Integrated Resource Management

IRM Information Consolidation and Project Criteria Development

Capital Regional District

November 3, 2017

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Note: Due to the substantial file size associated with the documents listed in the Appendices, and as these documents have previously been provided as supporting information as part of reports to previous CRD Board and Committee meetings, these documents are not included as part of this report file. A separate consolidated document file of these Appendices can be provided upon request.

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Glossary of Key Terms

The following glossary is not intended to be a comprehensive overview of all descriptive terms used in this report. However, in order to provide clarity for this report, key terms essential for understanding of the overall Integrated Resource Management (IRM) project are defined as follows.

Beneficial Use / Beneficial Reuse: Beneficial use and beneficial reuse are used interchangeably and for the purpose of this report and the Integrated Resource Management Project, are assumed to have the same meaning. Beneficial use is applied in the context of this project as a concept for the management of residual solid and liquid waste as a means to save landfill disposal capacity by avoiding disposal of materials and directing them to alternative uses. To be considered a beneficial use, the materials/products recovered from the solid or liquid waste stream must not be stored in anticipation of speculative future markets, the recovered materials must be an effective substitute for an analogous material or a necessary input to generate a new product, the use of the material should not adversely impact human health or the environment, and the material should be used in accordance with applicable standards, requirements, guidelines and best management practices. In accordance with CCME guidelines, Beneficial Use is the use of municipal biosolids, municipal sludge and treated septage according to the *Canada-wide Approach for Management of Wastewater Biosolids*.

Biosolids: For the purpose of this report the term biosolids is either used interchangeably with the term Class A biosolids when making reference specifically to this material in the context of the CRD or it is used as a generic term that in the most part refers to sewage sludge that has been treated. However, in some cases it has been used consistent with the terminology used in the source material and reflects the terminology applicable in that jurisdiction which in some cases includes jurisdictions where the terms biosolids and sewage sludge are used interchangeably.

Class A Biosolids: In all parts of the document that refer to Class A Biosolids as produced in BC including the CRD, Class A Biosolids are as defined under the BC Organic Matter Recycling Regulation, that meet the requirements of section 6 of the regulation (Schedule 1, Pathogen Reduction Processes; Schedule 2, Vector Attraction Reduction; Schedule 3, Pathogen Reduction Limits; Section 3 of Schedule 4, Quality Criteria; Schedule 5, Sampling and Analysis; Schedule 6, Record Keeping). There are portions of the document where reference to class A biosolids may be made in keeping with how this is defined in the host jurisdiction.

Compost: Means a solid mature product resulting from composting but does not include compost to which the Fertilizer Act (Canada) applies. This would include materials defined as "compost" under the BC Organic Matter Recycling Regulation.

Disposal: Is used in this report to refer to the disposition of solids, in a manner that does not result in the recovery of the resources (materials or energy) from those solids, including incineration (without energy recovery) and landfill disposal.

Fertilizer: Means any substance of mixture of substances, containing nitrogen, phosphorus, potassium or other plant food, manufactured, sold or represented for use as a plant nutrient that meets the requirements of the Fertilizer Act (Canada) and includes materials such as Compost where this material is sold as a fertilizer and thus must meet the requirements of the Fertilizer Act. This would include materials defined as "fertilizer" under the BC Organic Matter Recycling Regulation.

Integrated Resource Management (IRM): IRM is defined by the Capital Regional District as the integration of solid and liquid wastes, using currently landfilled or diverted materials along with biosolids, to maximize resource recovery through combined processing or some, or all, of these materials. Combined processing could be accomplished through the application of a single technology or a combination of technologies, from one or more technology providers, which recover resources in the form of materials and/or energy for beneficial use.

Municipal Solid Waste (MSW): Municipal Solid Waste includes solid waste material streams generated by the residential sector, institutional, commercial and light industrial sources as well as waste from construction, demolition and renovation activities. It does not include hazardous, biomedical or agricultural waste, motor vehicles or components, heavy industry waste or contaminated soil.

Pathogen: Means an organism including some bacteria, viruses, fungi and parasites that are capable of producing an infection or disease in a susceptible human, animal or plant host.

Resource Recovery: Resource recovery is identified as the 4^{th} R in the waste hierarchy, and involves the reclaiming of recyclable components and/or energy from the solid waste stream by various methods. To be considered a resource recovery facility, waste to energy facilities will achieve an energy efficiency criteria of obtaining at least 60% of the potential energy from the MSW used as fuel. The energy efficiency criteria is modelled after Annex II of the European Commission Waste Framework Directive model.

Sewage Sludge: Means the semi-liquid material that is removed from a wastewater treatment system as an end product of the treatment process. Generally sewage sludge has been used to refer to this material prior to treatment using elevated temperature and biological processes. However, in some cases it has been used consistent with the terminology used in the source material and reflects the terminology applicable in that jurisdiction which in some cases includes jurisdictions where the terms biosolids and sewage sludge are used interchangeably.

Scientific Evidence: Is evidence which serves to support or counter a scientific theory or hypothesis. Such evidence is expected to be empirical evidence and interpreted in accordance with the scientific method.

Table of Key Acronyms and Abbreviations

AD	Anaerobic Digestion
C&D	Construction and Demolition waste
CHP	Combined Heat & Power
CNG	Compressed Natural Gas
CRD	Capital Regional District
DB	Design, Build
DBFO	Design, Build, Finance, Operate
DBFOM	Design, Build, Finance, Operate, Maintain
DBO	Design, Build, Operate
DBOM	Design, Build, Operate, Maintain
DBOO	Design, Build, Own, Operate
DBOOM	Design, Build, Own, Operate, Maintain
DBOOT	Design, Build, Own, Operate, Transfer
EPC	Engineering, Procurement and Construction
FICFB	Fast Internally Circulating Fluidized Bed
FOG	Fats, Oils and Grease
GHG	Greenhouse Gas
Ha	Hectares
ICI	Industrial, Commercial and Institutional
IRM	Integrated Resource Management
kWh	kilowatt hours
LYW	Leaf and Yard Waste
m	Meters
MBT	Mechanical Biological Treatment
MSW	Municipal Solid Waste
MW	MegaWatt
Nm^3	Normal Cubic Meter
P3	Public Private Partnership
RDF	Refuse Derived Fuel
RFEOI	Request for Expression of Interest
SRF	Solid Recovered Fuel
SSO	Source Separated Organics
tpd	Tonnes per day
tpy	Tonnes per year
VOC	Volatile Organic Compound
WWTP	Waste Water Treatment Plant

1 Introduction

The Capital Regional District (CRD) has undertaken significant work over the past few years to further its investigations of advanced Integrated Resource Management (IRM) options to address solid and liquid waste streams generated in the district. Activities undertaken included the investigations by the CRD IRM Task Force in late 2015/early 2016, continued investigations by CRD solid waste staff on IRM activities as part of current programs and a decision in early 2017 to proceed with the issuance of a Request for Expressions of Interest (RFEOI) for advanced IRM solutions. As of late 2016, HDR was retained as the IRM advisor to the CRD to assist with the RFEOI, and has undertaken a number of subsequent activities as part of this work.

On June 28, 2017 a report was made to the Integrated Resource Management Advisory Committee (IRMAC) regarding the Advanced Integrated Resource Management, Request for Expressions of Interest, Detailed Analysis. The IRMAC recommended to the CRD Environmental Services Committee that five key deliverables be prepared and delivered for the September 6th, 2017 IRMAC meeting, based on the staff report regarding Advanced Integrated Resource Management, Next Steps and the presentation that was provided regarding the IRM Road Map. These recommendations were approved by the Environmental Services Committee on June 28th, 2017 and subsequently by the CRD Board.

The reports presented to the IRMAC meeting on September 6, 2017 included:

1. Report ERM 17-35 Advanced Integrated Resource Management – Facilities Tour Plan;
2. Report ERM 17-37 Advanced Integrated Resource Management – Procurement and Project Plan Update, including the IRM Project Plan Outline (Appendix A) and IRM RFQ – Draft Outline (Appendix B);
3. Report ERM 17-34 Integrated Resource Management Technology Gap Analysis – Biosolids Jurisdictional Review, including the IRM Technology Gap Analysis (Appendix A) and Beneficial Reuse of Biosolids – Jurisdictional Review (Appendix B);
4. Report ERM 17-36 Waste Flow Management Policy Backgrounder.

Subsequent to the IRMAC meeting, a motion was passed by the Environmental Services Committee and approved by the CRD Board that:

1. That staff be directed to work with the consultant to consolidate the reports and information presented to date and to bring forward criteria that would be used for advancing the procurement process; and
2. That the work, moving forward, not include any travel, at this time.

This report is intended to address this motion, to consolidate the reports and information presented to-date and to provide context for the development of criteria that would be used for advancing the IRM procurement process.

In addition to the reports and information presented to-date to the CRD, this document also presents some information sourced through additional research, to expand upon some key areas required to provide context to the procurement criteria. A series of case studies are presented, based on documents and information presented to-date and this research, identifying key issues that will need to be addressed in the IRM procurement process.

Based on the information reviewed, key findings regarding the following topics are discussed, to prepare CRD officials for a subsequent workshop to discuss and determine the direction in which the CRD chooses to proceed for the IRM procurement. This workshop session will provide direction for the development of the criteria which would be used to advance the IRM procurement process. The findings address (but are not limited to) the following key issues that will need to be confirmed to advance the procurement process.

Table 1 Key IRM Procurement Issues

Project Element	Impact
Site	Critical Asset Critical Factor for Project Success
Waste Supply	Key to Financeable Project
Ownership	Asset Control Risk Exposure
Financing	Ability to Secure Financing Cost of Financing
Technology	Degree of Complexity affects Risk Posture
Deal Structure	Depends on level of technology risk and risk allocation
Markets	Market Access and Value affecting financing and long-term viability
Residuals Management	Long term secure access to economically and environmentally sound residuals management capacity

These issues will be addressed in the development of risk management matrices that will be presented and discussed at the upcoming workshop session.

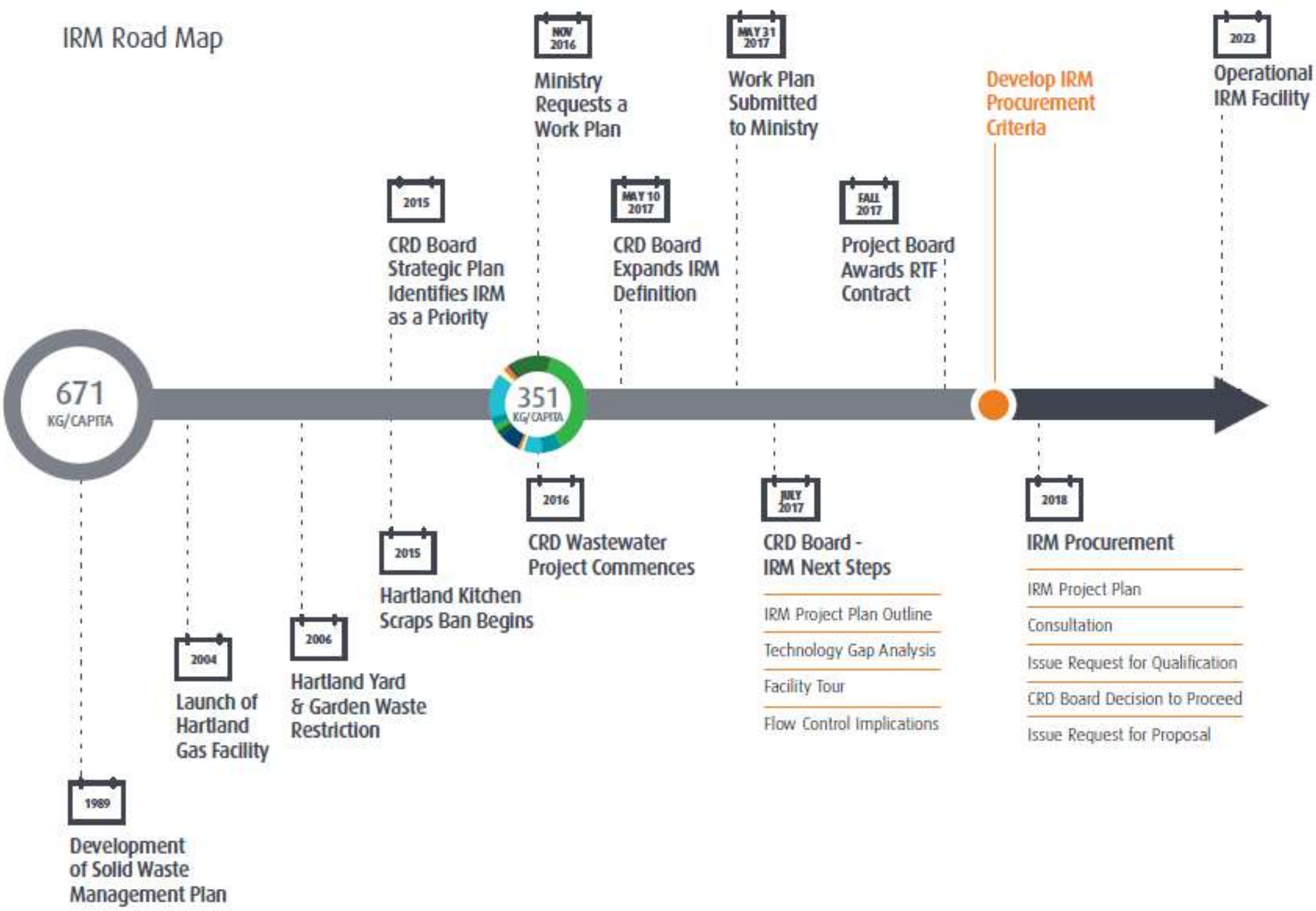
2 Summary of IRM Reports and Information

The reports and information developed to-date which support the IRM process, include materials that have been gathered for and presented to the CRD IRMAC, information arising from the Core

Area Liquid Waste Management Plan (CALWMP) process, and documentation gathered by the BC MOE in support of biosolids management in the province. The following provides an overview of reports and information that are related to the CRD IRM process and in particular the findings resulting from these reports/documents that are relevant to setting the context for IRM procurement.

Figure 1 presents a graphic timeline of the IRM roadmap indicating the progress made towards an IRM solution and proposed steps moving forward based on the IRM Workplan Outline. This progress includes progress related to the CRD Solid Waste Management Plan and the CALWMP and IRM Work plan.

Figure 1



2.1 CRD Board and Core Area Liquid Waste Management Plan – Key Information

The CRD is developing a wastewater treatment facility that will come online in 2020. The Project Board's Terms of Reference include the following key goals that are applicable to IRM:

a) optimizing opportunities to recover resources from waste as part of an integrated waste management approach; and,

b) minimizing GHG emissions.

The CRD Corporate Plan for 2015 to 2018 includes Climate Change and Integrated Waste Management as Board priority areas, and Environmental Protection and Regional Infrastructure as key corporate priority areas. In regards to Integrated Waste Management, the Board's strategic priorities include:

a) Acquiring additional expertise on technologies and solutions (including centralized/decentralized approaches and gasification) to liquid and solid waste management;

b) Investigate region-wide solutions to liquid and solid waste;

c) Establish a systematic process of evaluation for all liquid and solid waste decisions;

d) Investigate combined liquid and solid waste management plans;

e) Ensure responsible management of wastewater for the entire capital region.

Solid and liquid waste management within the CRD are currently driven by different legislative authorities/requirements and under the administration of different regional committees and Boards.

The Core Area Liquid Waste Management Plan includes the construction and commissioning of the wastewater treatment plant (WTP), development of a conveyance line for sewage sludge to the Hartland site, construction and commissioning of a residuals treatment facility (RTF) to produce Class A biosolids. The outcome of the CALWMP process, provides the key input to the advanced IRM process, being the Class A biosolids feedstock stream.

The CRD issued a Request for Qualifications (RFQ) for the RTF on December 5, 2016, and issued the subsequent RFP to qualified respondents in 2017. A decision on award of the RTF is anticipated in late 2017. Design and construction of the Residuals Treatment Facility is expected to begin in early 2018, with service commencement in the summer of 2020.

The outcome of the RFP process for the Resource Treatment Facility (RTF) will determine the quantity and composition of the biosolids stream that would be made available for an IRM solution.

Various supporting documents to the CALWMP process serve as supporting information for the IRM project. This includes for example, the various studies completed as part of the CALWMP Wastewater Treatment System Feasibility and Costing Analysis, such as Technical

Memorandum #3 – Costing and Financial Analysis which provided analysis of biosolids management costs (Appendix A). This analysis examined the energy content of the MSW stream and biosolids, and the energy balance and potential costs for AD and gasification options.

Currently there is a prohibition of land application of biosolids from CRD facilities either with or without treatment. As a result, the CRD requires that a beneficial use solution be found for management of the majority of the biosolids stream. Appendix B includes a copy of the decisions that encompass the CRD policy regarding land application of biosolids. This includes:

1. the minutes of the CRD Board meeting held on Wednesday July 13, 2011 which includes the following resolution:

   "*Be it so moved that the CRD will harmonize current and long-term practices at all CRD-owned regional facilities and parts with the approved policies of the regional treatment strategy, including ending the production, storage and distribution of biosolids for land application at all CRD facilities and parks; and*

   Be it further moved that the CRD does not support the application of biosolids on farmland in the CRD under any circumstances, and let this policy be reflected in the upcoming Regional Sustainability Strategy."

2. the minutes of the CRD Board meeting held on Wednesday October 30, 2013 which includes the following resolution:

   "*That the current policy, adopted July 13, 2011, regarding the banning of the land application of biosolids be confirmed*."

3. the minutes of the CRD Board meeting held on Wednesday, November 30, 2016, which includes the following resolution:

   "*That the Capital Regional District Board direct staff to include in the Integrated Resource Management project Request for Expressions of Interest the following:*

   1. A statement outlining the Board's current policy on land application and the concerns which drove its establishment; and

   2. A request for proponents to outline technologies that will deal with the Board's concerns; how the technology will mitigate the Board's concerns; applicability to the core area, Peninsula and other community sludge/biosolids management problem as a central and/or sub regional solution; costs, history and effectiveness.

It is the intent of the CRD to ensure that it has an integrated waste management solution that at minimum would allow for management of the Class A biosolids stream. Any system selected by the CRD, whether it consists of a single technology or a group of approaches must include a long-term solution for the management of these biosolids. The CRD is looking for a solution that can be integrated with the outcome of the current procurement process for the RTF, and is interested in identifying those options that present region-wide and/or sub-regional solutions.

2.2 BC MOE – Key Direction Documents

On November 18, 2016 the BC Minister of the Environment issued a letter regarding its revised conditional approval of Amendment No. 11 to the Core Area Liquid Waste Management Plan (CALWMP), attached as Appendix C. Amendment No. 11 includes the conveyance of sewage sludge from the McLaughlin Point WWTP to the Hartland landfill for processing into Class A Biosolids as defined under the BC Organic Matter Recycling Regulation, for beneficial use and optimization for potential opportunities for integrated resource management (IRM).

As a condition of approval, the Minister requires that the CRD develop a definitive plan for the beneficial reuse of biosolids that does not incorporate multi-year storage of biosolids within a biocell. On May 31, 2017 the CRD submitted a plan that outlines procedural steps and the schedule it will implement to achieve the definitive plan, attached as Appendix D. The definitive plan must be submitted as of June 30, 2019.

The definitive plan for beneficial reuse of biosolids:

a) is to be supported by an assessment of the full spectrum of beneficial uses and integrated resource management (IRM) options available for the Class A biosolids produced at the Hartland landfill;

b) incorporates a jurisdictional review of how similar-sized and larger municipalities within BC, North America and abroad successfully and beneficially reuse biosolids;

c) must select a beneficial reuse option for treated biosolids that meets the requirements for beneficial use specified in the Canadian Council of Ministers of the Environment *Canada-wide Approach for the Management of Wastewater Biosolids (*October 11, 2012) and be based on scientific evidence.

Upon receipt of the IRM Work Plan, the MOE issued correspondence on July 7, 2017 which noted that:

a) the IRM Work Plan submitted to the MOE exceeds the Minister's requirement as identified in the Minister's letter of November 18, 2016;

b) The Ministry distinguishes the implementation of the CALWMP and the advanced IRM facility initiative as two distinct projects. The first project is the CALWMP including the construction and commissioning of the wastewater treatment plant, conveyance line and residuals treatment facility and the beneficial use of Class A biosolids. The advanced IRM facility initiative is a longer term project where operation and commissioning is not dependent on the required timelines for implementation of the CALWMP. The Ministry concurs with the CRD that since the advanced IRM facility contemplate beneficial use of solid waste residuals, this initiative is better aligned with the CRD Solid Waste Management Plan process.

The full text of the letter is included in Appendix E. The IRM procurement process will reflect this approach.

The BC MoE has continued its own investigations and studies in support of beneficial use of biosolids in the province. Some of that work has been undertaken in support of the equivalency agreement that is being developed by the Ministry of Environment (MoE) and Environment Canada. This agreement will see amendments to the Municipal Wastewater Regulation making it equivalent in effect to the federal Wastewater Systems Effluent Regulation (WSER). The updated regulation will require all municipal wastewater facilities with flow rates greater than 100 m3/day discharging to water to have secondary treatment by 2040.

2.3 IRMAC – IRM Supporting Information

The documents discussed below, were presented and discussed as supporting information with the IRMAC, but were not prepared as specific documents within the IRM Project Plan.

2.3.1 CRD IRM Task Force Report

A CRD Integrated Resource Management (IRM) Task Force was created to examine the question of whether an IRM approach to managing waste streams might provide substantial financial benefit and substantially improved environmental outcomes to the region and its residents. In its terms of reference, the task force was asked to define the scope and parameters of Integrated Resource Management objectives, to recommend options to the CRD Board for endorsement and to recommend to the board a process for broadly seeking submissions from the private sector for implementing the recommended initiative.

It its report provided as of February 24, 2016 (Appendix F) the task force reported on the outcome of four presentations from potential technology providers.

In summary, information provided in this document that provides context to the IRM procurement process includes:

1. Partnerships with infrastructure and/or construction companies and technology providers will be required to develop the more complex IRM technologies. These entities would need to be able to guarantee and fund the development of the project. In the IRM procurement process, the RFQ stage would be required to qualify all key team members including the technology providers and the major partners required to execute a project.
2. Some technology providers offered a complete solution to manage CRD solid and liquid waste streams, while others focused on only specific material streams. This indicates potential for a single or multi-facility solution for IRM. The CRD has to determine if the procurement process would accommodate both.
3. Various potential contractual (and procurement) models were identified, with varying degree of risk transfer from the CRD. The evaluation of risk and identification of preferred contractual/procurement models will be a central part of the IRM procurement criteria development.
4. Various financial and environmental benefits were posited by the technology providers. The procurement process should include criterion related to financing and development of markets for beneficial use products which was a central theme, as well as criterion related to environmental benefits.

2.3.2 Gasification Technologies – Characterization of Waste Resources in the Capital (TWE)

Given the interest of the CRD in options for energy recovery from IRM materials, the CRD retained Talent with Energy (TWE) to undertake an assessment of waste resources available in the Capital Region to gain a better understanding of the potential for energy recovery associated with these resources. Their report on the Characterization of Waste Resources in the Capital issued in September 2016, is included as Appendix G. The analysis framework developed specifically for the CRD builds on a combination of elemental analysis data for the range of materials typically found in the domestic and commercial and industrial waste streams, and data from a composition study for solid waste streams collected within the Capital Region, developed for the CRD by Sperling Hansen Associates.

