TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE

To:	Nicole Kohnert, P.Eng	**Date:**	March 21, 2018
c:		**Memo No.:**	1
From:	Monica Wallani, MBA, P.Eng. Michel Lefebvre, P.Eng.	**File:**	SWM.SWOP03478
Subject:	Technical Memo No. 1 – Solid Waste Management Plan Disposal Option Information		

1.0 INTRODUCTION

The Regional District of North Okanagan (RDNO) retained Tetra Tech Canada Inc. (Tetra Tech) to manage a review and update of the RDNO's 2011 Solid Waste Management Plan (SWMP). The 2017 Draft SWMP Update will review existing solid waste management policies and programs, identify and evaluate options for reduction and diversion, residual management, and financing, and also set the RDNO's waste management principles, targets and strategies for the next ten years. A summary of the project phases and deliverables is included on Figure 1-1.

The assessment stage included the issued for review Current Solid Waste System Report that was presented at the meeting on August 1, 2017. The report documented the current condition of the RDNO's solid waste management system, and was used as a basis for discussion for the direction of the Draft SWMP Update entering the second stage, "Analysis and Evaluation".

Within Stage Two, the first technical memorandum (tech memo) focuses on recovery and residuals management, the interrelated fourth and fifth Rs of the 5-R waste prevention hierarchy (pictured on Figure 1-2). The purpose of this first tech memo is to determine which options require further research and analysis and include in the list of options for financial analysis, and which should be eliminated from consideration within the RDNO's Draft SWMP Update. The second tech memo will also address the first three Rs – reduce, reuse, and recycle. The third and final tech memos will assess the financial implications and synergies for selected options for integration with the 2017 SWMP.

This tech memo will be presented to the Regional Solid Waste Advisory Working Group (RSWAWG) at the third meeting on September 21, 2017, to gather feedback on the options and recommendations. The Working Group's input will be sought on each of the tech memos and this advice will guide the selection of options for inclusion in the updated plan. The selected options will be researched in more detail to gauge their specific application within the RDNO, including estimated costs and determining how they align with other plan components. A draft plan update with preferred options will be prepared for review by the Working Group prior to undertaking community and stakeholder consultation. Once these three tech memos have been issued for review, the consultation stage will engage RDNO constituents from public and private sectors through to First Nations to align on the direction of the 2017 Draft SWMP Update. Finally, the 2017 Draft SWMP Update will be crafted based on the outcomes of the previous deliverables, including a consultation summary.

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The project consists of four stages, as shown on Figure 1-1: Project Phases and Associated Deliverables below.

1. Assessment	Assessing the current system and reporting on implementation status. **Deliverable:** ▪ Current Solid Waste System Report (issued for review July 25, 2017)
2. Analysis and Evaluation	Analyzing opportunities and evaluating financial models. **Deliverables:** ▪ Tech Memo 1: Recovery and Residuals Management ▪ Tech Memo 2: Reduce, Reuse, and Recycle ▪ Tech Memo 3: Financial Options Review and System Overview
3. Consultation	Community and stakeholder consultation, engaging the public, key stakeholders, and First Nations to provide input on selected options. **Deliverable:** ▪ Consultation Plan ▪ Consultation Summary Report
4. SWMP Update for 2017	Development and writing of the 2017 SWMP Update for submission to the BC Ministry for approval. **Deliverable:** ▪ 2017 Solid Waste Management Plan

Figure 1-1: Project Phases and Associated Deliverables

1.1 Objective of Tech Memo 1

The waste prevention hierarchy (reduce, reuse, recycle, recovery, and residuals management) is a useful tool to evaluate opportunities to improve a solid waste management system (see Figure 1-2) and will be foundational for the RDNO's Draft SWMP Update. Where practical and feasible, the hierarchy order preference is for other waste management strategies to be undertaken after all opportunities for prevention and reduction at a higher level have been actively pursued. For example, after minimizing the amount of waste produced through reduction and reuse processes, the best practice is to divert as much useful and recyclable material as possible from the waste steam that is still being disposed. Opportunities for recycling should be explored after all opportunities for reduction and reuse of materials have been exhausted. Likewise, recovery is an option once all recycling opportunities are in place and fully optimized. Once these options have been exhausted, recovery technologies can be implemented prior to final disposal (landfilling) of any residuals to maximize the value of wasted resources.

In 2016, the calculated per capita disposal rate in the RDNO was 500 kg per capita, and a total of just over 43,000 tonnes of municipal solid waste (MSW) waste disposed of in the region's three landfills including 28,300 tonnes at the Greater Vernon Recycling and Disposal Facility (GVRDF), 11,419 tonnes at the Armstrong/Spallumcheen Recycling and Disposal Facility (ASRDF) and 1,841 tonnes at the Lumby Recovery and Disposal Facility (LRDF).

Recovery (fourth R) is the application of technology to recover material and/or energy from the solid waste stream as possible in a safe and environmentally sound manner. Section 2.0 of this memo provides an overview of a number of common recovery technologies to inform the options available to the RDNO. Section 2.0 also includes some technologies that can be utilized to further optimize the recycling infrastructure, including capture of materials for recycling and energy recovery.

Section 3.0 provides an overview of key issues currently being investigated or resolved at the three landfill sites, and presents a summary of options available for improvement. Through the process of maximizing the first 4 R's, the residual management (fifth R) component of the waste stream is expected to be minimized.

The benefits to this approach are as follows:

- **Actions taken at higher levels in the waste prevention hierarchy can eliminate or reduce the environmental management costs of actions at lower levels**. For example, waste prevention programs can reduce costs associated with handling waste in the first place.

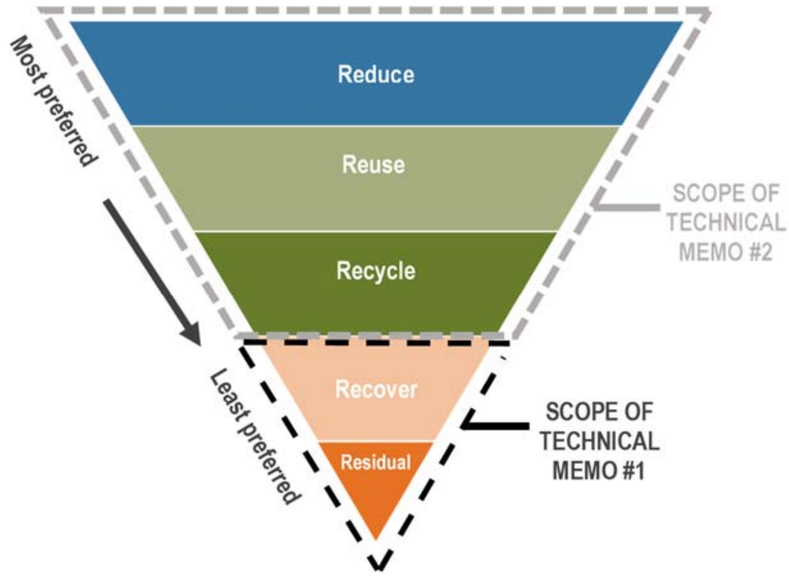

Figure 1-2: Waste Prevention Hierarchy

- **The waste prevention hierarchy can potentially reduce the environmental impacts of product manufacturing and distribution.** For example, reuse (and, to a lesser degree, recycling) will reduce the demand for and thus environmental impact of extracting and processing virgin resources, while the use of recycled materials can reduce the energy cost and virgin inputs needed to manufacturing new products.

