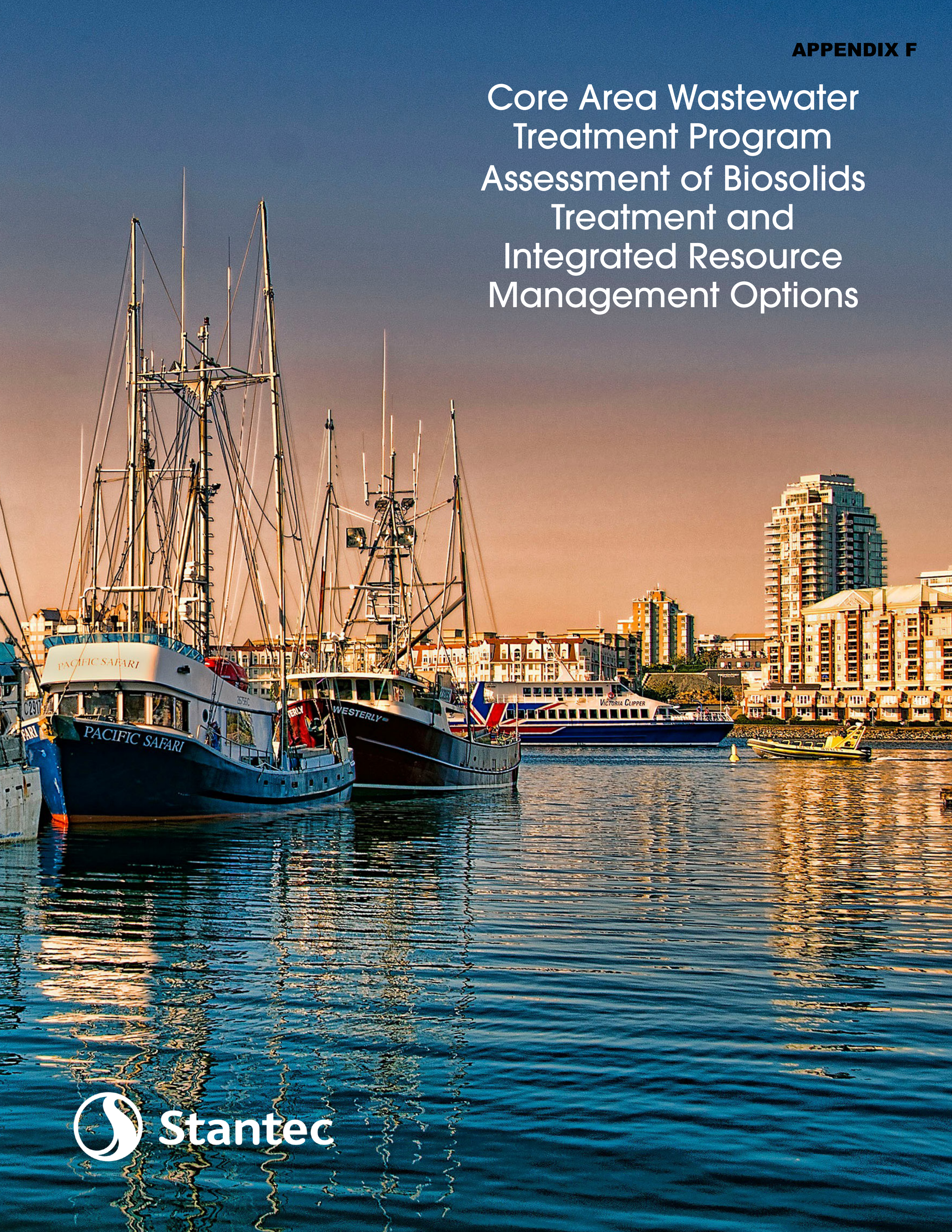
APPENDIX F

Core Area Wastewater Treatment Program Assessment of Biosolids Treatment and Integrated Resource Management Options



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ACKNOWLEDGEMENT

The Project Board, CRD staff and project advisors provided extensive input into the review of this report and the assessment and selection of the preferred biosolids treatment option. A series of workshops were held throughout the project to obtain input to the evaluation and selection of the preferred treatment option. The contributions of the following individuals are greatly appreciated.

- Jane Bird - Chair
- Don Fairbairn - Vice Chair
- Jim Burke - Project Board Member
- Brenda Eaton - Project Board Member
- Colin Smith - Project Board Member
- Dave Howe - Project Board Member
- Robert Lapham - CRD, Chief Administrative Officer, Project Board Member
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EXECUTIVE SUMMARY

This report has been prepared to provide the Core Area Wastewater Treatment Project Board with a summary of information compiled over the last 10 years for the approach to biosolids management for the Core Area Wastewater Program.

This report reviews planning work previously undertaken, outlines the regulatory framework and alternatives for biosolids management and identifies economic, environmental and social factors that support recommendations of the most promising alternative(s) via a triple bottom line analysis. Process technologies are reviewed along with examples from successful programs elsewhere in Canada, the U.S. and Europe. In reviewing the alternatives, flexibility and potential opportunities for phasing of facilities are considered. In addition the opportunities for future integration of biosolids and municipal solid and organic wastes are identified.

In previous work Hartland landfill has been identified as the preferred biosolids treatment site. This site provides significant advantages with respect to Integrated Resource Management ("IRM") opportunities with municipal solid and organic wastes ("MSW"). Developing IRM opportunities is an important CRD objective and is a key consideration common to all biosolids options. Biosolids represent about 10% by weight of the total combined biosolids and MSW streams. The CRD will have to plan their future solid waste/organic waste, and biosolids integration. The choices made for the solid waste will ultimately impact what opportunities are available for full integration with biosolids.

As part of the Core Area Wastewater planning work that has been undertaken over the past 10 years, several options for biosolids management have been reviewed by various consulting teams and advisory groups. The planning work has had a common theme throughout; that being, maintaining the ability to recover resources from the biosolids and having the ability to potentially integrate this waste stream with the management of the CRD's solid and organic wastes.

Residual solids processing reliability is fundamental to successful operation of the liquid train treatment process. Even before developing a robust design, including redundant units to act as standby during required maintenance, the selection of well-proven technologies is required for system reliability for both the biosolids and liquid treatment processes.

This report assumes that viable technologies are those which are well proven in the industry and therefore present little if any risk. As part of this assessment, newer technologies which have been brought forward to the CRD by their developers have been reviewed. Some of these technologies may show promise with further development and may warrant consideration in the future with integrated residual solids and MSW processing facilities. In the meantime the CRD can undertake the necessary planning to determine if these waste streams will be fully integrated.

One of the technologies that has been evaluated is emerging gasification technology. This process is a chemical-physical process in which compounds are broken down to their elements and reformed into combustible syngas compounds including methane, carbon monoxide and hydrogen. The process occurs at high temperatures with very little oxygen present. The operation of a gasifier is more complex than other processes typically found in biosolids processing. Successful use of gasification technologies for biosolids processing is limited at this time. While refinement to the technology continues to occur, there is no facility with a long track record of successful operation on biosolids feedstock only.

The CRD Board has adopted a Regional Biosolids Management Policy banning the land application of treated biosolids to farm land and parks or the production of any products which are ultimately applied to land. The policy does not support transporting biosolids for land application outside the CRD. This policy limits the available options for disposal of biosolids for the CRD. This report therefore concentrates on options which did not include land disposal. In the long term the CRD may wish to revisit this policy as beneficial reuse is currently strongly advocated by the BC Ministry of Environment.

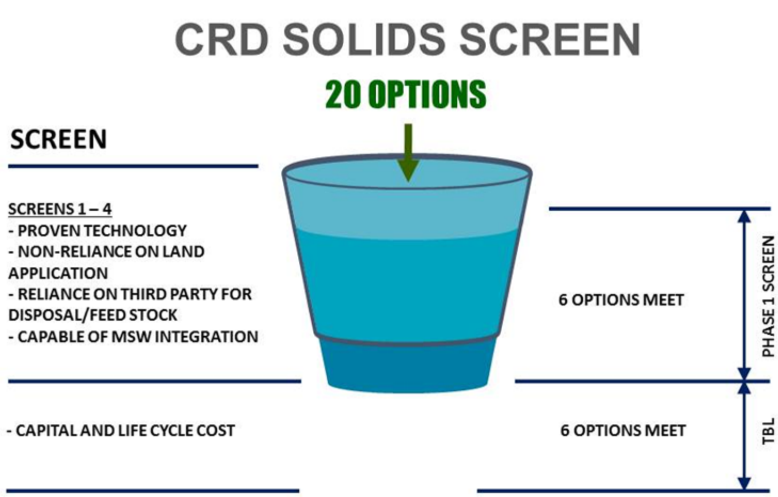
Regulatory requirements exist at the federal and provincial level in British Columbia that address biosolids quality, protect the environment, and regulate the management of wastes that include biosolids. Areas for consideration with respect to biosolids regulations relate to such factors as metal concentrations, pathogen reduction, vector attraction reduction and air quality. In British Columbia, land-based biosolids utilization is governed by the Organic Matter Recycling Regulation (OMRR).

Several engineering firms and expert Peer Review Teams have been involved in assessing biosolids treatment facilities as part of the evaluation of providing treatment facilities for the CRD.

Table 3.1 in the report summarizes the treatment technologies that have been reviewed during the various planning studies. The use of proven technology is necessary to meet the regulatory and reliability requirements of the project.

A common thread amongst many of the processes evaluated is their ability to either provide resource recovery or be part of future IRM opportunities. Many of the options also have the capability for beneficial reuse. With all of the processes that include anaerobic digestion, opportunities exist to generate, capture and utilize biogas. The utilization of biogas can include the production of heat for the overall residual solids treatment process, cogeneration for the production of electricity that can either be used internally or can be sold to the electrical grid, upgrading the biogas so it can be used to power fleet vehicles, and the scrubbing of the biogas to produce a quality suitable for mixing with utility pipeline quality natural gas.

An initial analysis of the option sets produced by the engineering consulting teams was conducted, and a total of 20 options were summarized for evaluation. It was proposed that the 20 options be first evaluated using a high level screening process which did not consider cost or schedule to provide an objective evaluation of all options. The screening approach is shown below.



After the first phase of screening, 14 of the 20 initial options were eliminated as many of the eliminated options rely on land application as the sole means of disposal. The options utilizing gasification were screened out as this technology is not considered proven in the context of using biosolids alone as the feedstock. A sub option of the 6 short listed options , noted as 4a below was added to assess the use of cost effective insulated steel tanks, as used at many European plants for the digestion facilities.

Using the screening protocol described above, a short list of seven options was advanced for further consideration by the Project Board.

The seven options carried forward for costing and triple bottom line analysis were:

1. Anaerobic digestion, biosolids drying (pelletization for multiple uses), struvite recovery and biogas conditioning
2. Anaerobic digestion with biosolids drying
3. Residual solids drying (pelletization)
4. Anaerobic digestion/ biocell reactors (with or without MSW)

4a. Anaerobic digestion (steel tanks) / biocell reactors (with or without MSW)

5 Undigested residual solids biocell reactors (residual solids with or without MSW)

6 Residual solids thermal destruction

Given the current CRD policy on land application, the CRD must have a reliable disposal method for biosolids for the time period until integration with MSW is planned and implemented. Recognizing that full integration planning and public consultation can take some time, a reliable disposable option is required. One potential option is a biocell. A biocell is a closed loop landfill reactor system that is operated in three stages.

A biocell provides multiple advantages over a traditional landfill system. The system enhances anaerobic microbial action, resulting in increased gas capture and power production. Stabilization of waste occurs in a shorter period of time. Also, compost material and other recyclables are recovered during the "mining" stage. Finally, the space and infrastructure within the reactor is reusable. The cells would be mined after five years and products could be incorporated into a beneficial reuse program or used as landfill cover.

The life cycle costs (rounded) for the seven options are summarized below.

Life Cycle Costs

Option	Capital Cost	Annual Operations and Maintenance Cost	Life Cycle Cost
Option 1 –Anaerobic digestion, drying, gas recovery, nutrient recovery (previously funded case)	$ 267,000,000	$ 3,021,000	$ 314,200,000
Option 2 – Anaerobic digestion, drying (with no gas scrubbing for utility sale and no nutrient recovery)	$ 224,000,000	$ 4,060,000	$ 287,200,000

Option	Capital Cost	Annual Operations and Maintenance Cost	Life Cycle Cost
Option 3 – Residual solids drying pelletization	$ 188,252,000	$ 4,405,845	$ 257,080,000
Option 4 – Anaerobic digestion biocell reactors	$ 165,557,000	$ 2,631,000	$ 206,700,000
Option 4a – Anaerobic digester (steel tank) / biocell reactors	$ 143,646,000	$ 2,631,000	$ 184,800,000
Option 5 – Dewatered residual solids / biocell reactors	$ 104,153,000	$ 3,483,000	$ 158,600,000
Option 6 – Residual solids thermal destruction	$ 223,997,000	$ 3,259,030	$ 274,900,000

The seven options were assessed using a triple bottom line (TBL) framework. The TBL considers economic, environmental and social criteria to provide balanced decision making.

Scoring completed indicates the current base case under the funding agreement (Option 1) provides the highest TBL in the absence of economic considerations. Options 4 and 4a anaerobic digestion with disposal to a biocell provided reasonable triple bottom line results and result in significant capital savings. Option 4a involves the use of insulated bolted steel tanks for the digesters and provides a cost effective solution that will produce Class A biosolids with significant flexibility for future end use. Option 4a is the preferred option to carry forward in the business case.

1.0 INTRODUCTION

1.1 Purpose of this Report

This report has been prepared to provide the Core Area Wastewater Treatment Project Board with a summary of information compiled over the last 10 years for the approach to biosolids management for the Core Area Wastewater Program. The report presents work that has been completed by the Capital Regional District (CRD), Core Area Liquid Waste Management Committee, and engineering consultants. A significant amount of work has been completed and is essential to the considerations of the Project Board in their efforts to review, select and ultimately recommend a biosolids management option(s) for the Core Area Wastewater Treatment Program.

1.2 Background

As part of the wastewater treatment and conveyance project for the Capital Regional District (CRD), consideration must also be given to the management of the residual solids that will be produced by whichever liquid treatment process is ultimately selected. The intent of this report is to outline the steps followed in assessing the best option(s) for biosolids treatment, resource recovery, and disposal or re-use. While there are three short-listed liquid treatment options and sites, it is assumed that each of the short-listed options will generate effectively the same biosolids volume, characteristics, and quality. The only difference being that tertiary treatment will produce approximately 10% more residual solids than secondary treatment. Consequently, this report focuses on planning for and recommending biosolids processing and ultimate disposal / re-use, including assessment of resource recovery and integration with municipal solid waste handling that are common to all remaining liquid treatment siting alternatives. In previous work Hartland landfill has been identified as the preferred biosolids treatment site. This site provides significant advantages with respect to Integrated Resource Management ("IRM") opportunities with Municipal solid and organic wastes ("MSW"). Developing IRM opportunities is an important CRD objective and is a key consideration common to all biosolids options.

Biosolids represent about 10% by weight of the total combined biosolids and MSW streams. There are no policies and regulations in place designed to directly support development of IRM options and at this point in time, there are insufficient, long term third party revenues that would justify investing in technology options to integrate treatment of biosolids with MSW streams. In addition, funding has not been made available by senior levels of government for IRM. Consequently, the primary objective is developing a robust and easy to operate biosolids treatment facility options that meet current regulatory requirements and available capital funding, while maximizing the potential for future integration of biosolids and MSW treatment and resource recovery options. Maximizing future integration will require close collaboration with local Municipalities and private sector contractors and the first step will be the development of IRM policies and regulations as well as an overall integration plan. Once effective policies and regulations are in place across the region, it will be easier to assess potential IRM options and the degree to which revenues from the sale of recovered products might fund operating costs and finance related capital investments.

The current funding in place for the Core Area Wastewater Treatment project includes funding from P3 Canada for the biosolids treatment facilities. This funding assumes delivery of the biosolids facilities as a design build operate finance contract. This report assumes a similar delivery model, regardless of the technology ultimately selected.

This report reviews planning work that has already been undertaken, outlines the regulatory framework, and alternatives for biosolids management and identifies economic, environmental and social factors that support recommendations of the most promising alternative(s) via a triple bottom line approach analysis. Process technologies are reviewed along with examples from successful programs elsewhere in Canada, the U.S. and Europe. In reviewing the alternatives, flexibility and potential opportunities for phasing of facilities are considered. In addition the opportunities for integration of biosolids and MSW are identified in this report.

1.3 Previous Biosolids Planning Work

As part of the Core Area Wastewater planning work that has been undertaken over the past 10 years, several options for biosolids management have been reviewed by various consulting teams and advisory groups. The planning work has had a common theme throughout; that being, maintaining the ability to recover resources from the biosolids and having the ability to potentially integrate this waste stream with the management of the CRD's solid and organic wastes.

The most recent planning work has revolved around a biosolids management facility located at the CRD's Hartland Landfill site. The intent with this site is to receive and process pumped residual solids from the liquid treatment plant(s). The residual solids would be thickened and then be made available for additional processing. The facility will be configured to manage the residual solids based on the quantities outlined in **Table 1.1**. These quantities are based on the liquid treatment facility having an average dry weather treatment capacity based on 108 MLD and design wastewater characterization based on analyses at the Clover and Macaulay outfalls.

Table 1.1 – Design Solids Loads for Secondary Treatment

Item	Average (kg/day)	Maximum Month (kg/day)
Primary solids	15,550	16,929
Secondary solids	14,260	15,671
Total raw solids	29,810	32,600
Total raw volatile solids [(1)]	25,070	27,417

1. Volatile fraction of total raw solids

If tertiary treatment is ultimately selected, it is estimated that the additional residual solids production from the tertiary process will be 2,160 kg/d. These additional solids are not significant enough to impact the selection of the ultimate biosolids process.

Once the new secondary liquid waste treatment facilities are commissioned, they will produce significant quantities of residual solids that must be handled on a continuous basis so as to not impact the performance of the liquid waste treatment facilities. Residual solids treatment options must provide reliable performance of both the liquid train and residual solids treatment processes. Any failure of the residual solids process will have significant impacts on the liquid train process.

1.4 Proven Technology Considerations

Residual solids processing reliability is fundamental to successful operation of the liquid train treatment process. Even before developing a robust design, including redundant units to act as standby during required maintenance, the selection of well-proven technologies is required for system reliability.

In undertaking a major wastewater treatment program such as this, the CRD has reviewed many new and emerging technologies. While many of these technologies show promise, they are in the development stage and have no or limited operating history at the scale of facilities required for the CRD. This report assumes that viable technologies are those which are well proven in the industry and therefore present little if any risk. For reference purposes, newer technologies which have been brought forward to the CRD by their developers were reviewed. Some of these technologies may show promise with further development and may warrant consideration in the future with integrated residual solids and MSW processing facilities. The intent is to provide the Project Board with an appreciation for some of the development challenges experienced by developers and users of these newer technologies.

1.5 CRD's Long Term Objective for Integrated Resource Management

The CRD operates the Hartland MSW landfill. There is an opportunity to consider long term integration of residual solids with MSW. There are opportunities for synergies to be realized if the processing and end use of these waste streams are considered together. A goal of the CRD Core Area WWTP project is to optimize the integration of biosolids facilities with the current and future solid waste program. Identification of the potential for integration of the biosolids with MSW is timely because the CRD solid waste management staff has been engaged in feasibility studies that have examined the potential for developing a waste-to-energy facility for management of the residual solid wastes remaining after recycling and separation of organic waste. The MSW will be the governing consideration in developing an integrated approach to management of solid waste and biosolids. The biosolids stream only represents 10% of the waste stream in the CRD so Municipal solid waste processing options will be the primary consideration in development of a future MSW / biosolids integration plan.

1.6 CRD Policy on Land Application of Biosolids

The CRD Board has adopted a Regional Biosolids Management Policy banning the application of treated biosolids to farm land and parks or the production of any products which are ultimately applied to land. The policy does not support transporting biosolids for land application outside the CRD. This policy significantly limits the available options for disposal of biosolids for the CRD. This report therefore concentrates on options which did not include land disposal. Land disposal options have been previously evaluated in the 2009 Biosolids Management Plan, prepared by Stantec / Brown and Caldwell. Future land application options would require a change to CRD policy.

1.7 Definitions and Terminology

Typical definitions and terminology used when discussing biosolids are provided for reference.

Anaerobic Digestion – is a common residual solids treatment process which is used to stabilize residual solids and reduce pathogen levels. The two most common types of anaerobic digestion include mesophilic digestion which operates at 35^{O}C and thermophilic digestion which operates at 55^{O}C. Mesophilic digestion is capable of producing a Class B biosolids while thermophilic digestion can produce a Class A biosolid. Class A and B biosolids are defined in Section 2.2.1 of this report.

Biocell – Biocell is a closed loop anaerobic / aerobic landfill cell in which biosolids and MSW are stored and treated. Resources can be recovered from the biocell including gas and material can be mined following a period of 5 to 7 years for beneficial use.

Biogas – Biogas can be produced from anaerobic digestion or biocells. Biogas can be used for heating digesters and buildings, drying sludge or it can be used to generate electricity in co-generation facilities.

Biosolids – The term biosolids is used to refer to residual solids which have undergone treatment to reduce the pathogens and stabilize the residual solids.

Dewatering – Following digestion solids are dewatered to concentrate solids further to 20 to 30% solids concentration depending on the type of dewatering equipment utilized. The most common types of dewatering equipment in the municipal wastewater industry include belt filter presses, centrifuges and rotary presses.

Drying – Drying is a thermal process which is used to dry digested or undigested residual solids to reduce the volume of material that is handled. Drying can produce a Class A pellet which can be used for fertilizer or fuel feed stock for waste to energy facilities. The residual solids concentration will typically be in the 92-95% range after drying.

Fats, Oils and Grease (FOG) – These products are generated by local industries including restaurants, andare normally recovered from the liquid treatment process. They offer beneficial value in the anaerobic digestion process and increase biogas production.

Municipal Solid Waste (MSW) – MSW is solid waste and refuse that is produced by residents and business operations that is typically disposed of in landfills. This waste includes organic and non-organic wastes. Organic wastes are often incorporated into reuse programs. MSW can serve as a fuel for waste to energy facilities.

Residual Solids – Residual solids are produced as a by-product of liquid treatment. These residual solids include primary solids, secondary solids and tertiary solids that are wasted from the respective processes. These solids are in their raw form and contain pathogens.

Thickening – Residual solids produced by the liquid stream are typically thickened to concentrate solids prior to digestion. Various technologies can be used for thickening including gravity thickeners, gravity belt thickeners and rotation drum thickeners to name a few. This type of process concentrates the solids further to 4 to 6% solids concentration.

Thermal Destruction – Thermal destruction is a thermal process where residual solids are reduced through the process of incineration. For the purposes of this report this process involves the thermal destruction of residual solids following dewatering.

Vector Attraction Reduction – Vectors include animals and birds which have the potential to transmit pathogens from unstabilized residual solids. Treatment processes typically require a volatile solids reduction of at least 38% to reduce the potential for vector attraction.

Waste to Energy Facility – This is a thermal process which is capable of producing electricity for use or sale.