The provision of information derived from this report as supporting information in the IRM procurement process would be valuable to potential respondents considering the potential for use of CRD solid waste streams for renewable energy recovery. However, this information does not provide a similar analysis of the potential CRD biosolids stream.

2.3.3 Gasification Technologies Information – City of Sydney Australia

Based on the interest of the CRD in advanced IRM technologies, the IRMAC sourced information from the City of Sydney Australia that had undertaken an extensive gasification technologies review, as documented in the City of Sydney Advanced Waste Treatment Master Plan, Gasification Technologies Review, August 2014 by Talent with Energy (TWE) on behalf of the City (Appendix H).

Further, the CRD engaged the former Manager of the Waste Strategy with the City of Sydney (Mark McKenzie) to present via video link at the IRMAC meeting of February 8, 2017 to provide an update and information regarding the City of Sydney gasification project. The presentation is included in Appendix I.

The Sydney report indicated that in the opinion of the author, all of the key technology components (conversion, gas upgrading and delivery) were available to generate a substitute natural gas product from the gasification of waste, the network level integration of these technologies would be a unique development.

A key driver in the Sydney decision making process was the potential to increase the City's resource recovery rate and maximize energy recovery. The potential for use of biosolids directed to biomass energy recovery was considered in this study. The approach selected for advanced waste treatment is documented in the City of Sydney, Advanced Waste Treatment Master Plan (Appendix J).

Key elements within the information provided in these documents that provides context to the IRM procurement process includes:

1. Risks noted for the implementation of this energy conversion project included the nature and variability of the waste resource, the multitude of stakeholders involved, the higher degree of technology and operational risk associated with the waste

conversion processes, issues arising from public perception of WTE schemes and lack of a clear and comprehensive regulatory framework. Similar risks are associated with the CRD project and would be addressed through a detailed risk matrix to support development of the IRM procurement criteria.

2. To manage these risks, various activities were proposed including: profiling of alternative sites, waste characterization, undertaking a pre-feasibility study and preparing a business case and an assessment of the techno/economic feasibility of the facility, undertaking a multi-step procurement process that encourages the partnership between gasification technology providers and industrial gas providers.
3. Context for renewable biogas recovery is critical. With significant emissions from coal fired electricity plants, there is a significant incentive for GHG emissions reduction through complementary energy contributions.
4. Regional partnering was identified as a critical element to reach viable levels of waste for a facility (120,000 tonnes per year). Current challenges to the project and achieving a regional partnership include changes in critical staff, the political cycle, competing priorities, challenging regulatory context and the choice of technology.
5. The outcome of the gasification technology assessment undertaken by the City, was the selection of high-temperature gasification plus ash melting. One of the examples considered was the Plasco technology and facility in Ottawa, which ultimately was decommissioned (see case studies below).

2.4 IRM RFEOI

At its February 8, 2017 meeting, the CRD Board approved the advanced IRM Project – Request for Expressions of Interest documentation and directed staff to proceed with issuing the RFEOI. The purpose of the RFEOI was to gather information on potentially viable alternatives for processing of the existing solid and future liquid waste residuals that are/will be managed by the CRD. The outcome of the RFEOI process was not intended to qualify technologies or respondents, nor was it intended to validate partners.

The RFEOI was issued on February 16, 2017 and closed on March 20, 2017. Ten (10) responses were received. An initial report was presented as an appendix of Staff Report ERM 17-15 to the IRMAC on April 12, 2017 and is attached as Appendix K. Key findings from the initial review and assessment of these submissions that provide context to the development of IRM procurement criteria include:

1. The majority of respondents prefer that the CRD provide the site for the IRM facility. Many prefer that the CRD owns the IRM facility.
2. The type of business offerings in the submissions were quite varied. Many respondents are open to a variety of development models (DB, DBOM, DBOOT, etc.).
3. The majority of respondents reported their technology as being proven (operating at a commercial level) and do not recommend that the CRD undertake a pilot project. Those

respondents that did not put forward a proven technology, were more interested in, or recommended that the CRD undertake a pilot.

Following the initial review, there were a number of items that required clarification for each submission. Letters were developed and issued to all respondents, seeking additional clarification of the submissions. Discussions were held with some respondents based on their interest in participating in a teleconference with the CRD.

A detailed analysis of the RFEOI submissions was presented to the IRMAC on June 28, 2017 (Appendix L).

Key findings in the detailed analysis of the RFEOI submissions that provide context to the development of IRM procurement criteria include the following:

1. Generally the outcome of the RFEOI identified a broad spectrum of technologies and approaches that combined could offer the CRD an IRM solution, and in particular offer a range of options to beneficially use some or all of the CRD biosolids stream. However, this did not necessarily cover the full range of vendors that are capable of offering these solutions, nor did the responses to the RFEOI address all options applicable to manage the other CRD material streams. The IRM procurement approach needs to consider approaches that would broaden the market response to ensure that a sufficient number of companies representing viable technologies are qualified as a result of the process.
2. The option to integrate additional market sounding processes within any future procurement process for an IRM facility, and to integrate a proponent review process for draft procurement and/or contract documents, offer the option to fully inform the IRM procurement process and to address uncertainty and concerns regarding risk management approaches.
3. A number of RFEOI respondents, noted the difficulty in identifying IRM solutions for feedstock that is not wholly controlled by the CRD, and where there is significant potential for the materials to vary in quantity and quality over time (e.g. the CRD MSW stream). The assessment of longer-term solid waste management system impacts and determination of potential shifts in material types and tonnages is an essential component of the IRM Project Plan as is the consideration of waste flow management policy.
4. Further understanding of the need for supplemental feedstock materials is required. Additional research will be undertaken as part of developing the IRM Project Plan, to identify the potential availability of materials such as woody biomass and commercial material streams, which may be required as supplemental materials for some processes (e.g. composting, gasification). This will assist in determining the viability of some approaches.
5. The assessment of economic implications (or preliminary business case) for the IRM project, should assess the cost of continuing under the status quo for the management of the range of CRD solid waste streams, compared to the range of potential IRM system costs. Full economic implications, including the effect on existing infrastructure (e.g. the

availability of landfill disposal infrastructure) as well as the potential range of revenues associated with recovery of beneficial use products and GHG emission credits should be addressed.

6. Development of the IRM project plan will include the identification of project risks. Some of the risks identified in the evaluation of the RFEOI submissions, include the adequacy of the location identified at the Hartland landfill site for the development of a full IRM solution. Facility siting is an exercise that has presented obstacles and delays in other similar projects. In addition, there are some IRM solutions that require access to infrastructure (e.g. suitable access to the electrical grid or gas grid) for them to provide a viable option to the CRD. The project risk assessment exercise undertaken as part of the IRM Project Plan development should address these items.

7. Overall, the RFEOI submissions indicate that a number of products could be recovered and marketed and/or directed to beneficial use, from the CRD liquid and solid waste streams as indicated in the RFEOI. The market value of these materials has yet to be determined, and is an important consideration in determining the overall cost of an IRM solution. Initial feedback through the RFEOI process indicates that additional research regarding markets and market risks would be appropriate as part of the development of the IRM Project Plan. The viability of technologies that recover energy such as AD or gasification, may be contingent upon identifying a higher value market for that energy such as vehicle fuel. In regards to other products, in some cases more limited markets were identified (e.g. cement kilns as an RDF market) while in others the respondents had identified potential for a broader market (Class A compost).

8. In general, about half of the RFEOI respondents indicated a longer term agreement would be preferred (e.g. 20+ years), particularly as some form of Design Build Operate (DBO) deal structure was proposed or preferred. Some respondents did not provide any preferred term, or indicated that it would vary based on the type of deal structure/agreement. Longer term agreements tend to be favoured when the contractor is being held to rigorous performance guarantees for the facility and/or where there is more operational risk given the complexity of the facility. Assessment of the appropriate deal structure will include development of recommendations related to the appropriate term of agreement.

9. There was wide variation in the type of preferred deal structure identified by the RFEOI respondents. Respondents to the RFEOI indicated a wide variation in approach to allocation of responsibility, which reflects allocation of risk. Some indicated preferences that were balanced between the parties, and others indicated preferences that would place more responsibility on the CRD or vice-versa on the respondent. In most cases, respondents clearly stated that their preferences related to allocation of responsibility either reflects their preferred type of deal structure or would vary based on the type of deal structure appropriate for the project. As part of the procurement process, an exercise needs to be completed to identify the range of potential project risks, and will

discuss the implications of risk allocation in making a decision on ownership, the preferred procurement approach (ies) and business/deal structure.

10. The RFEOI specifically sought to understand the potential interest in or perceived necessity to undertake a pilot program in order to demonstrate the applicability of a technology or technologies to process the CRD liquid and/or solid waste materials. Respondents were requested to identify the feedstock of interest to them, the technology solution proposed, whether that technology was demonstrated at a commercial scale and whether they would recommend a pilot be undertaken. The majority of respondents indicated that a pilot would not be required, but did identify the need for the CRD to provide greater understanding of the quantity and composition of the CRD solid and liquid waste streams. Prior to undertaking any future procurement process for an IRM facility, additional waste stream characterization is recommended (e.g. compositional analysis of the SSO stream).

2.5 IRM Reports – September 2017

The following reports were prepared and presented at the September 6, 2017 Integrated Resource Management Advisory Committee meeting:

- A draft Integrated Resource Management Project Plan Outline
- A Gap Analysis to complete the evaluation of the broader array of technologies and feedstock combinations (as required in the provincial approval of the Core Area Liquid Waste Management Plan, Amendment No. 11)
- A proposed IRM Facilities Tour Plan, to address identified information gaps; and
- An IRM RFQ Outline
- And a summary of potential policy/project implications resulting from the CRD's lack of flow control over much of the waste feedstock.

An overview of these reports, and key findings which provide context for the development of IRM procurement criteria is presented below.

2.5.1 Integrated Resource Management – Facilities Tour Plan

Within the IRM RFEOI report, it was identified that consideration should be given to undertaking facility tours of a representative sample of technologies and vendors. Facility tours have the potential to flesh out understanding of a technology, over a shorter timeline and for a lower overall cost compared to undertaking a pilot study. It was recommended that facility tours not be undertaken on an ad-hoc basis, but in a strategic fashion with specific information targets in mind and that facility tours could provide first-hand information on the performance of technologies, further understanding of the approaches used to select IRM technologies, expand CRD understanding of successful procurement and ownership models and of the markets for recovered energy and products. The IRM Facility Tour Plan (Appendix M) was developed to address these recommendations.

As indicated in the Introduction, a decision was made by the CRD Board not to proceed with travel at this time. In-lieu of undertaking any facility tour, HDR has gathered from the various CRD reports and information, and from HDR information and on-line sources, various case studies (Section 5) that address much of the same information as would have been gathered in a tour.

Key findings of the facility tour report that provide context relative to the development of IRM procurement criteria include:

1. The facility tour plan developed a comprehensive list of potential facilities of interest from various sources including the reference facilities identified in the RFEOI responses. Over 70 facilities in North America and overseas were identified. Of these facilities:
    a. A small minority processed the range of similar solid and liquid waste materials identified by the CRD;
    b. A small minority current process sewage sludge and/or biosolids, and only a few of these co-process biosolids with other waste streams.

    This indicates that care will be required when developing the criteria for reference facilities required in the RFQ submissions, to allow for reasonable technical equivalencies for materials processed.
2. There were few advanced thermal or chemical technologies that met the criteria for selection for the tour including having been in operation for 2 or more years, processing at least one feedstock similar to the CRD materials and that were owned by a Municipality or municipal corporation. The majority of the facilities that met the criteria used more conventional MBT, composting, AD or thermal technologies. This speaks to the potential degree of technology risk that should be addressed in the IRM procurement criteria.

2.5.2 Integrated Resource Management – IRM Project Plan Outline

The IRM Project Plan outline (Appendix N) builds upon the IRM Work Plan which was submitted to the Province in May 2017 as requested by the Minister of Environment in her conditional approval of Amendment No. 11 of the Core Area Liquid Waste Management Plan (CALWMP). The intent was that the IRM Project Plan outline, provide more details regarding the road map for the IRM process.

Key findings of the IRM Project Plan Outline that provide context relative to the development of IRM procurement criteria include:

1. The IRM Plan Outline indicates the key decisions that would be required, in the form of recommendations from the IRMAC and subsequent decisions by Environmental Services Committee and the CRD Board throughout the IRM planning process. This Plan Outline identifies the timing of key decisions related to policy, in particular waste flow management policy implications as reflected in a separate CRD Staff report presented to the IRMAC in September, as well as the implications related to the existing CRD policy regarding Land Application and implications associated with the beneficial reuse of products that could include biosolids. Decisions related to the regulation of the flow of solid waste and organic materials will determine whether the CRD will be in the position to guarantee feedstock for

an IRM solution. In the absence of feedstock guarantees, the viability of an IRM solution will depend on its ability to compete cost effectively with options to ship materials off-island for management elsewhere. Decisions related to the CRD policy regarding Land Application and how that policy would apply to the use of products generated by an IRM solution that could contain biosolids, will significantly scope the potential for product markets and thus effect both facility design as well as the business case for implementing an IRM solution.

2. The IRM Plan Outline addresses the need for development of a Preliminary and Final Business Case for an IRM solution. Generally for similar projects a municipality would be advised to develop a Preliminary Business Case in order to determine if a project of this nature was viable, and in the event that it was viable the outcome of the business case would be used to scope the subsequent procurement process in regards to defining the preferred service delivery model to undertake the project; the preferred technology and the feedstock that would be managed.

   The timeframes currently assumed for the IRM Project Plan do not allow for a separate business case to be developed in advance of procurement. Instead, during the development of the IRM RFQ document an assessment of service delivery models will be undertaken. The IRM RFQ document, could be structured so as to allow for pre-qualification of service providers that have capability to manage IRM solid and liquid waste streams, with the identification of any preferred technologies and the feedstock to be addressed in an IRM solution to be informed by the outcome of the RFQ process. The outcome of the RFQ, including a Preliminary Business Case assessment, will provide the basis for the CRD to decide whether to proceed with the next IRM steps and the RFP scope definition for an IRM solution. The Final Business Case would reflect the outcome of the IRM RFP.

3. The IRM Plan Outline reflects alignment with the CRD solid waste management planning process, as it contemplates beneficial reuse of solid waste residuals. IRM in the Capital Region is predominantly driven by the solid waste streams, as biosolids comprise a relatively small proportion of the combined liquid and solid waste streams. The IRM project would be a fundamental shift in the way solid waste residuals and potentially other materials like organics would be managed in the Capital Region and requires a major review of the solid waste management plan. As appropriate, key steps in the development of the CRD Solid Waste Management Plan (SWMP) which can affect the IRM planning process (and vice versa) were indicated in the IRM Plan Outline.

4. The IRM Plan Outline refers to the planning and development of an advanced IRM solution, rather than making specific reference to an advanced IRM facility (in the singular) to allow for flexibility in the outcome of the process. This reflects the real potential that the outcome of the initial steps of the IRM Project Plan, including the RFQ and Preliminary Business Case, may indicate that either a phased solution or a multi-facility approach may be identified as more feasible approaches to implement an advanced IRM solution for the CRD. For example, it may be made clear that initially the focus of an IRM facility should be the management of biosolids and a smaller subset of other CRD materials, with the option that

over time either a facility expansion or an additional facility could be developed to manage other CRD materials. A phased approach could be developed by the same or a different entity. Alternatively, it may become apparent that the most feasible IRM solution may include more than one facility at the outset, developed by different entities, managing separate CRD material streams.

In the event that an IRM opportunity managing biosolids and other CRD waste streams is not proven to be the most beneficial path forward, the CRD would pursue an individual resource recovery plan or plans for the Region's solid waste streams, and present the Province with a definitive plan for the beneficial reuse of biosolids as a stand-alone opportunity.

2.5.3 Integrated Resource Management RFQ – Draft Outline

The RFQ draft outline (Appendix O) describes the proposed approach to undertake the IRM RFQ along with a proposed table of contents. The IRM RFQ Outline reflects the staff reports and documents developed to-date in support the IRM process including the outcome of the RFEOI process, the outcome of discussions with CRD staff and work completed on other components of the IRM Project Plan.

Key findings of the IRM RFQ Draft Outline that provide context relative to the development of IRM procurement criteria include:

1. The CRD will not be in a position as of late 2017 to 'guarantee' all of the feedstock types or quantities that could be made available for an IRM solution. The outcome of the RFP process for the Residual Treatment Facility will be understood in late 2017 and will allow for greater definition of the biosolids material stream in the IRM RFQ document. However, work on the Solid Waste Management Plan (SWMP) process and decisions related to flow control that would be required to guarantee other solid waste feedstock materials, will not be completed as of the time the RFQ needs to be finalized and released in order to support the overall IRM Project Plan.

   As a result, this RFQ would not seek to pre-qualify service providers capable of managing specific feedstock as required by the CRD, other than management of biosolids. Rather the RFQ would seek to pre-qualify service providers that demonstrate that they have the capability to manage biosolids along with one or more other solid waste streams. The outcome of the RFQ could result in identifying service providers that demonstrate capability to manage the full range of the potential CRD liquid and solid waste feedstock within a single integrated IRM facility as well as service providers that can manage some of these materials with their proposed technology, potentially requiring a multi-facility approach to address the full spectrum of potential IRM feedstock.

2. In most RFQ processes, a preferred type of technology or subset of technologies is identified prior to development and release of the document, which focuses the exercise to qualifying vendors with specific technologies that meet key technical criteria. This is not possible for the IRM RFQ process for two key reasons:

i. Firstly, it is difficult (to impossible) to scope the technologies that are the subject of an RFQ, without first being able to scope or guarantee the feedstock that must be managed by the facility. The current spectrum of feedstock is capable of being managed through a range of mechanical, biological and thermal technologies.

ii. Secondly, to support the alignment of the IRM Project Plan with the SWMP process, decisions cannot be made to scope or focus technologies this early in the concurrent processes, without constraining the SWMP planning process in a way that is not consistent with provincial solid waste management planning policy.

As a result, the RFQ would be designed to qualify service providers that demonstrate capability to manage some or all of the potential IRM feedstock, and the technologies proposed by those service providers that meet the qualification criteria will be used to inform the SWMP process and subsequent steps of the IRM Project Plan.

3. The outcome of the RFEOI process, as documented in the report on the detailed analysis of the RFEOI responses, did not identify any consensus or focus by the technology providers on any specific service delivery models. Interest was expressed by the majority of respondents on a longer term of agreement (20+ years) for some form of Design, Build, Operate (DBO) service delivery model. There was wide variation in the type of the preferred deal structure identified by respondents. As noted below, it is recommended that concurrent with the development of the IRM RFQ that an assessment of risk management approaches, service delivery models and contract structures be undertaken to focus the RFQ approach.
4. The RFQ would seek to qualify respondents on the basis of: the qualifications of the proponent team; the technical capability of their proposed IRM solution; and the financial capability of the respondent, pending selection of the service delivery models and contract structure selected by the CRD.

2.5.4 Integrated Resource Management Technology Gap Analysis - Preliminary

The Gap Analysis was undertaken to complete the evaluation of the broader array of technologies and feedstock combinations, as required in the provincial approval of the Core Area Liquid Waste Management Plan, Amendment No. 11.

The preliminary Gap Analysis (Appendix P) identifies the full spectrum of possible technologies that could be considered by the CRD and considers the application of these technologies to the potential feedstock combinations considered by the CRD. This preliminary Gap Analysis reflects the outcome of the IRM RFEOI as reported in the detailed analysis of the RFEOI results provided to the IRMAC on June 28, 2017 as well as the outcome of the Jurisdictional Review both of which are key components supporting the assessment of the full spectrum of approaches to beneficially reuse biosolids. As the responses to the RFEOI did not reflect the full spectrum of possible IRM technologies that are available, additional resources were used to supplement this information.

This Gap Analysis should be considered as a preliminary document/analysis, as further work will be undertaken over the course of the next few months as set out in the recommended CRD IRM Project Plan Outline (discussed in the separate report to the IRMAC) regarding the approach for technology selection and development of feedstock assumptions for the RFQ. The assessment of the full spectrum of beneficial uses and integrated resource management options in the IRM Project Plan, would be comprised of this preliminary Technology and Feedstock Gap Analysis along with the additional work undertaken regarding the approach for technology selection and development of feedstock assumptions, and the outcome of the IRM RFQ process.

Key findings of the IRM Technology GAP Analysis that provide context relative to the development of IRM procurement criteria include:

1. It is clear based on the review of the technologies presented in the RFEOI submissions, the analysis of additional technologies not captured in the RFEOI process and the technologies identified in the jurisdictional review, that there is not one single technology applied at an operating facility that has managed the full range of IRM solid and liquid feedstock. It is anticipated that further steps in the IRM Project Plan, including the proposed RFQ process, will identify a viable sub-set of technologies that would be applicable to both the solid and liquid CRD waste streams that could be developed for the CRD by qualified companies. A successful IRM solution is most likely to consist of a combination of technologies at a single facility, or a combination of facilities, integrated into the CRD's overall system for solid and liquid waste management.

2. For a CRD IRM solution to be successful, it will require consideration of the appropriate combination of technologies and the appropriate combination of feedstock materials, considering:
   a) The properties of the feedstock materials (chemical composition, heating value, moisture content etc.), which will be supported by the CRD Solid Waste Management Plan (SWMP).
   b) The quantities of the feedstock materials considering the quantities required to achieve economies of scale as well as the availability of these materials considering flows of materials that are controlled by and that are not controlled by the CRD. Economies of scale could be achieved either through some form of regulatory control (flow control), or through functional competition of an IRM solution in comparison to other waste management facilities through market forces. Flow control would be addressed through the assessment of policy/project implications in the SWMP.
   c) Requirements for amendments and other supplemental materials (e.g. woody amendment materials). The IRM RFQ process would determine, based on the responses and technologies identified, if there would be a need for the CRD or the respondents to source supplemental materials in order to implement an IRM solution. The preliminary Business Case would need to analyse the current market value of any supplemental materials and the issues that could arise in sourcing/securing these material streams.

d) The range of beneficial materials that can be recovered, and the markets for these materials. The outcome of the IRM RFQ process will assist in this determination, along with the preliminary Business Case which will need to examine local market conditions.
e) The economic implications associated with applying specific technologies to this feedstock. . This would be addressed by the development of a preliminary Business Case based on the outcome of the RFQ and a final Business Case based on the outcome of the RFP

3. Decisions regarding the technology or combination of technologies that would comprise an IRM solution, and the feedstock that would be directed to an IRM solution, must be integrated with the other concurrent IRM planning processes, and consider the effect on the CRDs overall liquid and solid waste management systems.

2.5.5 Beneficial Reuse of Biosolids – Jurisdictional Review

As the regulator for the CRD regional wastewater treatment project, the Province of British Columbia requested that the CRD conduct a jurisdictional review "of how similar-sized and larger municipalities within British Columbia, North America, and further abroad, successfully and beneficially reuse biosolids." The jurisdictional review was undertaken to support a more informed biosolids option assessment for CRD wastewater treatment and Integrated Resource Management projects, and to meet the Province of BC request. As specified in the letter from the Province dated November 18, 2016, the beneficial reuse option selected by the CRD for their treated biosolids must meet the requirements for beneficial use specified in the Canadian Council of Ministers of the Environment 'Canada-Wide Approach for the Management of Wastewater Biosolids'. EDI Environmental Dynamics Inc. (EDI) was contracted by the CRD to complete this review. The jurisdictional review was provided to the IRMAC as Appendix B to report ERM 17-34 and is referenced here in this report as Appendix Q.

