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Technical Support Document #10

LEACHATE MANAGEMENT

TAGGART GROUP OF COMPANIES

THE MILLER GROUP

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

Leachate generated from the landfill component of the CRRRC will be collected within the landfill and removed from the leachate collection system by pumping. The leachate removed from the landfill, as well as surplus liquid wastewater from organic processing that will also be collected, will require management and treatment to achieve acceptable quality for surface water discharge. Runoff from the compost pad may also be removed for treatment. The evaluation of leachate management options is required for the proposed Capital Region Resource Recovery Centre (CRRRC) as part of the Environmental Assessment (EA). The following methodology was followed to evaluate the leachate management and treatment options:

- Screen potential on-Site leachate treatment technologies to produce a short list of potential technologies;
- Select a preferred on-Site treatment option based on demonstrated performance and cost-effectiveness;
- Identify potential off-Site leachate receiver/treatment alternatives (i.e., discharge to existing or upgrade off-Site treatment facilities with or without on-Site treatment or pre-treatment; combination with sewage treatment);
- Determine off-Site leachate receiver/treatment alternatives available to Taggart Miller;
- Describe potential alternatives to convey leachate to available off-Site leachate treatment alternatives (i.e., trucking, pipeline);
- Develop leachate management options; and
- If a viable off-Site leachate management option(s) is identified, compare the alternative leachate management options based on evaluation criteria provided in Appendix B of the approved Terms of Reference (EASR Appendix A).

2.0 WASTEWATER QUANTITY AND QUALITY ESTIMATES

2.1 Quantity Estimates

The leachate quantity is estimated to be about approximately 20,000 m^3/year during the initial years and increase to about 88,000 m^3/year by year 10 and continue to increase until the landfill is in its final phase to an estimated 230,000 m^3/year on and following closure, subject to any steps taken at closure to minimize leachate generation such as promoting surface run-off from the closed landfill.

Additionally, liquor from the organics processing will require treatment. The amount of organics to be processed at the Site is estimated to be approximately 50,000 tonnes per year and the liquor produced from this process is estimated to be 30,000 m^3 to 35,000 m^3 per year. During the initial period of Site operations it is proposed to pre-process source-separated organics and send the material to an off-Site farm or other commercially available approved digesters for processing. Although, the BioPower demonstration project will likely produce a limited amount of liquor, it is anticipated that it will be re-used in the processing. Hence, during this time no liquor has been accounted for requiring treatment. The following Table 2.1-1 shows the total estimated leachate and organics processing liquor quantities requiring treatment:

Table 2.1-1: Estimated Annual Wastewater Quantity

Year	Landfill leachate (m^3)	Organics processing liquor (m^3)	Total (m^3)
Initial years	20,000	-	20,000
By year 5	40,000	20,000	60,000
By year 10	88,000	30,000 – 35,000	118,000 – 123,000
Maximum	230,000	35,000	265,000
After landfill is closed	228,000	-	228,000

2.2 Wastewater Raw Quality Estimates

The main factors that affect leachate quality include leachate age, precipitation, waste type and composition. Due to the changing nature of leachate, overall peak concentrations were estimated for each parameter to represent the anticipated peak concentration throughout all operational stages of the landfill. Table 2.2-1 provides a comparison of typical leachate parameters from a municipal waste landfill to average concentrations from Otter Lake Waste Processing and Disposal Facility in Nova Scotia (Otter Lake) (Robert Orr, personal communication, July 3rd and 11th, 2013), which has a front end processor, waste stabilization facility and residual disposal facility somewhat similar to the proposed CRRRC facility. The estimated values for municipal landfill leachate are based on analytical monitoring results from municipal waste landfill Sites within Ontario, literature and values used in the Ontario Landfill Standards (MOE, 1998). In view of the diversion activities prior to landfilling and the IC&I/C&D waste sources, the leachate quality from the CRRRC landfill component is expected to be lower in strength than the estimated peak values of municipal waste landfill leachate and more similar to that of Otter Lake. To be conservative, the higher values from either the municipal landfill leachate estimates or Otter Lake quality data were used to estimate the CRRRC leachate quality for analysis of leachate treatment options. Actual values will not be known until the landfill is in operation and the leachate quality is monitored.

Table 2.2-1: Estimated Leachate Quality

Parameter	Typical Peak Concentration from Municipal Waste Containing Landfill (mg/L)	Otter Lake		
		Minimum Concentration (mg/L)	Maximum Concentration (mg/L)	Average Concentration (mg/L)[1]
Biochemical Oxygen Demand (BOD)	8,000	14[2]	5600[2]	761[2]
Nitrite + Nitrate (NO2+NO3)		0.05	270	35
Nitrate (NO3)	5	<0.1	87	22
Nitrite (NO2)		<0.1	190	15
Ammonia	800	4.2	620	260
Phenols	4			
Total Phosphorous (TP)	50	0.1	16	2.5
Sulfate (SO4)		2	530	215
Total Suspended Solids (TSS)	1,500	14	8,700	290
Aluminum (Al)	2	0.1	157	5.3
Arsenic (As)		0.01	1.4	0.16
Boron (B)	9	0.3	17	7

Parameter	Typical Peak Concentration from Municipal Waste Containing Landfill (mg/L)	Otter Lake		
		Minimum Concentration (mg/L)	Maximum Concentration (mg/L)	Average Concentration (mg/L)[1]
Cadmium (Cd)	0.05*			
Chromium (Cr)		0.02	2.8	0.3
Cobalt (Co)	0.05	0.01	0.4	0.04
Copper (Cu)	0.4	0.02	4.2	0.5
Lead (Pb)		0	0.2	0.03
Manganese (Mn)		0.09	11	2
Nickel (Ni)	0.4	0.06	2.3	0.25
Silver (Ag)	0.003			
Titanium (Ti)		0.01	3.7	0.2
Vanadium (V)	0.5	0.01	1	0.10
Zinc (Zn)	2	0.06	2.5	0.5
pH	5.2 – 8.0**	6.2	8.6	7.8
Iron (Fe)	50	0.3	229	14
Toluene	1*			
1,4 dichlorobenzene	0.01*			

Notes:
* Ontario Landfill Standards (MOE, 1998).
** Young leachate pH is 5.2 – 6.1; old leachate pH is 7.2 – 8.0 (Rowe, et al., 1995).
[1] Average concentrations are based on monitoring data between 1999 and 2011.
[2] Average concentrations for BOD are based on monitoring data collected between 2000 and 2008.

