City of Calgary,, Calgary, Alberta (Field Assessor)

Stantec was commissioned by the City of Calgary to visually review the present condition of the hazardous waste storage buildings at the East Calgary Waste Management Facility and provide cots to repair or replace building systems/components resulting from assessment recommendations.

** denotes projects completed with other firms*

Michael Just C.E.T

Project Manager / Facility Assessor

Imperial Oil – Strathcona Refinery, Edmonton, Alberta (Field Assessor)

Stantec was commissioned by Imperial Oil (IOL) to perform a Building Condition Assessment of the Administration Building and Annex. The Buildings are part of the larger Strathcona Refinery site. The purpose of the assessment was to provide an opinion of the overall physical condition of the building and recommendations regarding age-related building concerns as well as safety issues and compliance with the Alberta Building Code.

Scott Builders, Red Deer, Alberta (Field Assessor)

Stantec was retained to conduct a HPTB Ventilation Review investigation of an industrial equipment maintenance facility constructed by Scott Builders and owned and operated by Schlumberger. Field information was gathered to assess the operational performance of the ventilation system and provide design parameters of HVAC upgrades to the client.

Suncor Energy Services, Fort McMurray, Alberta (Field Assessor / Building Envelope Thermographer)

Stantec was commissioned by Suncor Energy to conduct a property Condition Assessment at the Millennium Lodge situated at Fort McMurray. The Millennium Lodge is a hotel-type facility that contains 1564 accommodation units, a kitchen and dining facility and support services for operations staff for the Suncor Energy Project. The purpose of the assessment was to visually review and obtain information relative to the current condition of the Lighthouse Lodge and related site components, and to establish requirements with respect to maintenance, repair, and capital replacement. Infra-red Thermography was also used to evaluate the facilities' building envelope performance.

Husky Energy, Fort MacKay, Alberta (Field Assessor / Building Envelope Thermographer)

Stantec was commissioned by Husky Energy to conduct a property Condition Assessment at the Lighthouse Lodge. The Lighthouse Lodge is a hotel-type facility that contains 1,475 accommodation units for operations staff for the Sunrise Energy Project. The purpose of the assessment was to visually review and obtain information relative to the current condition of the Lighthouse Lodge and related site components, and to establish requirements with respect to maintenance, repair, and capital replacement. Infra-red Thermography was also used to evaluate the facilities' building envelope performance.

Loblaw IPO Building Condition Assessments (Field Assessor)

Stantec was retained by Loblaw Properties Limited to conduct Building Condition Assessments of approximately 460 properties located across Canada. The assessments, along with other services offered by Stantec, were conducted as part of the due diligence process for the issuance of an Initial Public Offering (IPO) for a new Real Estate Investment Trust into which the properties' ownership was transferred. The Building Condition Assessment reports were prepared using iPlanTM, a Capital Asset Management system developed by 4tellTM Solutions.

Housing Co-operative Assessments and Capital Replacement Reserve Fund Studies (Field Assessor/Project Manager)

Since 2008, Stantec is retained by property management firms, housing co-operative board members, and the Agency for Co-operative Housing to conduct Building Condition Assessments and Capital Replacement Reserve Fund Studies of multi-family housing co-operatives, which are located in western Canada. Recommendations for improved funding of existing replacement reserve funds are provided using internal template reports to offset anticipated capital costs over a given evaluation period, while taking into account the effects of interest and inflation.

Nunavut Asset Facility Condition Assessments (Field Assessor / Task Manager)

Stantec assessed approximately 1,000 government and hamlet owned buildings and sites for the Government of Nunavut. The assessments were used to update the Government's existing asset database with current information obtained from assessment site visits. The portfolio included buildings ranging from fire halls to multiplex residential structures, as well as sites that included fuel farms, water reservoirs, sanitation facilities and breakwaters. The information obtained from the assessments was organized using a ReCAPP® Asset Validation Survey software database that the Government could use to prioritize repair and replacement events.

City of Edmonton Building Condition Assessment, Edmonton, Alberta (Field Assessor)

Stantec was retained by the City of Edmonton to provide detailed a Building Condition Assessment of a City-owned and tenant operated property at the Edmonton Municipal Recycling Facility to provide an understanding of the general condition and capital requirements over the next ten years.

** denotes projects completed with other firms*

Michael Just C.E.T

Project Manager / Facility Assessor

EPCOR Utilities, Edmonton, Alberta (Field Assessor / Building Envelope Thermographer)

Stantec was retained by EPCOR to conduct Building Condition Assessments of Service Centres and Electrical Substations. The project was conducted for capital planning purposes and provided an understanding of the capital requirements for each asset over the next ten years. Infrared Thermography was also used to analyze the condition of the structures building envelope assemblies.

Aeroterm Hangar - Property Condition Assessments, Abbotsford, British Columbia (Project Manager / Field Assessor)

Stantec was retained by Aeroterm Management Company to complete a property condition assessment (PCA) of a 231,000 sq. ft. commercial aircraft maintenance facility in Abbotsford, B.C.. The assessment was carried out for the purpose of capital planning and corporate acquisition. Potential liability issues identified include replacement requirements, deferred maintenance and repairs of structural, site, building envelope, mechanical and electrical and life safety components. Reviews of maintenance records, building components and site improvements were conducted, and findings/recommendations are presented using PARCEL® Asset Validation Survey software.

Residential Grow Operations Building Condition Assessment, Calgary, Alberta (Field Assessor)

Stantec was retained by Home Alone Property Management to conduct Property Condition Assessments of numerous residential buildings formerly found to be marijuana grow operations. The buildings were assessed for site, structural, building envelope, mechanical and electrical conditions in conjunction with an intrusive mould assessment. The reports were presented to the financial institution holding the mortgage on the property.

Canadian Imperial Bank of Commerce (CIBC) Building Condition Assessments (Field Assessor)

Building Condition Assessments of nearly 500 CIBC branches located across Canada was provided by Stantec in multiple phases between 2010 and 2013. In each phase, Stantec provided a five-year capital plan based on site assessment visits that were prepared using client-provided reporting templates. The assessments were used as a first step for a broader scope of renewal work, which included program planning, specification development, construction inspection, and commissioning.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Brad has spent over 25 years in the electrical industry prior to joining Stantec in April 2008. Building on his strong technical background, he currently serves as an electrical designer for a wide variety of educational and institutional projects.

Brad's project experience spans all phases of electrical consulting including administration, determining scope and construction costs for projects, the evaluation of building systems, fire alarm (data networks/testing) installation and verification, preparation and administration of contract documents, specification writing and design calculations.

EDUCATION

Certification, Fire Alarm Intelligibility Testing Course, Edmonton, Alberta, 2016

Construction Contract Administration - Specifier 1, Construction Specifications Canada, Edmonton, Alberta, 2013

Principles of Construction Documentation, Construction Specifications Canada, Edmonton, Alberta, 2012

Accreditation, Northern Alberta Institute of Technology (NAIT), Certified Electrical Engineering Technologist, Alberta, 1991

Journeyman Electrician / Inter Provincial Certificate, Northern Alberta Institute of Technology (NAIT), Edmonton, Alberta, 1983

Alarm Systems Certification, Northern Alberta Institute of Technology (NAIT), Edmonton, Alberta, 1986

Electrical Estimating Course, Northern Alberta Institute of Technology (NAIT), Edmonton, Alberta, 1989

Siemens Certified Data Designer, Edmonton, Alberta, 2003

Electrical Masters, Northern Alberta Institute of Technology, Edmonton, Alberta, 1985

REGISTRATIONS

Certified Engineering Technologist #10578, The Association of Science and Engineering Technology Professionals of Alberta

PROJECT EXPERIENCE

Commercial / Retail Development

Stanley A. Milner Library Edmonton Public Library Mechanical ventilation

Completed electrical design and specifications on a mechanical system ventilation replacement using new "Fan Wall" technology. Project included VFD Drive system, service upgrade, Normal and emergency power distribution.

Zellers stores re-development to new Walmart Super Centers (One year project)

Electrical redevelopment of existing store spaces and existing electrical system design, specifications and implementation (Contract Administrations) of Five (5) Edmonton stores and one (1) British Columbia store in Prince Rupert.

RioCan Meadows, Edmonton, Alberta (Electrical Consultant)

Completed the electrical design for the CIBC located in the new RioCan development in the Meadows area.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Mac's Convenience Store, High Level, Alberta (Assessor)
Conducted a due diligence report of the Mac's convenience store. Report was to assess the electrical building systems from video camera systems to building security and electrical distribution equipment.

APEGA, Scotia Place, Tenant Redevelopment, Edmonton, Alberta
This project encompassed four floors of office space design. Electrical systems for the design included power distribution, low voltage systems including card access systems, network cabling, tenant lighting and control, and life safety systems including exit signs, emergency lighting and fire roll shutter systems for stair wells. Design areas included open and closed offices, conference rooms and data server rooms. Preliminary site reviews were conducted to obtain as-built electrical plans and design drawings. Contract administration was conducted by the electrical lead, and design review was conducted by the project engineer.

AEMERA Tenant Redevelopment, 9888 Jasper Ave Tower, Edmonton, Alberta
This project encompassed three floors of office space design. Electrical systems for the design included power distribution, low voltage systems including card access systems, network cabling, tenant lighting and control, and life safety systems including exit signs and emergency lighting. Design areas included open and closed offices, conference rooms, and data server rooms. Preliminary site reviews were conducted to obtain as-built electrical plans and design drawings. Contract administration was conducted by the electrical lead, and design review was conducted by the project engineer.

Dr. Farhat Medical Clinic, College Plaza, Edmonton, Alberta
Electrical redevelopment of office space for new medical office, electrical system design, specifications and implementation (Contract Administration).

Canada Place AANDC Tenant Space Redevelopment, Edmonton, Alberta
Electrical system design, specifications and implementation (Contract Administration).

Building Condition Assessments

Onoway Sports Arena, Onoway, Alberta (Assessor)
Onoway sports arena assessment of mechanical cooling systems and chiller plant operation for the purpose of a due diligence property condition assessment.

Molson House, Edmonton, Alberta (Assessor)
Completed the building assessment for Molson House a replica of fur trading post located at Molson Brewery. Findings/recommendations in assessment report was to address the code review of the following items: current electrical and life safety systems.

Elementary School - Edmonton, Edmonton, Alberta (Assessor)
Facility assessment of decommissioned Edmonton elementary public school for the purpose of modernizing building for non profit groups and retail and office lease space.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Sunapee Multi-Tenant Building - City of Edmonton, Edmonton, Alberta (Assessor)
Conducted a building condition assessment of the multi-tenant Sunapee complex located in Edmonton. This project was commissioned by the City of Edmonton as part of their long term capital renewal plan and a 20 year maintenance plan of this apartment building.

Okeefe's Brewery Building Assessment, Edmonton, Alberta (Assessor)
Conducted electrical service equipment and power distribution assessment in the Okeefe's Brewery heritage building owned by the City of Edmonton. Also conducted an assessment, within the building structures, of the integrated building systems, fire alarms, security and lighting. Reports were provided to the City to determine costs involved to renovate this building into retail/office space.

Hanger 15 Building Assessment, Edmonton, Alberta (Assessor)
Completed building assessment of Hanger 15 located at Edmonton's municipal airport to determine future building maintenance costs. Also conducted reviews of manufacturing and reconditioning of planes and helicopters. Findings/recommendations in assessment report was to address the code review of the following items: paint boot and production areas of the building and explosion proof equipment used in the hanger.

Lethbridge University Building Assessment, Lethbridge, Alberta (Site Assessor)
Completed on schedule and within budget, the assessment of various buildings on the Lethbridge University campus for capital planning purposes. The project was a combined team initiative to assess building structures ranging from 10,000 to 560,000 square feet. Reviews of building components were conducted, and findings/recommendations were reported using ReCAPP® database technology

University of British Columbia Building Assessment, Vancouver, British Columbia (Assessor)
Completed the assessment of various buildings on the University of British Columbia campus for capital planning purposes. The project was a combined team initiative to assess building systems, within the building structures, including resource labs, containment clean rooms, lecture theaters and interactive classrooms. Reviews of building components were also conducted, and findings/recommendations were reported using ReCAPP® database technology.

Community Institutional

Ellerslie Fire Hall, Edmonton, Alberta (Electrical Designer, Anticipate LEED Silver)
Provided electrical, security and lighting design. Design Development commenced in December 2009.

Edmonton Public Library Relocation, Edmonton, Alberta (Electrical Consultant)
Provided the electrical design for the relocation of the Edmonton Public Library to the main floor of Enterprise Square.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Corporate / Office

Associated Engineering - 9888 Jasper Ave, Edmonton, Alberta (Electrical Consultant and Designer)

Provided electrical, security and lighting design, life safety and AV design. The project covered 3.600 sq. meters of office space renovation which incorporated closed and open office areas, staff rooms, meeting rooms and washroom upgrades. This project had an aggressive schedule with project design starting in June 2015 and issue for construction in August 2015. Prior to the commencement of the design, a complete review of the existing power distribution, low voltage systems, and life safety systems was conducted to obtain as-built electrical plans. Electrical design codes and calculations, drawings and specifications were completed for the tenant, design by the electrical lead, reviewed by the Project Engineer. Contract administration was administered by the electrical lead which included all site revisions.

Palomar Building, Edmonton, Alberta (Electrical Consultant)

Building evaluation.

CGI 5, 6, 7, and 8th Floor of Canadian Western Bank Tower, Edmonton, Alberta (Electrical Consultant)

Electrical redevelopment off office space for new software design office. Scope of project included electrical system design, specifications, and contract administration.

University of Calgary - Enterprise Square, Edmonton, Alberta (Electrical Consultant)

Redevelopment of an existing office space to accommodate the addition of the University of Calgary's satellite office.

Canada Place Western Economic Development (WED), 15th Floor Canada Place, Edmonton, Alberta (Electrical Consultant)

Electrical system design, specifications, and contract administration.

Due Diligence Surveys

Police Server Room - City of Edmonton, Edmonton, Alberta (Assessor)

Conducted a due diligence survey of the City of Edmonton's city police server room equipment and system cooling for the prisoner processing area. Reviews of building components were conducted, and findings/recommendations were reported for area system upgrades that would assist the City of Calgary with its capital renewal and maintenance plans for this facility.

Education

Edmonton Public Library Fan Wall Mechanical Upgrade, Edmonton, Alberta (Electrical Designer)

Edmonton Public Schools, Edmonton, Alberta (Electrical Consultant)

P3 modifications on Strathcona Composite High School and Prince Charles.

University of Lethbridge Building Assessment, Lethbridge, Alberta (Electrical Consultant)

Conducted a facility assessment for several buildings ranging from 10,000 to 560,000 ft² for the University of Lethbridge. Reporting was provided using the ARECAPP Validation Survey reporting system. Project was completed on schedule and within budget.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Remedial Investigations & Assessments

Church Hill Escalators Assessment, Edmonton, Alberta (Assessor)

Conducted assessment of building control systems integrated with video camera operation and escalators. Report was to assess the condition, use and replacement of two platform escalators for the City of Edmonton. Report was used to form a template of future LRT-station requirement and maintenance program requirements throughout the City of Edmonton

Retail

SunLife Place - Light Modelling Review/Report, Edmonton, Alberta

Target Retail Chain, Various Locations, Alberta (Evaluation)

Conducted assessments of various Zeller locations including fire alarms, security and lighting. Reports were provided to Target Corporation to the determine costs involved to renovate and rebrand under its name and logo.

Transit

St. Albert Transit Garage, St. Albert, Alberta (Electrical Consultant)

Building evaluation.

Bay LRT Escalator Replacement, Edmonton, Alberta (Electrical Consultant)

Urban Land

EPCOR Residential Subdivisions, Edmonton, Alberta (Contract Administration)

Provide construction administration services and site inspections for the electrical distribution, street lighting, and installation of CATV and telephone for new subdivisions and roadways. Projects include: Secord 3F (Hopewell Land Corporation), McConachie 2A and 2B (Walton Developments and Management), Laurel 3C and 7, Tamarack 5C , Maple Stage 1 (Lehndorff/Dundee), Orchards 4 (Brookfield Residential), Trumpeter Stage 6, Cameron Heights 11 (DIA Holdings).

Warehouse / Light Industrial

Canada Post Building, Vancouver, BC (Assessor)

Completed a due diligence survey on the electrical and mechanical system components of the building. Results from this survey will be used in recommending necessary system upgrades and capital planning.

Acute Care

Misericordia Hospital - Remodel of Intensive Care Nursing Area, Edmonton, Alberta (Electrical Consultant)

Misericordia Hospital Cabrini Centre – New Nurse Residence, Edmonton, Alberta (Electrical Designer)

Provided the design for the lighting, power distribution, and fire alarm.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

White Court Healthcare Centre, White Court, Alberta (Electrical Consultant)
Completed building assessments of healthcare facility, electrical, mechanical, nurse call, patient monitoring systems, wander guard systems to determine future building maintenance costs. Provided recommendations in assessment reports for the Alberta Infrastructure building data base.

Redevelop of Aerodrome /Heliport for Misericordia Community Hospital, Edmonton, Alberta
Completed electrical design and electrical specifications for the redevelopment of and existing Helipad to comply with The Minister of Transport for Canada with respect to the standards, and conditions set out in Transport Canada standards.

Redevelop of Aerodrome /Heliport for Gray Nuns Community Hospital, Edmonton, Alberta
Completed electrical design and electrical specifications for the redevelopment of and existing Helipad to comply with The Minister of Transport for Canada with respect to the standards, and conditions set out in Transport Canada standards.

Stars Air Ambulance Helicopter Landing Pad - Grey Nuns Hospital, Edmonton, Alberta (Designer)
Provided the lighting design for exterior lighting components for the helicopter landing pad.

Stars Air Ambulance Helicopter Landing Pad - Misericordia Hospital, Edmonton, Alberta (Designer)
Provided the lighting design for exterior lighting components for the helicopter landing pad.

Misericordia Hospital Operating Theatre, Edmonton, Alberta (Designer)
Provided the design for the chillers and freon detection systems.

Stars Air Ambulance Hospital, Edmonton, Alberta (Designer)
Provided lighting design for the facility.

Misericordia ICU Nursery, Edmonton, Alberta (Designer)

Misericordia Community Hospital, Edmonton, Alberta (Electrical Consultant)
Completed building assessment of healthcare facility, electrical distribution, emergency power, mechanical systems, nurse call, patient monitoring systems, wander guard systems, network video surveillance and card access.

Workplace/Office

ASET, 13 Floor Scotia Place Tower, Edmonton, Alberta
This project encompassed office space design. Electrical systems for the design included power distribution, low voltage systems including card access systems, network cabling, tenant lighting and control, and life safety systems including exit signs and emergency lighting. Design areas included open and closed offices, conference rooms, and data server rooms. Preliminary site reviews were conducted to obtain as-built electrical plans and design drawings. Contract administration was conducted by the electrical lead, and design review was conducted by the project engineer.

** denotes projects completed with other firms*

Bradley Herst CET

Electrical Consultant

Justice

Security Room Assessment for Edmonton Women's and Men's Maximum Institution, Edmonton, Alberta (Electrical Consultant)

Conducted assessment of the equipment in the Security Room for both the Women and Men's Maximum Institutions.

Security Room Assessment for Grande Cache Institutions (Electrical Consultant)

Conducted assessment of the equipment in the Security Room at the Grande Cache Institutions.

** denotes projects completed with other firms*

Appendix 3

Process Equipment Assessment – ECF.
Stantec Consulting Ltd. December 12, 2017

PROCESS EQUIPMENT ASSESSMENT - ECF

Edmonton Composting Facility (ECF)
Site 500, 250 Aurum Road NE,
Edmonton, Alberta

Prepared for:

City of Edmonton Integrated Infrastructure Services

12th floor, Edmonton Tower
10111 – 104 Avenue NW
Edmonton, Alberta
T5J 0J4

Prepared by:

Stantec Consulting Ltd.
1100 – 111 Dunsmuir Street
Vancouver, BC
V6B 6A3

December 12, 2017

Sign-off Sheet

This document entitled PROCESS EQUIPMENT ASSESSMENT - ECF was prepared by Stantec Consulting Ltd. ("Stantec") for the account of City of Edmonton (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________________

3/16/2018 (signature)

Alan Dick

Reviewed by ______________________________

Mar 16 | 2018. (signature)

Sharat Chandra

Approved by ______________________________

Mar 19/2018 (signature)

Bruce Ferguson

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the City of Edmonton Integrated Infrastructure Services, (the "Client") to prepare a Process Equipment Assessment (PEA) in support of a long-term Capital Replacement Plan for the facility referred to as the Edmonton Compositing Facility, located at Site 500, 250 Aurum Road NE, Edmonton, Alberta (referred to herein as the "site" or "property").

The purpose of the assessment is to visually review and obtain information relative to the current condition of the major process equipment in the two facilities located on the Edmonton Waste Management Centre (EWMC) namely the Edmonton Composting Facility, and the Materials Recovery Facility (herein referred to as the "Site" or "Properties"), and to establish requirements with respect to a current state assessment including maintenance, repair, and capital replacement. The PEAs are reported separately. The following report is for the Edmonton Composting Facility (ECF).

The purpose of the PEA is to:

(i) provide an opinion of the general age of the site's major process equipment, and

(ii) summarize the current state observation and analysis findings related to process capability, capacity, and throughput.

We understand that the Client requires the PEA report in support of capital planning for infrastructure renewal purposes for the site.

The scope of our work, methodologies used, and limitation of this PEA report are presented in Section 2.0 of this report.

1.2 PROPERTY DESCRIPTION

We understand that Edmonton Composting Facility (ECF) is situated at the municipal Edmonton Waste Management Centre (EWMC) site. The facility is located at Site 500, 250 Aurum Road NE, Edmonton, Alberta.

The ECF, occupies a total area of approximately 416,500 ft2 (38,690 m2). For the purpose of this report, the ECF is comprised of six (6) buildings that are connected to form the Edmonton Composting Facility (ECF). The buildings which house equipment included in the scope of this assessment are:

- Tipping Building (unit 20)
- North Download (unit 30)
- Dewatering Building (unit 10)
- South Download (unit 30)
- Finishing Building (unit 50)

- Aeration Hall Building (unit 40)

1.3 EQUIPMENT DESCRIPTION

We understand that there are two interconnected processing loops that are fundamental to the outputs from the ECF. A biosolids dewatering system, comprised mainly of pumps and centrifuges and a compost aeration and filtration system, comprised mainly of conveyor systems, turners and screens. The biosolids dewatering system, can be broken down into the “Dredge System” and a subsystem to inject polymer, referred herein as the “Polymer System”. The compost aeration and filtration system is divided into two systems, namely the “Aeration System” and the “Finishing Circuit”, respectively. Transport of compost from the tip floor to the Aeration Hall Building is via a conveyor system referred herein as the “Download System”. Each system has an associated unit number, which corresponds to the unit number of the building in which it is housed.

The associated unit numbers for the systems included in the scope of this assessment are:

- Dewatering System (unit 10)
  - Polymer Sub-System (unit 10)
  - Dredge Sub-System (unit 10)
- Download System (unit 30)
- Aeration System (unit 40)
- Finishing Circuit (unit 50)
- Biofilters (unit 61)
- Leachate Collection (unit 63)

Process equipment types are shared between the systems and will be assessed based on both type and area of service. For the purpose of this report, only the equipment agreed upon by Stantec and the COE to be of critical importance within these systems will be included in the assessment.

A full list of all process equipment included in the assessment is attached in Appendix A

2.0 SCOPE, METHODOLOGY AND LIMITATIONS

2.1 SCOPE OF WORK

The scope of our work was based on the scope of services as outlined in Stantec’s proposal letter dated September 18, 2017. The scope of our work included discussions with the site representative(s), a review of pertinent documentation (where provided by the Client or a site representative(s)) and a generalist (i.e., non-specialist) visual “walk-through” assessment of major process equipment at the site to observe and document process and equipment information. The site visit was conducted whilst operations were suspended, so no observations were made with the equipment in running condition.

The major process equipment observed (where applicable) include the following:

- Turners
- Centrifuges
- Screens
- Trommels
- Conveyor Systems
- Motors

The information obtained from discussions with maintenance staff and some existing documentation formed the basis for establishing our opinion of the general condition and capacity of the major process equipment. Discussions with maintenance staff, in conjunction with OEM data, also formed the basis for developing timing to repair or replace systems and components that have already surpassed their EUL, or are anticipated to achieve or surpass their EUL over the next twenty (20) years.

The scope of our work performed is summarized as follows:

- A site visit to the ECF facility to meet with maintenance staff and record observations related to the physical condition of the process equipment.

- Review background information including existing layout, process flow diagrams, mechanical drawings, and throughput data for the last 3 years.

- Review relevant equipment Operations and Maintenance Data (when available).

- Discussions with Original Equipment Manufacturers (OEMs) and suppliers to obtain detailed information about the equipment such as anticipated lifespan, rehabilitation or renewable schedules etc.

- Preparation of a technical report to summarize the current state observation and analysis and findings related to process capability, capacity, and throughput.

The review of mechanical systems and components at the property (where present), included discussions with the site representative(s), and a review of maintenance records when made available by the Client and/or the site representative(s). The visual walk-through assessment was conducted to determine the type of systems and components present, age, and aesthetic condition. No physical tests were conducted.

The PEA includes an assessment of existing components that are currently installed at the site; however, the PEA does not include comments, recommendations or opinions of probable costs for potential "upgrades" or future installation of components that are not currently at the site, or other extraneous amenities. However, recommendations for "Optional" work may be outlined in this report for certain equipment and these have been labeled as such.

2.2 METHODOLOGY

2.2.1 Component Life Expectancy

The systems and components observed during the site visit have been assigned a value for their Expected Useful Life (EUL). This value was used to determine an "event" year for renewal, based on the reported age or Remaining Service Life (RSL) of the system or component. Where this information was unavailable, the age and RSL were estimated based on the system or component's overall reported or observed physical condition. The values for EUL are based on information provided in manufacturer's literature, industry standards, our visual observations, and our experience with similar materials and systems. The values for EUL and RSL have been adjusted to suit our site observations. In certain instances, the EUL and RSL may not have a direct correlation due to circumstances such as the observed condition or nature in which a system or component is utilized.

The EUL of a system or component is a theoretical number that is arrived at with much estimation and is a function of the quality of materials used, manufacturing and installation, as well as the frequency and intensity of service, the degree of maintenance afforded to the system or component, and local weather conditions. Also, the realization of a system or component's EUL does not necessarily constitute its replacement. A detailed condition assessment or investigation may be a more prudent approach which may indicate a need for maintenance or refurbishment only, or may indicate adequate physical condition for an extended period.

Some systems or components have been assumed to have "indefinite" life expectancy as compared to the relative life of others. From time to time, localized repairs may be required due to deterioration or vandalism, which are assumed to be handled as part of ongoing maintenance.

2.2.2 Equipment Availability and Throughput

Equipment availability and throughput data for the last three (3) years provided by the Client has been summarized in this report. Throughput values for a facility are a factor of runtime, equipment capacity, and overall plant dynamics. As all plant equipment is inherently linked, the throughput data reported for one system may not be directly indicative to the overall efficiency of that system. Furthermore, varying composition and quality of material feeds will play a role in throughput volume and adherence to non-variable KPIs. A detailed throughput analysis including material audit data may be a more prudent approach which may indicate the need for equipment upgrade or system re-design. The data summarized herein is intended to serve as a benchmark for future analysis, and help identify potential areas which may be useful to guide a future needs assessment.

2.2.3 Independent Survey

In the absence of relevant qualitative data to support the conclusions of the current state assessment, Stantec developed a survey as one method of validating both observed and communicated information regarding equipment condition, age, functionality, capacity, failure rate, and criticality. This eight (8)-question multiple choice equipment condition survey, referred to herein as "Survey" was completed by sixteen employees of both the City of Edmonton and the contractor, SUEZ, that oversees the operation and maintenance of the facility. The Survey results were averaged over all participants and included in Appendix B, along with a list of all participants.

2.3 LIMITING CONDITIONS

Exclusive Use

This report, including its information and opinions, has been prepared for the exclusive and sole use of the City of Edmonton Integrated Infrastructure Services (the "Client").

Reliance Purposes

This report shall not be relied upon for any purpose other than intended for the Client within the scope of services negotiated between Stantec Consulting Ltd. (Stantec) and the Client without the express prior written consent of Stantec.

Third Party Reliance

This report may not be relied upon by any other person or entity without the express written consent of Stantec and the Client. Any reliance on this report by a third party, any decisions that a third party makes based on this report, or any use at all of this report by a third party without the prior written consent of Stantec is the sole responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

Distribution

No party shall distribute this report, in its final form or in draft form, or any portion or copy thereof without the express written permission of Stantec, except that the Client may make copies of this report as are reasonable for its own use and consistent with the intended purposes of this report.

Physical Limitations to Scope

Stantec's work did not include intrusive testing/investigation, destructive testing, testing of life safety systems or quantitative testing. As such, any recommendations and opinions of cost associated with these recommendations, as presented in this report, are based on walk-through non-invasive observations of the parts of the building(s) which were readily accessible during a visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report.
Opinions of cost presented in this report are also based on information received during interviews with site representatives, operations and/or maintenance staff. Stantec cannot be held responsible for incorrect information received during the interview process. Should additional information become available with respect to the condition of the building(s) and/or site elements, Stantec requests that this information be brought to our attention so that Stantec may reassess the conclusions presented herein.

Assessments

No legal surveys, soil tests, environmental assessments, geotechnical assessments, barrier-free compliance assessments, seismic assessments, detailed engineering calculations, or quantity surveying compilations have been made. No responsibility, therefore, is assumed concerning these matters. Stantec did not design or construct the building(s) or related structures and therefore will not be held responsible for the impact of any design or construction defects, whether or not described in this report. No guarantee or warranty, expressed or implied, with respect to the property, building components, building systems, property systems, or any other physical aspect of the property is made.

Standard of Care

The assessment outlined in this report generally captured conditions that existed at the time of the site visit. Stantec's opinions and recommendations presented in this report are rendered in accordance with generally accepted professional standards for like services under like circumstances for similar locales. The opinions and recommendations are not to be construed as a warranty or guarantee regarding existing or future physical conditions or regarding compliance of systems/components and procedures/operations with the various regulating codes, standards, regulations, ordinances, etc.

3.0 MAJOR PROCESS EQUIPMENT ASSESSMENT

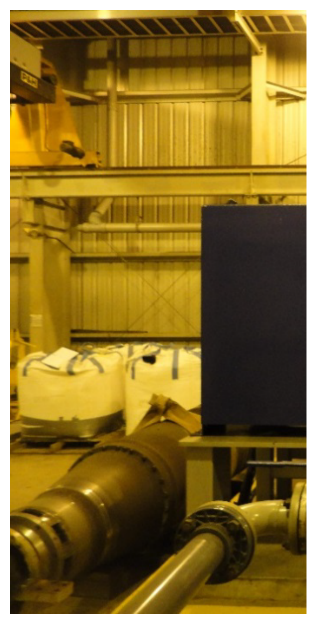
3.1 CENTRIFUGE UNITS

Description

There are three (3) centrifuges in the Dewatering System (unit 10) responsible for separating the solids from the biosolids pumped from the dredge. Inside the centrifuge housing is a horizontal cylindrical bowl equipped with a screw conveyor. The feed enters the bowl through a stationary inlet tube and centrifugal forces within the rotating bowl cause the solids to collect on the wall of the bowl. The rotating screw conveyor rotates at a different speed than the bowl, collecting the solids and pushing them towards the conical end of the bowl, and out through the discharge. The centrifuges are equipped with a motor, gearbox and VFD. These are called "Decanter" centrifuges, and are designed particularly for the waste management industry.

Two (2) of the centrifuge units 10-F-1 and 10-F-2, known also as Centrifuge A and Centrifuge B respectively, are type DS706 manufactured by Alpha Laval and installed during original construction in 2000. They each have a rated capacity of 50 m^3/h, but are understood to leak when operated beyond 45m^3/h.

One (1) centrifuge 10-F-3, known as Centrifuge C, is type G2, also manufactured by Alpha Laval and was added in 2014. The G2 is a newer model of similar design and functionality to the DS706. It has a rated capacity of 65 m^3/hr, but is understood to have major leakage when operated beyond 50m^3/h.



Picture 3-1 (left) View of Centrifuge C with lid removed (bottom left) for annual maintenance.

Picture 3-2 (right) View of the centrifuge internal rotating assembly taken out for annual servicing and laid on the floor (bottom left)

Findings

All Centrifuge units undergo annual maintenance performed by the OEM (Alfa Laval), with SUEZ assistance. Bearings and wear parts are replaced as needed and provided by the OEM. No abnormal frequency of maintenance has been reported for centrifuges A and B. Survey results suggest that these centrifuges will require unplanned corrective maintenance between 1-5 times per year.

