global environmental solutions

Parks Canada

Garden River Remediation Project – Detailed Landfill Design Report

Client Project Ref: 5P420-13-5137

January 2015

SLR Project No.: 200.02005.00000

GARDEN RIVER REMEDIATION PROJECT – DETAILED LANDFILL DESIGN REPORT

PARKS CANADA

PCA Contract No.: 5P420-13-5137

SLR Project No.: 200.02005.00000

Prepared by
SLR Consulting (Canada) Ltd.
200 – 1620 West 8th Avenue
Vancouver, BC V6J 1V4

for

PARKS CANADA AGENCY
WOOD BUFFALO NATIONAL PARK
BOX 750, FORT SMITH, NT X0E 0P0

January 2015

Prepared by:	Reviewed by:
DRAFT	DRAFT
Ben Arnold, MSc, BSc, MCIWM	**Mark Sungaila, M.A.Sc., P.Eng., PMP**
Director Waste Management Sector	Waste Engineering Discipline Manager

CONFIDENTIAL

Distribution: 1 copy – Parks Canada
1 copy – SLR Consulting (Canada) Ltd.

TABLE OF CONTENTS

Table of Contents

List of Tables

List of Drawings

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by the Parks Canada Agency (Parks Canada) to carry out the necessary studies and reports to facilitate the remediation of the existing Little Red River Cree Nation (LRRCN) community landfill and the construction of two new landfill cells, near Garden River, Alberta on the west side of Wood Buffalo National Park. The new landfill cells will be located adjacent to the existing landfill, which lies within NE Quarter Section 12, Twp 112, and Rge 23 W4M (herein referred to as “the Site”). The location of the site is shown in Dwg No. -00.

2.0 BACKGROUND

There are three main stages to the proposed remediation and development at the current Garden River landfill, together with various supporting infrastructure. These three stages can be summarized as follows:

- Cell A – To be excavated and lined prior to the importation of waste materials from the old Garden River dump site, prior to final capping and restoration. Design capacity 8,000 m^3 to include contingency, but now excluding any jet-fuel contaminated soils from the Airstrip, as RMC have advised that these have now self-remediated to within acceptable levels. Construction can take place any time from post-thaw 2015.
- Cell B - To be excavated and lined in readiness for the receipt of future wastes generated from the local community. Design capacity 20,000 m^3, as discussed below. Construction likely to take place in a separate and subsequent phase to the works in Cell A, and pending AANDC funding approval.
- Existing landfill – Waste materials to be consolidated into a consistent graded landform prior to final capping and restoration. Construction cannot take place until the completion and commissioning of basal lining in all or at least part of Cell B and will also be subject to AANDC funding approval.

3.0 OBJECTIVE

The purpose of this document is provide sufficient details from which Parks Canada and their other advisors can develop Contract documentation relating to the Cell A works and similarly AANDC can develop Contract documentation relating to the Cell B works and the capping of the existing landfill.

4.0 REGULATORY SETTING

The existing landfill site serving the Garden River community is currently unregulated, due to its historical status on federally controlled land. Regulatory approvals for the construction and operation of landfill sites in Alberta are normally controlled through the *Alberta Environmental Protection and Enhancement Act* of 1993, and last updated in 2014. Such approvals would normally be expected to specify minimum standards for the construction of the following elements of landfill design:

- Soils conservation;
- Basal lining system;
- Leachate collection system;

- Landfill gas management;
- Surface water management;
- Capping system; and
- Final landform.

As discussed and agreed during the RFP process, Parks Canada have requested that our design should "*to the extent that is practicable and feasible",* adhere to all Government of Alberta (GOA) Standards for Landfills. We have understood this to mean that our design should start from a position that accords with the GOA Standards, but where natural conditions or local circumstances make this impractical or impossible, it will be acceptable for us to propose alternatives which provide reasonable environmental protection.

5.0 EXISTING SITE CONDITIONS

A Site Investigation was carried out by SLR in March 2014 in order to establish the baseline ground conditions and to implement a program of groundwater monitoring. Full details of this investigation and monitoring are set out in SLR's Groundwater Characterization Report of December 30, 2014.