The organic processing liquor quality was also estimated based on information from the literature. Based on data obtained from a full scale treatment plant designed to treat the source separated organic fraction of municipal solid waste (OFMSW) in Spain, the effluent liquor has average ammonia, total phosphorous and total organic carbon concentrations of 1,360, 30 and 14,400 mg/L, respectively (Pognani, et al., 2012). Similarly the average ammonia concentrations in bench scale reactors anaerobically treating mechanically recovered OFMSW was reported as 1,470 mg/L (Zhang et al., 2012). The metal concentrations reported by Pognani et al. (2012) were: Cd 0.16 mg/L, Cr 10.9 mg/L, Cu 19.2 mg/L, Ni 9.1 mg/L, Pb 17.4 mg/L and Zn 55.2 mg/L. During the first five years, the CRRRC wastewater will have a higher proportion of liquor to leachate, which when combined will initially affect overall quality. However this will reverse by approximately year 10 of operations. Table 2.2-2 summarizes the estimated digested organics processing liquor quality. Similar to leachate quality estimates, the actual values will not be known until the organics processing is in operation and the liquor quality is monitored.

Table 2.2-2: Estimated Digested Organics Processing Liquor Quality

Parameters	Estimated Liquor Concentrations (mg/L)
Ammonia	1,700
BOD	2,000
TP	50
All metals	Same or less than maximum concentrations in leachate

3.0 ON-SITE TREATMENT FOR ON-SITE DISCHARGE OPTIONS

3.1 Discharge Criteria

The on-Site discharge location would be the Simpson Drain flowing to the east and eventually discharging to Shaw's Creek. Treated effluent from the CRRRC leachate treatment system would be required to meet Ministry of the Environment and Climate Change (MOECC) Provincial Water Quality Objectives (PWQO) (MOE, 1994), as the Drain is intermittent and does not have permanent base flow to provide as an adequate mixing zone.

Table 3.1-1 shows parameters required to be treated based on the quality estimates compared with PWQO and the conservative concentration estimates for these parameters.

Table 3.1-1: Parameters Exceeding PWQO and Estimated Concentrations in Leachate and Digested Organics Processing Liquor

Parameters	PWQO (mg/L)	Estimated maximum leachate concentrations (mg/L)	Estimated Liquor concentrations (mg/L)
BOD (2000-2008)	5	8,000	2,000
NO2+NO3		270	
NO3	3	87	
NO2		190	
Ammonia		800	1,700
Unionized ammonia	0.020		
Phenols	0.001	4	
TP	0.02	50	50
Al	0.075	157	Same or less than maximum concentrations in the leachate
As	0.1	1.4	
B	0.2 (I)	17	
Cr	0.001for CrVI 0.0089 for CrIII	2.8	
Co	0.0009	0.4	
Cu	0.005	4.2	
Pb	0.005	0.2	
Ni	0.025	2.3	
V	0.006(I)	1	
Zn	0.020 (I)	2.5	
pH	6.5-8.5	8.6	
Fe	0.3	229	

3.2 Available Treatment Technologies

A review was conducted of established and emerging technology for the treatment of the wastewater (primarily consisting of leachate). A variety of approaches were considered, ranging from chemical and mechanical treatment systems to passive treatment systems. From the review, it was determined that more options are available for the removal of the primary parameters (e.g., oxygen demand, nutrients and solids (i.e., BOD, ammonia, phosphorus, total suspended solids). There are fewer technologies that can treat other parameters (e.g., metals, minerals, etc.) to the PWQO limits.

The primary parameters considered in evaluating treatment technologies were biological oxygen demand (BOD), pH, total phosphorous (TP), total suspended solids (TSS) and ammonia nitrogen (NH_3-N). The options for treatment of these primary parameters are outlined in Table 3.2-2. The options for treatment of the remaining parameters are discussed below.

The best available technology to reduce the concentration of the remaining parameters of concern with regard to the PWQO criteria is identified as reverse osmosis (RO), with a possible contingency of an ion exchange stage. RO uses pressure to force water through a semipermeable membrane to remove dissolved minerals and metals. Although arsenic concentrations can be reduced by RO, to meet the PWQO limit ion exchange (IE) may be required to supplement the arsenic reduction by RO. The operational requirements of both RO and IE would produce a rejected concentrated waste liquid that will require subsequent management, expected to include an evaporator to decrease the liquid volume and solidification for the end sludge. The toxicity characteristic leaching procedure (TCLP) test would determine the end location for disposal of the sludge produced from these technologies.

Table 3.2-1 defines the general performance levels for select parameters used to evaluate each technology. Table 3.2-2 summarizes the available treatment technologies.

Table 3.2-1: Degree of Performance

Performance	Description
Good	High level of treatment; anticipated to meet the estimated discharge limits
Fair	Some treatment; requires further treatment to meet the estimated discharge limits
Poor	Inadequate treatment; requires separate treatment stage(s)

Table 3.2-2: Wastewater Treatment Technologies

Technology	Performance				Additional Comments	
	BOD	TSS	Ammonia	TP	Benefits	Drawbacks
Suspended Growth Biological Nitrification Processes						
Activated Sludge (AS)	Good	Good	Good (<1 mg/L)	Poor		▪ Requires high efficiency aeration system ▪ Continuous flow mode requires external clarification stage following the AS unit ▪ Requires closely controlled operational conditions
Oxidation Ditch	Good	Good	Poor	Poor		▪ Requires aeration system ▪ Requires external clarification stage following aeration ▪ Requires closely controlled operational conditions ▪ Susceptible to cold climate issues
Sequencing Batch Reactor (SBR)	Good	Good	Good	Poor	▪ Does not require external clarification stage	▪ Requires aeration system ▪ Requires closely controlled operational conditions ▪ Requires skilled operator
Membrane Bioreactor	Good	Good	Good	Poor	▪ Tertiary quality effluent	▪ Risk of membrane fouling ▪ Requires pre-treatment (primary settling) ▪ Requires high efficiency aeration system ▪ Requires closely controlled operational conditions ▪ Requires skilled operator ▪ High maintenance requirements