It has been communicated by SUEZ that there have been an influx of problems and significantly higher servicing and repair costs seen in Centrifuge C. Survey results, attached in Appendix B, suggest that Centrifuge C will fail over 5 times per year. The cause remains unknown, but it can be speculated that the new design is not as robust as the previous models. Further analysis is recommended to understand the cause and financial implications of the increased failures.

The manufacturer offers a range of packages for this item, such as enhanced wear protection, enhanced serviceability and enhanced control packages. It is recommended that further analysis and research be done to ensure centrifuges are equipped with the most reliable control, process optimization and predictive maintenance systems.

Throughput

Biosolids recovery data from all three (3) centrifuges was combined and supplied to Stantec by the Client for review and incorporation in the report. The figures on the following pages represent a graphical summary of tonnage processed, biosolids recovered, and the biosolids recovery rate for the three (3) centrifuges in the Dredge Sub-System. Table 1 (below) summarizes the biosolids recovery data over the last three (3) years.

Table 1 Annual Biosolids Recovery Data

	2015 Total	2016 Total	2017 YTD (October)
Sludge Feed (m3)	473,721 (37.6 m3/h)	535,916 (39 m3/h)	444,894
Polymer Consumption (m3)	34,744	38,110	36,385
Runtime (hours)	12,584	13,673	12,669
Biosolids Recovered (m3)	50,996 (4.05 m3/h)	64,024 (5.05 m3/h)	60,398 (4.76 m3/h)

Subtotal Biosolids (tonnes)	10,372*	16,379**	23,600
Biosolids Recovery Rate (annual average)	15.18%	11.37%	10.39%

**2015 Subtotal Biosolids excluding data for March, 2015*
***2016 Subtotal Biosolids excluding data for February, April and May 2016*

Biosolids recovery rate is directly correlated to the percent solids in the sludge feed, and thus is not necessarily indicative of centrifuge performance. Furthermore, it has been communicated by SUEZ that the supplied data contains a significant level of inaccuracy. It is understood that SUEZ is currently working on replacing the measurement system to improve the accuracy and scope of reported data. Further analysis is recommended once the reported variables are accurate and inclusive enough that they can aid in monitoring and achieving centrifuge optimization. Biosolids recovery rate for the last three (3) years ranges between 5% at the lowest and nearly 30% at the highest. A single spike in recovery rate for March 2015 is being viewed as a possible source of data error, pending further investigation. A correlation is seen to exist between throughput and recovery rate, but remains speculative without knowledge of percent solids of the biosolids feed. Zero throughput was reported for July 2015, which is understood to be due to a shutdown caused by a leak in the centrate line. Throughput data is also missing for May 2016. Only a short downtime for Centrifuge C was reported in May 2016, with all other centrifuges operating above target availability. The reason for absence of data for May 2016 remains unknown.

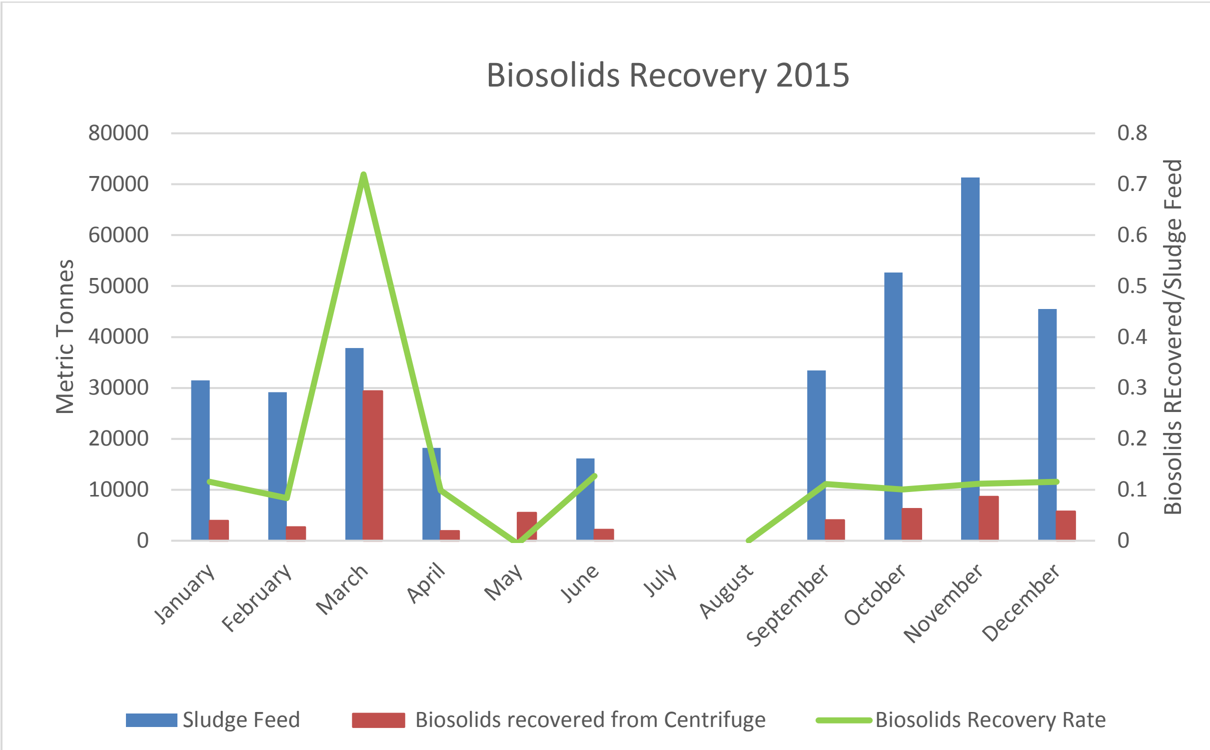


Figure 3-1 Biosolids Recovery 2015

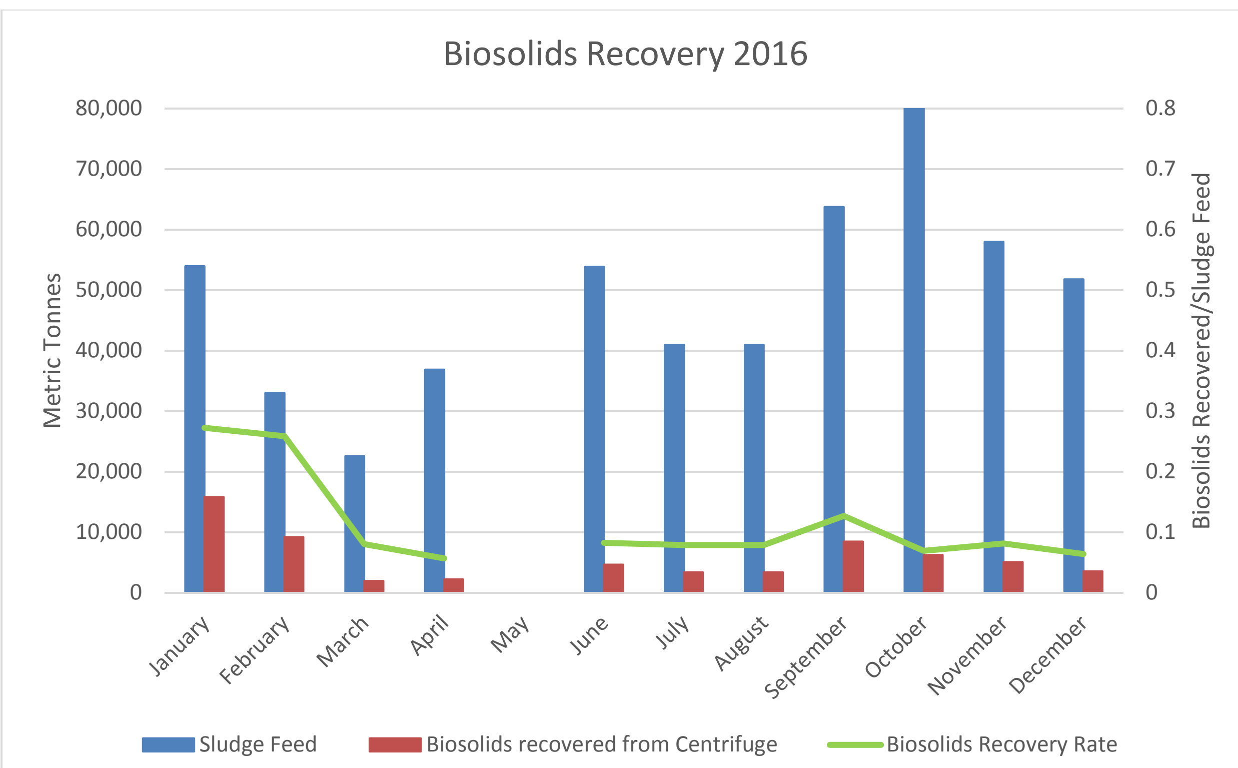


Figure 3-2 Biosolids Recovery 2016

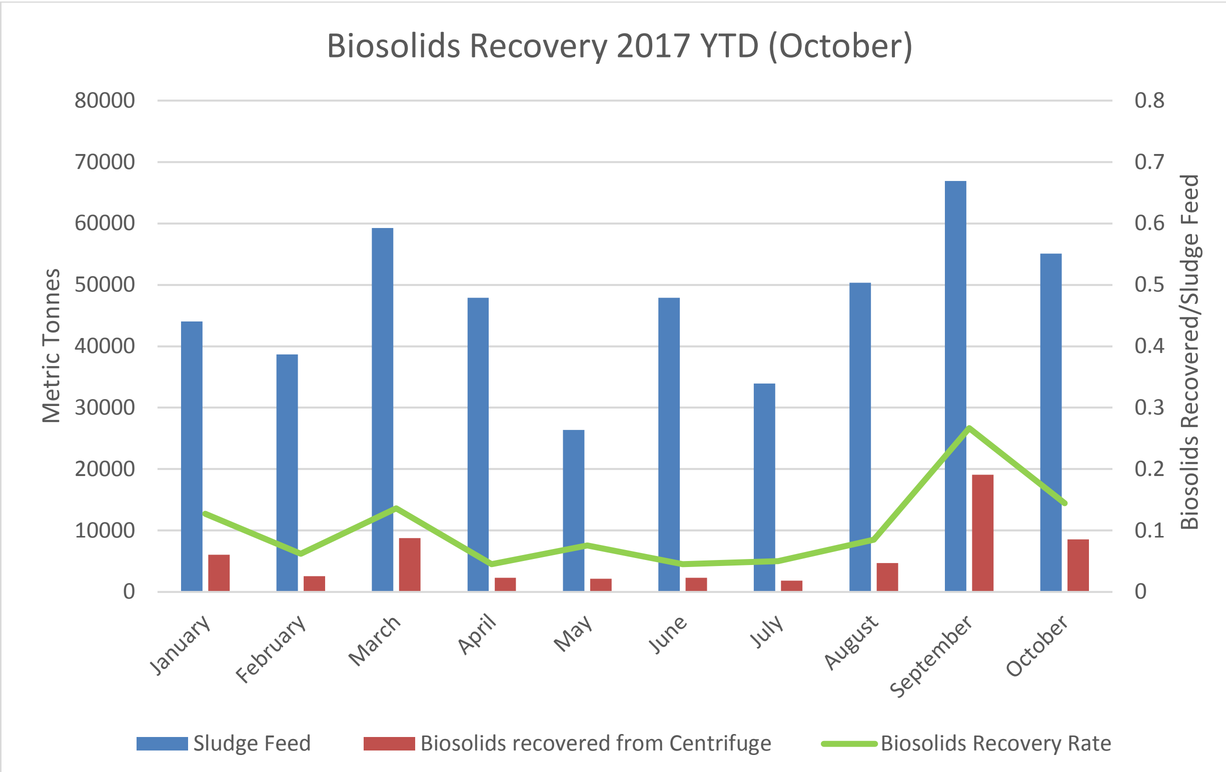


Figure 3-3 Biosolids Recovery 2017 YTD (October)

Little to no centrifuge operation from May-August 2015 was due to a leak in the centrate line to Gold Bar WWTP. The spike in recovery rate in March is not fully understood by Stantec at the time of this report.

Availability

Centrifuge availability data has been supplied for each centrifuge by the Client. The figures on the following page show the availability for all three (3) centrifuges, averaged monthly, for the last three (3) years.

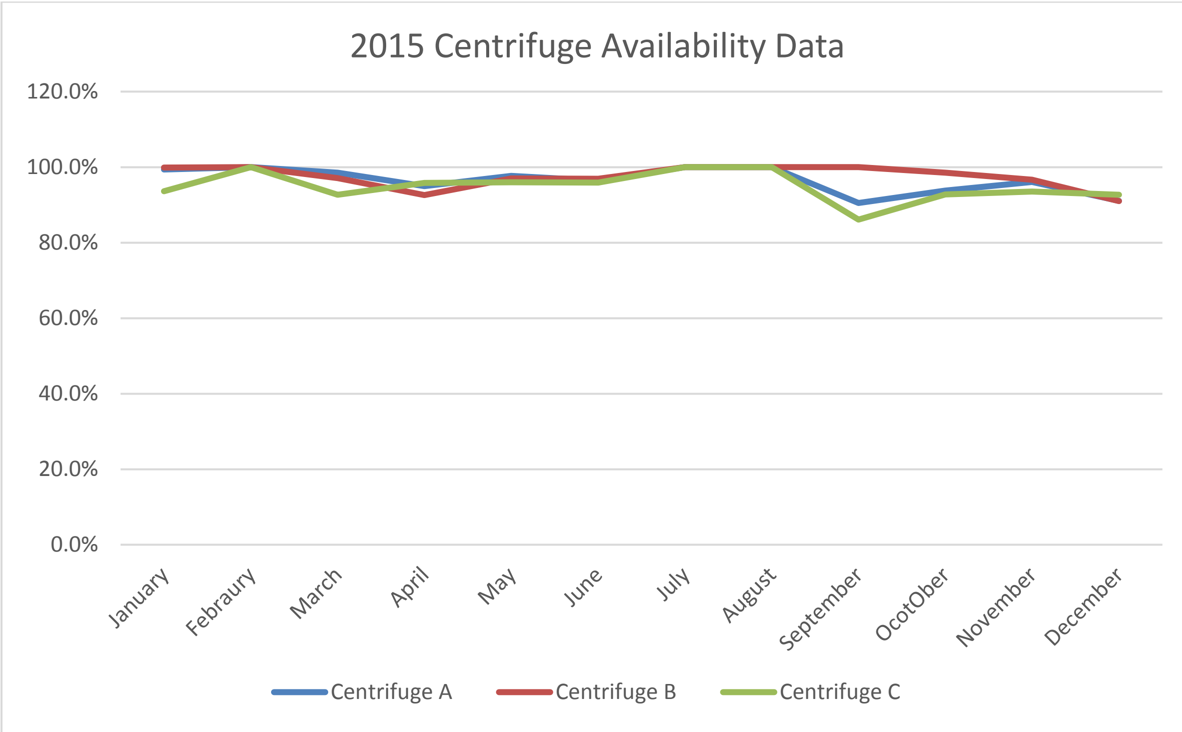


Figure 3-4 - Centrifuge Availability 2015

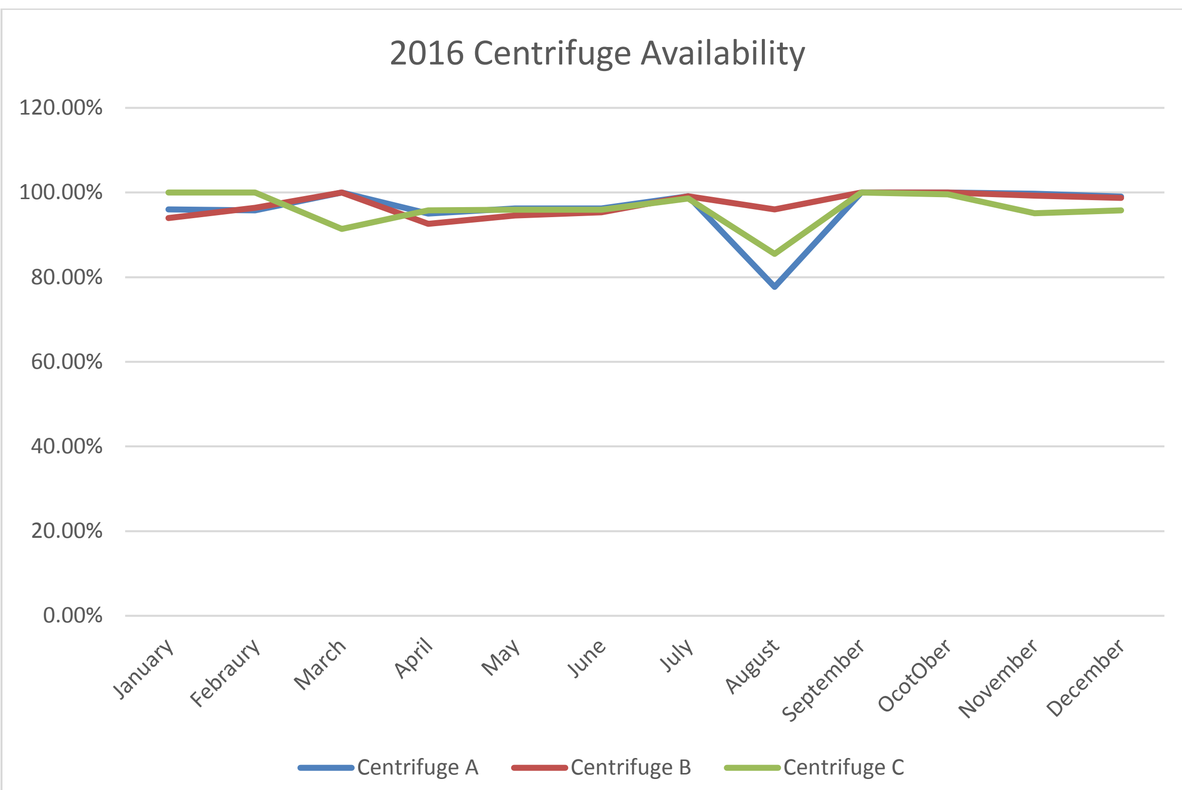


Figure 3-5 - Centrifuge Availability 2016

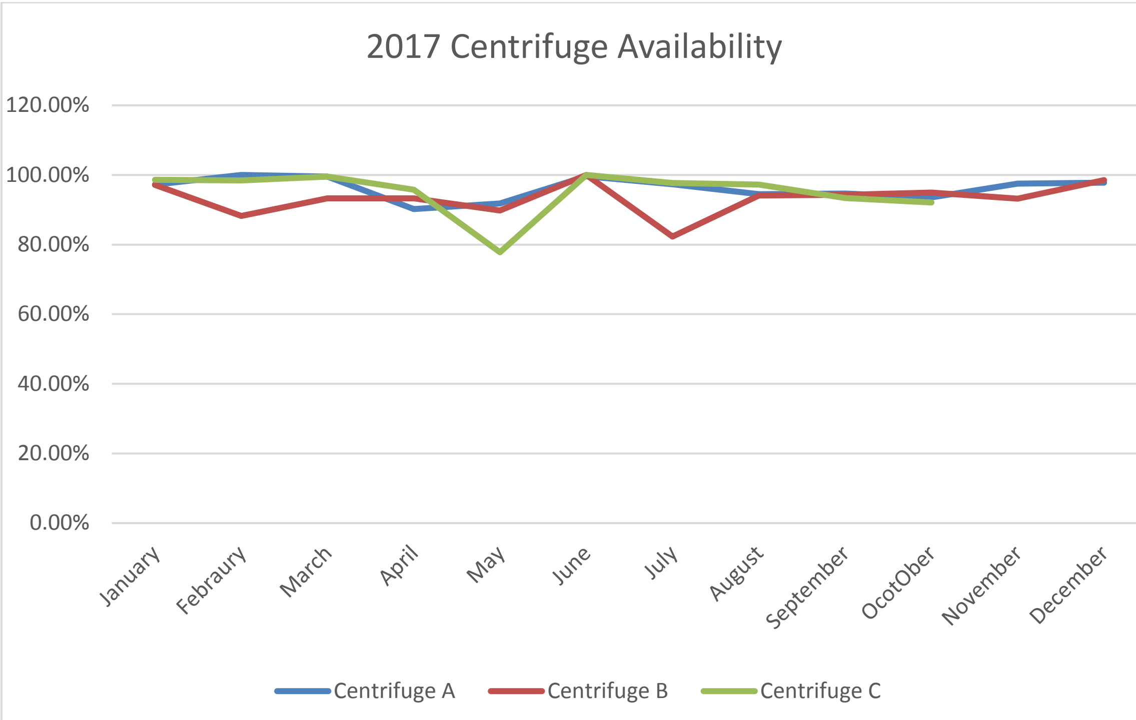


Figure 3-6 - Centrifuge Availability 2017

The combined average Centrifuge availability is over 90% each year for the past three years. This is above the 85% KPI target. As per the graphs above, no major downtime has been reported in the last three years.

3.2 TURNERS

Three (3) turners, manufactured by Sorain Cecchini, are utilized for breaking down and aerating the compost material fed into the Aeration Hall - one for each of the three (3) bays. The machines are comprised of two (2) rotating articulating augers mounted to a trolley which moves transversely along the bridge. The bridge moves along tracks parallel to the length of the aeration bay. A load-out wheel attached to the bridge pulls processed compost out of the aeration bay and onto load-out conveyors to be screened.

Findings

The turner bridge structure is understood to have a long EUL that we will consider indefinite for the purpose of this report.

Wear components of the Turners include motors, gearboxes, and augers, which are replaced and refurbished as needed. Alignment issues have caused accelerated wear in the bridge drive units specifically, necessitating local machine shop refurbishment every two to three years, and OEM replacement every four to six. Turner motors have also been reported to require replacement every three to five years.

The rotating screws (augers) are consumable items that are swapped out with spares every month, sent off site for hard facing rebuilding or flight replacement as needed, and then returned to service. Over time, the Auger stem tube material erodes, and the unit must be replaced. Historically, the Augers have required replacing every three years.

It is recommended that further research be conducted to understand the cause and cost implications of the reported alignment problems.

Picture 3-3 - Turner assembly showing the rotating screws (right), bridge (top) and conveyor track (bottom left)

Performance

A telling indicator of Turner performance is the amount of material it processes, which is measured as the amount of "lines" or journeys the bridge makes from one end of the Aeration Bay to the other in a given time period. Performance data for all three (3) Turners has been combined and supplied by the Client. Table 2 (below) shows overall performance data for the past three (3) years and the relevant targets.

Table 2 - Turner Performance Data 2015-2017

	2015	2016	2017 YTD (October)
Number of Lines Completed (total)	Target – 22,265 Achieved – 19,205	Target – 22,326 Achieved – 17,796	Target – 16,653 Achieved – 9,549
Number of Lines Completed (per hour)	Target – 0.95 Achieved – 0.87	Target – 0.85 Achieved – 0.79	Target – 0.85 Achieved – 0.60

In 2015 and 2016 the Turners achieved 86% and 79% of their target number of lines, respectively. In 2017, Turner productivity dropped significantly to 57% as recorded at the beginning of October. It is understood that this decrease was an intentional operational decision. It was found that by slowing the turner speed, the organic material was given more residence time in the aeration bay to maximize maturity prior to sending the material to the cure site. In order to determine true Turner efficiency, throughput must be coupled with a material quality audit.

The figures below and on the following page show the number of lines completed by all Turners on a monthly basis as well as the lines/hour averaged over each month.

Picture 3-4 - Aeration bay showing "lines" from Turner productivity

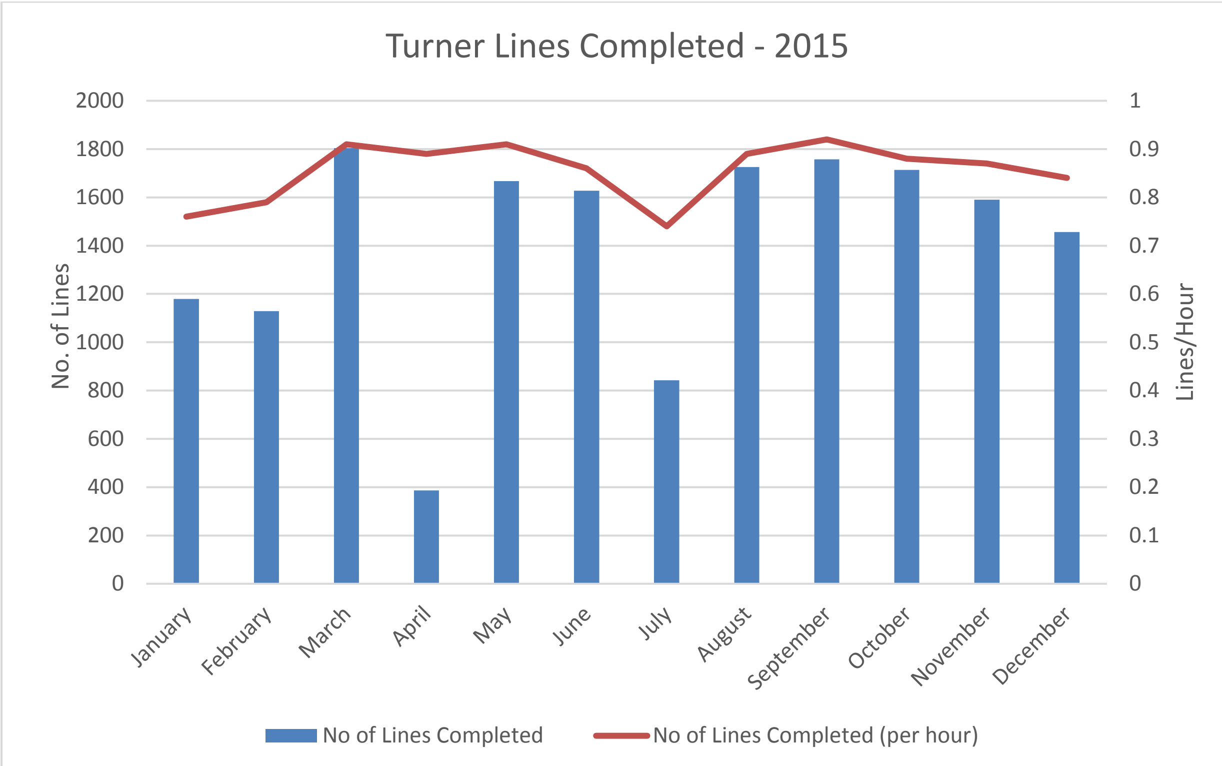


Figure 3-7 - Turnery Productivity 2015

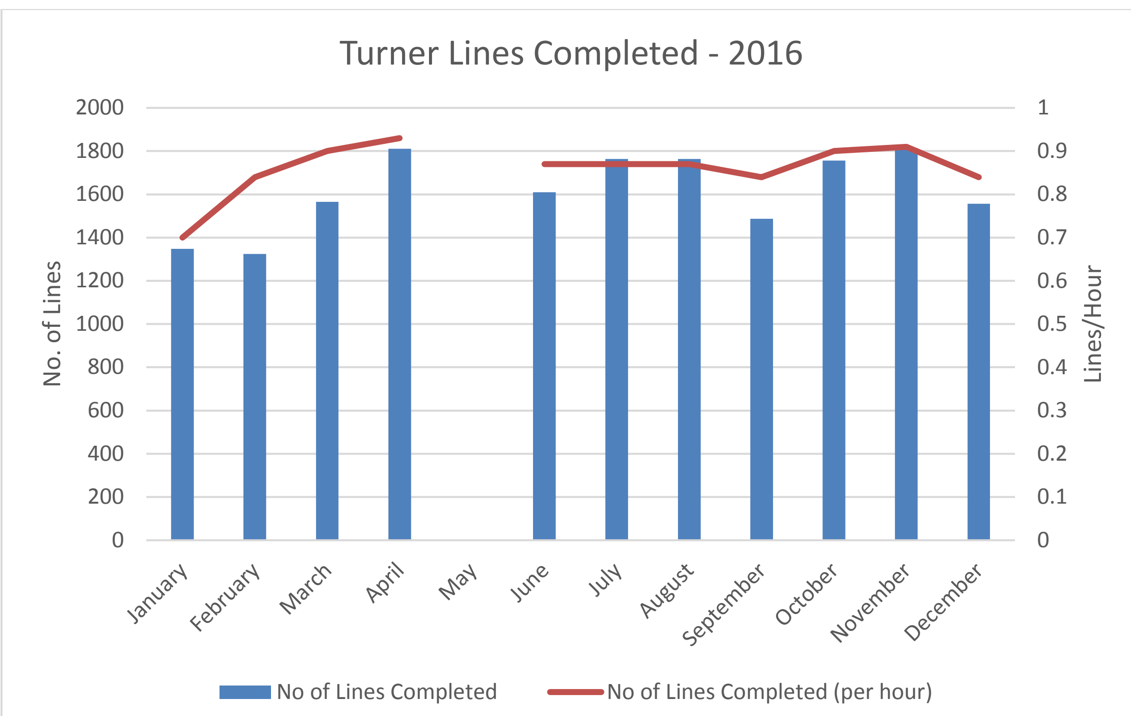


Figure 3-8 - Turner Productivity 2016

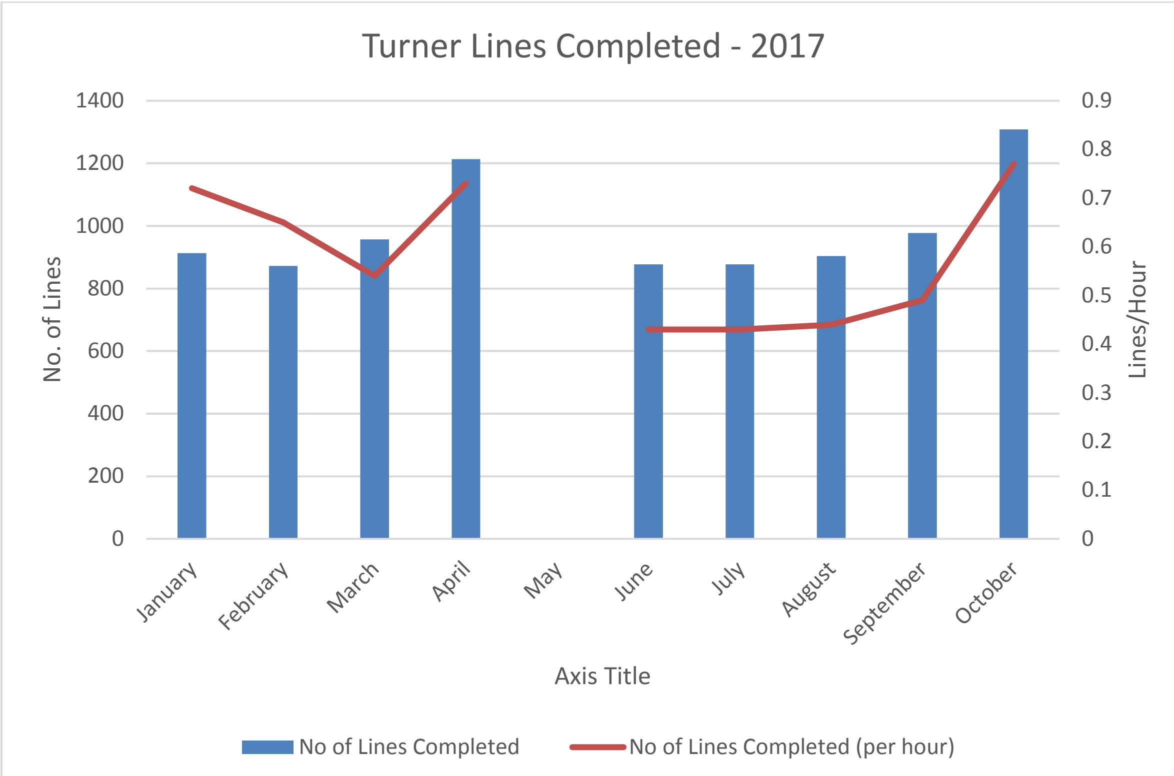


Figure 3-9 - Turner Productivity 2017

A significant reduction in number of lines completed is seen in 2017, which is consistent with the annual summary above. No explanation for the lack of data in May 2016 and May 2017 has been given.

3.3 CONVEYOR SYSTEMS

Conveyor systems are utilized throughout the ECF for the transfer of material from the tipping floor through the aeration and screening process and on to load out. The three (3) conveyor systems, by building, are the Download System, the Aeration Hall System and the Finishing Circuit. A description of each system has been provided below.

