APPENDIX I

Landfill Design and Operations

December 2014

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Landfill Design and Operations
Volume IV Design and Operations Report
Capital Region Resource Recovery Centre

Report Number: 12-1125-0045/4500/vol IV

REPORT

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1.0 INTRODUCTION

1.1 Purpose

This report presents the proposed design and operations (D&O) plan for the landfill component of the Taggart Miller Capital Region Resource Recovery Centre (CRRRC). This landfill portion of the CRRRC is highlighted in Figure 1.

1.2 Organization of Report

The D&O components addressed in this Appendix I are as follows:

- Waste characteristics and quantities to be landfilled;
- Grading plans and proposed final landfill geometry;
- Leachate collection;
- Excavated soil management;
- Landfill gas (LFG) and odour management;
- Site development and phasing;
- Construction activities;
- Site equipment;
- Fire control;
- Winter operations;
- Daily and intermediate cover;
- Inspection and maintenance (landfill, leachate collection system and LFG collection system); and,
- Landfill closure.

Other routine operational components, Site access, stormwater management and monitoring requirements are discussed within the overall facility D&O report and/or its Appendices.

All D&O components described in this report have been prepared to meet the regulatory requirements in the Landfill Standards (MOE, 1998b) and the associated *Ontario Regulation* (O.Reg.) 232/98 (MOE, 1998a).

1.3 Related Documentation

This report has been prepared as an Appendix to the overall facility D&O report and should be read in conjunction with it and its other Appendices. The overall facility D&O in its entirety has been prepared in support of an application for approval under the *Environmental Assessment Act* (EAA) (MOE, 2010a), and also for an Environmental Compliance Approval (ECA) under the *Environmental Protection Act* (EPA) (MOE, 2010b) and *Ontario Water Resources Act* (OWRA) (MOE, 2011) for the CRRRC.

2.0 WASTE STREAM

2.1 Waste Characteristics

The landfill component of the CRRRC is proposed to support the diversion operations for a planning period of 30 years. This is based on an assumed five year ramp up of waste and soil receipts to a maximum of 450,000 tonnes per year and an assumed ultimate diversion rate in the range of 43 to 57 % (including the use of soil for daily cover) over time. The landfill will receive residuals primarily from the on-Site construction and demolition (C&D) processing facility (C&D waste stream) and the on-Site materials recovery facility (MRF) (industrial, commercial and institutional (IC&I) waste stream), as well as residuals from other diversion and processing activities, and waste materials that are not reasonably capable of diversion at the time of receipt.

2.2 Waste Quantities

Based on the parameters in Section 2.1, and assuming a compacted waste density of 0.85 tonnes per cubic metre and a 4:1 waste:daily cover ratio, the landfill component of the CRRRC was assumed to require between approximately 9.4 and 10.7 million cubic metres of airspace volume for a planning period of 30 years.

3.0 LANDFILL DESIGN

3.1 Overview

Based on the results of the geological, hydrogeological and geotechnical investigations and analyses that were carried out at the Site (refer to Volume III of the Environmental Assessment (EA) documentation), it was determined that the presence of the clay deposit beneath this Site requires relatively flat sideslopes in order that the landfill has adequate stability. As such, the landfill design has 14H:1V sideslopes above a 3.5-metre high perimeter berm up to approximately elevation 89 metres above sea level (masl) or 12 to 13.5 metres above ground level, and then a 20H:1V slope up to a central peak or ridge area. The maximum height of the designed final landfill contours is approximately 25 metres above ground level. Based on the slope geometries and waste height constraints it was determined that the total landfill footprint area required to provide the necessary airspace volume to meet the overall facility's projected needs for 30 years is approximately 84 hectares. The waste disposal area (footprint) and proposed top of landfill (final cover) contours are illustrated in Figure 2 and cross-sections showing the general waste mound geometry are provided in Figures 4a and 4b. This configuration corresponds to an airspace volume of approximately 10,170,000 cubic metres for waste and daily cover. An allowance for a 0.75-metre thick (approximately) final soil cover has been provided. Final cover construction will take place after filling in a part of the landfill is complete.

3.2 Landfill Buffer Zones

Buffer zones around the east, south and west sides of the landfill component of the CRRRC will have a minimum width of 100 metres between the limits of waste disposal and the property boundaries so as to be consistent with the generic requirements of the Landfill Standards (MOE, 1998b). Based on the design of the stormwater ponds and corresponding geotechnical considerations, the width of the proposed buffer area adjacent to the east side, the east half of the south side and the northwest corner of the landfill has been increased from 100 metres to 125 metres (see Figure 1). The buffer widths are also shown on the cross-sections on Figures 4a and 4b.

3.3 Access

As described in the overall facility D&O report, the primary Site access will be from Boundary Road near the northwest corner of the CRRRC property. The main access road will be a two way road to the in-bound scale with a separate truck queuing lane. A separate single out-bound lane with an out-bound scale is also proposed (see Figure 1). Considering a queuing lane length of about 400 metres, as well as an in-bound lane length of another 450 metres, the total on-Site queuing lane length that will be available will be approximately 950 metres between Boundary Road and the in-bound scale. As such, it is expected that all queuing of waiting Site-related traffic will be on-Site and there will be no back up of incoming traffic onto Boundary Road. The main access road will be paved.

A secondary Site access/exit location is proposed near the northern end of Frontier Road primarily for Site personnel.

A small load drop-off area is proposed near the primary Site access location off Boundary Road. Vehicles will enter the Site over the in-bound scales and proceed to this facility to drop off their material in the appropriate bunker, and then exit the Site. A separate road is provided for on-Site trucks to access the containers within the bunkers, load them and take them to either a MRF or, where diversion is not possible/practical, directly to disposal in the landfill area. The roadways associated with the small load drop-off area will be paved.

A secondary scale is proposed on-Site along the main haul road from the primary Site access location to the landfill. This scale will be used to record tonnages coming from the diversion facilities to the landfill.

A truck tire wash is proposed between the landfill and the secondary scale area, to be used as required by trucks exiting the landfill.

As shown in Figure 1, secondary access roads will not be paved (gravel surface). In addition to the secondary roads shown in Figure 1, additional secondary roads will be constructed, as required, within the landfill footprint to access the active waste disposal area and Phases that are under construction. The perimeter secondary access road will be built progressively around the landfill as Site development advances and as it becomes needed.

3.4 Containment Berms

The landfill base will be excavated 1.5 to 2.5 metres below the existing ground level and will be surrounded with a perimeter containment berm. The perimeter berm will be constructed to approximately a 3.5 metre height using the excavated soils and/or similar types of imported materials. The perimeter berm will have a top platform width of around 36 metres to provide adequate overall landfill stability, with 7 horizontal: 1 vertical (7H:1V) sideslopes. The berm will also accommodate a perimeter road, header piping for leachate and LFG and other service lines, and provide conveyance of runoff to the stormwater management system. An approximately 20 metre wide bench will be provided between the exterior toe of the perimeter berm and adjacent facilities within the buffer, providing both access and working area around the landfill.

3.5 Base Grades

The design of the landfill base recognizes that consolidation settlement of the silty clay deposit will occur and that the largest settlements will be below the central portion of the landfill where the waste thickness is greatest. The silty clay subgrade (or surficial silty sand where it exists below the landfill base) will be shaped by excavation at a minimum 0.5 percent fall toward the centre-line of various drainage basins or “troughs” where a leachate header pipe (LHP) will be installed.

The layout of the base, including main subgrade slope break lines, constructed base grades and spot elevations is shown on Figure 5.

3.6 Leachate Containment and Collection System

For leachate containment, a Site-specific design approach has been followed. The natural low permeability silty clay deposit will provide the low permeability bottom “liner” for the landfill. The perimeter berm will incorporate a constructed low permeability hydraulic barrier (a geosynthetic clay liner or “GCL”) extending the full height of the berm and down through the surficial silty sand layer or weathered clay zone and keyed into the underlying upper silty clay. This would cut off the potential pathway for off-Site leachate migration via the berm fill and surficial silty sand layer. A typical cross-section showing the perimeter leachate containment is shown on Figure 7.

The leachate collection system will consist of the following components (from bottom to top) over the low permeability clay deposit that provides a natural liner:

- A non-woven separator geotextile;
- A leachate collection granular drainage blanket;
- A non-woven filter geotextile; and,
- A protective sand layer.

Embedded within the granular drainage blanket will be a network of leachate collection pipes. Leachate will be conveyed through the leachate collection pipes and a granular drainage blanket to collection manholes. The final design of the leachate collection system will conform to the requirements stipulated in 'Schedule 1' of the Landfill Standards (MOE, 1998b) for a primary leachate collection system with a 100-year service life.

3.6.1 Leachate Collection Pipes

The landfill base will be shaped to specified initial design grades and a series of trenches will be excavated for the placement of high density polyethylene (HDPE) perforated leachate collection piping (LCP), installed such that the maximum drainage path before leachate can potentially intercept a LCP is not more than 50 metres in length. This is consistent with 'Schedule 1' of the Landfill Standards (MOE, 1998b) for a primary leachate collection system with a 100-year service life. LCP extending up the containment berm slopes to the cleanout locations will be solid HDPE pipe. In this area the 7H:1V slopes should be sufficient to convey leachate through the granular drainage blanket towards the sump locations in the central parts of the landfill, and the drainage path will be less than 50 metres along the sideslopes.

The LCP will run parallel to the overall subgrade slopes with the exception of the outer 125 to 150 metre flanks of the overall landfill base on the north and south sides where they will be placed on an angle to the slope, as shown in Figure 6. The purpose of placing the LCP on an angle in these areas is to facilitate constructing a consistent subgrade slope, without the need for a "sawtooth" shape to ensure a maximum drainage path length of 50 metres to the nearest collection pipe. All LCP will connect to a perforated HDPE LHP which will, in turn, convey collected leachate to a sump. In order to obtain the required minimum 0.5 percent grades within the pipes, initial placement of LCP and LHP will require trenching below the excavated subgrade elevation by up to approximately 1.6 metres (see detail on Figure 7).

Cleanout access to the LCP and LHP will be provided around the perimeter of the landfill. Where access to the exterior is not feasible (i.e., flushing equipment has a maximum access/capacity length of approximately 300 metres), additional vertical cleanouts will be installed within the footprint. The interior and exterior cleanouts will provide access required for flushing/cleaning of the pipes and for camera equipment to facilitate inspection as part of system maintenance. Proposed cleanout locations and the overall leachate collection system piping layout are shown on Figure 6.

All LCP, LHP and cleanouts will have minimum diameter of 200 millimetres to accommodate flushing and inspection equipment. It is noted that the internal diameter of these pipes will exceed the minimum diameter of 150 mm specified in 'Schedule 1' of the Landfill Standards (MOE, 1998b). In addition, pipe perforations will be a minimum of 12 millimetres in diameter, also consistent with 'Schedule 1' for a primary leachate collection system with a 100-year service life.

3.6.2 Leachate Manholes

A series of nine leachate sumps (manholes) will be provided within the landfill; they will be located at the lowest points of the base grading, both when constructed initially and allowing for the longer term consolidation of the clay as the waste is placed. The leachate collection system design will accommodate the expected settlement of the subgrade. As the settlement of the clay occurs, the slope of the base and piping will increase from that originally constructed, thereby enhancing the transmission of leachate to the interior leachate sumps.

Vertical manhole sections will be added to provide access to the leachate sumps as landfilling progresses in each sump/manhole area. In order to minimize the number of internal locations with infrastructure that will need to be accommodated as landfilling progresses, it is also proposed to include vertical LHP cleanouts at each manhole location. The cleanout pipes at each manhole location as well as vertical cleanouts at other stand-alone locations within the landfill will also be raised by adding successive pipe sections as landfilling progresses in these areas.

The top section of each leachate manhole is proposed to be a stainless steel section instead of HDPE. This will facilitate connections to the leachate forcemain and electrical conduit as well as providing strength to support the leachate sump pump via a cable. The top stainless steel section of the manhole would be removed and reinstated as each section of HDPE manhole pipe is added. Efforts to minimize drag-down forces on the manhole piping will be made and may include the use of plastic sheeting or wrapping. The top of each manhole location will be protected when in use at interim heights by mounding cover fill material around the manhole or by constructing temporary barriers (e.g., from scrap tires, concrete manhole sections, etc.). A typical detail for the proposed manhole configuration is shown on Figure 7.

Leachate removal from each sump will be by means of submersible pumps and via piping to a forcemain that will convey the collected leachate for treatment. Proposed sump locations and the proposed alignment of the leachate forcemain are shown on Figure 1.

3.6.3 Leachate Pump Control Station and Forcemain

Leachate removal from each sump will be accomplished by means of removable submersible pumps that will be activated by electronic leachate level sensors. Pump controls and electrical panels will be consolidated in a single Leachate Pump Control Station (see Figure 1). The control station will be sized to accommodate the required controls as successive manholes are built and commissioned.

Three main north-south orientated leachate forcemain laterals are proposed that will feed leachate into an external forcemain running along the northern edge of the landfill and then north to the leachate pre-treatment facility. The external leachate forcemain will cross the Simpson Drain (together with the LFG header piping) at a single location to minimize disruption to the drain during construction (see Figure 1).

The diameter of the leachate forcemain laterals will be sized in sections with increasing diameters from south to north to accommodate increased flow as additional manholes are built and connected. Each lateral will ultimately connect three manholes to the external leachate forcemain.

The leachate forcemain laterals will be buried within the waste. Should breakage occur, the system will be designed such that a new leachate forcemain lateral could easily be connected and the broken lateral left cut-off within the waste mound. Temporary overland hose could also be used to convey leachate from the manholes to the external leachate forcemain.

3.6.4 Drainage Layer

It is proposed that the leachate collection pipes will be bedded in a continuous layer of crushed clear stone extending completely across the base of the landfill. The thickness and gradation of the drainage stone will meet or exceed the requirements in ‘Schedule 1’ of the Landfill Standards (MOE, 1998b) for a 100-year service life.

A suitable separator geotextile will be installed between the drainage stone and the silty sand or clay subgrade. A filter geotextile will be installed over the drainage stone, protected by a sand layer to prevent fine materials from the waste from being washed into the drainage layer.

3.6.5 Settlement Effects on Leachate Collection System

Settlement predictions are discussed in the Geology, Hydrogeology and Geotechnical Report (Volume III). The maximum settlement of the subgrade predicted within the 100-year service life of the leachate collection system is between approximately 6 and 8 metres. This settlement will be greatest under areas overlain by the highest waste thickness. The proposed sump locations have been selected based on areas within each Phase that are expected to experience the greatest amount of subgrade settlement. Landfill phasing is discussed further in Section 4.0 of this report. Redundancy has also been built into the proposed leachate collection system piping network by maintaining continuity of the leachate header piping between adjacent Phases and manholes such that leachate could flow to an adjacent subgrade drainage area or Phase should localized higher degrees of subgrade settlement be experienced.

Settlement of the subgrade near the outer limits of the landfill footprint is expected to be relatively negligible. Therefore, it is considered that it would not be practical to provide positive drainage to the outside of the landfill footprint that would overcome the eventual maximum differential settlement. This is the reason for the proposed internal manhole locations.

In order to minimize the initial excavation depth and maintain minimum as-constructed subgrade slopes of 0.5 percent, steps in the proposed subgrade are proposed along lines running east-west approximately 125 to 150 metres from the north and south edges of the waste footprint. The leachate header and sumps that will collect leachate from these drainage areas or “flanks” are located at the low end of this step. The proposed subgrade steps are visible in Sections B-B’ and C-C’ on Figures 4a and 4b, respectively.

As settlement of the subgrade occurs, there will be a need for flexibility in the lengths of the leachate collection pipes and header pipe. As such, it is proposed that slip couplings will be used to connect lengths of pipe as an alternative to welding. During final detailed design, the expected elongation of pipe sections will be calculated to ensure adequate slip coupling lengths.

All geotextile seams (separator and filter geotextiles) will be sewn (either factory seams or machine-sewn during installation) to ensure that adjacent geotextile panels are not pulled apart from each other during construction and subsequently as subgrade settlement occurs. The expected tensile forces that will be developed in the geotextiles and required elongation will be considered during final detailed design and when specifying the required geotextile products/properties.

3.7 Leachate Treatment

Leachate collected from the landfill leachate collection system will be conveyed via forcemain to an on-Site leachate pre-treatment facility. The design and operations for this facility are described in detail in Appendix J of the overall facility D&O report.

3.8 Leachate Detection and Secondary Containment System

To allow for monitoring of the performance of the landfill's leachate containment system (the natural clay deposit, the LCS, and perimeter berm with the perimeter GCL) and provide secondary containment in the unlikely event that leachate enters the surficial silty sand layer outside of the landfill footprint, a leachate detection and secondary containment system (LDSCS) will be positioned beneath the perimeter berm along the hydraulically downgradient (eastern) edge of the landfill component of the CRRRC, as shown on Figure 1. This monitoring and secondary containment feature will be provided along the entire length of the east side of the landfill and will be constructed in conjunction with the construction of the perimeter berm.