As part of this tech memo, a brief summary of the technologies utilized in solid waste management systems to aid in the recovery of additional materials or energy are included for the information of the committee. Technology recovery and residual options explored in this tech memo include:

Technology Opportunities

a. Mixed Waste Material Recovery Facilities (mixed waste MRF)
b. Anaerobic Digestion

Recovery Opportunities

c. Landfill Gas Capture
d. Thermal Conversion
    i. Refuse Derived Fuel
    ii. Gasification
    iii. Pyrolysis
    iv. Waste to Energy (Incineration)

Residual Management

a. Transfer Stations
b. Active Landfills
c. Closed Landfills

2.0 TECHNOLOGY OPPORTUNITIES

As part of the 2011 SWMP, it was determined the next plan review would include a review of recovery opportunities including waste to energy. The previous plan update stated the following:

- Monitor waste to energy technology as it becomes accessible to small communities in Canada. Report on the feasibility of establishing a MSW to energy facility in the North Okanagan.

Table 2-1 provides a brief description of the recovery technologies and applicable inputs that are used as a feedstock, and outputs that are recovered with the technology. Recovery is typically taken to mean the conversion of non-recyclable waste materials (or materials which otherwise escape the recycling stream) into useable energy which includes heat, electricity and fuel. The most common forms of energy recovery from waste in Canada include landfill gas (LFG) collection and advanced thermal conversion technologies.

Table 2-1 Recovery Technologies

Classification	Recovery Technology and Description	Inputs ("Feedstock")	Valued Outputs
Technology Opportunities			
Mechanical	**Mixed Waste Material Recovery Facilities (Mixed Waste MRF)** Manual and/or automated sorting and segregation of waste on conveyer belts to capture and recover recyclables that would otherwise be sent to landfill.	Mixed MSW	Recyclables Organic Materials
Biological	**Anaerobic Digestion** Biological processes that enable microorganisms to break down biodegradable material in the absence of oxygen.	Organic Material	Methane – Energy Digestate, used for composting, direct land application, or dehydration
Recovery Opportunities			
Biological	**Landfill Gas Capture** Using wells to capture the natural by-product of the decomposition of organic material in landfills.	MSW	Methane - Energy
Mechanical and Thermal	**Refuse Derived Fuel** A solid fuel produced from pre-processing MSW into combustible components and selected waste with recoverable calorific value for use in Thermal processes.	Mixed MSW or Pre-screened MSW	Solid fuel that can be combusted to offset use of fossil fuel
Thermal	**Gasification** High temperature oxidation process (oxygen starved environment) to break down organic portions of waste into elemental compounds and produce a syngas.	Mixed MSW or Pre-processed high energy content MSW	Syngas
Thermal	**Pyrolysis** Form of gasification, using high heat while being starved of oxygen utilizing catalyst to enhance the process.	Typically woody biomass, paper products, plastics, etc.	Syngas Char
Thermal	**"Waste to Energy" (Incineration / Combustion)** Combustion process that generates high heat to create high temperature steam for energy generation	MSW	High pressure steam, electricity and/or district heating

2.1 Mixed Waste Material Recycling Facilities (mixed waste MRF)

There are three general categories of material recovery facilities (MRFs):

- Clean MRFs which takes in co-mingled or source separated recyclable materials which is then sorted and baled for their respective commodity markets;
- Mixed waste MRF (aka "Dirty" MRF) which takes in mixed MSW (i.e., garbage), or MSW with organics removed, that is then sorted and baled for their respective commodity markets and/or separated for further organics processing; and
- Hybrid MRFs which may take in several different materials streams, some of which may be source separated recyclables, and/or mixed MSW.

Many solid waste management jurisdictions in North America are considering the use of mixed waste MRFs as part of an overall integrated solid waste management system. Mixed waste MRFs typically consist of conveyor systems, bag splitters, screens and/or trommels to separate the waste into different size fractions. The waste stream then travels through a series of magnets, eddy current separators, air classifiers and hand sorters to divide the waste stream into the required constituent streams for removal of recyclables and organics depending on the facility design. The process does not produce the same quality of commodities as a clean recycling MRF because of contamination from putrescible materials such as food scraps, liquids and other contaminants. As a result, the market value for commodities from a mixed waste MRF is typically less than that of a typical MRF used to sort collected recyclables.

The effectiveness of mixed waste MRFs is dependent on the remaining composition of the waste stream and any upstream initiatives that could mitigate contamination from wet organic materials. A source separated organics program can benefit a solid waste system with a mixed waste MRF. Typically these facilities are considered as an added element in the waste management system to increase the diversion of recyclable and compostable material from within the MSW stream by sorting and removing recyclable materials contained within the garbage after curbside recycling and prior to disposal. This added operation can increase diversion; however, there is an added processing cost to the waste management system to build and operate the facility.

There are many design considerations that impact the effectiveness of mixed waste MRFs, and the labour or technology required to capture enough recyclable materials from the MSW to justify the additional cost of building and operating the facility. For example, an important consideration is the waste composition of the material entering the facility, and whether a community proposes to use this technology as its primary form of recycling and waste diversion or as a supplemental step to take out the remaining recyclable and divertible materials before the residuals (or garbage) stream is ultimately disposed. Typical diversion rates of approximately 10% to >50% have been estimated for mixed waste MRFs depending on the facility design, the composition of the incoming waste, and the effectiveness of the source-separated recycling program.

A mixed waste MRF could be used to enhance waste diversion and capture of recyclables for jurisdictions that choose not to divert waste. The target MSW stream is the garbage stream with an objective to reduce the amount of material requiring disposal and to extend the available disposal capacity within the region. The most likely scenario for a mixed waste MRF being economically feasible is in cooperation and participation with the member municipalities to achieve economies of scale. In the RDNO, with a primary goal of the SWMP to focus on the first three Rs in the waste prevention hierarchy, and currently having many waste division programs in place, it is unlikely that a mixed waste MRF would be used to replace existing diversion programs.