2.0 REGULATORY REQUIREMENTS FOR TREATMENT AND DISPOSAL

Regulatory requirements exist at the federal and provincial level in British Columbia that address biosolids quality, protect the environment, and regulate the management of wastes that include biosolids. Areas for consideration with respect to biosolids regulations relate to such factors as metal concentrations, pathogen reduction, vector attraction reduction, emerging contaminants of concern in biosolids, and air quality.

2.1 Federal Regulations

The Canadian provinces are responsible for regulating biosolids. The only relevant Federal regulation that pertains to biosolids management is related to air quality. This only becomes a factor if the biosolids are used as a feedstock for a waste-to-energy facility, a cement kiln, or some other thermal destruction process, where air quality guidelines are regulated. The *Canadian Environmental Protection Act* (CEPA) presents national standards that apply to all potentially dangerous chemical substances. To comply with CEPA's air emission regulations, three sub-regulations must be met. First, emissions must be monitored on a yearly basis for priority pollutants as outlined in the National Pollutant Release Inventory (NPRI). Secondly, trends in pollutant emissions in Canadian cities must be monitored according to the National Ambient Air Quality Objectives (NAAQOs). Thirdly, the *Management of Toxic Substances Act* requires monitoring of polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans), mercury, and chlorobenzenes. In addition to monitoring emissions, the Canadian government committed to reducing the emissions of particulate matter and ozone by 2010.

The Canadian Council of Ministers of the Environment has produced a policy document titled *Canada Wide Approach for the Management of Wastewater Biosolids*, *October 2012.* This document outlines supporting principles for the beneficial reuse of biosolids. Beneficial use includes the production of energy, compost and soil products preparation, land application and land reclamation.

2.2 Provincial Regulations

There are several overlapping regulations that relate to the management of biosolids in British Columbia. The relevance of each is dictated by the means of disposal / reuse that will be utilized.

2.2.1 Organic Matter Recycling Regulation (OMRR)

In British Columbia, land-based biosolids utilization is governed by the Organic Matter Recycling Regulation (OMRR). This is perhaps the most relevant and applicable of the regulations and guidelines that apply to biosolids management in British Columbia. The OMRR was established in 2002 under the authority of the *Waste Management Act* and the *Health Act* and was revised in June 2016. The regulation governs the production, distribution, storage, sale, and use of biosolids and compost.

The regulations provide for two classes of biosolids, Classes A and B, whose characteristics are summarized in **Table 2.1**. Class A biosolids are processed to a higher degree than Class B biosolids, thus having a much lower pathogen concentration in the finished product and much less restrictive handling and land application requirements. The primary objective of biosolids treatment is to reduce the quantity of solids and pathogen levels so that treated solids can be handled safely and disposed of in a manner to minimize impacts to the environment.

Table 2.1 – OMRR Biosolids Classification Requirements

Characteristic	Class A Biosolids	Class B Biosolids
Pathogen reduction requirements	< 1,000 MPN/g (dry solids basis) to be produced by one of the pathogen reduction processes listed below	< 2,000,000 MPN/g (dry solids basis) or one of the pathogen reduction processes listed below
Acceptable processes for pathogen reduction	Thermophilic aerobic digestion at ≥ 55ºC for at least 30 min	Aerobic digestion with mean cell retention time between 40 days at 20ºC and 60 days at 15ºC
	Thermophilic anaerobic digestion at ≥50ºC for at least 10 days	Anaerobic digestion with a mean cell retention time between 15 days at 35ºC and 60 days at 20ºC
	Exposure to time-temperature processing requirements according to arithmetical formulae given in the regulation depending on the TS concentration of the biosolids	Air drying for > 3 months, during which the ambient temperature must be > 0ºC for at least 2 months
	Alkaline stabilization by maintaining the pH within the biosolids > 12 for 72 hours during which T > 52ºC for 12 hours, followed by air drying to > 50% TS concentration	Lime stabilization such that the pH of the biosolids is raised to ≥ 12 after 2 hours of contact
Vector attraction reduction requirements	Aerobic or anaerobic digestion resulting in > 38% destruction of volatile solids mass or another acceptable criterion specified in the Regulation	Aerobic or anaerobic digestion resulting in > 38% destruction of volatile solids mass or another acceptable criterion specified in the Regulation

The OMRR also specifies requirements for Classes A and B compost as well as the maximum allowable metal concentrations in biosolids, compost, and soils following land application. The regulation does not mention disposal of raw biosolids or compounds of emerging concern.

A summary of the quality and sampling requirements for OMRR residuals and products is provided in **Table 2.2**.

Table 2.2 – Quality and Sampling Requirements for OMRR Residuals and Products

Quality Criteria	Class A Biosolids	Class A Compost	Class B Biosolids	Biosolids Growing Medium
Parameters	Trade Memorandum T-4-93[1]	OMMR Schedule 4	OMMR Schedule 4	OMMR Schedule 4 and 11
Trace elements (μg g^{-1})				
Arsenic	75	13	75	13
Cadmium	20	3	20	1.5
Chromium	Not required	100	1,060	100
Cobalt	150	34	150	34
Copper	Not required	400	2,200	150
Lead	500	150	500	150
Mercury	5	2	15	0.8
Molybdenum	20	5	20	5
Nickel	180	62	180	62
Selenium	14	2	14	2
Zinc	1,850	500	1,850	150
Fecal coliform (MPN g^{-1}dw)	< 1,000	< 1,000	< 2,000,000	Not required
Foreign matter (%)	< 1 dw, no sharp foreign matter that can cause injury			
(%, dw)	Not required	Not required	Not required	< 0.6
C:N	Not required	≥ 15:1& ≤ 35:1	Not required	> 15:1
Organic matter (%, dw)	Not required	Not required	Not required	≤ 15
Sampling plan	Systematic, simple or stratified random	Systematic, simple or stratified random	Systematic, simple or stratified random	Simple random
Type of sample	Composite	Composite	Composite, 7 discrete samples for fecal coliform	Composite
Number of samples (minimum)	3 (each composed of 7 subsamples)	3 (each composed of 7 subsamples)	3 (each composed of 7 subsamples)	3 (each composed of 7 subsamples)

Direct application of Class A biosolids can occur for volumes less than 5 m^3 per parcel of land per year. For amounts greater than 5 m^3, a land application plan must be completed prior to application. The land application plan must include the following:

[1] Standards for Metals in Fertilizers and Supplements, as amended from time to time, as adopted by Agriculture and Agri-Food Canada under the *Fertilizers Act* (Canada) and regulations.

- The location of the application site and written authorization from the registered owner;
- A description of the biosolids to be applied including physical characteristics, nutrient, fecal coliform, and trace element concentrations;
- Storage and leachate management requirements at the application site;
- The intended date application will commence and the application rate;
- The projected trace element concentrations in the soil after application;
- A post-application monitoring plan if the application rate exceeds annual crop; and
- Nutrient requirements.

However, OMRR-compliant biosolids growing medium (BGM) can be distributed with no volume restriction. Sampling of the BGM is required to determine compliance with the OMRR. Sampling and analysis must be completed at least every 1,000 dry tonnes (DT) of BGM or once per year, whichever occurs first.

2.2.2 Municipal Wastewater Regulation

The MWR does not specifically address biosolids management, with the exception of a treatment facility's reliability requirements (installed redundancy). In this case, the MWR specifies the number of units that are required for anaerobic and aerobic digesters only. For all reliability categories, a minimum of two anaerobic digesters are required to meet the redundancy requirements. Should the CRD implement technologies other than digestion, good practice would be to have redundancy to ensure the biosolids processing facilities to operate with a high degree of reliability receive solids from the liquid train on a continuous basis.

2.2.3 Liquid Waste Management Plan

The CRD's liquid waste management plan encourages the beneficial use of biosolids and recovery of resources. Biosolids treatment options for the CRD biosolids should consider these opportunities where practical and cost effective. LWMP amendment No. 8 identified Hartland landfill as the preferred site for biosolids treatment and processing.

3.0 BIOSOLIDS TREATMENT TECHNOLOGY OPTIONS

Several engineering firms have been involved in assessing biosolids treatment facilities as part of the evaluation of providing secondary or tertiary treatment facilities for the CRD. The availability of sites large enough for the liquid and/or biosolids treatment facilities has been the most challenging issue facing the CRD. Due to the lack of available sites large enough to site both liquid and biosolids treatment, the biosolids treatment has been decoupled from the liquid treatment and is assumed to occupy its own site at Hartland landfill. This site, although remote from the liquid treatment, is an ideal site for the future integration with MSW.

The engineering firms involved in the review of appropriate treatment technology are summarized as follows and the text below highlights the solids treatment technology that has been examined:

- Urban Systems/Carollo Engineers - (2014 to 2016)
- Stantec Consulting - (2009-2014)
- Peer Review Team – (2009-2010)
- CH2M Hill/Associated Engineering/Kerr Wood Leidel (KWL) – (2006-2009)

Urban Systems/Carollo Work Summary (2014-2016)

The most recent planning on conceptual treatment options has been completed by Urban Systems and Carollo Engineers. The solids treatment options shortlisted by Urban Systems/Carollo included aerobic digestion and dewatering, anaerobic digestion and dewatering, and drying and gasification. They reviewed the feasibility of siting these technologies at both the Rock Bay and Hartland sites.

Stantec Consulting Work Summary (2009-2015)

In 2009, Stantec were retained to provide Program Management and Technical Planning services for the Core Area Wastewater Treatment Program. Stantec refined the previous planning studies provided by CH_2M Hill/Associated Engineering/Kerr Wood Leidel (KWL) and evaluated a long list of solids treatment technology options. Stantec also prepared a comprehensive Biosolids Management Plan in 2009 which included assessment of emerging technologies including gasification, biofuel and integration with MSW.

Peer Review Team (2009-2010)

The Peer Review Team indicated that “anaerobic digestion is an appropriate choice for sludge processing as it is an efficient way to produce energy from wet sludge, to reduce solids mass, and to provide pathogen destruction.”

CH2M Hill/Associated/KWL Work Summary (2006-2009)

A comprehensive review of solids treatment options was also undertaken by the CH_2M Hill/ Associated/KWL team from 2006 -2009. They produced a long list of options ranging from willow coppice land application to thermophilic digestion technologies.

The technologies reviewed by both the Urban / Carollo, Stantec and CH_2M Hill/Associated/KWL teams are presented in the following section.

3.1 Long List of Technologies Reviewed to Date

Table 3.1 summarizes the treatment technologies that have been reviewed during the various planning studies including an opinion judgement on the suitability of the solids treatment technology for the CRD project. The use of proven technology is necessary to meet the regulatory and reliability requirements of the project. The suitability is mainly driven by end use of the finished biosolids and the requirement to implement a proven technology.

Table 3.1 – Summary of Solids Treatment Technologies

Technology	Implementation Considerations	Consider for CRD
Anaerobic Digestion (Thermophilic)	Commonly used stabilization process in North American treatment facilities to produce a Class A biosolid.	✓
Anaerobic Digestion (Mesophilic)	Most commonly used stabilization process in North American treatment facilities and is capable of producing a Class B biosolid.	✓
Landfill Biocell Reactors (with or without MSW using digested or undigested sludge)	Approach is not regulated under OMRR, and would require permitting. Requires large land area.	✓
In-Vessel Composting (Residual or Digested Solids)	Less commonly used for larger facilities and requires significant movement of materials. Would require landfilling due to CRD policy.	✓
Residual Solids Drying (Pelletization)	Creates end product that can be utilized in combustion or gasification processes.	✓
Residual Solids Drying (Fuel for Cement Kiln or Wood Drying Kiln)	Long term viability is subject to long run viability of end user’s business.	✓
Digester Gas Utilization (Onsite Co-generation)	Becoming a commonly used approach for facilities with digestion.	✓
Land Application or Mine Reclamation of Stabilized and Dewatered Biosolids	Approach used by Metro Vancouver, but long term viability may be limited due to site availability and hauling costs off-Island.	✓
Biosolids Vitrification	Embryonic technology that is not proven on larger scale applications. Option eliminated for consideration.	✗
Anaerobic Digestion (Thermophilic) - Soil Amendment	Challenge to find end user and goes against current CRD policy. Option eliminated for consideration.	✗
Residual solids WTE Incineration (Fluidized Bed or Mass Burn)	Effectively eliminates end product requiring disposal, but permitting may be onerous and require schedule extension beyond 2020.	✓

Table 3.1 – Summary of Solids Treatment Technologies (cont'd)

Technology	Implementation Considerations	Consider for CRD
Residual solids WTE Gasification (Synthetic Fuel Production)	Novel technology that is not proven on residual solids-only applications. Option eliminated for consideration.	✘
Residual solids Integration with MSW or Wood Waste WTE (Gasification)	Better use of the application relative to residual solids-only feed stock. There is also a concern of the long term availability and cost of the feed stock if wood waste is utilized.	✓
Augmentation of Digester Input with Fat, Oil, Grease (FOG) and Source Separated Organics (SSO)	For enhanced biogas production, this is becoming a more commonly used approach at facilities with existing or planned digesters.	✓
Pre-processing for Optimizing Anaerobic Digestion (Thermal Hydrolysis Process)	Typically used for facilities where available footprint is an issue. Technology adds a more complicated process to the overall solids management train. Footprint is not an issue at Hartland. Option eliminated for consideration.	✘
Land Application of Stabilized Biosolids – Willow Coppice (High Rate Wood Fuel Biomass Production)	Approach has had limited use and is subject to land availability and possible third party service provider. It also goes against current CRD policy. Option eliminated for consideration.	✘
Lime Stabilization - In Vessel Process	Process familiar to the CRD, but creates additional waste material that must be disposed of/utilized. Can produce Class A biosolids.	✓
Co-Composting Residual solids with Yard Waste and/or SSOs	Less commonly used for larger facilities and requires significant movement of materials	✓
Resource Recovery from Biosolids - Biomethane Optimization (Fleet Vehicles)	This approach is not commonly used for municipalities that have facilities with existing or planned digesters. It is often ruled out based on a business case evaluation and requirement to convert vehicles to biogas operation. Natural gas prices have been low for a number of years.	✓
Clean up Biogas and Feed to Gas Utility	This approach is not commonly used for municipalities that have facilities with existing or planned digesters. It offers a significant carbon offset but is often ruled out based on the significant investment required for cleaning up the biogas to a standard that is acceptable by the gas utility. Natural gas prices have been low and a forecast to be low for a number of years so it is difficult to justify from a business case perspective.	✓
Geotube Dewatering and Storage	This technology works well for partially stabilized residual solids from lagoons, but would not be very practical for a facility of this size or for the use of residual solids. Difficult operationally. Option eliminated for consideration.	✘

3.2 Technology Carried in Current Funding Agreement and Procurement Approach

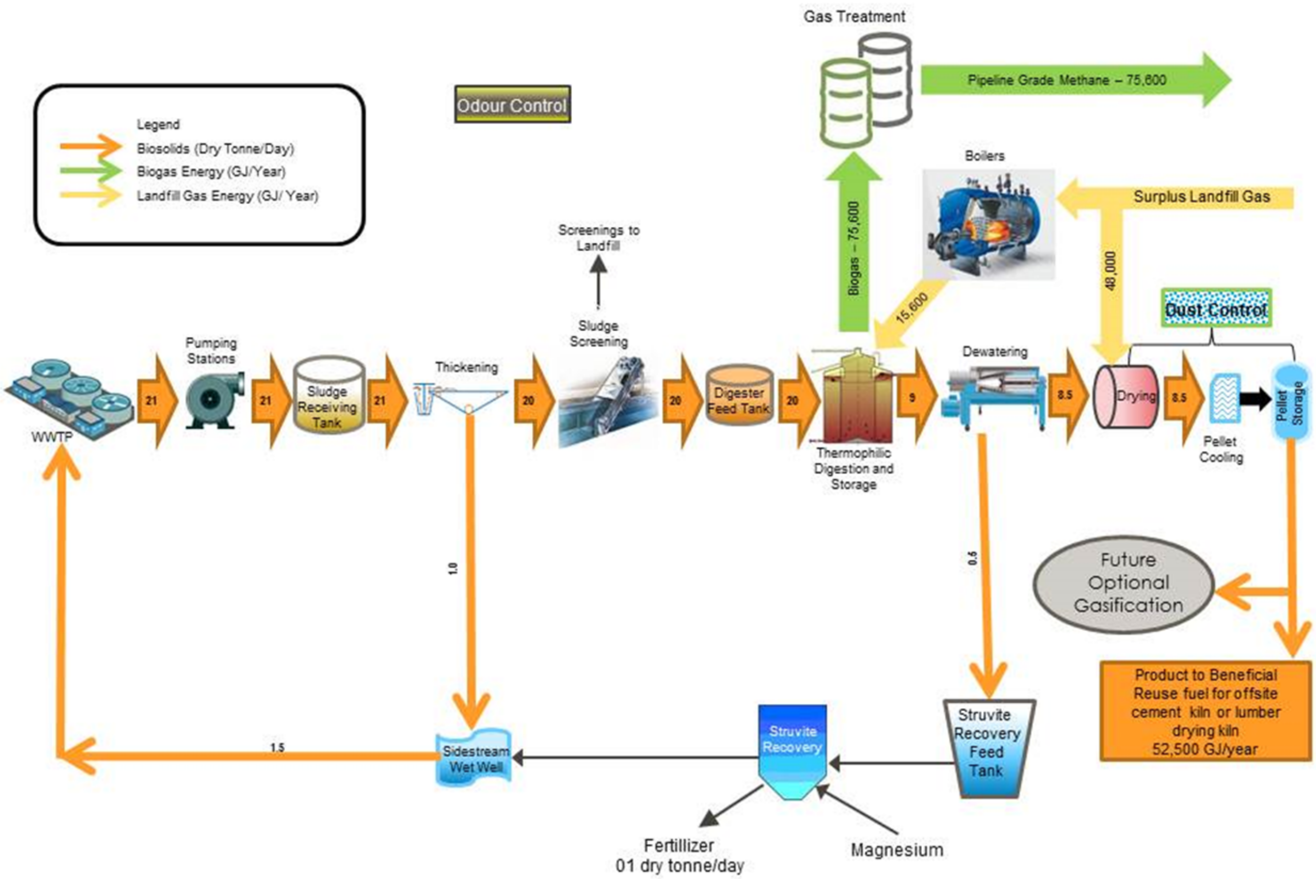
As part of the indicative design undertaken for the procurement phase of the Core Area WWTP, a potential approach for solids management was developed. This approach involved the following components:

- Pumping of residual solids (0.5 to 1% total solids) to the Hartland site
- Thickening of residual solids (4 to 5% total solids)
- Thermophilic anaerobic digestion of residual solids to produce Class A biosolids
- Dewatering of biosolids (25 to 30% total solids)
- Drying of dewatered biosolids (85 to 90% total solids)
- Pelletization of dried biosolids
- Hauling of pelletized product off-site for use as a fuel by a third party
- Ancillary processes – struvite recovery, biogas scrubbing

The technology approach is illustrated in **Figure 3.1**.

The procurement approach carried in the CRD Business Plan and funding applications has used Design-Build Finance Operate Maintain procurement. This is the same procurement model as was previously considered for the Seaterra Program. The term for this type of procurement would be at least 20 years to secure interest in the project from the private sector. A detailed procurement analysis was previously completed by Ernst and Young (2012) to select the appropriate project delivery method.

Figure 3.1 – Funded Solids Management Approach



This approach was developed to provide for future flexibility with regards to the utilization of the dried pellets produced by the process. The base case relied upon the pellets being hauled offsite for use as a fuel at either a cement kiln or other thermal process. In the future, if gasification processes are proven to be more reliable, the pellets could be utilized as a feedstock for a biosolids-only or a mixed biosolids/MSW feedstock to a gasification unit. This option does place reliance on a third party to accept the dried pellets until such time that other means of disposal are available that are under the control of the CRD.

3.3 Considerations of Technology Selection for IRM

A common thread amongst many of the processes outlined in **Table 3.1** is their ability to either provide resource recovery or be part of IRM opportunities. Many of the options also have the capability for beneficial reuse. With all of the processes that include anaerobic digestion, opportunities exist to generate, capture and utilize biogas. The utilization of biogas can include the production of heat for the overall residual solids treatment process including fuel to fire boilers, cogeneration for the production of electricity that can either be used internally for the biosolids management process or can be sold to the electrical grid, upgrading the biogas so it can be used to power fleet vehicles, and the scrubbing of the biogas to produce a quality suitable for mixing with utility pipeline quality natural gas.

Composting, anaerobic digestion and lime stabilization all produce an end product that can be used as a resource for the production of growing media, landfill cover, and media for mine and forest land reclamation. Current CRD policy however precludes the consideration of any of these land application options. Biosolids that are dried and made into pellets can also be used as a fuel that can be utilized in kilns, incinerators or gasifiers. Dried biosolids can also be used as a fertilizer supplement.

The biggest opportunity for IRM at the CRD exists with the potential integration of the various waste streams that may be available at the Hartland landfill. The Hartland site provides an excellent opportunity and location for such a facility. IRM can include any process which can combine municipal solid waste (MSW), fats/oils/grease (FOG) or source separated organics (SSOs) with the biosolids as a process feedstock. These combined streams could be incorporated into anaerobic co-digestion, co-composting, waste to energy (WTE), or gasification processes. Most of these processes will benefit from the added waste stream into the process feedstock, but each can also provide processing challenges and operating and commercial revenue risks.

3.4 Emerging Gasification Technology

Gasification is a chemical-physical process in which compounds are broken down to their elements and reformed into combustible syngas compounds including methane, carbon monoxide and hydrogen. The process occurs at high temperatures with very little oxygen present. This limits combustion of the feedstock material (in this case biosolids). The forming of the syngas occurs between 850^{o}C to 1,200^{o}C. The operation of a gasifier is more complex than other processes typically found in biosolids processing.

Gasification is widely used for processing dry high energy wastes into syngas. There have been several attempts at utilizing this technology to process biosolids in both short term pilot programs and full scale operations. In the full scale operations there have been very few successes and most have been with additional feedstocks. **Table 3.2** below summarizes some of the full scale operations:

Table 3.2 – Summary of Full Scale Biosolids Gasification Facilities

Project Owner	Location	Gasifier Type	Capacity (Maximum)	Operations Status
Full-Scale Installations				
EcoTech Gasification (private developer)	Philadelphia, PA	Downdraft Fixed Bed (Primenergy)	Approximately 1.8 dry tonnes/hr	Started June 2005, currently not operating vendor no longer in business
MaxWest Environmental Systems, Inc.	Sanford, FL	Originally Updraft Fixed Bed, converted to fluidized bed in 2012	0.6 dry tonnes/hr	Fall 2009 began operations currently not operating vendor no longer in business
MaxWest Environmental Systems, Inc.	Plymouth, ME	Fluidized Bed	1.3 dry tonnes/hr	Project dropped vendor no longer in business
Kopf (demonstration facility)[3]	Balingen, Germany	Bubbling fluidized bed	0.11 dry tonnes/hr Upgraded to 0.22 dry tonnes/hr in 2010	Started 2002, rebuilt in 2010, still in operation
Kopf (commercial installation)[2]	Mannheim , Germany	Bubbling fluidized bed	0.57 dry tonnes/hr to be expanded to 1.14 in the future	Began commissioning phase in 2010
Tokyo Bureau of Sewerage	Kiyose, Japan	Circulating Fluidized Bed	Approximately 0.75 dry tonnes/hr	Started in July 2010, presumed to still be in operation
PHG Energy	Covington, Tennessee	Updraft Fixed bed	10 tons/day wood waste 2 tons/day biosolids	Under construction

It is worth noting that the Tokyo system is used to reduce gas usage and greenhouse gas emissions from their incinerator. The Kopf plant is less than half the size of that required for CRD. The MaxWest Sanford facility used biosolids as a feedstock and was shut down because the vendor is no longer in business because the operation was not financially viable.