As shown on Figure 7, the LDSCS will be a 1 metre wide trench dug through the base of the upper silty sand into the top of the underlying silty clay, and extending approximately 860 metres from the north end of the landfill to the south end of the landfill as shown highlighted in pink on the attached plan figure. The alignment of the LDSCS is approximately 110 metres inside the east property boundary. The trench would be filled with a highly permeable 25 mm clear stone. A 200 mm diameter perforated pipe would be placed within the clear stone, approximately 150 mm above the base of the trench. As shown on Figure 6, the base of the trench (and piping) will be graded at a 0.5 percent slope in a "sawtooth" pattern to four manholes along the length of the LDSCS, while not extending more than 1 metre below the base of the surficial silty sand. The contents of the trench will be wrapped in a geotextile.

The LDSCS will passively collect groundwater from the surrounding surficial silty sand. With the presence of the overlying perimeter berm and the landfill acting as a hydraulic trap and locally lowering the water table in the immediate vicinity of the landfill footprint, it is expected that after initial pumping to evacuate the system prior to commencing landfilling, the volume of groundwater subsequently entering the LDSCS will be relatively small.

Monitoring of the LDSCS as described in Section 13.2 of the Volume III report will provide information on the quality and quantity of water entering the system, which will be used to determine whether the quality of water entering the system from the surficial silty sand layer has been impacted by leachate.

3.9 Final Contours and Waste Capacity

The final proposed landfill contours are illustrated on Figure 2, assuming a total final cover thickness of approximately 0.75 metres. The proposed top of waste and top of final cover slopes are illustrated in the cross-sections included in Figures 4a and 4b. Settlement effects on the final cover elevation and geometry and related considerations are discussed in Section 4.6 of this report.

As discussed in Section 3.1 of this report, the final landfill slopes will range between 14H:1V and 20H:1V (i.e., 5 percent or greater but less than 4H:1V), which is consistent with the requirements of the Landfill Standards (MOE, 1998b).

The waste mound depicted in Figures 2, 4a and 4b corresponds to a total volumetric capacity of approximately 10,170,000 cubic metres for waste and daily cover, without accounting for settlement.

3.10 Excavated Soil Management

Soil that is excavated during construction of the landfill base area will be used for construction of the perimeter landfill containment berms and the Site screening berms. It is expected that there will be an overall fill deficit for construction of the containment and screening berms and that imported fill will be required to complete portions of the berms. The total estimated volume of material to be excavated as part of landfill base construction is approximately 640,000 cubic metres. There will also be approximately 70,000 cubic metres of soil from excavation of stormwater management features and leachate ponds that will be available for re-use. The total volume of fill required to construct the containment and screening berms is estimated to be approximately 820,000 cubic metres. There will also be additional fill requirements for general grade raise in the northern portion of the Site where diversion facilities and other Site infrastructure will be built.

Despite the overall fill deficit for the various on-Site earthworks, it is expected that landfill construction will proceed at a rate that will necessitate temporary handling of surplus uncontaminated soils received from construction projects. As such, a surplus soil management area has been designated near the west central portion of the Site area north of the Simpson Drain (see Figure 1). The ongoing operation in this area, as well as other areas of the Site where surplus soil may be temporarily stored until such time that it is required for re-use, will basically consist of the dumping and dozing of incoming soil into a stockpile(s), and removal of this soil for re-use on-Site. It is anticipated that the temporary stockpiles could be up to approximately 5 metres in height.

3.11 Landfill Gas and Odour Management System

The following sections present a summary of the projected rates of LFG generation and describe the design of the LFG collection system for the proposed landfill component of the CRRRC.

3.11.1 Estimate of Landfill Gas Production

Estimates of LFG generation rates were prepared for the landfill component of the CRRRC using the LandGEM model (US EPA, 1991) developed by the United States Environmental Protection Agency (US EPA). The LandGEM model is based on a first-order decay model of LFG generation.

The methodology and results are presented in detail in the technical memorandum provided in Attachment A. A summary of the LFG generation rates estimated for the landfill component of the CRRRC using the LandGEM (US EPA, 1991) model are presented in Table 1.

Table 1: Estimated LFG and Methane Generation Rates (Using Maximum Projected Waste Tonnages)

Year	Total LFG		Total Methane*	
	m^3/hour	scfm	m^3/hour	scfm
5	1,115	655	555	330
10	2,240	1,320	1,120	660
15	3,165	1,865	1,585	930
20	3,925	2,310	1,960	1,155
25	4,545	2,675	2,270	1,335
30 (Peak)	5,050	2,975	2,525	1,485
35	4,135	2,435	2,070	1,215
40	3,385	1,995	1,695	995
45	2,770	1,630	1,385	815
50	2,270	1,335	1,135	670

Notes: * Assumes LFG is comprised of 50% methane.
m^3 = cubic metres
scfm = standard cubic feet per minute

Actual LFG generation rates may differ, perhaps significantly, from the model results due to differing future waste composition, annual waste tonnages, and the uncertainties associated with modelling a highly complex facility such as a landfill.

It should be noted that the theoretical LFG generation rates estimated are not the same as the LFG collection rate, since the future LFG collection system would not be able to collect all of the LFG generated.

3.11.2 Design of Landfill Gas Collection System

The active LFG collection system will consist of horizontal collector piping, header piping, condensate management facilities, an extraction facility and an enclosed flare. This collection system will also be able to supply a possible power generation facility.

The proposed LFG collection system will conform to the most recent version of B149.6-11 Code for Digester Gas and Landfill Gas Installations (CSA, 2011), which has been adopted by the Technical Safety and Standards Authority (TSSA) for use in Ontario as of December 2012. The LFG collection system will also be designed for the predicted subgrade settlement.

A description of the proposed LFG collection system is provided below. Design drawings and details for EPA (MOE, 2010b) approvals purposes are presented in the attached Figures 8 through 11.

Horizontal Collector Piping

Perforated horizontal collector pipes will be installed in Phases 1, 2, 3, 4, 6 and 7 of the landfill, as shown in Figures 8 and 9. The lower layer of horizontal collector pipes will be installed to maximize LFG collection as landfilling progresses in Phases 1 through 4 and phases 6 and 7. The upper layer of horizontal collectors will be installed on top of Phases 1 through 4 prior to landfilling in Phase 5, and on top of Phases 6 and 7 prior to landfilling in Phase 8.

The general layout of the horizontal collector pipes is east-west in Phases 1 and 2 and north-south in Phases 3, 4, 6 and 7. Horizontal collector pipes have been spaced approximately 30 to 50 metres apart based on waste thicknesses and estimated horizontal collector capture zones. Typical elevations and lengths of horizontal collectors are shown in Figure 9; exact elevations and lengths will vary with each collector.

The LFG horizontal collector pipes will be constructed using perforated HDPE LFG collector pipe attached to a non-perforated HDPE LFG conveyance pipe. The perforated horizontal collector pipes will be encased in a gravel drainage pack, with perforations appropriately sized to reduce the intrusion of gravel, and spaced to promote LFG collection. Drainage from the gravel drainage pack will be provided into the leachate collection layer or into the header pipe and condensate trap.

Each horizontal collector will be equipped with a flow control and monitoring port that will allow for the monitoring of LFG pressure and quality, measurement of LFG flow rates, and a valve to facilitate the regulation and balancing of LFG flow.

In addition, a perforated horizontal collector will be installed near the inside crest of the perimeter berm to collect LFG that enters the leachate collection granular drainage layer.

Main Header Piping

The main header pipe will transmit the LFG from the horizontal collector piping to the extraction plant and flare (or power generation facility). The main header pipe will be constructed within the landfill perimeter berm in a loop along the perimeter of the waste footprint (progressively, as each landfill phase is constructed). The direction of LFG flow in the header pipe will be from the perimeter of the landfill footprint towards the extraction plant in the northeast portion of the CRRRC Site.

The header pipe will be constructed of HDPE of suitable diameter to provide for an effective vacuum to be applied to the LFG collection wellfield. The header pipe will be installed with the pipe obvert at a depth below ground surface suitable for frost protection, or the pipe will be insulated. To provide for drainage of condensate, a minimum header pipe grade of approximately 1.0% will be provided for pipe segments sloping away (i.e., negative gradient) from the extraction plant and -0.5% for pipe segments sloping towards (i.e., positive gradient) the extraction plant. The actual pipe gradients will be determined as part of detailed design.

The typical header piping layout and details are presented in Figures 8, 9 and 10.

Condensate Traps

LFG will cool as it travels along the header piping, causing moisture in the LFG to condense in the piping. Liquid condensate in the header pipe will be conveyed by gravity into condensate traps, reducing the potential for blockage of LFG flow in the header pipe caused by an accumulation of liquid condensate from saturated LFG. More than one condensate trap will be required in the header pipe around the landfill footprint and along the header pipe to the extraction plant. A generalized condensate trap detail is presented in Figure 11. While condensate traps will be provided, uneven settlement of the subgrade may require that portions of the header be regraded in the future.

Liquid condensate will be conveyed from the condensate trap(s) into the leachate pre-treatment system via pneumatic pumps.

Extraction Plant

A LFG extraction plant will provide a vacuum to both the LFG collection system and the organics processing facility, and would convey the LFG/biogas to the flare, and to a possible future utilization facility or on-Site heating application. The extraction plant will be located in the northeast portion of the Site near the secondary digester, outside of the approved waste footprint. The main components of the extraction plant will be one or more centrifugal blowers, LFG treatment facilities, monitoring instrumentation and controls, and an air compressor.

Centrifugal Blower

One or more centrifugal blowers will be installed in the extraction plant. The blower(s) will be used to create a vacuum of up to 15 to 25 inches water column at each horizontal collector connected to the LFG collection system, and will convey the LFG to the flare. A separate blower system may be used to provide a vacuum to the organics processing facility.

The blower(s) will be equipped with a direct-drive motor and a variable frequency drive to provide suitable control at low flow rates. The blower(s) and associated motor and controls will meet the requirements of CSA B149.6-11. The blower(s) will be connected to a programmable logic controller (PLC) and to an external manually operated emergency shut-down device in accordance with CSA B149.6-11 (CSA, 2011).

LFG Treatment Facilities

A condensate knockout will remove most water droplets and mist as well as dirt from the LFG. The resultant liquid condensate will be disposed into the leachate pre-treatment system.

Monitoring Instrumentation and Controls

Automated control and monitoring within the extraction plant will be conducted via a PLC computer. The PLC will control the blower(s), flare and automatic shut-off valves, with input from various sensors including the gas concentration instrumentation. A datalogger will store data from the flare, blower and other instrumentation.

A flow meter will provide flow measurement for a range of LFG flow rates.

A methane and oxygen gas analyzer system will continuously measure and display concentrations of methane and oxygen in the LFG. Due to instrumentation limitations and the length of the connection line with the LFG pipe, there will be a time lag in response of the instrument to actual LFG concentrations in the pipe.

A pressure sensor will be installed to measure the LFG pressure generated immediately downstream of the blowers. A second pressure sensor will be located upstream of the condensate knockout.

A safety shut-off valve will be installed upstream of the blower and a check valve and second safety shut-off valve will be installed downstream of the blower as required by CSA B149.6-11 (CSA, 2011). Safety shut-off valves are actuated valves that can be shut off by the PLC.

Air Compressor

An air compressor will be located at the extraction plant and will be used to supply compressed air to condensate trap pump(s), safety shut-off valves, and the LFG instrumentation sampling system.

Enclosed Flare and Utilization Facility

An enclosed flare will be located in the northeast portion of the Site near the extraction plant and secondary digester.

The enclosed flare will have a capacity of some 2,000 to 2,500 scfm of LFG at 50% methane plus possibly additional capacity for biogas from the organics processing facility. A flare turn-down ratio of 4:1 is anticipated. An enclosed flare is specified because of its high hydrocarbon destruction efficiency and its flame will not be visible. The flare is estimated to have a diameter of approximately 3 metres and a height of approximately 12 metres. The enclosed flare will have a destruction efficiency of total organic compounds of approximately 99%. The temperature of the flare will be controlled by thermocouples at various heights inside the flare. An ultraviolet flame sensor, connected to the PLC, will enable the blower to be shut down if the flame extinguishes. The enclosed flare will meet the requirements of CSA B149.6-11 (CSA, 2011).

A flame arrestor (intended to reduce the flame temperature in the event of a flash-back) and a thermal valve (intended to shut in the event of a slow burn-back), both required by CSA B149.6-11 (CSA, 2011), will be located upstream of the enclosed flare. The header pipe leading from the extraction plant to the flare will be supported appropriately with pipe supports. The enclosed flare will be surrounded by a fence in accordance with CSA B149.6-11.

Two smaller flares (instead of one larger one) may be used for combustion if it is decided to combust biogas from the organics processing facility and that from the landfill in separate flares. The general location of the two flares would be at the same as that currently selected for the single flare.

A utilization facility may be installed in the future to generate electricity or to upgrade the gas to natural gas pipeline quality. A future utilization facility would be located in the northeast portion of the Site near the flare and would accept both LFG from the LFG collection system and biogas from the organics processing facility. The flare would be retained to provide a method of destroying the gas if the utilization facility is unavailable for any reason.

3.12 Stormwater Management

Design of drainage requirements from the landfill (as required by O.Reg. 232/98 (MOE, 1998a)) and from the diversion areas was carried out and the proposed stormwater management system is described in Appendix A of the overall facility D&O report. The approach to system design is to closely match post-development flows to pre-development flows by providing the required retention time in on-Site ponds, and by doing so also provide total suspended soils removal. The approach also aimed at dividing up the Site into three drainage areas that are similar in size to the three pre-development drainage areas leading to the three surface water discharge locations from the Site. The three discharge locations, which all flow eastward and enter Shaw's Creek, are to the Regimbald Municipal Drain to the northeast, to the Simpson Municipal Drain in the central portion of the Site, and the southern portion of the Site to an existing ditch leading to the Wilson-Johnston Municipal Drain. The stormwater management system consists of Site grading, ditching and culverts leading to linear stormwater ponds; two of the ponds will receive stormwater drainage from a portion of the diversion areas to provide a large fire pond (as per the building code) to provide water for firefighting purposes, if required.

Stormwater management considerations during construction of the landfill Site is discussed in Section 4.2 of this report.

4.0 OPERATIONS

4.1 Landfill Development

4.1.1 Phasing

The landfill has been planned to be developed in eight Phases. The Phase divisions recognize the layout of the base grades and the leachate collection system, and will allow for sequential construction of the overall landfill footprint. The proposed phasing is shown on Figure 3, and filling will generally progress from northeast to southwest within the landfill footprint. Interim waste slopes between Phases will be required to be constructed at grades no steeper than 14H:1V and the toe of the temporary slope on the upper Phase (Phase 5) will be required to be set back a minimum of 70 metres from the top of the temporary slopes on Phases 3 and 4. These temporary slopes are illustrated in the cross-sections on Figures 4a and 4b.

4.1.2 Landfill Development Schedule and Sequence

Sequential filling in Phases 1 through 4 will progress up to a height of approximately 12 to 13.5 metres above ground level (approximate elevation 89 masl). Phase 5 waste will be placed on part of the top of Phases 1 through 4 up to its final elevation. Phases 6 and 7 will then be filled similar to Phases 1 through 4, and Phase 8 filling will take place on top of Phases 6 and 7 (and Phases 3 and 4) to complete the landfill. The area of each stage varies from approximately 11 to 21 hectares, and it is estimated will provide airspace for operating periods ranging from approximately 2 to 6 years. The operating period for each Phase is variable because certain Phases have to be initially built with relatively flat temporary interior waste slopes on two sides (thereby reducing the available airspace above the footprint of that Phase), while filling in others involves the placement of waste above the temporary waste slopes within the previous adjacent Phase(s) footprints. The phasing is described in the table below.

Table 2: Landfill Development Schedule

Phase	Footprint Area (ha)	Estimated Years of Operation
1	21.6	4.5
2	12.9	3.6
3	11.0	2.3
4	11.3	4.8
5	On top of Phases 1 to 4	1.7
6	13.9	3.2
7	13.3	6.6
8	On top of phases 3 to 7	3.3
Totals	84	30

Recognizing that the actual rate of landfill airspace consumption will depend on the annual tonnage received and the diversion performance of the CRRRC over time (including the development of end markets), it is proposed that the landfill airspace be approved under the EPA in stages. Considering the proposed phasing shown on Figure 3, the practical approach is to split the landfill into two stages so that, as described above, the first stage of the landfill can be built to a completed configuration prior to starting to fill the second phase.

The two stages are:

- Stage 1 consisting of Phases 1 through 5, which corresponds to approximately 5.7 million cubic metres of airspace and an estimated operating life of approximately 17 years; and,
- Stage 2 consisting of Phases 6 through 8, which corresponds to approximately 4.4 million cubic metres of airspace and an estimated operating life of approximately 13 years.