5.1 Sub-surface Geology

The stratigraphy encountered at the landfill site consists of a thin soil overlying sand which in turn overlies clay to the maximum depth of investigation of 15.2 m. A layer of topsoil and/or organic material, 25 mm in thickness, was encountered in all borehole locations. Sand was encountered below the topsoil in all boreholes except one, where a silt layer was encountered to a depth of 1.1 metres below ground level (mbgl), overlying the sand. The sand ranged from fine to coarse grained and had varying amounts of silt and gravel with depth. Clay lenses (<25 mm in thickness) were encountered at various elevations in some of the boreholes. A soft, wet, silty clay of medium to high plasticity was encountered beneath the sand horizon, at depths of between approximately 11 and 13 mbgl. Bedrock was not encountered in any of the boreholes completed at the landfill site.

5.2 Hydrogeology

Depth to groundwater in the wells installed at the landfill ranged from 9.21 mbgl in March to 9.90 mbgl in November. These depths are equivalent to groundwater elevations of between 231.61 metres above sea-level (masl) in March and 231.35 masl in November. Groundwater elevations remained very consistent over the nine month monitoring period, with a maximum of only 5 cm in elevation change.

Hydraulic conductivity testing was completed within three of the installed wells during the September 2014 monitoring event. The results obtained from the tests indicated an average conductivity of 3.45×10^{-4} m/s. On the basis of the hydraulic conductivity values measured at the landfill site and hydraulic gradient, the Darcy velocity estimated for the landfill site is 1×10^{-6} m/s, assuming a typical effective porosity for sand of 0.3.

5.3 Geotechnical parameters

Grain size distribution was determined on five samples of the soils encountered in the SI boreholes. The samples collected at 3.0 m, 6.0 m, and 7.5 m indicated a relatively uniform gradation with approximately 90% of the particles corresponding to a fine-grained sand. The samples from 1.5 m and 4.5 m indicated an increased proportion of fine grained particles indicating a more clayey/silty sand. Gravimetric moisture content in the sand ranged from 3.2% in the unsaturated zone to 21.8% below the water table. Gravimetric moisture content in the underlying clay ranged from 23.6% to 33.2%.

A bulk sample of the sand from 0 m to 3.0 mbgl was analyzed to determine its suitability for use in the construction of berms or other site infrastructure, if required. The Proctor density of the sample was determined to be a dry density of 1,805 kg/m³ at an optimum moisture content of 14.2%. On the basis of the geotechnical laboratory results, SLR concludes that the native sand would be suitable as a bulk fill for construction purposes. It is possible that due to the relatively narrow grain size distribution it may be difficult to achieve effective compaction on this material which may limit its usefulness in applications requiring structural fill.

6.0 DESIGN BASIS FOR CELL A & B

This report sets out the approach that we have taken to the development of designs for the three stages of landfill construction at the Garden River site. It should be read in conjunction with the three accompanying drawings numbered Dwg No. -01 to -03.

6.1 Design Intent

Information gained from our site investigation work has confirmed that the selected location will not meet the siting requirements outlined in the Alberta Standards for Landfills; specifically the requirement for a natural clay layer of greater than 5 m beneath the site. We have therefore proposed a composite liner which is described below. Man-made lining systems typically do not provide the same level of robustness as deep natural clay layers. However, with properly supervised installation, the proposed lining system can provide an equivalent or higher level of impermeability, given the spatial variability of natural clays.

Cells A and B are not intended to operate as hazardous waste landfills. Rather, they will need to accept a small proportion of hazardous municipal wastes which it is either non-cost effective to remove from the material destined for Cell A, or which cannot be guaranteed to be removed from wastes destined for Cell B. We have therefore modified the standard Alberta Class 1 landfill specification to retain the principle of two elements to the lining system, but exclude the requirement for a leakage detection layer between the liners. Our approach is based upon the following:

a) The proposed total waste mass in each cell is very small by general landfill standards and in the unlikely future event that any significant contamination is identified in the peripheral boreholes, the option remains to excavate and re-encapsulate the waste - a process which is likely to be required anyway in the event contamination was identified in a leakage detection layer.

b) A composite liner comprising HDPE geomembrane laid directly over GCL forms a very effective barrier to leachate migration as, in the unlikely event of leakage through damage in the geomembrane, the bentonite in the GCL swells in the vicinity of the leak and effectively seals the lining system.