All of the installations listed above require the biosolids to be dried to about 90% solids prior to gasification. Therefore a dewatering process and a dryer must be upstream of gasification process. In the MaxWest system the syngas was burned directly and the heat generated was used in the dryer. There was no electricity production and the system acted as a closed loop disposal operation. In the Kopf facilities the drying is done separately and is outside the energy balance of the system. Thus the gas produced can be cleaned and burned in a generator to create electricity. This would not be the case for the CRD.

There is a low temperature aqueous gasification process marketed by Genifuels that can gasify dewatered biosolids in a two stage process. In the first stage a biocrude liquid is produced that can be refined to a fuel. In the second stage syngas is created with the aid of a catalyst. This technology is only in the pilot stage. Metro Vancouver's Annacis Island Wastewater Treatment Plant will be piloting the first stage only of this process in the near future. They felt the first stage produced most of the energy value of the system.

Pyrolysis is the first stage of the gasification process and occurs at around 700^oC. In pyrolysis the compounds are broken down but not reformed. Some syngas is released through volatilization of combustible compounds in the feedstock. The end product of the system is a char that is easily dewatered. If the char is dry it can be burned to produce heat that can be used in the drying process and potentially to produce energy. There has only been one large scale pyrolysis facility treating biosolids. A 300 to 600 ton per day facility utilizing the Enertech pyrolysis process was constructed to operate commercially in Rialto, California. The facility processed dewatered biosolids to produce liquid char slurry that was dewatered and dried to be used as a fuel in cement kilns. The facility went out of business and is now closed with no plans to restart operations.

Thames water is in the process of building a pilot unit for a different pyrolysis process marketed by Aqology. The system processes biosolids that have been dried and produces char that is burned to produce heat for the dryer and potentially to produce energy as well. The pilot is expected to be operational in 2017.

CRD has expressed interest in potentially gasifying MSW with biosolids as part of an integrated waste management plan. This would be an issue for the gasifiers utilized for biosolids so far due to the heterogeneous nature of the character of Municipal Solid Waste (MSW). Different materials have different ash melting temperatures. The ash melting temperature is the point at which slag is generated. Slag in the gasifiers used to date for biosolids interferes with the gasifier operation and must be cleaned out. However, gasifiers utilizing plasma torches to generate heat have been developed to gasify MSW. In England the Tees Valley gasification facility was under construction to gasify MSW using plasma gasifiers. The facility was to consist of two gasifiers. The first gasifier was completed and operations begun with it while the second and third gasifiers were constructed. However, the first unit was not successful and before completion of the second gasifier and investing close to a billion dollars the developer of the project abandoned the facility.

Successful use of gasification technologies for biosolids processing is limited at this time. While refinement to the technology continues to occur, there is no facility successfully operating that includes under its energy balance all of processes that the CRD would need to incorporate in a full scale facility. There are also issues related to emissions from gasifiers. Testing of air emission at the MaxWest facility demonstrated that facilities similar in size to that required by the CRD would potentially need to scrub the emissions for NOx and HCI removal. The performance of gasification on biosolids applications has met with mixed results and many of the facilities have had operational difficulties and have been shut down. At this time we would recommend CRD not consider gasification as there is no long term proven track record for the technology at the scale required for the solids processing facility. Other options such as thermal destruction (incineration) have a longer term operations track record and better reliability. These systems also have a better track record on combined MSW and biosolids.

If and when the technology performance and reliability improves in the future as a result of further technology refinement and longer term proven operating experience, the CRD could consider gasification as an add-on process for biosolids and MSW.

4.0 BIOSOLIDS OPTIONS ANALYSIS AND DISCUSSION

4.1 Biosolids Options Screening Approach

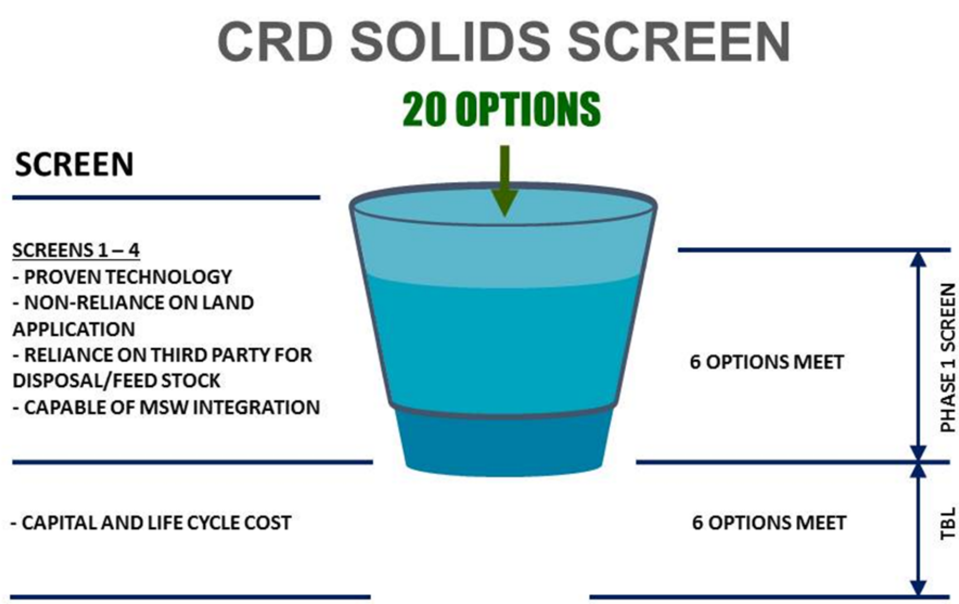
An initial analysis of the option sets produced by the engineering consulting teams noted in Section 3.0 was conducted, and a total of 20 options were summarized for evaluation. The screening process included input from a diverse team of discipline specialists with backgrounds in biosolids treatment, operations, construction, legal, business and financial analysis. The 20 options were first evaluated using a high level screening process which did not consider cost or schedule to provide an objective evaluation of all options.

All options were screened in consideration of the following factors:

1. **Proven Technology** – the proposed technology must have a track record of reliable operation for several years to a scale similar to CRD;
2. **Land Application** - technology that does not rely on land application as the sole means of final disposal to be in accordance with the CRD's policy on land application;
3. **Feed Stock or Disposal** – technology that does not rely on third parties to provide co-processing feedstock or means of final product disposal/re-use; and
4. **Integration with MSW** – ability of the technology to be integrated with future IRM strategy incorporating municipal solid waste in a co-processing facility.

This screening approach is illustrated in **Figure 4.1**.

Figure 4.1 – Screening Approach



The technology options evaluated using the first phase of screening were:

No.	Option	Pass / Fail
1	Anaerobic digestion and biosolids drying (pelletization for multiple uses, struvite recovery, biogas conditioning)	Pass
2	Anaerobic digestion / biosolids drying(scaled back version of funded biosolids management approach)	Pass
3	Residual solids drying (pelletization)	Pass
4	Anaerobic digested biosolids (with or without MSW) / biocell reactors	Pass
5	Undigested residual solids with or without MSW) / biocell reactors	Pass
6	Residual solids thermal destruction	Pass
7	In-vessel composting (residual solids or biosolids)	Fail
8	Anaerobic digestion and biosolids drying (fuel for cement kiln or wood drying kiln)	Fail
9	Residual solids drying (fuel for cement kiln or wood drying kiln)	Fail
10	Land application or mine reclamation of stabilized and dewatered biosolids	Fail
11	Biosolids vitrification	Fail
12	Anaerobic digestion (thermophilic) - soil amendment	Fail
13	Residual solids integration with MSW WTE incineration (fluidized bed or mass burn)	Fail
14	Residual solids WTE gasification (synthetic fuel production)	Fail
15	Residual solid integration with MSW (gasification)	Fail
16	Residual solids integration with wood waste WTE (gasification)	Fail
17	Land application of biosolids – Willow Coppice (high rate wood fuel biomass production)	Fail
18	Lime stabilization – in-vessel process	Fail
19	Co-composting residual solids with yard waste and/or SSOs	Fail
20	Geotube dewatering and storage	Fail

After the first phase of screening, 14 of the 20 initial options were eliminated (options shaded as white in **Table 4.1)**. The six remaining options (shaded in green) and one sub-option of one of the short-listed options were advanced for costing and TBL evaluation. This was to be expected, as the majority of the eliminated options rely on land application as the sole means of disposal. The options utilizing gasification were screened out as this technology is not considered proven in the context of using biosolids alone. While it is recognized that the technology has potential, we would not recommend that the CRD consider gasification as the only means of managing biosolids as there is no long term proven operating record for the technology at the scale required for this facility. If and when the technology performance and reliability improves as a result of further technology refinement and longer term operating experience, the CRD could consider gasification as an add-on process. The CRD could also consider thermal processing technologies such as WTE as part of an integrated MSW / biosolids solution. As noted below, potential for future use of this and other technologies to facilitate IRM was an important consideration of the Project Board in its final assessment of the options.

Future changes in beneficial reuse policy by the CRD would enable options where beneficial products are produced to be reconsidered in the future.

Table 4.1 – Summary of 20 Options Considered for Initial Screening - Residual Solids Management

Option #	Option Description	Screen 1 Proven Technology	Screen 2 Land Application	Screen 3 Feed Stock / Disposal Availability	Screen 4 Integration with MSW	Comment
1	Anaerobic digestion and biosolids drying (pelletization for multiple uses), struvite recovery and biogas conditioning	Pass	Pass	Pass	Pass	Technology currently carried in funding agreements.
2	Anaerobic digestion and biosolids drying	Pass	Pass	Pass	Pass	This is a modified version of the technology carried in the funding agreements.
3	Residual solids drying (pelletization)	Pass	Pass	Pass	Pass	Can produce a Class A biosolid but requires significant gas for drying
4	Anaerobic digested biosolids (with or without MSW) / biocell reactors	Pass	Pass	Pass	Pass	This option will use up landfill capacity unless policy for land application changes in future.
5	Undigested residual solids (with or without MSW) / biocell reactors	Pass	Pass	Pass	Pass	Passes all 4 screens, but permitting may be a challenge for a longer term solution.
6	Residual solids thermal destruction	Pass	Pass	Pass	Pass	Biosolids incinerated to produce minor amounts of energy.
7	In-vessel composting (residual solids or biosolids)	Pass	Fail	Fail	Fail	Option eliminated because it requires external feedstock
8	Anaerobic digestion and biosolids drying (fuel for cement kiln or wood drying kiln)	Pass	Pass	Fail	Fail	Concern with reliance on third parties that may not be viable over the longer term.
9	Residual solids drying (fuel for cement kiln or wood drying kiln)	Pass	Pass	Fail	Pass	Concern with reliance on third parties that may not be viable over the longer term.
10	Land application or mine reclamation of dewatered biosolids	Pass	Fail	Pass	Fail	Does not meet CRD policy for no land application

Table 4.1 – Summary of 20 Options Considered for Initial Screening - Residual Solids Management (cont'd)

Option #	Option Description	Screen 1 Proven Technology	Screen 2 Land Application	Screen 3 Feed Stock / Disposal Availability	Screen 4 Integration with MSW	Comment
11	Biosolids vitrification	Fail	Pass	Pass	Fail	Process has not been proven for larger scale facilities.
12	Anaerobic digestion (thermophilic) - soil amendment	Pass	Fail	Pass	Pass	Does not meet CRD policy for no land application
13	Residual solids WTE incineration (fluidized bed or mass burn)	Pass	Pass	Pass	Fail	Does not meet MSW integration requirements
14	Residual solids WTE gasification (synthetic fuel production)	Fail	Pass	Pass	Fail	Current state of gasification process technology is unproven using residual solids as a single source of fuel.
15	Residual solids integration with MSW (gasification)	Fail	Pass	Pass	Pass	Experience with integration of residual solids and MSW in gasifier is limited.
16	Residual solids integration with wood waste WTE (gasification)	Fail	Pass	Fail	Fail	Reliance on external source of wood beyond control of CRD with uncertain pricing and availability.
17	Land application of biosolids – Willow Coppice (high rate wood fuel biomass production)	Pass	Fail	Fail	Fail	Concern with reliance on a third party that may not be viable over the longer term.
18	Lime stabilization – In-vessel process	Pass	Fail	Pass	Fail	Does not meet CRD policy for no land application, can be operations intensive
19	Co-composting residual solids with yard waste and/or SSOs	Pass	Fail	Pass	Pass	Does not meet CRD policy for no land application, can be odourous
20	Geotube dewatering and storage	Fail	Pass	Pass	Fail	Can only be fed with treatment plant residual solids and is odourous.

4.2 Short List of Technology Options

Using the screening protocol described above, a short list of six options was developed. The screening of the 20 options produced 6 viable options (those shown shaded as green in **Table 4.1**). A lower cost sub-option of Option 4, Option 4a was also assessed as a cost saving measure. This option involves the use of insulated steel tanks, common in many European installations for the digester tanks.

The seven options carried forward for costing and triple bottom line analysis were:

1. Anaerobic digestion, biosolids drying (pelletization for multiple uses), struvite recovery and biogas conditioning
2. Anaerobic digestion with biosolids drying
3. Residual solids drying (pelletization)
4. Anaerobic digestion/ biocell reactors (with or without MSW)

4a. Anaerobic digestion (steel tanks) / biocell reactors (with or without MSW)

5 Undigested residual solids biocell reactors (residual solids with or without MSW)

6 Residual solids thermal destruction

4.2.1 Carbon Footprint of Short Listed Technology Options

According to the 2007 British Columbia GHG Inventory report, 0.1% of provincial emissions are from wastewater treatment operations. If managed appropriately, the biosolids management program is one way in which a municipality can offset operation emissions and accrue carbon credits. The credits will enable a municipality to achieve a net carbon footprint of zero more easily. The carbon footprint of anaerobic digestion facilities can be reduced by recovery of biogas and use for operation, heating and electricity generation. Note that options which rely on transportation of biosolids for long distances can have a significant negative impact on carbon footprint.

Carbon footprint analysis methodologies can vary widely. The Canadian Council of Ministers of the Environment (CCME) has published the Biosolids Emissions Assessment Model (BEAM): A Method for Determining Greenhouse Gas Emissions from Canadian Biosolids Management Practices (CCME 2009). BEAM was evaluated and consistent methodology and emissions factors were used for this report.

The three GHGs relevant to biosolids management are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The direct and indirect emissions and offsets of these GHGs are included in the carbon footprint analysis.

- **Carbon dioxide –** CO_2 enters the atmosphere by burning carbonaceous substances such as fossil fuels (oil, natural gas, and coal), solid waste, and trees, and as a by-product of chemical reactions (e.g., the manufacture of cement). CO_2 is also removed from the atmosphere (or sequestered) when it is absorbed by plants or stored in the soil as part of the biological carbon cycle.
- **Methane –** CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 is also produced from the anaerobic digestion of waste at wastewater treatment facilities, by livestock, and by the decay of organic waste in MSW landfills.

- **Nitrous oxide –** N_2O is emitted by agricultural and industrial activities, combustion of fossil fuels and solid waste, and through secondary biological nutrient removal wastewater treatment processes.

GHG emissions can occur from anthropogenic or biogenic sources. Anthropogenic emissions are produced by human activities that remove sequestered carbon from the earth's crust and release it to the atmosphere (e.g., through the burning of fossil fuels). Biogenic carbon occurs in plants and animals that intake and dispense of carbon cyclically. Biogenic sources do not increase the amount of GHGs in the atmosphere, but merely represent the "natural" cycling of carbon. Therefore, emissions of biogenic CO_2 are generally not accounted for in GHG inventories for wastewater treatment. In fact, biogenic carbon sources can be considered an offset when utilized in place of an anthropogenic source (for example, when using biogas from a wastewater treatment process as a fuel source in place of natural gas).

Once GHGs are emitted into the atmosphere, they absorb and re-radiate heat with varied levels of effectiveness. The global warming potential (GWP) quantifies the contribution of each gas over a specific time interval in terms of CO_2. The GWP of CO_2, by definition, is 1. The 100-year GWP values of CO_2, CH_4, and N_2O are shown below, based on the 2007 British Columbia Greenhouse Gas Inventory report:

- CO_2 GWP = 1 equivalent kg of CO_2
- CH_4 GWP = 21 equivalent kg of CO_2
- N_2O GWP = 310 equivalent kg of CO_2

At this screening level for the technology alternatives the intent is not to complete a full accounting of the likely GHG emissions for each, but rather provide a relative measure for each of the six shortlisted options. In previous planning work this type of analysis was undertaken, but significant GHG credit was provided for several of the alternatives where processed biosolids were to be used as a soil amendment. Since the practice of land application is not accepted by the CRD, this GHG offset credit cannot be applied. The carbon footprint for each shortlisted option is:

1. Anaerobic digestion, biosolids drying (pelletization for multiple uses), struvite recovery and biogas conditioning- (5,118) tonnes/yr CO2e credit
2. Anaerobic digestion with biosolids drying- (5,147) tonnes/yr CO2e credit
3. Residual solids drying (pelletization) -723 tonnes/yr CO2e impact
4. Anaerobic digestion/ biocell reactors (with or without MSW) - (4,762) tonnes/yr CO2e credit

4a. Anaerobic digestion (steel tanks) / biocell reactors (with or without MSW) - (4,762) tonnes/yr CO2e credit

5 Undigested residual solids biocell reactors (residual solids with or without MSW) - 2,586 tonnes/yr CO2e impact

6 Residual solids thermal destruction - 864 tonnes/yr CO2e impact

This ranking assumes GHG offsets would be available based on the quantity of biogas that would be produced or the quantity of electricity that could be generated by each of the options. The landfill options are not as readily quantifiable as it is not clear what degree of biogas could be captured from this type of operation.

4.2.2 Biosolids Treatment Site

The new biosolids treatment facilities, regardless of technology ultimately selected will be located at the Hartland Landfill site. Other sites in closer proximity to liquid treatment sites currently under consideration have been reviewed in previous studies and none have been found to be available or viable. The Hartland site provides good access and is located remote from concentrated residential development. There is sufficient space available to build and expand biosolids facilities in the future at this site. The site also provides good opportunities for synergies with the municipal solid waste program and future integrated resource management for biosolids and MSW waste streams.

4.2.3 Residual Solids Pipeline

A residual solids pipeline and pumping stations will be required to convey residual solids to the Hartland site. The pipeline would be approximately 200 mm in diameter and would require up to 4 pumping stations because of the elevation lift to Hartland. The pump stations will relatively small and similar to package type lift stations currently in the sewage collection system. They will include odour control facilities. Chemical addition provisions at the treatment plant and pump stations will be provided for hydrogen sulphide and methane control.

4.3 Facility Staging for Ultimate IRM

Throughout the planning process over the past ten years, there has been recognition of the potential synergies between the resource recovery and disposal needs of biosolids and municipal solid waste (MSW). As such, the CRD has adopted the goal of integrating biosolids management with the existing MSW program to the extent practical and beneficial. As noted in the previous sections, there are several opportunities for accomplishing this, ranging from direct disposal of biosolids in the landfill, co-digestion of suitable source separated organic wastes with biosolids, FOG, co-combustion in a WTE facility, and co-composting. This section describes how biosolids management alternatives could be integrated with the MSW program in a staged process.

As indicated in previous planning work, the best site to integrate biosolids management with the MSW program would be at the Hartland Landfill site. This would allow the biosolids management facility to be constructed in an area where land is available and over one kilometre away from the nearest resident. It will allow for ease of integration with any future MSW strategy that may be implemented by the CRD in the future.

All of the short listed options were chosen for their ability to be incorporated into a future overall integrated waste management program at the Hartland site. Any number of staging strategies can be utilized to allow for future incorporation of MSW. For the options that include solids drying and pelletization, they all produce a dry, readily useable fuel source that can be incorporated with MSW in either an incineration or gasification process in the future. The challenge will be in finding a disposal site / end user for the pellets in the interim. This could be a cement kiln, lumber drying operation or other thermal co-generation facility, assuming a facility is available and will accept the fuel on reasonable commercial terms. The other three shortlisted options rely on the storage of residual solids or biosolids in biocells at the landfill. These options have the advantage of being under complete control of the CRD. This is viewed as an interim option, although biosolids could be "mined" in the future for other beneficial use. This option also occupies valuable landfill space and may not be a practical long term solution. Until such time that MSW and biosolids are fully integrated, this option does provide a viable solution.

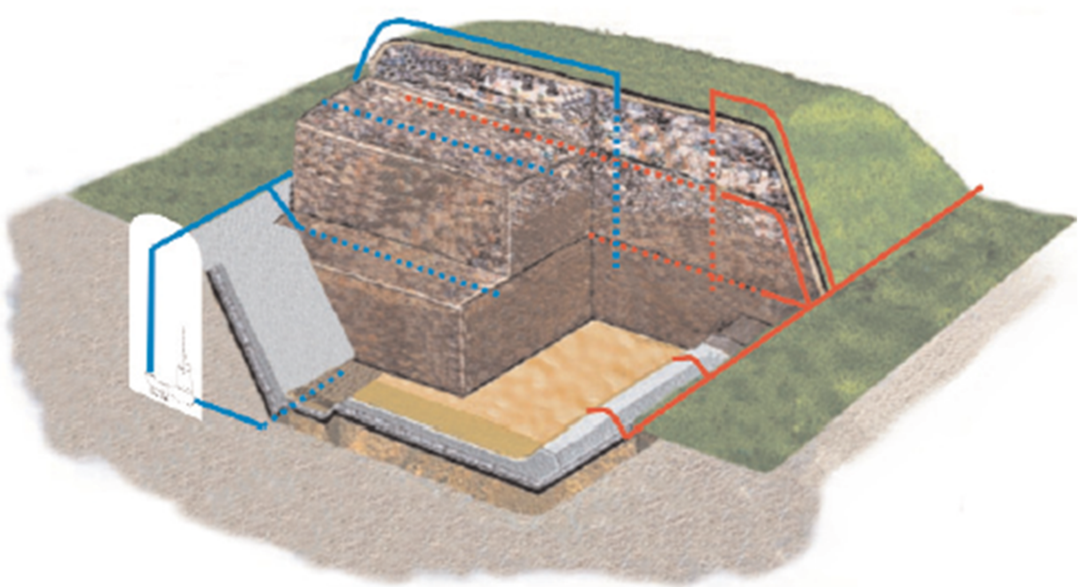
4.4 Biocell Disposal

Given the current CRD policy on land application, the CRD must have a reliable disposal method for biosolids for the time period until integration with MSW is fully planned and implemented. Recognizing that full integration can take some time, a reliable disposable option is required. One potential option is a biocell.