Although the impact assessment in the environmental assessment has been done for the full landfill configuration as set out in this report, and EA approval is being sought for the projected total airspace described in Section 3.1 above, EPA approval will only be sought initially for Phases 1 through 5 of the landfill configuration. An application for EPA approval of Phases 6 through 8 will be made when necessary.

4.2 Construction Activities

Landfill construction will take place progressively in advance of waste placement in Phases 1, 2, 3, 4, 6 and 7. In general, construction activities will include:

- Clearing, grubbing and stripping of topsoil;
- Base excavation and shaping;
- LDSCS construction;
- Perimeter containment berm construction;
- Geosynthetics installation (separator geotextile, GCL, filter geotextile);
- Manhole/sump construction;
- Placement of granular materials (including drainage stone and protective sand); and,
- Installation of leachate collection and header piping and appurtenances.

Phases 1, 3 and 6 will require the construction of two manholes whereas only one manhole will be required to be constructed during the preparation of Phases 2, 4 and 7. Temporary berms will be constructed, as needed at the limits of temporarily completed Phases, to protect the loose ends of the geosynthetic layers and for the purpose of leachate containment within the completed and commissioned portions of the landfill. Temporary berms may also be constructed within partially constructed Phases in an effort to manage stormwater that accumulates in areas under construction or as construction progresses separately from the leachate that is being generated in the landfilled areas. This may be relevant in Phase 1 at the subgrade drainage divide between the two manholes that are allocated to this Phase. It may not be necessary in the other Phases that have two manholes (i.e., Phases 3 and 6) as the step in the subgrade immediately south of the northern manholes in these Phases will isolate leachate generated in the northern flanks of these Phases from the more southern portions of these Phases.

Prior to commencing landfill operations, the LDSCS will be evacuated of whatever unaltered groundwater has entered the system.

4.2.1 Mitigation Measures

Mitigation measures relevant to the construction period have been identified for various potential environmental concerns. In general, landfill construction will conform to the appropriate construction procedures and best management practices to minimize impacts to the surrounding environment.

Surface Water

Construction of the landfill requires the excavation and redistribution of soils. During these operations the potential for increased surface erosion from exposed areas could result in increased sediment loading to the on-Site ditches or the Simpson Drain. To prevent this, erosion and sediment control measures will be implemented before landfill construction begins.

The main activities for which erosion and sediment control measures must be implemented are:

- Excavation within the landfill area and earthmoving;
- Construction of the on-Site roads and drainage ditches; and/or,
- Construction of berms.

Erosion and sediment control measures that will be incorporated include:

- Minimize the extent of disturbed areas and duration soils are exposed;
- Seed completed areas and ditches, protect with mulches and geotextiles to reduce erosion until vegetation takes hold;
- Install silt fences around disturbed areas; and,
- Provide straw bale check dams in existing drainage courses immediately downstream of construction activities.

Dust and Mud Control

Best practices typically required for construction activities will be followed. Specific measures could include:

- Watering or application of other approved chemical agents (e.g., winter use) on haulage roads to control dust, if required; and,
- If required, temporary truck washing station (before permanent station is built).

All necessary measures will be taken to ensure that visible mud and dust emissions do not carry beyond the property line.

4.3 Routine Operational Components

Routine operations of the landfill component of the CRRRC will be consistent with and as described in the overall facility D&O report. Reference should be made to the overall facility D&O report specifically for information on staffing, waste acceptance procedures, handling of suspect wastes, handling of other wastes, complaint procedures, record keeping, fencing, signage, dust control, noise control, litter and vectors/vermin control. Other routine operational information that is more specific to the landfill is described below.

4.3.1 Operating Hours

It is proposed that the overall CRRRC will be open for waste receiving between 6:00 a.m. and 6:00 p.m. Monday through Saturday. Landfill operations are proposed to be 6:00 a.m. to 7:00 p.m. Monday through Saturday. The Site is expected to operate between 300 and 312 days per year.

4.3.2 Equipment

Site equipment may be modified from time to time as necessary. Equipment as described below (or similar models) that is planned to be designated to the landfill component of the CRRRC includes:

- Ford F-150 pickup truck (4x4) – 1 (shared with organics processing facility);
- Triaxle 400 horse power dump truck – 1;
- Caterpillar 966 loader – 1 (shared with the PHC contaminated soil treatment area and surplus soil stockpiling facility);
- Caterpillar 336 excavator – 1;
- Caterpillar 430 backhoe – 1;
- Caterpillar 12 grader – 1 (shared with surplus soil stockpiling facility);
- Caterpillar D8 dozer – 1;
- Caterpillar D6 dozer – 1 (shared with surplus soil stockpiling facility);
- Caterpillar 836 compactor – 1; and,
- Water truck – 1.

4.3.3 Fire Control

The method of preventing surface fires will be to monitor all loads being received at the Site and check loads for any hot materials. Detection and determination of the size of a subsurface fire, while somewhat unlikely, can be more difficult. Subsurface fires will typically be indicated by:

- Unusual or rapid landfill settlement;
- Venting of smoke;
- Carbon monoxide in LFG; and,
- Elevated LFG temperatures.

The location and extent of a subsurface fire could be determined by the following methods:

- Excavation or borings to allow visual examination of refuse; and,
- Installation of test wells to allow monitoring of subsurface temperature gradients.

In the event of a landfill fire, the Ottawa Fire Department and the Ministry of the Environment and Climate Change (MOECC) District Office would be contacted and advised of the situation. Depending on the size of the fire, staff may attempt to contain the fire with on-Site fire extinguishers until the fire department arrives. Although the fire ponds are intended for extinguishing fires at the diversion facilities, it may be possible to also use this water for a landfill fire.

Additional considerations with regards to subsurface landfill fires caused by the operation of the active LFG management system are described in Section 6.1 of this report.

4.3.4 Burning of Waste

Burning of waste will be prohibited at the CRRRC. In addition, no burning of brush, trees or clean wood piles will be conducted at the Site.

4.3.5 Winter Operations

A variety of snow removal equipment will be available on-Site, including loaders, backhoes and pickup trucks (which may be equipped with snow plows, if required).

Stockpiles of sandy material will be available on-Site for use as cover material during cold winter weather, if required. A dozer or excavator equipped with a ripper will be used to remove frozen surficial material on the sand stockpiles and expose underlying material suitable for use as daily cover. Equipment will be available to transport sandy cover material to the active landfill face, if required.

4.4 Waste Placement

Waste placement will proceed in Phases 1 through 8 as described in Section 4.1.2 of this report. No waste will be placed outside the limits of landfilling or within the buffer zones around the perimeter of the Site. Waste haul vehicles will access the active face via on-Site roads and via well-maintained granular surface access roads within the landfill area. Upon arriving at the active face, a ground worker will screen the load and direct the driver to back into the active face. The active face length will be confined to as small an area as possible while having enough space for trucks to safely unload.

The first waste lift in a given area shall be placed in a thick layer in order to avoid damage to the drainage features due to equipment travel. A minimum 1.5-metre depth of waste shall be placed in the first layer. The waste will be placed initially near the perimeter of the fill area and pushed out over the prepared landfill base. The landfilled waste will act as a travelling surface for equipment and waste trucks, with appropriate additional granular material added for temporary roads, as required.

After placement of the initial lift, the waste will generally be placed in lifts of thicknesses between 0.45 and 0.6 metres. By placing material in thin lifts and compacting the waste, the waste density will be increased, thus reducing the rate of landfill space consumption.

The length of the operating face will be kept to a minimum (i.e., maximum length of approximately 30 metres) to help control insects, rodents, scavenging by birds, blowing litter, fires, odours and to maintain an aesthetically pleasing site appearance.

Asbestos waste will be landfilled in accordance with Section 17 of O. Reg. 347 (MOE, 1990). Asbestos handling procedures will include but not necessarily be limited to the following:

- Staff involved in the disposal of asbestos will be trained to recognize the related hazards;
- Asbestos will only be accepted in containers/bags and not in a loose form. Care will be taken to ensure that staff or equipment do not come into contact with the asbestos;
- Asbestos will only be accepted with 24-hour pre-notification;
- Appropriate personal protective equipment including disposable coveralls, head covers and respirators will be available for the handling of special wastes;
- Prior to the arrival of asbestos on-Site, a trench will be excavated to receive the material;
- Other operations in the immediate vicinity of the trench will be temporarily suspended while the containers are placed in the trench; and,
- The trench will be covered over immediately with at least 1.25 metres of waste or cover soil.

No waste will be accepted, deposited or removed from the Site unless the Site supervisor or a trained designate is present.

4.5 Daily and Intermediate Cover

Exposed waste will be covered by approximately 0.15 metres of suitable cover material on a daily basis. Areas not visited for more than 6 months will be covered with a minimum of 0.3 metres of cover material. In addition to general clean fill (uncontaminated soil), fines from on-Site diversion operations, wood chips and appropriately treated impacted soil may be used as daily or intermediate cover material. In addition, alternative daily cover systems or materials such as tarpaulin systems and/or spray foams may be used. Daily or intermediate cover will be removed, as much as practical, prior to resuming placement of waste in an area.

4.6 Effects of Settlement on Final Contours

The clay beneath the landfill will consolidate under the weight of the waste. As a result the elevation to which waste is placed will decline as the clay below it consolidates, some of which will occur during the period that filling is ongoing. Because the stability of the landfill is dependent on the thickness of waste, the thickness will be monitored. Waste thickness monitoring will occur primarily at the manhole locations since the base of the manholes will be founded on the landfill base and expected to settle with the overall subgrade settlement.

Although the overall final shape of the landfill will be similar to the design, it is expected that the landfill will not actually reach the maximum ridge/peak elevation presented in the design. In this regard, it is expected that the final contours for Phases 5 and 8 (the two periods of filling the upper part of the landfill above previously filled areas) may be somewhat lower than, but within the approved landfill landform contours. As the clay consolidates over time its shear strength will increase; this increase in shear strength will be considered in determining the total achievable waste thickness and the final contours for Phases 5 and 8. The final shape will also provide positive drainage of runoff.

Some settlement within the waste is also expected over time as any organics and biodegradable components of the waste degrade. Waste settlement as a percent of the overall settlement will be calculated based on settlement monitoring at each of the manhole locations.

Based on the anticipated Site development/landfilling schedule (see Section 4.1.2 of this report), it is expected that Phase 1 will have settled to a greater degree than Phases 2, 3 and 4 when landfilling commences in Phase 5. Regular inspections of the interim waste surface in these Phases will occur and minor modifications will be made to the waste surface and/or intermediate cover to ensure positive drainage from the interim waste surface and to prevent ponding of stormwater on the landfill surface. Surface grade adjustments may also be required when landfilling commences in Phase 5 due to differential settlement that will likely occur between the newer and older completed Phases.

5.0 SITE INSPECTION AND MAINTENANCE

A routine program of inspection and maintenance of all systems within the landfill component of the CRRRC will be carried out to ensure that the systems remain in good repair. Any deficiencies or deviations noted from the approved design operations plan will be addressed promptly. Operations maintenance observations will be made daily in the course of routine operations.

5.1 Landfill

Specific daily landfill observations will include but not necessarily be limited to confirming:

- No evidence of any unacceptable wastes or illegal dumping;
- Adequacy of the daily cover;
- Adequacy of dust control on working areas or access roads;
- Prevention and control of litter on or off-Site;
- No unacceptable odour levels; and,
- No evidence of leachate breakout or seeps.

In addition, specific weekly landfill inspection items will include but not necessarily be limited to:

- Condition of access roads (e.g., potholes, snow removal, etc.);
- General intermediate cover condition (e.g., signs of erosion, etc.);
- Inspection of litter control practices; and,
- Condition of drainage ditches and berms.

Operating staff will maintain a logbook with appropriate checklists and maintenance will be carried out on an as-required basis.

As discussed in Section 4.6 of this report, regular inspection of intermediate waste surfaces will be carried out to ensure positive drainage from the landfill surface.

5.2 Leachate Collection System

It is proposed that all leachate collection and header piping that has been installed in active landfilling areas or areas that have previously received waste will be inspected via camera equipment and flushed on an annual basis during the operating lifespan of the landfill. The frequency of the camera inspections may be decreased, particularly in closed areas of the landfill, should prior inspections indicate no operational challenges or concerns. The camera and flushing equipment will access the leachate collection and header piping via the cleanouts.

The purpose of these inspections will be to look for any blockage due to clogging/fouling or pipe breakage/ deformation. In addition, drainage directions will be noted (i.e., by observing the direction of flow from the flushing operations in each pipe), if possible. Should positive flow in a pipe not be maintained or should areas of settlement result in pipe depressions without positive drainage, leachate levels will be calculated based on the recorded length from the pipe entrance to where the camera becomes submerged and based on pipe elevation estimates. The pipe elevation estimates (and therefore the leachate levels) will only be approximate due to the expected settlement of the subgrade and leachate collection system.

5.2.1 Service Life of Engineered Components

The design for the leachate collection system in the landfill component of the CRRRC meets the requirements of 'Schedule 1' provided in O. Reg. 232/98 (MOE, 1998a) and the Landfill Standards (MOE, 1998b). Based on this regulation, the service life of a primary leachate collection system that meets the requirements in 'Schedule 1' can be taken as 100 years starting from year 10 or the mid-point of the landfilling period, whichever is less.

5.3 Leachate Detection and Secondary Containment System

The LDSCS will be pumped out from the manholes with mobile pumping; the frequency of pumping will depend on the quantity of water in the system as determined through monitoring. The perforated pipes will be flushed if and when necessary.

5.4 Landfill Gas and Odour Management System

Routine inspection and preventative maintenance of the LFG collection system will be conducted by the Owner in accordance with Section 22 of CSA B149.6-11 (CSA, 2011) Code for Digester Gas and Landfill Gas Installations. Records of inspection and maintenance will be maintained and stored on-Site. An operation and maintenance manual will be prepared for the LFG collection system and will include the inspection and maintenance activities described below. Maintenance activities will be coordinated where possible to minimize down-time of the extraction plant and flare.

LFG Horizontal Monitoring Ports

The LFG horizontal collector monitoring ports will be visually inspected during each LFG monitoring session. If the flexible hose, fittings or flow control valve are damaged, they will be repaired or replaced as necessary. Ongoing maintenance of the horizontal collector monitoring ports should be expected, including periodic replacement of fittings and flexible hose.

LFG Header Piping

In accordance with Section 22.2 of CSA B149.6-11 (CSA, 2011), the LFG header pipe will be inspected externally for corrosion on a periodic basis. In addition, the insulation and protective cladding on above-ground portions of the header pipe will be inspected. Any damage or corrosion to the LFG header pipe should be promptly documented, reported, and repairs arranged as required. If damage or significant corrosion is observed, the LFG collection system should be immediately shut down until repairs are completed.

LFG Condensate Trap

Condensate trap(s) will be inspected for the accumulation of sludge/debris and the pneumatic pump removed, checked and cleaned on an annual basis prior to winter.

LFG Extraction Plant

Typical routine inspection and maintenance activities associated with the LFG extraction plant include the following:

- Test the operation of all safety shut-off valves and other shut-downs in the extraction plant;
- Inspect the blower and motor for any unusual noises, vibration, excessive heat, build-up of dirt or debris, and signs of damage or deterioration, as per Section 22.5 of CSA B149.6-11 (CSA, 2011). Visually check that the blower is level and properly aligned;
- Lubricate the blower motor bearings;
- Test all functions of the alarm autodialler;
- Clean the flow meter probe;
- Inspect and clean the air compressor coalescing filter, air dryer and dust particulate filter. Inspect the air compressor oil level and verify that condensate is draining adequately;
- Check the condensate knockout liquid level and drain if necessary;
- Verify the extraction plant ventilation system air flow as per Section 22.9 of CSA B149.6-11 (CSA, 2011);
- Inspect, calibrate and maintain the LFG sampling system and analyzer;
- Inspect, calibrate and maintain the extraction plant ambient gas analyzer as per Section 22.9 of CSA B149.6-11 (CSA, 2011). Replace the gas analyzer sensor when calibration can no longer be achieved; and,
- Inspect manual valves to test for proper operation as per Section 22.6 of CSA B149.6-11 (CSA, 2011), and maintain as necessary. Lubricate valves in accordance with manufacturer's recommendations.