Download System

The downloading system has been significantly altered since original construction. Five (5) large drums which transported compost from the Tipping Floor to the Aeration Hall have been decommissioned and left in place. Transport from the Tipping Floor is now handled primarily by two conveyors 30-M-60 and 30-M-70 which run parallel to each other through Drum 3 and Drum 4 respectively.

Picture 3-5 - Conveyor 30-M-60 running through the decommissioned Drum 3

Picture 3-6 - Typical Conveyor Roller

Picture 5 - Typical Conveyor Tail Pulley

Aeration Hall

The Aeration Hall contains a series of "load-in" conveyor systems which transport compost infeed from the two (2) primary download conveyors to the three (3) Aeration Bays and a series of "load-out" conveyors which transport compost from the Aeration Bays to the Finishing Circuit. The long, 36", feed conveyors that transport compost the length of the Aeration Bay from the Download System are rated for 180 tonne/hr. Short load-in belts run perpendicular and move along the length of the feed conveyors via a tipping car. These short load-in belts that transport material from the feed conveyor to the Aeration Bay are rated for 130 tonne/hr. Tipping cars have not been included in this assessment. After the material has been processed in the Aeration Bay, it is pushed over the side via a paddle wheel and onto a load-out conveyor. There is a total of three (3) 24" load out conveyors which feed processed compost from each of the three (3) Aeration Bays to a single 24" discharge collection belt. The three (3) load-out conveyors are rated for 25 tonnes/hr each, and the discharge collection belt is rated for 75 tonnes/hr.

Finishing Circuit

Conveyors in the Finishing Circuit transport compost from the Aeration Hall through a Trommel and a series of Star Screens to filter out rejects from the material stream. A total of fifteen (15) conveyors comprise the finishing circuit system, several which are from original construction and the rest installed as part of a 2007 upgrade.

Figure 3-10 - View of Finishing Circuit looking downstream from Trommel to Screens

Findings

The major components that make up the conveyor are the frame, tail pulley, head pulley, rollers, belt, gearbox and motor. Of all the wear components, the belt is known to be the most expensive. In the ECF working environment, belt lifespan is unpredictable, as rips and tears commonly cause a belt to fail prior to its EUL under nominal circumstances. All other conveyor components are replaced as needed, as part of routine maintenance.

The frame of the conveyor is the most expensive component of a conveyor system that, barring any major trauma event, can be expected to last for 40 years. As such, complete conveyor replacement is not expected for any conveyors in the system in the short term. With regular upkeep, all conveyors are expected to last at least another 20 years. Commissioning age and EUL has been listed for every conveyor in the Appendix.

3.4 PUMPS

Pumps are utilized within the Dredge System and Poly System (unit 10) to move biosolids, poly, and water throughout the dewatering process. The type of pump used is dependent on the required capacity and intended service. Relatively low cost and routine replacement/overhaul of pumps excludes them from consideration from major equipment but are included in this report for system completeness, as they are vital to the process.

Dredge System Pumps

Initial transport of biosolids from the dredge to the pumphouse is via a single 40hp Vaughan Chopper pump 10-P-1. Downstream, two (2) hydro-solids pumps 10-P-2A and 10-P-2B manufactured by Goulds and rated for 140 m3/h move biosolids from the pumphouse to two holding tanks in the Dewatering Building.

Two (2) Vaughan Rotamix pump systems 10-P-15 and 10-P-16, circulate the sludge in two holding tanks. Three T-Series centrifugal pumps 10-P-4, 10-P-5 and 10-P-6 rated for 225 m3/h feed the sludge to Centrifuges A, B and C, respectively.

Downstream of the centrifuges, the dewatered bisolids are dropped into a tank 10-T-5. Two (2) hydraulic Schwing pumps 10-P-7 and 10-P-1108 push dewatered biosolids fed from T-5 through screw conveyors on to further processing or storage.

Water extracted from the biosolids via the centrifuges is recirculated with two centrifugal pumps 10-P-8A and 10-P-8B with an estimated capacity of 225 m3/h. Manufacturer is unknown.

Picture 3-7 – Centrate Pumps

Poly System Pumps

Polymer is added to the sludge mix via three (3) progressive cavity pumps 10-P-9, 10-P-10 and 10-P-11 which feed the centrifuges. Two (2) pumps 10-P-9 and 10-P-10 are manufactured by Moyno and rated for 6.8 m3/h. 10-P-11 is manufactured by Netzsch with a slightly higher rating of 9 m3/h, used to send a higher volumetric throughput of polymer as needed.

Picture 3-8 - Poly System Pumps – Left to Right 10-P-4, 10-P-5, 10-P-6

Findings

All biosolids pumps handle varying degrees of solids content and have a potential for wear. Preventive maintenance measures include an annual overhaul of the Chopper pump and both Hydro-Solids pumps. These pumps are closest to the sludge source and are purposed to break up the suspended solids before pushing the sludge to the Dewatering Building. Survey results indicate that 20% of the participants would consider the Hydro-Solids pumps in need of immediate replacement. Survey results also show this equipment to have one of the highest failure rates and lowest condition ratings of all ECF equipment. These values are consistent with Appendix A, which shows a suggested replacement date of 2015 for both pumps. Further analysis is recommended for both pumps to determine if immediate replacement is required.

All three (3) T-Series centrifugal pumps are also overhauled annually, but do see some cavitation, and are considered in need of a full unit replacement every 8-10 years. The hydraulic Schwing pumps are a relatively simple piston-cylinder configuration and have an indefinite lifespan, provided they are serviced regularly. Centrate recirculation pumps, under normal operating conditions, require replacing every fifteen (15) years. Progressive Cavity polymer pumps are overhauled annually as part of routine maintenance, and lifespan is roughly twenty (20) years.

3.5 SCREENS

Description

Two types of screens are used in the compost screening process downstream of the Aeration Hall in the Finishing Circuit. The screening process begins with a Trommel. A rotating screen with a hole size of 25 mm sends a maximum of 90 tonne/hr downstream. Three (3) Star Screens, 50-YM-107, 50-YM109 and 50-YM-111 provide secondary filtration before the compost is loaded out of the building.

Findings

It is understood that the Trommel screen was replaced in 2015. All shafts and stars on the star screens were replaced in 2016. No immediate or short-term replacement of screens is anticipated.

Figure 3-11 - Stars from screen YM-107

4.0 PROCESS AIR SYSTEM

Aeration in the aeration bays is primarily driven by six (6) blowers. Process air is fed to a common header, where leachate gravity drains to a sump. From the sump, the leachate is pumped to a collection tank and then distributed back into the process. The process air moves out through one of three biofilters before being discharged to atmosphere.

It has been communicated by SUEZ that aeration in the facility is a major problem, with dead air pockets throughout the Aeration Hall and South Download building.

In the summer of 2017, fluoridated water was found in one of the headers, which is suspected to come from a cracked utility water pipe. This leak is expected to lead to a large volume of liquid loss. It has been reported that drainage in the collection pipes is also a problem.

No major issues or concerns have been raised for the individual pieces of mechanical equipment within the process air system. A description of the major equipment is listed below. See Appendix A for lifespan details.

4.1 BLOWERS

The movement of air is handled by six blowers, 40-C-60A/B and 40-C-60C/D/E/F. They are rated for 25350 l/s and rated discharge pressure of 6.4 kPaG. They are understood to function as intended, however, problems have been reported with the ducting system through which they blow air.

4.2 PUMPS

Leachate is moved from the Aeration Bay Leachate Sump to the Leachate Collection Sump with two Sump Pump 63-P-42A/B. These pumps are rated for 13.7 m3/hr and a discharge pressure of 170 kPaG.

From the Leachate Collection Sump, the Leachate is pumped back into the process with two pumps 63-P-44A/B. The rated flow for these pumps is 60 m3/hr with a discharge pressure of 993 kPaG. Replacement of all leachate pumps is expected in 2020 based on a 20 year EUL and installation with original construction.

4.3 BIOFILTERS

The biofilter is a bed of media on which microorganisms grow. The biofilter is used to treat process air and remove pollution and odour. The biofilter media is changed on average every four years. The biofilter pit itself is lined in concrete. No powered equipment is used in the biofilter.

5.0 DOCUMENTS REVIEWED AND INTERVIEWS

5.1 SITE REVIEW

A visual walk-through review of the site was conducted by Alan Dick (Stantec), accompanied by David Rodgers, on December 12, 2017. Alan and David were joined by Clint Sherbinin for part of the tour and engaged in discussions about the equipment.

The weather at the time of the assessment was clear, with ambient air temperatures that generally ranged between 0 and 9 degrees Celsius.

During the site evaluation, the following equipment were not viewed or had limited access to viewing due to unsafe access:

1. The Lagoon dredge and pumps upstream of the Dewatering building
2. The New Polymer System

5.2 DOCUMENTATION REVIEW

Stantec requested relevant documentation from the Client and/or site representative(s) that could provide background information of the process equipment's age, service, intended function and anticipated remaining life. Stantec's review of documents provided does not include commenting on the accuracy of such documents or their preparation, methodology, or protocol.

The following documents were reviewed, and information derived from these documents was included in the preparation of this report.

Table 3 Documents Reviewed

Document Title	Date	Author	Type of Document
Edmonton Co-Composting Facility Unit 10 P&ID	June, 2014	TransAlta	Process and Instrumentation Drawings for the Dewatering System
Edmonton Co-Composting Facility Unit 40 P&ID	August, 1999	TransAlta	Process and Instrumentation Drawings for the Aeration System
Edmonton Co-Composting Facility Unit 50 P&ID	August, 2007	Hinz Automation Inc.	Process and Instrumentation Drawings for the Finishing Circuit
Edmonton Co-Composting Facility Unit 30 P&ID	August, 2000	TransAlta	Process and Instrumentation Drawings for the Download System
ECF Equipment List		SUEZ	Updated equipment list spreadsheet for all ECF Process Equipment provided by SUEZ

5.3 INTERVIEWS

The following personnel were interviewed or contributed information that was used in the process of preparing this PEA report:

- Dave Rodgers, Suez Electrical Lead Hand

- Clint Sherbinin, Suez Mechanical Lead Hand
- Martin Brewster, Suez Maintenance Manager
- Gordon Derick, COE Supervisor in Facility Planning and Design
- Jeremiah Gallinger, Supervisor, Composting Operations

The following contributed to the Survey results of Appendix B:

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6.0 CLOSURE

Stantec has completed a PEA for the site at the request of the Client. The independent conclusions represent Stantec's professional judgments based on conditions that existed and information and data made available to Stantec during the course of the assessment. Factual information received has been assumed to be correct and complete.

Should clarifications be required regarding the content or conclusions of this report, please contact the undersigned at the contact information provided below.

Respectfully submitted,

STANTEC CONSULTING LTD.

Appendix A   ECF EQUIPMENT LIST

EQUIPMENT NUMBER	UNIT	TYPE	DESCRIPTION	YEAR OF INSTALL	EUL	EVENT YEAR
?	10	PUMP	PUMP 2, SLURRY	2014	5	2019
10-P-15	10	PUMP	PUMP 15, RECIRC MIXING IN TANK 1	2014	10	2024
10-P-2A	10	PUMP	PUMP 2A, TRANSFER MSS FROM T1 TO T3 & T4	2010	5	2015
10-P-2B	10	PUMP	PUMP 2B, TRANSFER MSS FROM T1 TO T3 & T4	2010	5	2015
10-P-16	10	PUMP	PUMP 16, RECIRC MIXING IN TANK 3	2014	10	2024
10-P-17	10	PUMP	PUMP 17, RECIRC MIXING IN TANK 4	2014	10	2024
10-p-4	10	PUMP	PUMP 4, CENTRIFUGE A WET SLUDGE FEED	2015	8	2023
10-p-5	10	PUMP	PUMP 5, CENTRIFUGE B WET SLUDGE FEED	2014	8	2022
10-p-6	10	PUMP	PUMP 6, CENTRIFUGE C WET SLUDGE FEED	2016	8	2024

10-p-9	10	PUMP	PUMP 9, CENTRIFUGE A POLYMER FEED	2016	20	2036
10-p-10	10	PUMP	PUMP 10, CENTRIFUGE B POLYMER FEED	2017	20	2037
10-p-11	10	PUMP	PUMP 11, CENTRIFUGE C POLYMER FEED	2014	20	2034
10-f-1	10	CENTRIFUGE	CENTRIFUGE A, WEST	1999	30	2029
10-f-2	10	CENTRIFUGE	CENTRIFUGE B, WEST	1999	30	2029
10-f-3	10	CENTRIFUGE	CENTRIFUGE C, WEST	2014	20	2034
30-m-60	30	CONVEYOR	CONVEYOR 60, DRUM 3 TRANSFER TO CO13	2000	40	2025
30-M-70	30	CONVEYOR	CONVEYOR 70, DRUM 4 TRANSFER TO CO12	2000	40	2025
40-M-41	40	CONVEYOR	CONVEYOR 41A, LOAD-IN	2000	40	2022
40-m-27	40	CONVEYOR	CONVEYOR 27, 24" LOAD-OUT BAY 1	2000	40	2017
40-m-28	40	CONVEYOR	CONVEYOR 28, 24" LOAD-OUT BAY 2	2000	40	2020
40-m-29	40	CONVEYOR	CONVEYOR 29, 24" LOAD-OUT BAY 3	2000	40	2019

40-m-30	40	CONVEYOR	CONVEYOR 30, 24" DISCHARGE COLLECTION	2000	40	2018
40-m-21	40	CONVEYOR	CONVEYOR 21, 36" LOAD-IN BELT	2000	40	2019
40-m-43	40	CONVEYOR	CONVEYOR 43, LOAD-IN SHORT BELT	2000	40	2022
40-M-22	40	CONVEYOR	CONVEYOR 22, 36" LOAD-IN BELT	2000	40	2018
40-m-45	40	CONVEYOR	CONVEYOR 45, LOAD-IN SHORT BELT	2000	40	2022
40-M-23	40	CONVEYOR	CONVEYOR 23, 36" LOAD-IN BELT	2000	40	2021
40-m-47	40	CONVEYOR	CONVEYOR 47, LOAD-IN SHORT BELT	2000	40	2022
50-m-02	50	CONVEYOR	CONVEYOR 2, FINAL SCREEN FEED TO TROMMEL	2000	40	2040
50-m-16	50	CONVEYOR	CONVEYOR 16,COMPOST PRODUCT FROM TROMMEL	2000	40	2040
50-m-100	50	CONVEYOR	CONVEYOR 100, COMPOST FROM CO16	2007	40	2047
50-m-101	50	CONVEYOR	CONVEYOR 101, COMPOST FROM CO100	2007	40	2047
50-m-102	50	CONVEYOR	CONVEYOR 102, COMPOST DOSING HOPPER	2007	40	2047

50-m-103	50	CONVEYOR	CONVEYOR 103, DOSING HOPPER DELUMPER	2007	40	2047
50-m-104	50	CONVEYOR	CONVEYOR 104, COMPOST FROM CO103	2007	40	2047
50-m-114	50	CONVEYOR	CONVEYOR 114, 308 FINES FROM STAR SCREEN	2007	40	2047
50-m-8	50	CONVEYOR	CONVEYOR 8, 308 FINES PRODUCT LOADING	2000	40	2040
50-m-9	50	CONVEYOR	CONVEYOR 9, 308 DISTRIBUTION IN TRAILER	2000	40	2040
50-m-15	50	CONVEYOR	CONVEYOR 15, ROTATING SCREEN RESIDUALS	2007	40	2047
50-m-6	50	CONVEYOR	CONVEYOR 6, RESIDUALS FROM CONVEYOR 15	2007	40	2047
50-m-116	50	CONVEYOR	CONVEYOR 116, STAR SCREEN RESIDUALS	2007	40	2047
50-m-115	50	CONVEYOR	CONVEYOR 116, FINES CONVEYOR	2007	40	2047
50-m-11	50	CONVEYOR	CONVEYOR 11, RESIDUALS FROM CO6 & CO16	2000	40	2040
50-YM-107	50	SCREEN	SCREENER 107, STAR SCREEN 1 DECK DRIVE 1	2016	5	2021
50-YM-109	50	SCREEN	SCREENER 109, STAR SCREEN 1 DECK DRIVE 2	2016	5	2021

50-YM-111		SCREEN	SCREENER 111, STAR SCREEN 2 DECK DRIVE 1	2016	5	
50-s-05	50	TROMMEL	TROMMEL 5, ROTATING SCREEN	2015	10	2025
40-m-24	40	AUGER	AUGER 1W, W COMPOST MIXING	2015	4	2019
40-m-24	40	AUGER	AUGER 1E, E COMPOST MIXING	2015	4	2019
40-m-25	40	AUGER	AUGER 2W, W COMPOST MIXING	2016	4	2020
40-m-25	40	AUGER	AUGER 2E, E COMPOST MIXING	2016	4	2020
40-m-26	40	AUGER	AUGER 3W, W COMPOST MIXING	2017	4	2021
40-m-26	40	AUGER	AUGER 3E, E COMPOST MIXING	2017	4	2021
40-C-60A/B	40	BLOWER	AERATION BAY ZONES 1/2 BLOWERS	2000	20	2020
40-C-60C/D/E/F	40	BLOWER	AERATION BAY ZONES 3/4 BLOWERS	2000	20	2020
63-P-44A/B	63	PUMP	LEACHATE COLLECTION SUMP PUMPS	2000	20	2020
63-P-43B	63	PUMP	ZONES 3&4 CONDENSATE SUMP PUMPS	2000	20	2020

61-F-4A/B	61	FILTER	BIOFILTERS	2000	20	2020
61-F-5A	61	FILTER	BIOFILTERS	2000	20	2020
10-Y-48	10	BARGE	MSS BARGE	2014	10	2024
10-Y-1A	10	GRINDER	MSS GRINDER	2015	5	2020

Appendix B ECF CONDITION SURVEY

B.1 QUESTION/ANSWER LEGEND

In your opinion, what is the current condition of this equipment?

Answer to Question	Assigned Value
Like New	5
Fairly new, requires usual maintanenace	4
Aging, starting to require more maintenance	3
Not reliable, more breakdown maintenance	2
Completely unreliable, large maintenance costs	1

In your opinion, what is the expected useful life of this equipment, in years, in it's current operating conditions?

Answer to Question	Assigned Value
1 Year	1
2 Years	2
3 Years	3
etc …	etc…

In your opinion, how well does this equipment perform its intended service?

Answer to Question	Assigned Value
Functions as specified	5
Mostly meets function requirements	4
Generally meets function requirements, some improvement needed	3
Barely meets functional requirements	2
Does not function as currently needed	1

In your opinion, is the capacity of this equipment adequate for demand?

Answer to Question		Assigned Value
Able to handle all requirements, including peaks		5
Able to handle normal requirements, handles peaks with minimal overtime		4
Able to handle normal requirements, handles peaks with more overtime		3
Not able to handle normal requirements, cause delays		2
Not able to handle normal requirements, requires contracted equipment/services to keep up		1

To your knowledge, how frequently has this equipment failed in the past 3 years?

Appendix B ECF CONDITION SURVEY

Answer to Question	Assigned Value
None	5
One time per year	4
2-5 times per year	3
6-10 times per year	2
10+ times per year	1

In your opinion, is the current PM schedule adequate to prevent failures on this equipment?

Answer to Question	Assigned Value
Yes, this equipment recieves adequate PM	3
No, this equipment requires minor increase in PMs	2
No, this equipment requires significant increase in PMs	1

In your opinion, does this equipment need to be replaced immediately for any reason?

Answer to Question	Assigned Value
YES	1
NO	0

In your opinion, with respect to time, how critical is a machine failure?

Answer to Question	Assigned Value
Failure can be complicated to diagnose and repair or lead times can be long for parts resulting in long term machine outage	3
Failure complexity and repair is average and lead times are standard for parts resulting in medium machine downtime	2
Failure diagnosis is simple and lead times are short for parts resulting in short downtime for machine	1

B.2 SURVEY RESULTS

EQUIPMENT DESCRIPTION	ASSET NUMBERS	BUILDING	In your opinion, what is the current condition of this equipment?	In your opinion, what is the expected useful life of this equipment, in years, in it's current operating conditions?	In your opinion, how well does this equipment perform its intended service?	In your opinion, is the capacity of this equipment adequate for demand?	To your knowledge, how frequently has this equipment failed in the past 3 years?	In your opinion, is the current PM schedule adequate to prevent failures on this equipment?	In your opinion, does this equipment need to be replaced immediately for any reason?	In your opinion, with respect to time, how critical is a machine failure?
DREDGE BARGE	10-Y-48	ECF	3.8	11.3	4.0	4.4	2.5	2.8	0.0	2.3
DREDGE GRINDER	10-Y-1A	ECF	3.8	5.3	4.5	4.5	3.9	3.0	0.1	1.9
DREDGE PUMP	UNKOWN	ECF	3.9	3.1	4.4	4.5	3.2	2.8	0.1	2.5
PUMPHOUSE PUMPS	10-P-2A, 10-P-2B	ECF	3.4	5.2	3.6	4.0	2.5	2.7	0.2	1.6
RECIRC PUMPS	10-P-15/16/17	ECF	4.0	8.3	4.7	4.8	4.1	2.9	0.0	1.7
CENTRIFUGE SLUDGE FEED PUMPS	10-P-4/5/6	ECF	3.6	5.2	4.5	4.6	4.2	3.0	0.0	1.7
NEW POLY SYSTEM PUMPS	MULTIPLE PUMPS	ECF	3.8	6.0	4.2	4.5	3.2	2.8	0.0	2.0
CENTRIFUGE POLYMER FEED PUMPS	10-P-9/10/11	ECF	3.5	5.6	4.7	4.7	3.8	3.0	0.0	1.6
CENTRIFUGE A	10-F-1	ECF	3.1	11.0	4.5	4.4	3.5	3.0	0.0	2.5
CENTRIFUGE B	10-F-2	ECF	3.0	10.9	4.3	4.3	3.5	3.0	0.2	2.5
CENTRIFUGE C	10-F-3	ECF	3.0	9.7	3.3	4.4	2.8	3.0	0.1	2.9

PROCESS EQUIPMENT ASSESSMENT - ECF

Appendix B ECF CONDITION SURVEY

DOWNLOAD CONVEYORS	CONVEYOR	ECF	3.8	16.2	4.4	4.7	3.5	3.0	0.1	1.5
LOAD-IN CONVEOYRS	CONVEYOR	ECF	3.5	15.9	4.4	4.7	3.5	3.0	0.1	1.5
LOAD-OUT CONVEYORS	CONVEYOR	ECF	3.5	16.4	4.5	4.6	3.7	3.0	0.0	1.5
FINISHING CONVEYORS	CONVEYOR	ECF	3.4	16.4	4.5	4.6	3.5	3.0	0.0	1.5
STAR SCREENS	50-YM-107/109/111	ECF	3.2	5.2	4.2	4.3	3.3	2.6	0.2	1.7
TROMMEL	50-S-05	ECF	3.5	8.4	4.6	4.5	3.8	3.0	0.0	1.9
TURNER DRIVES	MULTIPLE DRIVES	ECF	3.5	5.8	4.5	4.5	3.5	3.0	0.0	2.3
TURNER MOTORS			3.5	6.1	4.7	4.5	3.8	2.8	0.0	1.7
TURNER FRAME	2 FRAMES	ECF	3.6	14.4	4.9	4.9	5.0	2.8	0.0	2.0
AERATION BAY BLOWERS	40-C-60	ECF	3.5	9.6	4.3	4.5	3.8	2.8	0.0	1.7
TUNNEL SUMP PUMP	20-P-37	ECF	3.4	5.0	4.3	4.0	3.9	2.5	0.1	1.3
WEST ANNEX SUMP PUMP	30-P-41	ECF	2.9	4.1	4.0	3.6	4.1	2.6	0.1	1.4
LEACHATE/CONDENSATE SUMP PUMPS	63-P-42A/B, 63-P-43A/B, 63-P-	ECF	3.4	4.3	4.6	4.4	3.8	2.8	0.2	1.5
BIOFILTERS	61-F-4/61-F-5	ECF	3.5	2.9	4.2	4.4	4.8	3.0	0.5	2.2

Appendix 4

Environmental Scan.
Stantec Consulting Ltd. March 2018.

Environmental Scan

Business Cases for Renewal of ECF and MRF

Prepared for:
City of Edmonton

Prepared by:
Stantec Consulting Ltd.
10160 112 Street
Edmonton AB T5K 2L6

Project No. 1101 28016

March 2018

Sign-off Sheet

This document entitled Environmental Scan - Business Cases for Renewal of the ECF and MRF was prepared by Stantec Consulting Ltd. ("Stantec") for the account of City of Edmonton (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

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1.0 INTRODUCTION

City of Edmonton (the City) Waste Management Strategic Plan, approved by the Council in 1994, provides the framework for an integrated solid waste management system that blends strong community engagement, a highly effective collection system, and innovative waste processing. Advancing the vision of this Strategic Plan, over the years the City's Waste Services Branch continues to demonstrate leadership in solid waste management.

The City's 2018-2020 Waste Services Business Plan is focused on increasing residential waste diversion, increasing public participation, increasing resource recovery and its marketability, and working towards an environmentally safe and financially sustainable waste management system. The current integrated waste management system closely aligns with three of City Council's ten-year strategic goals that are directed to: preserve and sustain Edmonton's environment, improve Edmonton's livability, and ensure Edmonton's financial sustainability. The City's vision is to be a customer driven world leader in sustainable and innovative waste management. Consistent with this vision is the fact the City has been ISO 14001:2004 Certified since 2006.

1.1 CONTEXT

The Business Plan for 2018-2020 has identified developing business cases for Council's approval for the improvements required to the facility infrastructure located at the Edmonton Waste Management Center (EWMC). These facilities were identified in the 2015 Infrastructure Inventory Report and includes the Material Recovery Facility (MRF) and the Edmonton Composting Facility (ECF). The equipment in the ECF is approaching 20 years (near end of life) with structural issues identified in the aeration hall, south download building and finishing circuits. Further, the City is considering implementing a Source Separated Organics (SSO) collection program with three streams: organics, recyclables, and garbage to minimize contamination in the waste currently being sent to the ECF. Similarly, the equipment in the MRF is approaching 20 years (near end of life) and the City is contemplating procuring a better or an upgrade to their existing technology to enhance quality of the final product keeping in view the market demand (e.g., the China's Green Fence Policy).

In view of the above, Stantec Consulting Ltd. (Stantec) was retained by the City to provide project management advisory services to guide the City in the development of business cases for the renewal of the ECF and MRF. The development of business cases includes several components as identified in the scope of work which includes an Environmental Scan as part of the project. This report specifically addresses the Environmental Scan completed as part of the business case development for the two facilities. It is the intention that this report will assist the City in acquiring a comprehensive picture of waste management in the context of the ECF and MRF and identify critical elements for consideration into the development of business cases. This report includes:

- Snapshot of solid waste management and government initiatives on the national, provincial, and regional fronts

- Overview of the City's solid waste management program and potential opportunities for collaboration in the Alberta Capital Region
- Assessment of future waste management needs for the City
- Regulatory Framework and Industry Development
- SWOT analysis with focus on Waste Services

2.0 BACKGROUND

2.1 ORGANIZATIONAL SETUP

The Waste Services Branch of the City provides waste management services through its four core units. Each of these units have been entrusted with a specific and important role as shown in Figure 2-1.

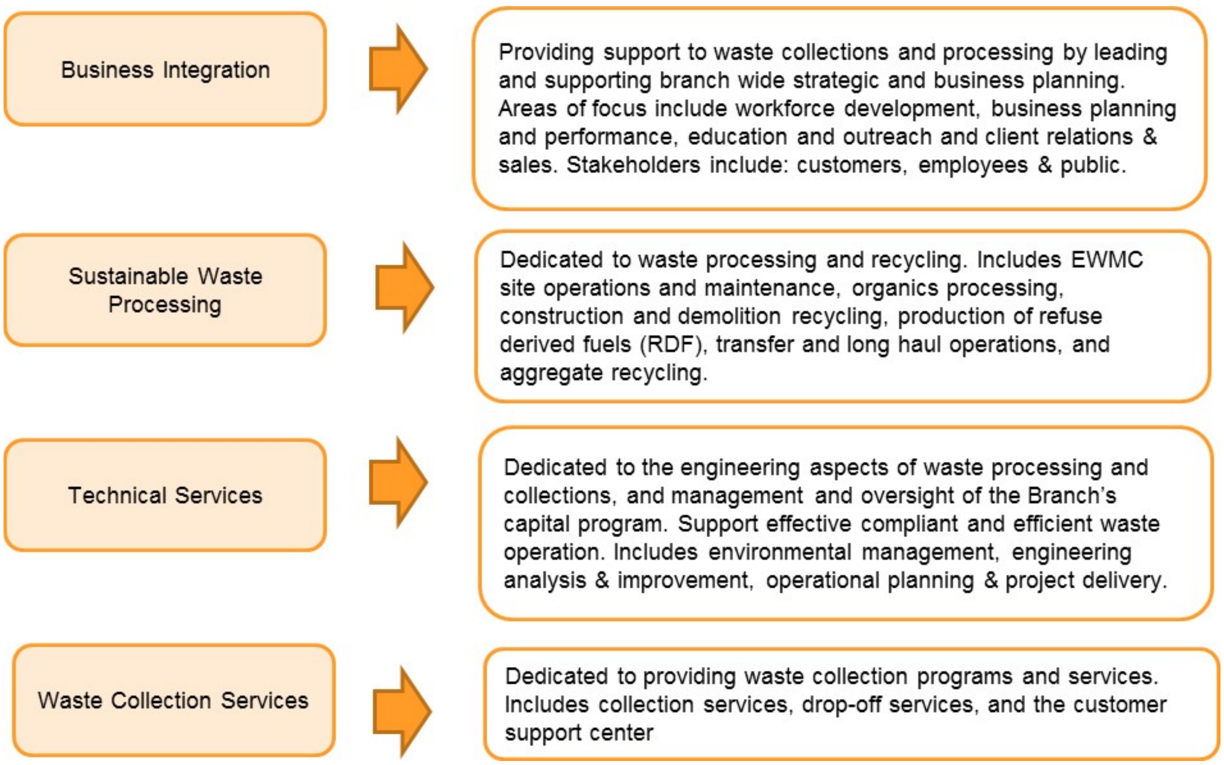

Figure 2-1 Organizational Setup – Waste Services Branch, City of Edmonton

2.2 DEMOGRAPHICS

Based on a review of historical census data and information available in the Growth Study[1], during the past 50 years the City has generally seen a consistent linear growth in population, as well as in the number of dwellings (serviced by the City). As per the municipal census data for 2016, the population of Edmonton was 899,447 with approximately 405,000 dwellings[2]. Table 2-1 shows the City's population from 2006 to 2016 in relation to different geographic regions in Canada. To maintain consistency in the data, the City's population shown in Table 2-1 was obtained from municipal Census as only limited data was available from Statistics Canada. It can be noticed that the City's share of population in the Alberta Capital Region (ACR) is approximately 67%.

[1] City of Edmonton Growth Study dated Aug 2017 prepared by Nichols Applied Management Inc.
[2] https://www.edmonton.ca/city_government/facts_figures/municipal-census-results.aspx accessed on Nov 24, 2017

A 30-year population projection was made as shown in Figure 2-2 using the historical census data of the past 20 years (1996-2016) obtained from City's website. These projections assumed a linear trend in the population growth. Based on these estimates, the City's population is expected to grow at an average growth rate of 1.6% reaching one million by 2024 and approximately 1.34 million in the next 30 years by 2047.