2.2 Anaerobic Digestion

Anaerobic digestion (AD) is a biological process where microorganisms break down biodegradable material in the absence of oxygen. The process is carried out by anaerobic micro-organisms that convert carbon-containing compounds (organics) to biogas in a contained process to optimize capture. The biogas is a mixture of methane (CH_4), carbon dioxide (CO_2), water, and other impurities. Total mass from the beginning to the end of the cycle is typically reduced by 30% to 40%.

Anaerobic systems are becoming increasingly popular for food scraps processing due to their ability to generate power and better contain odours for higher putrescible materials that can be used in limited amounts within open air composting systems. The technology has successfully operated at commercial scale for many years, particularly in the European Union. The art of building low-cost, reliable digesters is strictly dependent on the optimal adaptation of the design to the specific types of feedstock or substrate available. Their major drawback is that capital, operating and maintenance costs are high compared with aerobic composting systems.

The biogas is sequestered in storage tanks and can be sent through a combined heat and power unit ("CHP") to generate electricity, or be upgraded using scrubbing technologies for direct injection into the natural gas pipeline network or used as fuel for compressed natural gas ("CNG") vehicles. At the end of the digestion cycle, residual organic solids (digestate) can be used as a base material for composting to increase the biological value of the end product and optimize nutrient update to plants. The digestate material produced as a by-product is rich in soil nutrients and typically maintains high structural integrity which assists in erosion control. It can also be marketed as a fertilizer that has value for agricultural production.

AD is a common conversion technology for the organic fraction of MSW, agricultural waste, waste water treatment facilities, and other operations. It is carried out in an enclosed system, typically a stainless steel or concrete vessel that is connected to a computer system that monitors and controls air flow, temperature, moisture, and mixing. Retention times for all AD technologies depend on design specifics and feedstock characteristics, with a typical range of twelve to thirty days. There are a variety of systems available as described in Table 2-2 which are either referred to as "wet", involving high moisture content and often associated with waste water treatment and sludge, or "dry", which contain solid organics and yard debris from MSW.

The choice of which digester to use is driven by the existing or planned biomass handling system at the facility. Each type of digester has its own specialty and constraints. All technologies can capture methane and reduce pathogens, but they differ in cost, climate suitability, and the concentration of solids in feedstock. Typical technologies are detailed in Table 2-2 including information relevant to their potential application for the RDNO.

Table 2-2 Anaerobic Digestion (AD) Technologies

AD Technology	Details
Complete Mix Digestion **"Wet"** 	▪ Most commonly in municipal sewage sludge digestion practices, this process uses substrates in a slurry [1% to 15% organic total solids (TS) by mass], ▪ Waste entering the digester is mixed in order to uniformly distribute it. Waste is processed in a heated tank above or below ground. A mechanical or gas mixer keeps the solids in suspension so that the bacteria can decompose the feedstock. ▪ Generally suitable for liquid based feedstock (e.g., manure and pulped food waste) that has 2% to 15% solids. Therefore, this is often referred to as "wet AD." ▪ As this technology requires a considerable amount of preprocessing to process the organic fraction of MSW it is not considered a viable option for the RDNO.

AD Technology	Details
High Solids Digestion **“Dry”** 	▪ Dry AD can process solid substrates with as much as 40% to 50% total solids (TS) by mass. This is well within the range of available high “solid” or “stackable” substrates such as MSW, food waste, yard waste, and other organic substrates. ▪ The higher solids content equates to higher transport efficiencies in comparison to wet systems where 90% or more of the feedstock transported is simply water. ▪ The lack of stirring during the process means that not all materials are exposed to the methanogenic microbes vital to AD reactions, and the gas production suffers as a result. Depending on the preprocessing included dry AD can achieve a portion of the efficiencies (as low as 50% to 60%) of the production rates achieved by wet AD technologies. ▪ Numerous proprietary technologies have been developed to commercially execute dry AD. Most notable amongst these technologies are “garage style” digesters and assisted plug flow digesters. ▪ New innovations in the “dry” technology have begun to address smaller scale waste streams which align with the needs of the RDNO, and this could be a viable technology option.

Anaerobic digestion is an organic management processing option that can be taken into consideration given the amount of organics remaining in the RDNO’s waste stream (approximately 30% according to the 2012 waste composition study). Typically, composting is a simpler and less capital intensive organic processing option than anaerobic digestion. For either technology to be feasible, source separated organics needs to be collected from generators and markets for the end products needs to be available from each process.

2.3 Landfill Gas Capture

MSW disposed of in landfill facilities generate LFG due to the anaerobic decomposition of organic material in the waste material. LFG, comprised primarily of methane and carbon dioxide in combination with trace contaminants, is a significant source of greenhouse gas emissions. The capture of LFG from municipal landfills, and destruction via flaring or utilization of the captured gas offers the following environmental benefits:

- Reduced net greenhouse gas emissions associated with the destruction of methane, which has a global warming potential (GWP) 25 times greater than that for carbon dioxide;
- Reduced emissions of odours that may be associated with the LFG; and
- Development of LFG utilization opportunities typically associated with direct use (boiler fuel) options, the processing of renewable natural gas, and renewable electrical power generation projects.

The RDNO has a long-term goal to develop a LFG green energy project at the GVRDF. In preparation of this, a LFG management system has been implemented at the GVRDF and is currently flaring the collected gas. This existing project has set the groundwork for future energy recovery utilizing this gas.

Landfill gas must be monitored at all landfill sites in BC for health and safety reasons, and also to reduce impacts to air quality. The BC guidelines required that a landfill site that is estimated to generate greater than 1,000 tonnes or more of methane per year must ensure that a LFG management plan is prepared for the landfill site and an active gas collection system installed to reduce fugitive LFG emissions to the atmosphere. In the RDNO, the GVRDF exceeds the 1,000 tonnes per year threshold and is therefore required to capture and reduce methane emissions. The ASRDF and LRDF produce less than 1,000 tonnes of methane per year each and are therefore not regulated to collect and destroy LFG. LFG is monitored at the ASRDF and is further described below.

A LFG capture system typically consists of a series of vertical gas extraction wells joined through a system of lateral pipes, which are connected to a main header pipe that conveys the gas to a treatment facility. At the GVRDF, the gas treatment facility is comprised of an extraction plant equipped with a utility flare. It is estimated by the US EPA that a new engineered landfill can capture roughly 60% of LFG during operation depending on system design and effectiveness, and up to 90% of the methane can be captured after a geomembrane cover is placed on the landfill during closure. The LFG system at GVRDF was commissioned in April of 2015. The total quantity of methane destroyed at the LFG flare station in 2016 was 411 tonnes, with a carbon dioxide equivalent of 10,270 tonnes.