6.2 Design Principles

In preparing our design we have given consideration to the findings of the 2013 EBA Options Analysis, the original RFP for this assignment and the site conditions that we have identified through borehole drilling, walk-over appraisals, topographical surveying and ongoing environmental monitoring. We have also applied our experience of good practice in landfill design, gained over many years in a wide range of geographical and operational settings.

As proposed in our original submission to the RFP, we have assessed the likelihood that hazardous wastes may be included within the materials to be deposited in Cell A. Having concluded that these are likely to contain batteries, motor oils, solvents, paints and thinners (albeit as a modest proportion of the total), we have then assessed whether the cost of carrying out a sufficiently detailed waste characterization study, supervised segregation and out-of-area disposal of such wastes would more than outweigh the cost differential of developing Cell A to the equivalent of a modified Class 1 standard (as discussed further below), rather than to a Class 2 standard. In our view, because of the very small footprint of Cell A, the costs and organizational complexities of carrying out characterization and segregation are not justified.

Opportunities for engagement with the local community have been limited to only two meetings with LRRCN Chief and Council and one meeting with the wider community. In the absence of certainty regarding the funding of the Cell B landfill and the operational and training support that would accompany this, it has been necessary for us to assume that the exclusion of hazardous elements from the local municipal waste stream cannot be guaranteed. This cell has therefore also been designed to a modified Class 1 standard, as discussed and agreed with Parks Canada and AANDC staff.

6.3 Design Capacity

RMC-ESG have confirmed that the identified jet fuel contamination of soils at the airstrip has naturally degraded to the level where no remediation work is required. No capacity is therefore required in Cell A to accommodate this material.

The RFP for this project indicated a suggested design capacity of 8,000 m^3 for the material to be excavated and removed from the Old Dumpsite, prior to placement in Cell A, including a contingency allowance. We have reviewed the original EBA documentation and carried out a visual inspection of the Old Dumpsite. On the basis of the information available and reasonable allowances for bulking and re-compaction factors, we believe that the suggested capacity should be adequate. The volume estimate derived from the original site investigation of the Old Dumpsite is however likely to be prone to some uncertainty. In practice the proposed landform for the completion of Cell A should easily be able to absorb an additional 10% capacity, should this prove to be necessary, without compromising the design criteria for maximum slope gradients.

It has proven to be very difficult to get consistent data on the rate of waste generation within the Garden River community. Initial discussion with the acting Landfill Manager indicated that waste was generated at a rate equivalent to around 520 m^3 per year. However subsequent measurement on site indicated that a trench of approximate capacity 2,000 m^3 was expected to be filled within around one year, indicating a 10 year demand of 20,000 m^3. We have therefore used this higher figure for the purpose of design at this stage, as we believe the initial figure provided did not include any wastes brought directly to the site by the community.

6.4 Cell Configuration

Given the remote location of this site and the absence of any other development nearby, normal landfill setback criteria are of only academic interest. The existing landfill is already set back over 100 m from Highway 58 which lies due north and is screened by established vegetation, even in winter.

The edges of Cells A and B are equally displaced at 25 m offset from the design limits of the remediation works on the existing landfill. This is to ensure that there is adequate space for:

a) The installation of additional monitoring wells which can allow differentiation between the adjacent facilities, in the event that any future contamination is identified, and
b) The safe passage of construction plant in the event that two adjacent stages of the work are being carried out simultaneously.

The design basis for the overall configuration of Cells A & B is set out in Table 1.

Table 1: Design Basis for Cell A & B Configuration

Item	Design Assumption	Basis
Setbacks from water bodies, residences, & water wells.	There are no water bodies, residences or water wells within standard Alberta regulated setbacks from the design boundaries of Cells A & B.	From discussions with LRRCN and Parks Canada and from observations on site.
Height of internal berm (if required).	Minimum of 2.5 m above cell base.	Sufficient to allow effective installation of partial basal liner within Cell B footprint, if required.
Depth of excavation.	Maximum approximately 4.5 m below natural ground.	Sufficient to provide more than adequate vertical offset from maximum recorded groundwater elevations and required base grades.
Maximum side slope gradient of excavations.	3 horizontal to 1 vertical.	Consistent with previous designs in similar natural ground and where excavations are entirely within the unsaturated zone.