A biocell is a closed loop landfill reactor system that is operated in three stages. In the first stage, the bioreactor mimics an anaerobic digester to capture biogas released from decomposing biosolids mixed with solid wastes or the organic fraction of solid wastes. The captured gas can then be converted to power. The anaerobic stage is maintained at a critical moisture level through leachate recirculation. After 5–6 years, the gas generation rate decreases and the biocell is converted to an aerobic composting system. Air is injected into the solid waste using the same infrastructure used for gas collection. The aerobic phase occurs until the waste is sufficiently stabilized, approximately 1–2 years. The cell can then be mined for compost material and other recyclables. Multiple cells will be operated consecutively, so that each cell can be in composting, mining, or filling phases. Such as system would be ideally suited to the Hartland landfill location.

Biocells are designed with the following components: groundwater control system, composite liner, leachate collection system, liquid/leachate injection system, landfill gas collection/air injection system, bio-cap intermediate covers to oxidize methane (CH_4), final cover system, and a monitor sensor system. A schematic of a biocell is illustrated in **Figure 4.2**.

Figure 4.2 – Schematic of Biocell



A biocell provides multiple advantages over a traditional landfill system. The system enhances anaerobic microbial action, resulting in increased gas capture and power production. Stabilization of waste occurs in a shorter period of time. Also, compost material and other recyclables are recovered during the "mining" stage. Finally, the space and infrastructure within the reactor is reusable.

For the CRD sufficient biocell capacity would be provided to store biosolids in multiple cells. The cells would be mined after 5 years and products could be incorporated into a beneficial reuse program or used as landfill cover.

4.5 Schedule Consideration

All of the short-listed options can be procured, constructed and commissioned prior to December 31, 2020. The biosolids will be procured using a separate design build finance operate maintain contract. Schedules prepared for the short-listed liquid train treatment options are included in this report in **Appendix C.** The schedules include the biosolids treatment facilities and the interrelationship with the liquid treatment construction. The biosolids facility must be available to receive residual solids from the liquid plant when it is commissioned. The biosolids treatment facility would be wet tested prior to liquid train commissioning and would be ready to receive residual solids from the liquid train.

5.0 OPINION OF PROBABLE COSTS

5.1 Cost Estimate Basis

Capital costs have been prepared using the same approach as used for the liquid train assessment for direct and indirect costs, financing and inflation to mid-point of construction.

5.2 Capital Costs and Whole Life Cycle Costs

The capital costs (rounded) for each alternative are summarized in **Table 5.1** with detailed cost estimate appended to this report.

Table 5.1 – Life Cycle Costs

Option	Capital Cost	Annual Operations and Maintenance Cost	Life Cycle Cost*
Option 1 –Anaerobic digestion, drying, gas recovery, nutrient recovery (previously funded case)	$ 267,000,000	$ 3,021,000	$ 314,200,000
Option 2 – Anaerobic digestion, drying (with no gas scrubbing for utility sale and no nutrient recovery)	$ 224,000,000	$ 4,060,000	$ 287,200,000
Option 3 – Residual solids drying (pelletization)	$ 188,252,000	$ 4,405,845	$ 257,080,000
Option 4 – Anaerobic digestion biocell reactors (with or without MSW)	$ 165,557,000	$ 2,631,000	$ 206,700,000
Option 4a – Anaerobic digester (steel tanks) / biocell reactors (with or without MSW)	$ 143,646,000	$ 2,631,000	$ 184,800,000
Option 5 – Undigested residual solids / biocell reactors (with or without MSW)	$ 104,153,000	$ 3,483,000	$ 158,600,000
Option 6 – Residual solids thermal destruction	$ 223,997,000	$ 3,259,030	$ 274,900,000

***** Life Cycle Cost based on 25 year period and 4% discount rate. Discount rate is consistent with discount rate selected by Project Board for liquid assessment. Costs are engineering estimates and do not include development costs or retained risk costs.

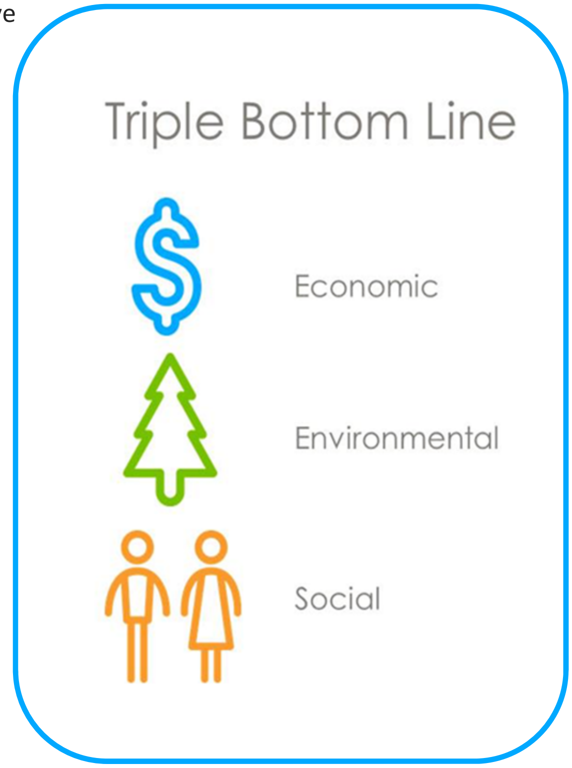
5.3 Discussion on Life Cycle Costs

The three options that involve the residual solids going to a landfill in a biocell (Options 4, 4a and 5) are the overall lowest cost but Option 5 may have permitting and other issues related to handling undigested residual solids in an open area. Option 4 and 4a have the advantage of providing a Class A biosolids which could be used for future beneficial use if there is a policy change regarding beneficial reuse of biosolids. Option 4 and 4a also produce biogas which will be used for heating the digesters and buildings with surplus gas being available to the CRD for expansion of their existing co-generation system at the Hartland Landfill. Option 4a results in significant capital cost savings due to use of bolted steel tanks and pre-engineered buildings. Option 3 is the next lowest overall cost after Options 4 and 5. Option 1 has the highest cost but has the lowest O&M due to the potential for cost recovery from the biogas produced and sale to the utility.

6.0 TRIPLE BOTTOM LINE ASSESSMENT

6.1 Approach

Seven biosolids treatment options were assessed using a triple bottom line (TBL) framework. The TBL considers economic, environmental and social criteria to provide balanced decision making. Many organizations including Metro Vancouver and BC Hydro have adopted the TBL framework to evaluate their performance in a broader perspective to create greater business value in consideration of non-monetary social and environmental criteria.



Municipal officials across Canada increasingly recognize that sustainable projects benefit not only the environment, but also the economy and society at large. For this reason, FCM promotes and measures Green Municipal Fund (GMF) project impacts using a triple bottom line approach — one that considers criteria from all three areas. The combined and often complementary effects of project benefits lead to tangible improvements at the community level — cleaner water, better municipal services, and more efficient use of resources such as energy. Understanding the economic, environmental and social considerations of a specific option can assist in evaluation.

- **Economic Criteria** – This category includes the capital and whole life cycle costs for each option. The whole life cycle costs have been calculated using a 4% discount rate over a period of 25 years.
- **Environmental Criteria** – This category includes a number of criteria associated with the environmental performance of the specific option. Some factors include ability to meet regulatory compliance, carbon footprint and other environmental criteria.
- **Social Criteria** – Social criteria include items which have a social impact on the public. This could include items such as operational traffic noise and odour.

6.2 Evaluation of Qualitative Criteria

A qualitative assessment and scoring of criteria was completed in each of the environmental and social categories. Economic criteria were not scored but information was provided to be considered in the overall TBL assessment. Each of the options was assessed using a listing of considerations and evidence provided to support the conclusions reached. The considerations and evidence are included **Appendix A**.

The evaluation was completed by the technical team and included input from the Project Board, CRD and a diverse team of legal, financial and business specialists.

As an example of social criteria, low construction impacts are considered preferable to moderate or high impacts. In the instance of construction impacts the characteristics of a particular option many be ranked (e.g., very good, good, average, fair, poor) based on characteristics such as noise, proximity to residential areas, requirements for transporting materials through residential or urban areas, need for blasting, excavation, etc. In this case little or no impact may be considered 'very good', whereas significant impacts may be considered 'poor', and therefore the low impact option would be ranked higher.

Ranking in this manner can also accommodate the assignment of a numerical result (e.g., from 1–5, corresponding to Poor to Very Good), to facilitate presentation of the results for an overall numerical outcome to support selecting a preferred option.

Very Good (5)	Good (4)	Average (3)	Fair (2)	Poor (1)
Exceeds the requirements of the criterion.	Meets the requirements of the criterion.	Meets the basic requirements of the criterion.	Minimally meets basic requirements.	Option fails to meet basic requirements of the criterion.

These numerical rankings are combined with weightings to arrive at an overall ranking. The Project Board applied one of the following weightings to each criterion:

- Very Important (3)
- Important (2)
- Somewhat Important (1)

The ranking and weighting were then applied to a TBL model to arrive at an overall assessment of each of the options. The economic criteria were not scored to ensure that the environmental and social criteria were given objective consideration. The results of the TBL evaluation are provided in **Table 6.1** (weighted) and **Table 6.2** (unweighted).

6.3 Triple Bottom Line Results

Scoring completed indicates the current base case under the funding agreement provides the highest TBL in the absence of economic considerations. This option is also the most expensive capital and life cycle option. A second option which also scores high is the anaerobic digestion without biogas scrubbing and nutrient recovery Options 4 and 4a anaerobic digestion with disposal to a biocell provided reasonable triple bottom line results. Option 4a involves the use of insulated bolted steel tanks for the digesters and provides a cost effective solution that will produce a Class A biosolid with significant flexibility for future end use. The Project Board will have to assess the economic implications of each option in the TBL assessment and selection of a preferred option (s) for consideration.

Table 6.1 – Triple Bottom Line Assessment Framework (Weighted)

		Evaluation	Quantitative								
		Weighted Evaluation	Weighted								
				Criteria							
Criteria	**No.**	**Criteria Categories**	**Measure Description**	**Weight**	**1**	**2**	**3**	**4**	**4a**	**5**	**6**
			Biosolids Treatment Technology		Anaerobic Digestion + Dryer + Gas Scrubbing and Nutrient Recovery	Anaerobic Digestion + Dryer No Gas Scrubbing or Nutrient Recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
Economic	**EC-01**	Capital Costs	Construction costs including both direct and indirect costs in 2016 dollars		$267 M	$224 M	$188 M	$166	$144	$104 M	$224 M
Economic	**EC-02**	Whole Life Cycle Costs	Capital, operating and maintenance costs		$314 M	$287 M	$257 M	$206 M	$185 M	$159 M	$275 M
Economic	**EC-05**	Schedule of Completion	Options which extend over a longer period and cause schedule impact costs		31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2022
Economic				**Economic**							
Environmental	**EN-01**	Carbon Footprint / GHG	Tons of eCO2 created	3	15	12	9	12	12	3	6
Environmental	**EN-02**	Meets or Exceed Regulatory Requirements	Treatment Process Meets Regulatory Requirements	3	15	12	12	12	12	3	9
Environmental	**EN-03**	Redundancy	Does Option meet the Reliability criteria specified in the Municipal Wastewater Regulations	3	12	12	12	12	12	6	9
Environmental	**EN-04**	Resource Recovery Beneficial Reuse	Do recovered resources have flexibility for beneficial reuse	2	10	8	6	8	8	4	6
Environmental	**EN-05**	Future Potential for Integrated Resource Management with MS	Suitability of the solids treatment process to integrate with Integrated Resource Management (IRM) system	3	15	12	9	9	9	6	6
Environmental	**EN-06**	Permitting Requirements	Complexity of permitting and approvals processes	2	10	10	6	8	8	4	4
Environmental	**EN-07**	Energy recovery	Does the process recover reusable energy - biogas/methane/syngas or heat	2	10	8	4	6	6	4	4
Environmental	**EN-08**	Leachate/Wastewater Production	Degree that the Option produces leachate or wastewater which must be treated	1	3	3	3	2	2	2	3
Environmental	**EN-09**	Environmental Controls (Air)	Does process require advanced air emission controls	2	8	8	4	6	6	4	4
Environmental	**EN-10**	Track Record of Performance	Does process have a proven track record of performance as specified in the draft P3 Canada agreement	3	15	15	9	12	12	6	12
Environmental	**EN-11**	Terrestrial Impacts	Impact that a given site would have on existing terrestrial habitat	2	8	8	8	6	6	6	8
Environmental				**Environmental Subtotal: 130 Points Maximum**	**121**	**108**	**82**	**93**	**93**	**48**	**71**
Social	**SO-01**	Operations Traffic	Amount of traffic nuisance caused to neighbouring residents post construction	1	4	4	3	2	2	1	5
Social	**SO-02**	Operations Impact on Local Community	Noise, dust and vibration inconvenience	2	8	8	8	8	8	8	8
Social	**SO-03**	Odour Impact on Local Community	Potential odour impact on nearby residential/commercial properties	3	12	12	6	9	9	6	6
Social	**SO-04**	Health and Safety - Workplace and Public	Potential workplace and public health and safety issues	3	12	12	9	9	9	6	9
Social	**SO-05**	Construction Impacts (Solids Conveyance)	Disruption to community during construction phase	1	3	3	3	3	3	3	3
Social	**SO-06**	Construction Impacts (Treatment)	Disruption to community during construction phase	1	4	4	4	4	4	4	4
Social	**SO-07**	Ease of Operations	Complexity of technology to maintain operational performance	2	6	6	6	8	8	6	8
Social	**SO-08**	Compatibility with Official Community Plan	Degree of planning activity to amend OCP, zoning and Development Permitting	2	6	6	6	6	6	6	2
Social	**SO-09**	Archeological Findings	Risk of a cultural site find during construction	2	8	8	8	8	8	8	8
Social	**SO-10**	Impact to local First Nations	Have First Nations communities who aboriginal interests may be affected been consulted?	2	6	6	6	6	6	6	6
Social	**SO-11**	Cultural and Heritage impacts	Impacts to any physical and cultural heritage value	2	6	6	6	6	6	6	6
Social				**Social Subtotal: 105 Points Maximum**	**75**	**75**	**65**	**69**	**69**	**60**	**65**
				Environmental + Social Subtotal: 235 Points Maximum	**196**	**183**	**147**	**162**	**162**	**108**	**136**

Table 6.2 – Triple Bottom Line Assessment Framework (Unweighted)

Criteria	No.	Criteria Categories	Measure Description	Criteria Weight	Option Results 1	2	3	4	4a	5	6
			Biosolids Treatment Technology		Anaerobic Digestion + Dryer + Gas Scrubbing and Nutrient Recovery	Anaerobic Digestion + Dryer No Gas Scrubbing or Nutrient Recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
Economic	**EC-01**	Capital Costs	Construction costs including both direct and indirect costs in 2016 dollars		$267 M	$224 M	$188 M	$166	$144	$104 M	$224 M
Economic	**EC-02**	Whole Life Cycle Costs	Capital, operating and maintenance costs		$314 M	$287 M	$257 M	$206 M	$185 M	$159 M	$275 M
Economic	**EC-05**	Schedule of Completion	Options which extend over a longer period and cause schedule impact costs		31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2020	31-Dec-2022
Economic				**Economic**							
Environmental	**EN-01**	Carbon Footprint / GHG	Tons of eCO$_2$ created	Very Important	5	4	3	4	4	1	2
Environmental	**EN-02**	Meets or Exceed Regulatory Requirements	Treatment Process Meets Regulatory Requirements	Very Important	5	4	4	4	4	1	3
Environmental	**EN-03**	Redundancy	Does Option meet the Reliability criteria specified in the Municipal Wastewater Regulations	Very Important	4	4	4	4	4	2	3
Environmental	**EN-04**	Resource Recovery Beneficial Reuse	Do recovered resources have flexibility for beneficial reuse	Important	5	4	3	4	4	2	3
Environmental	**EN-05**	Future Potential for Integrated Resource Management with MSW	Suitability of the solids treatment process to integrate with Integrated Resource Management (IRM) system	Very Important	5	4	3	3	3	2	2
Environmental	**EN-06**	Permitting Requirements	Complexity of permitting and approvals processes	Important	5	5	3	4	4	2	2
Environmental	**EN-07**	Energy recovery	Does the process recover reusable energy - biogas/methane/syngas or heat	Important	5	4	2	3	3	2	2
Environmental	**EN-08**	Leachate/Wastewater Production	Degree that the Option produces leachate or wastewater which must be treated	Somewhat Important	3	3	3	2	2	2	3
Environmental	**EN-09**	Environmental Controls (Air)	Does process require advanced air emission controls	Important	4	4	2	3	3	2	2
Environmental	**EN-10**	Track Record of Performance	Does process have a proven track record of performance as specified in the draft P3 Canada agreement	Very Important	5	5	3	4	4	2	4
Environmental	**EN-11**	Terrestrial Impacts	Impact that a given site would have on existing terrestrial habitat	Important	4	4	4	3	3	3	4
Environmental				**Environmental Subtotal: 55 Points Maximum**							
Social	**SO-01**	Operations Traffic	Amount of traffic nuisance caused to neighbouring residents post construction	Somewhat Important	4	4	3	2	2	1	5
Social	**SO-02**	Operations Impact on Local Community	Noise, dust and vibration inconvenience	Important	4	4	4	4	4	4	4
Social	**SO-03**	Odour Impact on Local Community	Potential odour impact on nearby residential/commercial properties	Very Important	4	4	2	3	3	2	2
Social	**SO-04**	Health and Safety - Workplace and Public	Potential workplace and public health and safety issues	Very Important	4	4	3	3	3	2	3
Social	**SO-05**	Construction Impacts (Solids Conveyance)	Disruption to community during construction phase	Somewhat Important	3	3	3	3	3	3	3
Social	**SO-06**	Construction Impacts (Treatment)	Disruption to community during construction phase	Somewhat Important	4	4	4	4	4	4	4
Social	**SO-07**	Ease of Operations	Complexity of technology to maintain operational performance	Important	3	3	3	4	4	3	4
Social	**SO-08**	Compatibility with Official Community Plan	Degree of planning activity to amend OCP, zoning and Development Permitting	Important	3	3	3	3	3	3	1
Social	**SO-09**	Archeological Findings	Risk of a cultural site find during construction	Important	4	4	4	4	4	4	4
Social	**SO-10**	Impact to local First Nations	Have First Nations communities who aboriginal interests may be affected been consulted?	Important	3	3	3	3	3	3	3
Social	**SO-11**	Cultural and Heritage impacts	Impacts to any physical and cultural heritage value	Important	3	3	3	3	3	3	3
Social				**Social Subtotal: 55 Points Maximum**							
				Environmental + Social Subtotal: 110 Points Maximum	**89**	**84**	**69**	**74**	**74**	**53**	**66**

Appendix A

Triple Bottom Line Considerations

Screening Summary Sheet

Rating System Proposed:

Very Good (5)	Good (4)	Average (3)	Fair (2)	Poor (1)
The impact of the option is very favourable and far exceeds minimum expectations.	The impact of the option is favourable and clearly exceeds minimum expectations.	The impact of the option is acceptable and meets or somewhat exceeds minimum expectations.	The impact of the option barely meets minimum expectations.	Option fails to meet basic requirements of the criterion.

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas Scrubbing and Nutrient Recovery	Anaerobic Digestion + Dryer No Gas Scrubbing or Nutrient Recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
Economic Criteria								
EC-01 **Capital Costs** Construction costs including both direct and indirect costs in 2016 dollars.	Total Capital Cost of option	**Capital Cost of Option:** **$ 267 million**	**Capital Cost of Option:** **$ 224 million**	**Capital Cost of Option:** **$ 188 million**	**Capital Cost of Option:** **$ 166 million**	**Capital Cost of Option:** **$ 144 million**	**Capital Cost of Option:** **$ 104 million**	**Capital Cost of Option:** **$ 224 million**
EC-02 **Whole Life Cycle Costs** Operating and maintenance costs, expressed as a net present value cost using a 25 year life cycle cost and a 4% discount rate, added to capital costs.	Whole Life Cycle Cost of Option	**Whole Life Cycle Cost of Option: $ 314 million**	**Whole Life Cycle Cost of Option: $ 287 million**	**Whole Life Cycle Cost of Option: $ 257 million**	**Whole Life Cycle Cost of Option: $ 207 million**	**Whole Life Cycle Cost of Option: $ 185 million**	**Whole Life Cycle Cost of Option: $ 159 million**	**Whole Life Cycle Cost of Option: $ 275 million**
EC-03 **Schedule of Completion**	Estimated Service Commencement Date Impacts included in the schedule assumption: • Timing needed for zoning and permitting requirements (e.g., development permit) • Environmental permitting requirements • Construction complexity • Commissioning	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2020 **Final Acceptance:** December 31, 2020	**Evidence:** Estimated Service Commencement Date: December 31st, 2022 extended due to additional time required for regulatory permitting **Final Acceptance:** December 31, 2022

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
Environmental Criteria								

EN-01
Carbon Footprint
Net carbon dioxide equivalent (eCO_2) during the construction and operation of the facility (tonnes/year).
	• Construction carbon footprint
	• Operations carbon footprint;
	• Pumping and other conveyance impacts to carbon footprint
		Evidence:
		• Estimated carbon footprint for construction (one time) 9,760 tonnes
		• Power (treatment only) 913 tonnes/year
		• Fugitive gas emission 267 tonnes/year
		• Residual trucking fuel carbon 90 tonnes/year
		• Carbon offsets:
		  ○ Gas collection, utilization and sale offset 6,199 tonnes/year
		  ○ Struvite production offsets 189 tonnes/year
		• Annual Operating Net carbon credit: (5,118) tonnes/year
		Conclusion: Very Good
			Evidence:
			• This option produces gas which can be used for digester heating, hot water system, boilers and could be connected to landfill gas system at Hartland for power generation. No gas sale for revenue.
			• Estimated carbon footprint for construction (one time) 9,242 tonnes
			• Power (treatment only) 696 tonnes/year
			• Fugitive gas emission 267 tonnes/year
			• Residual trucking fuel carbon 90 tonnes/year
			• Carbon offsets:
			  ○ Gas collection, utilization and sale offset 6,199 tonnes/year
			• Annual Operating Net carbon credit: (5,147) tonnes/year
			Conclusion: Good
				Evidence:
				• This option requires external landfill gas for drying but will produce a dry product which has fuel value.
				• Estimated carbon footprint for construction (one time) 6,878 tonnes
				• Power (treatment only) 547 tonnes/year
				• Residual trucking fuel carbon 177 tonnes/year
				• Net carbon credit: 723 tonnes/year
				Conclusion: Average
					Evidence:
					• This option produces gas which can be used for digester heating, hot water system, boilers and could be connected to landfill gas system at Hartland for power generation.
					• Estimated carbon footprint for construction (one time) 7,741 tonnes
					• Power (treatment only) 598 tonnes/year
					• Fugitive gas emission 832 tonnes/year
					• Residual trucking fuel carbon 7 tonnes/year for onsite Biocell.
					• Carbon offsets:
					  ○ Gas collection, utilization and sale offset 6,199 tonnes/year
					• Annual Operating Net carbon credit: (4,762) tonnes/year
					Conclusion: Good
						Evidence:
						• This option produces gas which can be used for digester heating, hot water system, boilers and could be connected to landfill gas system at Hartland for power generation.
						• Estimated carbon footprint for construction (one time) 7,086 tonnes
						• Power (treatment only) 598 tonnes/year
						• Fugitive gas emission 832 tonnes/year
						• Residual trucking fuel carbon 7 tonnes/year for onsite Biocell.
						• Carbon offsets:
						  ○ Gas collection, utilization and sale offset 6,199 tonnes/year
						• Annual Operating Net carbon credit: (4,762) tonnes/year
						Conclusion: Good
							Evidence:
							• Carbon footprint is amongst highest as there is no significant gas or energy production and emissions from raw sludge are higher.
							• Estimated carbon footprint for construction (one time) 4,876 tonnes
							• Power (treatment only) 420 tonnes/year
							• Fugitive gas emission 2,154 tonnes/year
							• Residual trucking fuel carbon 12 tonnes/year for onsite Biocell.
							• Annual Operating Net carbon credit: 2,586 tonnes/year
							Conclusion: Poor
								Evidence:
								• This option has the ability to generate minor amounts of electrical power from raw solids alone.
								• Estimated carbon footprint for construction (one time) 7,560 tonnes
								• Power (treatment only) 852 tonnes/year
								• Residual trucking fuel carbon 12 tonnes/year
								• Annual Operating Net carbon: 864 tonnes/year
								Conclusion: Average