Enclosed Flare

Typical routine inspection and maintenance activities associated with the enclosed flare include the following:

- Inspect all components of flare pilot fuel and ignition assembly for signs of damage. Clean the pilot fuel line flame check when necessary to keep free from deposits and accumulation of foreign matter;
- Inspect burner tips of the flare for deterioration;
- Inspect integrity of flare refractory ceramic fibre blanket;
- Clean the flare flame scanner lens and ensure no cobwebs or obstruction obscuring the scanner view path;
- Clean the spark plug in flare pilot igniter and check for proper gap;
- Lubricate the flare purge fan motor and bearings if necessary;
- Lubricate the flare dampers;
- Inspect the enclosed flare for general signs of damage;

- Monitor for leaks immediately adjacent to all above-ground header piping and fittings, propane pilot fuel train assembly, propane tanks, flare and associated equipment, as per Section 22.4 of CSA B149.6-11 (CSA, 2011);
- Inspect the flame arrestor element for dirt, corrosion and bent, warped or otherwise damaged sheets. Clean if necessary; and,
- If a flash-back or burn-back has occurred within the system or severe heat has been applied external to the thermal valve, inspect the thermal valve internal components.

6.0 MONITORING PROGRAMS

Environmental monitoring related to the landfill component of the CRRRC will be carried out concurrently with and as part of the overall Site monitoring program. As such, reference should be made to the overall facility D&O report for monitoring, trigger mechanisms and contingency measures related to groundwater, leachate, surface water, sediment, lateral LFG migration, dust, noise, odour and biology.

Regular monitoring that will be required related to the operation of the LFG collection and flaring system is discussed below as well as actions that could be carried out based on this operational LFG monitoring.

6.1 Operational Landfill Gas Monitoring

Ongoing, regular monitoring of and adjustments to the LFG collection and flaring system are required for the following reasons:

- To ensure LFG safety;
- To achieve proper operations and maintenance of the LFG system, and to optimize LFG recovery for flaring or utilization purposes;
- To comply with the Province of Ontario's LFG regulations;
- To achieve and maintain effective surface and subsurface gas migration control, protect structures near the landfill, and reduce LFG-related odours; and,
- To avoid overpulling in the horizontal collectors by application of excess vacuum, maintain a healthy anaerobic state within the landfill, and reduce the possibility of subsurface fires caused by drawing oxygen in from the atmosphere.

The following LFG monitoring activities should be conducted, with detailed records of monitoring activities maintained and stored on-Site.

LFG Horizontal Collector Monitoring

LFG horizontal monitoring port monitoring and adjustment (balancing the wellfield) are required to achieve a stable rate and quality of extracted LFG. The frequency of monitoring depends on the number and magnitude of recent changes to the landfill (in the area of the LFG collection system) and to the LFG extraction plant settings. If a large number and large magnitude (e.g., if several additional LFG horizontal collectors are added to the collection system) of changes have been introduced to the LFG collection system, then initial twice weekly to weekly monitoring of the LFG collection system is recommended. If only minor adjustments to a limited number of locations have been made, and LFG quality has been steady for the previous two months, the horizontal collector monitoring can occur monthly. However, as a minimum, it is recommended that not more than 31 calendar days elapse between rounds of horizontal collector monitoring.

Typically, the LFG pressure, quality and flow rate should be recorded at each horizontal monitoring port using calibrated monitoring equipment.

Landfill Cover Monitoring

Observation of the landfill cover should occur during each horizontal collector monitoring session. The location of any excessive settlement, cracking, seeps or evidence of a potential landfill fire should be noted during the observation of the cover, and subsequently reported and repaired by the appropriate parties. Horizontal collectors in the vicinity of large cracks or fissures should be isolated from the remainder of the LFG collection system to limit the opportunity for air intrusion until remedial action is taken to repair the landfill cover.

Extraction Plant Monitoring

During each horizontal collector monitoring session, the following LFG extraction plant monitoring is recommended:

- Record the LFG flow rate, vacuum, and methane and oxygen concentrations in the LFG reported on the human-machine interface (HMI) screen;
- Download the extraction plant (blower and other instrumentation) and flare data from the datalogger; and,
- Use a portable LFG analyzer to manually record methane, carbon dioxide and oxygen concentrations in LFG stream.

The LFG flow rate at the extraction plant and the flow control valves at the horizontal collector monitoring ports should be adjusted based on the results of the monitoring.

6.1.1 Landfill Gas and Flaring System Operational Contingencies

The following contingency options are provided for the LFG collection and flaring system:

LFG Odours or Insufficient Quantity of Collected LFG

If required, vertical LFG extraction wells could be installed following the completion of individual landfill phases to control odours or to augment the quantity of collected LFG recovered. Vertical LFG extraction wells could be located in individual phases already completed to final contours, specifically in areas of thicker waste and where horizontal collectors may have become blocked due to settlement. Vertical LFG extraction wells should be equipped with a wellhead to allow for the monitoring of LFG quality and pressure, measurement of LFG flow rates, and a valve to facilitate the regulation and balancing of LFG flow. Each vertical LFG extraction well would be connected to the LFG header pipe via lateral piping.

Unexpected LFG System Component Failure

In the event of the failure of a component that is connected to the PLC (e.g., LFG analyzer), the LFG system will automatically shut down and send an alarm via the autodialler.

A supply of typical spare parts will be maintained on-Site to allow for the timely replacement of failed components and to minimize down-time of the LFG collection system.

Landfill Fire

Site LFG personnel would be familiar with preventative measures and immediate action required in the event of a subsurface landfill fire due to the operation of the active LFG management system. Typical immediate steps that could be taken could include the following:

- Shut down the LFG blower and shut off each LFG horizontal collector;
- Contact a LFG professional;
- If safe, cover the area with 300 mm thickness of fine-grained soil to smother the fire;
- Record the methane, carbon dioxide, oxygen, balance gas, pressure and temperature of LFG in the horizontal collectors within the affected area; and,
- Maintain a record and photographs of all fires.

7.0 LANDFILL CLOSURE

Prior to approved waste capacity being exhausted, formal Site closure procedures will be developed. A closure report will be prepared and submitted to the MOECC for approval at least one year before the landfill component of the CRRRC is expected to close and stop receiving waste. The Closure Plan will outline the post-closure monitoring and maintenance program.

7.1 Final Cover

Based on the analysis of landfill performance in terms of compliance with the groundwater protection requirements of O.Reg. 232/98 (MOE, 1998a), it is currently proposed that a permeable soil final cover be used on the landfill consisting of a 0.6-metre thick general soil cover layer overlain by a 0.15-metre thick layer of topsoil or other material able to sustain plant growth, in accordance with O. Reg. 232/98. This will be confirmed in consultation with the MOECC during development and approval of the Closure Plan. The general earth material for the final cover can be permeable since there is a leachate collection system in place (MOE, 1998a). It is currently anticipated that the general earth material will consist of a soil layer that meets the following geotechnical requirements:

- A soil moisture content that enables the material to be handled, spread and compacted;
- Adequate internal strength to be stable on the proposed grades and sideslope angles;
- Adequate thickness to resist cracking due to the effects of differential settlement of the underlying waste;
- Material gradation ranging from gravel, through sand, to silty clay;
- Achieve at least 90% of the standard Proctor maximum dry density; and,
- Together with the topsoil and vegetative cover, be sufficiently erosion resistant.

For the landfill final cover, consideration may however be given to including measures to achieve increased runoff off the cover and thereby reduce infiltration and the corresponding volume of leachate requiring treatment. The approach would be to more quickly remove the water from the covered landfill area by reducing the surface runoff distance using such measures as a network of shallow surface ditching and/or piping on/within the soil cover to intercept surface runoff and convey it to the toe of the landfill and the stormwater management system. This will be confirmed in consultation with the MOECC during development of the final Closure Plan.

Final cover construction will take place after filling in a part of the landfill is complete. Completed portions of the final cover will be hydroseeded or otherwise vegetated in order to quickly establish a vegetative cover for aesthetics and erosion control purposes.

8.0 CLOSURE

We trust this report meets your current needs. If you have any questions regarding this report, please contact the undersigned.

GOLDER ASSOCIATES LTD.

P. Andrew S. Benson, M.Eng., P.Eng.
Senior Environmental Engineer, Associate

PASB/PAS/sg
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REFERENCES

CSA Group (CSA). (2011). *B149.6-11 - Code for digester gas and landfill gas installations.*

Ministry of the Environment (MOE). (2011). *Ontario Water Resources Act (OWRA).* Last Updated: 2011.

Ministry of the Environment (MOE). (2010a). *Environmental Assessment Act (EAA).* Last updated: 2010.

Ministry of the Environment (MOE). (2010b). *Environmental Protection Act (EPA).* Last updated: 2010.

Ministry of the Environment (MOE). (1998a). *Landfilling Sites: Ontario Regulation (O.Reg.) 232/98.* Last Updated: June 2011.

Ministry of the Environment (MOE). (1998b). *Landfill Standards – A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfill Sites.* Last Updated: January 2012

Ministry of the Environment (MOE). (1990). *General- Waste Management: Ontario Regulation (O.Reg.) 347.* Last Updated: December 2013.

PLOT DATE: November 10, 2014
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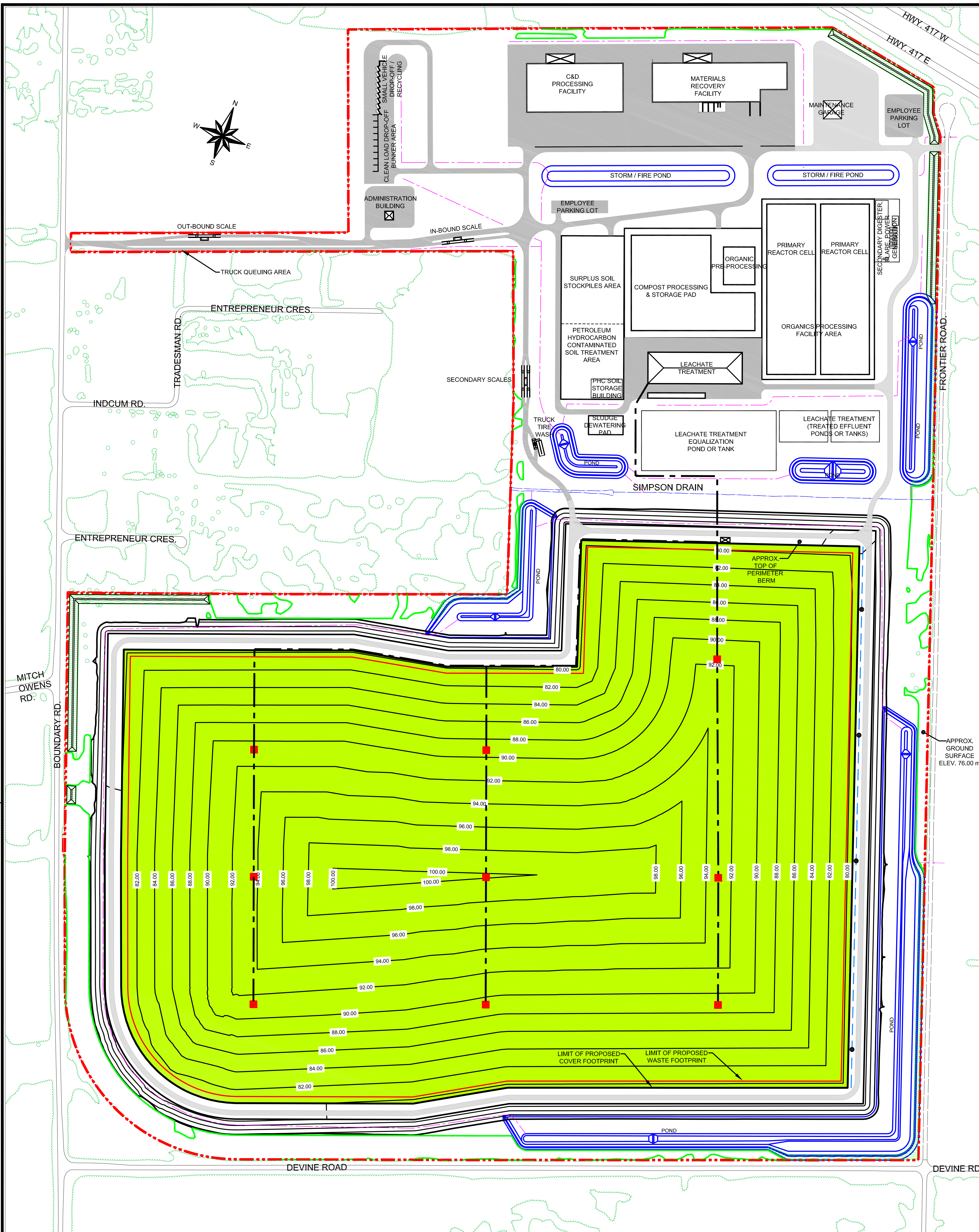


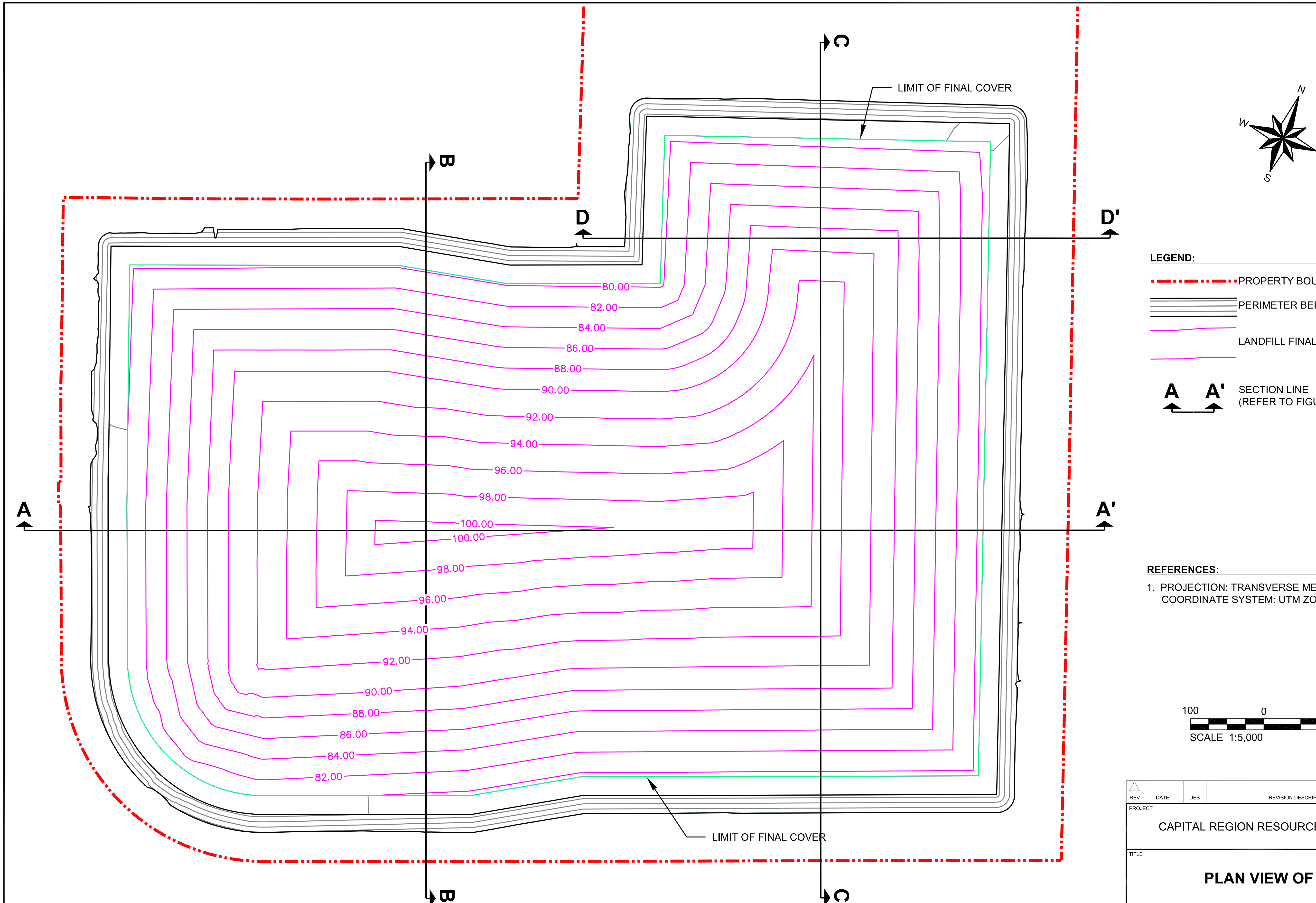
LEGEND

- LANDFILL COMPONENT
- PAVED ROAD (ASPHALT)
- GRAVEL ROAD
- PROPERTY BOUNDARY
- EXISTING VEGETATION
- CONSTRUCTED SCREENING FEATURE
- PERIMETER BERM CONTOURS (interval 1 m)
- STORMWATER MANAGEMENT PONDS
- LANDFILL FINAL CONTOURS (interval 2 m)
- LEACHATE MANHOLE
- LEACHATE FORCEMAIN
- LEACHATE PUMP CONTROL STATION
- LEACHATE DETECTION AND SECONDARY CONTAINMENT SYSTEM MANHOLE
- LEACHATE DETECTION AND SECONDARY CONTAINMENT SYSTEM

120 0 120 240
SCALE 1:6,000 METRES

Golder Associates
Ottawa, Ontario, Canada

SCALE	AS SHOWN	TITLE	SITE DEVELOPMENT PLAN
DATE	7 Nov. 2013		
DESIGN	M.L.F.		
CAD	M.L.F.		
FILE No. 1211250045-1500-4000-01.dwg	CHECK	P.L.E.	CAPITAL REGION RESOURCE RECOVERY CENTRE
PROJECT No. 12-1125-0045 REV.	REVIEW	P.A.S.	FIGURE 1



LEGEND:

- PROPERTY BOUNDARY
- PERIMETER BERM CONTOURS (interval 1.0 m)
- LANDFILL FINAL CONTOURS (interval 2.0 m)
- A A' SECTION LINE (REFER TO FIGURES 4a & 4b)

REFERENCES:

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

100 0 100 200

SCALE 1:5,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

PLAN VIEW OF LANDFILL

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	M.K.F.	15 Oct. 2013
CAD	M.L.F.	15 Oct. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-1500-4000-2-6.dwg

SCALE AS SHOWN REV. 0

DRAWING No.