6.5 Liner System

It is proposed that natural material on site will be excavated to create the two voids within which Cells A and B can be constructed. Cell A will be excavated to a maximum depth of 2.0 mbgl and Cell B to a maximum depth of 4.5 mbgl, in order to provide the necessary capacity, as shown in the accompanying Dwg No -02. The maximum depth of excavation will ensure that there is at least a 5 m separation between the base of the lining system and the highest recorded groundwater elevation.

The excavated materials will be used as follows:

- Regulating layer to provide a graded surface for the placement of the caps on cell A and the existing landfill area;
- Restoration soils to protect the placed caps on cell A and the existing landfill area;
- Stockpiled for use as daily cover material for the operation of Cell B; and
- Construction of internal berms within Cell B.

The Cell A and B voids will be excavated down to a basal surface at slope angles of 1V to 3H, which will be stable in the short term, prior to the filling of Cell A and in the medium to long term during the operation of Cell B. This slope angle is also practicable for the operation of specialist plant and the placement of the various elements of the lining system.

In the absence of any naturally occurring clay layer beneath the landfill area, we have selected a composite lining system which will provide a combination of very low permeability and an appropriate degree of robustness and redundancy. The details of the lining system are set out in Dwg No -03. Welded panels of High Density Polyethylene (HDPE) membrane of 80 mil (2 mm) thickness will provide the primary low permeability barrier to leachate migration, while the Geosynthetic Clay Liner (GCL) serves as the second component of the composite lining system and an additional protection layer beneath the geomembrane. A GCL normally comprises a pair of geotextile mats within which is sandwiched a layer of sodium bentonite. This material expands on contact with water to create a very effective seal. The design includes provision for protective layers above and below the critical lining elements.

Liner installation should be subject to rigorous Construction Quality Assurance (CQA) by a third party who is independent from the Contractor. Details of our recommended QA Program are set out under separate cover in the document entitled Garden River Landfill Construction – Proposed CQA Plan, Jan 2015.

Table 2 describes the design items for the liner system.

Table 2: Design Basis for Liner System

Item	Design	Basis
Upper layer of composite liner	2.0 mm thick HDPE geomembrane, textured on both sides.	Consistent with designs for similar waste types in similar hydrogeological settings.
Lower layer of composite liner	Geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1 x10^{-9} cm/s.	Consistent with designs for similar waste types in similar hydrogeological settings.
Additional containment in specific areas	Double GCL in sump area, with 1 m run-out.	Provides additional containment in area with highest potential for development of leachate head.
Liner anchoring on external berms	Anchor trench along external berm crest with a 1 m run-out.	Consistent with designs for similar waste types in similar hydrogeological settings.
Primary liner protection	16oz geotextile placed between geomembrane and gravel drainage blanket.	Consistent with designs for similar waste types in similar hydrogeological settings.

6.6 Leachate Management

Leachate is generated by the percolation of rainfall and snow melt through the waste mass, as well as the processes of microbial breakdown of waste. In order to ensure that a significant leachate head does not build up on the basal liner we propose the placement of a 300 mm deep gravel drainage blanket on the cell floor, above the geomembrane in Cells A and B and 150 mm depth on the side-slopes. This blanket will be protected by a 16oz geotextile. Perforated pipework located within the blanket will encourage leachate to flow along the 2% basal grade to a dedicated sump in each cell, from where it can be extracted via a submersible pump, using the side-slope riser pipe. These details are shown in Dwg No. -02.

The depth of leachate will need to be managed by routine monitoring at the sump and removal of excess leachate, as required. Landfill approvals in Alberta sometimes specify the maximum depth of leachate which is permitted to remain within a cell, usually measured at the sump location. It is recognized good practice to maintain leachate levels as low as practically possible, within the limitations of monitoring cycles and the need for visiting tanker trucks to remove full loads at each visit. This is discussed further in the Operations & Maintenance Plan.