Landfill gas monitoring probes are installed at the ASRDF in native soils around the perimeter of the landfill to monitor the subsurface migration horizontally and vertically through the soil. Monitoring started in 2011 when a number of probes were installed to assess a LFG migration issue on the south side of the landfill footprint. Probes are sampled on a quarterly basis, or more frequently as needed, to determine if LFG is migrating away from the landfill, indicating the possible need for LFG control. Generally, LFG migration probes are installed at or near the landfill property boundary as migration beyond the boundary may impact neighbouring structures.

Landfill gas capture technologies are well proven commercially, and provide the potential to capture energy and/or reduce greenhouse gas emissions from landfill. With regards to implementing LFG capture at other landfills within the RDNO (for example the ASRDF and LRDF), so far only the GVRDF meets the trigger levels under the BC Landfill Gas Regulation.

The candlestick flare at the GVRDF is being used as the primary instrument to destroy LFG at this site. Data is being collected with respect to LFG quantity and quality in order to facilitate the development of a suitable and sustainable beneficial use, green energy project at the GVRDF.

The highest potential next step for the RDNO with regards to the LFG collection system include:

- Continue with the evaluation of the current LFG management system at GVRDF and implement options for repurposing the collected gas beyond flaring on site as soon as possible: for example, processing and injection into the natural gas grid, or generating electricity;
- Further expand the landfill capacity at the GVRDF can allow for expansion of the existing LFG infrastructure allowing for optimal LFG recovery;
- Minimize the quantity of organics in the MSW disposed through implementation of a source-separated organics diversion program, thus significantly reducing the potential for LFG generation; and
- Complete the current investigation on the ASRDF LFG migration issue to determine the impacts and develop and implement mitigation strategies if required.

2.4 Thermal Technologies

2.4.1 Refuse Derived Fuel

Photo 1: Typical Refuse Derived Fuel (RDFuel)Pellet

Refuse-derived fuel ("RDFuel") are fuels made from the combustible components of MSW, including commercial, industrial and consumer waste. RDFuel can replace virgin biomass being used for energy production. Therefore RDFuel can be used to replace finite resources like fossil fuels, and also decrease the volume of waste being landfilled.

From within the MSW stream, all materials that are inert, i.e., non-combustible, and those which have practical value as recyclables are removed prior to treatment. This may include ferrous and non-ferrous metals, glass, gypsum board, plaster, rock, and dirt. What remains is ideally an assortment of plastics and fibre. The Btu value of RDFuel is determined by the caloric content of the material it contains. Typically, a higher plastics content equates to higher heating values for the resulting fuel. The fibre component may also include cardboard, boxboard, and other cellulosic fractions such as wood scrap or any biomass in the waste stream being processed.

Sorting and processing can incorporate shredding, size screening, magnetic separation, coarse shredding and final refinement. Final refinement can include further shredding of the sorted material, or dehydrating the combustible waste portion using various pre-processing technologies. RDFuel is typically produced as fluff, but is usually baled or densified into pellets to make storage and transportation more economical. Most RDF processing facilities are located near a source of MSW, but once the RDFuel product is prepared, it may be transported long distances to an incinerator, gasifier or other such facility for use.

RDFuel can be utilized as clean burning fuel to be co-fired with or replace coal, petroleum coke and other fuels in cement kilns, industrial boilers and at utilities generation plants. The fuels generated by these technologies are typically classified as clean burning (when used to off-set coal) and can be used as a partial [normally up to 10%] coal substitute. RDFuel can also be used in conjunction with other technologies such pyrolysis and gasification.

Feasibility of Creating Refuse Derived Fuel for the Regional District of North Okanagan

RDFuel is currently gaining momentum as both an alternative to landfill and a cleaner burning fuel due to innovations in related pre-processing technology. The long term hope in the industry is that this technology will be able to address dry material, including MRF residuals as part of an integrated system even for relatively low throughput facilities. This technology would likely be deployed as part of an integrated waste recovery system for MSW and would typically require complex mechanical sorting systems on the front-end. At this time, the RDNO's existing MSW stream does not have sufficient quantities necessary to make investments in processing technology worthwhile; however, there are specific source separated material streams such as clean and dirty wood that could be utilized by a private processer. These materials could be put to a higher and better use as a fuel source than currently used as alternative daily cover at the landfill.

2.4.2 Gasification

Gasification is a partial combustion process where the oxygen level is limited in order to convert organic or other fossil fuel based carbon-rich materials into a carbon-rich ash and a series of gases including carbon monoxide, hydrogen and carbon dioxide. This conversion of solid material into gas (fuels) and other desired end products is called synthesis and the gas therefore is known as synthetic gas or (syngas).

Photo 2: Gasification Plant

While gasification is a more complex technology than incineration, it allows for the recovery of valuable products (i.e., syngas) which can be processed into usable chemicals (fuels, alcohols, etc.). The syngas is typically used to fuel a boiler and generate electricity via a steam turbine, although further processing can convert syngas into easy to use biofuels like synthetic gasoline and diesel. The energy derived from gasification and combustion of the syngas is considered to be a source of renewable energy if the gasified compounds were obtained from biomass or other natural sources. One perceived advantage of gasification is that its use can be considered potentially more efficient than direct combustion of the original fuel, since the resultant clean syngas product typically has the ability to be used directly in gas engines, to produce methanol and hydrogen or be converted into other synthetic fuels.

Gasification has been developed in various formats, and several versions of gasification equipment are available or in various stages of commercialization although commercially. Gasification has not achieved as high a level of acceptance as traditional combustion because of its relatively high complexity and high capital costs.

This technology is growing in popularity in large part because of the wide variety of potential feedstock that may be processed, as well as the perceived level of variability that may be acceptable. Thus the benefits of gasification are considered to be increased efficiency, greater variety of end products, and fewer back-end pollution control requirements than incineration or pyrolysis, although, similarly to traditional incineration and pyrolysis, it requires a consistent, high volume of feedstock to be economically sustainable.

Among the primary challenges facing waste gasification technologies is to reach an acceptable energy returned on energy invested ratio, as the efficiency of converting syngas to electric power may be offset by the often significant power consumption required in preprocessing, the use of oxygen and the gas cleaning process. In addition, the build-up of residue in the reactor necessitates frequent shutdown for cleaning. This makes what should be the benefit of a continuous feed system potentially irrelevant. True capital and operating costs of a system are still unknown until a full commercialization cycle can be completed, making it difficult to compare to alternatives.

Gasification's Feasibility for the Regional District of North Okanagan

Commercialization efforts remain elusive due, in large part, to the uncertainty of both capital costs and ongoing operating costs. Similar to incineration, this technology is expected to be capital intensive, necessitating deployment in large metropolitan areas where aggregation may help to leverage economies of scale. While there is potential value in small scale gasification designs deployed in an integrated waste handling technology suite, larger scale commercialization must be realized first. Since gasification technology is more complex, more expensive than other thermo-chemical technologies, and has limited commercial viability, at this time it is not recommended as a viable option for the RDNO in the next ten years.