Table 2-1 City's Population in Relation to Other Geographic Regions

Geographic Region	Data Source	Year					
		2006	2008	2010	2012	2014	2016
Canada	CANSIM 051-0001	32,570,505	33,245,773	34,005,274	34,750,545	35,535,348	36,264,604
Alberta	CANSIM 051-0001	3,421,361	3,595,755	3,732,573	3,880,755	4,108,416	4,236,376
ACR	CANSIM 051-0056	1,074,111	1,131,156	1,183,047	1,238,949	1,327,425	1,386,788
COE	City Census Data	730,372	782,439	799,968	817,498	877,926	899,447

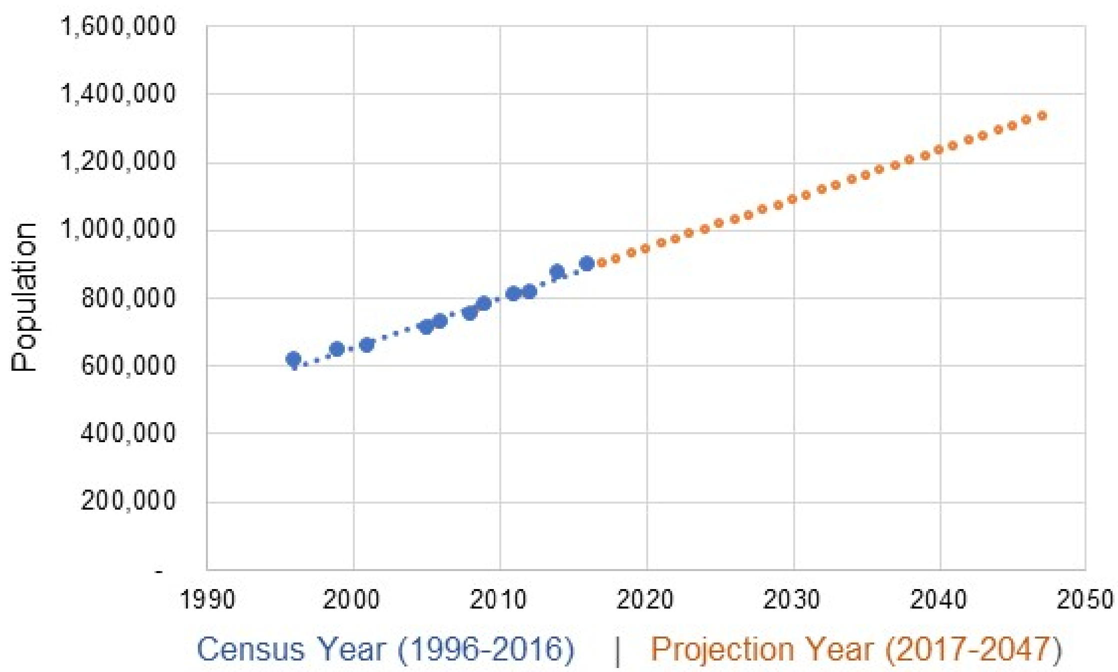

Figure 2-2 Population Projection for the City (2017-2047)

2.3 WASTE MANAGEMENT OVERVIEW

2.3.1 National - Canada

A snapshot of the state of waste management in Canada and Alberta over the past eight years from 2006 to 2014 is summarized in Table 2-2 along with Federal and Provincial waste disposal rates in Table 2-3. The information was obtained from the Waste Management Industry Survey Report (2010) developed by Statistics Canada and relevant CANSIM tables[3]. Based on the interpretation of this data, the average

[3] http://www5.statcan.gc.ca/cansim/a47 accessed on Nov 24, 2017

waste disposal rate in Canada exhibits a declining trend. The 2014 annual national waste disposal rate of 706 kg per capita is 18% lower than the 2006 waste generation rate of 836 kg/capita. Correspondingly, the national waste diversion rate exhibits an increasing trend with 36% waste diverted from landfill in 2014 which is up by 7% from its 2006 value. On the other hand, Alberta lags significantly behind the national averages with the per capita waste disposal rate of 997 kg and waste diversion rate of 20% in 2014. However, solid waste management in Alberta has relatively improved since 2006 as evident from Table 2-2.

At the national level, the proportion of residential to non-residential waste disposed is quite consistent at 40:60, for the period shown in Table 2-2, with 40% contribution by the residential sector and remaining contribution from non-residential sector (primarily ICI - Industrial, Commercial, and Institutional and C&D – Construction and Demolition waste). In Alberta, during the same period, on average approximately 30% of waste disposed was contributed by the residential sector.

Table 2-2 Snapshot of Waste Management in Canada and Alberta

Geography	Attribute	2006	2008	2010	2012	2014
Canada	Population (CANSIM 051-0001)	32,570,505	33,245,773	34,005,274	34,750,545	35,535,348
	Residential Waste (tonnes)	9,748,217	9,360,400	9,448,165	9,684,615	9,966,775
	Non-Residential (tonnes)	16,668,793	16,566,076	15,504,250	14,996,859	15,136,259
	Total (tonnes)	26,417,011	25,926,476	24,952,415	24,681,474	25,103,034
	Waste Disposal (kg/capita)	811	780	734	710	706
	Total Waste Diverted (tonnes)	7,626,683	8,310,571	8,096,119	8,464,645	9,057,177
	% Diversion	29%	32%	32%	34%	36%
Alberta	Population (CANSIM 051-0001)	3,421,361	3,595,755	3,732,573	3,880,755	4,108,416
	Residential Waste (tonnes)	973,683	993,976	1,093,155	1,176,226	1,230,635
	Non-Residential (tonnes)	2,846,189	3,153,581	2,824,337	2,737,698	2,866,949
	Total	3,819,872	4,147,558	3,917,492	3,913,924	4,097,584
	Waste Disposal (kg/capita)	1,116	1,153	1,050	1,009	997
	Total Waste Diverted (tonnes)	652,635	728,536	721,231	757,169	801,577
	% Diversion	17%	18%	18%	19%	20%
ACR	Population (CANSIM 051-0056)	1,074,111	1,131,156	1,183,047	1,238,949	1,327,425
COE	Population (City Census data)	730,372	782,439	799,968	817,498	877,926

Table 2-3 Federal and Provincial Waste Disposal Rates

Jurisdiction		2006	2008	2010	2012	2014
Federal		Waste Disposal Rate (kg/capita/year)				
	Residential	299	282	278	279	280
	Non-Residential	512	498	456	432	426
	Total	811	780	734	710	706
Alberta						
	Residential	285	276	293	303	300
	Non-Residential	832	877	757	705	698
	Total	1116	1153	1050	1009	997

2.3.2 Canadian Provinces

Nationwide, diversion rates are higher for the residential sector than for the non-residential sector. Nova Scotia and B.C. are amongst the top performers, diverting 41 and 37 per cent (respectively) of their total generated waste from landfills. Quebec, Ontario, and New Brunswick have diversion rates between 20 and 30 per cent. Alberta, Manitoba, and Saskatchewan have the lowest diversion rates, at around 15 per cent of total waste generated. Nationwide, the waste diversion rate has remained relatively static since 2002, increasing from 22 to 25 per cent by 2012[4].

Not surprisingly, the provinces that generate the least amount of un-diverted waste per capita (Nova Scotia and B.C.) also have the highest rates of waste diversion. Similarly, the provinces with the highest per capita waste generation (Alberta, Saskatchewan, and Manitoba) have the lowest rates of waste diversion across the provinces. This means that the worst-performing provinces can take two broad approaches to make improvements: reduce the generation of un-diverted waste and increase the amount and types of waste diverted[4].

Many municipalities have taken steps to increase waste diversion in recent years. Ottawa, for example, instituted its green bin program in 2010 to collect and compost organic waste. The City then moved garbage pickup to a biweekly schedule in 2012. Collectively, these changes increased Ottawa's diversion rate of residential waste from 32 per cent to 46 per cent. Other cities have similar green bin programs to collect residential organic waste[4].

2.3.3 Alberta

Based on information available in the Provincial Business Plan 2017-2020 (prepared by Alberta Environment and Parks, AEP), 661 kg per capita of waste was disposed in the Alberta Landfills in 2015. AEP collects this information from the communities through periodic data calls. Information about the waste recycled or recovered or the provincial waste diversion rate is not available from the Govt. of Alberta database. Therefore, a trend analysis of waste generation rate was undertaken for the data shown in Table 2-2 to estimate per capita waste generation rate in 2015. It was estimated that in 2015, the waste generation rate in Alberta was approximately 964 kg per person which reduced to 946 kg/person in 2016. Using the interpreted waste generation rates and the waste disposed rates per capita of 661 kg in 2015, it would infer to a provincial waste diversion rate of 31%. This diversion rate is significantly higher than that quoted by Statistics Canada and shown in Table 2-2. The 31% diversion rate seems reasonable in view of the current state of waste recycling and several other waste management initiatives in place in the ACR and the larger municipalities like Cities of Edmonton, Calgary, Leduc, and Lethbridge. Currently, there is insufficient legislation to encourage, enable and empower Alberta municipalities in their efforts to minimize waste and achieve reduction targets.

2.3.4 Regional – Alberta Capital Region

Founded in 1992, the Capital Region Waste Minimization Advisory Committee (CRWMAC) is a voluntary group of technical and political representatives from 24 municipalities in the ACR including the City of Edmonton with representation from Alberta Environment and Parks (Government of Alberta). The ACR

[4] http://www.conferenceboard.ca/hcp/provincial/environment/waste.aspx?AspxAutoDetectCookieSupport accessed on Feb 22, 2018

covers approximately 11,500 square kilometers with a total population of 1,321,426 as per the 2016 Census (Statistics Canada)[5] of which almost 67% resides within the City of Edmonton. Other than the City of Edmonton, there exists three other established regional solid waste management systems in the ACR – the Leduc District Regional Waste Management Authority, the Roseridge Waste Services Commission, and the Lamont County Regional Solid Waste Commission. Besides these, the region is also serviced by private waste management entities like Waste Management Inc., Progressive Waste Solutions (previously BFI Canada), GFL Environmental and Evergreen Ecological Services Ltd. who are engaged in waste collection, disposal, composting and material recovery.

The current state of waste management in the ACR is briefly discussed in Table 2-4.

Table 2-4 Snapshot of Waste Management in the ACR (Larger Municipalities)

Municipality	Waste management system	Comments
City of Edmonton	Two stream collection system (garbage and recyclables) for single family and multi-family homes	EWMC
City of Spruce Grove	Two-cart system (black cart for mixed waste and green cart for organics) + blue bag recycling program. Recyclables collected weekly and mixed waste bi-weekly	Organics composted at Cleanit Greenit composting facility
Strathcona County	Two cart system for mixed waste (black cart) and SSO & yard waste (green cart) + blue bag for recyclables. Collection services contracted out and all mixed waste hauled to Roseridge Regional Landfill.	
Town of Stony Plain	Three-container systems - black for mixed garbage, green cart for organic waste and blue cart for recyclables, weekly collection in summer and bi-weekly in winters	Recyclables processed by Evergreen, Organics processed by Cleanit Greenit Composting/AD Vegreville
City of St. Albert	Weekly curbside collection (bi-weekly in winter), PAYT system, Two cart system for mixed waste (brown cart) and SSO (green cart) + blue bag for recyclables.	Collection services contracted out and all mixed waste hauled to Roseridge Regional Landfill.
City of Fort Saskatchewan	Co-mingled waste collection and a curb-side blue-bag program for recyclables. Collection weekly and the co-mingled waste trasported to the City's waste transfer station for further transport by Progressive Waste Solutions to their landfill near Coronation, Alberta.	The City also operates a Recycling Depot for recyclables and a Composting Centre for yard waste. Service provided to ICI Sector as well.
Parkland County	Operates six Waste transfer stations, Curbside collection only provided to hamlet of Entwistle + Blue bag recyclables drop-off program.	Waste collected at the transfer stations are disposed at a third-party landfill
City of Leduc	Curb side collection, two container system - green for organics and black for mixed garbage + blue bag for recyaclables. Weekly collection for organics and recyclables and bi-weekly for garbage	Organics & garbage to Ever Green landfill for further processing/ disposal.Recyclables to Ever Green's MRF in Sherwood Park for processing and marketing
Leduc County	Nine waste transfer stations + one regional landfill - accepts mixed waste, recyclables and compostable yard waste. No curbside collection provide except for Pigeon lake	

[5] Statistics Canada- accessed November 24, 2017

CRWMAC's current mandate is to provide a forum for information sharing that brings together member municipalities in a collaborative effort to promote and facilitate joint waste reduction solutions aimed towards meeting the waste diversion target of 80% by 2032.

Most major municipalities in the ACR have an established waste collection system with SSO collection program in place. However, based on the data from the ACR municipalities, only 25% of the organics generated were collected through the SSO program. It is assumed that the SSO collection program is currently available to only single-family homes. No other information is available about the SSO collection program e.g. the level of contamination observed in the SSO waste stream and participation rate from tax payers in the ACR (excluding the City of Edmonton). Based on Four Seasons Waste Composition Study[6], the compostable waste in the City's residential waste stream constitutes an average approximately 58% (single family homes) and 32% (multifamily homes). Given that, it seems likely that a significant portion of organics remain disposed in landfill.

In 2011, the ACR's overall waste diversion rate was 49% (organics and recyclables combined)[7]. Approximately 90% of this waste diversion was contributed by Edmonton, Strathcona County and St. Albert municipalities. It is to be noted that this diversion rate only relates to residential waste and does not include any ICI and C&D waste generated in these communities.

2.4 CITY'S CURRENT WASTE MANAGEMENT SYSTEM

2.4.1 Waste Collection System

The City provides manual waste collection services to single family homes and automated front-load bin waste collection services to multi-family homes and a small number of commercial customers. Both programs are two-stream (garbage and recyclables). The current recycling program is a single stream collection system, meaning all recyclables are collected as comingled including all grades and types of paper, plastic, glass, and metals. The City also operates four Eco-Stations that accept household hazardous waste, E-wastes and large objects that cannot be collected at the curb or in bins. Recyclables from multi-family units and commercial customers are gathered at community-based recycling centers through a blue-bin system. Approximately half of the City's households (single and multi-unit residential) are serviced by City whereas the other half receives collection services contracted by the City.

Table 2-5 shows an analysis of the residential waste disposal rate based on waste collection data provided by the City. An average 336 kg of residential waste per person is disposed annually including yard waste and grass clippings which accounts for approximately 56% of the total waste collected and/or received at the EWMC. Of the total residential waste received, 75% waste is contributed by single family homes and remaining 25% by multi-family homes as shown in Table 2-6.

An assessment of the quantity of waste composted from the City's residential collection stream is shown in Table 2-7. It indicates that an average 30% of residential waste was composted annually from 2012 to

[6] City of Edmonton Four-Seasons Waste Composition Study prepared by EWMC and Tetra Tech November 2016
[7] Alberta Capital Region Integrated Waste Management Plan, Phase I report – Integrated Waste Management Options prepared by EBA Tetra Tech April 2013

2016. This percentage of waste composted is much less than total compostable fraction available in the City's residential waste stream as noted from the Four Seasons Waste Characterization Study.

Table 2-5 City's Residential Waste Disposal Rate

Description			2012	2013	2014	2015	2016	Average
Population		(A)	817,498	847,712	877,926	888,687	899,447	
Total Waste Collected - All sources		(B)	538,317	529,599	500,949	508,622	529,217	521,341
Total Inbound at IPTF - Residential		F =C+D+E	249,641	305,786	284,291	289,006	325,233	
1	Pre Processing	(C)	194,331	249,970	229,408	230,021	264,824	
2	Materials Recovery Facility	(D)	46,337	47,222	46,044	46,378	45,576	
3	Residential Drop Off	(E)	8,972	8,594	8,839	12,607	14,833	
Residential Waste Disposal Rate (kg/capita/year)		F/ A	305	361	324	325	362	335
Residential Waste Fraction in City's Collection System		F/B	46%	58%	57%	57%	61%	56%

Note: Quantities are in tonnes unless specified

Table 2-6 Contribution of Single- and Multi-Family Homes to City's Waste Stream

		2012	2013	2014	2015	2016	Average
Garbage (IPTF Pre-processing)							
	Single Family Homes	145,618	171,674	175,009	172,512	183,711	
	Multi-family Homes	47,321	71,035	47,100	50,285	72,662	
Recyclables							
	Single Family Homes	35,216	35,889	34,994	35,247	34,638	
	Multi-family Homes	11,121	11,333	11,051	11,131	10,938	
Waste Fraction from:							
(a)	Single Family Homes	76%	72%	78%	77%	72%	75%
(b)	Multi-Family Homes	24%	28%	22%	23%	28%	25%

Note: Quantities are in tonnes unless specified

Table 2-7 Compostable Organics in City's Residential Waste Stream

Description		2012	2013	2014	2015	2016	Average
Total Residential Inbound at IPTF	(A)	249,641	305,786	284,291	289,006	325,233	
Total Organic Waste Outbound to ECF from IPTF	(B)	112,175	134,491	119,425	122,958	134,468	124,703
Outbound (residuals) to Landfill from ECF	(C)	21,787	39,632	38,327	29,917	56,177	37,168
Outbound to RDF from ECF	(D)	0	130	205	0	6	
Total Compostable Organic Waste	E=B-C-D	90,388	94,729	80,893	93,041	78,285	
Percent Fraction of Organic Waste in the Residential Waste Stream	E/A	36%	31%	28%	32%	24%	30%

Similar analyses were completed to determine the quantity of recyclables currently collected from the City's residential waste stream as shown in Table 2-8. These analyses are based on MRF Review and Retrofit Study[8], which states that of the total recyclables received at the MRF, 76% are collected from single-family homes (blue bag program) and 19% from multi-family homes (blue bin program).

Table 2-8 Recyclables in City's Waste Stream

Description			2012	2013	2014	2015	2016	Average
Total Residential Waste Collected		E=A+B+C	248,249	298,525	276,992	281,782	316,780	
Total Residential Inbound at IPTF								
(a)	Single Homes		145,618	171,674	175,009	172,512	183,711	
(b)	Multi-Family		47,321	71,035	47,100	50,285	72,662	
	Total	(A)	192,940	242,710	222,109	222,797	256,372	
Total Recyclables Received at the MRF								
(a)	From Single Family Homes	76%	35,216	35,889	34,994	35,247	34,638	
(b)	From Multi-Family Homes	19%	11,121	11,333	11,051	11,131	10,938	
	Total	(B)	46,337	47,222	46,044	46,378	45,576	
Total Residential Drop off		(C)	8,972	8,594	8,839	12,607	14,833	
Recyclables Fraction Collected through Current System		(B)/(E)	19%	16%	17%	16%	14%	16%

Note: Quantities are in tonnes unless specified

2.4.2 Waste Processing Overview

Established in 1995, the EWMC is a collection of advanced waste processing and research facilities that serve residents, institutions, and commercial businesses of the City. The EWMC is managed and operated by the City's Waste Services Branch. Annually, over 500,000 tonnes of residential and commercial solid waste are received and processed at the EWMC. Figure 2-3 exhibits a snapshot of process flow for the waste received at the EWMC.

The garbage collected through the curbside collection program and multi-family bin collection program is transported to the tipping floor of the Integrated Processing and Transfer Facility (IPTF) located inside the Edmonton Waste Management Center (EWMC) where it is pre-processed (sorting and/or sizing). After pre-processing, the putrescible waste is transferred to Edmonton Compost Facility (ECF) for composting, non- compostable and non-recyclable transferred to Refuse Derived Fuel facility (RDF) for Enerkem and the rejects remaining are transported to an offsite third-party landfill for ultimate disposal. Currently, Enerkem is not consistently operating, therefore the portion of waste sent to Enerkem is landfilled when Enerkem is not in operation.

The ECF was designed to process up to 125,000 tonnes/year of the organics fraction of residential waste and 40,000 tonnes/year of digested sewage biosolids, and in turn produces approximately 50,000 tonnes of finished compost and 25,000 tonnes of digested biosolids compost products. Currently, the composts product is primarily used in City's parks, construction projects, reclamation, erosion control and absorbent

[8] City of Edmonton Material Recovery Facility Review and Retrofit Study Report July 2013 prepared by EBA Tetra Tech

in farmland application. The Anaerobic Digester (AD) – currently under construction – will provide additional capacity of 48,000 tonnes/year for organics processing. The ECF is operated by a contractor (SUEZ).

Constructed in 1998, the Material Recovery Facility (MRF) at the EWMC processes the materials collected through the curbside blue bag and multi-family blue bin recycling program where it is sorted and bailed for market. The MRF was originally designed to process 70,000 tonnes per year of recyclables, However, based on data provided by the City, currently approximately 45,000 tonnes are processed each year. There are two main streams – fiber (paper and cardboard) and containers with the fiber comprising more than 80% of total waste received through blue bag recycling. Both, manual and mechanical sorting/processing are undertaken at the MRF. However, much of the recyclables collected at the public drop-off depots i.e. blue bins are not sent to the MRF, instead marketed directly by the City as being mostly segregated within an acceptable level of contamination from the marketing viewpoint. The MRF is also operated SUEZ (contractor).

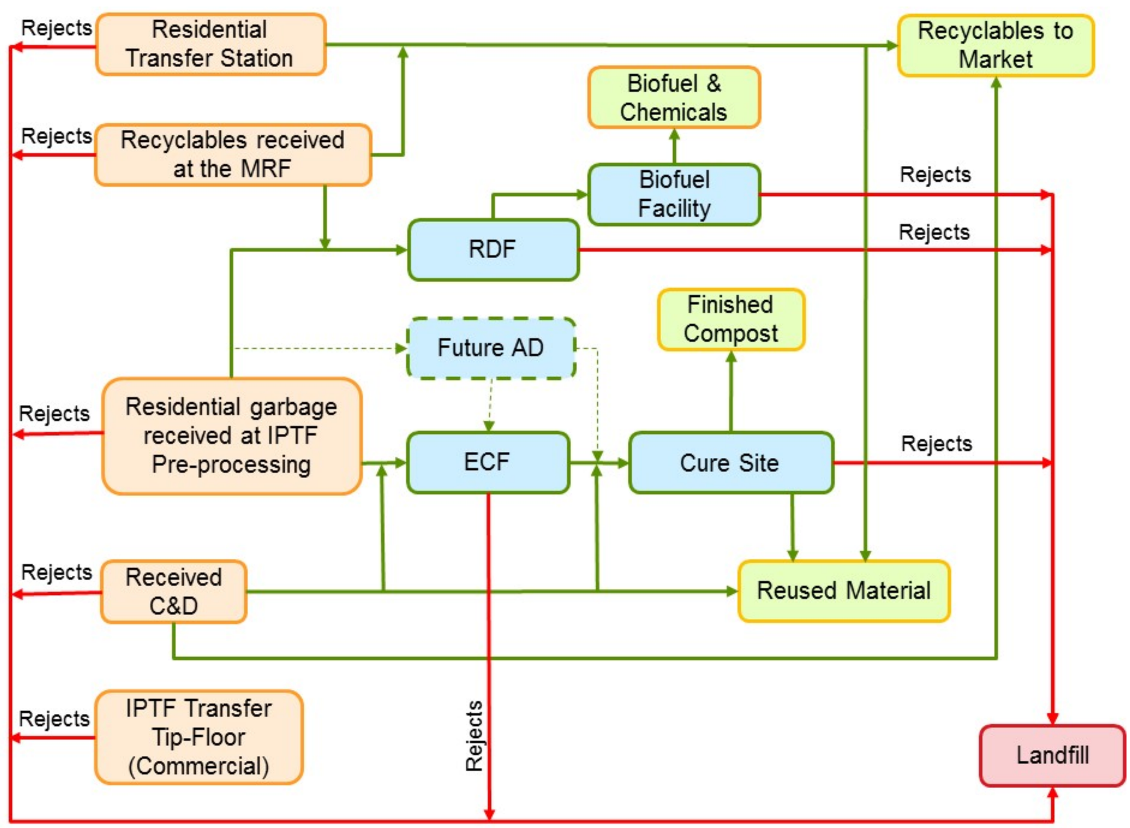

Figure 2-3 Schematic of Waste Flow Process at the EWMC

Non-recyclable and non-compostable wastes from IPTF are directed to the RDF plant to produce feedstock for the bio-fuel facility (Enerkem) which recently started operation. Rejects are generated at various stages of waste processing and are sent to an offsite third-party landfill for disposal. The landfills generally used are the Beaver Regional Landfill in Ryley or The Waste Management Inc. Landfill in Thorhild. Waste electronics collected at the Eco Stations are brought to the EWMC for processing and further recycling by a third-party agency as part of the provincial waste stewardship program. In the future, residuals from MRF, ECF, Cure site and C&D would be routed to the RDF.

The City also processes construction and demolition (C&D) waste which typically consists of clean wood, drywall, metals, trees and shrubs, concrete, and asphalt shingles. These materials are processed into secondary materials for a variety of other uses primarily on City projects. City-collected commercial waste is also processed to remove organics and recyclables which are then sent to the ECF and MRF respectively.

2.5 CURRENT WASTE DIVERSION RATES

Based on a review of the information provided by the City, an average of 520,000 tonnes of MSW was managed by the City annually from 2012 to 2016. A breakdown of waste generated by source and processed at the EWMC during this period is shown in Table 2-9.

Table 2-9 Determination of Waste Diversion Rate

Description		2012	2013	2014	2015	2016
Inbound/Received Waste at the EWMC:		(Tonnes)				
1	IPTF (Residential)	194,331	249,970	229,408	230,021	264,824
2	IPTF (Commercial)	135,435	104,768	89,437	96,516	99,588
3	MRF	46,337	47,222	46,044	46,378	45,576
4	C&D (Mixed)	29,859	40,467	40,685	35,401	46,781
5	C&D (Source Seperated)	81,703	66,534	66,119	60,338	57,615
6	Residential Drop-off	8,972	8,594	8,839	12,607	14,833
Waste collected in Roll-off bins (not received at IPTF but hauled directly to WELF		41,679	12,044	20,417	27,360	-
TOTAL WASTE COLLECTION		538,317	529,599	500,949	508,622	529,217
Outbound to Landfill from:						
1	IPTF (Residential)	64,513	100,712	115,359	99,281	102,050
2	IPTF (Commercial) - Direct hauled to LF	135,435	104,768	93,734	96,516	99,588
3	Compost Plant	-	-	-	-	-
4	Cure Site	14,798	-	15,879	27,698	16,206
5	C&D (Mixed)	8,779	14,512	24,063	22,156	20,617
6	C&D (Segregated)	319	464	765	470	28,177
7	MRF	7,964	5,794	10,325	11,081	9,850
8	ADC stockpile and Landfill Storage Area	-	-	-	-	4,914
9	Contracted Facilities	628	1,216	1,925	1,746	1,752
10	Residential Drop-off	604	3,700	3,452	6,987	9,682
Roll off bins directly hauled to WELF		41,679	12,044	20,417	27,360	-
TOTAL WASTE DISPOSAL AT LANDFILLS/RDF		274,720	243,211	285,920	293,295	292,835
Calculated Waste Diversion Rate		**49%**	**54%**	**43%**	**42%**	**45%**

Note: Since roll -off bins were directly hauled to WELF, it is counted in both Inbound and Outbound quantities

As noted above in Table 2-5, an average approximately 56% of the total waste received at the EWMC is from residential sources. Considering the national and provincial figures discussed in Table 2-2, where approximately 30-40% of the waste is contributed by the residential sector, the City's residential waste contribution is significantly higher. Since the City partially services non-residential sectors (ICI and C&D), it is likely that much of the waste generated by the non-residential sectors is collected/serviced by private haulers and disposed or processed at private facilities within or outside the City limits. For example, Northland Material Handling facility in the Parkland County provides an alternate avenue for C&D waste haulers. GFL Environmental and Evergreen Ecological Services Ltd. service both residential and non-residential waste sectors.

Looking at the data shown in Table 2-9, the average waste diversion rate in the City from 2012 to 2016 has been 47% which is significantly higher than provincial averages during the same period as noted above in Table 2-2, much higher than the national average diversion rate of 33% and reasonably close to the average ACR waste diversion rate of 49%[9]. It is worth noting that the containers collected through provincial stewardship programs and return to depots are not included in the waste recycled at the MRF. Therefore, in order to obtain a true picture of waste diversion by the City, it would be prudent to account for beverage containers received directly at the various bottle depots within the City as these containers are part of overall waste stream generated in the City.

[9] Alberta Capital Region Integrated Waste Management Plan: Phase I Report – Integrated Waste Management Options, Prepared by EBA Tetra Tech, April 2013

3.0 FUTURE WASTE MANAGEMENT NEEDS

MSW generation is influenced by economic conditions, living standards and population. Gross domestic product (GDP) per capita is a typical economic index correlated with MSW generation per capita and especially holds a strong correlation in countries with higher GDP per capita[10]. Future SSO and recyclables diversion rates depend upon several factors, many of them may not be in City's direct control. For example, building a facility with space for future expansion, either by City or ACR municipalities. Further, should Alberta choose to adopt an Extended Producer Responsibility (EPR) stewardship program on some types of packaging, there could be a shift in the type of recyclables generated and the way they would be processed.

3.1 WASTE DISPOSAL IN THE CITY OF EDMONTON

3.1.1 Total Waste (Residential and Non-residential)

The analysis of the City's data shown in Table 2-5 indicates that residential waste disposed in the City increased from 305 kg/person/year in 2012 to 362 kg/person/year in 2016, however, no specific trend in these values was evident. An average 336 kg per capita per year of residential waste was disposed during this period which includes yard waste. For making future projections, this was rounded-off to an approximate value of 340 kg per capita per year.

Further, an estimate of non-residential waste disposed in the City could not be made from the available data as the City does not provide services to the entire non-residential waste sector. In view of this, the City's non-residential waste disposal rate was determined by subtracting City's residential waste disposal rate from the provincial total waste generation rate of 946 kg/capita/year in 2016. This equates to 606 kg/capita/year of non-residential waste disposal rate in the City. Using this information and the population estimates as shown in Figure 2-2, an estimate of future waste quantities that would potentially be disposed by the City's residential and non-residential sectors were estimated as shown in Table 3-1.

Table 3-1 Waste Quantity Projections for the City

Year	City's Population (Forecast)	Waste disposal rate = 0.946 tonnes/capita/year		
		Residential @ 340 kg/capita/year (tonnes)	Non-Residential @ 606 kg/capita/year (tonnes)	Total Waste (tonnes)
2020	943,654	320,842	571,854	892,697
2025	1,016,157	345,493	615,791	961,284
2030	1,088,659	370,144	659,727	1,029,871
2035	1,161,162	394,795	703,664	1,098,459
2040	1,233,664	419,446	747,600	1,167,046

Given the historical trend in waste disposal rates for Alberta and considering a time horizon of 20-25 years, it seems unlikely that City's waste disposal rate would align with prevailing national waste disposal rates. However, should this happen, and the City's waste disposal rates align with national waste disposal

[10] Kosuke, K. and Tomohiro T. (2016). Revisiting estimates of municipal solid waste generation per capita and their reliability. Journal of Material Cycles Waste Management. 18, p 1-13.

rate of 706 kg/ capita/ year (with residential waste disposal rate of 280 kg/capital/year,Table 2-3), the total waste disposal in the City would be significantly reduced by 25% as shown in Table 3-2.

Table 3-2 Waste Quantity Projections assuming National Waste Disposal Rates

Year	City's Population (Forecast)	Based on Federal Waste disposal rate = 0.706 tonnes/capita/year		
		Residential @ 280 kg/capita/year (tonnes)	Non-Residential @ 426 kg/capita/year (tonnes)	Total Waste (tonnes)
2020	943,654	264,223	401,997	666,220
2025	1,016,157	284,524	432,883	717,407
2030	1,088,659	304,825	463,769	768,593
2035	1,161,162	325,125	494,655	819,780
2040	1,233,664	345,426	525,541	870,967

3.1.2 Compostable Waste

The Four-Season Waste Composition Study indicates that the compostable fraction in the residential waste stream is 58% and 32% for waste collected from single-family homes and multi-family homes respectively. Based on this information, an assessment of the total quantity of compostable waste available in the City's residential waste stream was generated, as shown in Table 3-3.

Table 3-3 Compostable Fraction in City's Residential Waste Stream

Description			**2012**	**2013**	**2014**	**2015**	**2016**	Average
Total Residential Inbound at IPTF								
(a)	Single Homes		145,618	171,674	175,009	172,512	183,711	
(b)	Multi-Family		47,321	71,035	47,100	50,285	72,662	
	Total	(A)	192,940	242,710	222,109	222,797	256,372	
Total Available Compostable Waste								
(a)	From Single Family Homes	58%	85,041	100,258	102,205	100,747	107,287	
(b)	From Multi-Family Homes	32%	15,190	22,802	15,119	16,141	23,324	
	Total	(B)	100,231	123,060	117,324	116,888	130,611	
Total Compostable Fraction Available in Residential Waste		(B)/(A)	52%	51%	53%	52%	51%	52%

Note: (a) Quantities are in tonnes unless specified

(b) Information about 58% and 32% compostable waste fraction was obtained from Four Seasons Study

[Note – currently an average 30% compostable waste is processed at the EWMC per Table 2-7].

The non-residential waste stream especially commercial, also contains a significant amount of organic waste such as kitchen waste generated from restaurants. Information about compostable waste in the commercial waste stream received at the IPTF was not evident from the data provided by the City. Therefore, a conservative estimate was made assuming that 5% of the non-residential waste received at the IPTF would be compostable. Considering this, the quantity of compostable organics potentially available in the future from both, the residential and the non-residential waste streams was calculated as shown in Table 3-4.