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
EN-02 **Exceeds Regulatory Requirements**	• Degree to which the treatment process exceeds current regulatory requirements	**Evidence:** • This Option will produce Class A biosolids which is suitable for a range of beneficial reuse options. • The Option will produce pipeline quality methane which can be sold to displace fossil fuels. • This Option will produce phosphorous fertilizer which is suitable as agricultural fertilizer. **Conclusion: Very Good**	**Evidence:** • This Option will produce Class A biosolids which is suitable for a range of beneficial reuse options. This option will produce pellets suitable for use as a fuel substitute. **Conclusion: Good**	**Evidence:** • This Option will produce Class A biosolids which is suitable for a range of beneficial reuse options including fuel substitute and/ or soil amendment. **Conclusion: Good**	**Evidence:** • This Option will produce Class A biosolids which is suitable for a range of beneficial reuse options. It is also stabilized and can be used for landfill cover or stored in a biocell. • The option produces biogas which is suitable for internal use for digestion process • The biocell is likely only a temporary measure if approved by Ministry of Environment **Conclusion: Good**	**Evidence:** • This Option will produce Class A biosolids which is suitable for a range of beneficial reuse options. It is also stabilized and can be used for landfill cover or stored in a biocell. • The option produces biogas which is suitable for internal use for digestion process • The biocell is likely only a temporary measure if approved by Ministry of Environment **Conclusion: Good**	**Evidence:** • This option produces un-stabilized biosolids with very limited disposal options and is likely only a temporary measure if approved by Ministry of Environment. **Conclusion: Poor**	**Evidence:** • This option thermally destructs raw solids and can produce energy. **Conclusion: Average**
Criteria and Description	**Considerations**							
EN-03 **Redundancy** Does Option meet the Reliability criteria specified in the Municipal Wastewater Regulations?	• Table 1 — Component and Reliability Requirements for Wastewater Facilities from the BC Municipal Wastewater Regulations • The remaining capacity with the largest unit process out of service must be at least 50% of the design maximum flow	**Evidence:** • Option has redundancy features that meet regulatory requirements. Option is reliant on third party for disposal of dried fuel. **Conclusion: Good**	**Evidence:** • Option has redundancy features that meet regulatory requirements. Option is reliant on third party for disposal of dried fuel. **Conclusion: Good**	**Evidence:** • Option has redundancy features that meet regulatory requirements. Option is reliant on third part for disposal of dried fuel. **Conclusion: Good**	**Evidence:** • Option has redundancy features that meet regulatory requirements. • Disposal to landfill under control of CRD **Conclusion: Good**	**Evidence:** • Option has redundancy features that meet regulatory requirements. • Disposal to landfill under control of CRD **Conclusion: Good**	**Evidence:** • This is an interim solution. Thickening and dewatering can be designed with redundancy. **Conclusion: Fair**	**Evidence:** • Facility can be designed with redundancy for critical components. Back up in the event of failure would be landfill. **Conclusion: Average**

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
EN-04 **Resource Recovery Beneficial Reuse** Do recovered resources have flexibility for beneficial reuse	• Type of resources that will be recovered by this Option (i.e. biosolids, phosphorous, energy) • Quantities of resources that will be recovered by this Option	**Evidence:** • This Option will produce 6,970 (wet) tonnes (wet) per year of Class A biosolids at 90% solids as feedstock for the IRM process train • This Option can utilized surplus landfill gas for plant heating • This Option will produce 272 tonnes of food grade phosphorous which is suitable as agricultural fertilizer. Potential revenue is estimated at ~$50,000/year • The cleaned biogas and landfill gas can be sold as a fuel for use in vehicles and to heat buildings. **Conclusion: Very Good**	**Evidence:** • This Option will produce 6,970 (wet) tonnes per year of Class A biosolids at 90% solids as feedstock for the IRM process train • This Option can create electricity from surplus landfill gas and biogas for the BC Hydro grid, **Conclusion: Good**	**Evidence:** • This Option will produce 12,090 (wet) tonnes per year of dried pellets (Class A biosolids) at 90% solids as feedstock for the IRM process train **Conclusion: Average**	**Evidence:** • This Option will produce 25,090 (wet) tonnes per year of Class A biosolids at 25% solids as feedstock for the IRM process train • This Option can create electricity from surplus landfill gas and biogas for the BC Hydro grid, **Conclusion: Good**	**Evidence:** • This Option will produce 25,090 (wet) tonnes per year of Class A biosolids at 25% solids as feedstock for the IRM process train • This Option can create electricity from surplus landfill gas and biogas for the BC Hydro grid. **Conclusion: Good**	**Evidence:** • This option produces un-stabilized biosolids and is likely only a temporary measure if approved by Ministry of Environment. • There will be gas recovered as landfill gas but the quantity of recovery is not possible to estimate. • This Option will yield 43,520 (wet) tonnes/year @ 25% of un-stabilize biosolids as feedstock for the IRM process train **Conclusion: Fair**	**Evidence:** • This option will recover heat from the thermal process but the quantity/quality of heat will depend on the technology selected. **Conclusion: Average**
EN-05 **Flexibility for Integrated Resource Management with Municipal Solid Waste** Suitability of the solids treatment process to integrate with Integrated Resource Management (IRM) system	• The potential for Integrated Resource Management via the Biosolids Management Strategy • The ability of the option to accommodate an IRM planning process either now or in the future (e.g., future retrofits to accommodate different uses for waste products).	**Evidence:** • This option produces a dried Class A biosolids which can be used for a range of beneficial uses including fuel and other products. • Option includes gas and nutrient recovery. **Conclusion: Very Good**	**Evidence:** • This option produces a dried Class A biosolids which can be used for a range of beneficial uses including fuel and other products. • Gas recovery only for internal use. • No nutrient recovery **Conclusion: Good**	**Evidence:** • This option produces a dried Class A biosolids which can be used for a range of beneficial uses including fuel and other products. External gas source required to run drier. **Conclusion: Average**	**Evidence:** • This option produces a dewatered Class A biosolids which can be used for a range of beneficial uses including landfill cover or a biocell. **Conclusion: Average**	**Evidence:** • This option produces a dewatered Class A biosolids which can be used for a range of beneficial uses including landfill cover or a biocell. **Conclusion: Average**	**Evidence:** • This option produces dewatered raw sludge which can only be stored in biocell likely an interim basis. **Conclusion: Fair**	**Evidence:** • This option produces ash which can be disposed of in landfill. **Conclusion: Fair**

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
EN-06 **Permitting Requirements** Complexity of permitting and approvals processes.	• Does this Option comply with the approved Liquid Waste Management Plan (LWMP)? • Does this Option require an amendment to the approved Solid Waste Management Plan (SWMP)? • Environment Impact Study (EIS) required? • Does this option comply with Federal/Provincial regulatory requirements? • Air Emissions Permit required? • Anticipated public support/opposition to technology.	**Evidence:** • This Option is consistent with the LWMP Amendment #10 • This Option does not require an amendment to the SWMP • EIS has been completed for this Option • This Option will meet all Federal/Provincial regulations **Conclusion: Very Good**	**Evidence:** • This Option is consistent with the LWMP Amendment #10 • This Option does not require an amendment to the SWMP • EIS has been completed for this Option • This Option will meet all Federal/Provincial regulations **Conclusion: Very Good**	**th exice:** • This Option is consistent with the LWMP Amendment #10 • This Option does not require an amendment to the SWMP • This option will meet all Federal/Provincial regulations • There are no raw biosolids dryers in BC so permitting may be more extensive. **Conclusion: Average**	**Evidence:** • This Option is consistent with the digestion component of the LWMP Amendment #10 • This Option does not require an amendment to the SWMP • This Option will meet all Federal/Provincial regulations • Additional permitting will be required for biocell. **Conclusion: Good**	**Evidence:** • This Option is consistent with the digestion component LWMP Amendment #10 • This Option does not require an amendment to the SWMP • This Option will meet all Federal/Provincial regulations • Additional permitting will be required for biocell. **Conclusion: Good**	**Evidence:** • **This Option will require a LWMP amendment.** • This Option does not meet all Federal/Provincial regulations • Option is only an interim measure and will require conditional approval from Ministry of Environment. **Conclusion: Fair**	**Evidence:** • This Option will require a LWMP amendment. • Intensive permitting process is required for thermal destruction projects including EIS and air shed modeling. • This technology could face public opposition. **Conclusion: Fair**
EN-07 **Energy recovery** Does the process recover reusable energy – biogas / methane / syngas or heat?	**Evidence:** • Energy balance o Gross energy recovery (biogas/heat) o Process energy consumption o Surplus biogas sale for revenue	**Evidence:** • Energy recovered from digester gas, • Digester gas for digestion heating, biosolids drying, boilers, plant wide and individual hot water systems • Surplus biogas for upgrade and sale to natural gas system for revenue. • Dried biosolids could potentially be used as fuel. **Conclusion: Very Good**	**Evidence:** • Energy recovered from digester gas, • Digester gas for digestion heating, biosolids drying, boilers, plant wide and individual hot water systems • No biogas upgrade, thus no surplus biogas sale for revenue. • Dried biosolids could potentially be used as fuel. **Conclusion: Good**	**Evidence:** • No digestion process, thus no energy recovered from digester gas, • Significant heat demand from solids drying, thus landfill gas and natural gas will be required. • No biogas upgrade, thus no surplus biogas sale for revenue. • Dried biosolids could potentially be used as fuel. **Conclusion: Fair**	**Evidence:** • Energy recovered from digester gas, • Digester gas for digestion heating, boilers, plant wide and individual hot water systems • No biogas upgrade, thus no surplus biogas sale for revenue. • No dried biosolids • Surplus biogas can be used for co-generation **Conclusion: Average**	**Evidence:** • Energy recovered from digester gas, • Digester gas for digestion heating, boilers, plant wide and individual hot water systems • No biogas upgrade, thus no surplus biogas sale for revenue. • Surplus gas can be used for co-generation • No dried biosolids **Conclusion: Average**	**Evidence:** • No digestion process, thus no energy recovered from digester gas, • Landfill gas and natural gas will be required for plant operation and head demand. • No biogas upgrade, thus no surplus biogas sale for revenue. • No dried biosolids **Conclusion: Fair**	**Evidence:** • Sludge being used as fuel to generate stream and thus electricity through turbine generator. • Residual heat being recovered to reduce the gas temperature for cleaning and discharging. • Sludge alone is not likely to sustain incineration operation. Combined MSW is likely required. **Conclusion: Fair**

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EN-08 **Leachate/Wastewater Production** Degree that the Option produces leachate or wastewater which must be treated.	• Quantity and quality of leachate generated by this Option • Quantity and quality of wastewater generated by this option.	**Evidence:** • This Option could yield 3.7 ML/d of process wastewater/ day from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Average**	**Evidence:** • This Option could yield 3.7 ML/d of process wastewater/ day from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Average**	**Evidence:** • This Option could yield 3.7 ML/d of process wastewater/ from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Average**	**Evidence:** • This Option will produce additional landfill leachate. • This Option could yield 3.7 ML/d of process wastewater/ from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Fair**	**Evidence:** • This Option will produce additional landfill leachate. • This Option could yield 3.7 ML/d of process wastewater/ from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Fair**	**Evidence:** • This option will produce additional landfill leachate. • This Option could yield 4.8 ML/d of process wastewater/ day from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Fair**	**Evidence:** • This Option could yield 4.8 ML of process wastewater/ day from solids dewatering. • All liquid waste by-product streams will be conveyed to the liquid treatment wastewater plant(s) for treatment with landfill leachate. **Conclusion: Average**
EN-09 **Environmental Controls (Air)** Does process require advanced air emission or odour controls?	• Complexity of environmental emissions control for the option under consideration	**Evidence:** This Option will require odour control for thickening and dewatering process. **Conclusion: Good**	**Evidence:** This Option will require odour control for thickening and dewatering process **Conclusion: Good**	**Evidence:** • This option will require odour and emissions control from raw sludge dryer. **Conclusion: Fair**	**Evidence:** • This Option will require odour control for thickening and dewatering process. **Conclusion: Average**	**Evidence:** • This Option will require odour control for thickening and dewatering process. **Conclusion: Average**	**Evidence:** • Odour control from raw sludge biocell at this scale will be difficult to control. **Conclusion: Fair**	**Evidence:** • This Option will process raw solids and will require additional odour control for thickening and dewatering process. • This Option will require advanced air emissions controls. **Conclusion: Fair**
EN-10 **Track Record of Performance** Does process have a proven track record of performance as specified in the draft P3 Canada agreement?	• Does the Option meet the P3 Canada requirement of 5 years of continuous operation under similar operating conditions?	**Evidence:** • Yes, many similar installations **Conclusion: Very Good**	**Evidence:** • Yes, many similar installations **Conclusion: Very Good**	**Evidence:** • Yes, more limited number of installations **Conclusion: Average**	**Evidence:** • Yes for digestion, limited number of biocells. Many cases where digested solids landfilled. **Conclusion: Good**	**Evidence:** • Yes for digestion, limited number of biocells. Many cases where digested solids landfilled. **Conclusion: Good**	**Evidence:** • CRD is currently landfilling raw solids from Saanich Peninsula and Sooke plant on an interim basis. **Conclusion: Fair**	**Evidence:** • There are a number of municipalities across North America which use thermal destruction. **Conclusion: Good**

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EN-11 **Terrestrial Impacts** Impact that a given site would have on existing terrestrial habitat.	• Impact on the vegetation and habitat for terrestrial areas of the site during construction • Degree of mitigation required for terrestrial environment.	**Evidence:** • No material difference in how the options meet the criterion. **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • Biocells occupy a significant footprint **Conclusion: Average**	**Evidence:** • Biocells occupy a significant footprint **Conclusion: Average**	**Evidence:** • Biocell occupy a significant footprint, raw solids will require additional area. **Conclusion: Fair**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**
Social Criteria (Including Health and Safety)	**Considerations**							
SO-01 **Operations Traffic** The impact of the traffic during the operations period of the option has on local communities.	• Number of trucks per month • Classification of local community, e.g., residential, industrial, or commercial properties • Number, and types, of schools along the access route • Types of roads; for example, residential, arterial	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 30 trucks/month **Conclusion: Good**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 30 trucks/month **Conclusion: Good**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 65 trucks/month **Conclusion: Average**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 155 trucks/month **Conclusion: Fair**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 155 trucks/month **Conclusion: Fair**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for biosolids disposal is estimated to be 282 trucks/month **Conclusion: Poor**	**Evidence:** • Daily traffic for staff access estimated at 8 to 10 vehicle movements per day • Access road to the site is a rural residential road. • Anticipate delivery of bulk chemicals up to twice per month • Monthly truck traffic for ash disposal is estimated to be 3 trucks/month **Conclusion: Very Good**
SO-02 **Operations Impacts on local community** Potential for operational noise, dust and vibration impacts on the local community during operation of the treatment facility.	• Impact of noise, dust and vibration on local community • Classification of local community (e.g., residential or industrial) • Distance of neatest neighbour to source of noise and vibration (e.g., 25 m)	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**	**Evidence:** • All mechanical equipment designed to minimize vibration and noise • All mechanical equipment contained inside buildings • Plant designed for limited vibration and noise levels. • Hartland site is remote from community **Conclusion: Good**

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Criteria and Description	**Considerations**							
SO-03 **Odour Impacts on Local Community** Impact of nuisance odours on the local community. This criterion assumes that the following design parameters have been followed: • Covered processes • Machines in buildings • Use of scrubbers • Requirement for no odour at the property line during normal operations	• Proximity to local community (e.g., 25m) and classification of local community (e.g., commercial, industrial, residential) • Potential odour due to fugitive emission • Degree of omission containment • Degree of odour control equipment • Dispersion specs and impact nearest residences	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Good**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Good**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Fair**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Average**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Average**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Fair**	**Evidence:** • Nearest residential property is 1,000 metres from the site. • All unit processes contained in buildings. • Plant designed to stringent odour control requirements. Odour control systems include biofilters and activated carbon filters. • Emission modeling has ensured low odour numbers at property boundaries. • Due to the distance between the facilities and nearby residences, there is a low probability of complaints relating to fugitive odour emissions. **Conclusion: Fair**
SO-04 **Health and Safety - Workplace and Public** Potential workplace and public health and safety issues.	• Sewage and untreated biosolids may contain bacteria, fungi, parasites, and viruses that can cause various illnesses and infections • Biological agents that are capable of causing disease and that are considered the greatest threat are called pathogens. • Pathogens may be	**Evidence:** • There is no potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • The biosolids processing equipment is generally enclosed and there is minimal potential to wastewater operators	**Evidence:** • There is no potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • The biosolids processing equipment is generally enclosed and there is minimal potential to wastewater operators	**Evidence:** • There is some potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • The raw solids processing is not enclosed and there is greater potential to wastewater operators	**Evidence:** • There is some potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • Biosolids have been stabilized via digestion process • The biosolids processing is not	**Evidence:** • There is some potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • Biosolids have been stabilized via digestion process • The biosolids processing is not	**Evidence:** • There is greater potential of landfill operations staff or the community being exposed to wind or water borne pathogens from this Option. • The raw solids have not been stabilized • The raw solids processing is not enclosed and there	**Evidence:** • There is some potential community being exposed to harmful emissions. • The raw solids processing equipment is generally enclosed and there is minimal potential to wastewater operators to be exposed to airborne pathogens. • For activities that

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	dispersed into the workplace and surrounding community by water or wind. • Potential health risks and illnesses may include, but are not limited to: ○ Gastroenteritis - characterized by cramping, stomach pains, diarrhea and vomiting ○ Weil's disease - a flu-like illness with persistent and severe headache, transmitted by rat urine. Damage to liver, kidneys and blood may occur and the condition can be fatal. ○ Occupational asthma - resulting in attacks of breathlessness, chest tightness and wheezing, and produced by the inhalation of living or dead organisms. ○ Infection of the skin or eyes • Rarely, allergic alveolitis (inflammation of the lung) with fever, breathlessness, dry cough, and aching muscles and joints.	to be exposed to airborne pathogens. • For periodic activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Good**	to be exposed to airborne pathogens. • For periodic activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Good**	to be exposed to airborne pathogens • For activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Average**	enclosed and there is greater potential to wastewater operators to be exposed to airborne pathogens • For periodic activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Average**	enclosed and there is greater potential to wastewater operators to be exposed to airborne pathogens • For periodic activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Average**	is greater potential to wastewater operators to be exposed to airborne pathogens. • For activities that require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Fair**	require workers to contact contaminated equipment, workers will be trained in Safe Work Practices and will use Personal Protective Equipment (PPE) such as gloves and masks to avoid any direct contact with untreated waste. **Conclusion: Average**
SO-05 **Construction Impacts (Solids Conveyance)** Construction impacts to the community along the conveyance route	• Consider the impacts (noise, dust and vibration) of conveyance construction to the local community (focusing on	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**

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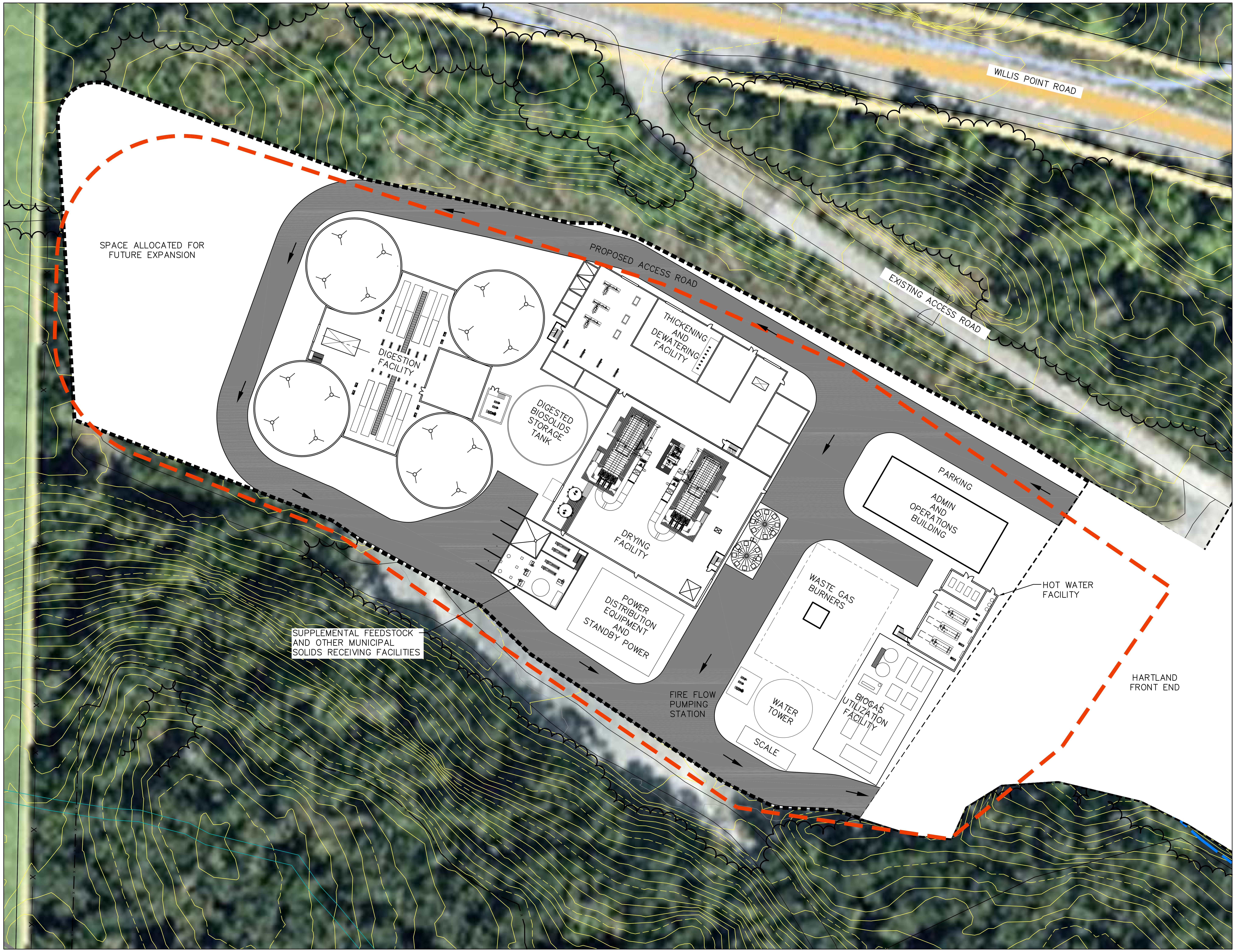
	residential and commercial) • Interruption of "quiet enjoyment" of private property owners • Impacts to vegetation and property, including any costs of remediation • Possible damage to property(consider causes, e.g., blasting or vibration) • Pipeline is small diameter 250 mm and impacts are not anticipated to be significant							
SO-06 **Construction Impacts (Treatment Facilities)** Construction impacts to the community	• Consider the impacts (noise, dust and vibration) of plant construction to the local community (focusing on residential and commercial) • Impacts to environmentally sensitive areas • Interruption of "quiet enjoyment" of private property owners • Impacts to vegetation and property, including any costs of remediation • Possible damage to property (consider causes, e.g., blasting or vibration) • Daily construction truck traffic	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 24 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 24 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 18 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 18 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 18 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 12 months. **Conclusion: Good**	**Evidence:** • Excavated material will be disposed on site. • Due to the remoteness of the facilities there is a low risk of significant dust, vibration, and noise impacts to the neighbours. • Daily traffic volumes from construction activities could be 100 vehicles movements/day for 36 months. • Concrete trucking to site will be up to 30 trucks/day over 30 months. **Conclusion: Good**