Key findings of this report that provide context relative to the development of IRM procurement criteria include:

1. Only a few examples were noted in the jurisdictional review of IRM approaches for co-management of liquid and solid waste streams. In the majority of cases where IRM was applied (e.g. the Mont De Marsan facility in France) the solid waste that has been co-processed has been limited to green waste (yard waste) or residential organic waste (Edmonton) and in some countries regulatory and other pressures have resulted in biosolids being incinerated with MSW or RDF (Germany, Netherlands). As a result, it will be difficult for many technology providers responding to an IRM RFQ to identify as reference facilities, facilities that current co-manage biosolids using the same process within the same facility. Most respondents will have to show equivalencies for their IRM approach, based on grouping of multiple technologies or facility types.
2. The majority of technologies noted in the Jurisdictional review, generate some form of beneficial use product that is used in some way to build soil productivity, support agriculture/silviculture/landscaping/gardening or is used for land reclamation. This includes the range of emerging technologies that were examined, the majority of which produce some form of Class A or B biosolids or ash/biochar which is proposed or used as soil amendment.

The expectations set out in the IRM procurement process needs to recognize the range of current products and markets for materials derived from biosolids.

2.5.6 Waste Flow Management Policy Backgrounder

This staff report (Appendix R) presents policy and financial considerations regarding flow control of waste feedstocks. One of the main challenges identified in the Core Area Wastewater Treatment Program Business Case was the lack of flow control over solid waste streams in the region. Flow control refers to the ability of a regional district to regulate the flow of solid waste and recyclable materials as provided for in the Environmental Management Act (EMA). Waste flow management provides a means to guarantee feedstock for the establishment of new facilities, such as the proposed IRM facility. Regional districts in the province have identified waste flow management as a critical issue and are trying different approaches to secure feedstock availability and funding for solid waste programs. The more successful approach, in the wake of the Province's rejection of Metro Vancouver's proposed flow management bylaw in October 2014, has been the application of financial mechanisms through reduction in tipping fees for large commercial loads. The proposed solid waste generation levy and licensing of commercial haulers by Metro Vancouver is also anticipated to affect waste flow.

As part of the IRM Work Plan and during the development of the IRM procurement documents, the CRD needs to address the CRD's lack of control over the flow of solid waste streams in the Region, so that respondents are fully aware of the potential risks. Securing material flows under current conditions, will require very competitive pricing for tipping fees at an IRM solution. Current conditions in the CRD are discussed in Section 3 below and the issue of waste flow control is discussed both in the Case Studies in Section 5 and in the Findings in Section 6, as it is one of the most significant issues to be addressed as part of the IRM Project Plan.

There may be other options for securing material flows that could also be considered such as inter-municipal agreements. Some of these options/concepts are discussed in the Case Studies presented in Section 5. Certainly, the CRD has previously examined the option of pursuing development of waste management infrastructure through joint initiatives that would allow for control over larger waste streams and thus economies of scale, through the Feasibility Study for a Tri-regional Waste-to-Energy Facility as discussed in the staff report to the Environmental Sustainability Committee in June 2011 attached as Appendix S. This study determined that a tri-regional option would secure more feedstock, allowing for greater viability of a range of technology options including conventional WTE, gasification and plasma arc, and greater economies of scale and lower costs for each unit of waste processed.

3 Current CRD IRM System

The Environmental Resource Management Division of the CRD is responsible for solid waste disposal of municipally controlled waste in the Capital Region. Programs offered by the CRD are funded through fees collected at the Hartland landfill, funding received from producers for managing stewardship items and the sale of resources and recyclable materials. No funding is drawn from the municipal tax system.

The programs offered by the CRD include:

1. The CRD residential blue box program provided to over 121,000 households in the Region.
2. Support for waste reduction, reuse and recycling through public outreach and initiatives such as the myrecyclopedia app.
3. Operation of a drop-off facility at Hartland, accepting recyclables, product stewardship items, household hazardous waste and residual garbage.
4. A Kitchen scraps landfill ban, resulting in residential collection programs provided through a combination of municipal programs and private services.
5. A yard and garden material landfill restriction, resulting in a number of municipal yard waste depots accepting the drop off of these materials including Hartland. This is also supported by collection services in 6 municipalities.
6. Operation of the Hartland landfill (discussed further below).
7. Management of construction and demolition materials at the Hartland landfill that meet the CRD landfill disposal requirements for removal of hazardous items and recyclables.

Municipal solid waste generated in the CRD that is destined for disposal, is managed at two specific sites within the region. The CRD owns and operates a landfill at the Hartland site in Saanich, approximately 14 km north of the City of Victoria. At the current rate of fill, the Hartland landfill has well over 30 years of life remaining. As indicated in Figure 1 above, since the original development of the CRD Solid Waste Management Plan, waste generation rates in the CRD have declined from 671 kg/capita/year as of 1989 to 351 kg/capita/year as of 2016 through the combined effort of the CRD and member municipalities to divert yard and kitchen scraps and through other waste reduction, reuse and recycling efforts.

Of the waste entering the Hartland landfill, approximately 50% of the approximately 150,000 tonnes per year that is landfilled, is generated by residential sources and the rest is generated by private sources and is hauled to the site by private contractors. Current tipping fees at the Hartland landfill are identified in the *Hartland Tipping Fee and Regulation Bylaw.* As of 2017 the charge for general refuse was $110/tonne. This is generally equivalent to the average tipping fees set by other Vancouver Island regional districts. The landfill gas system at the Hartland landfill currently captures 1,200 SCFM of landfill gas, of which approximately 50% is directed to a 1.6 MW co-generation plant, and approximately 50% is currently flared. The LFG that is currently flared, would be available as a supplementary energy source to an Advanced Integrated Resource Management Facility.

The CRD has embarked on a Landfill Gas Utilization Feasibility Study intended to determine if greater value can be derived from all the landfill gas generated at the site. The outcome of this exercise may provide an opportunity for co-management of landfill gas and biogas from the RTF, including the gas conditioning infrastructure to upgrade landfill gas and biogas to pipeline grade renewable gas to the grid or other options (e.g. CNG applications).

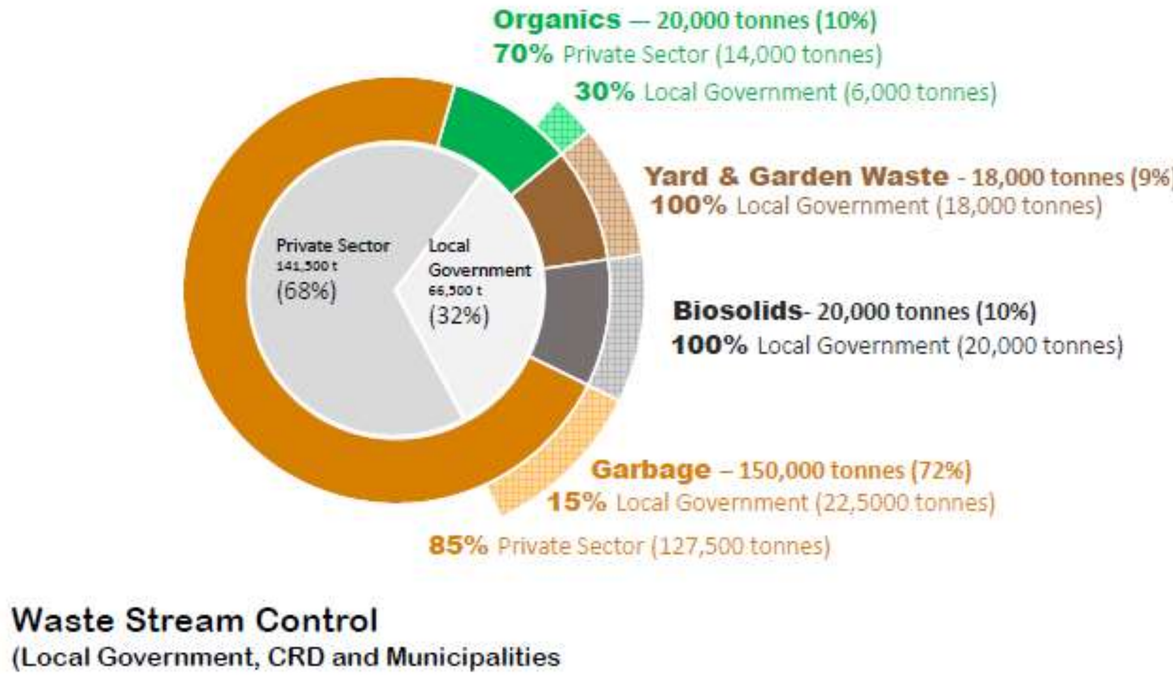
A second landfill owned and operated by Tervita known as the Highwest Waste Management Facility accepts construction and demolition (C & D) and non-hazardous institutional, commercial and light industrial (ICI) waste. This facility is the only private disposal facility located in the CRD and can dispose of a maximum of 25,500 tpy of selected non-putrescible wastes. Capacity at this site is expected to be reached around year 2019/2020.

The CRD has no control over the flow of C & D material to the Highwest facility nor does it have control of the flow of the privately managed MSW stream to the Hartland landfill beyond the current tipping fees and bans/restrictions on the disposal of yard & garden waste and kitchen scraps that are applied at the site. There may be some residual waste that flows outside the region via private haulers but that is considered negligible at this time. However, there is some concern that ICI material streams could be directed to other landfills in BC and Washington State should the tipping fee at Hartland increase such that the haul and export of waste outside of the CRD becomes financially viable.

The CRD has restricted kitchen scraps from disposal at the Hartland Landfill as of 2015. Household organics are collected through municipal services or private service providers across the CRD. Acceptable materials include food scraps, household plants and soiled paper towels and tissues. The CRD expects diverted organic tonnes to increase to 20,000 tpy over the next few years following implementation of this restriction. The CRD manages a portion (approximately 30%) of the processing of kitchen scraps collected across the Region for some of its municipal partners. This material is hauled to a transfer station at Hartland Landfill. Currently the CRD contracts for the haul and processing of these materials at a facility located outside the Region in Richmond BC.

Figure 2 below, provides an overview of the material streams generated within the CRD, and how these material streams are currently managed. This overview includes the potential generation of biosolids through the RTF.

Figure 2 **Current Waste Generation and Management in the CRD**



In 2012, the Capital Regional District (CRD) began development of a major revision of its 1995 Solid Waste Management Plan, referred to as the Integrated Solid Waste and Resource Management Plan (ISWRMP). The ISWRMP was put on hold in 2015 to investigate Integrated Resource Management (IRM) opportunities.

As indicated in the letter received from the MOE letter of July 2017, the Ministry's CRD Project Liaison, advised that the Ministry views the implementation of the CALWMP and the Advanced IRM facility as two distinct projects. The Advanced IRM facility initiative is seen as a longer term project which requires further details and would be better aligned with the CRD solid waste management plan process as it contemplates beneficial reuse of solid waste residuals. Updates to the SWMP would proceed under the new *Guide to Solid Waste Management Planning* released by the Province in September 2016. The Guide sets a new municipal waste disposal target of 350 kg per capita by 2020, requires consideration of eight new provincial guiding principles, and shifts the focus from a prescriptive to a results-based model for solid waste planning.

The IRM Project Plan outline presented in Appendix N was aligned with the CRD solid waste management planning (SWMP) process as it contemplate the beneficial reuse of some or all of the solid waste residuals currently managed by the CRD. The IRM project could result in a fundamental shift in the way that solid waste residuals and organics could be managed in the region. IRM has the potential to impact every aspect of the overall waste management system during the three main stages: system inputs (pre-processing), processing and system outputs.

Key steps in the re-initiation and updating of the SWMP which can affect the IRM planning process (and vice versa) have been indicated in the IRM Project Plan.

As noted in Section 2.5.6 above, as part of the IRM Work Plan and during the development of the IRM procurement documents, there is a need to address the CRD's lack of control over the flow of solid waste streams in the Region.

4 Overview of IRM and National/Regional Context in Various Jurisdictions

The national/Provincial and regional context in which IRM is implemented is a very significant factor in the success of any IRM initiative. This context includes the regulatory environment for solid waste and biosolids, greenhouse gas emission related regulations and emission reduction targets, availability of disposal capacity, the market for renewable energy and recovered materials amongst others.

In British Columbia and the CRD in comparison to other jurisdictions:

1. Management of residentially generated solid waste is largely a municipal responsibility, while management of commercial waste falls largely to the private sector. Authorities responsible for solid waste management are responsible for compliance with B.C. regulations and for the development of Solid Waste Management Plans under the new *Guide to Solid Waste Management Planning* released by the Province in September 2016, which provides a framework for how the waste streams they are responsible for are managed over time. The CRD Solid Waste Management Plan, which provides the current framework for the management of solid waste in the region, was developed in 1989.

2. There are no applicable Provincial or National bans or taxation initiatives that direct major material streams away from landfill disposal to possible IRM infrastructure. The CRD restricts the disposal of a number of materials including yard and garden waste and Kitchen scraps at the Hartland landfill, as a means of incentivizing diversion of these material streams.

3. There are no specific waste flow management requirements as discussed in Section 2.5.6 above. Generally, jurisdiction for waste management jurisdiction in the CRD is split, with the lower tier member municipalities being responsible for decisions regarding the provision of residential collection services and directing those materials to waste processing/disposal facilities for management, and the CRD being responsible for Hartland, and the services provided at this facility. As a result only 32% of the materials managed at Hartland are municipally 'controlled', with the remainder being solid waste hauled to this facility by the private sector. This is similar to the experience in other BC jurisdictions, and as a result pricing signals including the tipping fees at regional facilities are the primary influencers on waste flow. This is similar to the majority of the rest of North America. However, overseas there are many jurisdictions where waste flow is directed through regulations to regional authorities.

4. Pricing signals for disposal, often reflect the availability of landfill disposal capacity. While the CRD has significant remaining capacity at Hartland, it is recognized that the landfill is an asset that could not easily (or ever) be replaced. In jurisdictions like Ontario or the New England states, the lack of availability of landfill disposal space has resulted in higher landfill disposal tipping fees which has driven both investment in waste diversion programs and the application of IRM solutions including thermal technologies (e.g. Durham York Energy Centre discussed below). This is a significant factor in countries with limited available land or landfill disposal capacity.
5. In British Columbia the regulatory system supports the beneficial re-use of biosolids. Depending on the type and extent of treatment, biosolids can be produced as either Class A or Class B. British Columbia's Organic Matter Recycling Regulations (OMRR) outline the biosolids class requirements through quality criteria for pathogens, specifically faecal coliforms, and trace elements. Class A biosolids undergo more extensive treatment (e.g. anaerobic digestion, alkaline stabilization) and stabilization, targeted at pathogen removal, compared to Class B biosolids. Class A biosolids products are also lower in trace metal content due to the addition of additives during the treatment process such as lime, sand, or wood waste (Stantec 2011). As Class A biosolids are subject to more stringent quality criteria, they have less restrictive land application requirements than Class B biosolids due to their lower risk (BCWWA 2016, MoE 2017).
6. The availability of incentives for renewable energy production from solid or liquid waste streams varies from province to province, state to state and at a federal level. Some jurisdictions have no direct incentives at all. Some incentives are more substantial than others and provide a more significant financial premium for generation of renewable transportation fuels and/or for the generation of electricity from this type of renewable source. In BC incentives available under the Provincial Climate Leadership Plan and the Greenhouse Gas Reduction Regulation (GGRR) as well as under the Clean Energy Act are enabling utilities to increase incentives for the supply and use of renewable natural gas (RNG). RNG is considered carbon neutral. Increased use of RNG could result in up to 450,000 tonnes of GHG reductions per year in B.C., and will also help build the market for biogas, providing economic opportunities for local governments and farming and forestry operations. Amendments to the GGRR will allow utilities to double the incentives available to convert vehicles and marine vessels to natural gas when the new incentives go towards vehicles using 100% RNG, and enable utilities to recover the costs of acquiring and distributing RNG in rates.

The following sections provide some background on the national/Provincial and regional context which has affected the implementation of IRM initiatives elsewhere, and that are of relevance when reviewing the IRM case studies as presented in Section 5.

4.1 North America

Management of solid waste in North America is usually addressed within the development and implementation of solid waste management plans as required based on state or provincial acts, regulations and/or guidelines. Requirements vary significantly from those jurisdictions that are required to achieve specific diversion targets and those where only general guidance is provided.

There are several states, counties and local jurisdictions in the US that encourage similar types of programs for some of the suite of materials CRD desires managed. However, most such similar programs are integrated to address the management of solid waste and recyclable materials and few if any include biosolids in the suite of materials requiring an integrated approach.

The United States Environmental Protection Agency (EPA) is a US federal agency which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress. The EPA enforces the Resource Conservation and Recovery Act (RCRA) which was developed to protect communities and implement resource conservation. The EPA develops regulations, guidance and policies that ensure the safe management and cleanup of solid and hazardous waste, and programs that encourage source reduction and beneficial reuse. However, in practical terms the EPA and RCRA are primarily focused on protecting the environment and not focused on resource recovery in the way CRD defines the term. The EPA also oversees the management of biosolids[1]. The EPA enforces regulations that establish a protective regulatory framework to manage the use and disposal of sewage sludge. The EPA also governs the use of biosolids when used as fertilizer. However the EPA does not require the preparation or implementation of IRM approaches, nor does it stipulate a requirement for the beneficial use of biosolids.

As an example of a local governmental entity developing IRM type programs, the Ohio Environmental Protection Agency oversees Ohio's solid waste management planning program. The program is a multi-faceted, statutorily-based program developed to ensure the state's solid waste is properly managed. The overriding objectives are to ensure that Ohio has adequate disposal capacity and to reduce Ohio's reliance on landfills for disposing of solid waste. To achieve those objectives, Ohio EPA, working with the Materials Management Advisory Council, adopts a state solid waste management plan (state plan) that establishes goals for reduction and recycling.

The state reports approximately 40 years of available disposal capacity which allows the state to focus its attention on diverting waste to alternative management options. This is achieved by ensuring that communities and businesses have opportunities to reduce, reuse, and recycle their solid waste. Making those opportunities available is a collaborative effort among many stakeholders but is driven primarily at the local level through solid waste management districts (SWMDs). SWMDs, in turn, fulfil their planning obligations by preparing and implementing solid waste management plans. Through those plans, SWMDs demonstrate how they will fulfil their statutory requirements and achieve the goals in the state plan.

[1] https://www.epa.gov/biosolids

As another example, the state of North Carolina requires its counties to develop and submit a ten-year solid waste management plan (SWMP). Mecklenburg County developed its SWMP[2] with a goal of continuously evaluating the waste stream, developing waste reduction goals, and guiding future planning decisions to “Create recycling infrastructure for no wasted resources in our County”. The SWMP does not address biosolids. The County incorporates eight local governmental entities in the development of the SWMP. The latest 2012 Mecklenburg County Ten-Year Solid Waste Management Plan (Plan) represents the fifth update to the Plan, and encompasses eight local governments.

The state of California has a department (CalRecycle) devoted to managing its resources titled the California Department of Resources Recycling and Recovery[3]. The state has enacted numerous laws and regulations that mandate the recovery of resources that has resulted in significant improvement in the beneficial use of the state’s solid wastes and recyclables. Businesses in California are required to implement recycling their organic materials depending on the amount of waste they generate each week. Local jurisdictions must have an organic waste recycling program in place for those businesses. The state also set the goal of 75 percent recycling, composting or source reduction of solid waste by 2020 calling for the state and the Department of Resources Recycling and Recovery (CalRecycle) to take a statewide approach to decreasing California’s reliance on landfills. The approach is based on implementing programs to achieve the highest and best use of all materials in the state.[4] CalRecycle does not manage biosolids.

In regards to the Canadian approach to IRM and solid waste planning, there are general similarities in the regulatory and/or policy guidance regarding solid waste management programming for municipal jurisdictions. There are variations in extended producer responsibility programs, whether or not planning documents require approval as an overall framework for municipal systems (e.g. BC) or whether they are regarded as good practice and are expected to reflect Provincial policy (e.g. Ontario).

Within BC, as a comparison to the CRD system and SWMP as described in Section 3, the Greater Metro Vancouver Regional District adopted a Solid Waste and Integrated Resources Management Plan (ISWRMP)[5] which has been incorporated into the Metro Vancouver Regional

2 https://www.mecknc.gov/LUESA/SolidWaste/ManagementPlan/Documents/MeckCoSolidWasteMgmtPlanJune2012.pdf

3 http://www.calrecycle.ca.gov/stateagency/IWMPlans/

4 http://www.calrecycle.ca.gov/75Percent/

5 http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/ISWRMP.pdf

Growth Strategy (Bylaw 1136, 2010)[6]. The overriding principle of the Integrated Solid Waste and Resource Management Plan was based on the avoidance of waste through an aggressive waste reduction campaign and through the recovery of materials and energy from the waste that remains. In line with this principle, the Integrated Solid Waste and Resource Management Plan (ISWRMP) has four goals:

1. Minimize waste generation
2. Maximize reuse, recycling and material recovery
3. Recover energy from the waste stream after material recycling
4. Dispose of all remaining waste in landfill, after material recycling and energy recovery

Among a variety of strategies to manage resources, Strategy 2.6 of the ISWRMP targets organics for recycling and energy recovery and specifically seeks to identify beneficial and marketable products from various materials including biosolids and other utility residuals.

This plan and strategy is relatively unique in North America as it addresses the management of a range of materials outside of traditional solid waste, including biosolids.

In regards to management of biosolids in Canada, there is support for beneficial re-use of biosolids by federal and provincial agencies across Canada (CCME 2012). In Canada, the CCME has developed a 'Canada-Wide Approach for the Management of Wastewater Biosolids' (CCME 2012a) and a supporting 'Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage' (CCME 2012b). Federal and provincial acts and regulations are intended to ensure biosolids are managed and used in a safe and environmentally sound manner. Biosolids sold or imported as fertilizer or supplements are regulated under the Federal Fertilizer Act. End use of biosolids, including land application and disposal are governed by provincial or territorial acts and regulations, which specify standards and generally require licencing/permitting approvals for biosolids use.

Generally in North America, the driving factors that encourage any form of integrated waste management system for solid or liquid waste materials are indicated in Table 2.

Table 2 Factors That Affect IRM Project Development in North America

Political/Regulatory

Indicator	Definition/Description
Regulations banning disposal of residential and/or commercial organic wastes to landfills	Legislation that restricts or places limits on the disposal of organic/decomposable materials in landfills. Each jurisdiction has its own generator/trigger value.

[6] http://www.metrovancouver.org/services/regionalplanning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf

Carbon credit/trading programs or subsidy programs	State/Provincial level programs that provide financial incentives for facility/project owners to implement IRM solutions.
Regulatory limits on GHG emissions	Regulatory guidelines or legislation that places a cap on GHG emissions generated by waste and/or industrial facilities.
Legislation that creates renewable energy portfolio mandates/goals (e.g. 20% of state's energy will come from renewable sources)	State/Provincial level government enacted regulations and/or programs that set forth goals for energy generated by renewable sources.
State/Provincial diversion mandates requiring achievement of certain diversion goals	State/Province sets a broad goal for reuse or recovery of materials without stipulating how those goals should be achieved. States that target diversion rates higher than 50% draw market interest.
Limits/requirements regarding nutrients and land application	Specific regulatory limits/requirements that stipulates the quantity and/or type of nutrients that can be applied to land.
State's political climate on energy matters	The political makeup of the state (red/blue) and the influence of traditional energy sources on policy making.