Figure 2

PLOT DATE: September 4, 2014
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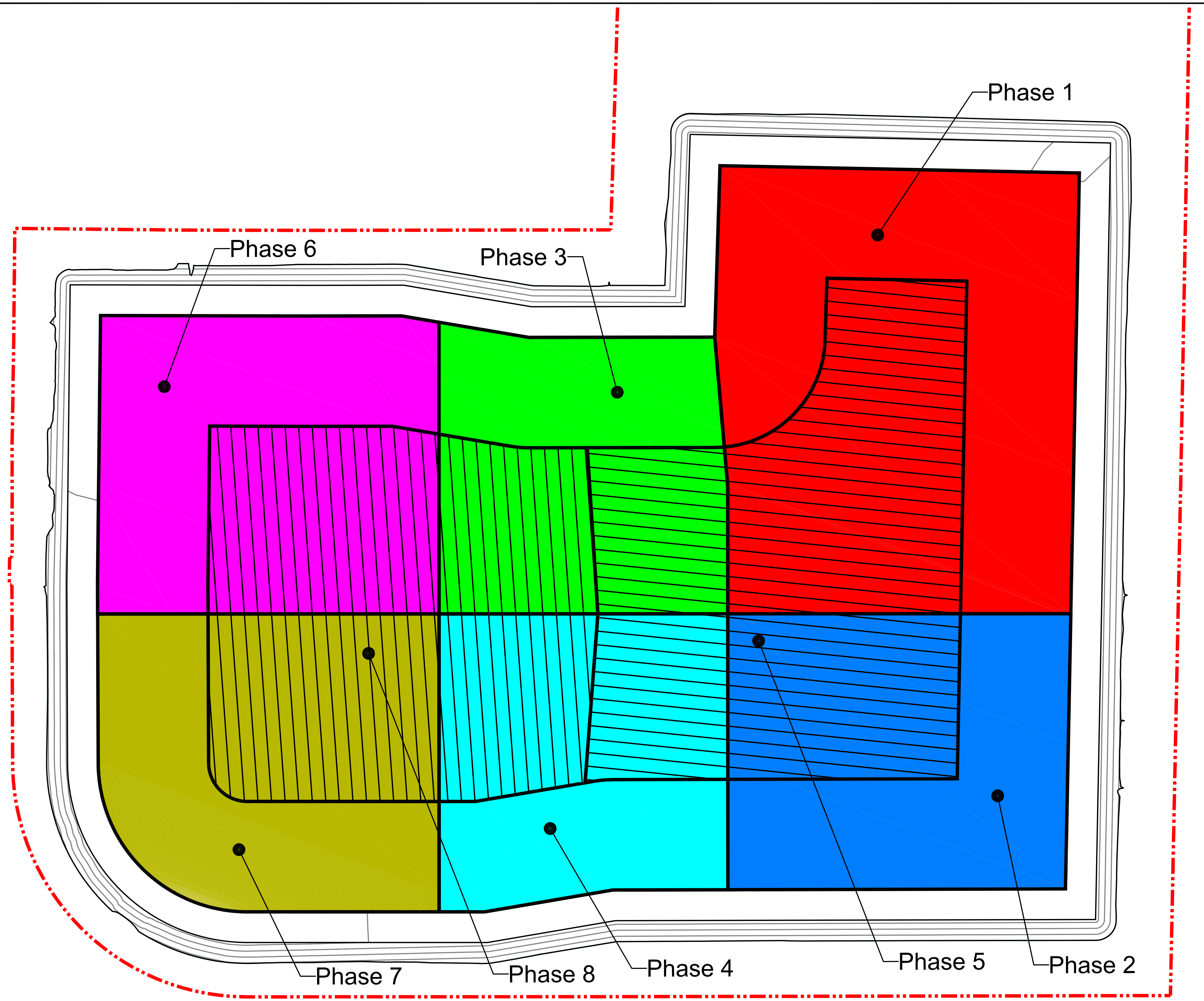

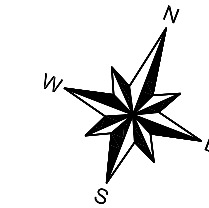

LEGEND:

PROPERTY BOUMDARY

PERIMETER BERM CONTOURS (interval 1.0 m)

REFERENCES:

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
   COORDINATE SYSTEM: UTM ZONE 18

100 0 100 200

SCALE 1:5,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

LANDFILL PHASING PLAN

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	M.K.F.	15 Oct. 2013
CAD	M.L.F.	15 Oct. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-1500-4000-2-6.dwg

SCALE AS SHOWN REV. 0

DRAWING No.

Figure 3

PLOT DATE: September 4, 2014
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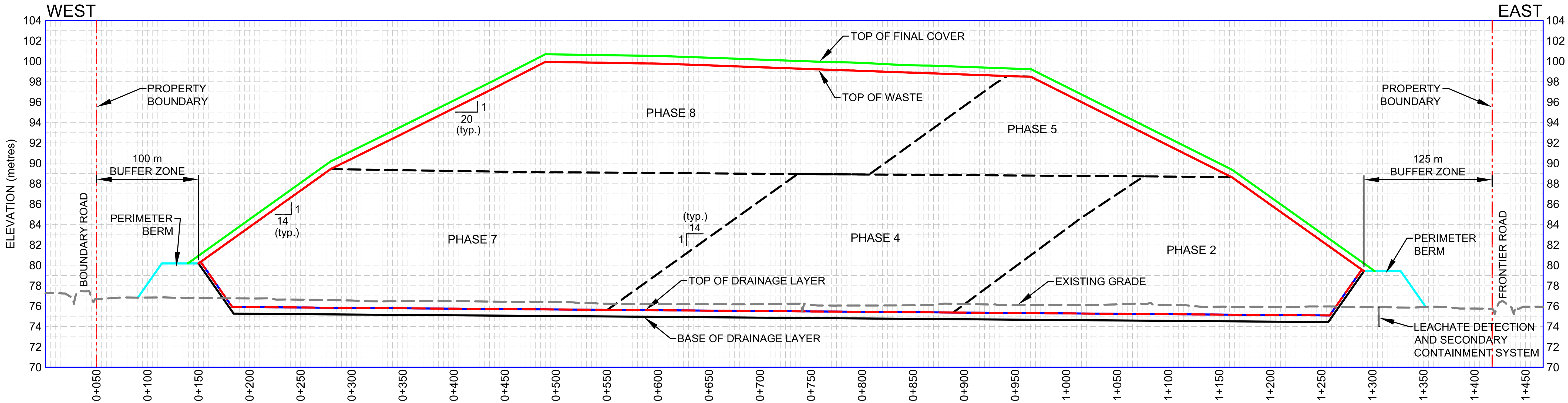
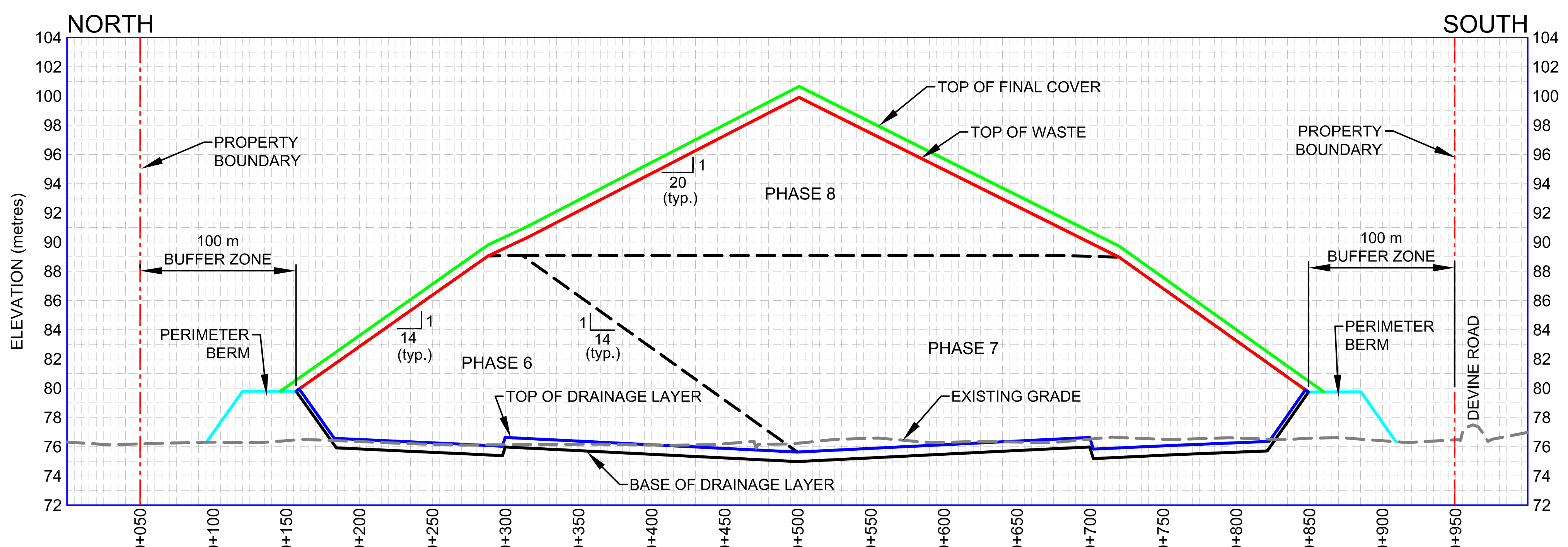


SECTION A-A'



SECTION B-B'

NOTES:

1. LEACHATE COLLECTION PIPING AND SUMPS ARE NOT SHOWN.

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SECTIONS A-A' and B-B'

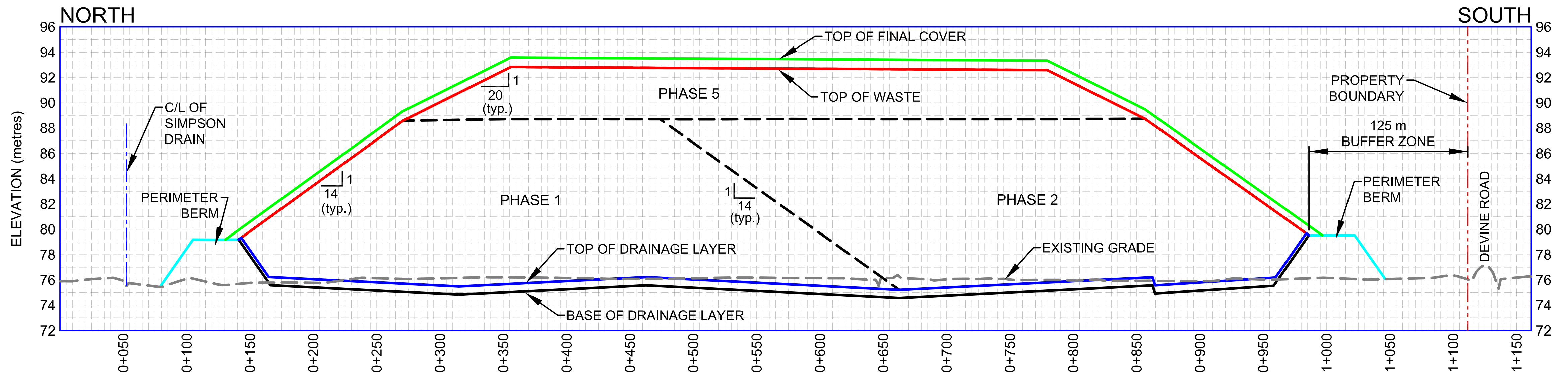
Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	M.K.F.	15 Oct. 2013
CAD	M.L.F.	15 Oct. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

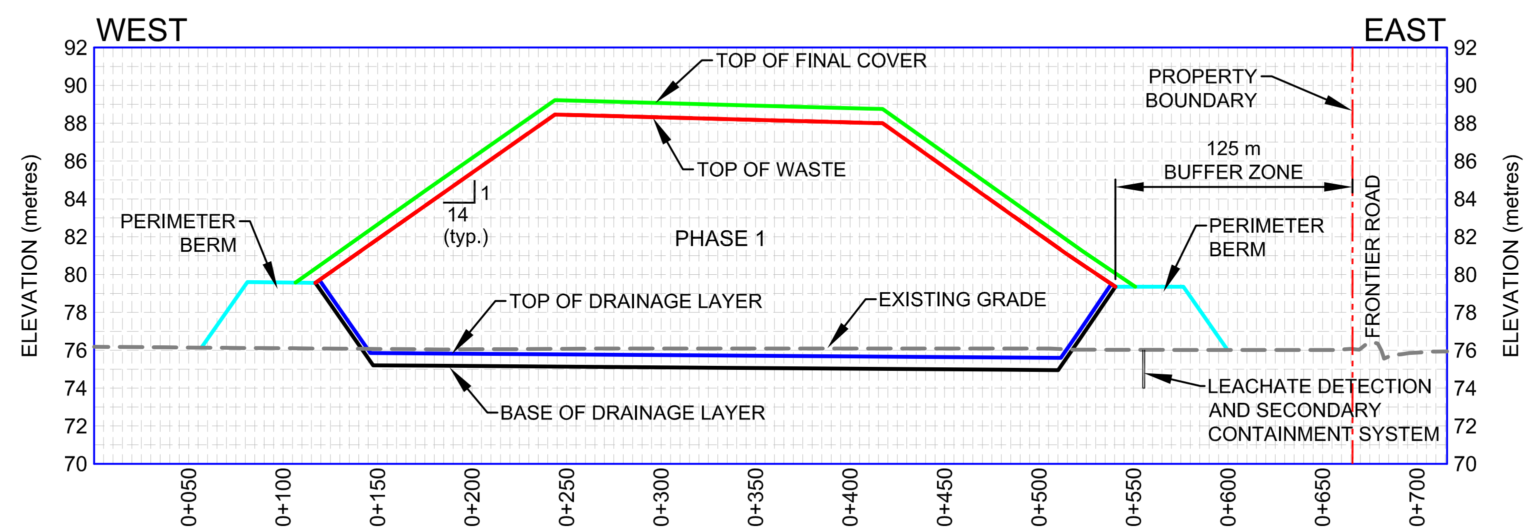
FILE No. 1211250045-1500-4000-2-6.dwg
SCALE AS SHOWN REV. 0
DRAWING No.