Technology	Performance				Additional Comments	
	BOD	TSS	Ammonia	TP	Benefits	Drawbacks
Aerated Lagoon	Good	Good	Poor	Poor	■ Minimal operational controls	■ Requires aeration system ■ Susceptible to cold climate issues ■ Large footprint
Trickling Filter	Good	Good	Poor	Poor	■ Minimal operation and maintenance requirements	■ Requires pre-treatment (primary settling) ■ Susceptible to cold climate issues
Rotating Biological Contractor (RBC)	Good	Good	Good (<3 mg/L)	Poor		■ Requires external clarification stage following the RBC unit ■ Requires electrical supply for shaft motor ■ Requires closely controlled operational conditions ■ Susceptible to environmental conditions and fluctuations in influent quality (e.g., temperature, pH, flow, concentrations, etc.)
Aerobic Submerged Fixed Beds	Good	Good	Good (<3 mg/L)	Poor	■ Can have higher organic loading rates compared to trickling filters ■ Smaller footprint	■ Requires aeration system ■ High energy use
Aerobic Submerged Mobile Beds	Good	Good	Poor	Poor		■ Requires aeration system ■ Susceptible to cold climate issues
Recirculating Sand Filters	Good	Good	Poor	Poor	■ Minimal operation and maintenance ■ Less susceptible to temperature changes	■ Requires pre-treatment unit ■ Requires recirculation/dilution tank ■ Susceptible to cold climate issues

Technology	Performance				Additional Comments	
	BOD	TSS	Ammonia	TP	Benefits	Drawbacks
Intermittent Sand Filters	Good	Good	Poor	Poor	■ Minimal operation and maintenance ■ Less susceptible to temperature changes	■ Requires pre-treatment unit ■ Susceptible to cold climate issues
Constructed Wetlands	Good	Good	Poor	Poor	■ Minimal operation and maintenance ■ Create natural looking habitats/environment	■ Large surface area ■ Susceptible to cold climate issues ■ Surface flow wetlands are less effective in removing ammonia than subsurface or vertical flow wetlands ■ MOECC will not approve a constructed wetland for treatment, only as a polishing step
Siemens PACT® System (Powder Activated Carbon Treatment c/w aerobic biological treatment step)	Good	Good	Good	Poor	■ May not require external clarification stage if operated in SBR mode ■ Improved dewatering of waste sludge	■ Requires frequent carbon addition ■ Changes in organic loadings in the influent affects the operations time; increases control requirements

3.3 Comparison of Selected Technologies

Biological treatment systems were found to be the most effective at removing high BOD and ammonia concentrations through nitrification processes; however, to maintain healthy biological processes certain compounds are required to be reduced (if found to be elevated to a point of creating toxic conditions) through chemical precipitation to lower their concentrations below their toxicity level. Therefore, the concentrations of these compounds (e.g., metals) require testing for toxicity. Chemical precipitation before biological treatment may be required for all on-Site treatment options as a contingency to address potential toxicity concerns and, where appropriate, compliance concerns. This requirement is noted and was considered in the comparison.

An equalization/storage pond/tank will be required, prior to treatment, for all of the technology options. Biological systems have minimal effect on reducing phosphorus; therefore, chemical coagulants and filtration are required to achieve an effluent total phosphorous concentration below discharge criteria prior to discharge. Filtration can be achieved by a diverse range of methods and approaches with varying degrees of performance and operational requirements. For the other parameters, reverse osmosis and ion exchange treatment systems are required. Chemical precipitation and filtration is required as pre-treatment for RO. Treated leachate would be stored in on-Site holding ponds/tanks prior to discharge. Sludge management and waste liquid management are required to complete the treatment system.

The evaluation of the available treatment technologies, summarized in Table 3.2-2, concluded that the following options would be more suitable for use as the main treatment stage:

- Activated Sludge
- Sequencing Batch Reactor
- Rotating Biological Contactor
- Siemens PACT® (Powder Activated Carbon Treatment c/w aerobic biological treatment step)

These options are discussed in the following sections. Table 3.3-1 provides a qualitative comparison of these treatment approaches.

Sludge management for each system includes chemical conditioning and dewatering/filtration through geosynthetic fabrics. It should be noted that depending on the leachate quality actually encountered, the dewatered sludge may have elevated concentrations of metals that may limit disposal options. A slump test and laboratory TCLP test would be required prior to disposal.

Table 3.3-1: Evaluation of Selected Leachate Treatment Systems

Criteria	Activated Sludge (AS)	Sequencing Batch Reactor (SBR)	Rotation Biological Contactor (RBC)	Siemens PACT® (Powder Activated Carbon Treatment c/w aerobic biological treatment step)
Flexibility	**Ranked 3rd because:** ▪ May require adjustment to optimize treatment at different flow rates ▪ May overcome increases in peak loadings ▪ System can be expended by adding new AS units and clarifier	**Ranked 1st because:** ▪ May require adjustment to optimize treatment at different flow rates ▪ Susceptible to increases in peak loadings ▪ Easier and less costly than the AS system to add additional treatment units to handle additional flow	**Ranked 4th because:** ▪ Can handle flow changes ▪ May be susceptible to increases in peak loadings ▪ System can be expanded by adding RBC units	**Ranked 2nd because:** ▪ May require adjustment to optimize treatment at different flow rates ▪ Susceptible to increases in peak loadings ▪ System can be expanded by adding new PACT® units and clarifier
Reliability	**Ranked 1st (tied) because:** ▪ Aeration system and pump failure are only reliability concerns	**Ranked 2nd because:** ▪ Restart of SBR would require a skilled operator (complex process control system) ▪ Aeration system is equipped with jet aerators that allow mixing, self-cleaning, and accessibility for maintenance. Pumps and automated switch failure are concerns	**Ranked 3rd because:** ▪ Has a reputation for variable performance, sensitivity to variable inflow quality and weight imbalances causing rotating shaft damage ▪ System upset would require cleaning discs and lengthy restart	**Ranked 1st (tied) because:** ▪ Aeration system and pump failure are only reliability concerns
Ease of Use	**Ranked 3rd because:** ▪ Requires regular maintenance of aeration system and the chemical addition system	**Ranked 4th because:** ▪ Higher level of operation and maintenance required due to controls, aeration system, pumps, valves and automated switches	**Ranked 1st because:** ▪ Minimal operation requirements	**Ranked 2nd because:** ▪ Can be operated in continuous mode or SBR mode ▪ In the case of SBR, higher level of operation and maintenance required due to controls, aeration devices, pumps, valves and automated switches