Table 3-4 Potential Compostable Waste Available in City's Waste Stream

Year	City's Population (Forecast)	COMPOSTABLE ORGANICS		
		From Residential Waste Stream (tonnes)	Non-Residential Waste Stream (tonnes) (tonnes)	Potential Total Compostable Waste (tonnes)
2020	943,654	166,838	28,593	195,431
2025	1,016,157	179,656	30,790	210,446
2030	1,088,659	192,475	32,986	225,461
2035	1,161,162	205,293	35,183	240,477
2040	1,233,664	218,112	37,380	255,492

Residential compostables: Population x 0.34 tonnes/capita/year x 52%

Non-residential compostables: Population x 0.606 tonnes/capita/year x 5%

3.1.3 Recyclable Waste

A similar analysis was completed for recyclables available in the City's waste stream. This analysis assumes that any recyclable in the non-residential waste stream is non-recoverable. Based on the Four Seasons Study, 12.2% and 17.7% recyclables in the single- and multi-family waste streams respectively are incorrectly disposed in the respective garbage streams. Accounting for these, a weighted average of approximately 31% recyclables are available in the residential waste stream for recovery as shown in Table 3-5 . Considering the above, the quantity of recyclables potentially available in the City's residential waste stream in the future is shown in Table 3-6 along with a breakdown for paper, plastic, glass, and metals.

In view of the above, the maximum waste diversion rate the City can target based on composting and recycling only would be 79% (52% compostable + 27% recyclables). This does not include the non-compostable portion of waste diverted to RDF and assumes that all the compostable and recyclables in the residential waste stream are recoverable. Recovering all the compostable and recyclables may be far from reality, however, a significant portion can still be recovered. Further, the City has a Contract with Enerkem for supplying 100,000 dry tonnes of waste per year. Although based on available data, this quantity has been significantly less for the period reviewed. However, should the City, in the future, is able to provide waste to Enerkem as per their Contract, it would further add to the effective diversion rate. For example, considering the inbound/outbound waste quantities for 2016 and assuming that 100,000 tonnes were diverted to RDF, the 2016 waste diversion rate would have been 64% instead 45% (Table 2-9).

Table 3-5 Assessment of Available Recyclables

Description			2012	2013	2014	2015	2016	Average
Total Residential garbage received at IPTF								
(a)	Single Homes		145,618	171,674	175,009	172,512	183,711	
(b)	Multi-Family		47,321	71,035	47,100	50,285	72,662	
	Total	(A)	192,940	242,710	222,109	222,797	256,372	
Total Recyclables Received at the MRF								
(a)	From Single Family Homes	76%	35,216	35,889	34,994	35,247	34,638	
(b)	From Multi-Family Homes	19%	11,121	11,333	11,051	11,131	10,938	
	Total	(B)	46,337	47,222	46,044	46,378	45,576	
(c)	Total Residential Drop off	(C)	8,972	8,594	8,839	12,607	14,833	
	Total	(D)	55,310	55,816	54,883	58,985	60,408	
			22%	19%	20%	21%	19%	20%
Total Residential waste collected (garbage + recyclables)		E=A+D	248,249	298,525	276,992	281,782	316,780	
Total Uncollected Recyclables (mixed in garbage)								
(a)	Single Family Homes	12.2%	17,765	20,944	21,351	21,046	22,413	
(b)	Multi-Family Homes	17.6%	8,329	12,502	8,290	8,850	12,788	
Total Available Recyclables in the City's Residential Waste Stream								
(a)	From Single Family Homes		52,982	56,833	56,345	56,294	57,050	
(b)	From Multi-Family Homes		19,449	23,835	19,340	19,981	23,727	
(c)	Total Residential Drop off		8,972	8,594	8,839	12,607	14,833	
	Total	(F)	81,404	89,262	84,524	88,882	95,609	
Total Recyclables Fraction Available in Residential Waste Stream (w/w)		(F)/(E)	33%	30%	31%	32%	30%	**31%**

Note: Quantities are in tonnes unless specified

Table 3-6 Potential Recyclables Available in City's Waste Stream

Year	Population	Paper	Plastic	Glass	Metals	Total Recyclables
		80.1%	**11.7%**	**4.3%**	**3.8%**	
2020	943,654	69,408	10,171	3,742	3,306	86,627
2025	1,016,157	74,740	10,953	4,030	3,560	93,283
2030	1,088,659	80,073	11,734	4,318	3,814	99,939
2035	1,161,162	85,406	12,516	4,605	4,068	106,595
2040	1,233,664	90,738	13,297	4,893	4,322	113,250

(a) Calculation for paper 2020: Population x 0.340 tonnes/capita /year x 27% x 80.1%

(b) Paper, plastic, glass and metal percentages are weighted average considering 75/25 single- and multi-family homes

(c) Weighted average was calculated based on mean value as provided in Four Seasons Study

(d) Quantities are in tonnes unless specified

3.2 WASTE DISPOSAL IN THE ACR

The projections for waste disposed in the ACR (excluding City of Edmonton) were made to determine potential opportunities for collaboration in waste diversion initiatives in the regional context, especially for the diversion of organics and recyclables. For making these projections, an average population growth rate of 1.6%, similar to City's growth rate, was used. It is estimated that between 2020 and 2040, approximately 60,000 to 84,000 tonnes of organics and recyclables (combined) could be available for a regional waste diversion program as shown in Table 3-7.

Analyses were also made for the case if a regional system is established with collaboration with other ACR municipalities for a centralized waste management facility for organic waste and recyclable wastes. Under that scenario, the total quantities of compostable waste and recyclables available in the region would be as per Table 3-8.

Table 3-7 Waste Quantities Available for Diversion in the ACR

Year	Population (excluding City of Edmonton)	Residential Waste (340kg/capita)	Organics available (~25%)	Recyclables available (~15%)	Total Waste Diversion
		(Tonnes)			
2011	347,668	118,207	29,552	17,731	47,283
2016	421,979	143,473	35,868	21,521	57,389
2019	442,560	150,470	37,618	22,571	60,188
2020	449,641	152,878	38,219	22,932	61,151
2025	486,782	165,506	41,376	24,826	66,202
2030	526,990	179,177	44,794	26,877	71,671
2035	570,521	193,977	48,494	29,097	77,591
2040	617,646	210,000	52,500	31,500	84,000

Table 3-8 Potential Waste Diversion Opportunities in Regional System

Year	City's Population (Forecast)	COMPOSTABLE ORGANICS		
		From City's Residential Waste Stream	From remaining other ACR municipalities	Potential Total Compostable Waste
		(tonnes)	(tonnes)	(tonnes)
2020	943,654	166,838	38,219	205,058
2025	1,016,157	179,656	41,376	221,033
2030	1,088,659	192,475	44,794	237,269
2035	1,161,162	205,293	45,511	250,804
2040	1,233,664	218,112	46,239	264,351

Year	City's Population (Forecast)	RECYCLABLES		
		From City's Residential Waste Stream	From remaining other ACR municipalities	Potential Total Recyclable Waste
		(tonnes)	(tonnes)	(tonnes)
2020	943,654	86,627	22,932	109,559
2025	1,016,157	93,283	24,826	118,109
2030	1,088,659	99,939	25,223	125,162
2035	1,161,162	106,595	25,627	132,221
2040	1,233,664	113,250	26,037	139,287

Based on this understanding, the City can make a strategic decision for collaboration with other municipalities in the region for a regional waste management facility. In making such decisions, the City would need to make several considerations including, but not limited to (a) waste quantities available from other municipalities in the region both, now and in the future, (b) level of efforts required to collect non-residential waste sector in the region (c) additional infrastructure required necessary for setting up a regional system, (d) collection efficiency from locating multiple processing sites in the ACR, and (e) anticipated additional revenue generation.

3.3 TREND IN RECYCLABLES COMPOSITION

Figure 3-1 exhibit trends in recyclables composition from 1960-2012 in the United States of America[11]. In the last 15 years there has not been significant change in the composition of recyclables generated in the residential waste stream. The future trend is expected to change a bit given the increasing trend in online shopping which would produce more packaging materials, such as paper and cardboard. Such increases may be masked by a reduction in glass and metals. However, implementation of an EPR regarding paper and packaging, although not considered right now, but if implemented may influence the City's revenue generation from a recycling operation.

[11] Making Sense of the Mix: Analysis and Implications of the Changing Curbside Recycling Stream, Prepared by Green Spectrum Consulting, LLC, and Resource Recycling Inc. for American Chemistry Council, February 2015

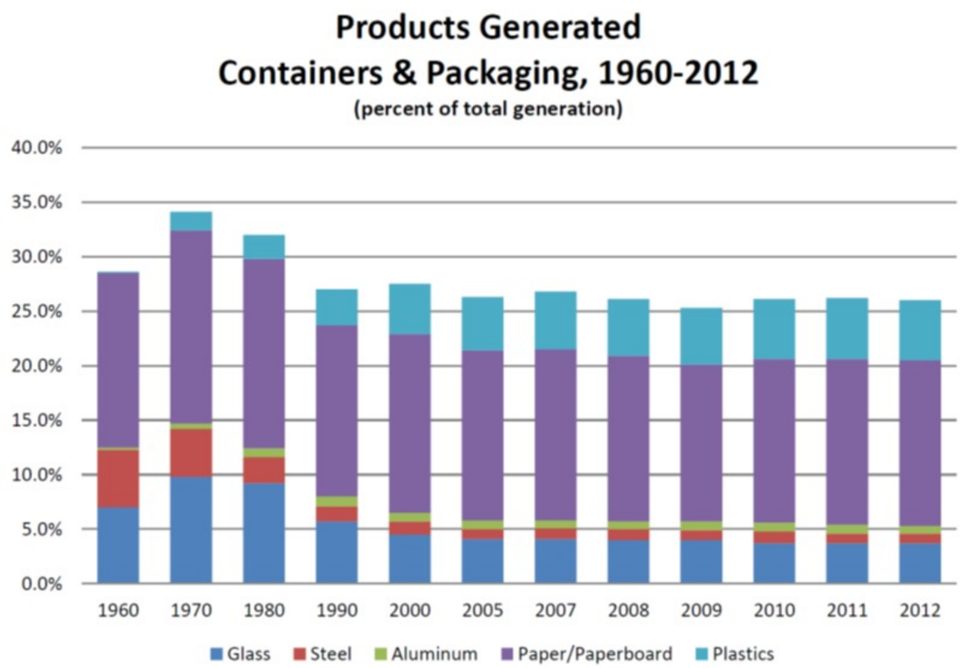

Figure 3-1 Trend in Recyclables Composition in the Curbside Collection Stream

4.0 LEGISLATIVE FRAMEWORK & INDUSTRY DEVELOPMENT

4.1 FEDERAL INITIATIVES

The responsibility for enacting legislation and/or regulations with respect to solid waste management rests with the provincial government whereby they regulate solid waste management in the province and ensure that waste management activities do not adversely impact the environment. While there are no specific regulatory directions from the Federal government on solid waste management it does set a framework through its council composed of the environment ministers from the federal, provincial, and territorial governments named the Canadian Council of Ministers of the Environment (CCME).

In 2009, the Council of Ministers approved a Canada-wide Action Plan for EPR, which is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. Further, in 2009 the Council of Ministers approved a Canada-wide Strategy for Sustainable Packaging which built on the larger Canada-wide Action Plan for Extended Producer Responsibility to make the producer responsible for end-of-life management of products and packaging. These policies, if implemented in Alberta may have implications on the recyclables managed by the City both in terms of quantity and quality.

4.2 GOVERNMENT OF ALBERTA TARGETS

4.2.1 Waste Management Strategy

"*Too Good To Waste: Making Conservation a Priority*" is Alberta's Strategy for Solid Waste Management which was proposed in 2007 and provides a road map for waste reduction and management in the Province. It is consistent with Alberta's 20-year strategic plan and provides a framework and long-term commitment to resource conservation and environmental protection while recognizing Alberta's accomplishments and strengths. Although this strategy states a desirable waste diversion rate of 80%, it does not mandate a timeframe to achieve the desired diversion target.

Considering the above, although the provincial strategy does not mandate a period for achieving the desired target, it is understood that local governments, like the City of Edmonton, should take the initiative and set their own waste diversion targets.

4.2.2 Government of Alberta Strategic Plan: 2017-20

The Alberta Strategic Plan identifies key priorities for government and includes three outcomes the government is working toward over the next three-year period. One of the expected outcomes of this Strategic Plan relates to "*Working to Make Life More Affordable*" with solid waste management identified as one of the performance indicators.

As stated in the 2017-20 Alberta Strategic Plan, the progress made in the waste management sector and its measurement has shifted to a performance indicator since the expected outcomes in this area are highly influenced by external factors which the provincial government has limited control. The performance in the solid waste sector has been set to be measured by kilograms of municipal solid waste per capita disposed in the landfills.

Further, upon review of this strategic plan, there appears to be no initiatives currently in place by the Alberta Government specific to solid waste management in the province. This implies that the onus lies with the local governments to ensure efficient solid waste management which includes reducing greenhouse gas emissions and diverting waste from landfills.

4.3 INDUSTRY DEVELOPMENT

4.3.1 Extended Producer Responsibility

In Canada, nine out of the ten Provinces have legislated EPR programs or requirements covering various product categories. In Alberta EPR programs are currently mandated for (a) used oils, anti-freeze, oil filters, oil containers and antifreeze containers, (b) Batteries, Tires and Thermostats, (c) Waste electronics and Paints. British Columbia is leading the implementation of EPR programs in many other areas such as packaging and printed paper, construction and demolition waste, carpets and textiles and furniture. Paper and packaging is a high value recyclable. If captured in Alberta's EPR program, a shift in the way recycling is currently done may be expected. it may impact the City's recycling programs financially being a high revenue item but overall it would contribute waste diversion goals, which is understood as prime instead revenue generation.

4.3.2 China's Green Fence Policy

China started to curb waste imports in 2013 when it launched its Operation Green Fence. This Green Fence Policy is essentially the strengthening of Article 12 of their legislation that regulates the import of solid waste into China. This has significantly impacted the global recycling industry that was shipping recyclables to China. Earlier in 2017, an even stricter policy was launched to further block imports of contaminated recyclables. As per Chinese media (South China Morning Post)[12], China recently notified the World Trade Organization that it will stop importing 24 types of solid waste, including plastics and unsorted/mixed paper.

Considering the above, for the City this would mean achieving much cleaner recyclables coming out of their MRF. Further, the Chinese stricter policies has/may lead to the advent of finding better and more efficient ways to minimize contamination in the recyclables including better technology. The technology assessment as part of this project will need to consider this aspect of waste recycling.

[12] http://www.scmp.com/comment/insight-opinion/article/2105049/how-chinas-stricter-waste-import-rules-may-well-sink-hong accessed Dec 4, 2017

5.0 SWOT ANALYSIS

The SWOT analysis discussed in the following paragraphs is focused on evaluating the general **S**trengths, **W**eaknesses, **O**pportunities and perceived **T**hreats on the City's solid waste management system and current and future waste minimization initiatives. The information was largely based on our general understanding of the City's waste management system, and information obtained from documents provided by the City including their website and other documents obtained from the provincial and federal governments, Recycling Alberta, CCME and Alberta Capital Region websites.

5.1.1 Strengths

1. Strong Leadership in sustainable waste management – The City is recognized as a leader in sustainable waste solutions and has been in the forefront in managing solid waste.
2. Good organizational set-up with a dedicated and established waste services branch with a distinct vison and mission – The City's Waste Services branch has a robust set-up with a distinct vison and mission. With its four sections, the Waste Services branch captures every aspect of solid waste management including providing education to public and enhancing their awareness for the environment.
3. Established enforcement mechanism and Waste Bylaw 17555 – The City's solid waste bylaw was recently updated in January 2018 and therefore reflects the City's commitment to ensure a proper and adequate enforcement tool.
4. Adequate funding mechanism – Generally, the robustness of a community is dictated by its population base. Despite many lows and highs over the past few decades, the City maintains a sound funding mechanism through its utility rate payers and is financially stable and a revenue generating entity.
5. Social consensus for proper waste management – There is consensus in the public with a strong public support and participation in the City's initiatives for waste recycling and diversion. This is partly supported by well-established recycling educational campaigns and voluntary programs at the elementary school level and the educational facility at the EWMC
6. Resource recovery earns carbon credits - Through its organic waste management program at the ECF and recyclables recovery from the waste stream, the City is playing a responsible role and supporting the National GHG emission control program. This also supports the federal, provincial, and regional vision for waste diversion.
7. Well established recycling educational campaigns and voluntary programs in elementary school level and at the EWMC for visitors
8. Maintaining useful technical data e.g. waste composition, as a starting point for future data collection and established Key Performance Indicators for facility operations

5.1.2 Weaknesses

1. Gap in information and inadequate data management. – Upon review of the information provided by the City some gaps in information were found and facility and/or equipment maintenance records that were either inadequate or missing.
    a. An example was worked out for a mass balance of the Compost facility operation for the year 2016 as shown in Table 5-1 which shows all the incoming and outgoing waste from the ECF. For this analysis, a typical value of 20% decrease in mass consequent to composting was assumed. Based on this analysis it shows an unaccounted waste tonnage of approximately 140,000

tonnes between 2012 and 2016. It would be crucial for the City to investigate and/or make improvements in data management.

b. High Unit Cost of Operation - Further, this analysis reflects that approximately 25-50% of the waste delivered to ECF was eventually disposed at the landfills as residuals. The possible reason may be that the waste being supplied to the ECF requires better sorting/segregation or the current process/technology is deficient in achieving adequate separation of organics at the IPTF. This may lead to multiple handling of a waste which could have financial implications. It is understood that City has installed bag breakers and is experimenting with changes to the trommel to improve separation.

2. Inadequate coordination amongst various units - engineering, planning and operations sometime may cause delays in decision making process
3. Process deficiencies in obtaining marketable recyclable and compost from the waste stream. More reliance on the contractor to improve final product
4. Aging processing and collection facilities
5. Non-residential waste sector not fully serviced – Although by way of City's Waste Management Policy (2007), the City is committed to leading technology and sustainable waste management services and supports initiative to move into non-residential waste services area. Based on data reviewed, there appears to be significant amount of waste in the non-residential sector that has not been captured by the City. Although it is not City's mandate to process ICI waste, the City's commercial collection has been set up and continues to grow. The City's intent is to provide options for customers, not take over the sector from private haulers and processors.

Table 5-1 Example Mass Balance for ECF

Total Waste Received at ECF	**2012**	**2013**	**2014**	**2015**	**2016**
From IPTF (pre-processing)	112,175	134,491	119,425	122,958	134,468
From C&D (mixed)	3,244	433	4,882	1,540	562
Woodchips from all sources e/x C&D	2,782	9,119	9,633	9,470	9,428
From C&D (source segregated)	1,056	13,581	7,868	5,872	353
TOTAL INCOMING TO ECF	**119,257**	**157,624**	**141,808**	**139,840**	**144,811**
Residuals sent to landfill from the Compost plant	(21,787)	(39,632)	(38,327)	(29,917)	(56,177)
Residuals sent to landfill from the Cure site	(14,798)	-	(15,897)	(27,698)	(16,206)
Residuals sent to RDF from Cure site	-	-	-	(845)	(276)
Output to all storages (compost pile, off-site, landfill)	(232)	(23,444)	(5,839)	(27,141)	
Marketable Compost generated	(24,433)	(19,468)	(20,475)	(19,503)	(18,355)
Total mass loss pursuant to composting (assumed 20%)	(23,851)	(31,525)	(28,362)	(27,968)	(28,962)
TOTAL OUTGOING FROM ECF	**(85,101)**	**(114,069)**	**(108,900)**	**(133,072)**	**(119,976)**
Undocumented Waste Quantity	**34,155**	**43,555**	**32,909**	**6,768**	**24,835**

5.1.3 Opportunities

1. New and improved technologies are available aimed at improving the product quality - Better waste processing, enhance resource recovery, minimize waste to landfill and increase waste diversion
2. An environmentally sound City's profile would mean privileged access to various federal and provincial funding that can support City's other green initiates and research programs
3. Service to ICI sector – The City currently provides partial garbage/recyclable collections from the ICI sector. Although, there is no City mandate to capture all commercial waste, there are opportunities to

provide enhanced services to this waste sector. Currently private haulers and processors manage the majority of this sector with only some managed by the City. The reason could possibly be vendors unwillingness to pay processing charges for mixed waste. An assessment may be required of the current capacity of the process facility and additional waste quantities that could be managed along with financial impact in consideration of political environment.

4. Collaboration with ACR communities - There may be opportunities for collaboration with other ACR municipalities as identified in this report. This would need to be evaluated prior to making a strategic decision in view of some of the considerations discussed earlier in this report.
5. Better sorting at the facility to capture recyclables and compostable from the garbage collected through curbside collection program.
   a. A review of the Waste Composition Study indicates that 24-34% of garbage collected through the curbside and multi-unit residential collection system are waste recyclables which either end up at the ECF and/or are eventually disposed of at the landfill. There exists opportunity to recover these recyclables from the garbage stream. It may not be feasible to recover all due to contamination and other reason. However, a substantial portion of these recyclables could still be recovered through public education, changes in the current processing system.
   b. Similar to recyclables, the Waste Composition Study indicates an average 32-58% compostable organic in the garbage collected from curbside and multi-unit residential. There is a good potential to capture remaining organics from the waste stream through making changes to the current process. This will equate to a revenue gain from the tipping fee paid at the landfill as well as carbon credits claimed by the City. It is understood that City is currently installing bag breakers to obtain better separation of organics at the IPTF.
   c. Currently, the recyclables collected at the various recycling depots are marketed directly by the City and the City getting 100% revenue. It is believed that by doing so, the City may be getting the best price for their commodity. Therefore, there exists an opportunity for the City to directly market recyclables recovered at the MRF themselves instead through the contractor and thus maximize revenue.

5.1.4 Threats

1. Potential for lower participation in the proposed SSO program, and willingness from the multi-family residential required
2. Best price for the commodity - Given the technological advancement in solid waste management over the past decade, solid waste is viewed more as a commodity or a resource. While the City can compete with private operators, there is still a possibility that some new players may enter the market and completely capture the garbage and recyclables collection from the ICI sector and transport it off the City limits to a private waste management facility. This may substantially impact revenue generation for the City.
3. Competition with Private Recyclers – Should the City want to capture the ICI sector, it may potentially be in competition with the private recyclers who are currently serving the major part of this sector including collection and processing. There could possibly be political pushbacks as well.
4. Market for recyclables & China's Green Fence Policy – As identified in the MRF Review and Retrofit study report[13], between 2007 and 2012, the fibers recovered constitute approximately 80% of the total material recovered. Eighty eight percent (88%), which is a substantial portion of the recovered fibers, was marketed internationally which includes the USA (and China). Therefore, the prevailing

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[13] City of Edmonton Material Recovery Facility Review and Retrofit Study Report July 2013 prepared by EBA Tetra Tech

overseas market and international policies including Canada's trade policies with those countries will dictate the market and hence revenue generation. Further, the market for fiber has seen a consistent decline between 2012 and 2016 (https://www.risiinfo.com/about-risi/)

5. Changes in packaging – Due to ongoing stricter regulations and the advent of Extended Producer Responsibility stewardship programs, businesses and manufacturers are moving towards better and environmentally friendly ways to market their products, especially packaging. Biologically degradable packaging has become more common in the past few years replacing plastics and flexible films. This will influence the way the City recovers recyclables from the waste stream including the technology that may be required to process new materials. There may be an evolution in the technology which would make current equipment unsuitable for processing. EPR may lead to potential changes to the waste stream.
6. Since the responsibility of marketing the recovered material rests with the Contractor, the City relies on the ability of the contractor to get the best price for the commodity which may or may not always be the case. This impacts revenue and the costs associated with recovering the marketable materials.

Appendix 5

Technology Assessment Report – Organics Waste Processing.
Stantec Consulting Ltd. April 2018.

Business Cases for the Renewal of ECF and MRF

Technology Assessment Report– Organics Waste Processing

April 2018

Prepared for:
The City of Edmonton

Prepared by:

Stantec Consulting Services Inc.

Sign-off Sheet

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1.0 BACKGROUND

The City of Edmonton owns a large agitated bay composting facility as part of the Edmonton Waste Management Center (EWMC). The facility was originally designed to process Municipal Solid Waste (MSW) using rotating drum digesters for pre-processing followed by agitated bay composting, refining and outdoor turned windrow curing. Several years ago, a new pre-processing and sorting system was placed upstream of the composting operation to divert Refuse Derived Fuel from the composting operation to a new gasification facility. At this same time, the rotating drum digesters were phased out of operation due to high maintenance cost. In addition to the agitated bay composting facility there is a new high solid anaerobic digestion (AD) facility under construction that will process 40,000 tonnes per year of source separated organics (SSO). The AD facility will utilize high solids anaerobic digestion followed by tunnel composting. The compost from the AD facility will join the compost from the agitated bay facility at the outdoor curing facility.

As part of long term strategy, the City is targeting an organics processing facility, which could either be renewal of the existing composting facility or an alternate technology to process SSO and organics from the MSW stream.

The purpose of this report is to review and assess various available technologies for organic waste management and provide recommendations for the best options that would meet City's current and future organic waste processing needs.

2.0 FEEDSTOCK MATERIAL

The Waste Flow Model for the EWMC summarizes the current and future waste processing needs. These are listed below:

Current material inputs include:

- 131,685 tonnes per year (TPY) MSW transferred to the composting facility from pre-processing at the Integrated Processing and Treatment Facility (IPTF)
- 40,000 TPY SSO received directly at the high solids anaerobic digestion (AD) facility
- Varying quantities of biosolids which change each year based on annual negotiations with the vendor that has responsibility for this material (Currently EPCOR)

Currently the material going into composting is organics derived from commercial and residential MSW that is processed through the large pre-processing operation upstream of the composting facility (i.e. IPTF). Material entering the pre-processing system passes through a variety of screens and shredders with the intent of removing non-compostable material. Non-compostable material removed at the IPTF is transferred to Refuse Derived Facility (RDF) and/or to the landfill.

The City is planning to change the waste collection system to improve the recovery of recyclables and source separate the organics from the curb side garbage (initially from single family curb side collection and later from multi-family bin collection systems). Practices included in the change will be to employ clear plastic bags to improve recycling, ban grass from collection, and collect SSO from single family residences. Below is an approximate breakdown of the City's waste by source:

- Single-family: 60%
- Multifamily: 37%
- Commercial: 3%

As can be seen, changing the single-family residences to SSO will have a significant impact on the relative ratios of MSW and SSO. Below is the City's projection of the organics waste stream:

Future material inputs:

- 70,000 TPY of SSO
- 20,000 TPY of MSW from the pre-processing system
- Some quantity of biosolids pending on processing availability and demand from the biosolids vendor

This represents a significant drop in the MSW stream and an approximately 81,000 TPY reduction in the overall material to be processed through any future proposed organics processing operation(s). It should be noted that the future tonnages assume a 12% increase in diversion rate from the current collection. The impact of lower diversion rates would be higher loading of the pre-processing system and more contaminants in the final product from the MSW material.

While the technologies that process the current MSW and the future SSO are the same, it is desirable to keep the two waste streams separate. The current composting operation has an issue with non-compostable contamination of the final product which includes sharps and film plastic. It is anticipated that final product derived from composting of SSO would be much cleaner, especially with regards to contamination e.g. sharps and therefore would fetch a higher price and have more end users. For this reason, it is likely it will be beneficial to keep the two material streams separate.

3.0 TECHNOLOGIES

Worldwide there are many reuse and disposal technologies for MSW with and without organics. These range from simple disposal in a landfill or destruction by thermal oxidation (incineration), to reuse technologies that produce products such as energy, soil amendment and fertilizer. It is the desire of the City to beneficially reuse the material described above to produce some type of product. Technologies reviewed in this TM will only be those that handle the materials discussed in Section 2 above and produce a beneficial reuse product. Table 3-1 lists the technologies that meet this criterion and the applicable products:

Table 3-1 Technology Overview

Technology	Variations of this Technology	Products Produced
Composting	Agitated Bay – Sorain Cecchini, ICS	Soil amendment, absorbent
	Tunnel	Soil amendment, absorbent
	Extended Aerated Static Pile	Soil amendment, absorbent
	Fabric Covered Aerated Static Pile	Soil amendment, absorbent
Anaerobic Digestion	High Solids Digestion	Power, soil amendment, absorbent
	Liquid Slurry digestion	Power, soil amendment, absorbent
Advanced Thermal Treatment	Pyrolysis	Power, char
	Gasification	Power, char
Conventional Thermal Process	Waste-to-Energy	Power, ash

Each of the above noted technologies are examined in further detail below:

3.1 COMPOSTING

There are several types of composting systems available that successfully handle material similar to that being processed by the City. The current system is an agitated bay system. This means the material is mechanically agitated several times in the composting process. Agitating the material is advantageous when processing heterogeneous materials. The agitation fluffs the material, improving air movement, and redistributes microorganisms and feedstock. Agitation is also helpful in breaking down fibrous materials. This benefit is demonstrated by spikes in compost temperature after agitation.

There are several agitated bay systems that have been successfully used to process MSW in North America; the Sorain Cecchini system is used in Edmonton; and the ICS™ system which is system used at the Delaware County Composting Facility in Walton, NY and Rapid City, South Dakota is the most common agitated bay system in North America. In any of the agitated bay systems the compost stays in the bays from 14 to 21 days. It then goes to curing. The length of time in curing depends on the method employed and how it is operated. For example, the City currently uses the extended turned windrow method for curing. The frequency of turning the windrow has significant impact on the amount of time is required for the curing process.

In the tunnel composting, the material is processed in an enclosed vessel with high rate aeration and a high degree of control of the temperature and moisture of the composting material. The material remains in the tunnel for 14 to 21 days. Afterwards it must be further composted in a curing process. There are several tunnel composting systems in Canada, including Calgary, Hamilton, and London, and the new AD facility in Edmonton will have tunnel composting after digestion. All these projects listed here process SSO. It is worth noting that these systems do not have agitation as part of the process, but they do successfully process the SSO.

Extended aerated static pile (EASP) composting has been most commonly used for processing biosolids, but there are two facilities in North America processing MSW with EASP - in Marlborough and Nantucket, Massachusetts. In EASP composting, piles are constructed each day by a front-end loader with air pushed up or drawn down through the pile. Generally, the material is not agitated. However, in the two North American facilities mentioned the material is agitated by moving the piles periodically. The pile is constructed at one end of the facility, is moved during the composting process, and exits at the other end of the building. In both cases, the material is moved by a front-end loader. Both facilities pre-process MSW in the large rotating drum digesters like City's previous organic waste processing system at the EWMC. The time in the aerated static piles is 21 days as a minimum in both facilities. Curing in the Nantucket facility takes place in windrows outdoors. In Marlborough the material often remains in the composting building longer than the 21 days or is cured offsite.

There are several large-scale, Fabric Covered aerated static pile (ASP) composting operations in North America, all handling SSO; Cedar Grove Composting in Washington State is the longest operating of these facilities. There are three in Ontario including the newest facilities in Belleville and in Thorold. There are several biosolids composting facilities using the covered ASP including Edmonton, which uses this technology for its outdoor biosolids composting operation, and a large facility in King County in California operated by the Los Angeles County Sanitation Districts (LACSD). For the SSO facilities, the residence time under the covers is six weeks with additional curing time required without the covers.

3.1.1 Existing System: Sorain Cecchini Agitated Bay

For nearly two decades the City has operated the existing agitated bay composting facility utilizing the Sorain Cecchini composting system. This system consists of the following:

- Negative aeration system that provides oxygen and controls pile temperatures
- Conveyor system that delivers the feedstock to the composting bays and removes it after 14 to 21 days
- Vertical augers that agitate the material. The augers also load the conveyor that removes the material after 14 to 21 days
- Screen that removes contaminants when the material leaves the aeration bays
- Curing in a turned windrow process
- Final screen after curing is complete

Material from the pre-processing system is picked up from the tip floor, loaded into a conveyor feed hopper, and conveyed to the one of two large aeration bays. The material is tipped into the bay by the feed conveyor. Vertical augers mounted on a bridge crane that spans each aeration bay move the material across the bay with each pass (Figure 3-1). The final agitation places the material on a conveyor belt that moves it to a screen. From the screen the material is loaded into trucks and transported to the curing site. At the curing site it is further composted in extended piles using the turned windrow method. With each pass of the windrow turning machine the pile is moved to the side, making room for new material to be added to the windrow. At the end of curing the material is screened again and stockpiled or trucked away to a customer. Marketing and distribution of the finished product occurs at the curing site.

In the aeration bays the compost is aerated by pulling room air down through the compost and sending it out to the biofilter for odor control. This is also the only way to ventilate the building housing the aeration bays. Table 3-2 lists the relative advantages and disadvantages of the current composting system.