2.4.3 Pyrolysis

Pyrolysis is a method of applying heat (thermal energy) to organic materials to decompose them. Pyrolysis occurs in the absence of oxygen, sometimes with the addition of a catalyst to spur the reaction. Pyrolysis in the waste industry typically refers to transforming solids like plastics, tires or biomass, into gases, liquids and a solid by-product rich in carbon content. The products of the pyrolysis process and their uses are described in Table 2-3.

Table 2-3: Products of Pyrolysis; their Contents and Uses

Products of Pyrolysis	Contains	Uses
Char (or 'biochar')	▪ Solids with a high carbon content. Can also include inorganics or catalysts that were carried through the process.	▪ Typically burnt, or more recently incorporated as a soil amendment.
Non-condensable Gas	▪ Made up of hydrogen, methane, carbon monoxide and other non-condensable gases.	▪ May be used as a heat source, flared, or burned similarly to conventional natural gas.
Liquid Fuel	▪ Composed of dozens of organic chemicals. Pyrolysis 'oil' typically requires additional processing before replacing traditional fuels.	▪ Liquids undergo a process to separate water from other materials, after which they may be processed and refined into fuels, oils and chemicals.

In general, the technology is thought to have a great degree of flexibility as most organic compounds can be broken down to basic components using the pyrolysis process, and upgrades enable pyrolysis systems to generate a range of specific, valuable end products within the categories identified above.

Pyrolysis has been used for many years in the chemical industry to produce charcoal, activated carbon, methanol, and other chemicals from wood, which are then converted to compounds used to produce consumer products; e.g., turn coal into coke; convert biomass into syngas and biochar. It can also be used to neutralize waste into non-hazardous substances for safe disposal. Recently, experimental and pilot pyrolysis plants have been used to turn waste plastics back into usable oil and fuels; waste tires into carbon black (used to manufacture new tires) or fuel oil blends, and; biomass into fuels and chemicals for transportation.

Photo 3: Plastics Pyrolysis Facility

Pyrolysis' Feasibility for the Regional District of North Okanagan

The most crucial determinant of success for these technologies is the ability to aggregate and prepare the feedstock materials, since this ultimately determines the quality of the final product. End products must meet market standards for quality and quantity which impact the economics of the plant. Challenges exist for all forms of pyrolysis, with the relative variability or inconsistency of feedstock making it difficult to control the quality and uniformity of the final products. Pyrolysis is a technology with many potential applications for waste materials management, which helps explain the high degree of experimental activity currently taking place; however, there are no known facilities operating in Canada. Capital costs and operating costs tend to be higher due to the complexity of the process, varying feedstock quality, and additional processing requirements. Because this technology is generally considered to not be commercially viable for mixed waste due to its high variability, it is not being considered further for implementation in the RDNO. There could be opportunity to support a private facility that could be built in partnership with the forestry industry, and the RDNO could consider separating the clean wood received at the landfills, and currently being sued for cover, and provide it instead to a private facility for a higher and more beneficial use (e.g., Tolko's Co-Gen in Spallumcheen).

2.4.4 Waste to Energy (Incineration/Combustion)

Waste remaining after diversion efforts must be dealt with. With declines in landfill capacity and significant challenges siting new landfills, long-term disposal options are a high priority for regional governments. Waste to Energy (WTE) technologies are often considered a viable alternative to landfills as they convert waste materials to fuel products which can be used in place of virgin fossil fuel. Depending on the technology, employing WTE can result in an 80% mass reduction (by weight), and 90% reduction in volume. The remaining material is in the form of bottom and fly ash that must be landfilled or recycled depending on available markets.

Photo 4: Burnaby WTE Facility.

Although all of the advanced recovery technologies covered in this section qualify as 'waste to energy', the most common and long-standing form of WTE processing is incineration, also known as combustion, defined as the burning of fuel to produce power and/or heat. This requires oxygen and high temperatures in an enclosed vessel. Incineration technology produces heat, ash residue, and gas, predominantly nitrogen (N_2), carbon dioxide (CO_2), and water vapour.

Heat generated by incineration is captured and used to heat industrial boilers to generate pressurized steam, which can be used for direct heating, or passed through steam turbine generators to produce electric power, as in the Metro Vancouver WTE facility pictured in Photo 4. The gas must be treated to meet regulatory emission requirements for chemical pollutants and particulates. Ash residues are produced in both light ("fly ash") and heavy fractions ("bottom ash"). Both forms tend to contain residual compounds, and are typically landfilled. Fly ash requires pre-processing to dampen it prior to landfilling. Some options for beneficial reuse of bottom ash are being practiced, for example, as an additive in road building. Environmental concerns associated with these systems include air emissions that could impact air quality.

WTE technologies need to be operated at their designed processing capacity to be economical. If they are designed and sized appropriately to meet anticipated long term disposal capacities, then ideally, the costs can be as projected. Two examples are summarized below to demonstrate this requirement, and a feasibility assessment of value for the RDNO is presented.

Durham Region Waste to Energy Facility

Durham Region in Ontario is commissioning their mass burn WTE facility (WTEF). It employs a similar thermal processing technology to Metro Vancouver's WTE facility in Burnaby. This facility is estimated to cost $260 million and process 140,000 tonnes per year. Although this facility cost $260 million, much of the foundation and infrastructure was designed for a 400,000 t/yr facility. This facility has elevated capital costs which affects its unit processing cost. The calculated unit processing cost for the Durham WTEF is estimated to be $250 per tonne. This includes a 20 year amortization at an interest rate of 6%. If the facility was built for its design capacity, the unit processing cost is estimated to be $150 per tonne. This includes the cost for disposal of the residuals.

City of Edmonton Waste to Energy Facility

The City of Edmonton in Alberta is also commissioning a WTE facility that uses gasification technology from Enerkem. This facility is one of the first commercial scale gasification facilities in North America and cost over $210 million. It is designed to process 100,000 tonnes of MSW annually.

The unit processing cost was calculated for the Enerkem facility. Additional pre-processing activities supports higher operating costs (estimated to be 20% higher than the Durham WTEF). The unit processing cost is estimated to be $195 per tonne.

Tri-Regional Waste to Energy Feasibility Study

In 2010, the Cowichan Valley Regional District, the Comox Valley Regional District, and the Regional District of Nanaimo conducted a Tri-Regional District Solid Waste Study. The study assessed the feasibility of thermal treatment (or WTE) technologies for MSW for the three southern Vancouver Island regional districts. The study assessed different technologies, considering the combined solid waste available from the three regional districts. Figure 2-1 illustrates the expected unit processing cost for thermal treatment technologies based on their design processing capacity. For the three regional districts, the design capacity was 200,000 tonnes per year. This indicates a unit processing capacity that is just over $100 per tonne in 2009 dollars.