Economic

Indicator	**Definition/Description**
Market price for electricity (KW/h)	The market price of electricity per kilowatt-hour (KW/h) in a given geography, particularly for energy from renewable sources.
Landfill tipping fees	The average tipping fee for landfill disposal of waste
Market price for recovered material (e.g. compost, fertilizer)	Average bulk retail price for recovered material

Social

Indicator	**Definition/Description**
Green ranking of a state/province or city	State/city green score.
Recycling rates or landfill diversion rates	Current waste diversion rate
Public awareness of past failures (e.g. odor, environmental, etc.) where facilities have been a public nuisance.	News articles that cite complaints regarding large-scale waste facilities.

Technology

Indicator	**Definition/Description**
Proximity/accessibility to distribution infrastructure (e.g. gas pipeline, grid)	Estimated natural gas pipeline mileage as reported by U.S. Department of Energy
Waste collection and pre-processing infrastructure	Status of waste collection and pre-processing infrastructure and the degree of material flow control held by the jurisdictions considering IRM

4.2 European Union

The management of waste material in the European Union (EU) reflects the diversity of the various countries that make up the EU. There are overarching regulations and guidelines in place that have for some time favoured the processing of waste, rather than direct disposal in landfills. Additional regulations and guidelines address extended producer responsibility and recently there is additional emphasis on moving towards a circular economy.

In general, members of the EU have regulations in place that require that no untreated organic waste be deposited directly in landfills, that landfills are reserved for the disposal of residual materials that remain following some form of processing and treatment. A number of jurisdictions also impose significant fees on any waste going to landfills, which in turn serves to increase the number and types of processing facilities because the higher cost of processing waste materials is competitive with these increased landfill disposal fees.

Regulations and guidelines promulgated by the EU include minimum requirements for managing certain types of waste. These include the Landfill Directive targeting biodegradable municipal solid waste, the Packaging and Packaging Waste Directive focused on recycling, the Waste Framework Directive emphasizing the hierarchy and various directives related to the treatment and disposal of waste water sludge and biosolids. The Waste Directive focuses on waste prevention and puts in place new targets which will help the EU move towards its goal of becoming a re cycling society. It includes targets for EU Member States to recycle 50% of their municipal waste and 70% of construction waste by 2020.

The Directive introduces a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort. EU waste legislation aims to move waste management up the waste hierarchy.

The Waste Framework Directive, revised in 2008, streamlines waste legislation, incorporating rules on a number of issues such as the management of hazardous waste and waste oils. Other pieces of EU waste legislation include

1. The Regulation on waste shipments which aims to ensure the safe shipment of all types of waste, including hazardous waste;
2. The Packaging and Packaging Waste Directive which sets standards for the design of packaging and lays down specific targets for the recycling and recovery of waste packaging;
3. The Landfill Directive and the Waste Incineration Directive which set standards and limits for the release of pollution into the air or into groundwater;
4. The End-of-Life Vehicles Directive which sets increasing re-use, recycling and recovery targets and restricts the use of hazardous substances in both new vehicles and replacement vehicle parts;
5. The Waste Electrical and Electronic Equipment (WEEE) legislation which addresses collection, recycling and recovery targets for electrical goods;

6. The Directive on the Restriction of Hazardous Substances in electrical and electronic equipment which restricts the use of hazardous substances in electronics;
7. The Batteries Directive which sets collection, recycling and recovery targets, and
8. The Council Directive concerning urban waste water treatment which states that sludge arising from waste water treatment shall be re-used whenever appropriate and that disposal routes shall minimize the adverse effects on the environment.

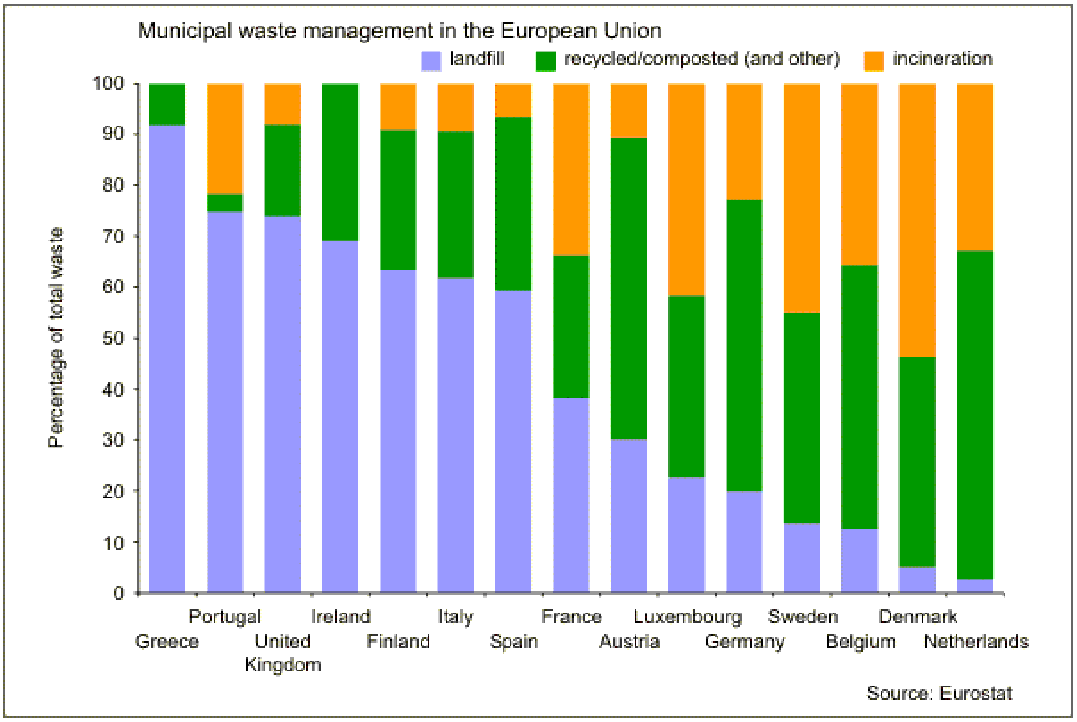
The Waste Framework Directive has also introduced life-cycle analysis into waste policies, which provides a broader view of economic and environmental aspects.

The measures used within each country to affect changes in practices varies. These include landfill bans, landfill and incineration taxes, mandatory source separation of organic waste, pay as you throw and extended producer responsibility. More recently, the emphasis on sustainability and the circular economy has increased within the EU.

These factors, coupled with the existing competing pressures on land use, have resulted in greater diversion of materials from disposal to various forms of processing/treatment. As shown in Figure x, there is significantly less landfilling of materials in many of the EU member countries than is found in North America.

In regards to biosolids management, the Jurisdictional Review (Appendix Q) provides an overview of treatment and disposal and beneficial use programs across the EU. The processing and use of biosolids varies considerably across the EU, with the dominant processing/utilization methods including application to agricultural land; composting and other land applications; landfilling; and incineration (Evan 2012, Fonts et al. 2012). Countries within the EU are required to enact Regulations and Directives into their own national legislations. While Regulations must be transposed verbatim, Directives are minimum requirements. Relevant directives include the Sludge (use in agriculture) Directive (CEC, 1986), the Landfill Directive (CEC, 1999), and the Waste Incineration Directive (CEC, 2000). EU member states have chosen a range of measures and limits in the implementation of the EU Sludge (use in agriculture) Directive (Evan 2012). Within the EU, biogas and phosphate recovery appear to be areas of future interest (Evan 2012).

Figure 3 Waste Management in the European Union



Regarding biosolids, the ultimate end use depends on the specific circumstances of each country. Countries with large populations and limited agricultural land utilize disposal/processing options other than land application. Land application is common in England, France and Spain, while in Austria and Germany, the trend is towards incineration.

4.3 Japan

Japan has a unique set of circumstances as well. Land is at a premium, so significant emphasis is placed on minimizing use of valuable land for waste disposal. Energy is also a prime driver in Japan. Japan is dependent on the overseas markets for most of its energy and resources and is therefore very focused on maximizing the efficient consumption of these resources. It has a goal of 100% energy independence, including at its wastewater treatment facilities and therefore has focused efforts on recovering energy from biosolids. Utilization of sewage sludge in Japan includes use in i) direct application to agricultural lands, ii) as a component of compost, iii) as a raw materials in cement and iv) incineration and anaerobic digestion to recover the energy content. Approximately 70% of the sludge is incinerated.

The Japanese, through a combination of public policy, private market conditions, and geographic necessity, practice integrated MSW management. The Japanese rely heavily on incineration/waste-to-energy driven by the country's severe shortage of landfill space, the desire to sanitize and sterilize the waste to minimize environmental impacts of the residuals and the drive to energy and materials sustainability.

In 2000, Japan enacted the Fundamental Law for Establishing a Sound Material-Cycle Society (Law No. 110/2000) which focused Japan's efforts toward a Sound Material-Cycle Society where resources are conserved and the environmental load is reduced to the greatest extent possible. There are a number of regulatory and legislative initiatives that directly relate to this effort. These include:

1. Law for the Promotion of Sorted Collection and Recycling Containers and Packaging which addresses collection of containers and packaging by municipalities recycling of containers and packaging by producers and users
2. Law for the Recycling of Specified Kinds of Home Appliances which addresses retailers receiving used appliances from consumers, recycling by manufacturers, etc. and consumers shouldering cost for recycling
3. Construction Material Recycling Law which requires construction contractors are responsible for the sorting and dismantling and are responsible for the recycling of construction waste
4. Law for promotion of Recycling and Related Activities for treatment of Cyclical Food Resources which requires recycling of food waste by food manufacturer, processors and sellers
5. Law for the Recycling of End-of-Life Vehicles which requires the recycling of end-of-life vehicles and payment of recycling fee at the time of purchase of new vehicle
6. The Basic Law for Environmental Pollution Control which provides basic policies for environmental conservation
7. The Fundamental Plan for Establishing a Sound Material-Cycle Society Amended in 2013, which seeks to ensure societal control of consumption of natural resources and to reduce environmental load The Basic Act for Establishing a Sound Material-Cycle Society

As Japan's landmass is limited and finding landfill disposal sites is difficult, they have developed an integrated system to collect and transport waste, process it through intermediary treatment by incineration and other methods, and then dispose of the treated residuals in sanitary landfills. As a result, Japan is host to over 1,200 incineration facilities which use several methods including stoker furnaces, fluidized bed furnaces, and gasification.

5 IRM Facility Case Studies

Based on review of the various IRM documents and information as discussed in Section 3, as well as additional investigations undertaken by HDR, a number of IRM facility case studies have been documented below to inform the development of IRM procurement criteria. The context for development of these facilities from a regulatory and market place standpoint as discussed in Section 4 above, is important to consider when reviewing these case studies and findings in regards to the implications for the CRD IRM project. The definition of biosolids, Class A biosolids and sewage sludge in these jurisdictions varies, and may be different from how these terms are applied in BC and in the CRD.

5.1 ZAB Nuthe-Spree (Redwave reference facility)

The Zweckerverband Waste Treatment Nuthe-Spree or ZAB association was formed by two regional waste authorities in Germany, the SBAZV and the LOS in 2002. Both authorities are responsible for the management of residual waste disposal within their respective jurisdictions. The ZAB planned the facility and awarded a contract to construct an MBT facility to manage waste generated in their area. Construction began in 2004. The original general contractor became insolvent, and new contracts were signed in 2005 with Herhof GmbH for technology provision and Waste Tec GmbH for development of the facility. The facility began operations in the summer of 2007. The ZAB association runs the MBT facility and manages its affairs. Committees of the association that govern the facility including annual funding requests (facility tariffs) include an Association Assembly and a Board of Directors, with representatives from both regional waste authorities.

The primary technology applied at the ZAB Nuthe-Spree facility is a Mechanical Biological Treatment (MBT) process for the MSW and bulky waste stream. MBT is a broad term that refers to multiple sub-processes including pre-treatment, biodrying, recyclables recovery, recovery of solid recovered fuel (SRF). The equipment for each sub-process is based on a series of conventional equipment installations similar to those used in operating MBT plants elsewhere in the world. The specific technology applied at the ZAB facility is the Herhof Stabilat technology. First the waste is dried through a biological process and then the dry waste is mechanically processed. The combustible components are separated from metals and inert components (stones, sand, glass, and ceramics) in several stages. The secondary fuel produced in this way (SBS or RDF) is utilized energetically in brown coal power plants and by the cement industry.

The facility was constructed over a two and a half year period from June 2004 to November 2006 and was commissioned over a four month period. Redwave reported capital costs of 45 million euros as of 2004/2006.

The rationale for application of IRM in this jurisdiction is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and German directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory environment and energy market that favours use of SRF and other renewable or partly renewable fuels.

Key facility information:

a. Feedstock and Flow Control
   This facility is owned and operated by the ZAB. The two regional waste authorities that formed ZAB are responsible for management of MSW and bulky waste primarily from residential sources, and are able to direct these solid waste streams to the facility. The plant has capacity for135, 000 tonnes per year of MSW and 15,000 tonnes per year of bulky waste.

b. Management of Biosolids
   This facility does not manage biosolids.

c. Site Size and Characteristics
   The facility occupies a site of approximately 3 hectares, and is located in an industrial area at the outskirts of a local community. The site was identified and secured by the ZAB.

d. Technology Risk
   The MBT technology applied at the ZAB Nuthe-Spree facility is relatively conventional, and has been applied in many facilities across the EU. There was minimal technology risk associated with the facility, supporting the application of a DB contract as noted below. Key risks associated with the functionality of the facility were addressed through the commissioning phase of the project.

e. Products and Markets
   Products recovered from the facility include recyclable materials and RDF. RDF is marketed as an alternative substitute fuel to be used in solid fuel electricity generating facilities and by cement kilns. It is important to note that the use of alternative fuels by the cement sector in Germany and many EU nations is a well-established practice with a defined market.

f. Cost and Financing
   As noted above, the reported capital cost for the facility was of 45 million euros as of 2004/2006. The constructor was responsible for temporary financing during the construction phase of the facility, but ultimately the overall costs were addressed and financed by the ZAB authority. Information regarding the exact nature of the financing relationships is not available.

g. Procurement/Contract Structure
   Herhof and WasteTec were retained to Design, Build and Commission the facility. They were responsible for project development, the permit application, tendering and awarding of trades in coordination with their municipal client, project management and supervision during construction and commissioning of the facility. This is typical for facility development based on conventional technologies with minimal technology risk.

h. Residuals Management
   It is unclear exactly how inert non-recyclable (or mineral fraction) residue generated by the ZAB facility is managed. Generally this material can be directed for use in aggregate applications, or alternatively it would meet EU and German requirements for landfill disposal.

Applicability to the CRD / Context for IRM Procurement Criteria:

1) The Regional waste authorities responsible for the ZAB and the MBT facility have the responsibility to manage the residual waste in their jurisdiction and thus have flow control and certainty regarding the waste streams that are directed to the facility.
2) The application of EU waste directives and German legislation to comply with these directives, facilitated the development of the facility and of the markets for the RDF recovered through the MBT process. The existence of a robust market for this type of recovered fuel is essential for diversion of this material from landfill disposal.
3) The technology applied at this facility is a proven technology, applied at many facilities across the EU. As a result it was possible and reasonable for the ZAB to apply a straightforward Design/Build procurement and contract structure for the development of the facility.

5.2 ZAK Kaiserslautern Facility (Anaergia Reference Facility)

The ZAK is a 'joint communal institution' of the City of Kaiserslautern and the Kaiserslautern regional waste authority in Germany. ZAK is responsible for managing mixed solid waste generated by area residents and contracts for the management of waste from a nearby U.S. military base (60,000 servicemen). The ZAK is one component of an overall system managed by ASK a certified municipal waste management entity.

The MBT facility at ZAK uses the Organic Extrusion (OREX) Press to extract organics from mixed municipal solid waste. The installation at Kaiserslautern is operating on mixed solid waste which has a high level of contamination. The combined OREX and Organic Polishing (OPS) technologies provide a pre-treatment system is robust and flexible to handle virtually any level of contamination. The MBT facility was commissioned in 2006.

Municipal waste is unloaded in the reception area and directly fed into the hopper of the OREX. The OREX separates the input waste into two fractions: a dry and a wet fraction. The dry fraction, which has 75-80% solids concentration and a calorific value of 11,000-13,000 kJ/kg is sent directly to energy from waste plants. The wet fraction with 35-40% solids concentration is conveyed to a dry anaerobic digestion plant. The first step for the AD process is an organic polishing system where incoming material is blended with AD digestate into a slurry, which is passed through a cyclone to remove light (floating) contaminants and heavy (sinking) contaminants. The 'clean' slurry enters the digester.

The digested matter is extracted from the digester (DRANCO digester), is pressed to remove excess water, and then sent to an aerobic stabilization process. During aerobic stabilization, the matter is left to rest in static biocells with air infiltration for 3-4 weeks and then matured under a canopy for 60 days. The stabilized matter obtained is used as covering soil in landfill sites.

The facility is part of a larger existing integrated waste processing site, which includes a recycling facility, a composting facility for source separated organics, a hazardous waste management centre, and a new landfill disposal facility for inert residues developed on an old landfill site.

The rationale for application of IRM in this jurisdiction is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and German directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory environment and energy market that favours production of biogas as a renewable fuel.

Key facility information:

a. Feedstock and Flow Control
The ASK is responsible for the control and management of municipal waste generated within its regional area including residential and commercial materials. The ASK contracts for additional waste streams, including the waste generated by the US military base. The services provided by ASK are recovered through a municipal refuse disposal fee collected on an annual basis and depending on the size of the non-recyclable refuse container used for collection. The overall capacity for the OREX system has been designed for 100,000 tonnes per year.

b. Management of Biosolids
The ZAK is not responsible for the management of Biosolids.

c. Site Size and Characteristics
The full ZAK facility encompasses 88 hectares hosting a number of IRM related activities. The facility is in a valley surrounded by forest plantations and is both visually and physically separated from residential areas.

d. Technology Risk
Generally, the technologies employed at the ZAK facility have been proven through application in a number of locations. The OREX technology itself is a newer technology, and was chosen by ZAK to replace the previous pre-processing facility which had been used to extract the organic fraction from MSW to direct that stream to the existing AD digester. The contract with Anaergia for the OREX facility requires that it meets a guaranteed feed rate of 35 tonnes per hour.

e. Products and Markets
The products recovered from the OREX pre-processing system and the anaerobic digester include: RDF with energy content of between 11,000 to 13,000 kj/kg; Biogas between 70 and 80 cfm/tonne used to generate electricity; Stabilized digestate material used for landfill cover; and ferrous and non-ferrous metals.

f. Cost and Financing
The facility was financed by the ZAK. The estimated cost of installation of the new front end processing system for the MBT as of 2006 was 3.6 million euros for installation of OREX press ($5.4 million CAD). 6 million euros (9 million CAD) for separate front end recycling processing system. 20 million euro ($30 million CAD) for overall system overhaul.

g. Procurement/Contract Structure
Anaergia was contracted for the Design, Build and Maintenance of the new front end processing system. Currently a full service maintenance contract is in effect. The guaranteed feed rate for the OREX press is 35 tonnes per hour.

h. Residuals Management

The ZAK is responsible for the disposal of inert residues, and recently entered into a contract with a private sector partner REMEX to develop an inert landfill disposal facility for 'slightly polluted' mineral waste.

Applicability to the CRD / Context for IRM Procurement Criteria

1) The Regional waste authorities (ASK) responsible for the ZAK and the MBT facility have the responsibility to manage the waste streams in their jurisdiction including commercial waste and thus have flow control and certainty regarding the waste streams that are directed to the facility.
2) The application of EU waste directives and German legislation to comply with these directives, facilitated the development of the facility and of the markets for the RDF recovered through the MBT process. The existence of a robust market for this type of recovered fuel from landfill disposal.
3) The majority of the technologies applied at this facility are proven technologies, applied at many facilities across the EU. As a result, the majority of the technologies were procured through DB contracts. For the relatively newer OREX technology, the ZAK addressed potential risk through the longer term maintenance contract and the guaranteed OREX feed rate.

5.3 AVR Rozenburg Facility, Rotterdam

The AVR Rotterdam facility is a private sector-owned integrated waste management facility which includes a number of waste to energy components as well as an ash processing and metals recovery facility. The processing capacity offered by AVR is approximately 870,000 tonnes per year of household waste and 350,000 tonnes per year of commercial waste, 20% of the overall processing capacity for residual waste in the Netherlands.

AVR operates four transfer stations in the Netherlands, accepting domestic and commercial waste streams that it transfers to its Rotterdam facility. The AVR Rotterdam facility accepts and processes residual waste, paper pulp, wood residue and industrial waste water.

The AVR facility accepts and processes 1.5 million tonnes of residual domestic waste, originating from households in the Netherlands and England. The facility also accepts and processes a range of commercial waste materials. These materials are processed through conventional grate furnace incinerators, recovering both electricity and heat for district heating.

The AVR facility accepts and processes 150,000 tpy of non-reusable waste wood (B-wood) including treated wood from demolition can cannot be directed to wood-processing industries. This material is directed to a biomass power plant, generating renewable power. AVR will be commissioning a system for direct delivery of district heating and process steam from this facility in early 2018.

The industrial waste water that it accepts for processing is unsuitable for conventional wastewater treatment, and is directed to four Vortex furnaces that are relatively unique in the EU. Collectively the Vortex furnaces are capable of processing 325,000 tonnes of industrial waste water per year. Materials are recovered from the solid residues from the furnaces (such as molybdenum) and heat is recovered for district heating for residential and commercial development in the area.

Products and services offered by AVR include:

1. District heating for the equivalent of 160,000 homes and commercial operations. They are currently working with local utilities to provide district heating for the greenhouse farming sector.
2. Use of the bottom ash from the WTE facility to create construction products such as paving stones, clinker bricks, kerbstones and products for road construction. This material is processed through an agreement with a secondary processor that has secured product markets including Dutch Public Works and Water Management.
3. Pulp residue from paper recycling facilities is first sent to separate combustion and then the remaining minerals are processed into a product called Topcrete which is a calciferous binding agent that can be used in building materials.
4. A pilot project is under development to use CO2 from the flue gases from the facility as a carbon source for greenhouse facilities.
5. Processing of waste wood and industrial waste water as discussed above.
6. A composting facility that processes 90,000 tonnes per year of organic material.

AVR is part of a partnership with three other companies and the Port of Rotterdam for the development of an Enerkem facility to process synthesis gas from residual waste to produce methanol. This partnership was announced in the fall of 2016, the current status of development of a facility is unclear.

The rationale for application of IRM by AVR is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and Dutch directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory and energy markets that favours energy recovery (heat, power) from non-fossil fuel sources.