Criteria	Activated Sludge (AS)	Sequencing Batch Reactor (SBR)	Rotation Biological Contactor (RBC)	Siemens PACT® (Powder Activated Carbon Treatment c/w aerobic biological treatment step)
Capital Costs	**Ranked 1st (tied) because:** ■ Requires high efficiency aeration system ■ Continuous flow mode of AS requires external clarification stage following the AS unit ■ May require pre-treatment (chemical precipitation) ■ Requires equalization pond/tank ■ Lower capital cost compared to Siemens PACT system but similar to SBR and RBC	**Ranked 1st (tied) because:** ■ Requires high efficiency aeration system ■ SBR does not require external clarification stage ■ May require pre-treatment (chemical precipitation) ■ Requires equalization pond/tank ■ Lower capital cost compared to Siemens PACT system but similar to AS and RBC	**Ranked 1st (tied) because:** ■ Does not require aeration system but requires large motors for shaft rotation ■ Requires external clarification stage ■ May require chemical precipitation treatment unit ■ Requires equalization pond/tank ■ Lower capital cost compared to Siemens PACT system but similar to AS and SBR	**Ranked 2nd because:** ■ Requires high efficiency aeration system ■ SBR mode does not require external clarification stage ■ Continuous mode requires external clarification stage following the PACT unit ■ Requires equalization pond/tank ■ Highest capital cost compared to the other options considered
Operational Costs	**Ranked 2nd because:** ■ Electricity is required for aeration system and pumps operating in continuous mode ■ Chemical cost to remove metals, non-biodegradable and toxic compounds prior to AS treatment unit ■ Requires heating of the AS tank to maintain optimal temperature (10-15ºC)	**Ranked 1st (tied) because:** ■ Electricity is required for pumps and blowers operating in intermittent mode (less electricity than continuous aeration systems) ■ Chemical cost to remove metals, non-biodegradable and toxic compounds prior to SBR treatment unit(s) ■ Requires heating of the SBR tank to maintain optimal temperature (10-15ºC)	**Ranked 1st (tied) because:** ■ Energy requirement for pumps and the shaft ■ Regular bearing maintenance ■ Requires heating of the RBC tank to maintain optimal temperature (10-15ºC)	**Ranked 3rd because:** ■ Electricity is required for pumps and blowers operating in continuous mode ■ Requires continuous addition of activated carbon (~ 220 kg/day) ■ Requires heating of the biological treatment unit to maintain optimal temperature (10-15ºC)

Criteria	Activated Sludge (AS)	Sequencing Batch Reactor (SBR)	Rotation Biological Contactor (RBC)	Siemens PACT® (Powder Activated Carbon Treatment c/w aerobic biological treatment step)
Operations and Maintenance	**Ranked 2nd (tied) because:** ■ Regular pump, blower and boiler maintenance ■ Sludge removal from AS treatment unit, chemical precipitation unit and clarifier on a regular basis ■ Plate air diffusers require shutdown and removal for cleaning and replacement	**Ranked 1st because:** ■ Regular pump, blower and boiler maintenance ■ Sludge removal from SBR treatment unit(s) and chemical precipitation unit on a regular basis ■ Less sludge volume from SBR treatment unit(s) compared to other selected options ■ Jet aerators are located above water for maintenance without shutdown and are self-cleaning	**Ranked 2nd (tied) because:** ■ Regular pump, and boiler maintenance ■ Chemical cost to remove metals, non-biodegradable and toxic compounds prior to RBC ■ Sludge removal from RBC and chemical precipitation unit on a regular basis	**Ranked 2nd (tied) because:** ■ Regular pump, blower and boiler maintenance ■ Sludge removal from biological treatment unit, clarifier or SBR reactor and chemical precipitation unit on a regular basis ■ Plate air diffusers require shutdown and removal for cleaning and replacement
OVERALL RANKING	**2nd (TIED)**	**1st**	**3rd**	**2nd (TIED)**

3.4 Activated Sludge

As noted in Table 3.2-2, the activated sludge process can successfully treat BOD, TSS and ammonia. To incorporate nitrification with BOD removal, the conventional activated sludge process requires the addition of an anoxic treatment stage. Generally, in an aerobic zone (in the presence of oxygen) ammonia is converted to nitrate. There are many alternative layouts for activated sludge with a nitrification process. The general flow diagram for leachate treatment using an activated sludge process is as follows:

Raw Wastewater → Equalization Pond or Tank(s) → Activated Sludge Process (aerobic) → Clarifier → Chemical Precipitation/Filtration → Reverse Osmosis (RO) → Ion Exchange (IE) → Phosphorous Removal→ Effluent Holding Ponds or Tanks

This system requires regular sludge management. Sludge would be collected from the chemical precipitation process and the clarifier on a frequent basis. The equalization pond/tank(s) is also expected to require sludge removal every 4-5 years. Waste liquid from RO and IE would be evaporated and solidified prior to disposal.

3.5 Sequencing Batch Reactor (SBR)

The SBR process has three stages with recycling between stages (sludge storage, mixed liquor digestion, followed by SBR stage) and can incorporate not only BOD removal but also nitrification and denitrification. Additionally, it can provide sludge reduction inside the system. To remove phosphorus, additional treatment would be required following the SBR stage. The general flow diagram for leachate treatment using the SBR process is as follows:

Raw Wastewater → → Equalization Pond or Tank(s) → SBR Process→ Chemical Precipitation/Filtration → Reverse Osmosis (RO) → Ion Exchange (IE) → Phosphorous Removal→ Effluent Holding Ponds or Tanks

This system requires regular sludge management. Sludge would be collected from the chemical precipitation process on a frequent basis. The equalization pond/tank(s) will also likely require sludge removal every 4-5 years. Waste liquid from RO and IE would be evaporated and solidified prior to disposal.