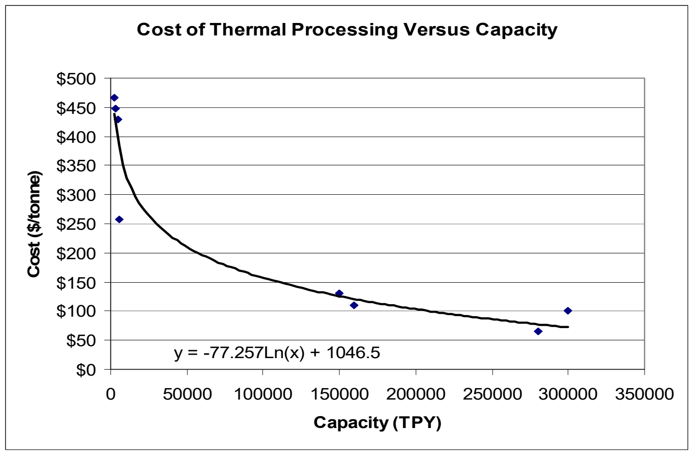

Figure 2-1: Cost of Thermal Processing Versus Capacity

Waste-to-Energy Feasibility for the RDNO

The combustion process is highly developed commercially and is available in numerous vendor specific designs. The technology is also highly complex and requires high upfront capital costs and long term contracts typically 20 to 30 years that guarantee a specific quantity of MSW. Currently in Canada there are four WTE facilities, and they are in located in highly populated areas with sufficient volume to sustain the economics of incineration. There have been a large number of proposals from companies that have come forward with smaller-scale WTE technologies; however, there is no full-scale operational facility in Canada that can be used as operating examples for the smaller scale WTE technologies. With the RDNO total garbage tonnage of 43,020 tonnes in 2016, and new diversion programs likely to decrease the total amount of MSW requiring disposal, it is recommended that a WTE plant not be considered for development or inclusion in the options for the 2017 Draft SWMP Update.

2.5 Technology Options Available and Priorities for Further Evaluation

The BC Ministry expects local governments to have a minimum target of 70% reduction of waste (or a 350 kg/capita/year) before utilizing WTE as a waste management option. The 70% target is calculated only from reduce, reuse, and recycle initiatives. When a region has sufficient reduction, reuse, and recycling, there is often not a viable business case for incineration/combustion technologies such as waste to energy, pyrolysis or gasification, which rely on a minimum threshold of feedstock to be financially viable. Likewise the production of refuse derived fuel technologies require certain minimum feedstock thresholds to develop a business case for the technology investment. Table 2-4 summarizes the recommendations for residuals management in the RDNO.

Table 2-4: Residual Management Options for Consideration in the Draft SWMP Update

Recovery Technology and Description	Inputs ("Feedstock")	Valued Outputs	Considerations for Draft SWMP Update
Technology Opportunities			
Mixed Waste Material Recovery Facilities (Mixed Waste MRF)	Mixed/MSW	Recyclables	Not recommended for this Draft SWMP Update.
Anaerobic Digestion	Organic Material	Methane – Energy Digestate, used for composting, direct land application, or dehydration	Keep as an option for organics processing when developing an organics program.
Recovery Opportunities			
Landfill Gas Capture	MSW	Methane – Energy	Options available including utilizing LFG at GVRDF, and expanding and further enhancing capture at GVRDF. Prevention and mitigation strategies include minimizing organics in landfills, and resolving migration issues at ASRDF.
Refuse Derived Fuel	Feedstock preparation including shredding and screening of MSW	Solid fuel for waste to energy technologies	Not recommended as a technology for the RDNO, however some source separated materials (wood, asphalt shingles) could potentially find better use in these markets through private facilities involved in wood waste management or with Energy BC.
Gasification	Pre-processed high energy content MSW	Syngas	
Pyrolysis	Typically woody biomass, paper products, etc.	Syngas Char	
"Waste to Energy" (Incineration / Combustion)	Feedstock preparation including shredding and screening of MSW	Electricity, high pressure steam, or district heat Metals	Not Recommended.

With respect to waste Recovery, current measures such as LFG capture are considered the most viable measures to capture energy from waste and mitigate environmental impacts from landfilling. With respect to residual waste, landfilling is the RDNO's only current residual management process. A review and evaluation of the transfer stations, active landfills, closed landfills, and proposed next steps in landfill management are presented in Section 3.0.

3.0 RESIDUAL MANAGEMENT

3.1 Active Landfills

3.1.1 Landfill Facilities Overview

Landfilling, as the primary residuals management strategy, has been part of the RDNO solid waste management system since the first SWMP was developed in 1995. Even with high diversion targets and diversion rates, landfills will continue to remain an essential component of the RDNO solid waste management system to deal with the residual waste which cannot be practically removed from the waste stream along with items not well designed for recycling that are disposed of as garbage. Since the first plan was developed for the RDNO in 1995, four small landfill sites have been closed. In both the 1995 and 2002 plans, the RDNO stated that existing regional landfills will remain in operation until they reach design capacity, while remaining environmentally and economically viable.

In BC, landfills are designed and managed to minimize risk to public health and safety and to ensure environmental protection. The “Landfill Criteria for Municipal Solid Waste” guidance document provides standards for siting, design, construction, operation and closure of MSW landfills. This guidance document, originally developed in 1993, was updated by the BC Ministry in 2016 to reflect the current best management practices and standards that have been developed over the years to enhance environmental protection.

Modern landfills are engineered and managed facilities for the disposal of solid waste residuals. They are designed, operated and monitored to ensure compliance with environmental criteria. Landfills have value measured by the amount of MSW that can be placed into available engineered disposal capacity termed “airspace”. It is typically advantageous to preserve the airspace to extend the lifetime capacity of a landfill as regions that exhaust their landfill capacity may have difficulty siting a new landfill. This can cause a region to require waste exporting, which can escalate costs. The economics of transfer and disposal out-of-region can be prohibitive and leave the region unable to deal with their own waste. Landfill capacity in the RDNO is estimated to be 34 years at the GVRDF, 17 years as the ASRDF and 57 years as the LRDF.

3.1.2 Operational Risks and Opportunities

Tetra Tech’s Current Solid Waste Management System Report provided an overview of the three operating landfills within the RDNO. Each year annual reports are produced by April 30 for each operation and close landfill as required by the BC Ministry. The reports are published on the RDNO website and submitted to the BC Ministry. Based upon these reports, it is understood that all currently available permitted landfill space is expected to be consumed by 2075. It is noted that the ASRDF has the most finite life (2034) while the GVRDF has lateral expansion potential. Long term planning with respect to all three landfill sites is necessary in order to ensure future residuals disposal capacity and where to direct investments in infrastructure. There are a number of studies underway including an update to the design, operations, and closure plans (DCOPs) for each landfill site, along with environmental investigations that can influence the ongoing economic viability of the LRDF and ASRDF sites. Table 3-1 provides a synopsis of the ongoing operations at each of the RDNO’s RDFs and provides a summary of the key risks and opportunities for consideration for a long term disposal plan for the RDNO.