Key facility information:

a. Feedstock and Flow Control
AVR competes in the open market for waste materials. Currently the facility accepts waste materials from a variety of sources including solid waste from the United Kingdom and the Netherlands.

b. Management of Biosolids
Conventional biosolids are not managed at the AVR facility. However, various industrial waste water streams are managed.

c. Site Size and Characteristics

The AVR facility is located within an industrial area of the City of Rotterdam. Information could not be found indicating the size of the overall site.

d. Technology Risk
The thermal technologies used at the AVR site are more conventional Waste to Energy technologies, with advanced emissions control and energy recovery systems. Some of the ancillary technologies and approaches to derive products and energy are more advanced than others in the EU and North America. The risk associated with technology adaption has been borne by the company, which has sought expertise and outside partners/advisors as necessary to support innovation.

e. Products and Markets
The facility produces a range of solid material products from processing residues as discussed above. Energy products include electricity generation equal to the requirements of around 200,000 homes as well as heat recovery for district heating. No public information on the energy market for AVR power could be found.

f. Cost and Financing
No public information on the capital investment for the AVR facility could be sourced. As a private entity, this information would be expected to remain confidential. AVR appears to have been largely if not solely responsible for financing all development, no information was found to indicate any investment from government entities. AVR generates its income from three sources: gate fees for receipt of waste materials, sale of energy and the sale of recovered materials.

g. Procurement/Contract Structure
AVR sourced all technologies/equipment and services for construction. This is a fully DBFOM facility. The majority of gate fees have been secured through long term contracts from municipalities and commercial customers. Sale of electricity and heat are also sold under long term contracts with utilities, local municipal district heating networks and industrial steam users. AVR Rotterdam has been able to import waste from other countries and states in the EU as it as a qualified energy efficient waste treatment plan holding R1 status.

h. Residuals Management
AVR is responsible for the management of all residues. The prohibitive price for landfill disposal in the Netherlands including landfill disposal taxes, incentivizes the market for alternative products derived from solid residues remaining after thermal processing.

<u>Applicability to the CRD / Context for IRM Procurement Criteria</u>

1) AVR has secured long term contracts for waste supply, which facilitates their ability to invest in and grow their facilities including advanced schemes such as CO2 recovery.
2) Market conditions such as the availability of local district heating schemes for energy products in the EU support the sale of recovered heat increasing the viability of thermal technologies.

3) AVR has mitigated technology risk by using conventional thermal technologies to form the central component of their facility, and then choosing to work with partners/advisors for the development of new products and markets.

5.4 Altriom MBT Facility (3Wayste technology)

The Altriom MBT facility in Polignac France uses the 3Wayste technology developed by the Vacher group, and was developed by a private corporation under the terms of a long term (15-year) contract with four communities in the Polignac region. These communities participated in a 7 year planning process to determine a solution to reduce waste to disposal. The resulting procurement process resulted in four bids, with a new company - Altriom winning the process. Driving factors behind the municipal decision to contract for an MBT facility were: current economics for disposal, markets for energy recovery, soil quality in area and potential market/need for soil amendment.

This MBT facility was developed to process 'grey waste' being residual mixed garbage to recover recyclables, compost and RDF. The area has a yellow bag program for recycling, which is processed at a separate facility within the same site and the Altriom MBT facility. The facility was designed to process 120,000 tpy of MSW, however in the first few years of operation the facility received and processed only 40,000 tpy. The contract was designed to ramp-up waste quantities sent to the facility as contracts expire with the local host jurisdictions. Construction of the facility took 14 months. It has been in operation since June 2014.

The MBT process used by the facility includes: material pre-sort to remove large items; opening of bags through a proprietary bag breaker, separation of the materials into a large and small fraction. The large fraction is sent through a series of optical sorters to recover recyclables. The small fraction sent to composting is largely organic (80%). Optical sorting is used to removal small metal items from the small fraction sent to compost. In-vessel composting is used to generate a compost that meets EU standards.

The rationale for application of IRM in this jurisdiction is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and French directives and regulations that favour the processing of waste rather than direct disposal in landfills.

Key facility information:

a. Feedstock and Flow Control
   The facility was designed to process mixed solid waste. This material is provided under long term (15 year) agreement with the communities responsible for the collection of the domestic waste stream in this region.

b. Management of Biosolids
   The 3WAYSTE facility does not manage biosolids.

c. Site Size and Characteristics

Under the DBOOM procurement process, the participating municipalities made a site available within the same site as is currently used for processing recyclables. The site in is the order of 3 to 4 hectares in size. This site is on the outskirts of the local community.

d. Technology Risk
The majority of the component technologies used at the facility are conventional MBT technologies, however the overall design and some key pieces of equipment such as the initial bag-breaker are unique to this facility. Altriom has borne the technology risk and is responsible for meeting performance guarantees under the terms of its agreements.

e. Products and Markets
The facility recovers HDPE, PET, PP, ferrous and non-ferrous metals, some paper products, compost and RDF. The recyclables generally have a downgraded value compared to the source separated recyclables. Compost recovered from processing of the organic fraction is sold for $15 CAD per tonne. Value for recyclables: 120 euro ($179 CAD)/tonne ferrous; 1,400 euro ($2,090 CAD) /tonne non-ferrous; 314 euro ($468 CAD)/tonne foil; 50 to 70 euro ($75 to $105 CAD) /tonne paper; 20 euro ($30 CAD)/tonne for RDF.

f. Cost and Financing
The estimated capital cost for the facility was 25 million Euro ($37 million CAD). Altriom was responsible for financing of the facility. Financing was secured on the basis of the waste supply contract as noted below.

g. Procurement/Contract Structure
The participating municipalities undertook procurement under a DBOOM contract structure, under which the facility was fully financed and completed by Altriom. The municipalities entered into a 15 year waste supply agreement. Altriom guaranteed under the terms of the contract, 80% recovery of recyclable materials from the mixed solid waste stream (including recovery of RDF).

h. Residuals Management
Altriom is responsible for residue disposal. Approximately 10 to 20% of the incoming waste stream cannot be recovered and is sent to disposal.

Applicability to the CRD / Context for IRM Procurement Criteria

1) Altriom was able to finance the development of the facility on the basis of the long term contract for waste supply and as the facility was designed using largely conventional technologies resulting in less technology risk. Reasonable local markets were also available for the sale of recovered recyclables and RDF.
2) The local/district municipalities transferred risk to Altriom through the DBOOM contract structure including the recovery rate guarantees.

5.5 SYDEC Mont de Marsan Biosolids Co-composting Facility

The Mont de Marsan biosolids composting facility is owned and operated by the SYDEC municipal waste water utility. SYDEC is a public body that includes 331 municipalities of Landes and the County Council and Regional Council of Aquitaine in France.

In April 2001, Syndicat Mixte Departemental d'Equipement des Communes des Landes (SYDEC), the regional utilities authority responsible for providing services to manage wastewater treatment plant biosolids and department green waste, conducted a study to determine the best alternative for managing biosolids and utilizing the end product. The study showed that composting biosolids with green waste and wood waste would create a product to greatly enhance the soil quality. In June 2003, SYDEC selected Veolia Water Systems/OTV-SUD Ouest, a division of Veolia Environnement, to design a composting plant that would use the USFilter IPS Composting System. Five months later, the project received environmental approval and administrative authorization to proceed. The technology provider was BPD industries.

The Mont de Marsan biosolids composting facility is comprised of ten 45-meter (148-foot) long bays, the facility is designed to handle 44 tonnes/ day (48.5 tons) of dewatered biosolids at 15 percent solids concentration and 50 tonnes/day (55 tons) of green waste. Once a day, the automated composting machine travels through each bay to mix and move the material about 4 meters (13 feet). At this rate, the compost is retained in the bays for 16 to 18 days before being transferred to the curing area where it matures for another 28 days. Although French regulations focus on specific standards for the end product and not on the actual process, the Mont de Marsan plant is required to achieve a minimum of 60°C for seven days to ensure that pathogen requirements for the final product are met. The bays are also equipped with an automated aeration system and a moisture addition system, to aid the composting process.

Odour control is imperative to the successful operation of the Mont de Marsan plant. Two chemical scrubbers and two large biofilters treat the facility's process air. Pine trees surrounding the plant's boundary provide an additional buffer between the site and its neighbours.

Mont de Marsan is centrally located to receive biosolids from the surrounding communities' wastewater treatment facilities. Initially, approximately 30 wastewater treatment facilities will participate in the composting project. Trucks will transport dewatered biosolids from as far away as 100 km (62 mi). In an effort to accommodate wastewater facilities great and small, a mobile dewatering truck will serve five small plants that wish to participate in the project.

The rationale for application of IRM in this jurisdiction through the co-composting of biosolids and yard trimmings is based on the EU and French directives and regulations that favour beneficial use of biosolids.

Key facility information:

a. Feedstock and Flow Control
   The facility processes in the order of 18,000 wet tonnes per year of biosolids, anaerobically digested to 15 to 20% DS, along with 20,000 wet tonnes per year of yard trimmings. Both material streams are municipally controlled.

b. Management of Biosolids
The primary purpose of this facility is to derive a beneficial use compost product from the processing of municipal biosolids.

c. Site Size and Characteristics
The facility site is 8 acres, and is located in an agricultural area, within a mile of the closest town.

d. Technology Risk
This facility was developed using largely conventional in-vessel composting technology. Technology risk was addressed through retaining a reputable designer, experienced in the EU market.

e. Products and Markets
Compost from the facility is marketed for agricultural applications. Initially, market assistance was provided through the French government and SYDEC paid for hauling costs for the first year.

f. Cost and Financing
Financing for the 8.05 million facility came from several sources. Agencies included Landes Counseil General (18%), European Union (20%), Agence de l'Eau Adour Garonne (20%), Agence de l'Environnement et de la Maitrise d l'Energie or ADEME (12%) and SYDEC (30%).

g. Procurement/Contract Structure
This facility was procured and developed under a Design/Build contract structure, and is owned and operated by SYDEC.

h. Residuals Management
SYDEC is responsible for the management of any residuals from the facility. However minimal residuals are generated under normal operations.

<u>Applicability to the CRD / Context for IRM Procurement Criteria</u>

1) SYDEC through the municipalities that are part of this utility, has control of the biosolids and yard trimmings that form its feedstock.
2) Technology risk was mitigated through technology selection and the selection of a qualified contractor with a lengthy track record of successful biosolids management.
3) Marketing risk for the recovered compost product was mitigated in the initial years through incentives such as free hauling and assistance provided by the French government.

5.6 UTE TEM, Mataro (Veolia)

The UTE TEM facility in Mataro Spain, is an integrated waste management facility which includes a 190,000 tpy MBT plant, a 35,000 tpy AD facility, a 41,000 tpy composting facility and a 160,000 tpy waste to energy plant.

The facility is owned by the Consorci de Residus del Maresme. The facility treats household waste from the 28 member municipal consortium as well as industrial waste. The facility serves the needs of 470,000 people within the Maresme region of Spain. The new incineration process at the Mataro facility was designed and built by a consortium including Veolia and Spanish partners. The entire treatment site including the WTE plant, composting and AD facility is operated by Veolia.

Construction of the facility began in 2009. The facility was commissioned in 2011. Veolia's operating contract runs into 2022.

Mixed solid waste received at the facility is directed to the MBT plant. Following mechanical sorting, recyclables are recovered and the organic fraction of the waste stream is directed to AD or composting. RDF from the MBT is directed to the WTE plant along with other industrial waste. The facility also separately receives and processes bulky waste and source separated recyclables.

The rationale for application of IRM in this jurisdiction is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and Spanish directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory environment and energy market that favours use of RDF and other renewable or partly renewable fuels.

Key facility information:

a. Feedstock and Flow Control
The municipal consortium that owns the facility, has flow control over the household residential waste stream that supplies the majority of the feedstock for the facility. The supplementary feedstock used for blending with the biosolids is primarily hog fuel, purchased from a local sawmill at $1.75/cubic yard as of 2010.

b. Management of Biosolids
Biosolids are not managed at this facility.

c. Site Size and Characteristics
The facility occupies a relatively small site in an industrial area, with an unusual configuration. The total site size is approximately 3 hectares.

d. Technology Risk
The technologies used at the facility are relatively conventional. The Compost process employs a wide-bed in-vessel aerobic composting process, while the AD uses the BTA technology which is used at many facilities across the EU and here in North America in the City of Toronto. The WTE facility is a conventional combustion facility with two processing lines using Martin grates and a steam boiler.

e. Products and Markets
The MBT facility recovers recyclable materials and compost as well as electricity from the AD facility and 12 MW of power from the WTE plant. Overall, 24% of the received material is

recovered for market. Information on the market value of these products has not been publicly available.

f. Cost and Financing
The municipal consortium was responsible for the capital financing for the facility. Information could not be sourced regarding the total capital cost.

g. Procurement/Contract Structure
The facility was procured through a DBOM procurement and contract structure. Following installation, the operating contract has been held with Veolia, while various maintenance contracts with specific technology providers are also in effect.

h. Residuals Management
Overall the facility generates 37,000 tpy of residue that requires landfill disposal. Disposal is the responsibility of the municipal consortium.

Applicability to the CRD / Context for IRM Procurement Criteria

1) The municipal consortium which owns the UTE TEM facility have the responsibility to manage the waste streams in their jurisdiction and thus have flow control and certainty regarding the waste streams that are directed to the facility.
2) The majority of the technologies applied at this facility are proven technologies, applied at many facilities across the EU. However, the complexity of the overall installation resulted in the selection of a DBOM procurement model and long term operating and maintenance contracts to facilitate and minimize operational risk.

5.7 Lahti Energia, Kylmijarvi II Power Plant, Finland

Lahti Energia is an energy and energy services company owned by the City of Lahti in Finland. Lahti Energia has used gasified biofuel and SRF as a complementary fuel in their coal-fired generating facility since 1998.

The Lahti Energia Kymijarvi II Power Plant uses solid recovered fuel (SRF) in a gasification process with capacity to process 250,000 tonnes of SRF to produce 160 MW of power. The facility uses 'energy waste' collected by the municipal waste authorities in the Paijat-Hame region as its primary feedstock. Energy waste consists of unclean plastic, paper, cardboard and wood. Current waste fuel suppliers collect MSW from domestic and commercial sources. Energy waste from domestic sources is collected separately and shredded, and then is hauled to the facility and comprises 20% of the fuel feed. Commercial waste is processed to recover solid recovered fuel that meets the facilities fuel specifications. Lahti energy purchases this material from these local fuel suppliers.

Construction of the project began in November 2009, with commissioning in 2012. The facility was handed to Lahti Energy as of June 2012.

The Kymijarvi II facility is a demonstration plant. Fuel is received and stored in silos. Fuel is feed from the silos to two separate gasifiers. The gasifiers use an atmospheric pressure circulating fluidized bed (CFB) gasification technology. The gas is cooled and then cleaned, prior to being directed to a steam boiler where it is combusted to generate steam which is then directed to a steam turbine. The facility produces 50 MW of electricity and 90MW of district heat which is conducted to a district heating network to customers in the Lahti and Hollola region. The facility achieved its first 25,000 hours of operation as of October 2017.

Waste incineration plants that only utilize waste, are exempt from the carbon emissions trading system which encouraged Lahti Energy to focus on developing gasification technology.

The rationale for application of IRM in this jurisdiction is similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and Finnish directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory environment and energy market that favours use of renewable fuels.

Key facility information:

a. Feedstock and Flow Control
Lahti Energia purchases energy waste and solid recovered fuel. No information was found regarding the market value of this material.

b. Management of Biosolids
The Kymijarvi II facility does not process biosolids.

c. Site Size and Characteristics
The Kymijarvi II facility is set in a forested area, near the City of Lahti. While exact information regarding the site size was not available, the site appears to be in the order of a few hectares. The facility was sited and the site is owned by Lahti Energia which is the municipally owned energy utility.

d. Technology Risk
The Kymijarvi II facility is the largest, successfully operating gasification facility in the EU. While the technology is advanced, Lahti Energia had developed operating experience over the prior use of gasification and SRF to supplement fuels at its coal fired generating facility, thus minimizing some of the technology risk borne by the company.

e. Products and Markets
The primary products from the facility are electricity which is sold to the national grid, and heat which is sold through Lahti Energia's local district heating systems.

f. Cost and Financing
The original budget for the facility as 157 million Euros, rising to 160.5 million during the project. Lahti Energia primarily financed this facility, with some funding support of 15 million Euros from the Finnish state and 7 million Euros from the EU.

g. Procurement/Contract Structure
Lahti Energia procured the facility from Valmet through a DB contract. Valmet has agreed on a long-term agreement for further marketing and commercialization of the gasification

technology. Lahti Energia had the operating experience from its existing facilities to operate the facility following commissioning and turn-over of the facility.

h. Residuals Management
   Lahti Energia is responsible for the management of solid residues from the gasification process.

Applicability to the CRD / Context for IRM Procurement Criteria

1) Lahti Energia is owned by the City of Lahti, which also has control over the domestic waste stream in the Region and thus has some control over the sourcing of fuel for the facility.
2) As Lahti Energia is also a local electricity and district heating supplier, they had an existing marketing approach for recovered energy.
3) While the application of gasification to SRF is an advanced technology and not widely applied in the EU, Lahti Energia was able to mitigate technology risk through their contractual arrangement with Valmet and through their years of experience in applying similar approaches to provide some fuel for their existing coal-fired power plant.

5.8 Kelowna/Vernon Compost Facility

The Cities of Kelowna and Vernon co-own an aerobic composting facility processing municipal biosolids. The regional composting facility is located on the outskirts of Vernon and opened in 2006. It converts 100% of the received biosolids to a Class A product under the BC OMRR and meets the requirements of the federal Fertilizers Act. Major contributors of biosolids to the facility include Kelowna, Vernon and Westbank.

The technology used at the facility is an advanced aerated static pile composting process which converts biosolids to Class A compost in approximately 80 days. The composting technology was supplied by Engineering Compost Systems. Biosolids are mixed with wood waste comprised of wood chips or hog fuel and wood ash. Once composted and cured, the compost is screened to remove large woody residues and is tested in compliance with provincial and federal guidelines. Large woody residues are returned to the composting system as inoculant. The facility has a capacity to process 36,400 tonnes annually, and typically produces approximately 28,500 tonnes of compost per year. Stormwater and leachate from the facility is treated in a wetland and detention area before being discharged to the Vernon effluent force main.

The facility has recently undergone an upgrade and expansion, including additional odour control measures.

Key facility information:

a. Feedstock and Flow Control
   The Cities of Vernon and Kelowna control the municipal biosolids stream. Supplemental feedstock (wood waste, ash) is purchased for the operation.

b. Management of Biosolids
   The primary focus of this facility is the generation of a Class A product from the processing of biosolids.

c. Site Size and Characteristics
The current facility has a 9 hectare footprint, to accommodate expansion over the first 10 years of operation. A total 33 hectare area is available to accommodate further expansion. The site is located in an agricultural area. The site was provided by the City of Vernon. The site selection and acquisition process was lengthy, involving in-depth review, consultation, stakeholder engagement and negotiations.

d. Technology Risk
The advanced aerated static pile process used at this facility is relatively conventional presenting minimal technology risk.

e. Products and Markets
The compost product generated at the facility is marketed as 'Ogogrow' for various applications including commercial landscaping, residential gardening, nurseries and orchards and as final cover for landfill closure. The cities decided to work with compost distributors and landscape supply centres rather than entering into a competitive market position. The sale of compost has covered approximately 23% of the facility operating costs.

f. Cost and Financing
The facility was developed based on the terms of a MOU between the Cities of Kelowna and Vernon, signed in the early stages of the project. Both municipalities contributed to the capital cost of the facility based on their projected use, 2/3 Kelowna and 1/3 Vernon. The total capital cost in 2006 was 7.4 million. It is estimated that the economies of scale of the project resulted in significant savings for each partner. To cover annual operating costs, a tip fee is collected per tonne of biosolids processed from each customer group using the facility. A portion of the operating costs is covered from product revenues.

g. Procurement/Contract Structure
The facility is owned by the municipal partnership in proportion with the financing arrangement. Consultants were retained to advise through the facility design, tendering and construction period. A DB procurement and contract structure was used. The facility is operated by the municipalities under the terms of their agreement.

h. Residuals Management
The Cities of Vernon and Kelowna are responsible for the management of any non-compostable residue generated at the facility.

<u>Applicability to the CRD / Context for IRM Procurement Criteria</u>

1) The municipal consortium that owns the facility have the responsibility to manage the biosolids in their respective jurisdictions and thus have flow control and certainty regarding the primary waste stream directed to the facility. Supplementary materials are purchased on the open market.
2) The technologies applied at this facility are proven technologies, facilitating the DB procurement and contractual arrangement chosen by the Cities.

3) Siting of the facility was a complex and time consuming process. By selecting a site with room for expansion, the Cities mitigated risk associated with future biosolids management requirements.

5.9 Durham York Energy Centre

The Durham York Energy Centre is a 140,000 tonne per year mass-burn energy from waste facility procured by the Regions of Durham and York under a Design Build Operate procurement. The Regions deliver the residential municipal solid waste remaining after source reduction, recycling and composting programs in place throughout the Regions.

Planning for this project, the first new energy from waste facility in Canada in twenty years, began in the 90's. The Regional Council determined that they did not want to rely on out- of-Region disposal options and established a Long Term Strategy Plan: 2000 to 2020 with the main goals of diverting at least 50% of the residential waste from disposal, to implement an integrated residential waste management system for collection, processing and disposal of blue box recyclables, food and yard waste compostables, special wastes, and to consider energy from waste for residential garbage residential.

Over the past two decades, Durham Region has implemented several key infrastructure assets including a materials recovery facility opened in December , 2007, an organics processing facility opened in the fall of 2006 and the remediation of old landfill sites. Most recently, the Region is investigating implementation of an AD facility to recover energy and expand the capacity of local organics management options.

The factors contributing to the implementation of IRM in Durham Region include provincial regulations and policy that favour the recovery of materials, lack of landfill disposal capacity and an environment in southern Ontario that does not favour new landfill capacity development, and the cost of disposal outside the Region.

Key Facts regarding the Durham York Energy Center include:

a. Feedstock and Flow Control
   Residential MSW from the Regions of Durham and York delivered via transfer trailers from municipally controlled transfer stations. The Durham Region is responsible for 110,000 tonnes per year and the York Region 30,000, which represents the total annual capacity of the Facility. These material streams are wholly controlled by the two municipalities

b. Management of Biosolids
   Biosolids are managed under a completely separate program. Biosolids from the Region's anaerobic digesters is either directed to land application or to a regionally owned and operated biosolids incinerator. Ash from the biosolids incinerator is directed to a local cement operation where is it blended with the raw feed to supplement cement production.

c. Site Size and Characteristics
   The Durham York Energy Center is sited on approximately 28 hectare site located in Clarington. The greenfield site was selected following a multi-year site selection process. The site selection process began in 2006 and included a series of over fifteen separate public

information centres held in the Durham and York Region over a two year- span to narrow the siting options down to the preferred site, approved by the Durham and York Regional Councils in January of 2008. The site selection and approvals process included an extensive Environmental Assessment process, which examined the full suite of residual waste processing technologies, a long-list of potential sites, an REOI, RFQ & RFP and included a procurement process, and detailed site specific studies, including a Human Health and Ecological Risk Assessment, an Air Quality Assessment; Surface Water and Groundwater Assessment; Facility Energy and Life Cycle Assessment; Geotechnical Investigation; Acoustic Assessment; Visual Assessment, Natural Environment Assessment, Social/Cultural Assessment; a Stage 2 Archaeological Assessment and Built Heritage Assessment; a Traffic Assessment; an Economic Assessment; and, a Site-Specific Human Health and Ecological Risk Assessment. More than 20 different companies, and over 100 team members were involved in completing and reviewing these reports. The Notice of Completion of the Review of the EA was issued in February, 2010, almost four years after the approval of the terms of reference on March 31, 2006. The site is owned by the Region and is located in an industrial/commercial area directly off the 401 in a rural setting along the shore of Lake Ontario.

d. Technology Risk
The Facility is a mass burn combustion unit, coupled with state of the art combustion and emission controls and generates electricity via a steam turbine generator utilizing high temperature/pressure steam generated by the combustion of the MSW in a waterwall boiler. The mass burn technology is the predominant approach used throughout the world for combustion of MSW and has a long operating history.

e. Products and Markets
The Facility generates electricity for sale to the local power utility. Ash is also processed to recover ferrous and non-ferrous metals, which are sold in the regional scrap metals market.

f. Cost and Financing
The capital costs totaled approximately $284 million. This included approximately $255 million for construction of the facility and $29 million for permitting, site servicing, consulting fees and economic development activities in the host community. The annual cost of operations is approximately $16 M and revenues from electricity metal sales are on the order of $8 to $9 M.

g. Procurement/Contract Structure
The Facility is owned by the Regions and operated under a 20 year operating agreement by Covanta. It was procured under a DBOM approach, with the Regions financing the capital costs which were paid to Covanta during the construction period based on milestones achieved.

h. Residuals Management
The responsibility for managing the residuals from this Facility is the operators (Covanta). The residuals are transported in closed transfer trailers to a landfill for disposal as a non-hazardous waste.