3.6 Rotating Biological Contactor (RBC)

The RBC process uses a fixed film of bacterial growth attached to a large disc, which rotates in a concrete tank where it makes contact with the influent leachate. The disc is partially submerged in the leachate in the tank to allow the bacteria exposure to oxygen when the disc rotates out of the leachate. The biological treatment occurs on the surface of the disc as the biomass gradually accumulates. When mass builds and anaerobic conditions develop at the disc interface, the excess biomass naturally shears off and accumulates inside the tank. Several RBC units are required to treat large flows and/or high contaminant loadings.

The general flow diagram for leachate treatment using RBC units is as follows:

Raw Wastewater → Equalization Pond or Tank(s) → RBC → Denitrification Unit(s) → Clarifier → Chemical Precipitation/Filtration → Reverse Osmosis (RO) → Ion Exchange (IE) → Phosphorous Removal → Effluent Holding Ponds or Tanks

This system requires regular sludge management. Sludge would be collected from the chemical precipitation process and the clarifier on a frequent basis. The equalization pond/tank(s) will also likely require sludge removal every 4-5 years. Waste liquid from RO and IE would be evaporated and solidified prior to disposal.

3.7 Siemens PACT® (Powder Activated Carbon Treatment comes with Aerobic Biological Treatment Step)

Siemens PACT® system combines a granular activated carbon adsorption system with an aerobic biological system in SBR mode operation. Activated carbon provides removal of some of the inhibitory compounds along with metals from the influent. Carbon also provides higher retention time for compounds that are not easily biodegraded in the reactor, consequently enhancing COD removal. The general flow diagram for leachate treatment using the PACT® system is as follows:

Raw Wastewater → Equalization Pond or Tank(s) → PACT® → Chemical Precipitation/Filtration → Reverse osmosis (RO) → Ion Exchange (IE) → Phosphorous Removal→ Effluent Holding Ponds or Tanks

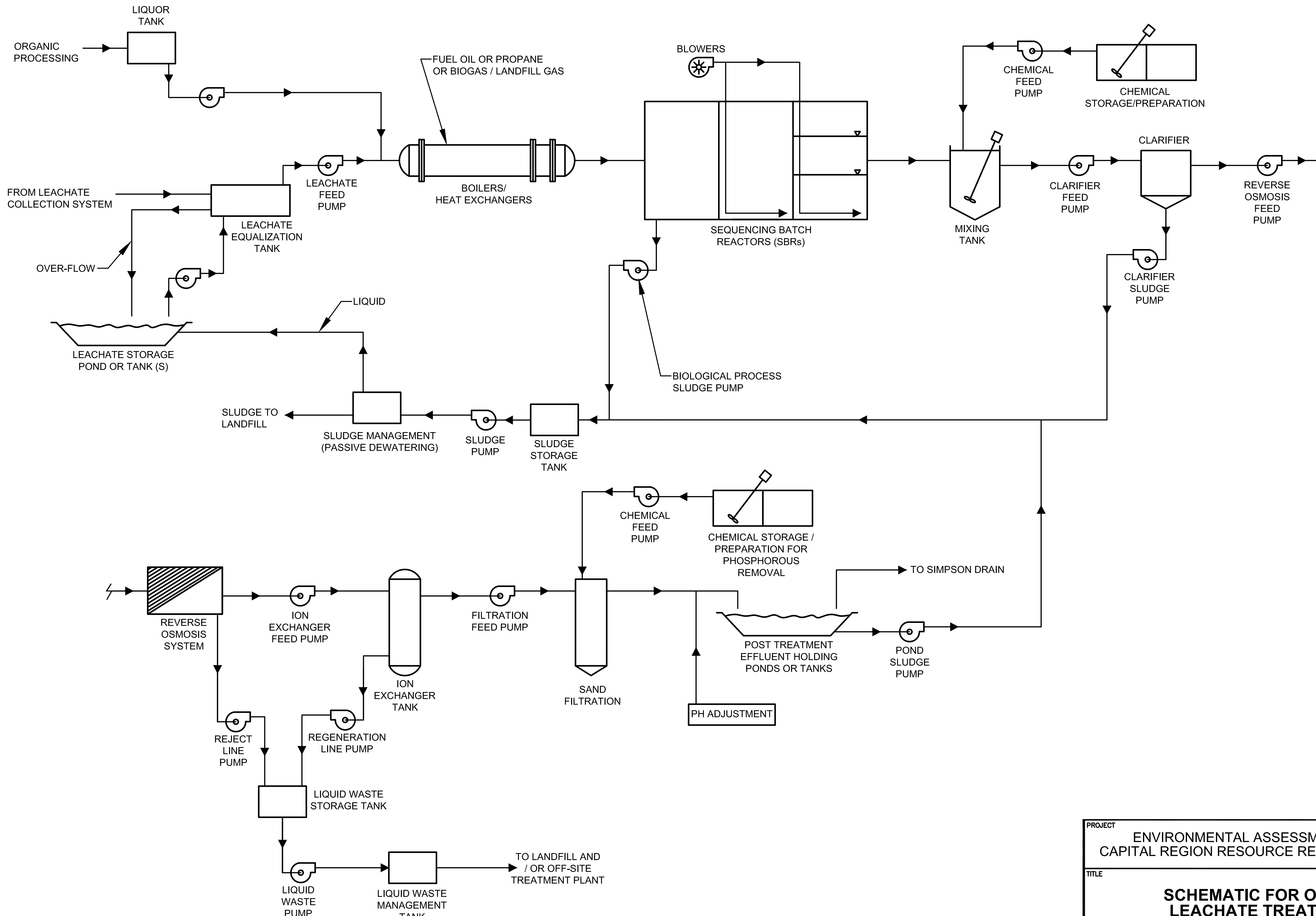
This system requires regular sludge management; sludge would be collected from the chemical precipitation process on a frequent basis. The equalization pond/tank(s) will also likely require sludge removal every 4-5 years. Waste liquid from RO and IE would be evaporated and dewatered prior to disposal.