Table 3-1 Recycling and Disposal Facility Information Matrix

Variable	Lumby RDF	Armstrong/Spallumcheen RDF	Greater Vernon RDF
Population served and capture area	4,505 residents	17,184 residents	61,655 residents
Distance from service area, and from the City of Vernon	6.5 km north of Lumby, and 33.5 km East from the City of Vernon.	2.0 km north of the City of Armstrong and 24.6 km north from the City of Vernon.	7 km southwest of the City of Vernon.
Filling rate (tonnes/year)	1,841 tonnes	11,419 tonnes	28,296 tonnes
Years until full/closure under current design plans	2074 (57 years)	2034 (17 years)	2051 (34 years)
Expansion capacity available	Yes - Potential expansion to the south	None	Yes – Current landfill is approximately 14 ha of the 79 ha site. Additional land to the west of the current landfill cells is available for expansion.
Tipping fee	Refuse/MSW $100/tonne, $5 minimum charge per load		
Approximate funds generated from tipping fees (2017 estimate)	**$220,000**	**$1,375,000**	**$3,600,000**
2016 direct operation and maintenance expenditures	$219,836 ($119/tonne)	$842,865 ($74/tonne)	$1,686,274 ($60/tonne)
Estimated 2016 funds transferred to landfill closure reserve	$29,456 ($16/tonne)	$182,704 ($16/tonne)	$452,736 ($16/tonne)
Total direct operation and closure (Does not include capital projects and shared expenses)	**$249,292 ($135/tonne)**	**$1,025,569 ($90/tonne)**	**$2,139,010 ($76/tonne)**
Estimated shared expenses (Administration, Eco-Depot, Composting Facility, Recycling Programs, etc.)	$753,000 + $800,000 (Capital Expenditures)		
Total RDNO landfill closure statutory reserve funds (2017)	$5,588,167 (Contribution are made to the reserve at a rate of $16/tonne)		
Estimated closure cost	Under review in development of updated Design, Operation and Closure Plans for each RDF		
Landfill design type	Unlined natural attenuation landfill	Historically an unlined attenuation landfill, 7 new landfill cells are lined	Unlined natural attenuation landfill
Significant work completed or underway since 2011 plan	▪ Land swap with property owner south of the landfill to create larger buffer area for natural attenuation to take place	▪ Phase one closure of area where leachate breakout occurred ▪ Installation of popular tree plantations and evaporation ponds for leachate control ▪ Construction of lined landfill cell (Cell 7) for new waste placement ▪ New leachate pump station and pump ▪ LFG migration investigation and mitigation	▪ Land acquisition to the east for landfill expansion, and preliminary conceptual design developed ▪ Installation of LFG capture system ▪ The filling plan for the next five to ten years is focused on the upper northeast bench of the footprint in order to maximize LFG extraction potential over the next 10 years ▪ Construction of the Regional Yard Waste Composting Facility was completed in the fall of 2011 ▪ New leachate pump stat and reservoir ▪ Upgraded entrance and storm water management

Variable	Lumby RDF	Armstrong/Spallumcheen RDF	Greater Vernon RDF
Site challenges	▪ Long term plan for groundwater quality and buffer zones for leachate impacts, possible leachate plume mitigating risks identified ▪ Stormwater planning ▪ Economics of operating a small landfill	▪ 2015 significant leachate breakout occurred ▪ Ongoing leachate plume and migration issues around the ASRDF and at the property boundary ▪ LFG migration identified at property boundaries and mitigation strategy under development ▪ Limited availability of good cover material for intermediate or side cover ▪ Residential properties are located in close proximity to the RDF leaving small buffer zones for contaminant management	▪ Site access from the highway - the left turn exiting the landfill onto the highway has bad sight lines and no space for acceleration before merging with traffic ▪ Seepage from the leachate pond identified, options for controlling seepage are being developed ▪ Ensure adequate stormwater control measures or storage capacity are in place ▪ Wood waste management (significant stockpiles)
Key risks	▪ Potential leachate plume below the property, slowly migrating south in the direction of groundwater travel	▪ Stormwater control, leachate plume migration to the north west and LFG migration. ▪ Risk that cost of mitigating the environmental risks makes the site financially unsustainable	▪ Landfill expansion will include significant quarrying of rock, and the cost for the new expansion airspace would be more than the existing airspace or constructing a new landfill at an alternative site ▪ Inability to mitigate leachate migration off site toward both lakes
Identified long term mitigation strategies or opportunities to minimized key risks	▪ Continue with hydrologic studies to identify leachate plume migration ▪ Determine if the economics of the current site operation is adding value, or if the option to close the site to MSW, and use available airspace for dry inert waste (construction and demolition material) to limit the ongoing environmental liabilities is a superior option	▪ Continue with hydrogeological studies to identify leachate plume migration, and resolve LFG migration issues ▪ Determine if the economics of the current site operation is adding value, or if the option to close the site to MSW, before 2034, and construction of a transfer facility is a superior option	▪ Continue with expansion area exploratory drilling to determine the geotechnical parameters for the area ▪ Consider utilization of LFG once more wells are turned on and the volume of LFG increases ▪ Consider locations for new recovery facility and location for regional compost facility

The RDNO will need to consider whether the budget for the ASRDF and LRDF site can be increased to address the additional requirements of the updated guidelines and ongoing environmental control measures, or if the closure of the landfill and installation of transfer stations would provide better economic and environmental performance. Additional studies currently underway may determine that additional control measures and infrastructure will be required, and this will dictate whether the continued operation of the sites are financially viable. If the sites cannot continue to operate over the long term for MSW, it may be necessary to construct transfer stations that would collect waste to be transferred to the GVRDF. The GVRDF would therefore become the centralized disposal facility for the region, and the property would undergo expansion and investment to address the new landfill criteria and optimize performance.

3.2 Closed Landfills

There are four closed landfills in the RDNO. Two of these sites (Cherryville and Kingfisher) are currently used as transfer stations. All sites have ongoing environmental monitoring programs to assess trends in groundwater quality. A summary for the four closed landfills are included in Table 3-2.