While there is the option to extract and store leachate in external surface tanks, our design assumes that sump depths will be routinely monitored and leachate extracted directly to a tanker truck, as required. This approach is proposed because it is simpler and more robust than the use of tanks, which involve double handling and therefore more risk of spillage/leakage. The site layout has been arranged to ensure that tankers can directly access the leachate collection points in Cells A and B.

Leachate pipework can over time become clogged by microbial growths. Access points for the basal leachate pipes have therefore been incorporated into the Cell B design. It is considered that these are not required in Cell A because the waste is older and more degraded and will be fully capped immediately following placement in the cell, leading to much less leachate generation.

The base of Cells A & B are to be graded to sumps in their southwest and southeast corners respectively. Dwg No. -03 illustrates the proposed design base contours, location of the leachate collection pipes, sump, extraction pipes, and clean-out riser pipes. Table 3 describes the design basis for the leachate collection and extraction system.

Table 3: Design Basis for Leachate Collection and Extraction System

Item	Design	Basis
Leachate collection	Gravel drainage blanket 300 m deep on base of cell and 150 mm deep on side-slopes. HDPE pipework located within the drainage blanket.	Consistent with designs for similar waste types in similar hydrogeological settings.
Pipe size and minimum pipe slope for leachate collection layer	200 mm diameter, minimum 1% slope.	Consistent with designs for similar waste types in similar hydrogeological settings.

Table 3: Design Basis for Leachate Collection and Extraction System		
Item	**Design**	**Basis**
Leachate pipework spacing	Maximum spacing 70 m.	Consistent with designs for similar waste types in similar hydrogeological settings. Results in acceptable drainage lengths.
Base slope	Minimum 2% grade.	Consistent with designs for similar waste types in similar hydrogeological settings.
Extraction system	Sumps located in one corner of each cell. Upslope riser pipes used for leachate extraction.	Unlike built up vertical extraction wells, leachate extraction riser pipe is not at risk of compromise from waste placement and/or settlement.
Clean-out riser pipes	Clean-out riser pipe on one end of each diagonal leachate collection pipe. Side slope blanket depth increased to Upslope riser pipes located in sidewall trenches.	Provides alternative sump access if primary riser is compromised.

6.7 Landfill Gas Control

The capping of Cell A and the current landfill area will provide the important and immediate benefit of significantly reducing the rate of water infiltration into waste and the generation of leachate. However, the biodegradable elements within the waste will generate landfill gas, comprising predominantly methane and carbon dioxide, and these will require management in order to avoid the risk of pressure build up beneath the cap, leading to ballooning and eventual rupture of the membrane.

This situation can be avoided by the retrospective drilling of passive gas venting wells through the cap after its installation. The depth of drilling will need to be carefully controlled in order to ensure there is no risk to the integrity of the basal liner. The wells will comprise boreholes through the waste, no closer than 1.5 m above the liner, into which slotted HDPE pipe will be installed and the annulus filled with suitable gravel. The upper 1.5 m of below-ground pipework will be plain and the annulus will be filled with bentonite to provide an effective seal. The pipework will extend for a height of 1.5 m above ground and will be capped with a rotating cowl which will encourage gas movement out of the wells. Given the small area of each cell we would anticipate the installation of no more than four wells per cell. Our cap design includes provision for a gas permeable horizon immediately beneath the cap to enable gas to flow freely to the vents.

It is not anticipated that odor from the gas wells will be a significant issue in terms of the health and safety of workers or visitors at the site or in terms of off-site nuisance. However in the event that this does become a concern it will be possible to retrospectively install a form of wood-chip biofilter through which the wells can exhaust to atmosphere. The very small volumes of waste at this site will be insufficient to sustain any sort of flare system for the burning off of any generated gases.

It will also be necessary to install gas vents in the final cover of Cell B, once this is installed.

6.8 Groundwater Management

The environmental monitoring programme is now complete and the results are set out in the Groundwater Characterization Report. Groundwater levels at the site have been very consistent, at between 9.21 and 9.88 mbgl, in the period March to November. This timeframe normally encompasses the highest groundwater levels, as it includes the end of the winter period and the spring thaw. This therefore provides a reasonable basis for the design process.