3.8 Preferred On-Site Treatment Approach

The options discussed in Section 3.3 to 3.6 were compared based on flexibility, reliability, ease of use, capital and operational costs, and maintenance considerations. The activated sludge and SBR are comparable in estimated capital cost; however, the Siemens PACT® system has higher annual electricity and chemical costs, which over the lifetime of the CRRRC increases the total investment. The SBR and activated sludge processes offer similar performance; however, the activated sludge process will produce larger volumes of sludge that require additional digestion and dewatering. The anaerobic stage in the SBR limits sludge production and reduces the anticipated volume of sludge that will require dewatering and disposal. The nature of the SBR sludge also requires less treatment and can be handled using a simple approach, such as a dewatering filter bag (Geotube®). Additionally, the SBR is less sensitive to operational changes (quality and quantity) and more flexible in operating scenarios to optimize treatment compared to the activated sludge process.

Based on this assessment, the sequencing batch reactor has been identified as the preferred on-Site primary treatment approach. The nature of leachate is such that the quality varies over time and, prior to landfill operation, it is difficult to predict leachate quality precisely. The preferred approach has been selected with this in mind, to provide the ability to adjust with the changing leachate quality and to provide enough operational control that most peak loadings can be addressed and the system adjusted, as needed, through the addition of treatment steps, changes in chemical dosing, and changes in holding time, etc. Although up to 60% of a skilled operator's time is anticipated to be required for the operation of the SBR, this attention can result in a more efficient and reliable treatment process. Once the SBR is commissioned and has demonstrated that it is effectively treating the leachate, operator involvement can be reduced and the system can be highly automated.

The efficiency and liquid discharge quality/quantity of the reverse osmosis and ion exchange treatment systems to reduce the metals and other parameters that cannot be removed by any biological system require bench and/or pilot scale testing; sizing and operational changes may be required based on this information. Figure 3.8-1 shows the process flow diagram schematics of the preferred on-Site treatment system.



PROJECT
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
SCHEMATIC FOR ON-SITE LEACHATE TREATMENT

Golder Associates
Ottawa, Ontario

PROJECT No. 12–1125–0045			FILE No. 1211250045-V1-tds-FIGs.dwg	
DESIGN	I.T.M.	Nov. 2013	SCALE N.T.S.	REV. 0
CADD	M.L.F.	Nov. 2013	**Figure 3.8-1**	
CHECK	P.L.E.	Aug. 2014		
REVIEW	P.A.S.	Aug. 2014		

FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 1 (Report Figures)\TSD 10\1211250045-V1-tds-FIGs.dwg

4.0 POTENTIAL OFF-SITE LEACHATE RECEIVER/TREATMENT ALTERNATIVES

4.1 Methodology

Based on the publicly available information on existing local municipal sewage treatment facilities, in the area of the CRRRC Site, and wastewater collection infrastructure within the City of Ottawa, potential off-Site leachate receiver/treatment alternatives were assessed. Information has been collected from the following sources:

- Municipal websites; and
- Publically available Official Plan documents and development reports.

4.2 Off-Site Wastewater Treatment Plant Options

Based on available information, the following wastewater treatment facilities were identified for potential acceptance and treatment of wastewater from the proposed CRRRC. Table 4.2-1 below provides details on these local municipal sewage treatment facilities.

Table 4.2-1: Local Municipal Sewage Treatment Facilities

Facility Name	Location	Service Area (estimated population)	Treatment Process	Capacity (Est. % Available)	Discharge Point
Robert O. Pickard Environmental Centre	Ottawa, Ontario	City of Ottawa (~800,000 est.)	Secondary treatment c/w chemical addition and disinfection	Avg = 545,000 m^3/day (23%) Peak = 1,362,000 m^3/day (38%)	Ottawa River
Embrun Sewage Treatment Facility	Embrun, Ontario	Community of Embrun (~5,000 est.)	Lagoons c/w chemical addition and aeration	Semi-annual discharge: Fall – 457,300 m^3 Spring – 331,100 m^3	Castor River
Russell Sewage Treatment Facility	Russell, Ontario	Community of Russell (~3,000 est.)	Lagoons c/w chemical addition (Batch operation) and aeration	Semi-annual discharge (no specifics in CofA) Storage = 115,000 m^3 (approx.)	Castor River
Village of Limoges Sewage Treatment Facility	Limoges, Ontario	Village of Limoges (~2,000 est.)	Lagoons c/w chemical addition and aeration	Semi-annual discharge Storage = 230,000 m^3 (approx.)	Castor River

The Robert O. Pickard Environmental Centre (ROPEC) currently accepts leachate for treatment from three landfills (Waste Management Ottawa Landfill, BFI Navan Landfill, City-owned Trail Road Landfill). The Boundary Road Site proposed for the CRRRC is located in the City of Ottawa; ROPEC is also located within the City and provides wastewater treatment for City sewage from residences, businesses and institutions as well as some industrial wastewaters under specific conditions. ROPEC is a large wastewater treatment facility that is operating well below its design hydraulic capacity. The landfills that send leachate to ROPEC do so under individual agreements with the City of Ottawa that generally have specific maximum concentrations for parameters of concern. Pre-treatment of the leachate is in some cases required to meet these limits, prior to conveying the leachate via forcemain to discharge to the sanitary sewer or conveying the leachate via tanker truck to the plant headworks, but is dependent on the specific leachate characteristics and agreement requirements. In some cases, a surcharge cost is applied to leachate parameters that exceed these concentrations (City of Ottawa Sewer Use By-law (City of Ottawa, 2003) and Sewer Use Program (City of Ottawa, 2011)).

The Embrun, Russell and Village of Limoges wastewater treatment facilities all consist of lagoons and it is understood that future expansion is required to accommodate anticipated population growth. The Embrun and Russell facilities are located within the Township of Russell and the Village of Limoges facility is located in the Township of the Nation, different municipalities from the Boundary Road Site. The estimated CRRRC wastewater generation represents a significant increase in loading in terms of their existing capacity and treatment requirements of the facilities and would require modifications/expansion to accept CRRRC wastewater and meet their effluent discharge requirements.

No other options available to Taggart Miller were identified.

Based on the available information, ROPEC is indicated to be the realistic off-Site leachate receiver/treatment option for the proposed CRRRC.