<u>Applicability to CRD / Context for Procurement Criteria</u>

The lessons learned in the DYEC implementation include:

1) A new Facility needs to be part of an integrated system that aligns with the preferred hierarchy. Adding new waste management infrastructure can be a controversial undertaking. It is critical that any new asset be right sized taking into account aggressive source reduction, composting, and reuse/recycling programs. The facility wouldn't have been approved by the Province of Ontario without the 3R's taking priority and 'recovery' being the identified method of addressing the remaining waste stream.
2) Every project needs a champion. Durham and York have strong leadership in support of this initiative from individuals who has spent considerable time learning about the technology before deciding what to do
3) Determining and understanding what "sufficient consultation" is. Even with over 100 public meetings, some residents still believe that they were not consulted enough.
4) Recognize that it is likely that there are some individuals who will never support what you are doing. These individuals should of course be allowed to be heard, but attention shouldn't come at the expense of other voices and opinions.
5) Plan for the long haul. Implementing a regional project with multiple levels of approvals and participation by various political levels is a time and energy consuming process. Be sure that there are adequate resources available and that the timeline takes into account the fact that there will be delays and surprises.
6) Having a site. The siting process was long and at times controversial. It is key to a successful project.

5.10 Palm Beach, Renewable Energy Facility 2

The Palm Beach Renewable Energy Facility 2 is the first greenfield facility built in the US in twenty years. The Palm Beach Renewable Energy Facility 2 (PBREF 2) entered commercial operation on July 18, 2015. It is a 95-MW plant, owned by the Solid Waste Authority (SWA) of Palm Beach County, was designed and constructed by a consortium of Babcock and Wilcox and KBR, Inc., and is operated under a DBO agreement by a subsidiary of Babcock and Wilcox Power Services Group. It utilizes mass burn technology, consists of three boilers and is sized to combust up to 3,000 t/d of post-recycled MSW. It generates electricity by passing the steam generated in the water wall boilers though a single turbine generator with the power (net of in-house use) supplied to Florida Power and Light Co. under a long-term power purchase agreement.

WTE facilities are subject to very stringent emissions standards. The Facility controls emissions through advanced combustion controls, use of powdered activated carbon to control dioxin, furan, and mercury emissions, a spray dryer absorber to remove acid gases, a pulse jet fabric filter (baghouse) to remove particulate matter and a selective catalytic reduction (SCR) system installed for NOx control. The bottom and fly ash generated are conveyed to an ash management building. There, a rotary magnet removes ferrous metals and an eddy current separator removes nonferrous metals from the ash stream for sale.

Planning for the Facility began in 2004 to build on other elements of the County's integrated solid waste system, which included a 1,800 tpd Refuse Derived Fuel (RDF) WTE facility, several regional transfer stations, a Subtitle D sanitary landfill, a MRF, a composting facility, a metals processing facility and household hazardous waste collection program, Remaining life at the landfill was less than 20 years. Continued population growth and a series of hurricanes in 2003, 2004 and 2005 strained the capacity of the system.

A number of alternatives were developed based on six principles

a) Waste generated in the County should be processed and disposed of in the County;

b) Should utilize proven state of the art processes;

c) Should be protective of human health and the sensitive environment;

d) Solutions should conserve resources;

e) New processing facilities should be publicly owned but be developed and operated in partnership with experienced private firms; and

f) Solutions should be cost effective and long term in nature.

After a lengthy options evaluation phase, the Board voted in 2007 to explore procuring a new WTE and in 2008 authorized the issuance of a Request for Qualifications (RFQ) for a full service design/build/operator to provide a mass burn facility. The Authority has a history of owning its facilities. While it has operated its transfer stations and landfills, it has historically used the design/build/operate model for the processing facilities.

The Facility is funded through a series of bond issues. The total project cost is estimated at $762 million. Repayment will be through revenues realized by the Authority. Revenues of the Authority include revenues from the sale of electricity, recovered materials, commercial tipping fees and non-ad valorem assessments.

Treatment of biosolids is a completely separate activity. The Authority has a biosolids pelletizing facility which opened In August 2009. The biosolids processing facility uses landfill gas as its primary fuel source to fuel the dryers.

Key facility information:

a. Feedstock and Flow Control
   The Authority's System consists of a 1,600 TPD RDF waste-to-energy WTE plant and a 3,000 TPD mass burn facility, Class I and Class III landfills, a state-of-the-art Recovered Materials Processing Facility (RMPF), a household hazardous waste (HHW) processing facility, a vegetation waste processing facility, several transfer stations, and various maintenance and other ancillary support facilities, Approximately 70 percent of all solid waste and recyclables collected in Palm Beach County pass through one of the Authority's transfer stations. PBREF2 processes mixed MSW. Most of the MSW processed at the Facility is delivered in transfer trailers.

b. Management of Biosolids
The Authority also separately operates a biosolids pelletizing facility, fuelled by landfill gas, to serve wastewater treatment plants in Palm Beach County.

c. Site Size and Characteristics
The Facility is sited on 24 acres within a larger County owned Energy Park (~ 1,300 acres). This site was chosen because of several advantageous factors. First, it was already owned by the Authority. Second, it is near the existing Energy from waste facility and the site was thus already certified as a power site. Third, it would not require any significant change in collection/transfer routing, as the waste was already coming to the site. Fourth, there was significant supporting infrastructure already in place. Fifth, residue landfilling and recovered metals processing capacity already existed close by. The Energy Park includes an 1,800 tpd RDF WTE facility, Subtitle D sanitary landfill, recovered materials processing facility for both commercial and residential recyclables, yard waste and wastewater sludge composting facility, wastewater sludge pelletizer facility, metals processing facility, and household hazardous waste drop-off facility, and administrative offices.

d. Technology Risk
The technology risk is minimal. Proven technologies were designed, constructed and operated by experienced companies.

e. Products and Markets
Markets for the energy and metals generated at the Facility are well defined and in the case of electricity sold under a long term defined contract with a secure off-take agreement.

f. Cost and Financing
The project is funded through the Authority's revenues, which include a non -ad valorem assessment, tip fees, energy and recovered ad valorem assessment. The capital cost of the winning bid was $667,981,128. The annual operating fee for the first year was $20,490,000.

g. Procurement/Contract Structure
The Facility was procured under a design build long term operate structure.

h. Residuals Management
The Facility operator is responsible for managing the residuals.

<u>Applicability to the CRD / Context for IRM Procurement Criteria:</u>

The lessons learned in the Palm Beach implementation include:

1) New Facility needs to be part of an integrated system that aligns with the preferred hierarchy. Adding new waste management infrastructure can be a controversial undertaking. It is critical that any new asset be right sized taking into account aggressive source reduction, composting, and reuse/recycling programs.
2) Control of the Waste stream simplifies the process of developing a Facility. The Authority had in place existing control of the feedstock to the Facility.

3) Having a secure source of funding is critical to obtaining project funding. The Authority had in place a funding system that was secure and thus were able to issue significant debt to fund the capital costs associated with the Facility.

5.11 Pivotal – Gussing Reference Facility

Güssing Austria was the first community in the European Union to produce its whole energy demand (electricity, heating/cooling, fuels) from renewable resources located within the Region. This arose out of a policy adopted in the early 1990’s out of which a number of initiatives were developed including an initial pilot facility to gasify locally sourced wood chips and recover electricity and heat for district heating.

The Güssing Austria facility is reported to process 50 tonnes per day of biomass (wood chips from wood thinned from the forest and waste wood from a wooden flooring company) producing 2MW of electricity and 4.6 MW thermal energy. The Güssing facility was constructed in 2001-02 and produces energy for the town of Güssing. The Gussing facility does not process biosolids. The development of the facility was supported with federal funding from the Austrian government and the EU, which covered 6 million euros of the initial 16 million euro capital investment for the plant as of 2001.

The biomass gasifier plant installed at Güssing was a joint effort of a consortium called “Renet Austria” which included: AE Energietechnik as the construction company, (ii) Institute for chemical engineering (Technical University of Vienna), (iii) EVN the regional energy utility, (iv) District heating company Güssing, (v) GE Jenbacher company, and (vi) Repotec Umwelttechnik GmbH. In 2009 Renet Austria merged with the Austrian Bioenergy Centre and formed Bioenergy 2020+, a centre of excellence funding by the Austrian COMET programme. This organization is not currently involved in day-to-day operation of the facility.

The heat energy is directed to the municipally run district heating system, supplying heat to mainly private homes and local institutions as well as green industry that has been attracted to the City. The electricity is sold to the grid under an original feed-in-rate of 12.3 cents/kWh, however the current rate is not known.

Biomass supply is secured by long term contracts for purchase of wood chips from a local wood farmers association. The price was initially fixed for a duration of ten years at 1.6 cents/kWh. The water content of the wood ships is approx. 25%. It was intended that over time that in the order of 40% of the fuel would be replaced by cheaper (0.7 cents/kWh) dry fuel from local wood working industries.

The technology deployed at Güssing plant is Fast Internally Circulating Fluidized Bed (FICFB) gasification system, this process is also called dual fluidized bed gasification, developed jointly by the Institute of Chemical Engineering (Technical University of Vienna) and by AE Energietechnik in Austria. In this system, the gasification reactor is physically separated from the combustion reactor in order to gain a largely nitrogen-free product gas.

The rationale for development of this facility in Gussing are the EU and Austrian directives and regulations that favour use of renewable fuels and the local economic and policy environment.

Key Facility Information:

a. Feedstock and Flow Control
Feedstock for the facility is biomass (wood chips and biomass). The materials are secured in a long term supply contract from a local farmers association. The price was initially fixed for a duration of ten years at 1.6 cents/kWh. The water content of the wood ships is approx. 25%.

b. Management of Biosolids
Not applicable for this facility

c. Site Size and Characteristics
The facility processes 50 tpd of biomass. Site characteristics of the Gussing facility are not known.

d. Technology Risk
The Gussing facility was developed using a demonstration facility in the late 1990's prior to its development in 2002.

e. Products and Markets
The facility produces 2 MW electricity and 4.5 MW of thermal energy, both of which are used by the community. There are no liquid emissions from the CHP plant at Gussing, as the condensate from the scrubber is evaporated and fed into the combustion zone, where the organic matter is combusted.

f. Cost and Financing
The facility reportedly cost 16 million euros in 2001. The development of the facility was supported with federal funding from the Austrian government and the EU, which covered 6 million euros of the initial 16 million euro capital investment.

g. Procurement/Contract Structure
The procurement and contract structure are not known. However, the original ownership structure consisted of a joint effort of a consortium called "Renet Austria" which included: AE Energietechnik as the construction company, (ii) Institute for chemical engineering (Technical University of Vienna), (iii) EVN the regional energy utility, (iv) District heating company Güssing, (v) GE Jenbacher company, and (vi) Repotec Umwelttechnik GmbH. The ownership structure changed in 2009 when Renet Austria merged with the Austrian Bioenergy Centre and formed Bioenergy 2020+, a centre of excellence funding by the Austrian COMET programme.

h. Residuals Management
The FICFB technology literature reports the only solid residue is the fly ash from the combustion zone. The carbon content in this fly ash is reported as being very low (<0.5%) and can be handled similar to an ash from biomass combustion.

Applicability to the CRD / Context for IRM Procurement Criteria:

1. The feedstock for this facility is wood chips and biomass, which is typical of this type of gasification facility. Biomass supply is secured by long term contracts for purchase of wood chips from a local wood farmers association.
2. Since the beginning of the plant operation in the year 2002, continuous improvement in the plant operation and optimisation has been done. Publicly available information indicates that the Güssing plant had consistent hours of operation and continuously improved the availability of the plant. After the initial optimization period (2002 to 2006), the system running hours both for gasifier and engine were quite consistent; about 7000 hours and more than 6000 hours per year respectively.

5.12 Walker Industries – Thorold Facility (Net Zero Waste Reference)

Walker Industries (Walker Environmental) owns and operates an Integrated Waste Management facility in Thorold, Ontario. The site has been the location of a commercial landfill development for many years, and over time the facility has grown to include: an N-Viro biosolids treatment facility managing biosolids generated by the Region of Niagara, an aerobic composting facility processing 35,000 tonnes of municipal source separated organics and 40,000 tonnes per year of yard waste annually, and a public drop-off and recycling centre.

The Region of Niagara selected a joint venture between Walker Industries and N-Viro Systems Canada to construct a centralized biosolids treatment facility following years of study and a competitive procurement process to find an alternative beneficial use solution to manage a portion (1/2) of the Region’s biosolids. The Region entered into a long term contract to supply biosolids to Walker who developed and currently operates the N-Viro facility. The process yields a Class A biosolids product marketed under the name Niagara N-Rich. It is approved for use as a fertilizer or soil amendment by the CFIA.

Niagara N-Rich is sold to large farm fertilizer distributors who sell the Class A biosolid product and the direct application service to farmers in Ontario. Most of the product is sold to neighbouring regions where the province’s large cash-crop farms are located. Niagara N-Rich is well received by consumers for agricultural use and has required little marketing to date (Gunn 2015). The facility is also working with a contractor, a mining company, and university researchers to look for more uses for the product, such as mine reclamation and reforestation (Gunn 2015).

The facility processes 26,000 tonnes of treated Class B biosolids annually, most of which are from the region, and produces approximately 35,000 tonnes of the Class A Niagara N-Rich soil amendment per year (Walker Industries 2014a). The product is sold for approximately $10 per tonne (Gunn 2015). In 2014, Walker Environmental acquired N-Viro and became the sole owner of the facility, operating under a contract with the regional government. The Niagara Region pays Walker Environmental to process the Class A biosolids; however they split the net revenue from sales of the N-Rich product.

Walker Industries has also won successive contracts with the Region of Niagara for receipt and processing of the curbside collected source separated organic stream, which includes a combination of food residuals and yard waste. The facility is a GORE cover system composting facility, with forced aeration for the initial phase of composting, followed by curing in outdoor windrows. Initially the composting facility depended on passive aeration, however, following an increase in material receipt and potential odour incidents Walker invested in the GORE technology. The overall capacity of the compost facility is 90,000 tonnes. Walker markets the compost product, largely for agricultural use.

Key information on the Walker Thorold facility:

a. Feedstock and Flow Control
Walker industries is a private company that competes in the open market for long term material supply contracts with municipal and commercial waste generators. Walker has contracts with the Region of Niagara for the management of source separated organics and yard waste, and for the supply of 26,000 tonnes of Class B biosolids. Walker buys its alkaline agent for the process from a regional cement plant.

b. Management of Biosolids
Walker's Thorold facility includes the NViro treatment facility for management of a portion of the Region of Niagara's Biosolids. The NViro process is a flash-lime stabilization process that creates a fertilizer product that meets federal standards.

c. Site Size and Characteristics
The Compost facility at the Thorold site is approximately 13.5 acres. This facility is surrounded by 100's of acres of land owned and controlled by Walker Industries, which has actively secured land surrounding its operations.

d. Technology Risk
The technologies chosen by Walker are proven technologies in the Canadian market. Walker mitigates its technology risk through its own internal technology selection process.

e. Products and Markets
Compost and fertilizer product generated by Walker Industries are sold to larger distributors of fertilizer products. As noted above, the Niagara N-Rich product is currently sold for $10 per tonne.

f. Cost and Financing
The reported capital cost for the compost facility was $10 million CAD as of 2009. Walker self-financed the capital for the facility. Walker also self-financed the NViro facility and all other site infrastructure.

g. Procurement/Contract Structure
Walker has entered into long-term material supply agreements with the Region of Niagara and other entities based on competitive market conditions. Walker has been directly responsible for the design, engineering, construction and operations of the facilities in Thorold.

h. Residuals Management
   Walker is responsible for managing all residues from their operations, and dispose of these at their adjacent landfill facility.

Applicability to the CRD / Context for IRM Procurement Criteria

1) Walker has secured long term contracts for waste supply, which facilitates their ability to invest in and grow their facilities.
2) Walker has mitigated technology risk by using proven technologies for the primary components of their facility, and where appropriate choosing to work with partners/advisors for the development of new products and markets. For the N-Viro facility, it was originally developed through a joint venture and then Walker acquired N-Viro and became the sole owner of the facility following years of successful operation.

5.13 ARK Power Dynamics (APD) – Stamps Arkansas

The Ark Power Dynamics facility in Stamps Arkansas was developed as a private facility to demonstrate the Ark Reformer technology on chicken litter wastes. The facility was developed in order to derive additional value from the management of this organic material stream versus conventional approaches (e.g. land application) used to manage manures. The facility began operations in 2012. It is unclear if the facility is currently in operation.

The ARK Reformer operates at a relatively low temperature of 65 degrees C. The Ark Reformer technology reportedly can accept materials containing up to 75% moisture content (similar to biosolids) as opposed to gasification technology (which according to APD, is limited to 15% moisture)[7].

Key Facility Information:

a. Feedstock and Flow Control
   The facility processes chicken litter which has a moisture content up to 75% moisture. The facility processes as much as 3 tons of feedstock per day. Feedstock with a water content of 50 to 60 percent is reportedly preferred. The chicken litter processing revealed the facility may process any carbon-based wet waste, such as animal waste which is similar to other carbon based wet materials such as biosolids. In regards to control of the material processed by the facility, this is through agreement with local suppliers. There are no indications that this technology may be suitable for other solid material streams generated in the CRD.

b. Management of Biosolids
   Biosolids were not processed at this facility however APD points out that the high moisture content feedstock of chicken litter is similar to that of biosolids.

[7] http://www.google.com/patents/US9005536

c. Site Size and Characteristics
The facility processes 1 to 3 tons per day. The actual site size has not been noted, but generally the size required to process this quantity of material would be relatively small.

d. Technology Risk
It is unclear exactly how the risk associated with the development of the technology was addressed, however it can reasonably be assumed based on the current ownership of this plant that it was largely (or completely) assumed by the technology provider.

e. Products and Markets
The exact products derived at this facility and the market value of these products are not known, however APD reports output could include: a synthetic oil, syngas and a remnant ash that is also referred to as a sterile soil.

Applicability to the CRD / Context for IRM Procurement Criteria:

1. The facility processes feedstock (chicken litter) which has a moisture content of up to 75% moisture which is similar to dewatered biosolids. Although there are no indications the technology is suitable for other solid wastes, the technology could be suitable for the CRD's biosolids, particularly if they are blended with wood chips at an appropriate mixture to yield a feedstock moisture content in the 50 to 60% range.

5.14 Ostara – Gold Bar, Edmonton

The Ostara nutrient recovery facility was constructed at the Clover Bar sewage-settling lagoons at Edmonton's 310- million-litre-per-day Gold Bar wastewater treatment plant in 2015. The Ostara Gold Bar facility was the largest largest-ever nutrient-recovery facility in Canada as of 2015. The facility removes phosphorus from the liquor following biosolids dewatering and is reported to produce 10,000 kilograms per day of plant fertilizer. The facility was a scale up by 20 times of an initial demonstration plant installed in 2007.

The Ostara nutrient recovery process recovers phosphorus from post-digestion liquor resulting from dewatering biosolids, through a controlled precipitation of struvite from the biosolids. Phosphorous recovery from post-digestion liquor is a chemical precipitation process that recovers nutrients (phosphorus and nitrogen) from dewatering liquor stream before they accumulate as struvite in pipes and on equipment. Struvite is a crystalline formation of minerals that occurs in alkaline conditions which is common in post digestion liquor (biosolids that have been digested). Phosphorous recovery is a controlled chemical precipitation process that facilitates the generation and growth of struvite "seeds" (crystalline pellets). This process occurs in an up-flow container that keeps the struvite seeds in suspension until they accumulate mineral crystals to a desired size for commercial fertilizer markets. The crystals are allowed to settle, extracted and dried for commercial horticulture and agriculture markets.

Key Facility Information:

a. Feedstock and Flow Control
The Gold Bar Ostara facility receives the liquor from post-digestion biosolids dewatering of the 310- million-litre-per-day Gold Bar wastewater treatment plant.

b. Management of Biosolids
This facility processes the liquor from dewatered biosolids to recover phosphorus in the form of a crystal pellet called Crystal Green™.

c. Site Size and Characteristics
The 600-sq-meter, 12-m-high facility was constructed at the Clover Bar sewage-settling lagoons at Edmonton's Waste Management Centre. The facility is designed to produce 10,000 kilograms per day of slow release plant fertilizer.

d. Technology Risk
Ostara's proprietary technology incorporates a fluidized-bed reactor and crystallization process to precipitate phosphorus and nitrogen out of dewatering recycle streams at the Gold Bar treatment plant. An added benefit of the process is the reduction in the build-up of struvite that typically occurs in the process equipment. The technology is considered proven and commercially operating in dozens of facilities in the US, Canada and Europe.

e. Products and Markets
The Crystal Green product Ostara produces is reportedly a multi-nutrient source (5-28-0 with 10%Mg). Phosphorus from Crystal Green® reportedly optimizes crop performance by providing plants with a more effective and efficient source of nutrients than conventional phosphate fertilizers. The product is marketed for a variety of agricultural fertilizer purposes. Ostara would assume responsibility for the certification, management, storage and distribution of the produced fertilizer product, providing a revenue share to the CRD under a fertilizer offtake agreement (fixed price or index price).

f. Cost and Financing
Not known for this facility. As a private company Ostara is not required to disclose financial information. The equipment reportedly ranges between $5 million to $10 million for a typical facility.

g. Procurement/Contract Structure
The contract structure consists of a partnership between EPCOR Water Services Inc. (the WWTP owner/operator) and Ostara Nutrient Recovery Technologies. The WWTP (EPCOR) owns and operates the facility which was designed by Ostara. Ostara supports EPCOR in periodic operations as needed and retains a long-term offtake agreement for the Crystal Green™ fertilizer by-product.

h. Residuals Management
Solid residuals of the process are the Crystal Green™ product that Ostara commits to purchase at agreed upon price. Ostara takes responsibility for the certification,

management, storage, and distribution of the produced fertilizer product while still also providing a revenue share to the public sector consistent with the respective responsibilities of each party Ostara has used this method to accept the financial risks for the product thereby insulating the City from the significant volatility of the agro-chemical, commodity fertilizer market. Ostara then resells Crystal Green primarily to retailers in the agriculture market and distributors in the turf and ornamental markets. These retailers and distributors combine Crystal Green with other fertilizer components to produce finished products that provide the desired nutrient balance for specific end user applications. These finished products are then sold to end-users (e.g. farmers, golf courses, lawn care professionals). Ostara has built relationships with an extensive network of customers across the United States, Canada, and Europe.