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
SO-07 **Ease of Operations** Complexity of technology to maintain operational performance	• Is the treatment technology robust and will respond favourably to changing feedstock conditions • Does the treatment technology require frequent operator monitoring and intervention	**Evidence:** • Anaerobic Digestion is a stable process that will perform well without operator oversight during periods of unattended operation • Biosolids dewatering using centrifuge technology use high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on biosolids characteristics. • Drying technology uses indirect heat and is typically only operated when operators are onsite. Unattended operated is not recommended. • Based on historical operating experience, drying technology requires significant maintenance. **Conclusion: Average**	**Evidence:** • Anaerobic Digestion is a stable process that will perform well without operator oversight during periods of unattended operation • Biosolids dewatering using centrifuge technology use high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on biosolids characteristics. • Drying technology uses indirect heat and is typically only operated when operators are onsite. Unattended operated is not recommended. • Based on historical operating experience, drying technology requires significant maintenance. **Conclusion: Average**	**Evidence:** • Undigested solids dewatering requires additional equipment using centrifuge technology with high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on solids characteristics. • Drying technology uses indirect heat and is typically only operated when operators are onsite. Unattended operated is not recommended. • Based on historical operating experience, drying technology requires significant maintenance. **Conclusion: Average**	**Evidence:** • Anaerobic Digestion is a stable process that will perform well without operator oversight during periods of unattended operation • Biosolids dewatering using centrifuge technology use high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on biosolids characteristics. **Conclusion: Good**	**Evidence:** • Anaerobic Digestion is a stable process that will perform well without operator oversight during periods of unattended operation • Biosolids dewatering using centrifuge technology use high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on biosolids characteristics. **Conclusion: Good**	**Evidence:** • Undigested solids dewatering requires additional equipment using centrifuge technology with high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on solids characteristics. • More difficulty handling raw sludge **Conclusion: Average**	**Evidence:** • Undigested solids dewatering requires additional equipment using centrifuge technology with high speed rotating elements and are normally only utilized when operators are onsite. • Solids dewatering or thickening utilizes polymers which require frequent monitoring and adjustment based on solids characteristics. **Conclusion: Good**
SO-08 **Compatibility with Official Community Plan** Degree of planning activity to amend OCP, zoning and Development Permitting	• Compatibility with existing Official Community Plan • Requirement for rezoning or variance on zoning, including risk of receiving	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • Rezoning not required for this Option. • OCP has been amended for the	**Evidence:** • Solids processing is a permitted use. • This option may require rezoning • This option will require extensive

Option Number		1	2	3	4	4a	5	6
Option Description		Anaerobic Digestion + Dryer + Gas scrubbing and nutrient recovery	Anaerobic Digestion + Dryer No gas scrubbing or nutrient recovery	Dryer Residual Solids	Anaerobic Digestion / Dewatered Solids / Biocell	Anaerobic Digestion / Dewatered Solids / Biocell	Dewatered Residual Solids / Biocell	Thermal Destruction Residual Solids
	variance in a timely manner • Development permitting process, including risk of achieving DP in a timely manner • Anticipated opposition to rezoning by host municipality or impacted property owners	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	approved zoning. • Development Permit (DP) may be required. **Conclusion: Average**	public consultation **Conclusion: Poor**
SO-09 **Archeological Findings** Risk of discovering archeological items during construction	• Consider archeological studies completed to date	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Good**
SO-10 **Impact to Local First Nations** How the option impacts local First Nations, either by providing benefits, or lack of consultation	• Can the option accommodate First Nation interests? • Has the local First Nations been consulted on the proposed sites? • Are there opportunities for the local First Nations to benefit through the development of the option?	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**
SO-11 **Cultural and Heritage Impacts** Ability to use and/or respect culture and heritage. This would include consideration of existing structures or features on the proposed sites.	• How the option respects and incorporates existing cultural or heritage structures, site, or artifacts	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**	**Evidence:** • No material difference in how the options meet the criterion **Conclusion: Average**

Appendix B

Site Drawings of Options



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Making a difference...together

Capital Regional District | Core Area Wastewater Treatment Program

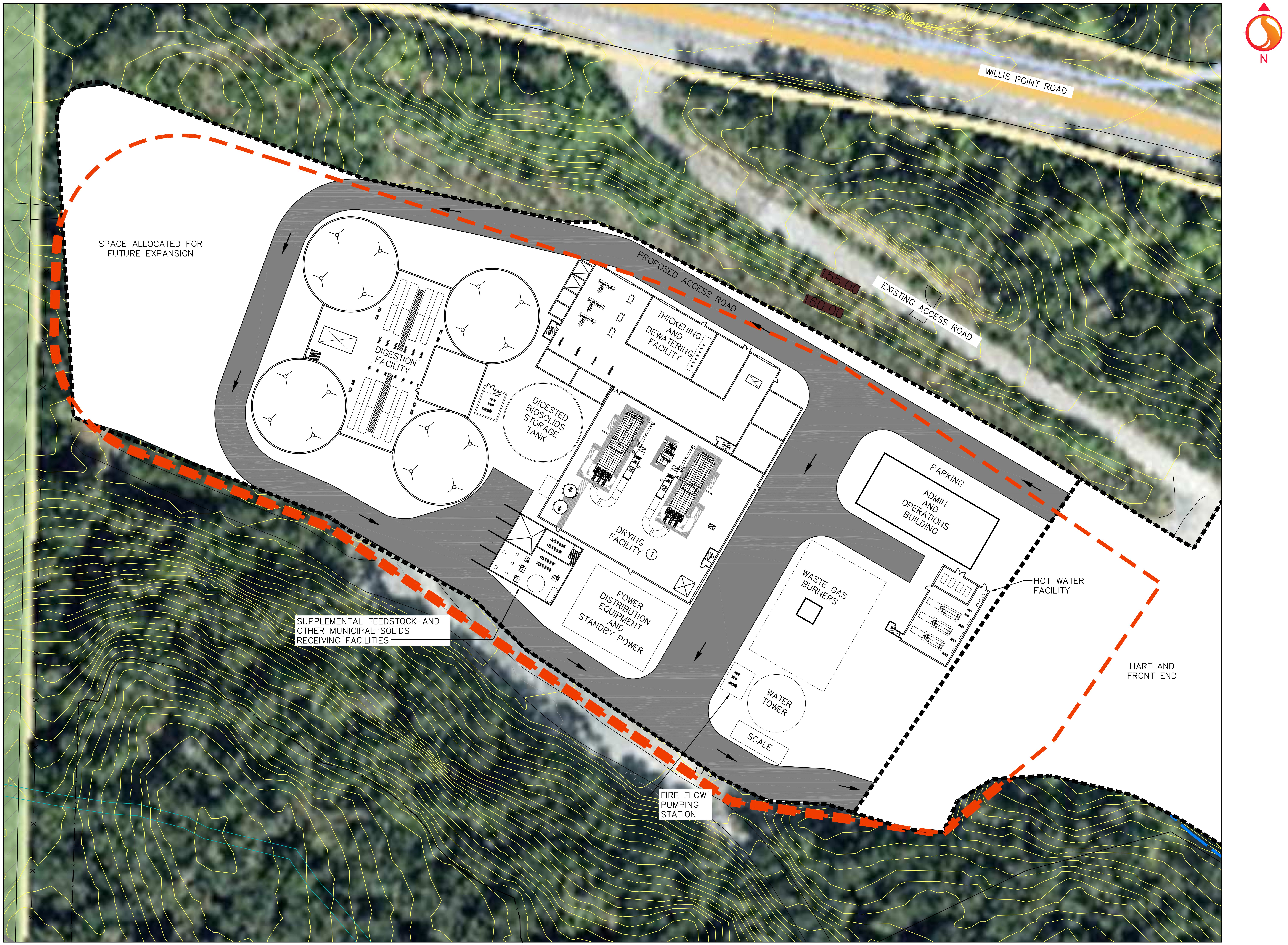
DESIGNED	R.A.F	SURVEYED	–
DRAWN	B.G	DATE	02/08/16
SCALE HORIZONTAL	1:500	CHECKED	
SCALE VERTICAL		APPROVED	

CORE AREA WASTEWATER TREATMENT PLANT

OPTION 1 – ANAEROBIC DIGESTION, BIOSOLIDS DRYING, STRUVITE RECOVERY AND BIOGAS CONDITIONING

HARTLAND PLANT SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF



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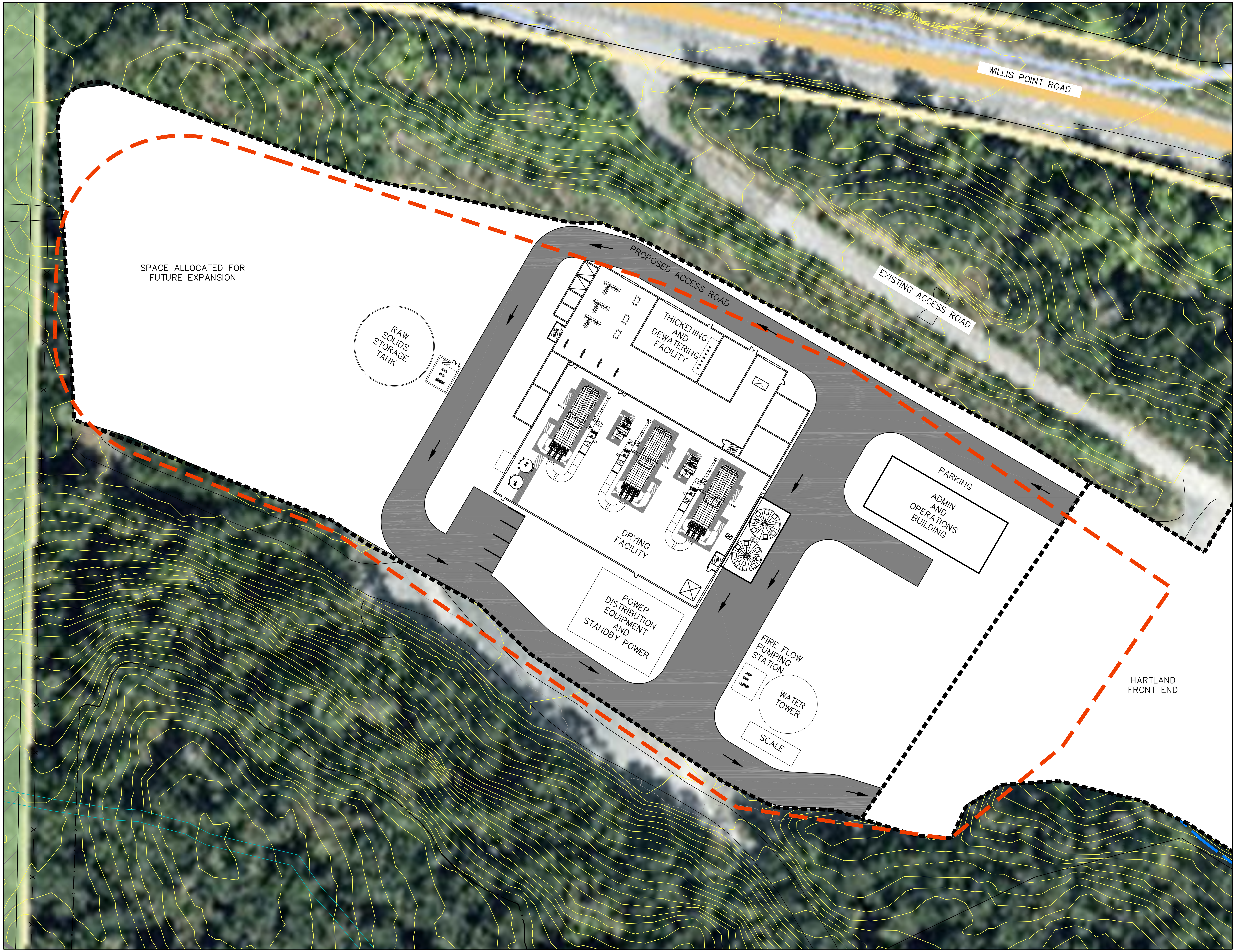
SCALE VERTICAL	APPROVED

CORE AREA WASTEWATER TREATMENT PLANT
OPTION 2 – ANAEROBIC DIGESTION WITH BIOSOLIDS DRYING
HARTLAND PLANT SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF



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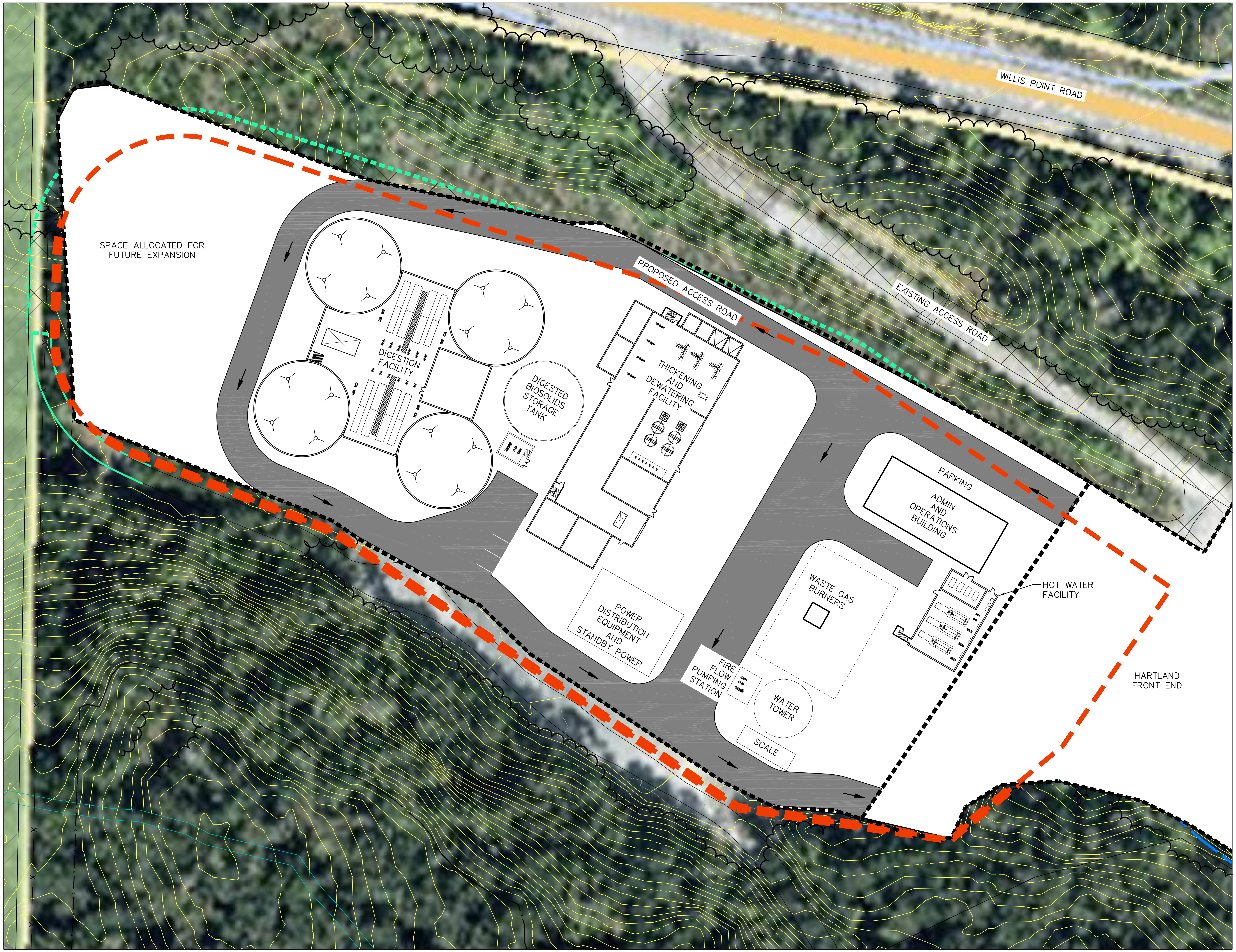
SCALE VERTICAL		APPROVED	

CORE AREA WASTEWATER TREATMENT PLANT

OPTION 3 – RESIDUAL SOLIDS DRYING (PELLETIZATION)

HARTLAND PLANT SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF



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SCALE VERTICAL		APPROVED	

CORE AREA WASTEWATER TREATMENT PLANT

OPTION 4 – ANAEROBIC DIGESTION / BIOCELL REACTORS (WITH OR WITHOUT MSW)

HARTLAND PLANT SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF

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BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE

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DESIGNED DL	SURVEYED –	OPTION 4 – ANAEROBIC DIGESTION / BIOCELL REACTORS (WITH OR WITHOUT MSW)	
DRAWN PRC	DATE 02/08/16		
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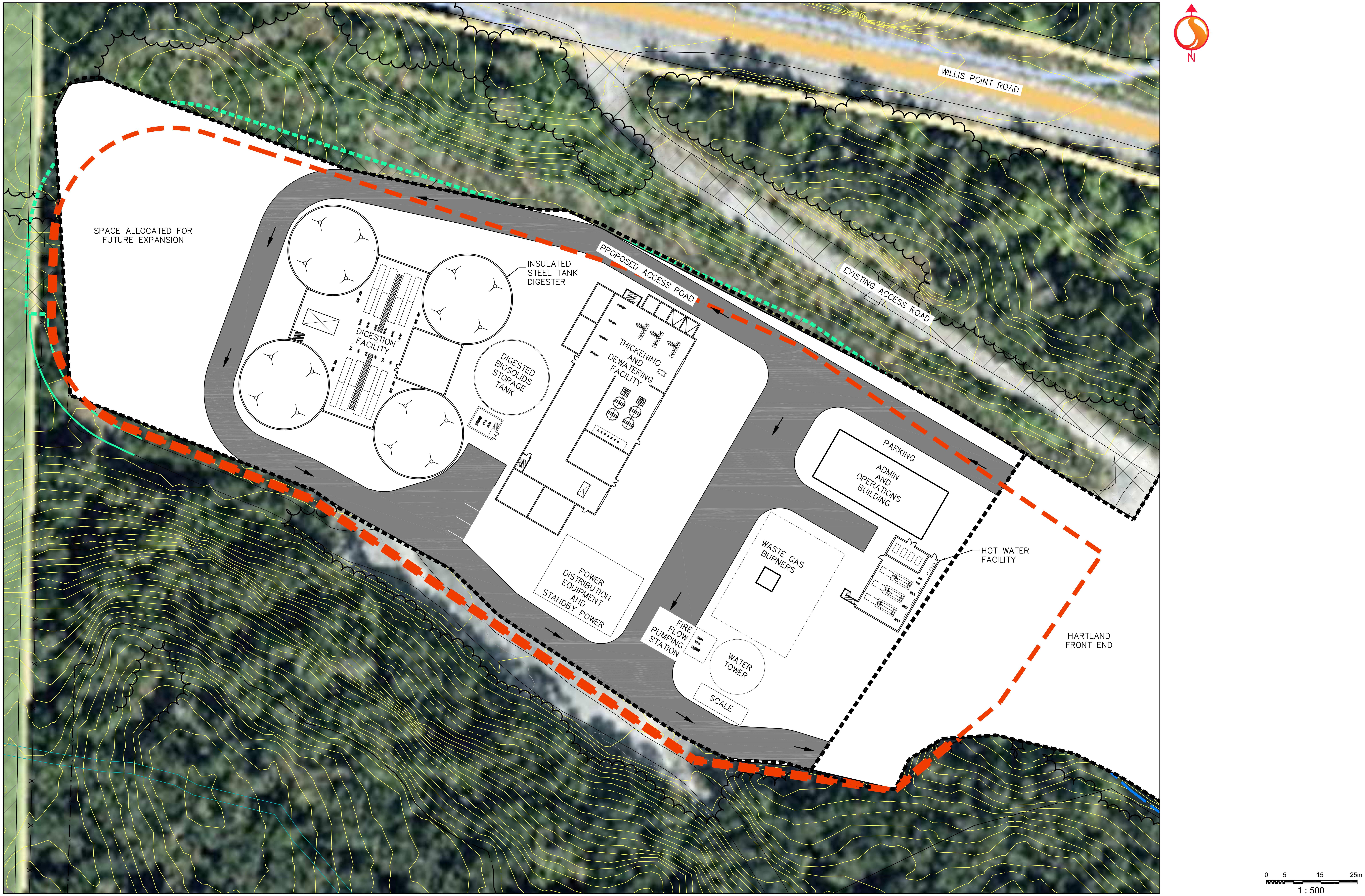

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CHECKED
SCALE VERTICAL
APPROVED

CORE AREA WASTEWATER TREATMENT PLANT

OPTION 4a – ANAEROBIC DIGESTION (STEEL TANK) / BIOCELL REACTORS (WITH OR WITHOUT MSW)