Table 3-2: Closed Landfills Information

	Ashton Creek RDF	Cherryville RDF	Kingfisher RDF	Pottery Road RDF
Closure date and activities	Stopped landfilling waste in 1996; final closure completed in 1997	Stopped landfilling waste in 2008; final closure completed in 2016	Stopped landfilling waste in 2002; final closure in 2003	Stopped landfilling waste in 1986; final closure completed in 2015, including purchase of a right of way to allow for natural attenuation of the leachate plume west of the landfill footprint
Current site use	None	Transfer Station (since 2008)	Transfer Station (since 2003)	None
Future site use	None planned	Transfer station	Transfer Station	Recreational, specifically a disc golf course, trails and a bike skills park.
Ongoing operations	▪ Environmental monitoring	▪ Environmental monitoring ▪ Transfer station operation activities	▪ Environmental monitoring ▪ Transfer station operation activities	▪ Environmental monitoring
Identified site risks	▪ Ongoing environmental monitoring is performed and evaluation of trends in exceedances for specific metals and leachate parameters			
Identified mitigation strategies or opportunities to minimized risks	▪ Long-term monitoring required for the length of this new plan to monitor the performance of environmental controls ▪ Repairs as necessary to fencing, ditching and cover area			

No new options have been developed for the closed landfill sites. Ongoing environmental monitoring and periodic site maintenance will be required for the foreseeable future. The post closure use of the Pottery Road RDF may be turned over to the Parks Department in the near future.

3.3 Transfer Stations

As reviewed in the Current System Assessment Report, the RDNO manages three transfer stations – Cherryville Transfer Station, Kingfisher Transfer Station, and Silver Star Transfer Station as summarized in Table 3-3.

Currently the Cherryville and Kingfisher transfer station facilities accept the majority of the recyclable materials that are accepted at the operating RDF facilities to encourage waste diversion and recycling. This current strategy to capture all recyclable materials requires the service to be offered at a subsidized rate, as the facilities are not able to capture the required funds to cover the costs of operating the transfer stations through tipping fees alone. Current service hours have been minimized to balance the budget for operating the sites while still ensuring residents have adequate site access.

Table 3-3: Transfer Station Information

	Cherryville Transfer Station	Kingfisher Transfer Station	Silver Star Transfer Station
Hours	Tuesday and Saturday, 9 am – 4 pm	November 1 – March 31: Sundays, 9 am – 4 pm April 1 – October 31: Wednesdays and Sundays, 9 am – 4 pm	Open 7 days per week, 24 hours per day.
Site history	Landfill closed in 2008. Operating as transfer station since 2008.	Landfill closed in 2003. Operating as a transfer station since 2003.	Operated since 2000
2016 tonnage collected	227 tonnes	123 tonnes	369 tonnes
Service population	1,010	300 (population varies seasonally)	98 (population varies dramatically on a seasonal basis)
Approximate funds generated from tipping fees (2017 estimate)	$29,000	$14,000	$116,814 (for transfer station operation)
2016 direct operation and maintenance expenditures	$67,700	$48,000	$116,814

Although no new options have been developed for the existing transfer stations, it may be necessary to assess the economics of continuing to collect wood and bulky items at the Kingfisher and Cherryville Transfer Stations. The costs to process and remove the wood chips and to accept the large bulky items (e.g., furniture) are increasing. It may be best to require these materials be hauled directly to the nearest RDF. The provision of recycling services at all transfer stations and RDFs in the region has been part of the ongoing strategy to maximize waste diversion. Identification of a clean wood waste market or uses on site is required to ensure the stockpiles of wood and other materials at the Cherryville and Kingfisher transfer stations is well managed.

4.0 OPTIONS AVAILABLE AND PRIORITIES FOR FURTHER EVALUATION

Based on a review of technology opportunities and residual management, the following scenarios and opportunities are under consideration for further evaluation in the economic analysis phase of the project and for potential inclusion in the updated plan. A more detailed review of technology option considerations is provided in Section 2.5 within the Table 2.4 Residual Management Options for Consideration in the SWMP. The selected scenarios and opportunities factored in what would still help to optimize reduction, reuse, and recycling and consider minimum feedstock thresholds needed to develop a business case.

- Anaerobic Digestion
  - Keep for consideration as an organics processing option when developing an organics program.
- Landfill Gas Capture
  - Continue with the evaluation of the current LFG system at the GVRDF and implement options for repurposing the collected gas beyond on-site flaring. For example, use the LFG for processing and injection into the natural gas grid, or to generate electricity; and
  - Minimize the quantity of organics in MSW through implementation of a source-separated organics program diverting these materials away from the landfill thus significantly reducing the potential for LFG generation.

- Thermal Technologies
  - Not recommended to pursue any thermal technologies for MSW treatment (as summarized in Table 2-4);
  - Include opportunities for some high energy source separated materials (clean and dirty wood) and identify markets for them through private thermal facilities involved in wood waste management or with Energy BC; and
  - Minimize costs associated with collection wood and other materials at transfer stations by having these materials direct hauled to local RDFs.

The options for potential residual management scenarios under consideration are summarized in Table 4-1.

Table 4-1 Summary of Residual Management Scenarios

Variable	Lumby	Armstrong	Vernon	Outcome
Current operation	▪ Monitor and evaluate site financial model and environmental performance, mitigate environmental issues as identified	▪ Monitor and evaluate site financial model and environmental performance, mitigate environmental issues as identified	▪ Monitor and evaluate site financial model and environmental performance, mitigate environmental issues as identified	▪ Minimize financial liability or operating three close proximity landfills
Modified operation scenario for consideration	▪ Convert to MSW transfer station, and preserve landfill space for inert C+D material only to limit environmental risks	▪ Close landfill early to mitigate environmental risks and construct a transfer station ▪ Develop LFG control system	▪ Confirm expansion design, and invest in the landfill expansion to improve site performance and create long term centralized disposal site for the region	▪ Development of long term disposal capacity for the RDNO ▪ Invest financial capital in GVRDF landfill site for optimal outcomes
Performance criteria for decision making	▪ Financially sustainable model for landfill operation and closure ▪ Environmental performance meets monitoring requirements	▪ Financially sustainable model for landfill operation and closure ▪ Environmental performance site upgrades meets monitoring requirements	▪ Financially sustainable model for landfill operation and closure ▪ Environmental performance site upgrades meets monitoring requirements	▪ Use financial performance for maintaining environmental standards and performance benchmarks to evaluate and determine potential early closure and site upgrades

Landfill capacity in the RDNO is estimated to be 34 years at the GVRDF, 17 years as the ASRDF and 57 years as the LRDF. The ASRDF has the most finite life (2034) and the GVRDF has lateral expansion potential which could extend site life beyond 2051. Long term plans for all three landfill sites is necessary in order to ensure future disposal capacity and where to direct investments in infrastructure. Pending confirmation from the RDNO Board and Regional Solid Waste Advisory Working Group, these options will undergo financial analysis for application scaled to the RDNO's current and future projected waste management status. The results of this analysis will be presented in Technical Memo No. 3, once all options further up the waste management hierarchy have been discussed and selections made through Technical Memo No. 2.

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We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

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Attachment (1): Tetra Tech's Limitations on the Use of this Document

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