Figure 4a

PLOT DATE: November 4, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Landfill Design\1211250045-1500-4000-2-6.dwg



SECTION C-C'



SECTION D-D'

NOTES:

1. LEACHATE COLLECTION PIPING AND SUMPS ARE NOT SHOWN.

SCALE 1:4,000 HORIZONTAL METRES (80 0 80 160)

SCALE 1:400 VERTICAL METRES (8 0 8 16)

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT: CAPITAL REGION RESOURCE RECOVERY CENTRE

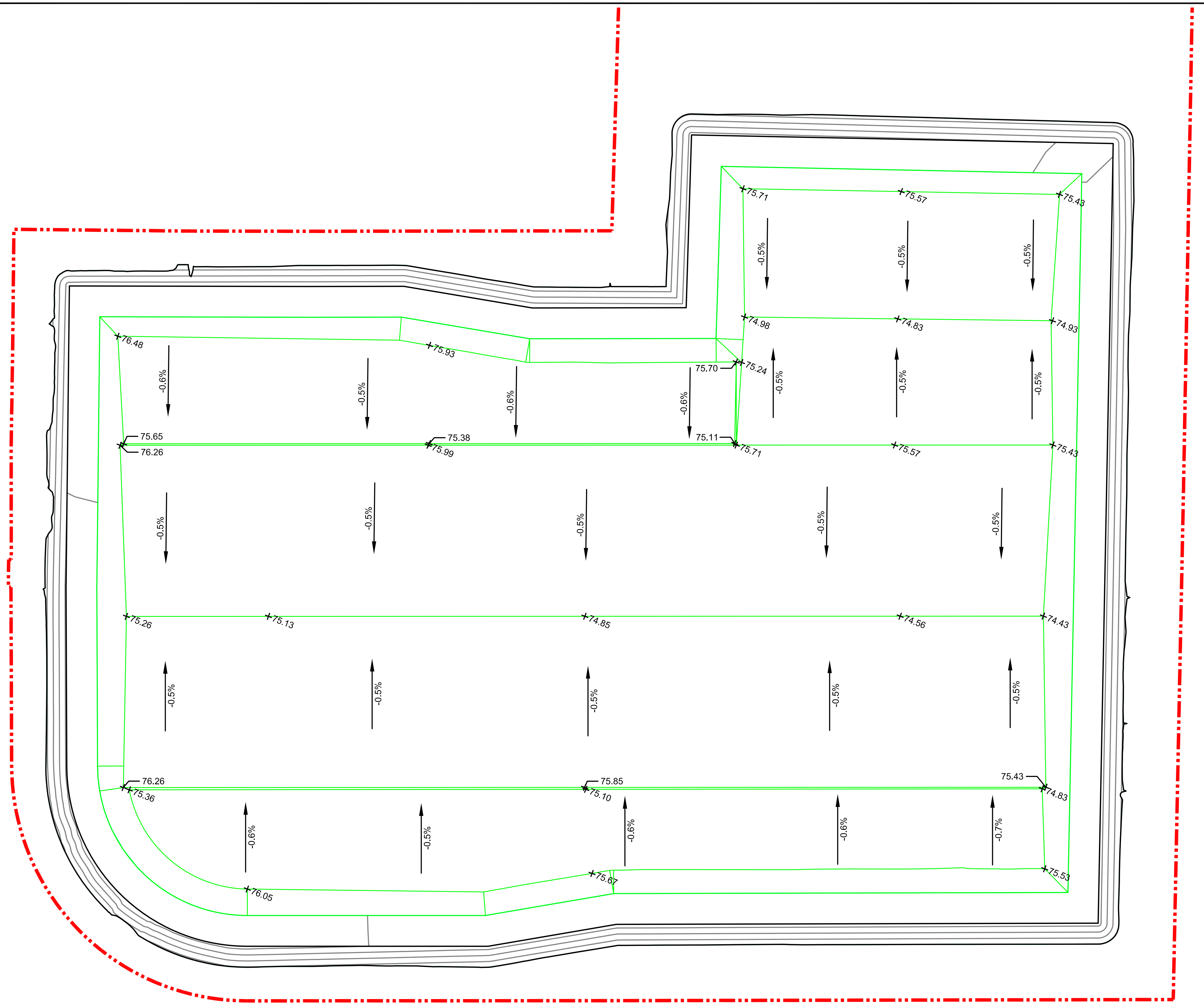
TITLE: **SECTIONS C-C' and D-D'**

Golder Associates, Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	M.K.F.	15 Oct. 2013
CAD	M.L.F.	15 Oct. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-1500-4000-2-6.dwg
SCALE AS SHOWN REV. 0
DRAWING No. **Figure 4b**

PLOT DATE: November 4, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Landfill Design\1211250045-1500-4000-2-6.dwg



LEGEND:

PROPERTY BOUNDARY

74.85 SUBBASE ELEVATION

-0.5% SUBBASE SLOPES

MAIN SUBGRADE SLOPE BREAK POINTS

REFERENCES:

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
   COORDINATE SYSTEM: UTM ZONE 18

NOT FOR CONSTRUCTION

100 0 100 200

SCALE 1:5,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

LANDFILL BASE GRADES

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.	12-1125-0045		FILE No. 1211250045-1500-4000-2-6.dwg	
DESIGN	M.K.F.	15 Oct. 2013	SCALE AS SHOWN	REV. 0
CAD	M.L.F.	15 Oct. 2013	DRAWING No.	
CHECK	P.L.E.	Aug. 2014	Figure 5	
REVIEW	P.A.S.	Aug. 2014		

PLOT DATE: September 4, 2014
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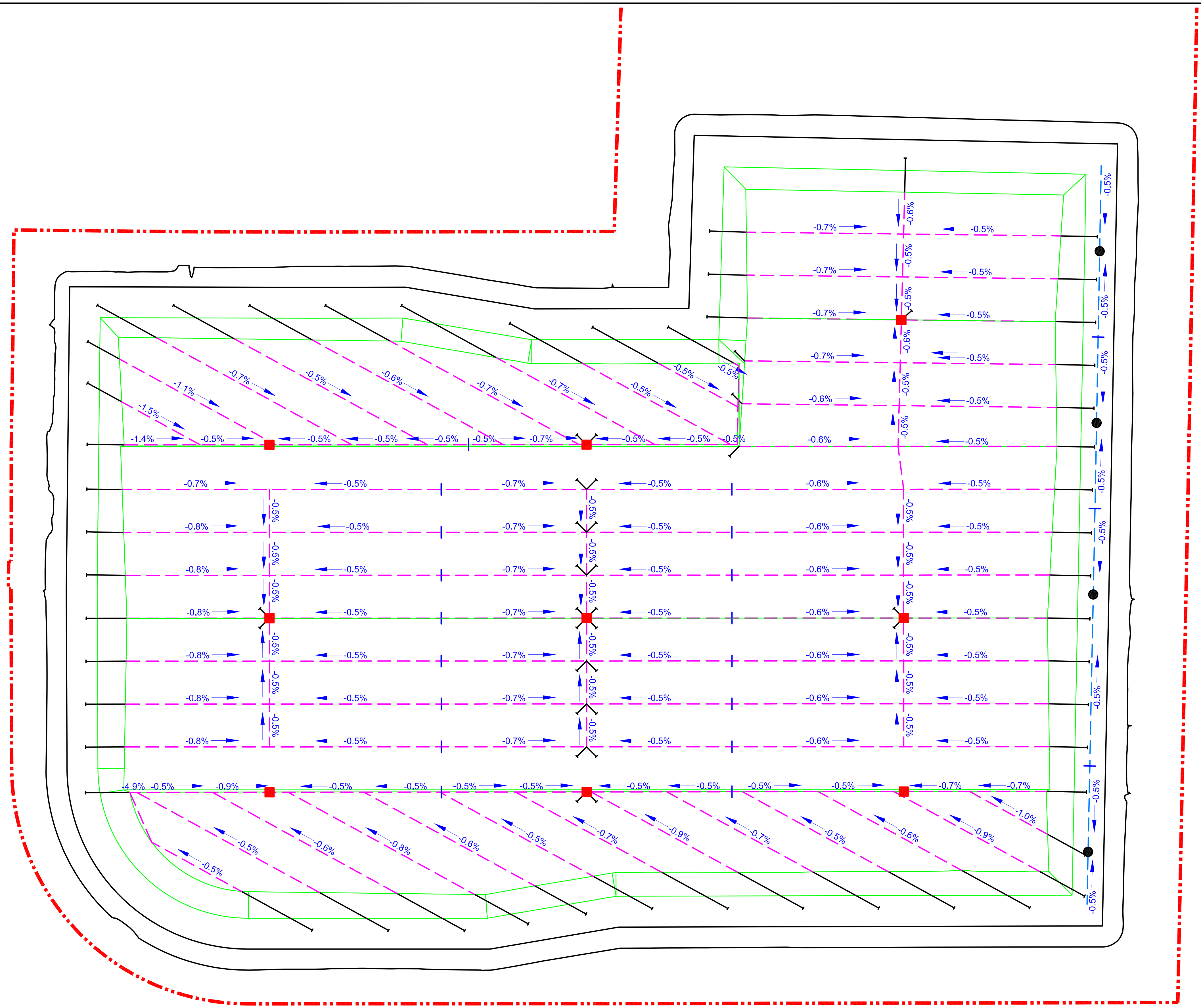


LEGEND:

- PROPERTY BOUNDARY
- -0.5% LEACHATE COLLECTION PIPE SLOPE (initial)
- LEACHATE MANHOLE (nts)
- CLEAN OUT LOCATION (nts)
- PIPE GRADE BREAK POINT
- LEACHATE COLLECTION PIPE
- MAIN SUBGRADE SLOPE BREAK POINTS
- PERIMETER BERM SLOPE BREAK POINTS
- LEACHATE DETECTION AND SECONDARY CONTAINMENT SYSTEM MANHOLE (nts)
- LEACHATE DETECTION AND SECONDARY CONTAINMENT SYSTEM COLLECTION PIPE

REFERENCES:

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
   COORDINATE SYSTEM: UTM ZONE 18

NOT FOR CONSTRUCTION

100 0 100 200

SCALE 1:5,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

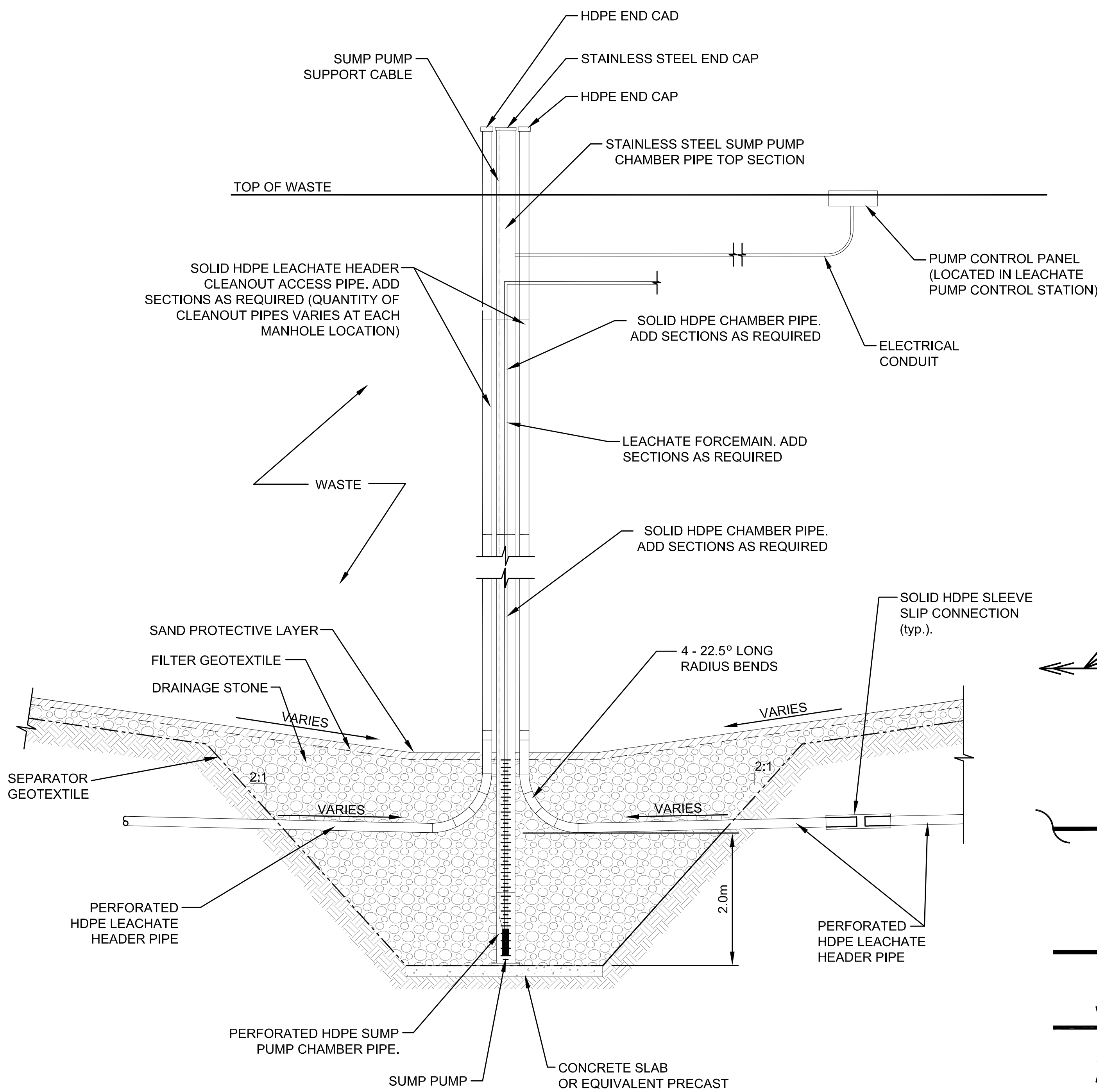
TITLE

LEACHATE COLLECTION AND LDSCS PIPING LAYOUT PLAN

Golder Associates
Ottawa, Ontario, Canada

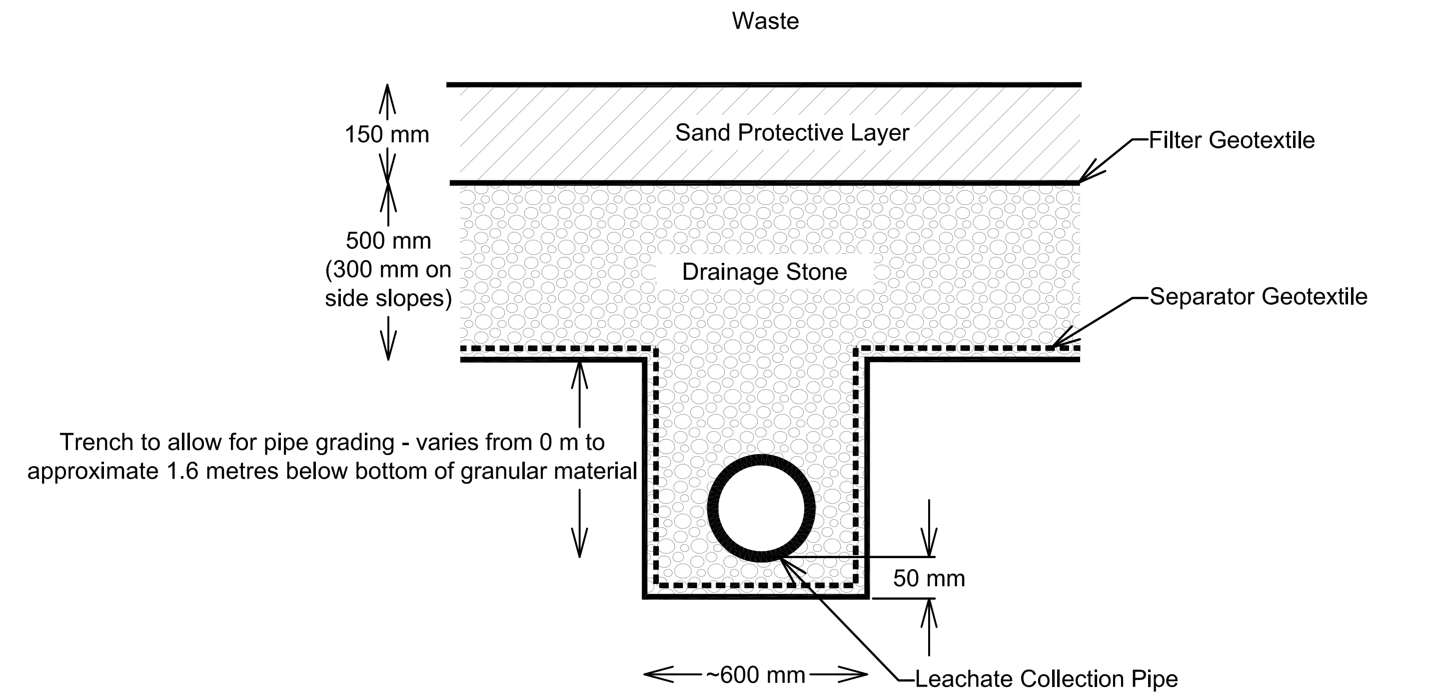
PROJECT No.		12-1125-0045	FILE No. 1211250045-1500-4000-2-6.dwg
DESIGN	M.K.F.	15 Oct. 2013	SCALE AS SHOWN REV. 0
CAD	M.L.F.	15 Oct. 2013	DRAWING No.
CHECK	P.L.E.	Aug. 2014	**Figure 6**
REVIEW	P.A.S.	Aug. 2014	

PLOT DATE: November 10, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Landfill Design\1211250045-1500-4000-2-6.dwg