HARTLAND PLANT SITE PLAN

CONTRACT NUMBER | DRAWING NUMBER | ISSUE | SHT. No. OF

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DRAWN PRC	DATE 02/08/16
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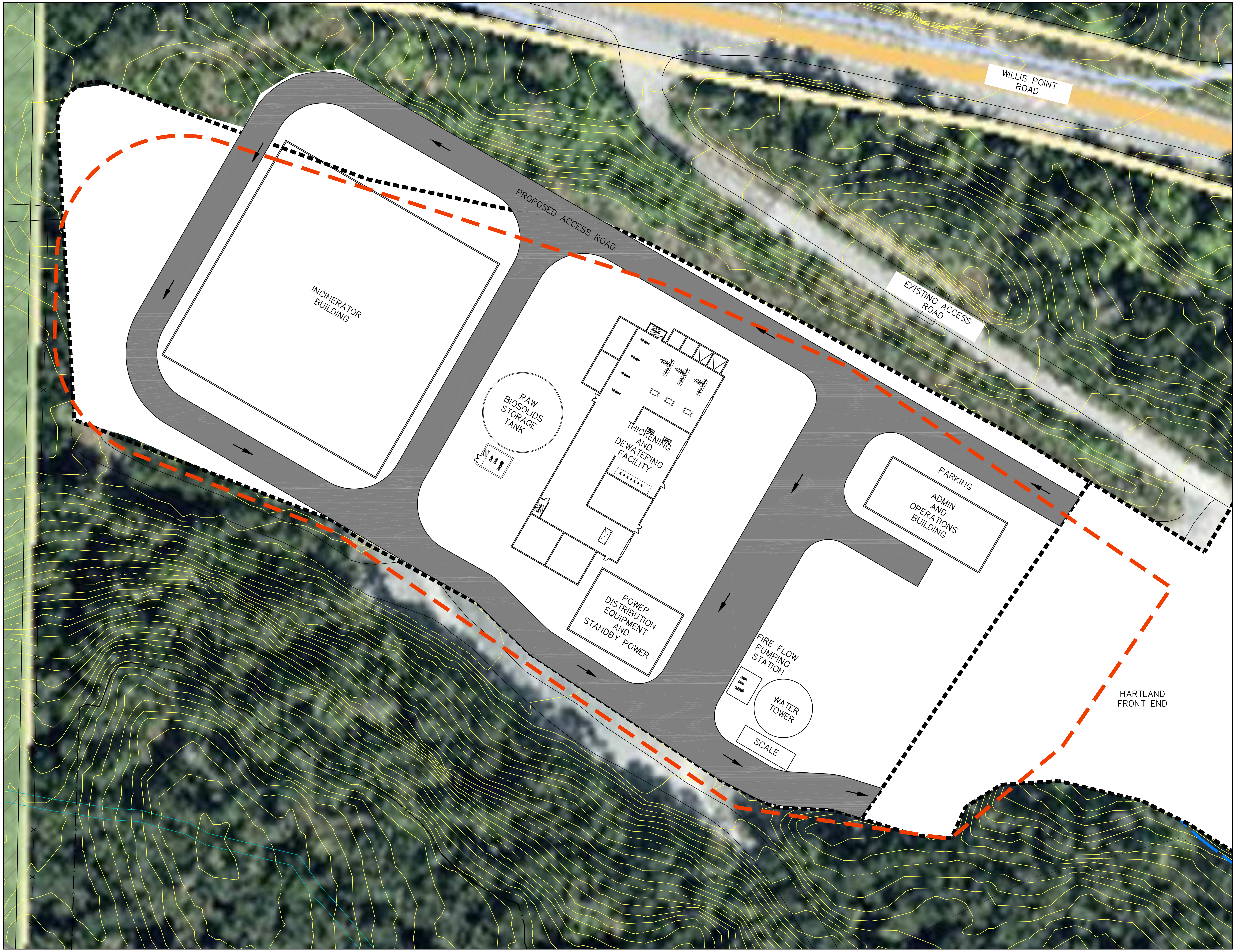
SCALE VERTICAL –	APPROVED RAF

CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 5 – UNDIGESTED RESIDUAL SOLIDS BIOCELL REACTORS (RESIDUAL SOLIDS WITH OR WITHOUT MSW)

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
		–	–



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SCALE HORIZONTAL	1:500	CHECKED	
SCALE VERTICAL		APPROVED	

CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 6 – RESIDUAL SOLIDS THERMAL DESTRUCTION

PLANT GENERAL SITE PLAN

CONTRACT NUMBER	DRAWING NUMBER	ISSUE	SHT. No. OF
	–		

Appendix C

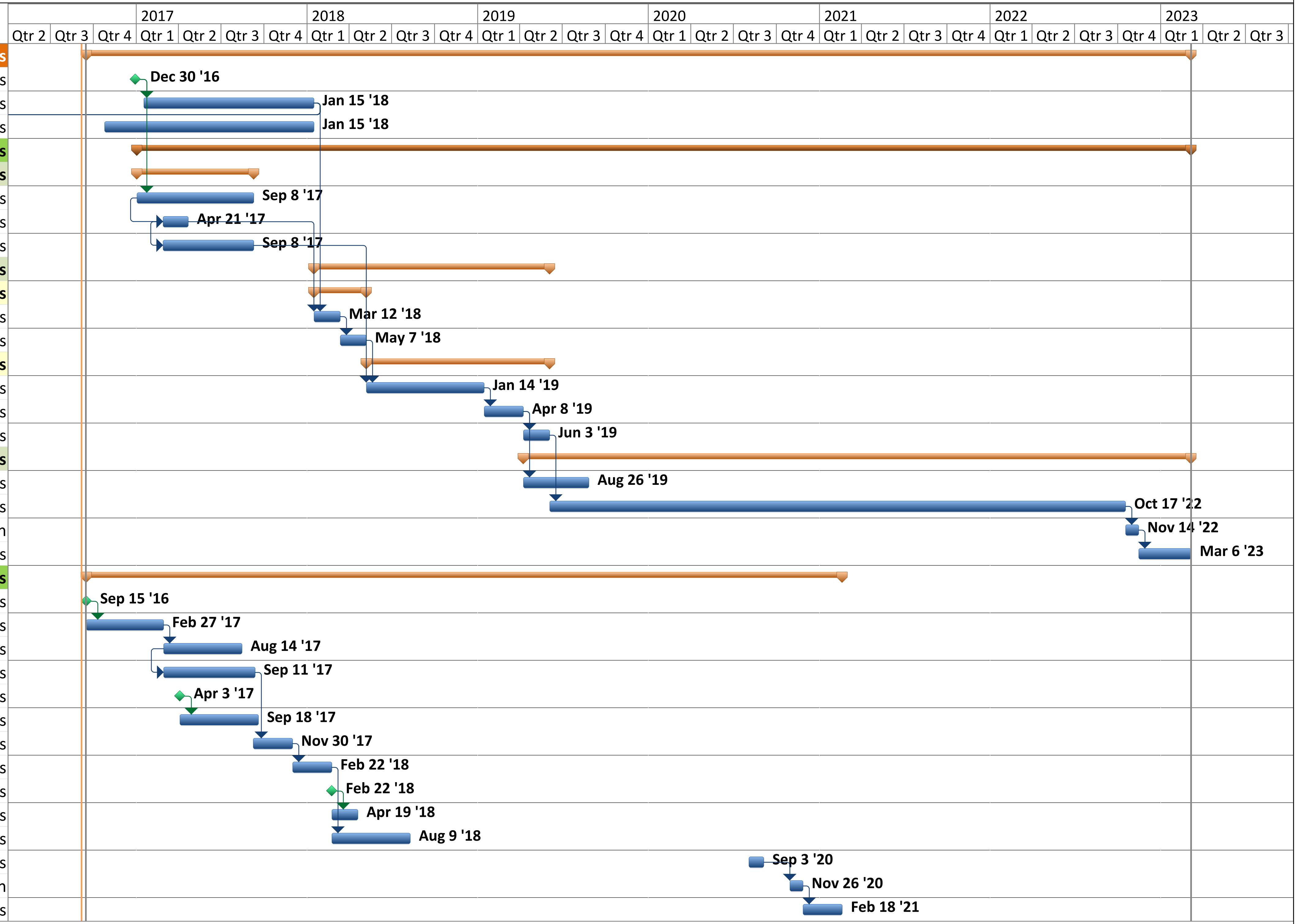
Schedules

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 4 - Rock Bay Secondary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 5B'**	**84.35 mons**
2	**Funding in Place**	0 mons
3	**Secure Property/Zoning /Lease**	13 mons
4	**Environmental Impact Study (EIS)**	16 mons
5	**Rock Bay Liquid Plant**	**80.55 mons**
6	**Planning**	**9 mons**
7	Scope/Indicative Design/PA	9 mons
8	Prepare RFQ	2 mons
9	Prepare RFP	7 mons
10	**Procurement**	**18 mons**
11	**RFQ**	**4 mons**
12	RFQ Submission	2 mons
13	RFQ Evaluation/Shorlist	2 mons
14	**RFP**	**14 mons**
15	RFP Submission	9 mons
16	RFP Evaluation and Preferred Proponent	3 mons
17	Financial Close	2 mons
18	**Construction**	**51 mons**
19	Early Work/Design	5 mons
20	Construction & Commissioning	44 mons
21	Wet Testing	1 mon
22	Acceptance Testing	4 mons
23	**Biosolids Hartland**	**57.75 mons**
24	Approval of Business Case	0 mons
25	Procurement Planning	5.85 mons
26	Release RFQ to Market	6 mons
27	Approval of Shortlist	7 mons
28	Release RFP to Market	0 mons
29	Proposal Preparation	6 mons
30	Technical RFP Submission Due	3 mons
31	Financial Submission Due	3 mons
32	Preferred Proponent Announced	0 mons
33	Commercial / Financial Close	2 mons
34	Design / Construction of Facility	6 mons
35	Wet Testing	1.2 mons
36	Functional Testing	1 mon
37	Acceptance Testing	3 mons



Date: Tue 9/6/16

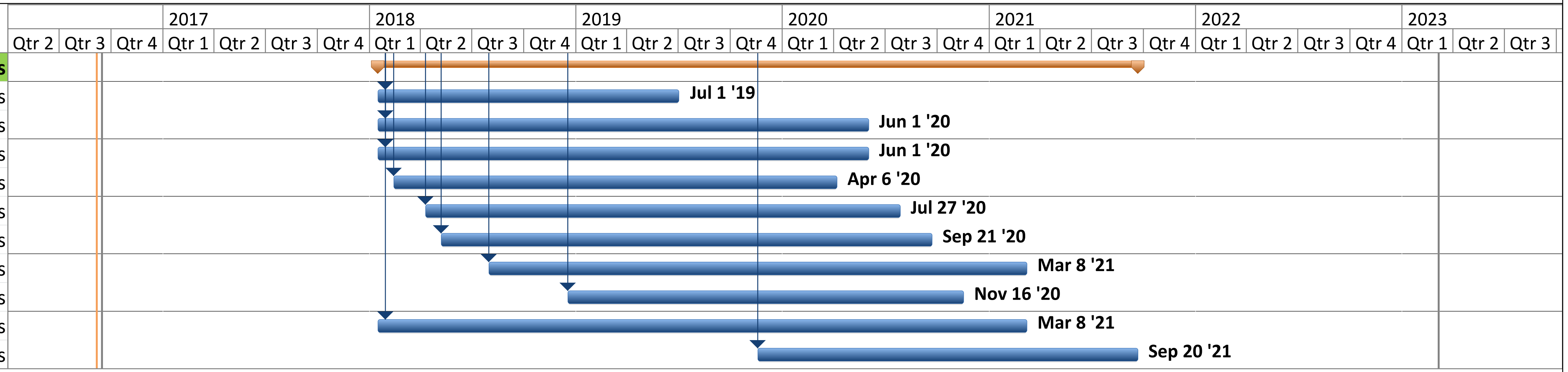
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 4 - Rock Bay Secondary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
38	**Conveyance (Scope TBD)**	**48 mons**
39	Arbutus Road Attenuation Tank (DBB)	19 mons
40	Clover Forcemain to Rock Bay	31 mons
41	Rock Bay to Clover Forcemain	31 mons
42	Clover Pump Station	28 mons
43	ECI/Trent Twining (DBB)	30 mons
44	Macaulay Forcemain to Rock Bay	31 mons
45	Currie Forcemain	34 mons
46	Currie Pump Station	25 mons
47	Macaulay Pump Station	41 mons
48	Clover Outfall Twin	24 mons



Date: Tue 9/6/16

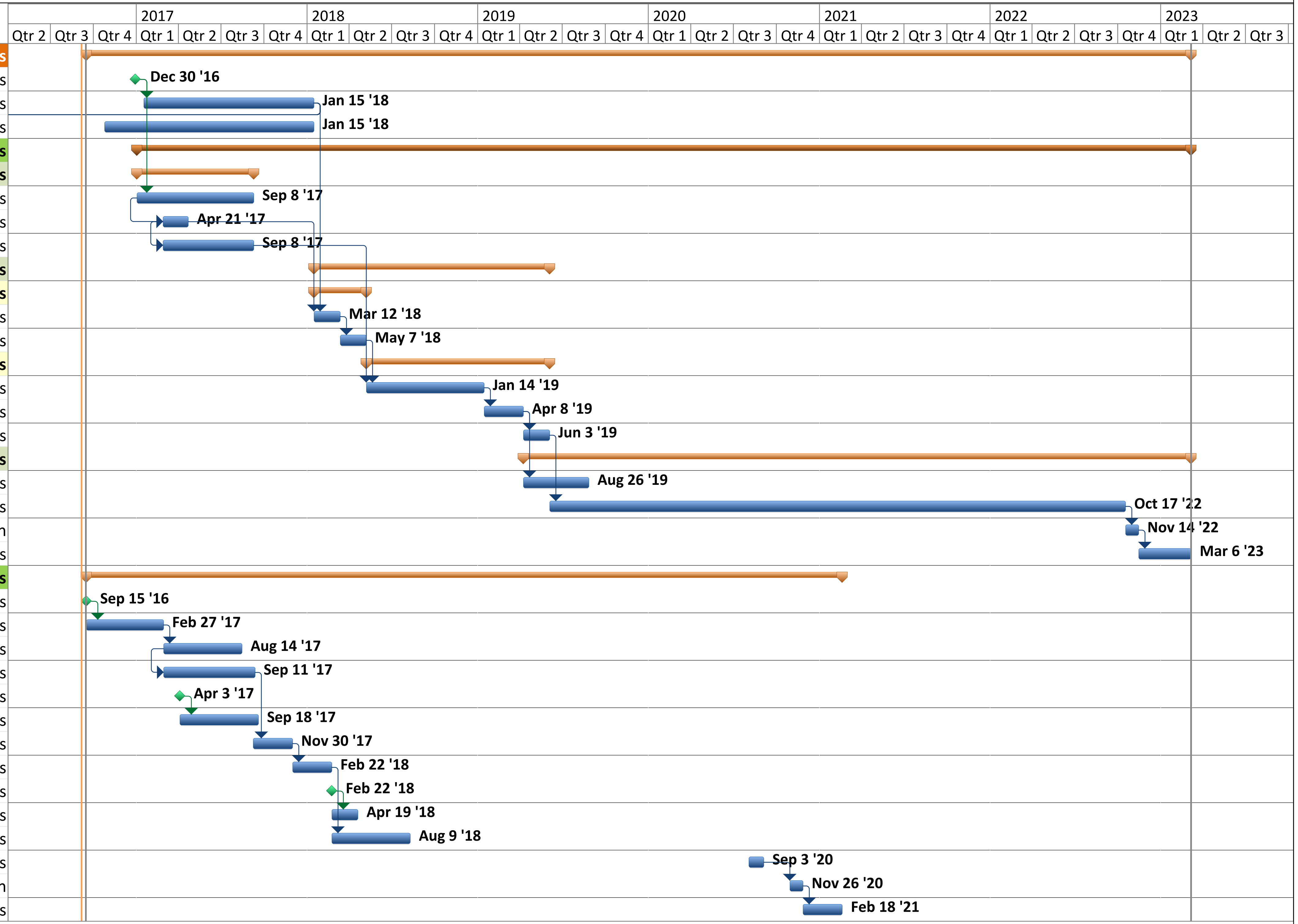
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 4a - Rock Bay Tertiary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 5B'**	**84.35 mons**
2	**Funding in Place**	0 mons
3	**Secure Property/Zoning /Lease**	13 mons
4	**Environmental Impact Study (EIS)**	16 mons
5	**Rock Bay Liquid Plant**	**80.55 mons**
6	**Planning**	**9 mons**
7	Scope/Indicative Design/PA	9 mons
8	Prepare RFQ	2 mons
9	Prepare RFP	7 mons
10	**Procurement**	**18 mons**
11	**RFQ**	**4 mons**
12	RFQ Submission	2 mons
13	RFQ Evaluation/Shorlist	2 mons
14	**RFP**	**14 mons**
15	RFP Submission	9 mons
16	RFP Evaluation and Preferred Proponent	3 mons
17	Financial Close	2 mons
18	**Construction**	**51 mons**
19	Early Work/Design	5 mons
20	Construction & Commissioning	44 mons
21	Wet Testing	1 mon
22	Acceptance Testing	4 mons
23	**Biosolids Hartland**	**57.75 mons**
24	Approval of Business Case	0 mons
25	Procurement Planning	5.85 mons
26	Release RFQ to Market	6 mons
27	Approval of Shortlist	7 mons
28	Release RFP to Market	0 mons
29	Proposal Preparation	6 mons
30	Technical RFP Submission Due	3 mons
31	Financial Submission Due	3 mons
32	Preferred Proponent Announced	0 mons
33	Commercial / Financial Close	2 mons
34	Design / Construction of Facility	6 mons
35	Wet Testing	1.2 mons
36	Functional Testing	1 mon
37	Acceptance Testing	3 mons



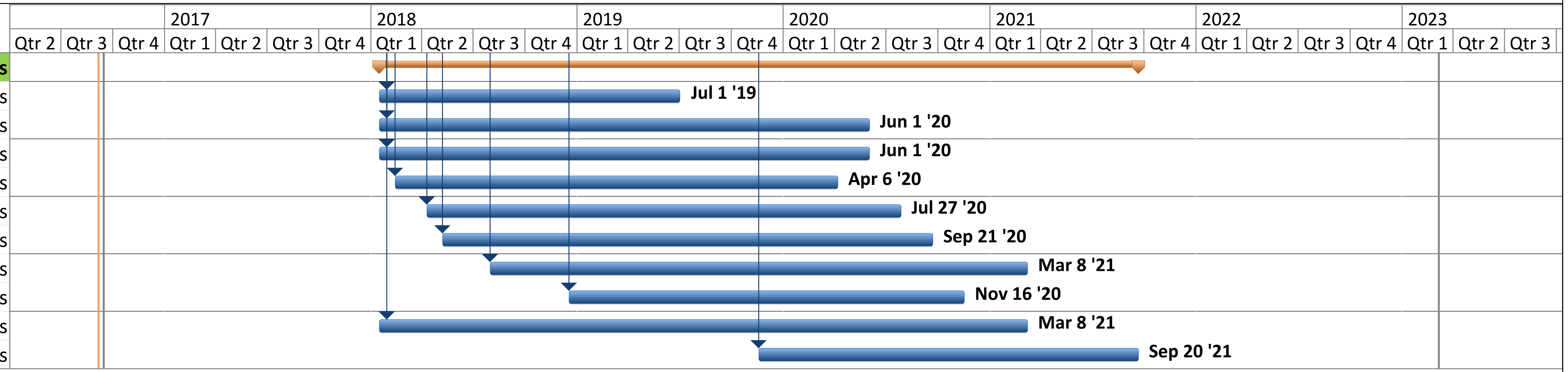
Date: Tue 9/6/16

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 4a - Rock Bay Tertiary. Biosolids at Hartland

ID	Task Name	Duration
38	**Conveyance (Scope TBD)**	**48 mons**
39	Arbutus Road Attenuation Tank (DBB)	19 mons
40	Clover Forcemain to Rock Bay	31 mons
41	Rock Bay to Clover Forcemain	31 mons
42	Clover Pump Station	28 mons
43	ECI/Trent Twining (DBB)	30 mons
44	Macaulay Forcemain to Rock Bay	31 mons
45	Currie Forcemain	34 mons
46	Currie Pump Station	25 mons
47	Macaulay Pump Station	41 mons
48	Clover Outfall Twin	24 mons



Date: Tue 9/6/16

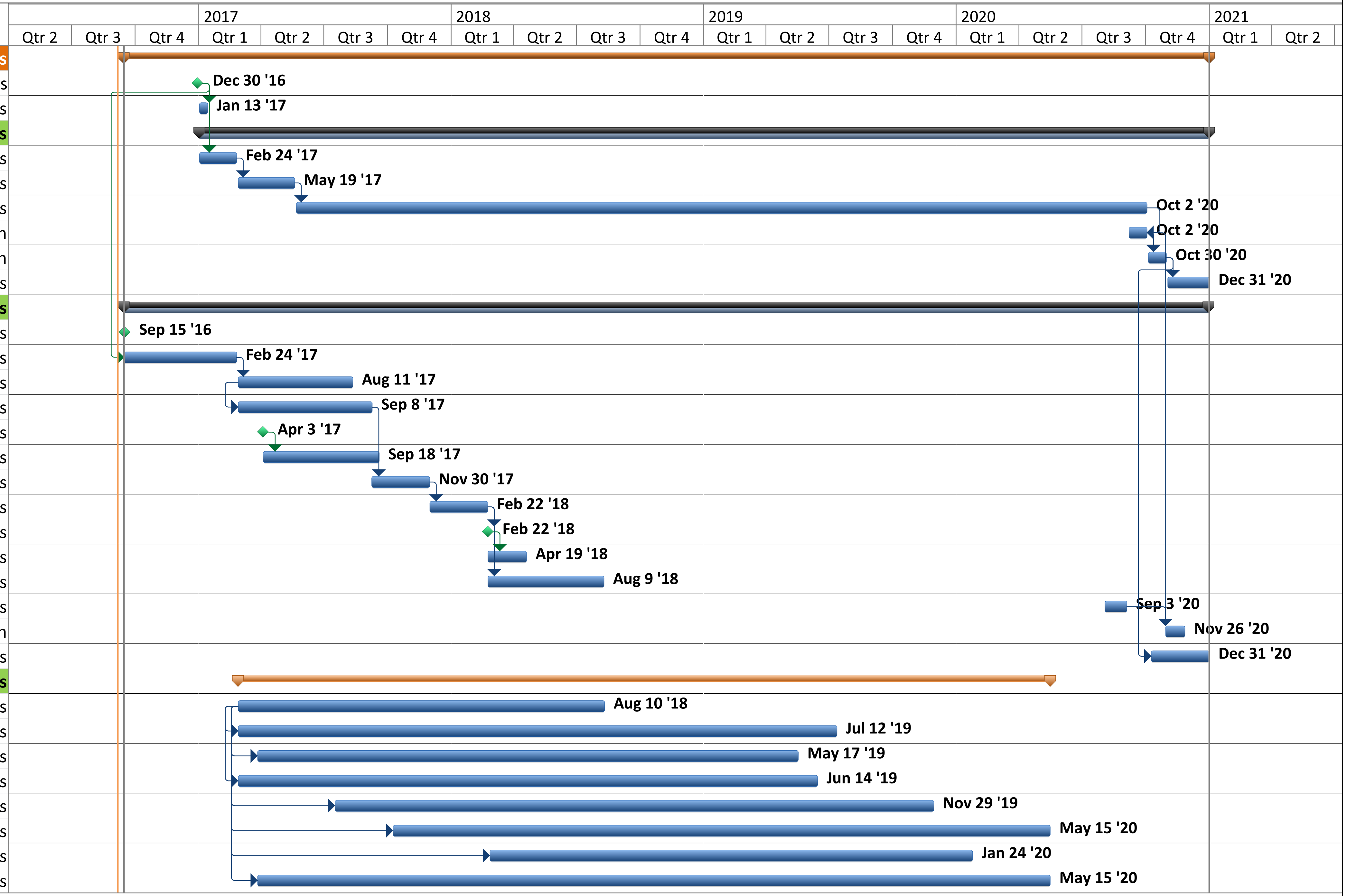
Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 8 - McLoughlin Point Secondary, Biosolids Treatment at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 8**	**56.05 mons**
2	**Funding in Place**	0 days
3	**McLoughlin Point Zoning/Property Finalized**	0.5 mons
4	**Liquid Plant McLoughlin Point**	**52.2 mons**
5	Negotiation financial submission	2 mons
6	Preparation for Financial Close (include Board approval)	3 mons
7	Construction & Commissioning	44 mons
8	Wet Testing	1 mon
9	Functional Testing	1 mon
10	Acceptance Testing Liquid Treatment	2.2 mons
11	**Biosolids Facility Hartland**	**56 mons**
12	Approval of Business Case	0 mons
13	Procurement Planning	5.85 mons
14	Release RFQ to Market	6 mons
15	Approval of Shortlist	7 mons
16	Release RFP to Market	0 mons
17	Proposal Preparation	6 mons
18	Technical RFP Submission Due	3 mons
19	Financial Submission Due	3 mons
20	Preferred Proponent Announced	0 mons
21	Commercial / Financial Close	2 mons
22	Design / Construction of Facility	6 mons
23	Wet Testing	1.2 mons
24	Functional Testing	1 mon
25	Acceptance Testing	3 mons
26	**Conveyance**	**42 mons**
27	Arbutus Road Attenuation Tank (DBB)	19 mons
28	Clover Forcemain	31 mons
29	Clover Pump Station	28 mons
30	ECI/Trent Twining (DBB)	30 mons
31	Macaulay Forcemain	31 mons
32	Currie Forcemain	34 mons
33	Currie Pump Station	25 mons
34	Macaulay Pump Station	41 mons