Figure 3-1 Sorain Cecchini Auger System for Moving Compost Through and Out of the Aeration Bays

Table 3-2 Advantages & Disadvantages of Current Composting System

Advantages	Disadvantages
Fully automated system with automated material transfer	Composting in general has high energy consumption for aeration and
Proven and effective process	Building ventilation is through the compost only. This has two potential drawbacks, (a) There are competing demands for control of the aeration rate - control of compost temperature and the need to maintain a negative pressure in the building, (b) There is potential to send air too hot to the biofilter (above 40^{o}C), reducing odor treatment effectiveness.
Produces beneficial reuse product	Pile depth limited to approx. 2 meters, leading to large footprint.
Agitation improves composting with heterogeneous material.	

3.1.2 Agitated Bay System

The main difference between the ICS and the Sorain Cecchini system is the shape of the aeration bays and the type of agitator. The ICS system has a series of concrete bays, each about three meters wide and 70 meters long. Material is loaded into the front of the bays each day. The agitator rides on a rail on the bay walls, and as it moves down the bay it advances the material about 3.4 meters with each pass. After 21 agitations, the material is discharged from each bay, falls onto a conveyor or into a pit, and then goes to curing and screening. The compost can be aerated either by pushing the air up through the compost (positive aeration) or it can be pulled down through the compost (negative aeration). Figure 3-2 shows the agitator in front of the aeration bays. The agitator is on a trolley that moves it from one bay to the next. Table 3-3 lists the relative advantages and disadvantages of the ICS system.

Figure 3-2 ICS System Agitator

Table 3-3 Advantages & Disadvantages of ICS System

Advantages	Disadvantages
Highly automated but less so than Sorain Cecchinni	High energy consumption
Proven and effective process	Product quality and salability are potentially impacted by small sharps and other visible contaminants as in the current system.
Produces beneficial reuse product	Pile depth limited to approx. 2 meters, leading to large footprint.
Agitation improves composting with heterogeneous material.	Equipment requires significant maintenance compared to most composting systems.

3.1.3 Tunnel Composting

Tunnel Composting, like other composting systems, is a batch process. However, in tunnel composting each batch is placed into a concrete vessel that has an air tight door. Figure 3-3 shows the outside of several of the vessels with the air tight doors. The composting takes place in the closed vessel, which provides the benefit of isolating the process air and moisture from the rest of the facility. The process air in the vessel is recirculated through the vessel at a high rate. The system controls draw some of this recirculating air off to the odor control system and replace it with building air. This is done based on pile temperature and oxygen content. In addition, each vessel has a water spray system that adds moisture to the pile as needed to maintain optimum composting conditions. Although the loading of each vessel can be semi-automated, a front-end loader is required to take the compost out of the concrete vessel and move it to an area for curing. Other than this last step, the composting process itself is highly automated. There are several vendors that supply Tunnel systems. Most of these are European. The following facilities in North America. Orgaworld, Christiaens, GICOM, Engineered Compost Systems uses this technology.

Because it is recirculated throughout the composting process, ammonia concentrates in the air stream directed to odor control unit. Therefore, it requires the addition of an acid scrubber to the odor control system. Further, experience has shown that the material coming out of the vessel for curing is more odorous than other composting methods, so the curing area may potentially require odor control as well. Table 3-4 lists the relative advantages and disadvantages of tunnel compost systems.

Figure 3-3 Air-tight Door on the Outside of Composting Tunnels

Table 3-4 Advantages & Disadvantages of Tunnel Compost Systems

Advantages	Disadvantages
Highly automated aeration controls	More use of loaders, resulting in higher diesel costs and GHG emissions
Composting process environment is isolated from the rest of the compost building, improving air quality for workers.	Higher levels of air contaminants requiring scrubber before biofilters
Proven and effective process	
Produces beneficial reuse product	
Piles up to 3 meters reducing overall footprint relative to agitated bay systems	
Lower overall energy use, due to recycled air instead of single pass through	

3.1.4 Extended Aerated Static Pile

Extended Aerated Static Pile (EASP) utilizes three-meter-tall piles built over an aeration floor that can supply either positive or negative aeration to the material. All the material movement is performed by a front-end loader, and thus the labor requirements are higher than other systems. Since the piles are contained in a building that also must allow for equipment movement, there are extensive odor control requirements.

The system is not truly static pile when utilized for MSW, as the piles are moved during the process to add agitation. The piles are constructed at one end of the composting building and moved periodically to the other end of the building during the 21-day composting period. The material then goes to curing which often occurs outside. Capital costs tend to be lower than other systems because low cost building structures can be used such as the fabric composting building shown in Figure 3-4. Table 3-5 lists the relative advantages and disadvantages of EASP composting.

Figure 3-4 EASP Composting Facility Processing MSW

Table 3-5 Advantages & Disadvantages of EASP Composting

Advantages	Disadvantages
Low capital cost	High energy consumption due to high airflow for odor control
Proven and effective process	Low automation and high O&M cost due to high labor cost
Produces beneficial reuse product	Large odour control requirement since process air is not isolated from the rest of the building
Piles up to 3 meters in height reduces foot print	Less aggressive agitation

3.1.5 Fabric Cover Aerated Static Pile

There are several Fabric Cover composting facilities processing either source separated organics (SSO) or biosolids, including Edmonton's own biosolids composting facility. Edmonton's system consists of aerated static piles, each 10 by 50 meter. Each pile is covered by a Gore-Tex™ fabric that traps moisture but allows air to pass through. The air is blown up through the piles (positive aeration), and the covers trap a significant portion of the process odors. Figure 3-5 shows a typical fabric covered composting pile using the Gore™ Composting System. Often this provides sufficient odour control for the operation. However, in one case in Belleville, Ontario, the first two weeks of the composting operation required additional odour capture and dispersion, which was accomplished by placing the covered piles inside a building and exhausting the emissions from a tall stack. This was required to meet the very stringent odour regulations in Ontario.

The material remains in the piles for six to eight weeks. After removing the material from the cover, it must be cured and screened. With these fabric cover systems, the process generally takes place outdoors, and therefore handling of raw feedstock in the pile building process also takes place outdoors without odour control or prevention of windblown contaminants such as plastics not removed during pre-processing. Even long-standing operations such as the Cedar Grove facility in Washington State have had odor issues due to the outdoor handling of material. This can be remedied by enclosing the piles in a building. The only benefit of the covers in this case would be the potential to reduce odor control to dispersion only. Table 3-6 lists the relative advantages and disadvantages of Fabric Cover Composting.

Figure 3-5 Gore™ Fabric Cover Pile

Table 3-6 Advantages & Disadvantages of Fabric Cover Composting

Advantages	Disadvantages
Low capital cost	Low automation and high O&M cost due to high labor cost
Proven and effective process	Less aggressive agitation which can impact product quality
Produces beneficial reuse product	
Piles up to 3 meters in height reducing footprint	
Low odour control system requirements	

3.1.6 Composting Comparative Evaluation

The authors' observation has been that all composting facilities processing MSW have some sort of agitation. Agitation improves the composting processes for heterogeneous materials by redistributing the microorganisms and breaking up cellulose. This can be seen by the temperature spike that normally accompanies agitation of the composting material. Of the four technologies discussed above, only the agitated bay process provides efficient agitation. EASP provides agitation, but only by using a front-end loader, which is labor intensive and creates vehicle emissions in the enclosed composting building, resulting in the need for additional ventilation and thus odor control for the building. For SSO facilities this has not been the case. There are several facilities processing SSO that do not incorporate aggressive agitation. There are several tunnel systems operating in Canada processing SSO.

3.2 ANAEROBIC DIGESTION

In general AD technologies have been more focused on SSO rather than MSW. Even the plant under construction in Edmonton is slated to receive a cleaner waste stream than the existing composting operation. However, as more facilities accept post-consumer food waste, the levels of contamination in the feedstock are rising. The pre-processing system at Edmonton provides a high percentage organic feedstock that should be acceptable to high solids AD.

3.2.1 High Solids Digestion

High solids digestion is really a combination of solids and liquid digestion. The solid material is loaded into concrete vessels with air tight doors like those used in tunnel composting systems. Liquid is sprayed over the material, collected, and sent to a tank for traditional liquid anaerobic digestion. Methane is collected from both the solids vessels and the liquid tank and burned in an engine driving a generator that makes electricity. Heat from the engine warms the liquid going to both the solids and liquid digesters.

High solids digestion, also known as dry fermentation, has been widely used in Europe with 49 facilities as reported in a 2010 article in Biocycle. In North America there are at least five operating facilities excluding the new facility in Edmonton. These are:

- San Jose, CA;
- Surrey, BC;

- Oshkosh, WN;
- Richmond, BC and;
- Monterey, CA.

After digestion is complete the material is removed from the digestion vessel and placed into a composting vessel (tunnel composting system) to undergo composting. This transforms the material into something drier and friable that can then be screened to remove contaminants. After tunnel composting is complete, the material can be screened and sent to curing, and then given a final screening in same manner as the current MSW composting operation.

As noted in Section 3.2, high solids digestion has been used for SSO, and the facility under construction in Edmonton follows this model. Therefore, it will be necessary to run a trial with the MSW material to ensure the level of contamination will not prevent adequate digestion. Figure 3-6 shows the Surry BC SSO High Solids Digestion Facility. The tank in the foreground is the liquid digestion tank, while the solids are loaded into the concrete vessels inside the building. See Figure 3-7 for a photograph of the vessel type.

Figure 3-6 Surry SSO High Solids Digestion Facility

Figure 3-7 High Solids Digestion Vessels

Table 3-7 lists the relative advantages and disadvantages of high solids AD.

Table 3-7 Advantages & Disadvantages of High Solids AD

Advantages	Disadvantages
Power production	Material movement is all by front-end loader resulting in high O&M costs
Expansion of operation now under construction at the site	Less aggressive agitation for composting process
	Level of contamination must be understood and potentially controlled
	Some, but not all systems require substantial inoculant. This reduces the capacity for a given footprint

3.2.2 Liquid Slurry Digestion

Liquid slurry digestion is traditional mesophilic digestion with post-consumer food waste that has been pre-processed into a slurry of about 10% to 14% solids (Figure 3-8). This technology has been most widely used to process liquified food waste. The pre-processing commonly involves de-packaging of food waste in equipment such as the Scott Turbo Separator or similar. Often the separation process is performed by a third party specializing in this and is considered proprietary. From discussions with pre-processing firms it was indicated that a contamination level of 20% to 25% or less is best and that most types of contamination including metals can be removed. Items that cannot be removed are grit and broken glass.

In Ontario there are two facilities processing SSO into a liquid slurry for digestion. Both use a proprietary German technology supplied by BTA international that has a grit removal operation as part of the pre-processing. BTA has several projects in operation or planned in Europe but all are processing or will process SSO. Although MSW is mentioned on the BTA website there are no operating plants handling MSW. The two facilities in Ontario produce a dewatered digestate which is sold to a third party for composting with other materials. Because the slurry process involves large amounts of water at least one of the Ontario facilities has a treatment plant on site to reuse process water sand storm water for the slurry process. Table 3-8 lists the relative advantages and disadvantages of liquid slurry digestion.

Figure 3-8 Food Waste Slurry

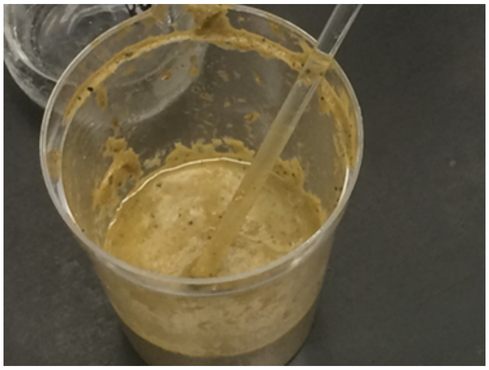

Table 3-8 Advantages & Disadvantages of Liquid Slurry Digestion

Advantages	Disadvantages
Power production	Not proven with Edmonton MSW feedstock
Relatively small footprint	Glass and other contaminants may make it not viable for pumping if not removed in pre-processing
Grit removal process improves end product quality	Additional pre-processing required
	Potential to need an additional dewater step
	High water use to create slurry and sewerage is not available at the City's site
	Plug flow process does not allow separate batches for MSW and SSO

3.2.3 Digestion Comparative Evaluation

High solids digestion is in the process of being implemented for SSO in Edmonton. Applying this technology to the MSW should not pose any process problems. However, since the final product will still be contaminated it will have to be kept separated from the SSO digestate. Since the high solids digestion is a batch process, MSW and SSO can be handled separately with the same technology.

Most pre-processing for slurry processes cannot remove glass and other small grit material. The BTA process does have a grit removal step in the pre-processing but it has not been used for MSW. As a plug flow process the MSW and SSO cannot be handled separately. For this technology to be considered viable it must be piloted to demonstrate sufficient ability to remove grit from Edmonton's MSW feed stock.

3.3 ADVANCED THERMAL TREATMENT

Advanced Thermal Treatment (ATT) consists of pyrolysis and gasification. Both are high temperature processes that occur in a low oxygen environment. Pyrolysis occurs at about 700oC and is the breakdown of organic compounds to carbon and synthetic gas. Gasification occurs at temperatures of about 1,200^{o}C. In gasification, the compounds broken out in pyrolysis reform into synthesis gas. Both processes are more efficient if the feedstock material is dried to 85% or higher solids content. Note that some moisture is needed in forming some synthesis gas. The synthesis gas is either combusted directly to generate heat used in drying the infeed material or to generate steam, or it is cleaned and burned in an engine generator to make electricity. The latter process generally only occurs with higher temperature gasification, the gas from lower temperature pyrolysis has too many impurities and is difficult to clean. It is therefore combusted directly to generate heat or steam.

Worldwide gasification of MSW has only been in widescale use in Japan. A significant driver in Japan is the lack of landfill space. Most of the gasification plants are a combination of gasification and ash melting plants. The MSW is first gasified in a fluidized bed gasifier. The resulting synthetic gas is used to combust the ash from the gasification process to create a molten slag that is recycled. The heat generated is used to produce steam that generates electricity. To prevent dioxin emissions, the process is run at higher temperatures of about 1,600^{o}C. Given the fact that gasification with ash melting is the only MSW gasification process with a significant track record with MSW, it is the only technology associated with either pyrolysis or gasification that will be considered in this evaluation.

Table 3-9 list the relative advantages and disadvantages of advanced thermal treatment.

Table 3-9 Advantages & Disadvantages of ATT

Advantages	Disadvantages
Power production	Highly complex process
Relatively small footprint	Significant air treatment
Low volumes of solid and liquid end products	Supplemental fuel may be required to meet high temperatures for process in ash melting stage
	No installations in North America and availability of operations vendors is unknown
	Ash may not be a viable product depending on heavy metals content

3.4 CONVENTIONAL THERMAL TREATMENT

Conventional Thermal Treatment is traditional waste-to-energy (WTE) via incineration of MSW. From a 2006 report to the Canadian Council of the Ministers of the Environment (CCME), there are seven large MSW incinerators in Canada, of which five are WTE facilities, with one 30-tonne-per-day facility located in Wainwright, Alberta.

There are several types of furnaces used in MSW WTE incinerators. However, the overall process is similar for all. Bulk MSW is dumped into a receiving pit where it is fed into the furnace/boiler by a grapple crane loading the waste onto a conveying system. Often there is some preliminary sorting of the waste to detect radioactive materials and large items not suitable to the furnace. Initially hot air from the process is passed through the waste to reduce the moisture content. High temperature and pressure steam is created in a boiler with heat from the furnace as in a conventional fossil fuel power plant. There is extensive emissions treatment requirements with dioxin, mercury, NOx and particulate emissions of primary concern. The residual products are ash and metals recovered from the waste.

Table 3-10 summarizes the advantages and disadvantages of WTE incineration.

Table 3-10 Advantages/Disadvantages of WTE Incineration

Advantages	Disadvantages
Power production	Highly complex process
Relatively small footprint	Significant air treatment
Significant volume reduction	Ash may not be a viable product depending on heavy metals content

4.0 TECHNOLOGY EVALUATION

As noted in Section 1 of this report, the purpose of this review is to determine the best technology option for future processing of the SSO and MSW waste streams.

Although biosolids are mentioned in Section 1, they are not a part of this evaluation as they are only an opportunistic material that may or may not be part of the process. In general, biosolids should not be considered in digestion since they are already digested at the Gold Bar WWTP. Thermal treatments for biosolids are not realistic because these systems require a steady stream of material of a set quantity to be run efficiently. The variability in annual quantities makes these technologies untenable for biosolids treatment at the EWMC. Therefore, composting is the only viable alternative. Given that the price paid for biosolids compost has been higher than others it would be best to keep them as a segregated waste stream if possible. Otherwise they will be blended with the MSW to improve product appearance.

In reviewing MSW and SSO technologies, the general goals of the City are to process both waste streams in the most efficient, cost effective, and environmentally responsible manner that ensures the end products of the process are beneficially reused. The process should be a well-established technology that is manageable by City staff and can be operated by a well-respected third-party operator. With these goals in mind, the following evaluation system and criteria will be used to perform a non-economic review of the technologies discussed above. The economics of the potential processes will be examined during the business case portion of the project.

4.1 CRITERIA

- Beneficial reuse of all end products
- Maximum use of existing infrastructure
- Process City staff can oversee
- Low overall energy consumption
- Low environmental impact
- Small footprint, capable of being sited at the existing site
- Availability of third-party vendors for operations and potential public-private partnership (P3)
- Sufficiently proven technologies

Each of these criteria is given a score from 1 to 3 in which 1 means poor performance relative to the criteria, 2 means medium and 3 means high performance. In addition, each criterion will be weighted on a scale of 1 to 3 where 3 is most important and 1 is least important.

Beneficial reuse of the end products is self-explanatory. However, it must be understood that any potential inability to use a product will reduce the score for an option. This criterion is weighted as a 3, as beneficial reuse has been the City’s mission since the co-composting facility was constructed almost 20 years ago.

Making the best use of existing infrastructure is straightforward as well, as it is generally the path to lower capital cost investment. The weighting factor of 2 was given to this criterion because it should not stand in the way of the best overall solution.

Having a process, the City staff can oversee does not mean the City has to run the operation, but it must be a process the City can observe accurately judge the level of performance, as well as understand the operation so multiple vendors can be evaluated. In general, this discourages black box proprietary processes. Because of the importance of understanding the process, this criterion has a weight factor of 3.

Low overall energy usage generally impacts greenhouse gas emissions and overall operations costs. Even when energy is low cost, it often represents one of the most significant operations costs for any waste processes. This criterion has a weight factor of 3.

Small footprint is important because there is limited space available at the Edmonton Waste Management Centre site, and significant investment has been made to make the site the one stop for the City's waste management needs. These two factors give this criterion a weight factor of 3.

The City has used third-party operations vendors for much of the life of the co-composting facility. In addition, there is a trend to P3 arrangements for construction, financing, and operations of large municipal facilities. The technology should lend itself to these options by having multiple vendors capable of providing and operating the technology. Since this is not essential this criterion is weighted with a factor of 2

The City has prided itself in leading the way in waste treatment and has the Waste Management Centre of Excellence at the Edmonton Waste Management Centre site. However, with that said the substantial investment by any Municipality must be made in best available technology with sufficiently proven track-record of performance. This criterion has a weight factor of 3.

Most of the technologies are capable of processing both SSO and MSW with the possible exception of liquid slurry anaerobic digestion. Since there is to be a significant shift in material from mostly MSW to mostly SSO the technologies are reviewed separately for each material type.

From **Section 3** of this report the following technologies were remaining for evaluation:

- Agitated Bay Composting for MSW. Tunnel composting can be considered for SSO based on the number of existing facilities
- High Solids Anaerobic Digestion
- Liquid Slurry Digestion
- Advanced Thermal Treatment
- Conventional Thermal Treatment

Table 4-1 and Table 4-2 lists the scoring for these five technology alternatives for processing SSO and MSW respectively.

Table 4-1 Technology Evaluation Scoring for MSW Processing

Criterion	Weight Factor	Composting Agitated Bay	High Solids Anaerobic Digestion	Liquid Slurry Anaerobic Digestion	Advanced Thermal Treatment	Conventional Thermal Treatment
		Score				
Beneficial reuse of all products	3	2	2	2	1	1
Use of existing infrastructure	2	2	1	1	1	1
City staff ability to oversee	3	3	3	3	1	2
Low energy usage	3	1	3	3	2	3
Small footprint, can be sited at the Waste Management Centre site	3	3	3	3	2	3
Availability of vendors and P3 potential	2	3	3	1	1	2
Technology sufficiently proven for MSW	3	3	1	1	3	3
Total Scores		**46**	**44**	**40**	**31**	**44**

Table 4-2 Technology Evaluation Scoring

Criterion	Weight Factor	Composting Agitated Bay & Tunnel	High Solids Anaerobic Digestion	Liquid Slurry Anaerobic Digestion	Advanced Thermal Treatment	Conventional Thermal Treatment
		Score				
Beneficial reuse of all products	3	3	3	3	1	1
Use of existing infrastructure	2	2	1	1	1	1
City staff ability to oversee	3	3	3	3	1	2
Low energy usage	3	1	3	3	2	3
Small footprint, can be sited at the Waste Management Centre site	3	3	3	3	2	3
Availability of vendors and P3 potential	2	3	3	3	1	3
Technology sufficiently proven for SSO	3	3	3	3	3	3
Total Scores		**49**	**53**	**53**	**31**	**44**

4.2 RATIONAL FOR THE SCORES PROVIDED

The following is the rational for the scores given to each technology for each criterion for MSW:

- Beneficial reuse of all products:
  - Composting and both types of digestion technologies were given a 2 based on contamination issues with current MSW compost product. Since all these processes do not remove the

contamination up front and all have composting and screening at the end, the same result would be expected for all three.

- Both advanced and conventional thermal process were given a 1 since both produce char or ash that may or may not be usable. While the ash can be used as an aggregate or in cement production, it is often landfilled.

- Use of existing infrastructure:
  - Composting received a 2. Although there is the existing Sorain Cecchini system, structural issues have rendered the building unusable for long stretches of time. This is not a viable mode of operation and thus at least parts of the system will likely have to be replaced.
  - High solids digestion was given a 1. Even though a new high solids system is being constructed now, expanding the system would likely mean all new construction with little shared infrastructure.
  - Liquid slurry digestion, advanced thermal treatment and conventional thermal treatment were each scored 1 on this criterion. Each would each require all new construction with little reuse of existing infrastructure.
- City staff ability to oversee:
  - Compost and digestion are common relatively low-tech processes that City staff either already have firsthand experience or would readily adapt to. Therefore, these were each scored with a 3.
  - Both thermal processes are complex high temperature processes that take time to master and can be damaged if not run properly. For these reasons they were scored with a 1.
- Low energy use:
  - Composting uses significant energy with no energy creation and was scored a 1.
  - Both digestion technologies as well as conventional thermal processes produce energy and were scored with a 3. Advanced thermal treatment as practiced in gasification with ash melting produces energy but also uses some supplemental energy in the high temperature ash melting process. Thus, this technology was scored with a 2.
- Ability to fit on the Edmonton Solid Waste Management Centre site
  - All technologies were given a 3 except advanced thermal treatment. Even though composting uses a large area it is already on the site and is demonstrated to fit.
  - The gasification with ash melting plant in Japan have many internal processes and images of these facilities show significant space usage. Thus, it was given a 2.
- Availability of vendors and P3 potential:
  - Compost and high solids digestion were both given a 3 due to the large number of firms that can design, build, and operate such facilities.
  - For MSW only one liquid slurry digestion company may be plausible and that will require pilot testing to prove and thus it was given a 1.
  - The only advanced thermal treatment technology demonstrates to work with MSW is the gasification with ash melting which is found only in Japan. Therefore, it was also scored with a 1.
  - There are several vendors that build and operate waste to energy incinerators and thus conventional thermal treatment was scored with a 3.

- Technology sufficiently proven with MSW:
  - Composting was scored with a 3 due to the long-standing practice at Edmonton and around the world of composting MSW.
  - Both digestion technologies were scored a 1 since they are most commonly used for SSO or separately collected pre, and post-consumer food waste.
  - Both advanced and conventional thermal treatment have a significant track record processing MSW and were each scored with a 3.

Most of the scoring for SSO technologies was the same as for MSW processing with following exception:

- Beneficial reuse of all products:
  - Composting and both digestion technologies were scored with 3 since a low contamination product, particularly in compost form is proven to be salable.
- Availability of vendors and P3 potential:
  - There are several vendors proving pre-processing for SSO and food waste without significant grit and glass. Therefore, liquid slurry was given a 3.
- Technology sufficiently proven for SSO:
  - Both digestion technologies have successful operations mostly in Europe but some in North America. This was sufficient to score both with a 3.

Table 4-3 lists the combined total score for each technology:

Table 4-3 Total Combined Scores for Both Materials

Material	Composting Agitated Bay	High Solids Anaerobic Digestion	Liquid Slurry Anaerobic Digestion	Advanced Thermal Treatment	Conventional Thermal Treatment
MSW	46	44	40	31	44
SSO	49	53	53	31	44
Total Score	95	97	93	62	88

When looking at the MSW only the existing composting operation scored the highest based on the assumption that a portion of it may be usable in the long term. If this is not correct it would have the same score as high solids digestion. For SSO only high solids and liquid slurry were tied for the highest ranking. When looking at the two material flows treated with just one technology, high solids digestion was scored highest with the current composting operation second.

The thermal technologies suffered from environmental concerns over emissions treatment, and the potential inability to beneficially reuse the ash.

The condition of the existing composting building is a significant unknown variable. Prior to issuing a request for expression of interest to vendors the building condition must be fully assessed and a determination made on the ability to use the structure reliably in the future.

5.0 CONCLUSIONS

Both high solids digestion and composting received the highest score. However, it may be possible for liquid slurry to compete. It was held back in the MSW score because there appears to be only one vendor with suitable pre-processing. It is important to note that neither digestion technology has been used to process MSW. For either digestion technology to be considered for MSW it would have to be piloted. For the liquid slurry technology only, the pre-processing system would need to be piloted to demonstrate its' ability to sufficiently remove contaminants. The high solids technology should be piloted with the MSW to see if the process is impacted by contamination.

In the absence of pilot testing digestion cannot be considered for MSW and composting would be the best alternative. The SSO could be digested but the digestate would have to composted.

The following are recommended criteria for a request for expressions of interest from vendors:

- Process 30,000 TPY of SSO utilizing digestion followed by composting
- Process 20 TPY of MSW utilizing composting. Digestion will only be considered if the process is piloted and demonstrated effective with the Edmonton MSW waste stream
- MSW and SSO must be processed separately
- The process must fit into the space outlined in Figure 5-1
- The existing biosolids dewatering operation exists within the designated space and must be left alone and operable
- The building housing the existing composting operation is structurally unsound and must be modified or replaced (this can be eliminated if further investigations find the structure to be sound)
- Further criteria will be developed in the business caser development portion of the project.

Regardless of the final technology selection, there is a potential issue with contamination of the product from the MSW waste stream, reducing its' value. This requires separating the MSW from other waste streams throughout processing. This impacts technology selection and the potentially the size of the facility. We understand that the City has made many attempts to improve the refining process for the compost to remove these contaminants. However, all parties now involved in making decisions need to be aware of the full extent of these efforts. It is also true that there are some facilities such as the MSW composting facility in Nantucket, Massachusetts that can remove the contamination using a screen followed by an oversized destoner and drying the product as close to 55% to 60% solids prior to final refining. It is also true that Nantucket has a very high degree of recycling and utilizes clear bags for collection with a high level of inspection and enforcement. Edmonton is planning to adopt the clear bag system which will reduce glass and metal contaminants. In Nantucket removing contamination is a bottleneck in the system but has been successful in combination with the clear bag collection. This is worth revisiting for the City given the impact of contamination on the process and final product.

Figure 5-1 Project Area

Appendix 6

Organics Processing Facilities – Request for Information.
Stantec Consulting Ltd. May 28, 2018.

Stantec

Organics Processing Facilities

REQUEST FOR INFORMATION

RFI No. - Stantec_COE_ECF Business Case

Issue Date: May 28, 2018

Closing Date: June 15, 2018

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Stantec

Cover Letter

RE: Request for Information for City of Edmonton Compost Facility Retrofit

Stantec Consulting Ltd. (Stantec) on behalf of City of Edmonton, AB, Canada is currently developing a business case for processing Source Separated Organics (SSO) and Municipal Solids Waste (MSW) located at the Edmonton Waste Management Centre (EWMC). As part of preparing the business case, we are issuing this Request for Information (RFI). This RFI is intended to assist City and Stantec in adequately identifying technologies and/or equipment that best serves City's intent for organics processing from SSO and from pre-processed MSW.

You are invited to submit a response to this RFI. We appreciate your time and look forward to your response by the closing date stated on the cover page of this RFI documentation.

Yours Sincerely,

Bruce Ferguson
Vice President, Programs & Project Management
Stantec Consulting Ltd.
10160-112 Street
Edmonton, AB T5K 2L6

1 PART 1 - BACKGROUND

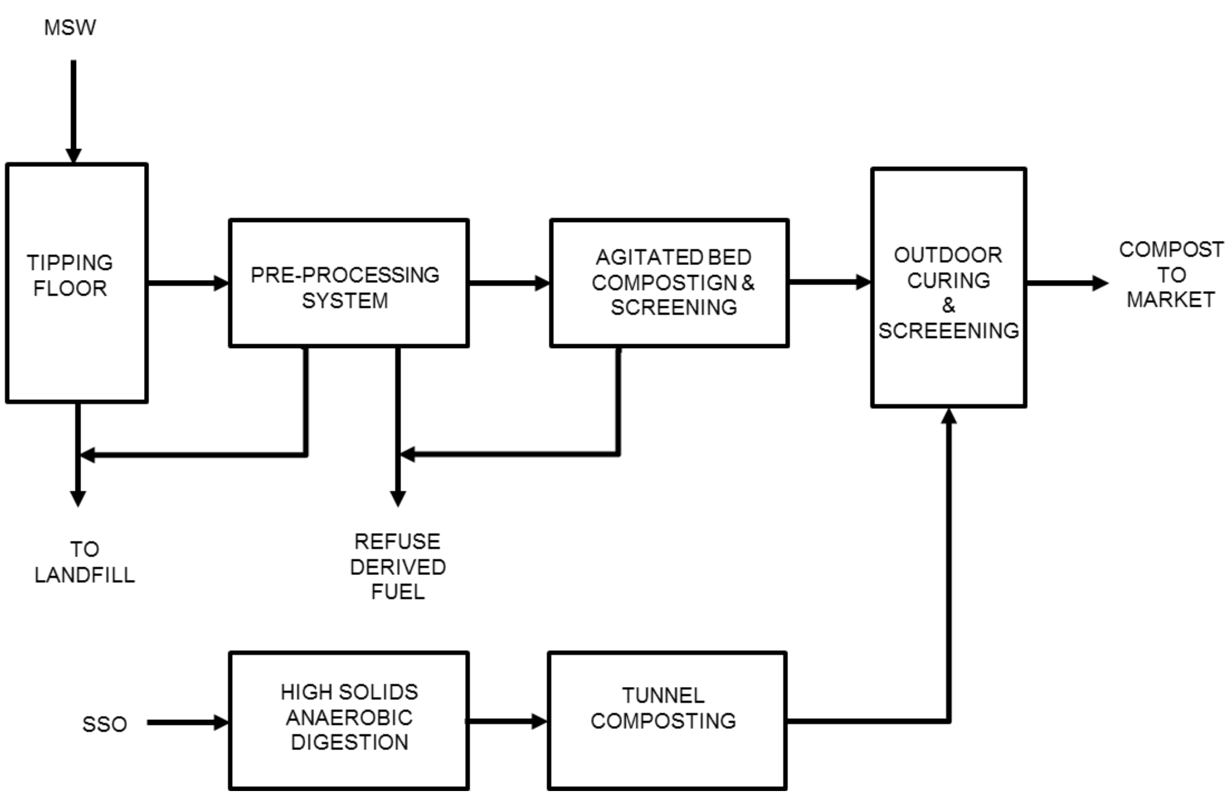
1.1 Overview of City's Organics Processing

The City currently processes organics as follows:

- 131,000 tonnes per year (tpy) of MSW that has been pre-processed to remove non-compostable material such as refuse derived fuel, glass and metals through an agitated bed composting facility (Sorain Cecchini).
- 40,000 tonnes per year (tpy) through high solids anaerobic digestion (commencing 2018). This feedstock will become SSO in 2020 when the City implements its new collection system.
- Sporadic amount of biosolids through the agitated bed composting facility

Figure 1 shows the schematic of the current process:

Figure 1: Current organics processing schematic



A characterization of the current waste streams can be found in **Appendix A**. The compost derived from the organics fraction of the SSO often has contamination that impacts the value of the end product.