4.2.1 Summary of City of Ottawa Consultation

The City of Ottawa was accordingly consulted regarding the possible use of ROPEC to treat the CRRRC's wastewater. From these discussions the following conclusions were drawn:

- ROPEC is currently operating at well below its hydraulic capacity. It was indicated by the City that the volumes have actually decreased over the past few years due to several factors including on-going work separating storm and sanitary sewers. The estimated wastewater quantity from CRRRC was confirmed with City staff to be very small compared to the available treatment capacity at ROPEC.
- For ROPEC to accept leachate from the CRRRC Site, the objective is to meet the Sewer Use By-law quality requirements (City of Ottawa, 2003). Certain parameters may be allowed to exceed and be subject to a surcharge cost. Methane, hydrogen sulphide and ammonia were highlighted as the parameters of greatest concern.

4.2.2 Potential Alternatives to Convey Leachate to Off-Site Disposal

The two options available to convey pre-treated leachate from the CRRRC to ROPEC are: 1) tanker truck; and 2) a dedicated forcemain pipe to the City sanitary sewer system. As described in Section 4.2, both of these options are currently used to convey leachate from waste disposal facilities in Ottawa to ROPEC.

Based on consultation with the City of Ottawa, it is understood that the City would prefer the wastewater from CRRRC to ROPEC to be trucked, at least initially, so that information and assurance on leachate quantity and especially quality over time could be obtained. In view of the City's understood preference, the preferred method of conveyance is by tanker truck at this time.

The possibility of forcemain conveyance will be reconsidered in consultation with the City in the future, after leachate quality from the CRRRC over time is established and the requirements for and success of pre-treatment to meet City Sewer Use By-Law (City of Ottawa, 2003) requirements are established and confirmed.

4.3 Criteria for Discharge to City of Ottawa Treatment

Any effluent from the CRRRC would be required to meet City of Ottawa Sewer Use By-law (City of Ottawa, 2003) in order to be accepted at ROPEC. Based on the leachate and liquor quality estimates, in addition to the expected presence of methane and hydrogen sulphide, the following parameters would likely require pre-treatment.

Table 4.3-1: CRRRC Estimated Wastewater Parameters Compared to City Sewer By-law

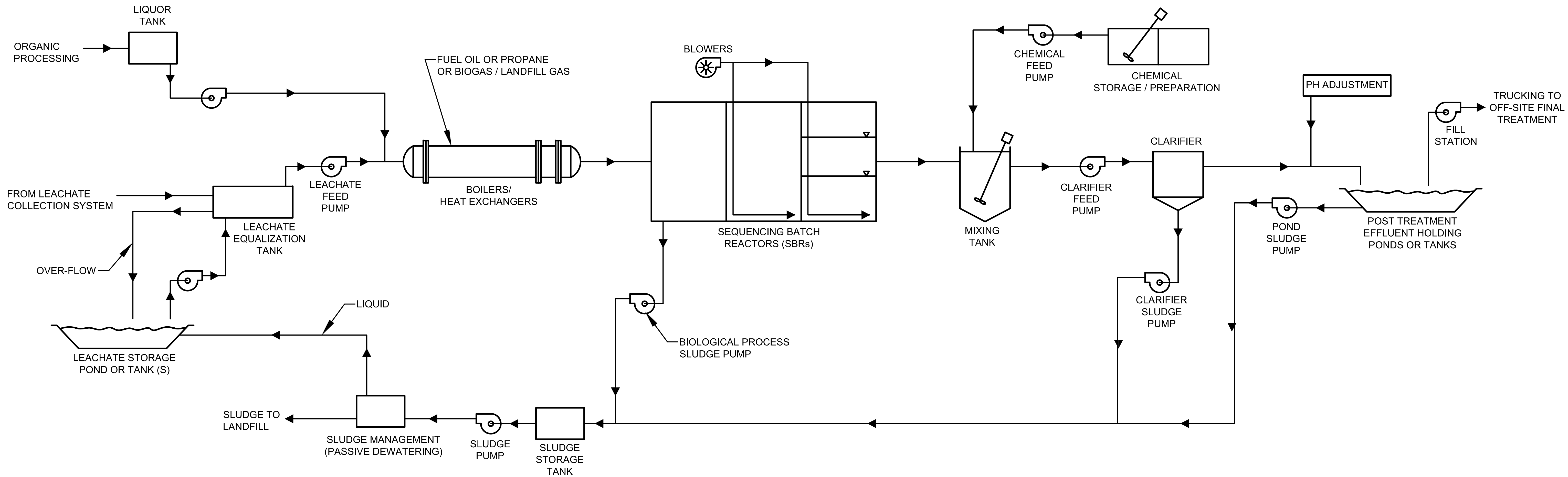
Parameters	City of Ottawa Sewer Use By-law Limits (mg/L)	Estimated Maximum Leachate Concentrations (mg/L)	Estimated Liquor Concentrations (mg/L)
BOD	300	8,000	2,000
TKN	100	>800	>1,700
Ammonia		800	1,700
P	10	50	50
TSS	350	8,700	Same or less than maximum concentrations in the leachate
Al	50	157	
Cd	0.02	0.05	
Cu	3	4.2	

4.4 Proposed On-Site Pre-Treatment System for Off-Site Treatment

Similar to the treatment options for on-Site treatment described previously, high BOD and ammonia concentrations in the raw leachate are the two main parameters of concern to comply with the City of Ottawa Sewer Use By-law (City of Ottawa, 2003). The treatment technology assessment outlined in Section 3.3 (on-Site treatment and discharge) is also applicable for on-Site pre-treatment. The preferred pre-treatment technology is also identified as an equalization pond/tank(s) followed by the SBR system. Chemical precipitation may be required before the SBR system to reduce toxic conditions for biological removal, if they occur. The concentrations of the metals identified in Table 4.3-1 are expected to be below the By-law limits after discharge from the SBR system, eliminating the need for the Reverse Osmosis (RO) → Ion Exchange (IE) final treatment stages noted in Section 3. However, chemical precipitation is included as a contingency if the metal concentrations are found to be higher than the By-law limits. The effluent storage ponds/tanks will be included to balance flows and provide storage for pre-treated leachate prior to final treatment at the selected location. The general process flow for on-Site leachate pre-treatment is as follows:

Raw Wastewater → Equalization Pond or Tank(s) → SBR system→ Chemical Precipitation of Metals (pH adjustment) → Effluent Holding Ponds or Tanks

The pre-treatment system will require sludge management similar to the on-Site treatment option. Figure 4.4-1 shows the preferred on-Site pre-treatment system for subsequent off-Site treatment and disposal.