In order to provide a secure base for the proposed landfill cells we have proposed a maximum cell excavation depth that remains greater than 5 m above the maximum recorded groundwater elevation. There will therefore be no requirement for installation of any groundwater management infrastructure beneath the lining system.

6.9 Surface Water Management

The gentle local topography means that there is unlikely to be any prospect of significant run-on of surface water into the landfill cells. However, the raised topography of Cell A, the remediated existing landfill and the developing Cell B, will all require the establishment of an effective network of ditches to convey surface water run-off to the proposed retention swale.

Effective capping of landfill cells requires that rainfall and snow melt can be quickly and effectively shed from the protective soils layer. This is achieved through a combination of suitable gradients and the provision of a drainage layer between the base of the soils and the capping material. Flow from surface run-off or via the drainage layer will be directed to a series of peripheral drainage ditches which will be lined with compacted clayey fill, to minimise local infiltration.

These drainage collection ditches are shown in Dwg -01 and will be designed to fall to a low point within the site where surface water will be allowed to soak into the ground through a retention swale. An overflow ditch on the south side of the swale will direct storm flow to the land to the south of the landfill area.

The purpose of this swale will be to allow slow infiltration of accumulating precipitation under normal conditions and to allow the settlement of any suspended solids (soil particles) which become entrained during storm flow conditions. The reduction of flow velocity in the swale during storm conditions will cause all but the finest suspended solids to be deposited. The swale can become part of the future network of monitoring points to ensure operations are not impacting the local environment.

Table 4 describes the design parameters used for the surface water management aspects of Cells A & B.

Table 4: Design Basis for Surface Water Management Items		
Item	**Design**	**Basis**
Permanent surface water run-off ditches	To be constructed as indicated in Dwg No. -01.	Based on existing topography, to convey run-off from the landfill to the proposed surface water swale.
Permanent ditch cross-section	0.5 m wide base, 3H:1V side slopes, and a minimum depth of 0.5 m. Lined with compacted clay.	Designed to accommodate a 1 in 100 year storm event.
Minimum slope of ditches	0.5% for permanent site ditches.	Consistent with good design standards.

6.10 Access and Supporting Infrastructure

It will be necessary to extend the access road from Highway 58 into the site, in accordance with the layout shown in Dwg -01. The specification of the road will comprise 300 mm of compacted 75 mm minus crushed aggregate, overlain by 50 mm of compacted 19 mm minus crushed aggregate, in order to provide all weather access and be sufficiently robust to manage the regular passage of heavy vehicles.

Provision has been made, on a hard surfaced area adjacent to Cell B, for an area which can be used for the local community to drop off wastes which may contain hazardous or difficult materials. These can then be segregated by site staff and stored within lockable steel shipping containers which will be located in the waste diversion bays.

While the open burning of wastes is discouraged and is being gradually phased out in many jurisdictions it is recognised that under the circumstances of remote communities, it can be a valid part of a waste management system. It is important that this approach only applies to wastes that are capable of being burned in a safe and controlled manner and without any generation of harmful emissions. Recommended operating procedures are set out under separate cover within the Operations & Maintenance Plan.

The entire site will be enclosed within suitable wildlife proof fencing, with lockable steel gates where the fence line crosses the access track from Highway 58.

Table 5 describes the transportation and supporting infrastructure design items.

Table 5: Design Basis for Access and Supporting Infrastructure

Item	Design	Basis
Extension of existing site access road	To serve the waste segregation area, the two leachate extraction points and the swale.	In order to ensure all year round access for maintenance.
Turnaround area	Located adjacent to each of the access points to the leachate side-slope risers.	In order to ensure all year round access for maintenance. Turn-around sized to accommodate standard 4 axle tanker trucks.
Stockpile locations	Topsoil stripped from Cell A & B construction area is to be placed in new stockpile to be located to the north of Cell A.	To ensure minimal haulage distance from operations

6.11 Capping and Restoration

The proposed capping specification is identical for all three waste areas and is shown in the accompanying Dwg -03. The key element is a 40 mil (1 mm) thick Linear Low Density Polyethylene (LLDPE) geomembrane, which will be constructed from welded panels which will be laid out in alignment with the slope of the landform. The cap will be protected from punctures above using a geotextile and below by the gas-permeable sand layer of 200 mm depth, which will require pre-screening on site to remove any oversize material.