The City is instituting changes to the waste collection system aimed at converting to mostly SSO collection in 2020 with a reduction in yard waste and improved recycling. By 2024 the following material is expected to be processed at the EWMC:

- 70,000 tpy SSO
- 50,000 tpy of MSW, containing approximately 50% organic fraction, sorted through pre-processing.

The City is seeking information on alternatives as part of a business case development for processing these materials in the future.

1.2 The Opportunity for Vendors

The City is seeking alternatives for processing the following:

- 30,000 tpy in 2024 growing to 40,000 tpy in 2044 of SSO. It is expected that 40,000 tpy of SSO will continue to be processed through the new high solids digestion facility.
- 25,000 tpy in 2024 growing to 35,000 tpy in 2044 of MSW

The two types of materials, SSO and MSW are to be processed separately either as separate batches in the same process or in separate operations. The materials are to be processed through either of the following:

- High solids anaerobic digestion and composting to improve product quality and provide a Process to Further Reduce Pathogens (PRFP); or
- Composting alone.

The vendor is free to select only one type of material or both.

The intent is to produce a reusable organic material of the highest possible quality meeting(PRFP), Provincial and Canadian Council of Ministers of the Environment (CCME) guidelines.

1.3 Purpose of the RFI

The purpose of this RFI is to obtain input from industry to allow the City of Edmonton to assess technology provider responses and use such assessments in future decision making regarding the selection and supply of SSO and MSW processing. The information received from this RFI process will be used to support the selection of a technology for incorporation into a strategic business case being prepared in mid-2018. The business case will be presented to City Council in the fall of 2018 and, if approved, the City’s goal is to commence with detailed planning and design of the selected technology and business strategy in 2019.

As the purpose of this RFI is to obtain information from industry on technologies that will meet the City’s goals for future organics processing, it is not a formal tender or request for proposals. Suppliers providing input into the assessment of technologies at this stage will not be precluded from future participation in the implementation of the business case and procurement of the selected technology solution.

The RFI process is intended to provide accurate information in developing a business case for future organics processing at the EWMC. Information gathered will inform the technology(s) to be employed based on both anticipated performance and cost of construction and operation as well as other factors determined by the City.

Neither Stantec nor the City make any representation, obligations or undertakings in any way to:

- go to the next stage of procurement, or
- accept any RFI information received from technology providers, or
- include or exclude technology providers responding to this RFI in any future tender invitation, or
- any other commitment whatsoever including any intention to form a binding contract with Stantec or the City for supply or installation or operation of the ECF.

2 PART 2 - INSTRUCTIONS FOR VENDORS

2.1 RFI Key Dates

The following key dates apply to this RFI

RFI Issue Date: May 28, 2018

RFI Closing Date: June 15, 2018

2.2 Contact Person for this RFI

The RFI process is being undertaken for the City by Stantec Consulting Ltd. (Stantec). All inquiries related to this RFI are to be directed in writing to:

Name: Courtney Newsham

Title/ Position: Assistant Project Manager

Email Address: courtney.newsham@stantec.com

Mailing Address: 10160 – 112 Street, Edmonton, AB, T5K2L6 Canada

2.3 Submission, and Queries and Questions during the RFI period

1. Submissions in response to this RFI should be made electronically
2. Any queries or clarifications should be emailed to the Contact Person. Stantec may choose to convey responses to submitted questions and queries to all invited vendors.

2.4 Vendors to Inform Themselves

Stantec has taken all reasonable care to ensure that the RFI is accurate; however, neither Stantec nor the City give any representation or warranty as to the accuracy or sufficiency of the contained information.

2.5 Costs of preparing the response

All costs relating to the preparation and submission of a response are the sole responsibility of the vendor. The City or Stantec shall not pay the supplier, wholly or in part, for its response.

2.6 Confidentiality

Except as required for the preparation of a proposal, vendors must not, without City's or Stantec's prior written consent, disclose to any third party any of the contents of the RFI documents. Vendors must ensure that their employees, consultants, and agents also are bound and comply with this condition of confidentiality.

2.7 Acceptance of these conditions

Vendors, by submitting a response to this RFI, are deemed to have acknowledged and agreed to the conditions set out in this RFI.

3 PART III – INFORMATION TO BE PROVIDED

This Part details all the information vendors are required to provide to Stantec. Submitted information will be used by the Stantec as set out in Section 1.3. Your answers may include as much or as little detail as you feel is necessary. Additional information or questions on matters or issues not raised is welcomed. The following minimum information is to be provided.

3.1 Vendor Information

1. Vendor Business/Registered Name and address.
2. Details of Manufacturing Unit(s) and their locations.
3. Ownership information, including details of Directors and other key office bearers and number of employees.
4. Details of any current legal actions pending against the supplier or its directors and/or office bearers.
5. Relationships with any parent company (if applicable).
6. Details of joint venture arrangements (if applicable).
7. Details of when the supplier organization was founded, including origins and historical development of the organization (if needed).
8. Details of Canadian Dealer, if any, or nearest dealer to the City of Edmonton

3.2 Vendor Capabilities and Experience

1. A description of the Vendor's core business, listing relevant case studies or examples (a maximum of three) that support this description. Where possible, include case studies that may relate to activities consistent with the RFI. Within necessary boundaries of confidentiality, please be as specific as you can.

2. Additional services, products and works provided outside of your core business.

3. Vendor should supply up to three project references in which the recommended technology was employed on similar materials to those being proposed for the EWMC.

4. Details of key health and safety, environmental and other performance measures.

3.3 Certification and Awards

1. Details of all certifications held (e.g., ISO 9001) including date of last certification/recertification and details of the certifying body (copies of certifications may be appended to your response).

2. Details of any recent external corporate awards, including the awarding body, if relevant to the Opportunity.

3.4 Policies

1. Details of all major supplier policies, including Health and Safety, Environmental/ Sustainability, Employee Relations and Local Participation. Copies of policies are to be appended to your response.

3.5 Recommended Contracting Strategy

The vendor may provide experience or recommendations for their preferred delivery method for their technology including:

- Supply only;
- Design Build;
- Design, Build, Finance
- Design, Build, Finance, Operate and Maintain; or
- Other

3.6 Processing Alternative

The following information is requested:

- Material to be processed
- Technology to be employed for each material

The following should be provided for each technology recommended at 2044 levels of processing:

- Process flow diagram for each material and technology recommended
- Green field footprint of the suggested alternative at 2044 estimated volume
- Anticipated quantities of product to be produced by each technology and anticipated quality including refining or product finishing to maximize product quality
- Anticipated emissions/odour controls for each technology
- Stipulate method to achieve PRFP product requirements
- Power usage and/or creation for each technology
- Anticipated downtime for major equipment items
- Staffing levels of each technology

- Flexibility and scalability of equipment or process to handle increased future volumes (i.e., implementation of an Edmonton metropolitan region waste management strategy as opposed to a City-specific one with increased volumes from surrounding jurisdictions).

3.7 Indicative Pricing

The RFI is only seeking an estimated pricing to assist with the preparation of business case for budgeting or expenditure approval purposes. The following costs are requested:

- Greenfield capital cost for purchase and construction for each technology
- Annual O&M cost for each technology
- Market value of each product produced

Stantec understands the sensitive nature of process and pricing to the vendors. Indicative pricing from multiple vendor's will be used as well as other estimated costs for items such as demolition, site work, etc. in developing a business case for future organics processing. Vendor specific information will not be disclosed in the business case.

3.8 Assumptions

The existing composting facility is not expected to be operable into 2044. It may have use in 2024 but only with a major retrofit to the building and potentially to the mechanical equipment. Vendors should not consider the existing composting facility or system as part of their submittal.

Vendor's may assume the existing tipping building will be available for future use and need not include a separate tipping portion of the process unless essential to the recommended technology.

All pricing should be considered for greenfield construction. Do not include any demolition of existing facilities.

Appendix 7

Memorandum Re: COE ECT/MRF Business Cases – Proposed KPIs for Technology Assessment. April 5, 2018.

Stantec

Memo

To:	ECF/MRF Steering Committee City of Edmonton	From:	Bruce Ferguson Stantec Consulting Ltd.
File:	1101-28016 (Business Cases for Renewal of MRF and ECF)	Date:	April 5, 2018

Reference: **COE ECF/MRF Business Cases – Proposed KPIs for Technology Assessment**

The following KPIs are proposed for assessing new and better technologies for (a) the Material Recovery Facility (MRF) to process recyclables collected through the blue bag/ blue bin collection stream, and (b) processing organic fraction of municipal solid waste received at the EWMC. These KPIs have been finalized based on discussions held with the City project team during the workshop of Dec 13, 2017 and subsequent meetings on Jan 22, 2018, February 2, 2018 and February 16, 2018. It is believed that some or all the KPIs may be applicable to the current operation of existing MRF and the Edmonton Compost Facility (ECF), however, the terms of reference for the project requires the business cases to be forward-looking.

Proposed KPI	What is being Measured	Target Value (specific to Technology Assessment)	KPI Significance as it relates to:	
			Technology Assessment	Current Operation
ORGANIC WASTE PROCESSING FACILITY				
KPI-1(ECF): Operation Cost	Cost of operation	Comparative parameter	This provides a comparative value of various technologies assessed in terms of power consumption, manpower, rejects, etcetera that influence overall operation cost. (the overall capital cost is part of the triple bottom line methodology and therefore has not been includes as a KPI for either facilities)	City can use current value of their operation cost as a target to improve upon in this KPI
KPI-2 (ECF): Product Marketability	Market value of finished product (per tonnes)	Comparative value for assessment of technologies	This provides an assessment of finished product quality and its market acceptance of product, (c) net cost to City to produce such product(s)	City can use a weighted average value of compost marketed to set as a target to improve upon in this KPI

Reference: COE ECF/MRF Business Cases – Proposed KPIs for Technology Assessment

KPI-3 (ECF): Diversion rate of Organics	System efficiency for organic waste processing	Industry best processing time in producing a desired quality of product	The technologies assessed should consider SSO and mixed stream infeed, as well as pre-processing options to influence overall diversion rates. The intent is having the technology provide (a) industry best processing time in producing a desired quality of marketable product and (b) reduce any organic matter in the residuals been sent to landfill	SSO program is not in place yet. However, City could improve pre-sorting at the IPTF to enhance organic waste going to ECF with less residuals coming out of it and improve upon the overall diversion targets
KPI-4 (ECF)	Proprietary and Non-proprietary technology	Individual proprietary equipment is acceptable, but the overall system must be open sourced to several vendors	The KPI would ensure that the new technology is not a black box technology with proprietary controls such as the current gasification system. It should provide flexibility and ease in operation	Not Applicable to current operation
KPI-5 (ECF): Environmental	Emissions	Comparative value for reviewing technologies	The technology should be environment friendly, regarding power consumption, control odors at source and able to be retrofitted to the existing odour control system (biofilters)	Current operation has GHG accounting. City can set targets to improve upon by reducing rejects going to landfill. This KPI can also be used to measure odour containment efficiency e.g. maintaining negative pressure in the aeration hall 99% of the time
KPI-6 (ECF): Process Availability	Planned and Unplanned Equipment downtime	5% or less	Planned maintenance schedule and resulting downtime and spare parts availability is one of the criteria in technology assessment, not per se, a KPI for technology assessment	The City can use this KPI to set a target of 5% or less unplanned equipment downtime to improve upon and > 95% target for PM

MATERIAL RECOVERY FACILITY				
KPI-1 (MRF): Productivity	Productivity gap	± 10% of optimum productivity obtained based on factored value of equipment design capacity making allowance for equipment downtime etcetera.	Tech Assessment will review design capacity and turndown required in relation to processing needs for recyclables over the next 20 years design life.	± 10% of optimum/ target productivity that can reasonably be achieved under the given circumstances is a good target for the current operation. The KPI to be calculated from total quantity of recyclables coming out from the operating line(s) regardless of product quality for each work shift divided by Run Time (tonnes/hour). The Run Time accounts for planned and unplanned stops.
KPI-2 (MRF): Recovery Rate	Sorting Effectiveness and diversion rate	>80% recovery rate considering both single- and multi-family homes based on weighted values for each	Proper design of conveyors and separation equipment for the type and quantities of material handled directly affects recovery rates. Technology assessment will review sorting effectiveness for processing recyclables collected from single family and multi-family homes. The later waste stream is expected to have relatively more contamination and the technology assessment will review pre-processing options to enhance recovery rates.	For the current operation, this KPI target may be set at 65-70% to improve upon due to average 30% residuals/rejects. The KPI to be calculated as the weight of marketable recyclables produced per tonne of infeed (discards quantity to be deducted from infeed quantity, typically <3%) Separation and processing required or desired is influenced by market requirements, infeed quality, and economics of separation. If the product is difficult to market for whatsoever reason and it is going to be landfilled ultimately, it is not worth recovering from the waste stream.
KPI-3 (MRF): Quality (Marketability)	Product Quality	>85% of the time the final product meets or exceeds the desired quality standard to be set by the City	The technology assessment will aim at identifying technologies targeted at producing product with acceptable	City can use a weighted average value of all marketable products (recyclables) sold and set it as a target to improve upon.

		considering current market policies and Industry Standards (Scrap Specifications Circular 2017)	contamination given prevailing market policies.	
KPI-4 (MRF): Workability or Time	Equipment Utilization in view of planned and unplanned stops	>85%	Not applicable to technology assessment	The City currently measures Uptime (%), TPH and residual rate (%) which can be set as targets to improve upon
KPI-5 (MRF): Total Operating Expense	Expenses to operate MRF including labor cost to run extra shifts	City to set a target for O&M cost ($/ tonne of operating MRF) based on financially sustainable operation and City's intended business goal	For technology assessment, this is one of the criterion for evaluation and not a KPI	It is believed that City currently measures operation cost per tonne i.e. O&M Cost to address this KPI.

The following describes the Criteria being used for technology assessment:

Organic Waste Processing	**Material Recovery Facility**
• Leading edge but sufficiently proven technologies	• Proven with mix of sorting and separation technologies that ensure efficient and economical sorting with desired output quality driven by market
• Beneficial use of product	• Maximize material throughput and minimize residue. Produce consistent stream of quality recovered materials
• Best use of existing infrastructure	• Operational Efficiency – resources (labor and capital) required in sorting and processing materials

Reference: COE ECF/MRF Business Cases – Proposed KPIs for Technology Assessment

• Process City staff can oversee	• Pre-processing to handling special material like glass/ broken glass, large items ahead of main process line
• Low energy Uses	• Operational adaptability – ability to meet changing business needs, future changes in packaging, and future expansion requirements
• Low Environmental Impact	• Meet and exceed regulatory requirements and import regulations
• Small Footprint, capable of being accommodated at the existing site, but allowing for future expansion	• Best use of existing infrastructure and ability of being accommodated at the existing site
• Availability of third party vendors for operations and potential P3	• Availability of third party vendors for operations and potential P3
• Capability of keeping two organics streams separate andproducing separate products	• Process Flexibility – ability to process/ bale pre-sorted materials received at the MRF from Depots and Eco-stations

STANTEC CONSULTING LTD.

Bruce Ferguson, MBA, P.Eng.
Vice President, Programs & Project Management

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Appendix 8

EWMC Mass Balance Model Summary, Forecasted to 2024.
City of Edmonton, Waste Services.

EWMC Mass Balance Model Summary
Forecasted to 2024

	Current Scenario (All Facilities Operational)	Proposed Scenario (All Facilities Operational) (All Diversion Options Active)	Difference between Current and Future Scenarios
Cear Bag Ovr. Garb Reduc.	0	18,804	
Textiles	0	16,527	
Grass Ban	0	36,689	
Total Incoming Waste	376,161	322,945	53,216

IPTF - Pre Pro

		Current Scenario	Proposed Scenario	Difference
Input:		331,992	189,252	142,741
Outputs:	Organics	171,685	51,910	119,775
	RDF	135,040	122,938	12,101
	Landfill	25,268	14,404	10,864

ECF

		Current Scenario	Proposed Scenario	Difference
Inputs:	SSO Direct	0	28,085	-28,085
	Pre-Pro Dist.	171,685	51,910	119,775
	Woodchips	8,000	8,000	0
Outputs:				0
	Residuals	54,114	24,779	29,335
	Cure-Site	39,475	34,178	5,297
	Landfill (Excess Cap)	0	0.00	0

AD

		Current Scenario	Proposed Scenario	Difference
Inputs:	Pre-Pro	40,000	0	40,000
	SSO	0	40,000	-40,000
	Woodchips	8,000	8,000	0
Outputs:				0
	Cure-Site	20,014	28,654	-8,640
	Residuals	12,146	3,506	8,640

Cure-Site

		Current Scenario	Proposed Scenario	Difference
Inputs:	ECF	39,475	34,178	5,297
	Leaf & Yard Waste	0	15,000	-15,000
	AD	20,014	28,654	-8,640
Outputs:	Market	44,101	65,483	-21,382
	Residuals	15,387	12,349	3,038

MRF

		Current Scenario	Proposed Scenario	Difference
Inputs:	Total Input	58,169	64,608	-6,439
Outputs:	Market	46,972	52,171	-5,199
	RDF (Residuals)	2,472	2,746	-274
	Landfill (Residuals)	8,725	9,691	-966

RDF

		Current Scenario	Proposed Scenario	Difference
Inputs:	PPF	135,040	122,938	12,101
	ECF	54,114	24,779	29,335
	Cure-Site	15,387	12,349	3,038
	AD	12,146	3,506	8,640
	MRF	11,198	12,437	-1,239
	Total	**227,885**	**176,010**	
Outputs:	Mass loss	17,488	18,877	-1,389
	Enerkem	122,692	129,704	-7,012
	Landfill (Residuals)	23,381	23,381	0
	Landfill (Excess Cap.)	52,885	1,010	51,875

Enerkem

		Current Scenario	Proposed Scenario	Difference
Inputs:	RDF	122,692	129,704	-7,012
Outputs:	Landfill	4,417	4,669	-252
	Market	118,275	125,034	-6,760

LANDFILL

		Current Scenario	Proposed Scenario	Difference
Inputs:	PPF	25,268	14,404	10,864
	RDF	76,267	24,391	51,875
	AD	5,572	5,572	0
	Cure site	0	0	0
	ECF	0	0	0
	C&D	0	0	0
	MRF	0	0	0
	Enerkem	620	7,885	-7,264
	Total	107,726	52,251	55,475

Appendix 9

Supplemental Analysis – Impacts of Electricity vs RNG Production

Appendix 9 Summary of Preliminary Analysis of Different Biogas Use for Digestion Option

As described in the business case, biogas produced by the digestion process can have two different uses—biogas-to-electricity (Alternative 3A) or biogas-to-RNG (Alternative 3B). The digestion process to produce biogas is the same for both cases; however, the process of producing electricity versus RNG is different. Thus capital and O&M cost for the digestion process is the same for both approaches, but capital and O&M costs for producing electricity and RNG are different. Additionally, market value of electricity and RNG are also significantly different.

The business case seeks approval of recommendation of digestion for the new facility, and presents results of analyses using Alternative 3B, biogas-to-RNG, as the representative digestion case. Prior to construction either kind of facility, it is understood that a more in-depth analysis of how to use biogas is necessary during subsequent planning and engineering phases. Preliminary analysis comparing the two different uses for biogas were conducted as part of the process of this business case initiative. This appendix summarizes key results.

Tangible Benefits

Tangible **Environmental** benefits include GHG emissions and contribution from waste to energy. GHG emission was determined by estimating the amount of CO_2 equivalent offset. The form of waste-to-energy is different depending on the process technology (i.e.: composting vs. digestion) used. The type and amount of energy was quantified. Table A9-1 provides a summary of comparison for the four alternatives.

Table A9-1 Comparison of tangible environmental benefits for each alternative

Benefit (cumulative 2019-2048)	Alternative 1	Alternative 2	Alternative 3A	Alternative 3B
GHG emission offset (tonne CO2e)	2,999,710	2,740,000	3,946,905	4,403,571
Type of Waste-to-Energy	N/A	N/A	Electricity	RNG
Amount of Energy Produced MWh (electricity) or GJ (RNG)	N/A	N/A	1,180,162	32,344,247

Figure A9-1 shows cumulative revenue for all four alternatives over 30 years.

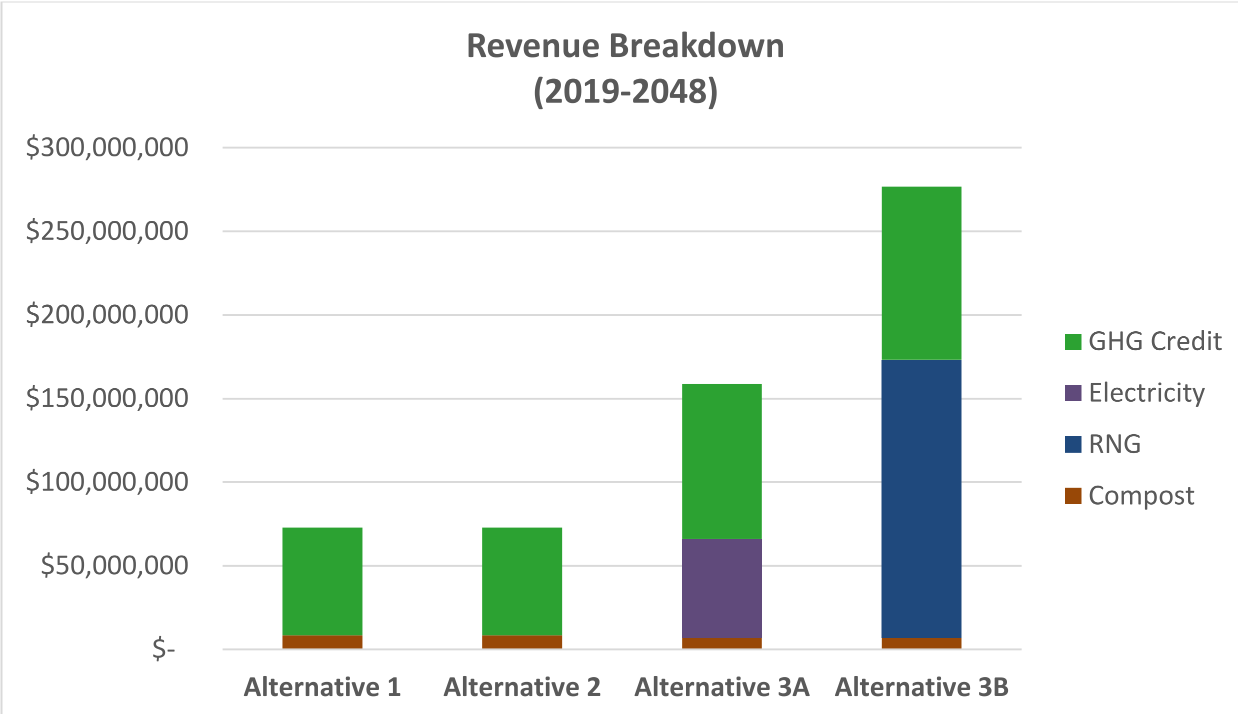


Figure A9-1 Comparison of revenue and breakdown of alternatives during period of 2019-2048

Installing a digestion facility and equipment at the existing ECF site (Alternative 3A and 3B) has the ability to generate more revenue than composting (Alternative 1 and 2). However, the final renewable product generated from biogas from digestion generates different revenue. Based on the assumption made in the baseline case that is presented here (Section 8.4), producing RNG generates more revenue than producing electricity. Revenue estimation is sensitive to market conditions for RNG and electricity in the future.

Capital Cost

Capital cost includes costs associated with new equipment, repair or construction of buildings and facilities. Other costs such as engineering, construction management, etc. are also included. Figure A9-2 shows comparison of capital costs of alternatives as well as their breakdown.

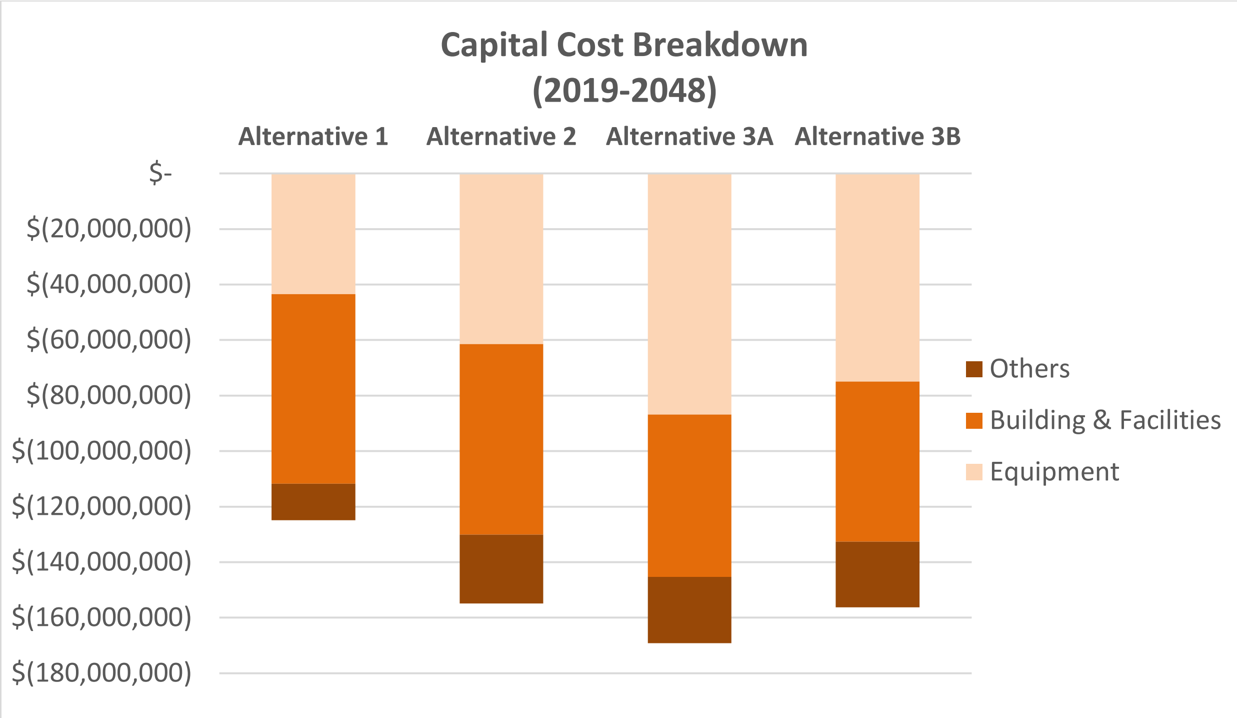


Figure A9-2 Comparison of capital cost and breakdown for alternatives during period of 2019-2028

Alternative 3A has slightly lower capital cost than alternative 3B, even taking into account replacement of CHPs (every 10 years as the worst case), which are used to generate electricity.

O&M Cost

O&M costs include cost of labor, material, non-labor operation and maintenance, fleet service, utility, disposal of residuals and one-time demolition of existing facilities and equipment. Figure A9-3 shows comparison of cumulative O&M cost and breakdown for the long-term period.

During the period of 2019-2022, existing facility and equipment in Alternative 2, 3A and 3B is expected to be demolished, resulting in a one-time demolition cost. O&M cost for other categories are relatively the same across the four alternatives because operations during this period are assumed to be relatively similar while design and construction occurs.

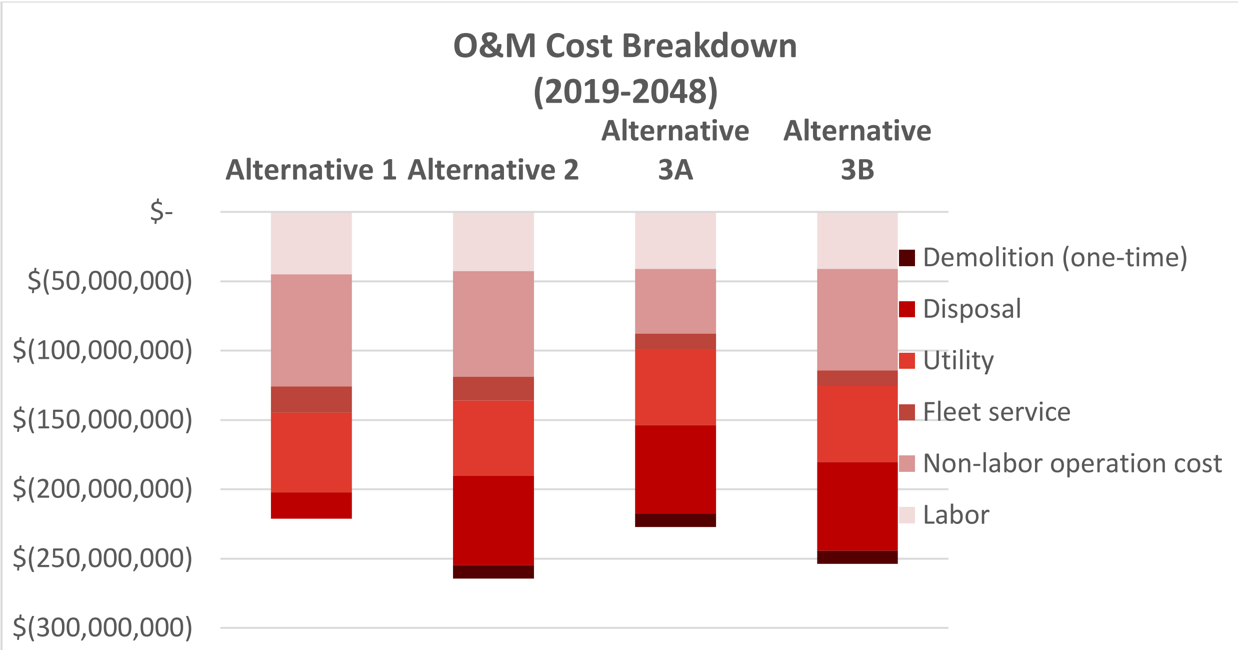


Figure A9-3   O&M cost and breakdown of alternatives during period of 2019-2048

As shown in the figure above, Alternative 3A has the least O&M cost among the four alternatives. It is worth noting that although Alternative 3A and 3B both use digestion with the difference on waste-to-energy product, the O&M cost of producing RNG (Alternative 3B) is much higher than producing electricity (Alternative 3A).

Assumptions

Key assumptions are the same as described in section 8.4. Price of biogas-to-electricity is $0.05/kWh. This is a conservative assumption. Electricity cost from grid is $0.08/kWh. It is assumed that all biogas-to-electricity is marketable and generates revenue.

Comparison of Alternatives Under Baseline Assumptions

Note that NPVs are negative for all alternatives, meaning that the cumulative present value of revenue cannot recover cumulative present value of costs (both CapEx and OpEx). The smaller the NPV (i.e. the less the negative), the better the alternative from the economic aspect. Figure A9-4 and A9-7 compares NPVs for the 30-year period.

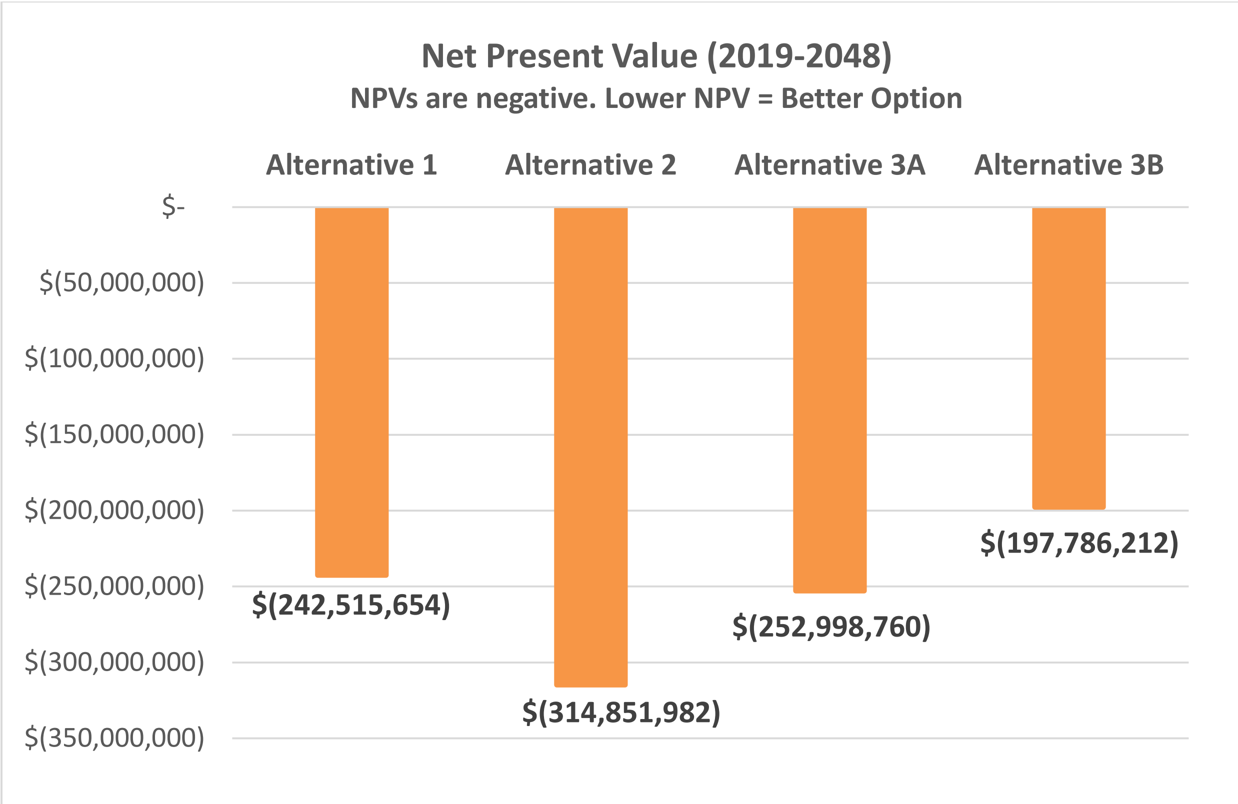


Figure A9-5 Comparison of NPV for alternatives during period of 2019-2048

The above figure clearly shows that digestion with biogas-to-RNG (Alternative 3B) has a lower negative NPV value than digestion with biogas-to-electricity (Alternative 3A), meaning that generating RNG is more economical than generating electricity.