Date: Tue 9/6/16

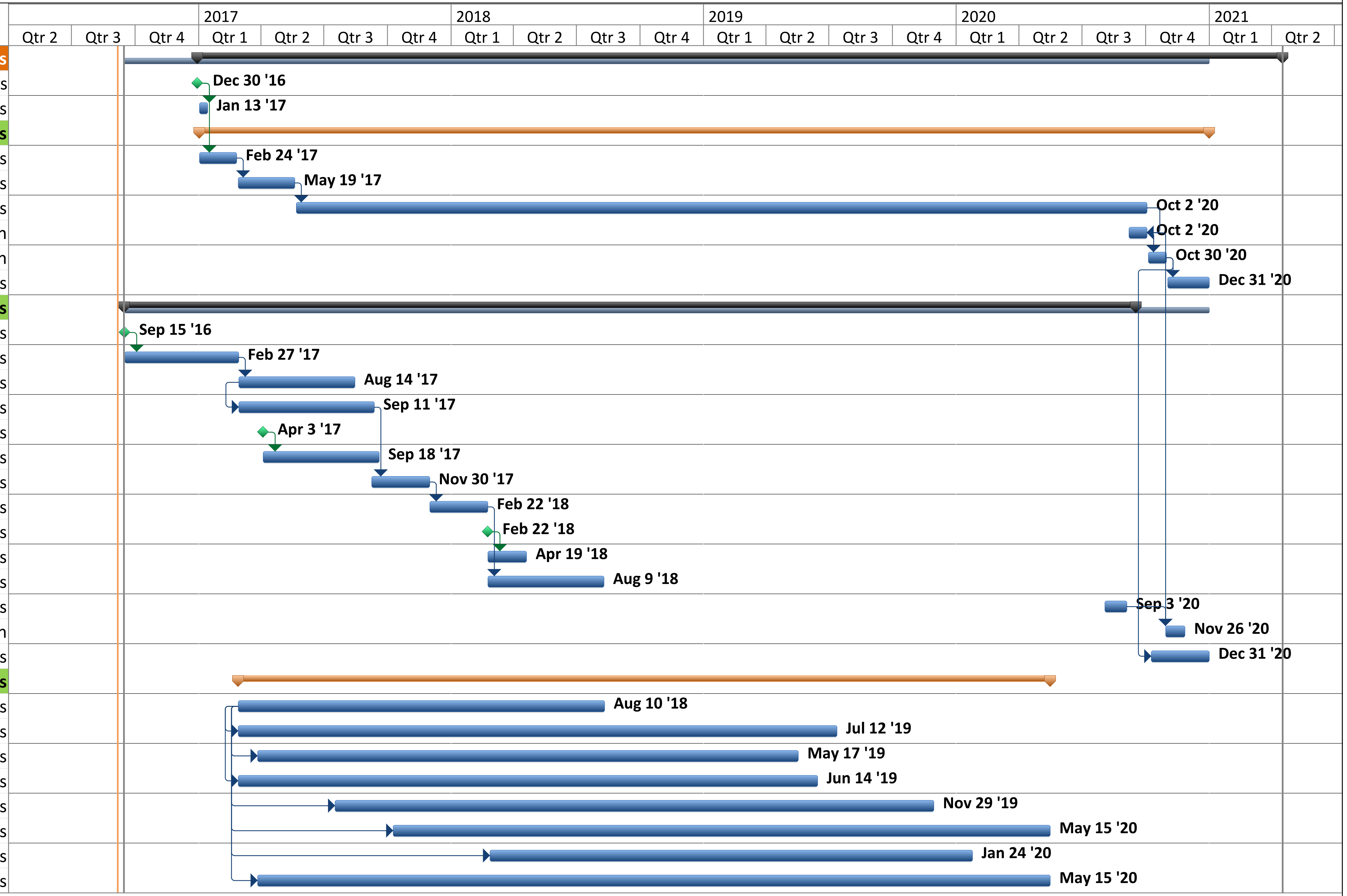
Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 8a - McLoughlin Point Tertiary, Biosolids Treatment at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 8**	**56.05 mons**
2	**Funding in Place**	0 days
3	**McLoughlin Point Zoning/Property Finalized**	0.5 mons
4	**Liquid Plant McLoughlin Point**	**52.2 mons**
5	Negotiation financial submission	2 mons
6	Preparation for Financial Close (include Board approval)	3 mons
7	Construction & Commissioning	44 mons
8	Wet Testing	1 mon
9	Functional Testing	1 mon
10	Acceptance Testing Liquid Treatment	2.2 mons
11	**Biosolids Facility Hartland**	**52.25 mons**
12	Approval of Business Case	0 mons
13	Procurement Planning	5.85 mons
14	Release RFQ to Market	6 mons
15	Approval of Shortlist	7 mons
16	Release RFP to Market	0 mons
17	Proposal Preparation	6 mons
18	Technical RFP Submission Due	3 mons
19	Financial Submission Due	3 mons
20	Preferred Proponent Announced	0 mons
21	Commercial / Financial Close	2 mons
22	Design / Construction of Facility	6 mons
23	Wet Testing	1.2 mons
24	Functional Testing	1 mon
25	Acceptance Testing	3 mons
26	**Conveyance**	**42 mons**
27	Arbutus Road Attenuation Tank (DBB)	19 mons
28	Clover Forcemain	31 mons
29	Clover Pump Station	28 mons
30	ECI/Trent Twining (DBB)	30 mons
31	Macaulay Forcemain	31 mons
32	Currie Forcemain	34 mons
33	Currie Pump Station	25 mons
34	Macaulay Pump Station	41 mons



Date: Tue 9/6/16

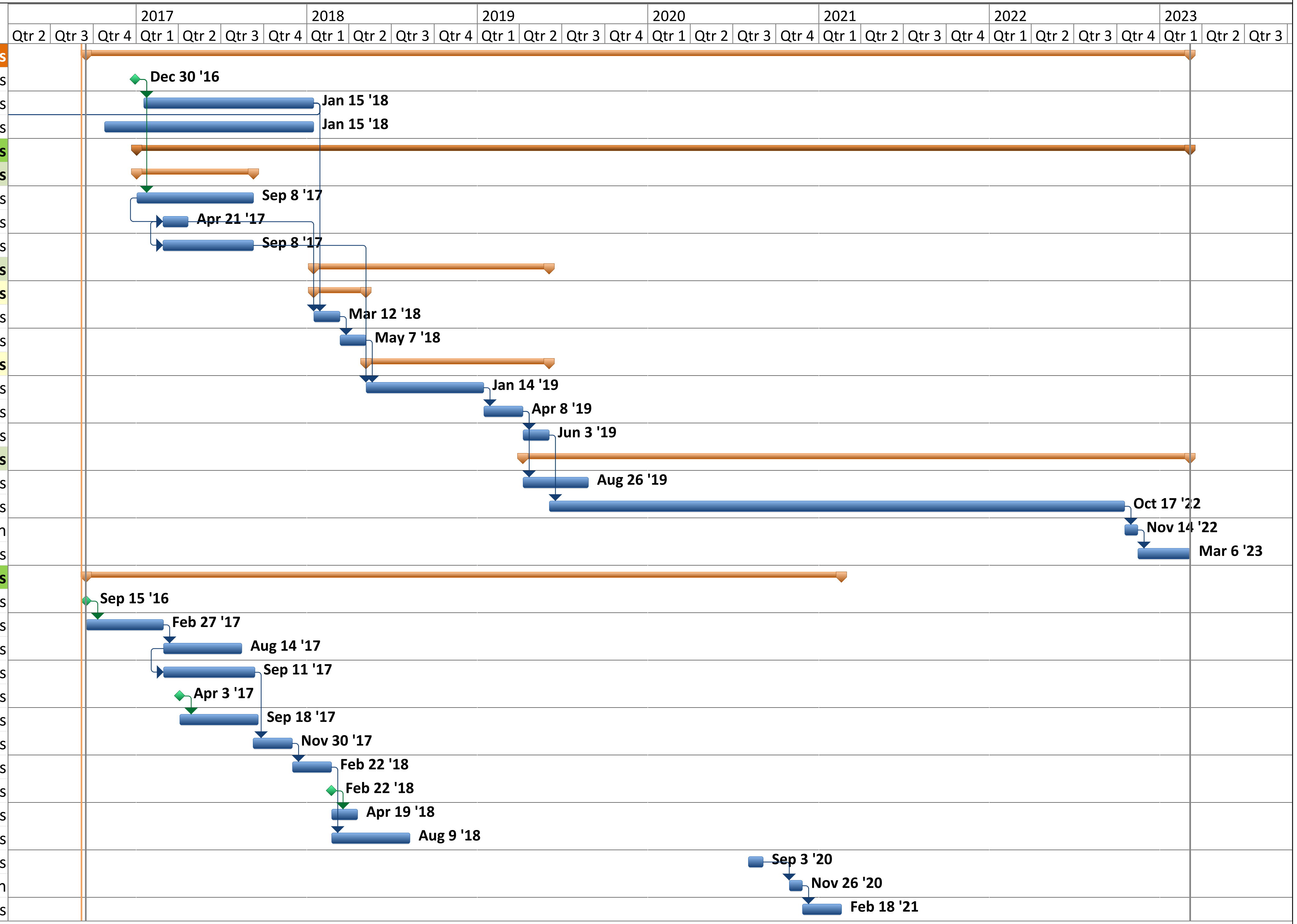
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 18 - Rock Bay / McLoughlin Secondary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 2B & 3B**	**84.35 mons**
2	**Funding in Place**	0 mons
3	**Secure Property/Zoning /Lease**	13 mons
4	**Environmental Impact Study (EIS)**	16 mons
5	**Liquid Plants**	**80.55 mons**
6	**Planning**	**9 mons**
7	Scope/Indicative Design/PA	9 mons
8	Prepare RFQ	2 mons
9	Prepare RFP	7 mons
10	**Procurement**	**18 mons**
11	**RFQ**	**4 mons**
12	RFQ Submission	2 mons
13	RFQ Evaluation/Shorlist	2 mons
14	**RFP**	**14 mons**
15	RFP Submission	9 mons
16	RFP Evaluation and Preferred Proponent	3 mons
17	Financial Close	2 mons
18	**Construction**	**51 mons**
19	Early Work/Design	5 mons
20	Construction & Commissioning	44 mons
21	Wet Testing	1 mon
22	Acceptance Testing	4 mons
23	**Biosolids Hartland**	**57.75 mons**
24	Approval of Business Case	0 mons
25	Procurement Planning	5.85 mons
26	Release RFQ to Market	6 mons
27	Approval of Shortlist	7 mons
28	Release RFP to Market	0 mons
29	Proposal Preparation	6 mons
30	Technical RFP Submission Due	3 mons
31	Financial Submission Due	3 mons
32	Preferred Proponent Announced	0 mons
33	Commercial / Financial Close	2 mons
34	Design / Construction of Facility	6 mons
35	Wet Testing	1.2 mons
36	Functional Testing	1 mon
37	Acceptance Testing	3 mons



Date: Tue 9/6/16

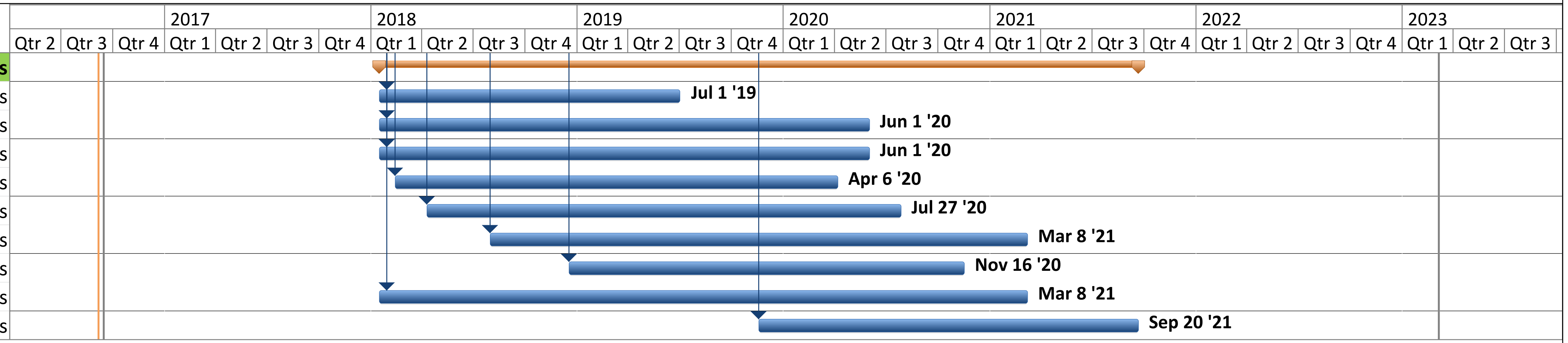
Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 18 - Rock Bay / McLoughlin Secondary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
38	**Conveyance (Scope TBD)**	**48 mons**
39	Arbutus Road Attenuation Tank (DBB)	19 mons
40	Clover Forcemain to Rock Bay	31 mons
41	Rock Bay to Clover Forcemain	31 mons
42	Clover Pump Station	28 mons
43	ECI/Trent Twining (DBB)	30 mons
44	Currie Forcemain	34 mons
45	Currie Pump Station	25 mons
46	Macaulay Pump Station	41 mons
47	Clover Outfall Twin (TBD)	24 mons



Date: Tue 9/6/16

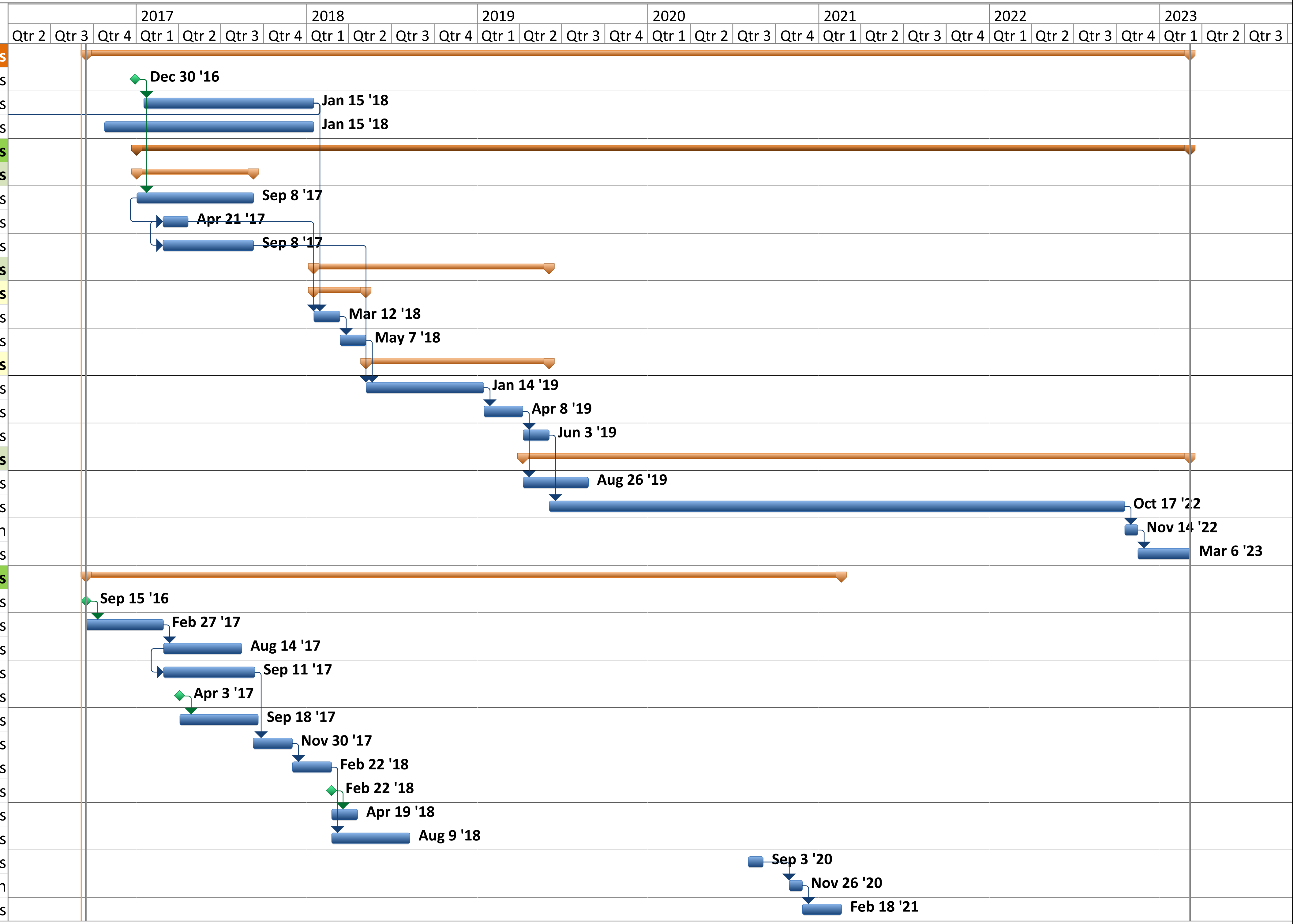
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 18a - Rock Bay / McLoughlin Tertiary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
1	**Core Area Wastewater Treatment Program - Option 2B & 3B**	**84.35 mons**
2	**Funding in Place**	0 mons
3	**Secure Property/Zoning /Lease**	13 mons
4	**Environmental Impact Study (EIS)**	16 mons
5	**Liquid Plants**	**80.55 mons**
6	**Planning**	**9 mons**
7	Scope/Indicative Design/PA	9 mons
8	Prepare RFQ	2 mons
9	Prepare RFP	7 mons
10	**Procurement**	**18 mons**
11	**RFQ**	**4 mons**
12	RFQ Submission	2 mons
13	RFQ Evaluation/Shorlist	2 mons
14	**RFP**	**14 mons**
15	RFP Submission	9 mons
16	RFP Evaluation and Preferred Proponent	3 mons
17	Financial Close	2 mons
18	**Construction**	**51 mons**
19	Early Work/Design	5 mons
20	Construction & Commissioning	44 mons
21	Wet Testing	1 mon
22	Acceptance Testing	4 mons
23	**Biosolids Hartland**	**57.75 mons**
24	Approval of Business Case	0 mons
25	Procurement Planning	5.85 mons
26	Release RFQ to Market	6 mons
27	Approval of Shortlist	7 mons
28	Release RFP to Market	0 mons
29	Proposal Preparation	6 mons
30	Technical RFP Submission Due	3 mons
31	Financial Submission Due	3 mons
32	Preferred Proponent Announced	0 mons
33	Commercial / Financial Close	2 mons
34	Design / Construction of Facility	6 mons
35	Wet Testing	1.2 mons
36	Functional Testing	1 mon
37	Acceptance Testing	3 mons



Date: Tue 9/6/16

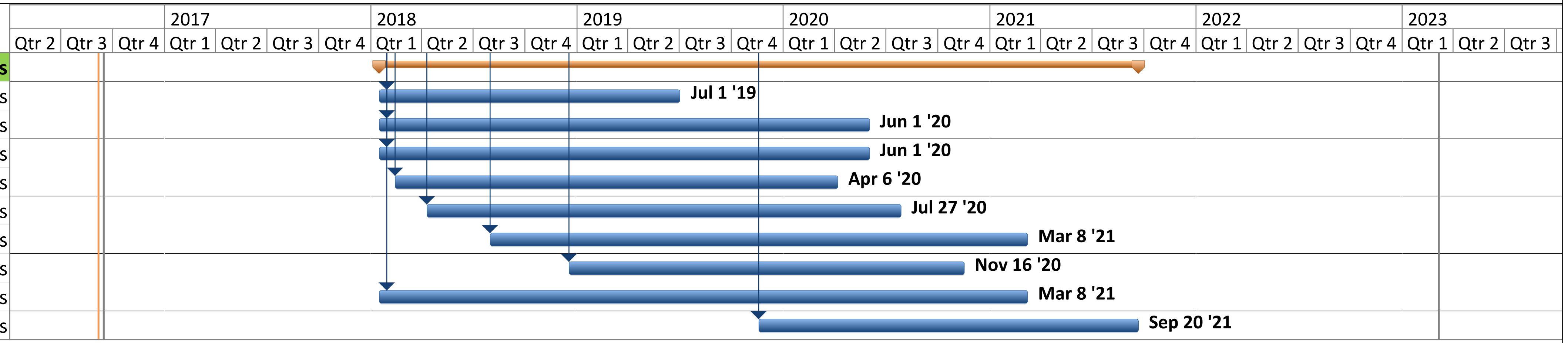
Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

CAPITAL REGIONAL DISTRICT - CORE AREA WASTEWATER TREATMENT PROGRAM

OPTION 18a - Rock Bay / McLoughlin Tertiary. Biosolids at Hartland

Stantec

ID	Task Name	Duration
38	**Conveyance (Scope TBD)**	**48 mons**
39	Arbutus Road Attenuation Tank (DBB)	19 mons
40	Clover Forcemain to Rock Bay	31 mons
41	Rock Bay to Clover Forcemain	31 mons
42	Clover Pump Station	28 mons
43	ECI/Trent Twining (DBB)	30 mons
44	Currie Forcemain	34 mons
45	Currie Pump Station	25 mons
46	Macaulay Pump Station	41 mons
47	Clover Outfall Twin (TBD)	24 mons



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Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
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Appendix D

Cost Estimates

(Commercial Confidential – Under Separate Cover)