PROJECT

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SCHEMATIC FOR LEACHATE PRE-TREATMENT FOR CONVEYANCE TO OFF-SITE WASTEWATER TREATMENT PLANT

Golder Associates
Ottawa, Ontario

PROJECT No. 12–1125–0045			FILE No. 1211250045-V1-tds-FIGs.dwg	
DESIGN	I.T.M.	Nov. 2013	SCALE N.T.S.	REV. 0
CADD	M.L.F.	Nov. 2013	**Figure 4.4-1**	
CHECK	P.L.E.	Aug. 2014		
REVIEW	P.A.S.	Aug. 2014		

5.0 COMPARISON OF LEACHATE MANAGEMENT OPTIONS

The comparison of the two identified wastewater management options, i.e., 1) on-Site treatment to 2) on-Site pre-treatment for off-Site treatment and disposal, considered the following environmental components as set out in Appendix B of the approved TOR:

- Atmosphere
- Geology and Hydrogeology
- Surface water
- Biology
- Land use
- Traffic
- Technical effectiveness
- Regulatory approvability
- Capital and operating costs

Table 5-1 summarizes the comparison of the wastewater management options.

Table 5-1: Comparison of Wastewater Management Options

Environmental Component	On-Site Wastewater Treatment and Discharge to Simpson Drain	On-Site Wastewater Pre-Treatment and Off-Site Wastewater Management at City of Ottawa Wastewater Treatment Facility
Atmosphere – Odour	**Ranked 2nd because:** Treatment operations would have a greater number of more complex processes; hence potential odour generation is greater.	**Ranked 1st because:** Pre-treatment operations would have less complex processes; hence potential odour generation is less.
Atmosphere – Air Quality	**Ranked 2nd because:** Treatment operations would have greater number of more complex processes; hence potential air quality impacts are greater.	**Ranked 1st because:** Pre-treatment operations would have less complex processes, hence potential air quality impacts are less.
Atmosphere – Noise	**Ranked 1st because:** This option has more equipment, however does not require the use of leachate transport vehicles.	**Ranked 2nd because:** This option has less equipment, however would require the use of leachate transport vehicles.
Geology and Hydrogeology – Groundwater Quality	**Ranked 1st (tied) because:** No predicted effect on off-Site groundwater quality.	**Ranked 1st (tied) because:** No predicted effect on off-Site groundwater quality.

Environmental Component	On-Site Wastewater Treatment and Discharge to Simpson Drain	On-Site Wastewater Pre-Treatment and Off-Site Wastewater Management at City of Ottawa Wastewater Treatment Facility
Surface Water – Surface Water Quality	**Ranked 2nd because:** Although this option is designed to meet the PWQO within the receiving surface water course, there will still be a discharge to manage and monitor and some parameter concentrations will increase from the baseline conditions. Limited flow in the receiving surface water course to provide a mixing zone.	**Ranked 1st because:** No predicted effect on off-Site surface water quality. The surface water received for ROPEC provides a significant mixing zone and PWQO readily achievable in that receiver.
Surface Water – Surface Water Quantity	**Ranked 1st (tied) because:** This option would discharge to the Simpson Drain. The discharge quantity will be controlled and predevelopment flows largely matched.	**Ranked 1st (tied) because:** This option would discharge to the Ottawa River and will have negligible effect on water quantity in the river.
Biology – Aquatic Biological Resources	**Ranked 2nd because:** Although this option is designed to meet the PWQO within the receiving surface water course, there will still be a discharge to manage and monitor and some parameter concentrations will go up from the baseline conditions.	**Ranked 1st because:** This option does not influence aquatic biological resources on or in the area of the Site and treatment of CRRRC wastewater by the City plant would not have any measureable effect on aquatic resources at that location.
Biology – Terrestrial Biological Resources	**Ranked 1st (tied) because:** No basis to distinguish the two options for this criterion as area in which facility will be located will be disturbed in any event.	**Ranked 1st (tied) because:** No basis to distinguish the two options for this criterion as area in which facility will be located will be disturbed in any event.
Land Use	**Ranked 1st (tied) because:** No predicted impact on off-Site existing or probable planned future land use.	**Ranked 1st (tied) because:** No predicted impact on off-Site existing or probable planned future land use.
Traffic	**Ranked 1st because:** This option does require trucks to haul wastewater.	**Ranked 2nd because:** This option requires trucks to haul wastewater, which will generate additional Site-related traffic.

Environmental Component	On-Site Wastewater Treatment and Discharge to Simpson Drain	On-Site Wastewater Pre-Treatment and Off-Site Wastewater Management at City of Ottawa Wastewater Treatment Facility
Technical Effectiveness	**Ranked 2nd because:** Full treatment required to meet the PWQO. Less flexible to variations in wastewater quality.	**Ranked 1st because:** Wastewater can be readily treated to meet Sewer Use By-law (City of Ottawa, 2003) limits. Not expected to adversely affect operation or performance of City of Ottawa wastewater treatment plant.
Regulatory Approvability	**Ranked 2nd because:** This type of treatment system has been approved for the treatment of wastewater in the province of Ontario, and has generally performed acceptably. However it will require greater regulatory scrutiny.	**Ranked 1st because:** Wastewater pre-treatment system readily approved. City treatment system already approved and in operation.
Capital and Operating Costs	**Ranked 2nd because:** Higher capital cost compared to the other option. Higher operational requirements and costs. Monitoring of discharge quality is required.	**Ranked 1st because:** Lower capital cost compared to the other option. Lower operational requirements and costs. Monitoring of discharge quality is required.
OVERALL RANKING	**2nd**	**1st**

The preferred leachate management option is on-Site pre-treatment and trucking off-Site to the City wastewater treatment facility (ROPEC). Considering that implementation of this preferred option requires Taggart Miller to enter into agreement with the City of Ottawa to accept the wastewater from the CRRRC at ROPEC, if the City of Ottawa option proves not to be available, it will be necessary to treat the wastewater using another approach. An amending procedure is set out in the main EASR document.

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