Impact on utility rates

Capital spending and the amount of revenue that can be generated from marketing processing products and waste-to-energy product directly impact the utility rates, resulting a direct impact on the community, making this an important **social** impact. It can be evaluated via comparing cumulative present value of revenue requirement for the alternatives. The "revenue requirement" here refers to **additional revenue that need to be generated from utility rates.** Thus, the higher the cumulative present value of revenue requirement, the more increase on the existing rate, having larger negative impact on rate payers. Figure A9-6 presents different impact on rate payers in the form of revenue requirement.

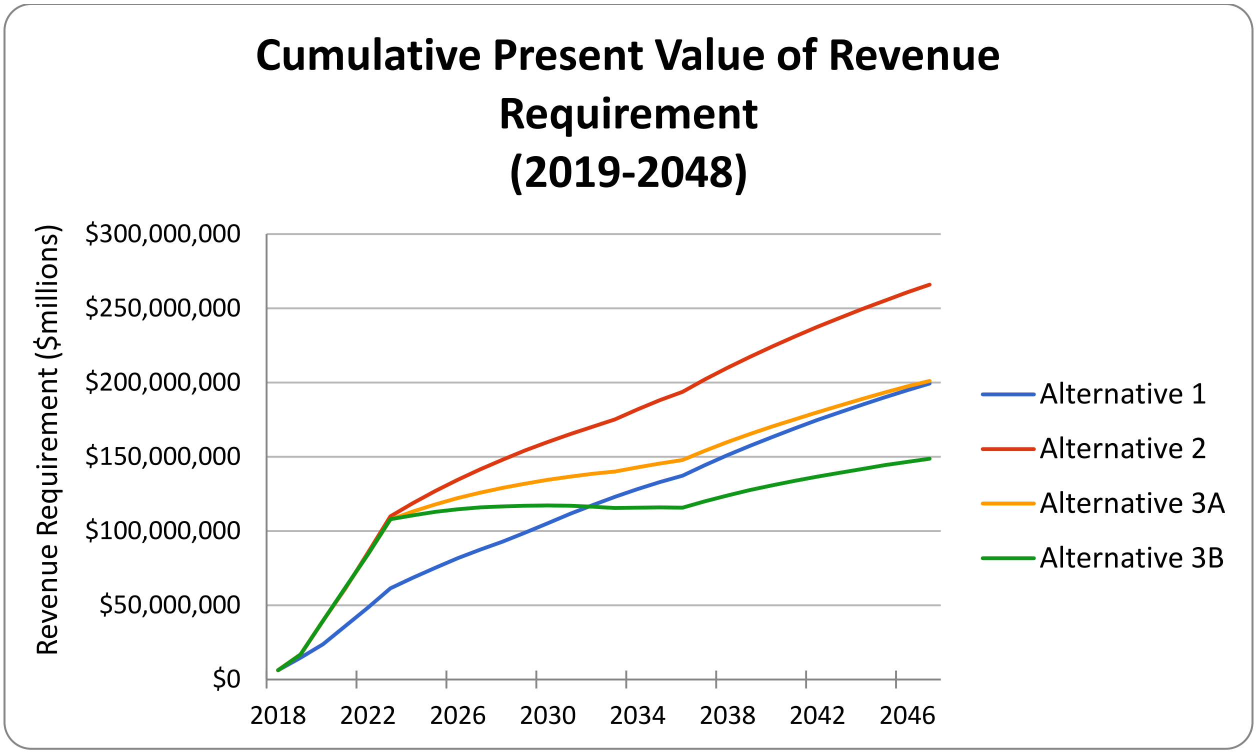


Figure A9-6 Comparison of impact on rate pA9ers during period of 2019-2048

When evaluated for the project life of 30-year where revenues are realized over time, the relative impact on rate payers from different alternatives changes from the comparison of a 5-year perspective.

Over time, **digestion with RNG (Alternative 3B) has least negative impact on utility rates**. As shown in the figure above, once revenue from RNG, GHG credit, and compost starts to kick in, the total required revenue to be collected from utility rates gradually goes down. Alternative 3A—digestion with electricity—has the second least impact on rate pA9ers.

It is worth noting that comparison of alternatives with respect to the impact on utility rates has completely opposite trend when being view with a 5-year, capital cost focused perspective versus a 30-year, long-term perspective.

Sensitivity Analysis and Discussion of Impacts of Key Assumptions

Identified in earlier sections, revenue from GHG credit and selling of waste-to-energy products are significant revenue contributors. Estimation of potential revenue is dependent on key assumptions such as carbon tax price (i.e.: price of CO2e), market price of electricity, and market price of RNG. To evaluate impact of the alternative comparison should the assumption changes, sensitivity analyses were conducted. Note that results using assumptions listed in 8.4 are referred to as the “baseline” scenario.

Impact of GHG Credit

Presented in Figure A9-1, revenue from GHG credit is a major contributor for all alternatives. Although unlikely, a worst case scenario may assume no more GHG credit in the future, or that the carbon price becomes $0/tonne. Figure A9-7 shows NPVs of alternatives and compares baseline scenario with the scenario of no GHG credit.

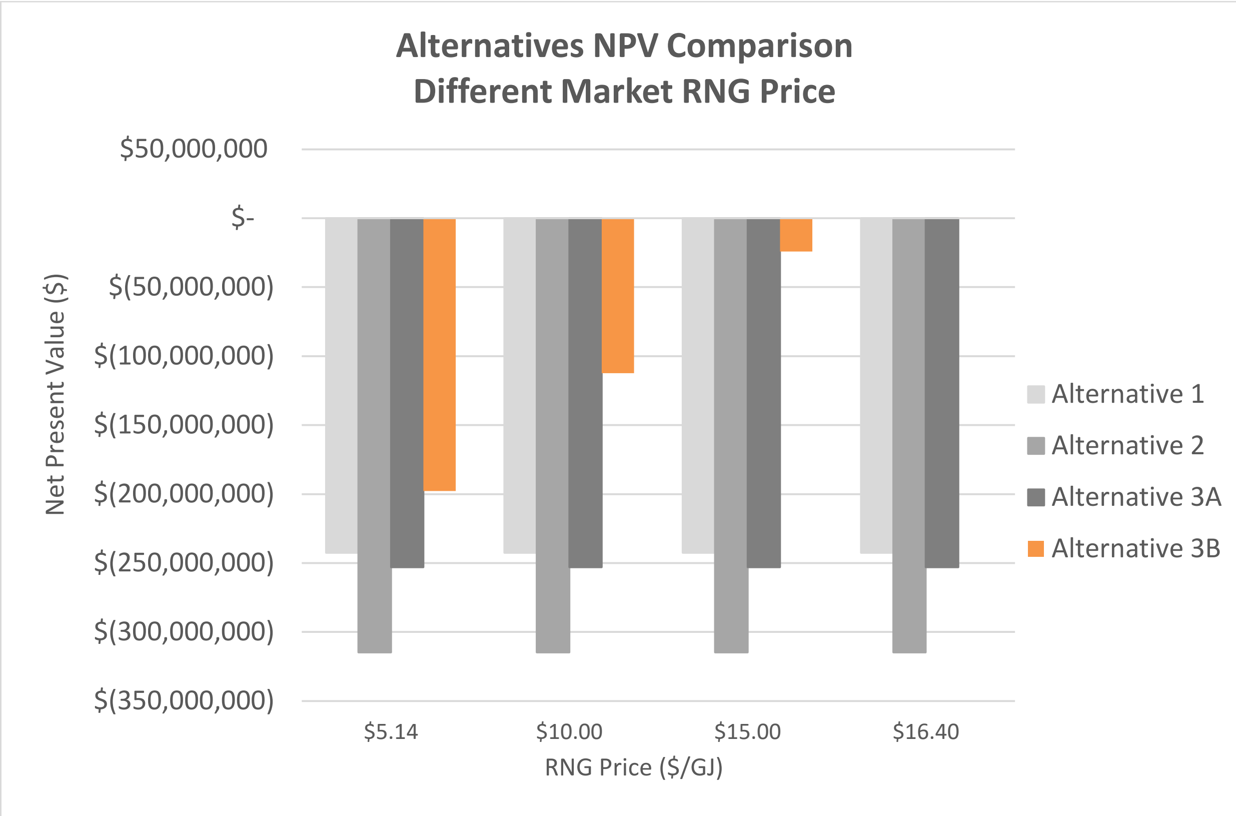


Figure A9-7 Comparison of alternatives (NPVs) under different GHG credit revenue scenario

Under the scenario of **full GHG credit** (baseline scenario), the order of most economical alternative to least is Alternative 3B > Alternative 3A > Alternative 2 > Alternative 1.

Under the scenario of **no GHG credit**, the order of most economical alternative to least is Alternative 3B > Alternative 3A > Alternative 1 > Alternative 2.

The comparison shows that **even under the very unlikely scenario of no GHG credit, the digestion alternatives (Alternative 3A and 3B) still makes the most economical sense**, especially Alternative 3B.

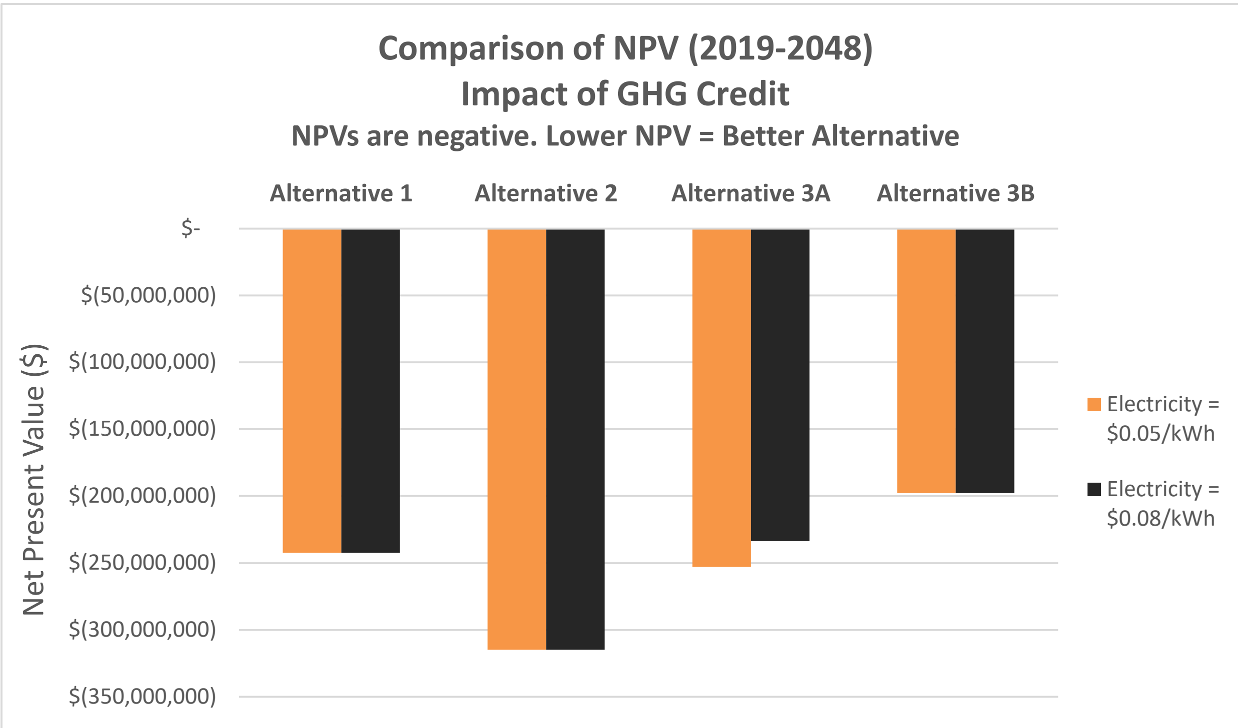
Impact of market price of biogas-to-electricity

The assumption used in baseline scenario of market price of biogas-to-electricity of $0.05/kWh is conservative. The current electricity price, also used to estimate electricity cost for all alternatives, is $0.13/kWh. The baseline assumption is more than 50% less than the current utility price. Therefore, it is very unlikely that the biogas-to-electricity price will be lower than the baseline assumption.

On the other hand, in a more optimistic scenario, if the biogas-to-electricity price can be marketed at current electricity price of $0.13/kWh, NPV of Alternative 3A is slightly better than Alternative 3B (Figure

8-12). However, it is worth noting that this comparison compares benefit based on the most optimistic electricity price and the most conservative assumption for RNG price.

Figure A9-8 Comparison of alternatives NPV under more optimistic biogas-to-electricity market price



Appendix 10

ECF Economic Analysis Version 11.
December 12, 2018, 2018. Stantec Consulting Ltd.

Appendix 10: ECF Economic Analysis Version 11.

12-Dec-18

Stantec Consulting Ltd.

Financial Analysis Summary

Years: 2019-2048

Waste Services ECF (2019-2048)	**ALTERNATIVE 1- ECF Case 1 - Status Quo**	**ALTERNATIVE 2 - ECF: All new composting for both SSO and MSW**	**Alternative 2 Net Change from Status Quo**	**ALTERNATIVE 3A - ECF: All new digestion (CHP) for both SSO and MSW**	**Alternative 3 Net Change from Status Quo**	**ALTERNATIVE 3B - ECF: All new digestion (RNG) for both SSO and MSW**	**Alternative 3 Net Change from Status Quo**
Total Capital Cost (2019-2048)	($172,869,751)	($215,776,100)	($42,906,350)	($236,986,880)	($64,117,129)	($214,562,988)	($41,693,237)
Total Capital Cost (2019-2029)	($170,283,900)	($147,563,745)	$22,720,154	($161,250,240)	$9,033,660	($162,731,130)	$7,552,770
Total Capital Cost (2019-2022)	($94,851,387)	($147,563,745)	($52,712,359)	($161,250,240)	($66,398,853)	**($162,731,130)**	($67,879,743)
Total Revenues (incl. cost offset)	$ 93,511,068	$ 93,511,068	$0	$212,053,025	$118,541,957	$379,836,744	$286,325,676
Total Revenues (excl. cost offset)	$ 93,511,068	$ 93,511,068	$0	$158,837,008	$65,325,939	$276,821,558	$183,310,489
Total Operating and Maintenance Costs	($356,379,588)	($415,421,459)	-$59,041,871	($353,143,544)	$3,236,043	($397,298,149)	-$40,918,561
Project Net Inflows (Outflows)	($435,738,270)	($537,686,491)	-$101,948,221	($378,077,399)	$57,660,871	($232,024,393)	$203,713,877
WACC Discount Rate	5.4%	5.4%		5.4%		5.4%	
Net Present Value (2019-2048)	**($242,515,654)**	**($314,851,982)**	**-$72,336,328**	**($252,998,760)**	**($10,483,105)**	**($197,786,212)**	**$44,729,442**

Appendix 11

ECF Site Plans

Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Consultants

Permit-Seal

Stantec

5 Burlington Woods Drive, Suite 210
Burlington MA
www.stantec.com

Client/Project

EDMONTON CO - ECF

City of Edmonton, AB

File Name: | Dwn. | Chkd. | Dsgn. | YY.MM.DD

Title

EDMONTON CO - ECF
ALT 1 PHASED
MSW & SSO EXISTING FACILITY

Project No.	Scale	
110128016	AS NOTED	
Drawing No.	Sheet	Revision
1	1 of 1	0

ORIGINAL SHEET - ISO A1

V:\1951\temp\Edmonton_waste_business-case\Site_Plans\Alt_2_phased_Site_Plan(1).dwg
2018/11/19 4:45 PM By: Alix, Charlie

Revision	By	Appd.	YY.MM.DD
Issued	By	Appd.	YY.MM.DD

Consultants

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Burlington MA
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The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay.

Client/Project

EDMONTON CO - ECF

City of Edmonton, AB

File Name:

Dwn. Chkd. Dsgn. YY.MM.DD

Title
EDMONTON CO - ECF
ALT 2 PHASED
MSW & SSO COMPOSTING

Project No.	Scale	
110128016	AS NOTED	
Drawing No.	Sheet	Revision
2	1 of 1	0

ORIGINAL SHEET - ISO A1

Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

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Client/Project

EDMONTON CO - ECF

City of Edmonton, AB

File Name: | Dwn. | Chkd. | Dsgn. | YY.MM.DD

Title

EDMONTON CO - ECF
ALT 3 PHASED
MSW & SSO ANAEROBIC DIGESTION

Project No. 110128016

Scale AS NOTED

Drawing No. 3

Sheet 1 of 1

Revision 0

Appendix 12

Impacts of Grass, Leaf, and Yard Waste Top-Up

To:	Steering Committee City of Edmonton	From:	Micaela Brown Stantec Consulting Ltd.
File:	ECF Business Case	Date:	January 11, 2019

Reference: ECF Business Case – Impact of Allowing Bin Top-Up of Grass, Leaf & Yard Waste

A foundational assumption of the ECF Renewal Project is that a program change for grass, leaf and yard waste (GL&YW) will be implemented before the project is ready to commission. This means yard leaf and grass waste will be collected and processed separately from the ECF.

To test the impact on the ECF Business case should a top-up of green carts be allowed a high-level analysis comparing the impact of allowing up to 20,000 tonnes per year of GL&YW spread over five months with a 20 percent peaking factor in a month. The impact of this top-up was examined for Alternative 1 (composting) and Alternative 3 (digestion). The results of this analysis are summarized below. As this analysis is preliminary, should the decision be made to allow top-up, a more detailed economic analysis should be undertaken to determine more accurate costing.

Impact of top-op on Alternative 1: Rehabilitate Aeration Hall Building and Maintain All Equipment

With GL&YW top-up, the existing site can accommodate the additional capacity with relocation of some existing facilities and equipment. Under this scenario, the aeration hall building would have to be expanded to add an additional compost bay around 2032 compared to no expansion needed to 2044 in the base case.

Expansion will likely need to be to the North which will require relocation of the biofilter. Looking at the site plan (Attachment 1), this relocation is likely to be challenging, as room at the North end of the site is extremely limited. Relocation of the biofilter will also result in additional capital and O&M costs, with a capital cost in the order of $5 million. Expansion of the Aeration Hall to add one more compost bay will result in approximately $68 million capital cost around 2032. Not accounting for any O&M cost, allowing grass, leaf and yard waste top-op could result in an additional $73 million capital cost.

Impact of top-op on digestion Alternative 3A/B: Demolish Existing ECF, Construct New AD Facility

Assuming implementation of Alternative 3 with no GL&Y top-up, the plan is to initially construct 16 digestion tunnels and 10 composting tunnels for SSO and add 4 digestion and 3 composting tunnels by 2034 for future capacity (see Attachment 2). With GL&YW top-up, the additional capacity requires 23 digestion and 19 composting tunnels for SSO in 2024 and an additional 3 digestion and 2 composting tunnels by 2034. Estimating based on the current financial model and adjusting for more tunnels, this means that approximately $45 million is required prior to 2024 period in addition to the $54 million in 2034 (as per the original estimate). This does not include the additional capital and O&M cost required to relocate the odour control system and the transformer and other electrical equipment in the area of the drum digester to utilize that space for the new facility. As is the case with Alternative 1, site limitations will also make this relocation challenging.

These options are summarized in the table below.

Reference: ECF Business Case – Impact of Allowing Grass, Leaf & Yard Waste Top-Up

Table 1 Summary of Impacts of Grass, Leaf & Yard Waste on Alternatives 1 and 3

Alternative	Base Case Estimated Capital Cost (2019 – 2048)	Infrastructure Impacts of GYL Bin Top-Up	Estimated Capital Cost Impacts of GYL Top-Up
Alternative 1 (Composting)	$172M.	Relocation of biofilter, additional compost bay in 2032	Base Case + $73M for new total of $245M
Alternative 3 (Digestion)*	$216M	3 additional digesters and 6 additional composting tunnels in 2024; relocation of electrical and odor control systems	Base Case + $45M for new total of $261M

*Note: Digestion with RNG is assumed as base case for this purpose.

Additional Collections of Grass, Leaf and Yard Waste

As an alternative to the additional capital costs above, the City could consider additional collections during the summer months to specifically collect GL&Y and deliver it to the Cure Site for composting. A single collection is estimated to cost approximately $750,000 so four additional collections to deal mainly with thatch in the spring and leaves in the fall would result in an annual cost of $3 Million, thereby avoiding $45 - $73 Million of capital costs.

Stantec Consulting Ltd.

Micaela Brown

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micaela.brown@stantec.com

Attachment: Alt_1_phased_Site_Plan(1).pdf
Alt_3_phased_Site_Plan(1).pdf

Appendix 13

ECF GHG Credit Calculator

Appendix 13: ECF GHG Credit Calculator
Alternatives 1 & 2

Project	Edmonton Composting Facility
Proponent	City of Edmonton
Crediting Period	1 Jan 2015 - 31 Dec 2017
System	Alberta Emissions Offset System
Protocol	*Carbon Competitiveness Incentive Regulation - Quantification Protocol for Aerobic Composting Version 3.0, September 2018*

OFFSET SUMMARY SHEET

This sheet contains a summary of baseline and project emissions from each SS on the other worksheets, as well as a calculation of the total credits created.

	CO_2	CH_4	N_2O
GWPs:	1	25	298

VERRs Summary

Baseline Emissions			t CO_2	t CH_4	t N_2O	tCO_2e	TOTAL (CO_2e)
SS	B5	Organics Landfilling	-	3,266.6	-	-	81,664.0
		ALL	**-**	**3,266.6**	**-**	**-**	**81,664.0**

Project Emissions			t CO_2	t CH_4	t N_2O	tCO_2e	TOTAL (CO_2e)
SS	P5	CCF Facility Operations	2,274.53	0.06	0.10		2,306.0
SS	P6	Material Treatment		2.47	4.93		1,531.7
SS	P7	Electricity Usage				7,829.3	7,829.3
SS	P11	Residual Transportation	270.5	0.01	0.04		281.8
SS	P12	Residual Processing	132.9	0.01	0.02		139.0
SS	P15	Fuel Extraction & Processing	169.0	5.95	0.01		320.1
		ALL	**2,846.9**	**8.5**	**5.1**	**7,829.3**	12,407.9

Emissions Offset Credits Created	t CO_2	t CH_4	t N_2O	tCO_2e	TOTAL (CO_2e)
ALL	- **2,846.9**	**3,258.1**	- **5.1**	- **7,829.3**	**69,256.0**
				t waste	82218
				tCO2e/t waste	0.84

Appendix 13: ECF GHG Credit Calculator
Alternatives 3 & 3B

Project	Edmonton Composting Facility
Proponent	City of Edmonton
Crediting Period	2024
System	Alberta Emissions Offset System
Protocol	*Carbon Competitiveness Incentive Regulation - Quantification Protocol for Biogas Production and Combustion - Version 1.0, December 2017*

OFFSET SUMMARY SHEET

This sheet summarizes the calculations in the "Updated Calculations Spreadsheet"

ALTERNATIVE 3 - New Building, New AD and CHP			
Baseline Emissions			tCO_2e
SS	B5	Fuel Extraction & Processing	N/A
SS	B7	Grid Electricity Generation Displaced in Project	12,325.1
SS	B8	Pipeline Natural Gas Displaced in Project	N/A
SS	B16	On-site Heat Generation Displaced in Project	Assumed 0
SS	B17	On-site Electricity Generation Displaced in Project	6,652.4
SS	B39	Landfill Decomposition	81,664.0
ALL			**100,641.4**
Project Emissions			tCO_2e
SS	P5	Fuel Extraction & Processing	410.7
SS	P22	Levied Fossil Fuel Flaring	3.5
SS	P26	Combustion of Biogas	304.3
SS	P27	Combustion of Levied Fossil Fuels	Assumed 0
SS	P28	On-site Biogenic CO2 Emissions	657.9
ALL			**1,376.4**
Emissions Offset Credits Created			tCO_2e
ALL			**99,265.0**
		Tonnes of compostable Waste	82218
		Tonnes of CO2e / Tonnes of waste	**1.21**

ALTERNATIVE 3B - New Building, New AD and Export RNG			
Baseline Emissions			tCO_2e
SS	B5	Fuel Extraction & Processing	5,362.6
SS	B7	Grid Electricity Generation Displaced in Project	N/A
SS	B8	Pipeline Natural Gas Displaced in Project	24,328.5
SS	B16	On-site Heat Generation Displaced in Project	N/A
SS	B17	On-site Electricity Generation Displaced in Project	N/A
SS	B39	Landfill Decomposition	81,664.0
ALL			**111,355.0**
Project Emissions			tCO_2e
SS	P5	Fuel Extraction & Processing	410.7
SS	P22	Levied Fossil Fuel Flaring	3.5
SS	P26	Combustion of Biogas	N/A
SS	P27	Combustion of Levied Fossil Fuels	Assumed 0
SS	P28	On-site Biogenic CO2 Emissions	N/A
ALL			**414.1**
Emissions Offset Credits Created			tCO_2e
ALL			**110,940.9**
		Tonnes of compostable Waste	82218
		Tonnes of CO2e / Tonnes of waste	**1.35**

Appendix 14

ECF Business Case – Implementation Phase Risk Register – 13 Dec 2018

Appendix 14: ECF Business Case - Risk Register
13-Dec-18

Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Score	Response Strategy	Response Description (Actions)
Concept	Corporate Governance	Organics Waste Program business case not implemented resulting in lower quality inputs and outputs (top-up option)	Medium	Mitigate	Align Program Business Case approval with Project Business Case approval.
Concept	Project Management - Quality	Mass Balance estimates are high resulting in more organics processing capacity than required	Low	Mitigate	Validate mass balance projections against other jurisdictions. Develop phased strategy to increase future flexibility while minimizing short-term costs.
Concept	Project Management - Quality	Mass balance estimates are low resulting in demand for additional capacity	Medium	Mitigate	Validate mass balance numbers against other jurisdictions. Continually review mass balance calculations and adjust during design. Incorporate adequate organics volume contingencies into design criteria.
Build	Economic	Currency fluctuations change value of project estimates	Medium	Transfer	Monitor currency fluctuations during implementation and manage using currency instruments or advance procurement. Negotiate contracts in $Cdn.
Development Design	Project Management - Cost	Site conditions (i.e., high water table) results in increased costs.	Low	Mitigate	Monitor implementation of groundwater project. Undertake additional investigations during design.
Development Design	Project Management - Schedule	Site utility connection/disconnect may result in change/delay of schedule as timelines for utility companies' services are unpredictable	Medium	Mitigate	Engage with utility providers as early as possible.
Build	Political Influences	Trade issues (i.e., steel tariffs) increase project costs.	Low	Mitigate	Incorporate tariff impact risks into project budget. Monitor market conditions during procurement stage.

Appendix 14: ECF Business Case - Risk Register
13-Dec-18

Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Score	Response Strategy	Response Description (Actions)
Development Design	Technology / Equipment	Existing Anaerobic Digester does not achieve design volumes resulting in increased loads on new organics facilities	Low	Mitigate	Monitor AD commissioning and operations during ECF design phase and adjust design as required. Incorporate into project risk analysis during design stage.
Build	Public Perception	Lack of public confidence in ability to deliver large projects reduces support for overall initiative.	Low	Mitigate	Develop proactive public engagement and communication strategy to keep public informed.
Concept	Corporate Governance	Changes in City Council impacts support for project.	Low	Mitigate	Ensure Council is provided project updates routinely
Build	Project Management - Cost	Cost estimates are low resulting in budget or rate increases that are higher than announced to the Utility Committee and the Public	Medium	Mitigate	Include contingencies appropriate to project stage in budget. Advance design to Checkpoint 3, including developing more accurate cost estimates, prior to proceeding to final design and construction.
Build	Customers / Citizens	Grass-Leaf-Yard Waste collection change not accepted by Public resulting in increased volumes of organics	Medium	Mitigate	Develop proactive public engagement and education campaign to demonstrate need for GL&Y ban. Incorporate GL&Y ban into by-laws and/or regulations.
Operate	Customers / Citizens	Compost quality not sufficient to market for agricultural use, or not able to sell compost; resulting in lower returns for project	Low	Mitigate	Compost sales are minor portion of returns, could have giveaway days for residents at ECO-Stations. Make compost storage, marketing part of operating contract
Development Design	Legal / Regulatory	Alberta Environment & Parks (AEP) approval is required which can cause schedule delay, change to design....	Medium	Mitigate	Early consultation with AEP and routine follow up
Development Design	Project Management - Schedule	Schedule risk - construction not completed per schedule	Low	Mitigate	Conservative estimates of schedule, penalties for late completion of construction to be considered

Appendix 14: ECF Business Case - Risk Register
13-Dec-18

Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Score	Response Strategy	Response Description (Actions)
Build	Project Management - Cost	ONEC Cost Estimates are low resulting in increased project costs	Medium	Mitigate	Determine sensitivity of costs on overall project analysis. Develop design to Checkpoint 3 including updated cost estimate prior to proceeding further.
Build	Financial	Existing structure continues to deteriorate after new roof is installed further increasing costs or impacting operations	Low	Mitigate	Incorporate advanced bracing into repair portion of the project.
Development Design	Technology / Equipment	Future equipment does not fit into existing structure or impacts efficiency of operations	Medium	Accept	Existing structure is very large and likely will be acceptable for new technology
Build	Project Management - Cost	Renovation risk - encountering unknown conditions during construction increases project costs.	Medium	Mitigate	Include appropriate contingencies in project budget for unknown conditions.
Strategy	Commercial	Market for biogas by-products changes resulting in decrease financial benefits to City	Medium	Mitigate	Sensitivity analysis of these impacts was undertaken and worst-case scenario utilized in business case. Discuss project with local distribution companies. Continue to monitor market conditions. Enter into appropriate sales contracts during design phase to secure predictable revenue streams post-construction.
Development Design	Technology / Equipment	Biogas quantity risk - lower than specified by Vendor	Medium	Transfer	Mitigate by using conservative estimates. Make biogas quantity part of performance holdback
Strategy	Legal / Regulatory	Greenhouse Gas Credit programs are eliminated by future governments.	Low	Mitigate	Sensitivity Analysis was undertaken to confirm elimination of GHG credits will not impact design or recommended solution. Continue to monitor.
Strategy	Legal / Regulatory	Greenhouse Gas Credit programs are eliminated by future governments.	Low	Mitigate	Sensitivity Analysis was undertaken to confirm elimination of GHG credits will not impact design or recommended solution. Continue to monitor.

Appendix 14: ECF Business Case - Risk Register
13-Dec-18

Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Score	Response Strategy	Response Description (Actions)
Development Design	Technology/Equipment	Technology provider may request changes to City's general conditions & require confidentiality agreement/policy	Medium	Mitigate	Law will be required to review changes & policy and provide recommendations in City's best interest. Negotiations/changes to be reviewed/accepted before letter of intent is issued. Require proposed changes to T & C to be included in proposals.
Development Design	Technology / Equipment	Composting digestate - maturity level not sufficient for curing	Medium	Mitigate	Specify a maturity level for the compost leaving the facility in the equipment specifications
Development Design	Technology / Equipment	Biogas quality is lower than specification or is variable	Medium	Mitigate	Specify a gas cleaning system to deal with variations. Specify RNG upgrading system to deal with low methane content or variations of quality.