Applicability to the CRD / Context for IRM Procurement Criteria:

1) The Ostara process focuses on processing the liquor from post-digestion biosolids. As such it could form part of an overall IRM solution, but would not on its own constitute an IRM approach suitable for management of some or all of the CRD solid and liquid waste streams. A process like Ostara could be considered and implemented outside of the IRM procurement process or as a step in IRM implementation.
2) Ostara enters into a long term Crystal Green™ product repurchase agreement whereby Ostara agrees to purchase the fertilizer by-product at agreed upon pricing. This off-take agreement has been used to remove the financial risks of the potentially volatile agro-chemical commodity market from the public entity where it can be managed by the private sector.

5.15 WTT – Surrey Biosolids Facility

The Surrey Organics to Biofuel Facility employs a dry anaerobic digestion system and is designed to recover energy from a co-collected yard and food waste feedstock. The City of Surrey Organics to Biofuel project was the result of the City of Surrey seeking to identify beneficial use of its organic wastes pursuant to a regional directive by Metro Vancouver who adopted a comprehensive, long term waste strategy to divert 70% of all wastes from the landfill by 2015. A key tenant of the strategy is to divert yard and kitchen wastes from being landfilled. Accordingly, the City expanded its residential yard waste collection program in October, 2012 to accept kitchen wastes and food solid paper. The City implemented a waste sampling and composition protocol throughout the first year collection of the combined material streams and provided that information to the prospective proposers as the information became available.

The City applied and secured P3 Canada funding in support of the facility development for provincial funds up to 25% of the capital or not to exceed $16.9M.

The City solicited for developers to provide design, construction, financing and operations of an Organics to Biofuel facility for a 25 year operating period. The terms included the obligation to provide equipment to process the biogas for use as a pipeline grade natural gas or to produce electricity for sale to BC Hydro. The City also expressed a preference for the production of pipeline gas including compressed natural gas suitable for CNH fuelled vehicle use. The solicitation requested the facility include pre-processing of the mixed feedstock materials, anaerobic digestion, biogas production and recovery, and by-product management.

The City offered the use of a city-owned site. The site is a 6.6 acre parcel of land located adjacent to the Surrey Waste Transfer Station within the Port Kells Industrial Park. The City also offered an additional 3.3-acre parcel of land located adjacent to the 6.6 acre parcel but separated by the only entrance/exit to the Waste Transfer Station. The offering of the 3.3 acre parcel obligated the developers to be responsible for environmental remediation of the site. The 3.3 acre site had been used as a storage area for biomass from a former facility and would necessitate the removal of the biomass prior to its use in the development.

The City required that the project finance structure meet its affordability ceiling. The affordability ceiling was set as the maximum cost of organic waste disposal based on the 2013 Metro Vancouver disposal rates for municipal wastes. The City intended to pay the developer annual service payments, net of any revenues the developer would secure, over the 25 year term of the agreement.

The agreement included a hand-back provision which includes the developer turning over the ownership and operations to the City at the end of the 25 year operating agreement.

The procurement process included an RFQ phase wherein capable companies were requested to submit evidence of their qualifications. After review and shortlisting, the process included an RFP process to request facility design, build, finance, own, operate cost proposals. The RFP process included collaborative meetings to explore technical and commercial matters through workshop and key topic meetings.

The City selected Orgaworld as the preferred proponent. The project includes a dry fermentation anaerobic digestion technology with biogas clean-up and compression into the pipeline grid in addition to CNG offtake for vehicle use. Solids from the project are composted and will be sold to the agri-business by the project company. The project development, design and construction has been on-going since 2014. Project completion has been reported and commencement of operations is expected in late 2017 or early 2018.

Key Facility Information:

a. Feedstock and Flow Control
   The City of Surrey was obligated to deliver all of the waste collected from the city's residential co-collected yard and food waste program to the facility. The contract includes a provision for increased quantities, beginning with approximately 80,000 tonnes per year of material and increasing over the contract duration to eventually 115,000 tonnes per year. The City has flow control to guarantee the material which was used as the basis for the private sector development partner when securing private financing for the project. In addition to the city's residential organics, the development partner was obligated to secure industrial, commercial and institutional (ICI) wastes to make the economies of scale attractive for the project. As the city's residential wastes increase over time, the private operator will need to reduce the quantities of ICI wastes to allow the City's waste as first priority for processing.

b. Management of Biosolids
   The Surrey facility does not receive or process biosolids.

c. Site Size and Characteristics
The city provided a site consisting of approximately six acres for the proponent to use under a long-term no-cost lease for the duration of the contract. The City also offered an additional three acre site that the developer could use if desired however, it is separated from the primary six acre parcel by an access road that serves as the primary access to the City's waste Transfer Station. The developer choose to not use the additional three acre site. The site is located in an industrial area of the City. The site was equipped with utilities and street access. The developer has used the entirety of the six acre parcel for the facility.

d. Technology Risk
The project developer proposed and guaranteed the technology, assuming all risks for the adequacy and efficacy of the technology and Facility design, construction and operation. The technology risk of the facility was relatively minimal as anaerobic digestion was the selected technology. The somewhat problematic risk of feedstock quality and related pre-processing risk was minimized by the city implementing a co-collected yard and food waste collection system a year in advance of the project. The City performed an analysis of the feedstock on a monthly basis providing the information to the prospective bidders. The bidders were also allowed access to the feedstock during this time.

e. Products and Markets
The primary product of the facility is the biogas which is to be upgraded to pipeline quality renewable natural gas (RNG). The City initiated interaction with utility companies, entering into a long term off-take agreement with Fortis BC for the RNG produced by the facility.

f. Cost and Financing
The capital cost for the facility was $68M Canadian. The project was partially funded by P3 Canada, receiving $16.9M in funding towards capital costs. According to the P3 funding process, private equity funding was included in the financing.

g. Procurement/Contract Structure
The procurement process consisted of a Request for Expressions of Interest, followed by a Request for Qualifications, followed by a short-listing of firms. The top three qualified firms were invited to participate in a Request for Proposals. The two firms that competed but were ultimately not selected were compensated for their efforts by payment in the amount of $125,000 to each of the firms. The procurement process followed the procedures of P3 Canada and included a Fairness Advisor, collaborative/in-confidence (sounding) meetings and strict adherence to the confidential management of information under P3 Canada's guidelines. The contract obligates the developer to secure private industrial, commercial and institutional (ICI) wastes from the region to meet the facility capacity levels in the early stages of the contract when the City's wastes have not grown to the ultimate capacity, as anticipated in the later years of the contract. The contract requires private financing of the project beyond the P3 contribution of $16.9M. The contract includes a 25-year design, build, own, operate agreement that includes a hand-back provision that returns facility ownership to the City at the end of the 25-year operating agreement (DBOOT).

h. Residuals Management
   Solid residuals from the anaerobic digestion process are converted to a soil amendment using an aerobic composting process.

Applicability to the CRD / Context for IRM Procurement Criteria:

1) The Surrey Organics to Biofuel facility's dry fermentation anaerobic digestion system represents the biological portion of the mechanical-biological system offered by WTT.
2) The dry fermentation technology demonstrates the ability to process food waste, yard waste (SSO) for beneficial uses including energy, and compost.

5.16 Edmonton Waste Management Centre

The Edmonton Waste Management Centre is a 200+ hectare integrated waste management system incorporating an integrated processing and transfer facility, a composting facility, a materials recovery facility, a construction and demolition waste recycling facility, a transfer station, an electronic waste recycling facility, a closed landfill with landfill gas recovery, a waste to biofuels production facility, a biosolids management facility, a research facility and administrative offices.

The Integrated Processing and Transfer Facility (IPTF)

Waste arrives at the IPTF and is divided into three separate waste streams: composting, biofuels production and landfill. Waste that can't be recycled or composted becomes feedstock for Enerkem's waste to biofuels facility.

The IPTF includes two loading bays, two rotating screens with bag breaking "spikes" to separate materials into different streams, manual pick stations, magnets and other equipment to remove unprocessable materials such as propane bottles, a mechanical system to produce feedstock for Enerkem's waste-to-biofuels facility from processed waste, a conveyor to transfer organic waste materials to the composting and non-recyclable, non-compostable waste to the adjacent Waste-to-Biofuels Facility, bays to load materials for transport to other landfills for disposal.

Biosolids Management Facility

Biosolids generated from the Edmonton region's two wastewater treatment plants are stored in the Clover Bar lagoons. Biosolids are currently managed through a combination of land application (the NutriGold program which utilizes liquid biosolids from the Clover Bar lagoons) and via co-composting

Composting Facility

Edmonton's organics processing program uses the organic portion of the waste collected in combination with biosolids (treated sewage sludge) to create compost. Processing organic waste currently take place at the composting facility. The composting facility is the largest of its kind in North America by volume and size. It was built in 2000 and processes compost from 160,000 tonnes of organic waste and biosolids per year for use in agriculture and horticulture.

The Enerkem Waste to Biofuels Facility

The waste to biofuels facility is owned and operated by Enerkem. It receives 100,000 tonnes per year of pre-processed MSW for conversion into liquid methanol/ethanol. The company has been producing and selling methanol since 2016. Enerkem is responsible for financing, construction and operation of the ~ $100 M Facility. It is the first industrial scale waste to biofuels facility of its kind.

The C & D Processing Facility

The C&D facility located at the Waste Management Centre processes mixed C&D recycling or segregated C&D recycling. The C&D Facility recycles wood, drywall, asphalt shingles, concrete, metals and brush and trees. .Mixed loads of material are diverted from landfill and either sold to recycling processors or used in the City's operations.

Global Electric and Electronic Processing, Inc. Facility

The electronics processing facility processes more than 30,000 tonnes per year of old computers, televisions, and other electrical and electronic waste materials for recycling. It was built and is operated by GEEP Alberta, Inc.

The Proposed Anaerobic Digestion Facility (ADF)

This facility will also be located at the Edmonton Waste Management Centre and will supplement the composting facility by processing up to 48,000 tonnes of organic waste per year to generate renewable energy and a high quality compost for use in agriculture and horticulture. It is a partnership between the City of Edmonton, BIOFerm and the University of Alberta. The ADF is scheduled to be in operation by the first half of 2018

The Materials Recovery Facility (MRF)

The MRF is almost 6,000 square metre (64,000 square feet) sized to handle processing 50,000 tonnes per year, the MRF processes all types of recyclables accepted in the City's blue bag, blue bin and recycling depot programs.

The Facility is owned by the City and has been operated since April 2014 by SUEZ Canada Waste Services Incorporated.

Key information regarding the Edmonton Waste Management Centre:

a. Feedstock and Flow Control
   There are several waste streams being delivered directly to the Waste Management Centre by various public and private entities. The City is responsible for the management of all residential waste streams, including the collection of residential waste from single and multi-family residents. The City also offers services to the commercial sector, competing with a number of private companies who also operate in Edmonton. There are multiple competing landfills and transfer stations located in or near Edmonton.

b. Management of Biosolids
   Biosolids are currently managed through a combination of composting and land application.

c. Site Size and Characteristics

The site is over 570 acres and serves as the home of several waste processing/management facilities.

d. Technology Risk
The majority of the facilities at the Waste Management Centre utilize proven technology with long operating histories on the specific feedstocks. The one exception to this is the waste to fuels facility which represents a significant step in the commercialization of this technology to convert waste to methanol and ethanol.

e. Products and Markets
The process outputs vary depending on the Facility and thus the markets as well. The various products include recovered materials sold into the recyclables and compost markets and biofuel sold in the fuel market.

f. Cost and Financing
The expenses of the Management Centre are funded primarily through a Waste Management Fee line item in the utility bill, which is $44.90 per month in 2017 for a typical residential customer. Additional revenues includes fees and grants. The capital cost of the Enerkem facility owned and operated by Enerkem is ~ $100 M. The IPTF owned by the City and operated under subcontract cost ~ $40 M. Alberta Innovates contributed $29 M to funding the biofuels initiative.

g. Procurement/Contract Structure
Edmonton utilizes public private partnerships extensively. The waste to biofuels facility, the IPTF Facility, the Electronics Processing Facility, the C & D Facility and the MRF are all operated and/or maintained by private companies.

h. Residuals Management
The City provides residuals management at the Waste Management Centre.

<u>Applicability to the CRD / Context for IRM Procurement Criteria:</u>

1) The Edmonton Waste Management Centre is a good example of an integrated resource management system. There are a number of separate facilities co-located on a single site operated by different entities which have been developed sequentially over several years.
2) The City controls all of the residential waste materials and the biosolids and has control over the various processing operation. The system is funded through an enterprise fund tied to the utility bill. Thus, they are able to provide assurance of long term supply of feedstock and ultimately a secure source of revenues.

5.17 PGH Energy – Lebanon Tennessee

The PHG Energy (now the Aries Clean Energy Project) is a 64 TPD gasification plant co-located at the city's wastewater treatment plant. It will convert up to 64 tons of blended waste wood, sewer sludge and scrap tires into power, generating up to 300 kilowatts that will be used for the power needs of both the plant and the wastewater treatment facility. PHG completed a similar, but smaller-sized project in Covington, Tennessee, in 2013.

Funding for the project included a $250,000 matching-funds grant awarded by the Tennessee Department of Environment and Conservation's (DEC) Clean Tennessee Energy Grant Program and $5.5 million of the Qualified Energy Conservation Bonds initiative, a low-cost financing tool offered by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

A key project participant is Lebanon-based Rockwood Recycling who has assumed all responsibility for collecting, transporting and preparing the feedstock for the plant. It also receives discarded tires from Wilson County officials. Rockwood has a yard located close to the Facility where they store wood and tires for the plant's fuel.

Lebanon is the 13th commercial gasification plant installed by PHG Energy. The plant is expected to divert more than 8,000 tons of waste from the landfill annually. It currently processes 32 tons per day—3 tons of sludge, 3 tons of tires and 26 tons of wood waste. At full capacity, it will use 64 tons of feedstock per day. The plant will convert up to 64 tons per day of waste into fuel gas and five percent of the waste which turns into biochar, which will be sold for fertilizer or kiln fuel.

Wood and tires are first shredded to a particle size of 1 to 3 inches (25 to 76 mm) and blended with sludge before gasification with a target moisture content of 30%. The materials are then fed into a down draft thermal gasifier. The syngas produced by the gasification process is combusted and the thermal energy is used to heat water, which in turn drives three Clean Energy Technologies' Organic Rankine Cycle generators with a total output of 420Kw.

Key facility information:

a. Feedstock and Flow Control
   Two of the three feedstock elements (wood waste and tires) are furnished by a private company, Rockwood Recycling, while the third material, sludge, is provided by the City.

b. Management of Biosolids
   The biosolids from the City's WWTP are processed in this Facility.

c. Site Size and Characteristics
   The footprint of the Facility is approximately one acre and is located on City property adjacent to the WWTP.

d. Technology Risk
   Wood waste, shredded tires and sludge are blended prior to introduction into the gasifier. There are fewer risks with this mix of fuels when compared to gasification of more non-homogenous feedstocks.

e. Products and Markets
   The syngas is used to reduce the energy demands of the adjacent wastewater treatment plant and the biochar can be used in fertilizer or other applications.

f. Cost and Financing

The City utilized funds available under the Qualified Energy Conservation Bonds initiative, a low-cost financing tool offered by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

g. Procurement/Contract Structure
The facility was procured under a DB type arrangement, with the City owning and operating the Facility and Aries providing the technology, general contracting services and operational support.

h. Residuals Management
The City operates the Facility and is responsible for managing the gasification process residuals.

Applicability to the CRD / Context for IRM Procurement Criteria:

1) The mix of feedstocks used by this facility are limited to wood waste, tires and sludge.
2) Development of the facility permitted the City to change its then current management of sludge which involved the use of an ATAD (Autoheated Thermophilic Aerobic Digester) to produce Class A biosolids for land application to the recovery of energy from the sludge, thus reducing the cost of operation and energy demand at its existing WWTP.

5.18 Plasco – Ottawa

In the mid 2000's, the City of Ottawa entered in an agreement with Plasco to deliver a portion of their waste stream to a pilot plasma arc facility. The proposed technology utilized plasma arc to refine gases produced during gasification, which were then fed into Jenbacher internal combustion engines to generate electricity. The Facility began operation in 2008.

In December 2012, Plasco concluded a contract with the city of Ottawa for the construction of a three train commercial plant. The plant as designed was intended to process up to 405 tonnes/day, producing electricity and aggregate.

This contract offered an option for the City to reduce the waste landfilled at the Trail Road landfill facility, extending the life of the landfill and would have contributed to the City's efforts to increase diversion of materials from disposal.

In 2015, the City terminated its relationship after several extensions intended to provide Plasco with time to make modifications in the process and bring the Facility up to full scale operations. Plasco was not able to meet project milestones for financing of the facility and to bring the Facility up to full scale operations. Plasco sought protection from creditors and the Facility was auctioned off in 2015.

Key facility information:

a. Feedstock and Flow Control
The City was obligated to deliver waste to the Facility which it controlled and was then currently sending to the Trail Road landfill

b. Management of Biosolids

This was not part of this project.

c. Site Size and Characteristics
Plasco leased land from the City across from the Trail Road landfill. The Facility occupied three acres.

d. Technology Risk
Clearly there was technology risk, as the Facility was not able to reach full scale production after several years.

e. Products and Markets
The Facility was intended to utilize the syngas generated to power internal combustion engine generator sets.

f. Cost and Financing
When initially proposed, Plasco was to fund the costs to build the pilot Facility, then estimated at approximately $30 million. In 2008, Plasco proposed to build an expanded 400 TPD $125 million facility. Plasco reportedly raised over $300 million over the span of several years from various private and public investors, but was not able to implement the needed modifications to bring the Facility up to full scale operations.

g. Procurement/Contract Structure
Plasco was responsible for the design, construction, operation, ownership and financing of the Facility. The City's obligation was to deliver 109,500 tonnes of city waste annually and pay $83.25 for every tonne of garbage it processed.

h. Residuals Management
Plasco was responsible for the management of process residuals

<u>Applicability to the CRD / Context for IRM Procurement Criteria:</u>

1) It is critically important that the technology selected, works at the proposed scale on the waste streams being considered. The criteria applied during the RFQ stage to qualify proponents and the performance guarantees and specifications at the RFP stage are intended to screen out those technologies that would not work or meet the CRD requirements.
2) The private partner in a public private partnership needs to have the financial capacity to weather potential upsets. The application of procurement criteria related to the qualifications and capability of the private partner and their financing is critical to the success of this type of project.

5.19 Tees Valley

Commissioning on the first phase of the Tees Valley 1 Facility was started in late 2014. The advanced gasification facility being developed by Air Products utilizes the AlterNRG Westinghouse plasma arc. Air Products developed the Tees Valley Renewable Energy Facility in Northeast England intending to process 950 tonnes per day of household waste and convert it into 50 MW of electricity.

Problems first arose shortly after Tees Valley 1 reached completion. The facility had been due to enter operations in summer 2014 – but 18 months later was still undergoing commissioning due to technical issues. Construction work on the second of the two facilities was suspended in November 2015 because of the operational challenges in making the facility function correctly. On April 4, 2016, Air Products announced it was leaving the waste-to-energy business, and was taking a write-down of $0.9-$1.0B. The company said that the decision was due to technical difficulties in making the technology work as expected. As a result, the company treated the energy from waste business segment as a discontinued operation.

The rationale for application of IRM in this jurisdiction was similar to that in other jurisdictions in the European Union (EU) being lack of available landfill disposal capacity and the EU and English directives and regulations that favour the processing of waste rather than direct disposal in landfills, and the regulatory environment and energy market that favours energy generation from renewable fuels.

Key facility information:

a. Feedstock and Flow Control
   The waste is supplied by the site's owners, Impetus Waste Management.

b. Management of Biosolids
   Not part of this project

c. Site Size and Characteristics
   The total acreage for both facilities is approximately 37 acres. They are located on industrial land owned by Impetus Waste Management adjacent to a major chemical complex.

d. Technology Risk
   The degree of technology risk was reflected in the need for a major corporation to take an almost $1 billion write off upon abandoning the project due to the inability to bring the facility up to full operations.

e. Products and Markets
   The Facilities used the syngas generated to generate ~ 50 MW of electricity per facility.

f. Cost and Financing
   The combined facilities capital cost totalled over $800 million.

g. Procurement/Contract Structure
   Air Products developed this project under a DBFOM model.

h. Residuals Management
   Residual management was the responsibility of Air Products.

Applicability to the CRD / Context for IRM Procurement Criteria:

1) It is critically important that the technology selected, works at the proposed scale on the waste streams being considered. The criteria applied during the RFQ stage to qualify proponents and the performance guarantees and specifications at the RFP stage are intended to screen out those technologies that would not work or meet the CRD requirements.
2) The private partner in a public private partnership needs to have the financial capacity to weather potential upsets. The application of procurement criteria related to the qualifications and capability of the private partner and their financing is critical to the success of this type of project.

5.20 Silicon Valley Clean Water

The Silicon Valley Clean Water (SVCW) Authority is a joint powers authority located in Redwood City California and serves the communities of Redwood City, City of San Carlos, and the City of Belmont as well as the West Bay Sanitary District. Since the 1980s, the SVCW has disposed of its biosolids through contracts with private companies that haul the biosolids to dedicated agricultural land application and compost sites or, when necessary, to an approved landfill for either burial or preferably as an alternative daily cover.

The disposal of biosolids is a major expense for any wastewater treatment facility and the options for disposal continue to shrink, while costs increase. The cost per ton of biosolids disposed has increased approximately 10 percent per year, every year for the past decade with the expectation of continued increases in the future.

SVCW began working towards alternative disposal options as an active participant in the Bay Area Biosolids to Energy Coalition (BAB2E), a consortium of Bay Area wastewater treatment facilities. The BAB2E operates under a “Joint Exercise of Powers” agreement. This group is focused on finding alternative processes that will eliminate the need to dispose of biosolids and turn it into an asset that produces more energy than the cost of treatment and to address the increasingly restrictive environment for land application of biosolids in the state. That process has proven very difficult and the coalition continues to work with vendors and educational facilities in the evaluation and testing of processes to meet the goal. The BAB2E coalition has worked in support of its members to advocate for state legislation to support the conversion of biosolids to clean energy and in federal bills to support biosolids to energy technologies. The intent of the coalition is to address the challenges with technology development, recognizing that commercial-scale demonstration of biosolids to energy technologies requires large capital investment that is difficult to obtain without a revenue stream, yet agencies cannot commit a revenue stream without commercial-scale demonstration.

SVCW has employed a practice of having more than one disposal option available at all time for biosolids. This practice is due to the fact that the options for disposal have changed many times over the years and continue to change today. SVCW currently has only one biosolids disposal contract in place. Synagro Inc. is a major biosolids disposal company in the United States and the SVCW contract with them allows for disposal via agricultural land application, at a landfill or for composting. While this contract provides three methods for disposal, it is with one company that has little control over their cost of disposal due to the fact that they are using other people's or agencies' property for the majority of their operation. This fact makes the Synagro disposal options susceptible to closures or increases in cost.

The current average cost per ton of biosolids disposed by Synagro for SVCW is approximately $49 per ton and is expected to exceed $60 per ton within two years. The goal of the BAB2E has been to find a disposal option that will allow the production of some level of energy to be created from the disposal of biosolids and at a cost of less than $100 per ton.

Based on a three-year study, the SVCW elected to proceed with an agreement with BioForceTech, Inc. for a full service biosolids disposal contract. BioForceTech is an Italian firm with a new process that uses very little energy to dry the biosolids. BioForceTech approached the SVCW offering a partnering relationship in the United States to test their process, with an ultimate goal of installing a facility utilizing their equipment. SVCW agreed to work with them in the testing process and to evaluate the potential for a full-scale installation at the Authority's site.