Capping installation should be subject to rigorous Construction Quality Assurance (CQA) by a third party who is independent from the Contractor. Details of our recommended QA Program are set out under separate cover in the document entitled Garden River Landfill Construction – Proposed CQA Plan, Jan 2015.

Following completion of cap placement, the membrane will be protected by a 12oz geotextile onto which will be placed 150 mm of clean gravel to facilitate drainage of infiltrating precipitation. This will be covered with an 8oz geotextile prior to placement of 250 mm of sand fill from stockpile. Finally a depth of 250 mm of previously stripped soils will be placed from stockpile onto the graded sand fill surface. This will be prepared for seed placement, in accordance with details set out in the Operations & Maintenance Plan.

7.0 QUANTITIES

Table 6 summarises the principal material quantities for Cells A & B. The soil stripping volume is based on the assumption of 0.25 m of topsoil and subsoils over the stripping area, as this the minimum practical depth of stripping which can be achieved.

Table 6: Summary of Quantities Relating to Proposed Works[1]

Property	Unit	Cell A	Cell B	Existing LF
Plan area of construction	m^2	8,000	9,000	11,000
Soil stripping volume (0.25 m depth)	m^3	2,000	2,250	N/A
Bulk sand excavation volume	m^3	10,500	16,000	N/A
Plan area of liner placement (geotextile, geomembrane, GCL)	m^2	5,000	5,800	N/A
Leachate drainage blanket volume (0.3/0.15 m depth)	m^3	1,250	1,220	N/A
Plan area of cap placement	m^2	4,900	5,630	6,500
Gravel volume for road construction & segregation area	m^3	310	1,260	N/A
Total length of surface water ditching	m	470	320	430

8.0 SCHEDULE

Due to the proposed funding arrangements for these works, as shared between Parks Canada and AANDC, the construction of Cells A & B and associated closure of the existing operation is likely to be implemented across two construction seasons. It is anticipated that Cell A construction can commence as soon as possible after the completion of the thaw in May 2015 and, subject to weather conditions, should be ready for receipt of wastes from the Old Garden River Dumpsite within 6 – 8 weeks of commencement.

Subject to the timing of funding approval, the development of Cell B and the closure and remediation of the existing landfill could also be carried out in 2015, provided works could be scheduled to be completed by late September. Construction of Cell B, or a sufficient part of it to allow landfilling to be carried out for the next 5 years, would also be expected to require a period of 6 – 8 weeks. Works required in respect of the existing landfill would be likely to require a further 3 – 4 week construction period.

The size and layout of Cell B as described in this report is the preferred option, however it is acknowledged that due to the uncertainty in waste acceptance rates, and the uncertainty in material and labour costs (and thus uncertainty in bid pricing) AANDC may elect to decrease the overall size or configuration of Cell B, within the footprint as described in this report.

9.0 CLOSURE

Cells A & B have been designed to meet the general requirements of the Alberta Landfill Regs within the physical constraints of the physical setting of the selected Site. It is possible that minor deviations may be required during construction to address local ground conditions encountered during excavation However, a description of these deviations and confirmation that the performance of the system will not be compromised should be included in the as-built documentation.

[1] The quantities are to be confirmed following an existing ground survey prior to construction, and layout of Cells A & B.

10.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Parks Canada and it is intended for their sole and exclusive use. Other than by Parks Canada and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR's professional opinion based on limited investigations including: visual observation of the site, surface and subsurface investigation at discrete locations and depths, and laboratory analysis of specific physical and chemical parameters. The results cannot be extended to previous or future site conditions, portions of the site that were unavailable for direct investigation, subsurface locations which were not investigated directly, or physical/chemical parameters and materials that were not addressed. SLR does not warranty information from third party sources used in the development of investigations and subsequent reporting.