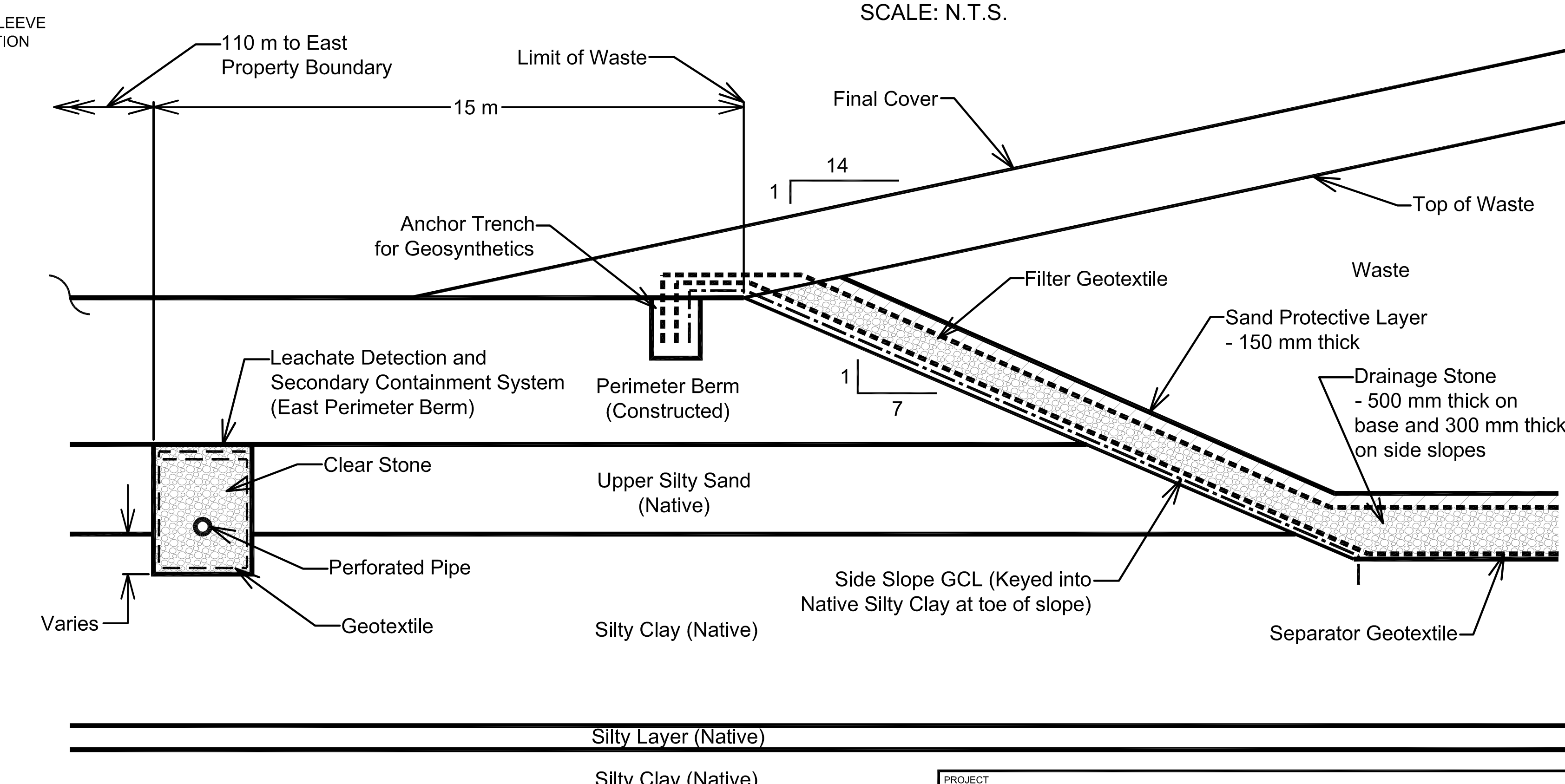
LEACHATE MANHOLE DETAIL

SCALE: N.T.S.



TYPICAL LEACHATE COLLECTION SYSTEM SECTION

SCALE: N.T.S.



TYPICAL PERIMETER LEACHATE CONTAINMENT CROSS-SECTION

SCALE: N.T.S.

NOT FOR CONSTRUCTION

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
LEACHATE COLLECTION CONCEPTUAL DETAILS

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045	FILE No. 1211250045-1500-4000-07.dwg
DESIGN	M.K.F.	15 Oct. 2013	SCALE AS SHOWN REV. 0
CAD	M.L.F.	15 Oct. 2013	DRAWING No.
CHECK	P.L.E.	Aug. 2014	**Figure 7**
REVIEW	P.A.S.	Aug. 2014	

PLOT DATE: November 5, 2014
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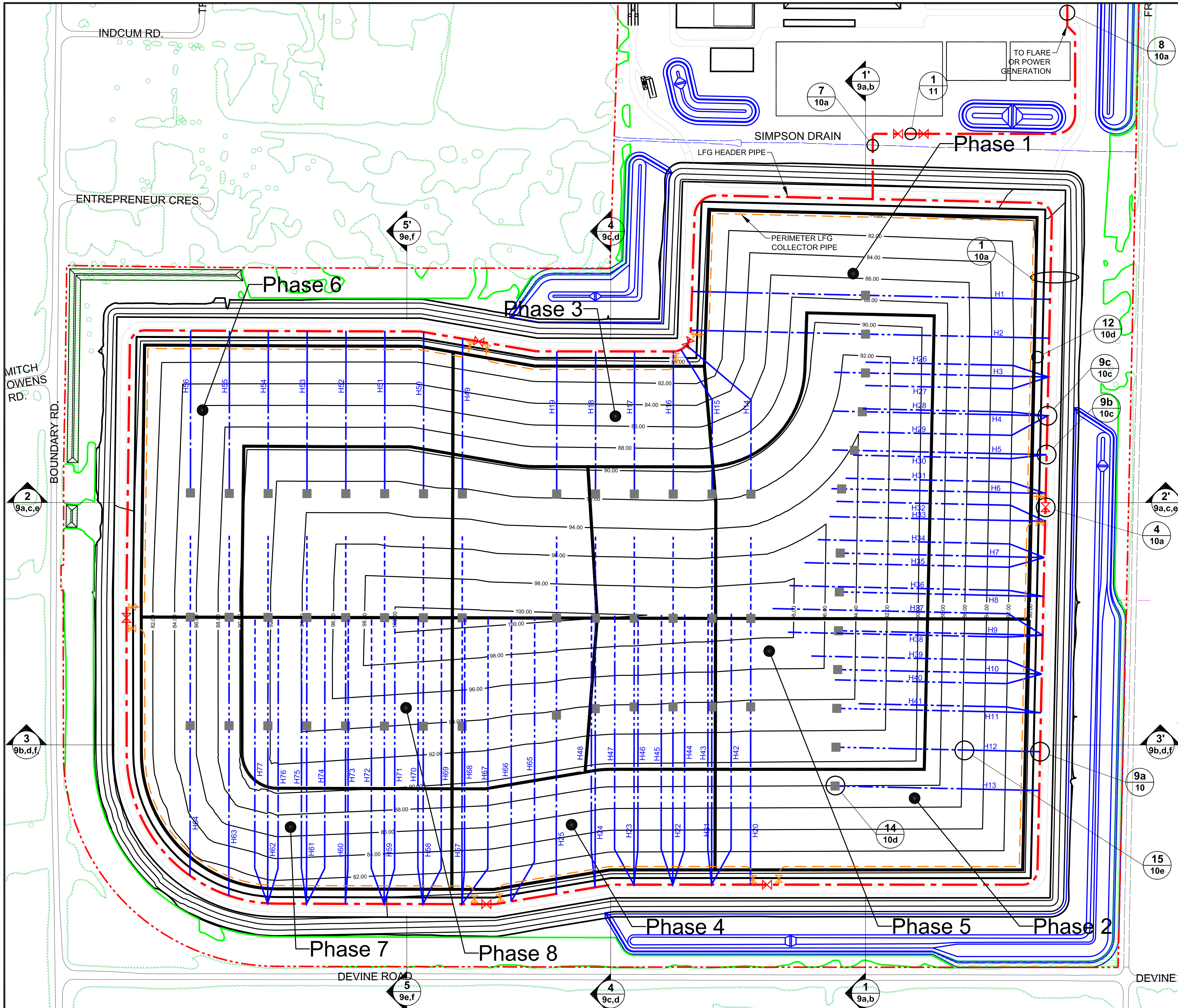

LEGEND:

- HDPE LFG HEADER PIPE
- HDPE LFG PERIMETER COLLECTOR PIPE
- HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)
- HORIZONTAL COLLECTOR DRAIN
- VALVE
- CONDENSATE TRAP
- 0/10 0/10 SECTION LINES
- X/X REFERENCE DETAIL OR SECTION / REFERENCE DRAWING SHEET

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.
2. WELLHEAD / VALVE AT DOWNSTREAM END OF HORIZONTAL COLLECTOR IS NOT SHOWN.

NOT FOR CONSTRUCTION

100 0 100 200

SCALE 1:5,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

LANDFILL GAS COLLECTION SYSTEM LAYOUT

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.	12-1125-0045	
DESIGN	A.M.H.	29 Nov. 2013
CAD	M.L.F.	03 Dec. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-4000-LGW-08.dwg

SCALE AS SHOWN REV. 0

DRAWING No.

Figure 8

PLOT DATE: October 9, 2014
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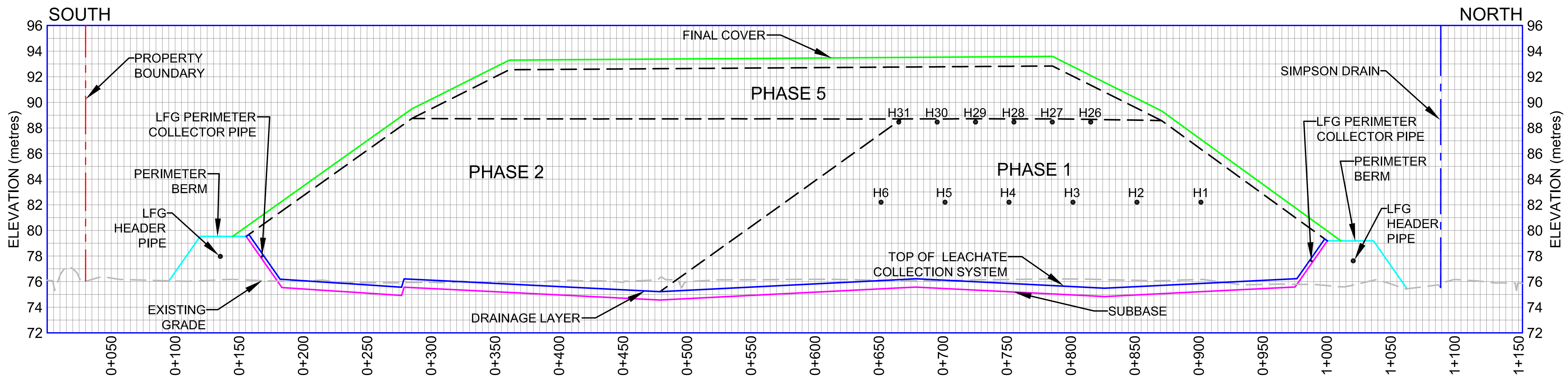
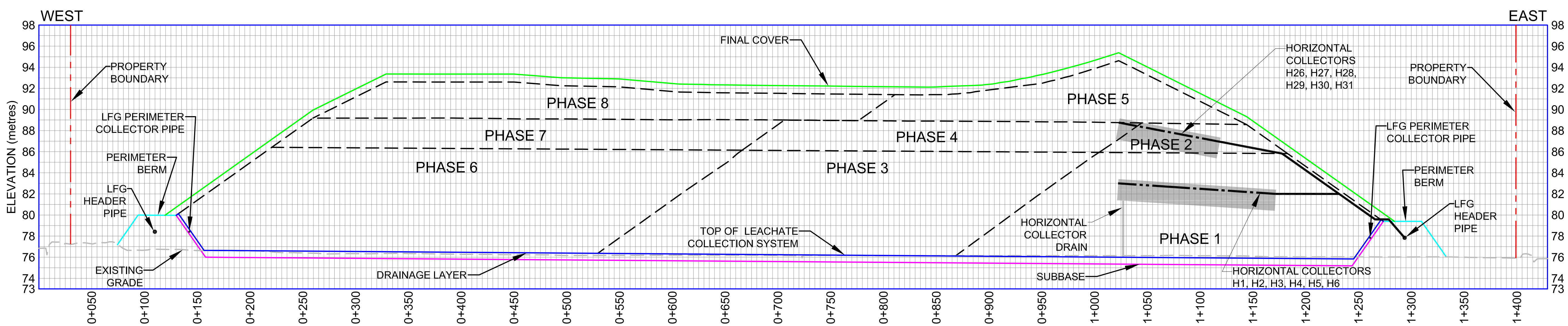


PROFILE 1-1'



PROFILE 2-2'

LEGEND:

HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE

HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)

HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)

HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.

TYPICAL HORIZONTAL COLLECTORS FOR PHASE 1

NOTE: CROSS-SECTION OF TYPICAL HORIZONTAL COLLECTORS. ELEVATION AND LENGTHS OF INDIVIDUAL HORIZONTAL COLLECTORS VARY

NOT FOR CONSTRUCTION

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
TYPICAL LANDFILL GAS HORIZONTAL COLLECTOR CROSS-SECTION

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.	12-1125-0045	FILE No.	1211250045-4000-LGW-09.dwg
DESIGN	A.M.H. 29 Nov. 2013	SCALE	AS SHOWN REV. 0
CAD	M.L.F. 02 Dec. 2013	DRAWING No.	
CHECK	P.L.E. Aug. 2014		**Figure 9a**
REVIEW	P.A.S. Aug. 2014		

PLOT DATE: July 7, 2014
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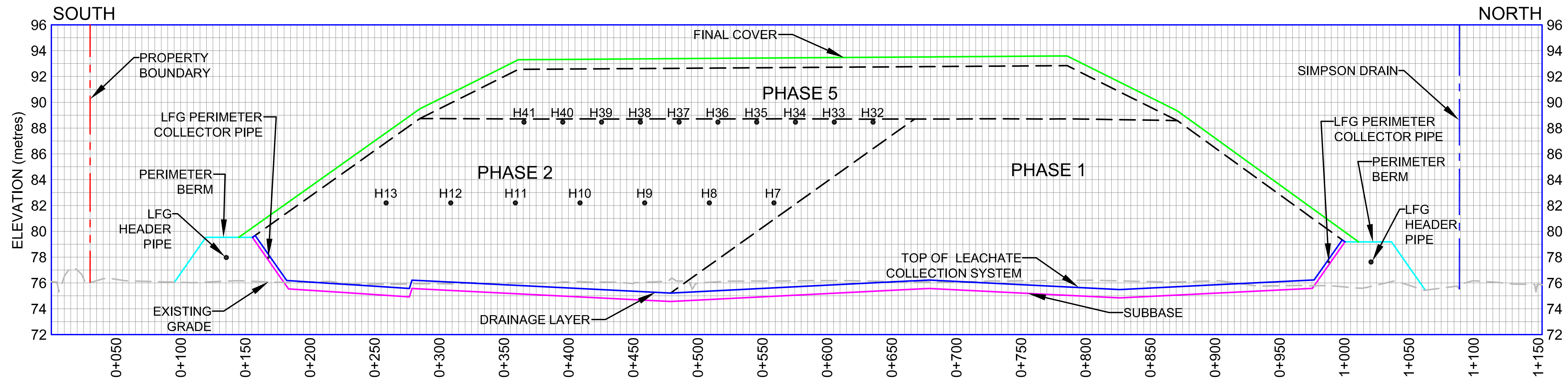
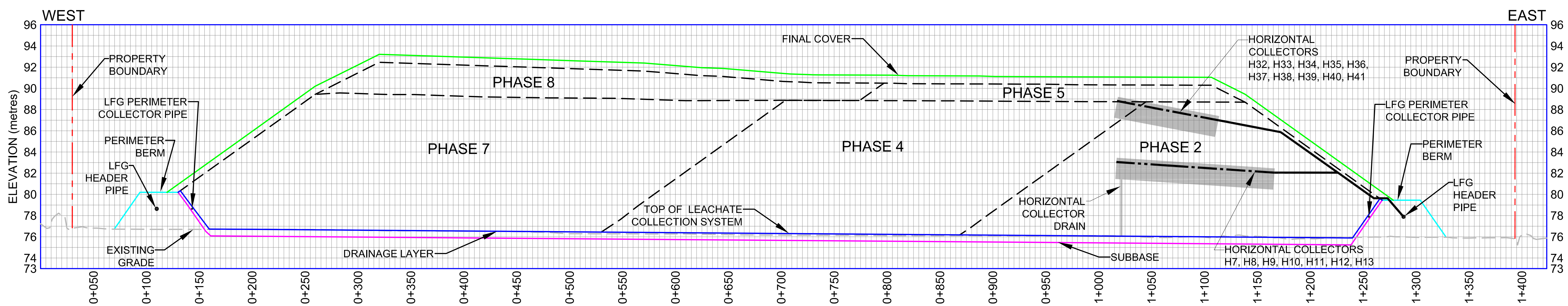


PROFILE 1-1'



PROFILE 3-3'

LEGEND:

- ───── HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE
- ─·─·─ HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)
- ─··─··─ HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)
- - - - - HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.