SVCW and BioForceTech have developed a system through the combined testing that will allow for disposal of the biosolids and production of a small amount of electricity for use in the treatment facility for a cost of $59 per ton of biosolids during the first year of operations. This cost is lower than BioForceTech's expected retail cost to other future facilities due to the fact that the SVCW installation is the first in the country and is, at least in theory, at their "cost" of providing the service. It should be recognized that the cost should be considered speculative at this time and that the true cost will not be known for several years, or until the facility has been developed and is fully operational.

While even this cost is more than the current cost of biosolids disposal, it is expected to be very competitive in the near future, and is much less expensive than the options the BAB2E coalition has found to date.

SVCW has worked very closely with BioForceTech in the development of a facility at the SVCW site. BioForceTech intends to develop a full scale operating facility to demonstrate to others that the technology works and is cost effective. Initially, BioForceTech proposed that SVCW purchase a full scale facility to treat 100% of the SVCW biosolids for a reasonable price, but SVCW staff felt it was not prudent for the agency to risk our capital to prove their process and staff also believed it was in the Authority's best interest to develop multiple alternatives for long-term biosolids disposal.

For these reasons, SVCW entered into a 10-year service contract with BioForceTech. The contract calls for BioForceTech to build, operate and maintain a facility that is capable of drying and disposing of approximately one-half (50%) of the biosolids produced by the SVCW. SVCW provides a site and utilities for the facility, at the proposed land lease cost to BioForceTech of one dollar ($1.00) per year.

BioForceTech will make all connections to the utilities at their cost. BioForceTech is responsible for all permits needed for construction and continued operation of the facility for the term of the agreement.

From an operational standpoint, the financial impact over the long term is expected to save SVCW money. Short term, for the first year or two, the added cost to dispose of approximately one-half of SVCW's annual biosolids production through the BioForceTech process could result in an additional cost of $70,000 per year, if there is no inflation or other costs added to the current Synagro costs.

It is believed the actual impact will be much less than this as Synagro costs have gone up each year of the contract term to date, due to inflation and transportation cost increases. The estimate of $70,000 is a worse-case scenario. This also does not take into account the value of electricity that will be produced by the BioForceTech system and used in the treatment facility. The quantity and reliability of power generated will be determined as the facilities come on line.

An added benefit of the BioForceTech process is the elimination of many truck trips from the SVCW facility to the out of county disposal locations. It is estimated that over 500 truck trips per year will be eliminated due to the drying and power production onsite versus disposal at the current offsite locations. The BioForceTech facility employs an oxygen-rich compost process to dry the biosolids. The process occurs in a set of large cylinders aimed at accelerating a process similar to compost, in which oxygen-fueled bacteria break down the solid matter into smaller pieces. The process reportedly dries the biosolids without using any gas from about 80 percent water to 20 percent water in 48 hours.

Once dried, the shrunken biosolids will be fed into a pyrolysis process that heats them up in the absence of oxygen to about 1,100 degrees Fahrenheit, causing more of the mass to evaporate and creating the energy used to fuel the two machines. The process produces thousands of small, black particles with large pores and a volume that is 8 percent of the volume of the waste fed into it. BioForceTech have named the particles 'Nutrieno' and intend to explore their ability to absorb/adhere toxins and other chemicals. The presence of trace chemicals, drugs and other toxins in processed biosolids have caused some jurisdictions to ban or restrict their agricultural use.

Key Facility Information:

a. Feedstock and Flow Control
   The SVCW is providing a feedstock (biosolids) and flow control (half the SVCW biosolids) for a ten year period in the form of a service agreement, whereby BioForceTech will design, build, own and operate the facility.

b. Management of Biosolids
   The facility will process biosolids from the SVCW WWTP.

c. Site Size and Characteristics
   The SVCW provided the site and utilities. The size of the site and its characteristics are not known at this time.

d. Technology Risk
   The technology risk is borne by the developer BioForceTech as a part of a ten year service agreement to produce a system that beneficially uses biosolids at a cost equal to (or near) the current land application rate.

e. Products and Markets
   The process produces dried biosolids which are then gasified in a pyrolysis process. The process produces excess heat which is available for accelerated biosolids drying.

f. Cost and Financing

The cost and financing are not clear at this time, however the preliminary findings indicate the process will be able to manage biosolids for $59/ton (US ton) which is slightly higher than the current $49/ton for transportation and land application cost provided by an independent contract.

g. Procurement/Contract Structure

BioForceTech is reported to have approached the SVCW seeking an agreement to test, and then to design, build, operate a biosolids processing technology. The 10-year service contract appears to be a service agreement for half of the SVCW biosolids.

h. Residuals Management

The BioForceTech process produces a small quantity (approximately 8% by volume) of the dried biosolids fed into the pyrolysis process. At this time, further research is on-going as to the use of the residuals.

<u>Applicability to the CRD / Context for IRM Procurement Criteria</u>

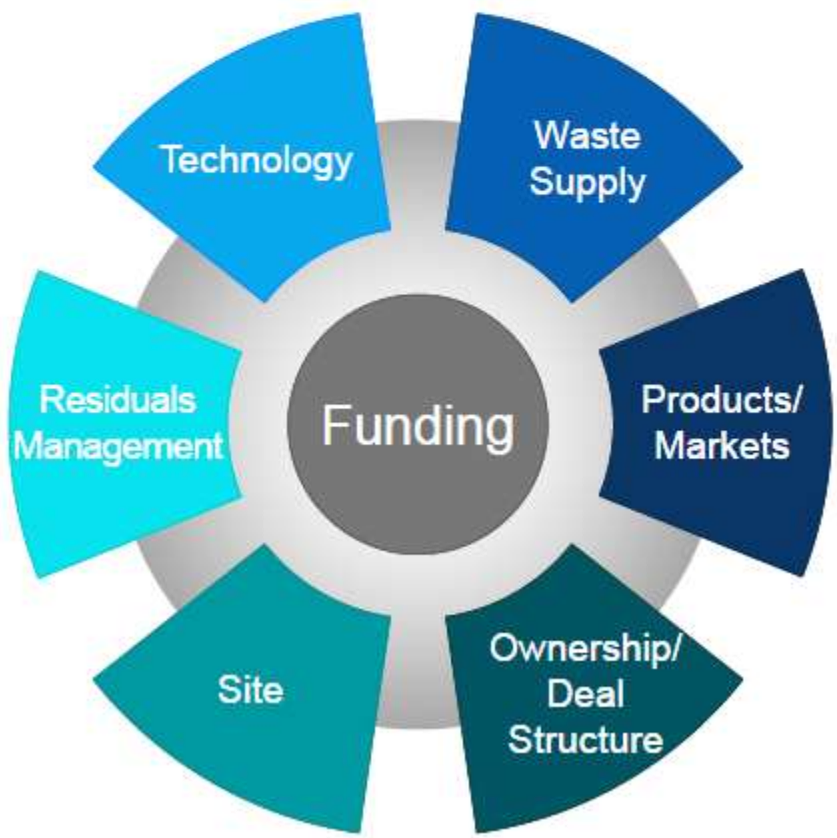
1) The combined drying and pyrolysis process being developed by BioForceTech is potentially applicable to the CRD biosolids feedstock. The BioForceTech process does not address the other feedstock materials the CRD wishes to be managed.
2) The BioForceTech process is in a developmental phase at this time. Further proof of technology is anticipated in the coming years.
3) The form of agreement between the SVCW and BioForceTech apportions the majority of the risk associated with the biosolids to energy technology to BioForceTech.
4) SVCW began working towards alternative disposal options as an active participant in the Bay Area Biosolids to Energy Coalition (BAB2E), a consortium of Bay Area wastewater treatment facilities. Project participants in the BAB2E share their respective progress towards biosolid to energy programs through the coalition which includes various technology assessments and progress on a number of partnerships with various companies to implement solutions (e.g. SVCW with BioForceTech, FSSD with Lystek international). The work of the coalition has advocated for state legislation to support the conversion of biosolids to clean energy and in federal bills to support biosolids to energy technologies to address the funding/financing/revenue gap to develop successful technologies.

6 Summary of Findings

The review of the IRM related documentation prepared to-date in support of this project, and of IRM related case studies arising out of these documents, provides context for the key procurement issues that will need to be addressed as part of the development of the IRM procurement criteria which would be applied through the IRM RFQ and RFP process. The key findings arising from this review and the implications for the development of IRM procurement criteria are discussed below. These findings are organized around key themes that are critical to the success of the IRM procurement process.

The key elements of a successful project are indicated in Figure 4.

Figure 4 Elements of a Successful IRM Project



This summary of findings, as presented below, is intended to:

1. Form the basis for the development of a risk assessment matrix and supporting documentation for an IRM procurement workshop to be held with elected officials later this year. This will serve to clarify the CRD's preferred risk posture related to key project elements which will define the appropriate structure of the business arrangement and clearly define the respective roles of the CRD and the Respondent.

2. Provide the context for key decisions that need to be made to support development of the IRM procurement criteria. Some 'Criteria' reflect fundamental decisions or elements of the project that should be decided upon prior to the procurement process proceeding. They form the framework for the procurement such as identifying the waste supply that is available, the CRD role in providing a site, and the deal structure that the CRD is interested in considering. Certain criteria will reflect mandatory requirements regarding minimum technical, team and financial qualifications, experience and capability, while other criteria will be rated or scored reflecting evaluation of their specific proposal as it relates to financing, design/engineering, construction, operations and maintenance and marketing and deriving value from recovered materials and energy.

Each of the key elements of a successful project in the context of the IRM project, are discussed below.

6.1 Site

Facility siting was noted as a significant risk element in many supporting information reports (e.g. Sidney Master Plan) and in the IRM case studies (e.g. Durham York Energy Centre). Arising from the IRM RFEOI process, the majority of respondents preferred that the CRD provide the site for the IRM facility. In the majority of case studies that were examined, for facilities managing municipally controlled waste, the municipal authority was responsible for facility siting. The facility siting process itself can be complex and controversial. The CRD has attempted to mitigate this by identifying as set out in the IRM RFEOI, that it has space available at Hartland for development of an IRM solution. However, comparison of this space to the site size requirements for many of the IRM options (which vary by technology) indicates that this space may not be sufficient. Certainly, the Hartland site offers conveniences to an IRM solution including proximity to the RTF, potential for shared infrastructure such as access roads, scales etc. and potential access to the electrical and/or gas grid (and potentially opportunities to share some gas infrastructure).

While the CRD has expressed interest in examining the concept of sub-regional IRM solutions, the approach to facility siting for sub-regional facilities has not been identified.

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. If the CRD will retain specific responsibility for identifying and providing a site for an IRM facility, and exactly what its role would be in siting for options that include any sub-regional or multi-facility approaches;
2. If the CRD can provide more area at Hartland for consideration as a location for an IRM facility;
3. If a siting process would be required, would the CRD lead this process and how would it be addressed within the IRM Project Plan and/or the CRD Solid Waste Management Plan process.

6.2 Waste Supply

As indicated in the majority of the case studies discussed in Section 5 of this report, secure waste supply is the key for a financeable and sustainable project. Waste supply is usually secured through two means. For municipal entities that have implemented facilities, waste supply focuses on the materials over which those entities have waste flow control. Some municipalities do compete on the open market, however, generally facility sizing decisions and financing decisions are focused on the material streams for which they have certainty of supply. For the private sector entities that have implemented facilities, the majority of waste supply is secured through long term contracts.

Where there is more than one municipal body (upper and lower tier jurisdictions) or in those areas where multiple jurisdictions have partnered to develop facilities, waste supply has been addressed through long term agreements. This could be an option for the CRD to consider, particularly if the CRD is interested in pursuing any relationships with other jurisdictions to seek an IRM solution.

Currently, as discussed in Section 3 (see Figure 2), the CRD only controls a fraction of the solid waste stream generated in the region. The CRD currently only has assurance that it can make available the RTF Biosolids stream, and a portion of the organics stream (primarily yard waste) that it currently manages. In regards to the MSW stream, while the Hartland landfill currently manages significant IC&I waste streams, and the disposal of residential waste as directed by the area municipalities, this stream is not a guaranteed feedstock for an IRM solution as its availability is governed through competitive pricing and the availability of competitive disposal/processing options.

A number of RFEOI respondents, noted the difficulty in identifying IRM solutions for feedstock that is not wholly controlled by the CRD, and where there is significant potential for the materials to vary in quantity and quality over time (e.g. the CRD MSW stream). The assessment of longer-term solid waste management system impacts and determination of potential shifts in material types and tonnages is an essential component of the IRM Project Plan as is the consideration of waste flow management policy.

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. What specific material streams will the CRD identify and guarantee that it would make available for processing for an IRM solution;
2. Are there any contractual or other relationships that the CRD would want to pursue itself, in order to secure additional material streams?
3. Although not preferred, how much risk for waste supply would be passed onto the respondents to the IRM procurement? Would this focus only on the supplemental materials required by their technology (e.g. wood waste) or would it extend more broadly to any other commercial material streams required to develop a viable IRM solution? What are the implications of this risk on pricing and the future availability of a facility?

Based on the decisions regarding waste supply, this could reduce the range of potential IRM solutions that are viable in the CRD, and allow for greater focus in the IRM procurement process.

6.3 Ownership

The question of facility ownership is central to the decisions made regarding deal structure, financing and allocation of project risk. In the majority of the case studies discussed in Section 5, the municipal authority held ownership of the IRM infrastructure that was developed particularly when the potential technology risk was lower through the application of proven/conventional technologies. There were some examples however, of municipal jurisdictions choosing to allow for private sector ownership of infrastructure (e.g. Walker Industries, Thorold Facility) where competitive pricing and long-term contractual guarantees provided a reasonable solution for the municipality and reduced the need for municipal capital investment.

No specific position on IRM facility ownership has been taken by the CRD Board. Many of the respondents to the IRM RFEOI indicated some preference towards CRD ownership of the facility, although most were flexible in the type of procurement and ownership model that could apply. Decisions regarding ownership are reflected in the form of procurement and contract structure as discussed below, and can affect access to federal or provincial grants that may require either immediate or transfer of ownership of the asset.

As shown in the case studies, there are facilities that are owned by the public sector and there are those that are owned by the private sector. The decision as to the which structure makes the most sense depends on the local circumstances and several key parameters. These include:

1. What do the parties bring to the transaction- i.e. technology, site, waste supply, market contracts, operating capability, and residuals management?
2. What is the historical preference of the public participant?
3. What is the tolerance for risk?

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. What is the preferred ownership arrangement?
2. Are there any circumstances in which the CRD would not want to own the Facility?
3. What is the preferred risk posture?

6.4 Procurement and Contract Structure

The predominant procurement and contract structure utilized in those instances in which the Respondent is providing proprietary technology is some form of DBOM, either a straight DBOM, where the public sector provides the financing, a DBFOM where the Respondent provides the financing, a DBOOM, where the Respondent retains ownership or a DBOOT, where ownership of the Facility is ultimately transferred to the public sector.

Control of the asset beyond the initial contract term is one element of the decision process. In those situations in which the public sponsor provides the site and the procured facility is part of a larger system, there is greater emphasis on retaining access to the asset. That in turn tends to drive in the direction of public ownership. As noted above, decisions regarding ownership are reflected in the form of procurement and contract structure, and can affect access to federal or provincial grants that may require either immediate or transfer of ownership of the asset.

Several of the RFEOI respondents were open to a wide range of business arrangements, ranging from providing the technology to DBFOM.

Prior to proceeding with the IRM procurement process, the CRD should confirm:

1. If preferred business model is some form of public/private partnership with the private sector providing design, construction, and operation and maintenance services for at least a portion of the operations period; and,
2. The recommended procurement approach is an RFQ/RFP structure to procure the selected business model (i.e.), with the RFQ and RFP including technical, financial, and team criteria.

6.5 Financing/Funding

Project financing is directly correlated to commitment of a waste supply over time (i.e.: flow control) enhanced by long term off-take agreements for the process byproducts. As discussed in Waste Supply above for the majority of the case studies discussed in Section 5 of this report, secure waste supply was the key for a financeable and sustainable project. In addition to waste supply the project financing can be enhanced with long term committed off-take agreements for the byproducts of the facility. Financing through local government authorities is usually obtained at a lower rate of interest than private financing, reducing the overall cost of IRM facility development.

Obtaining the required capital to fund the permitting, design and construction of the facilities needed to meet the IRM goals of the CRD is a critical element in the ability to successfully develop an IRM program. Financing approaches in the industry vary. As noted in the various case studies, some projects are financed by the private sector, others are financed by the public sponsor. The RFEOI respondents varied in their preference for which party would provide the financing. One of the factors in considering which approach to take is that private sector financing is generally more costly than public financing.

Financing is tied to ownership and structure of the procurement model/business deal, which in turn is linked to technological risk. As noted in several of the case studies, one of the ways technology risk was addressed was to require the Respondent to provide the financing for the project, with the public sector providing the waste under a long term fee for service.

Another mechanism for mitigating technological risk is to require that the Respondent provide construction financing, with the public sector providing payments either in the form of a large single payment upon successful completion of an acceptance test or via debt service payments over the operating term.

Another important consideration is the financial strength of the Respondent. One of the project elements that providers of capital will review is the financial strength of the Project participants and their ability to backstop their guarantees and performance obligations.

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. Availability of Public Funding. What sources of funds could be used to fund the Project and the attendant security and interest rates anticipated.
2. Preferred Approach. Will the CRD require private financing of the Project, either during the construction period or overall?
3. What specific material streams will the CRD identify and guarantee with long term payment provisions that would make it possible for a private developer to secure project financing.
4. What off-take agreement terms will the CRD entertain.

6.6 Technology Risk

In summary, the IRM process undertaken to-date and discussed in Section 2 and the Case Studies discussed in Section 5 of this report, address a range of thermal, chemical, mechanical and biological processes. These technologies range from conventional processes (combustion, anaerobic digestion, composting, mechanical and biological treatment, RDF production, nutrient recovery) and more emerging technologies from the perspective of managing integrated solid and liquid waste streams (gasification, plasma arc gasification, pyrolysis, hydrolysis, catalytic and thermal depolymerization, waste to fuel).

Technology risks affect:

1. Performance of the facility with respect to the ability of the facility to receive and process the agreed upon quantity of material the large majority of the time. This is often expressed as the percent of operational time over the course of an operating year.
2. Performance of the facility with respect to achieving material and energy recovery rates.
3. Performance of the facility with respect to achieving environmental performance requirements related to emissions (air, water), greenhouse gas emission targets, noise/odour/dust effects on the community etc.

Decisions made on the procurement and contract structure that would be applied by the CRD, are usually coupled to the degree of risk associated with the technologies, although as discussed in the case studies, there are various means of sharing risk through performance guarantees and other contractual mechanisms.

In general, the following trends were clear from the review of the supporting documents and case studies:

1. Less technology risk is associated with conventional technologies, in many cases resulting in decisions by municipal entities to assume more risk related to the project and often less complex DB procurement and contractual structures.
2. More technology risk is associated with less conventional technologies, in many cases resulting in decisions to allocate more risk to the facility developer, including responsibility for long-term facility operations and in many cases for the majority of all areas of responsibility under the contract. Projects offering more technology risk are generally avoided by municipal entities to protect public funds from speculative enterprises.

Technology risks for the IRM would be addressed through the application of criteria in the RFQ process to select qualified respondents, through the various performance guarantees and specifications applied through the IRM RFP, and through the deal and contract structure decided upon by the CRD as discussed below.

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. As discussed above, what specific waste streams will be provided, as this will impact technology options.
2. What degree of technology risk the CRD is willing to accept.
3. What minimum reference project/ team experience will the CRD require.

6.7 Markets

The financial viability of the majority of IRM solutions also reflects the range of potential products that can be recovered (materials, energy) and the market value of those materials. Market value is often driven by factors beyond municipal control, such as the regulatory environment, availability of raw materials and/or other energy sources. It is clear that market conditions in jurisdictions like the EU for example, reflect that a premium is often available for electrical or bio-energy (liquid or solid fuels) that support transition from fossil fuels, and that lack of competing raw material sources (e.g. aggregate) can support marketing of alternative products derived from waste materials.

The responses to the IRM RFEOI indicate that a number of products could be recovered and marketed and/or directed to beneficial use, from the CRD liquid and solid waste streams. The market value of these materials has yet to be determined, and is an important consideration in determining the overall cost of an IRM solution. The viability of technologies that recover energy such as AD or gasification, may be contingent upon identifying a higher value market for that energy such as vehicle fuel. In regards to other products, in some cases more limited markets were identified (e.g. cement kilns as an RDF market) while in others the respondents had identified potential for a broader market (Class A compost).

Respondents to the RFEOI provided varying feedback as to who should be allocated energy/commodity price risk and responsibility for energy offtake agreements.

Prior to proceeding with the IRM procurement process, the CRD should determine:

1. Does it have a preference for how responsibility would be allocated for energy offtake agreements.
2. Does it have a preference as to how responsibility would be allocated for energy/commodity price risk and marketing of recovered products/energy.

Additional research regarding markets and market risks would be appropriate as part of the development of the IRM Project Plan, and will be undertaken to support the risk and procurement workshop in December.

6.8 Residuals Management

Secure, long term availability of residual management capacity is critical to financing the Project. Most of the respondents to the RFEOI indicated that they were looking to CRD to provide this. As noted in the case studies, responsibility for residuals management in most instances rests with the owner.

Prior to proceeding with the IRM procurement process, the CRD should confirm its willingness to provide residuals management capability throughout the proposed term of the agreement or identify the specific anticipated obligations of the private sector to address this critical aspect of the project.

6.9 Alternative Approaches / Concepts

In order to address many of the above elements of a successful IRM project, some jurisdictions have applied alternative approaches / concepts to resolve one or more of these issues. As indicated in Section 5:

1. In some cases a consortium or group was formed with private sector companies and/or municipal entities (e.g. Lahti Energia Kylmaijarvi II, Finland) to pursue a project and reduce the technical risk assumed by the partners in pursuing advanced technologies.
2. There were cases such as with the Kelowna/Vernon biosolids composting facility or the Durham York Energy Centre, where municipalities have partnered to develop a project to address the requirements for feedstock flow control, economies of scale and financial risks.
3. In some cases municipal coalitions / consortiums / agreements have been used to resolve broader IRM issues associated with biosolids and solid waste management such as the BAB2E Coalition in California. The CRD had previously explored the concept of tri-regional energy from waste solutions. It is possible that multi-regional concepts or inter-regional agreements could also play a role in IRM. The complexity of such arrangements can sometimes require significant effort to overcome, however there could be benefits of examining this type of relationship either on the island or with jurisdictions like Metro-Vancouver on the mainland.

At this stage in the process, the CRD should carefully examine the potential viability of difference partnership arrangements, particularly with other regional jurisdictions, to determine if they offer an option to address IRM risks. This is particularly important to address prior to entering into IRM procurement at the RFP stage, as it could significantly alter the scope and contractual arrangements that would apply to IRM facility development.

7 Next Steps

In summary, the elements of a successful IRM project reflect a combination of critical factors, many interrelated, that need to be addressed as part of moving forward with the successful implementation of an IRM system. This summary of findings is intended to provide the context for key decisions that need to be made to support development of the IRM procurement process. It is proposed that these findings would form the basis for the development of risk management matrices that will be presented and discussed at an IRM procurement workshop to be held with elected officials later this year to help address the key decisions that must be made.

Following this workshop, the criteria that would be used for advancing the IRM procurement process will be developed.