TYPICAL HORIZONTAL COLLECTORS FOR PHASE 2

NOTE: CROSS-SECTION OF TYPICAL HORIZONTAL COLLECTORS. ELEVATION AND LENGTHS OF INDIVIDUAL HORIZONTAL COLLECTORS VARY

NOT FOR CONSTRUCTION

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
TYPICAL LANDFILL GAS HORIZONTAL COLLECTOR CROSS-SECTION

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	A.M.H.	29 Nov. 2013
CAD	M.L.F.	02 Dec. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-4000-LGW-09.dwg
SCALE AS SHOWN REV. 0
DRAWING No.
Figure 9b

PLOT DATE: July 7, 2014
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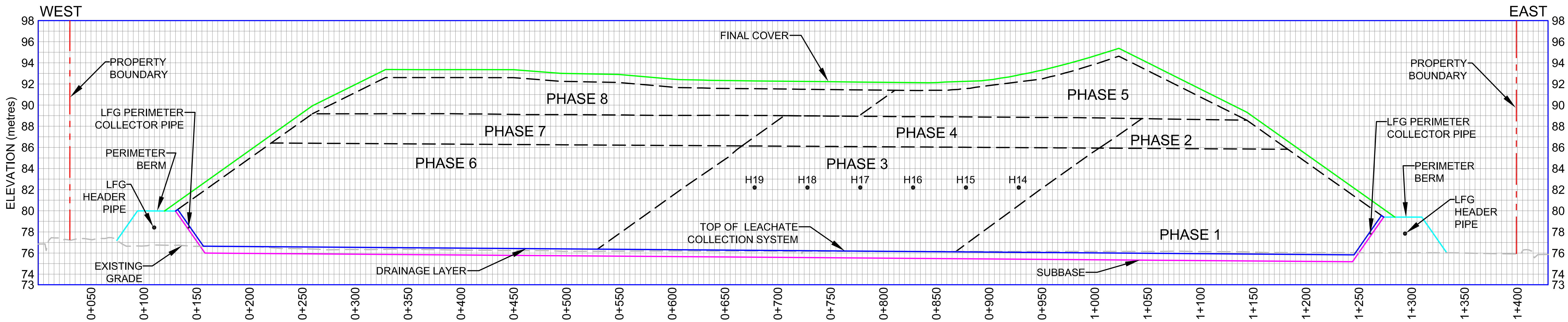
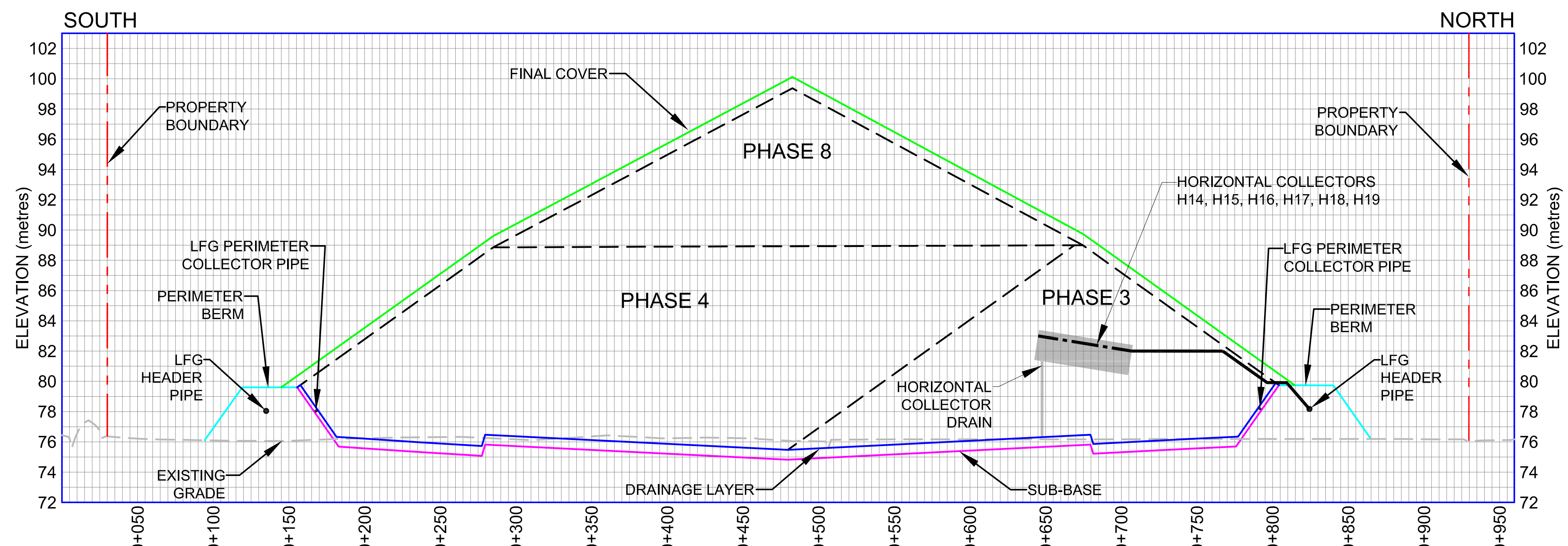


PROFILE 2-2'



PROFILE 4-4'

LEGEND:

- HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.

TYPICAL HORIZONTAL COLLECTORS FOR PHASE 3

NOTE: CROSS-SECTION OF TYPICAL HORIZONTAL COLLECTORS. ELEVATION AND LENGTHS OF INDIVIDUAL HORIZONTAL COLLECTORS VARY

NOT FOR CONSTRUCTION

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
TYPICAL LANDFILL GAS HORIZONTAL COLLECTOR CROSS-SECTION

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.	12-1125-0045	FILE No.	1211250045-4000-LGW-09.dwg
DESIGN	A.M.H.	29 Nov. 2013	SCALE AS SHOWN REV. 0
CAD	M.L.F.	02 Dec. 2013	DRAWING No.
CHECK	P.L.E.	Aug. 2014	**Figure 9c**
REVIEW	P.A.S.	Aug. 2014	

PLOT DATE: July 7, 2014
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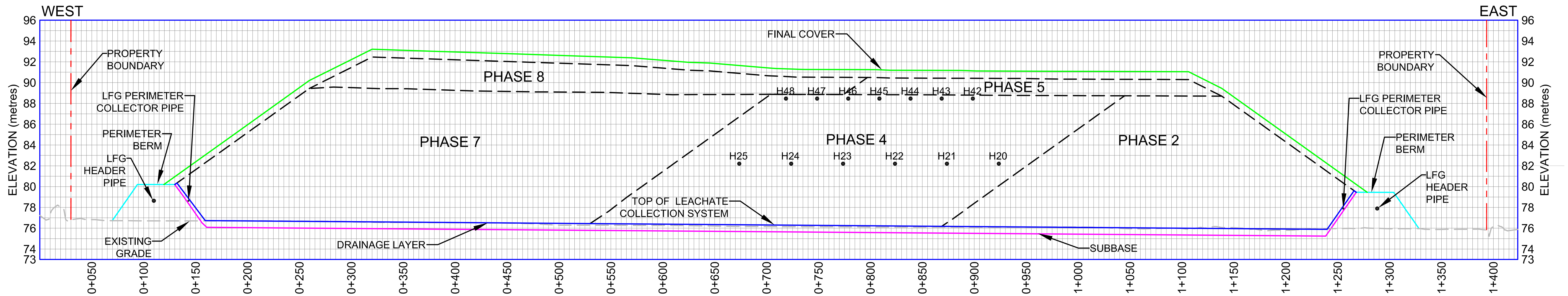
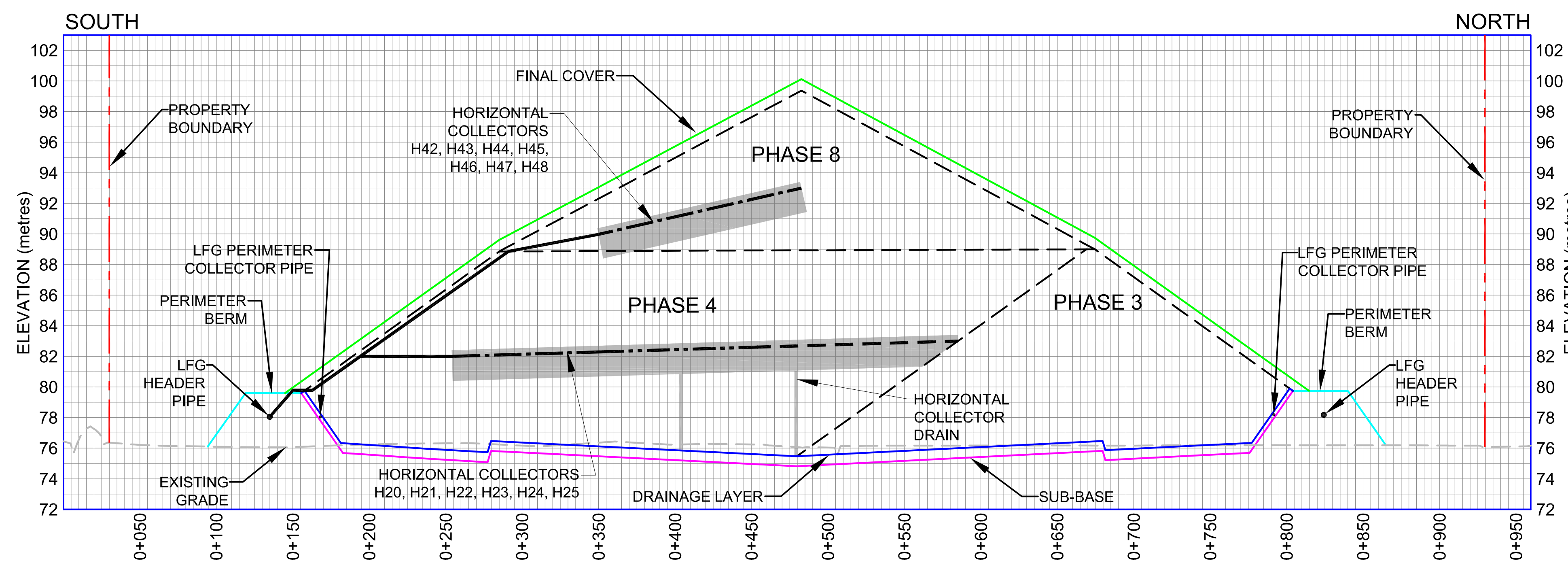


PROFILE 3-3'



PROFILE 4-4'

LEGEND:

- HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.

TYPICAL HORIZONTAL COLLECTORS FOR PHASE 4

NOTE: CROSS-SECTION OF TYPICAL HORIZONTAL COLLECTORS. ELEVATION AND LENGTHS OF INDIVIDUAL HORIZONTAL COLLECTORS VARY

NOT FOR CONSTRUCTION

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

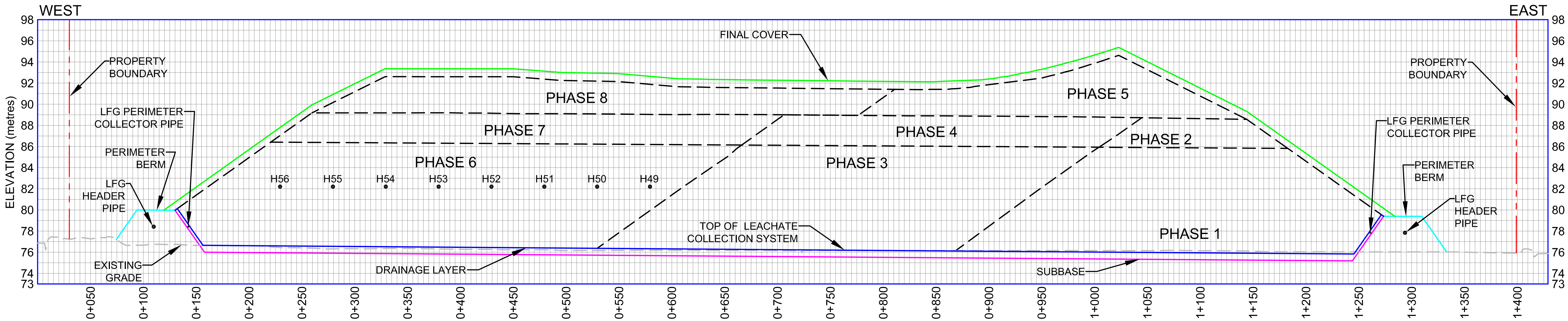
PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
TYPICAL LANDFILL GAS HORIZONTAL COLLECTOR CROSS-SECTION

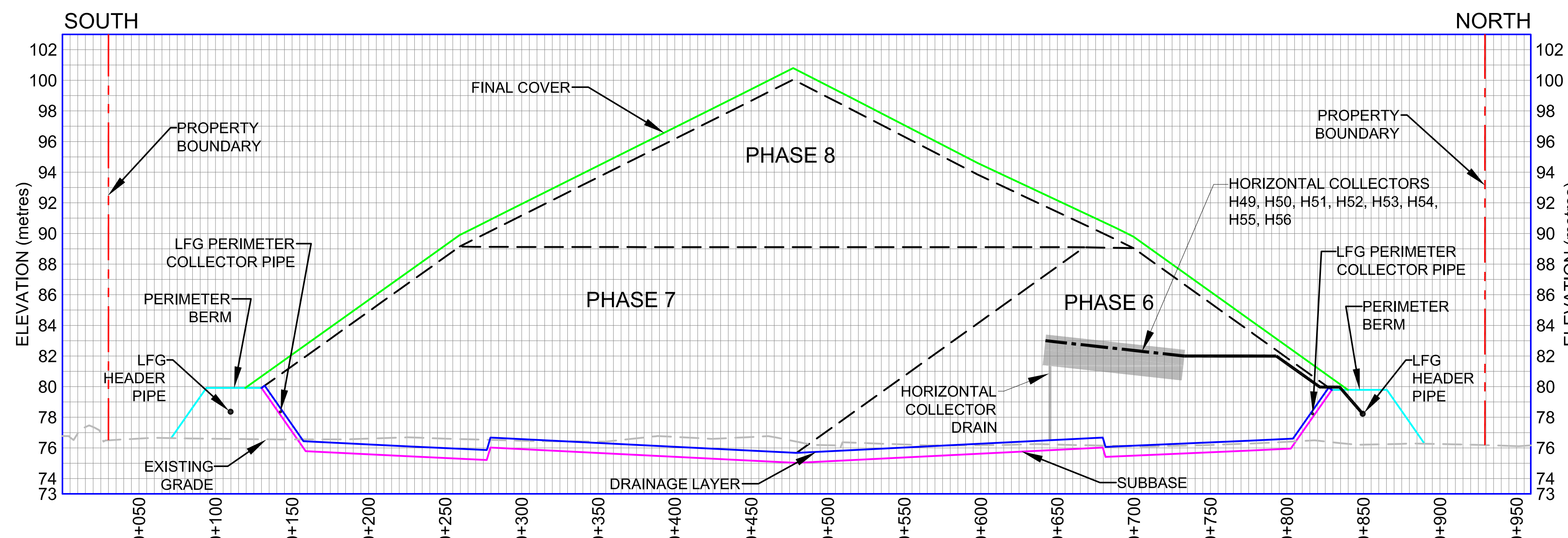
Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045	FILE No.	1211250045-4000-LGW-09.dwg
DESIGN	A.M.H.	29 Nov. 2013	SCALE AS SHOWN	REV. 0
CAD	M.L.F.	02 Dec. 2013	DRAWING No.	
CHECK	P.L.E.	Aug. 2014	**Figure 9d**	
REVIEW	P.A.S.	Aug. 2014		

PLOT DATE: July 7, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Landfill Gas\1211250045-4000-LGW-09.dwg



PROFILE 2-2'



PROFILE 5-5'

LEGEND:

- HDPE NON-PERFORATED LFG HORIZONTAL CONVEYANCE PIPE
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 500 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 250 mm)
- HDPE PERFORATED LFG HORIZONTAL COLLECTOR (PERFORATION SPACING - 125 mm)

NOTES:

1. DETAILS AND DIMENSIONS SUBJECT TO MODIFICATION DURING DETAILED DESIGN.

TYPICAL HORIZONTAL COLLECTORS FOR PHASE 6

NOTE: CROSS-SECTION OF TYPICAL HORIZONTAL COLLECTORS. ELEVATION AND LENGTHS OF INDIVIDUAL HORIZONTAL COLLECTORS VARY

NOT FOR CONSTRUCTION

80 0 80 160
SCALE 1:4,000 HORIZONTAL METRES

8 0 8 16
SCALE 1:400 VERTICAL METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
TYPICAL LANDFILL GAS HORIZONTAL COLLECTOR CROSS-SECTION

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.	12-1125-0045	
DESIGN	A.M.H.	29 Nov. 2013
CAD	M.L.F.	02 Dec. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No. 1211250045-4000-LGW-09.dwg
SCALE AS SHOWN REV. 0
DRAWING No.
Figure 9e

PLOT DATE: July 7, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Landfill Gas\1211250045-4000-LGW-09.dwg