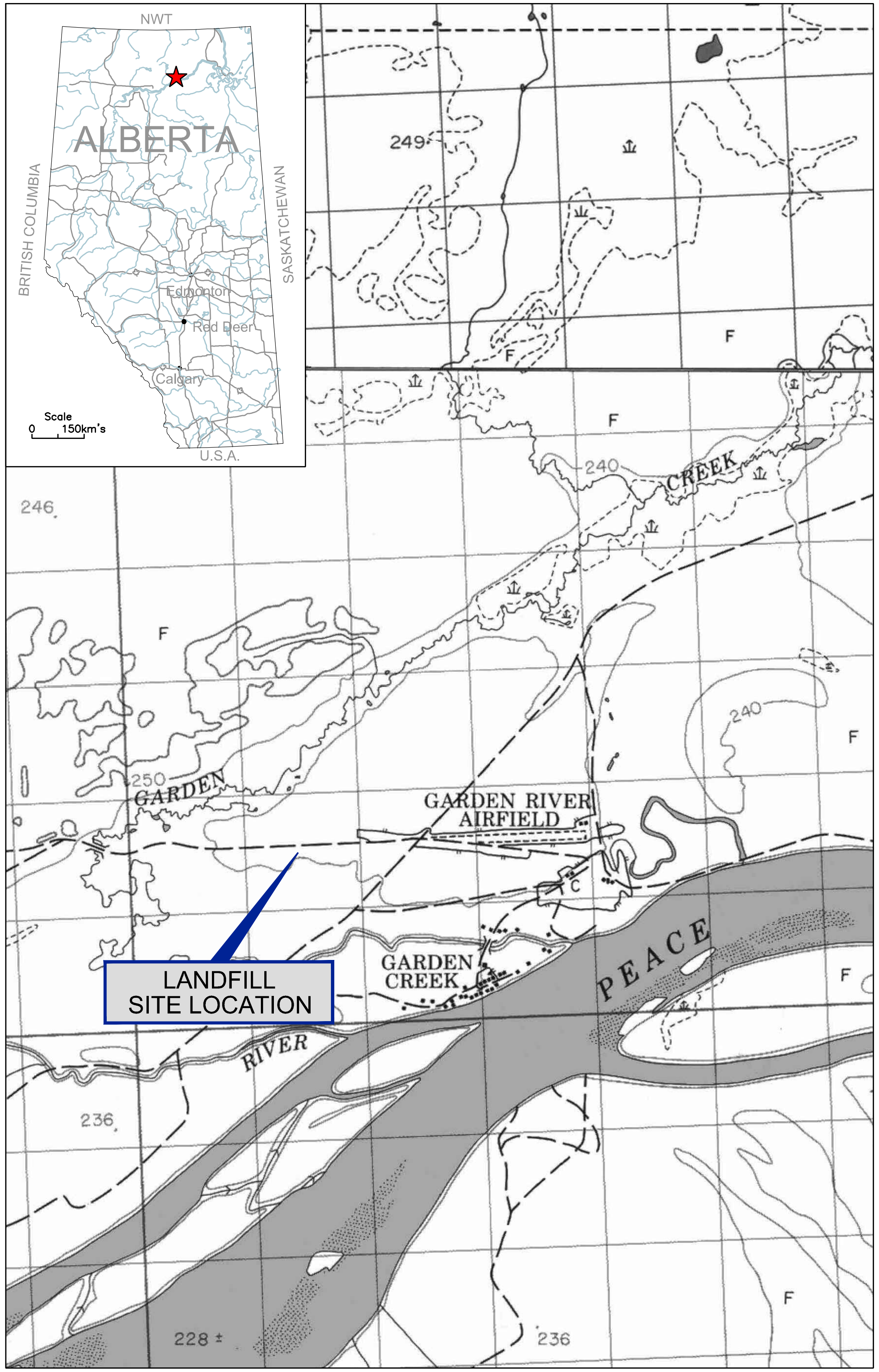
Nothing in this report is intended to constitute or provide a legal opinion. SLR expresses no warranty to the accuracy of laboratory methodologies and analytical results. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

The Client may submit this report to Alberta Environment and Sustainable Resource Development and/or related Alberta or Canada environmental regulatory authorities or other persons for review and comment purposes.

N:\Vancouver\Projects\Clients\200.02005.00000 Parks Canada - Garden River Remediation\Reporting\Landfill Design Reports\
1. Garden River_ Landfill Design Report_FINAL DRAFT.docx

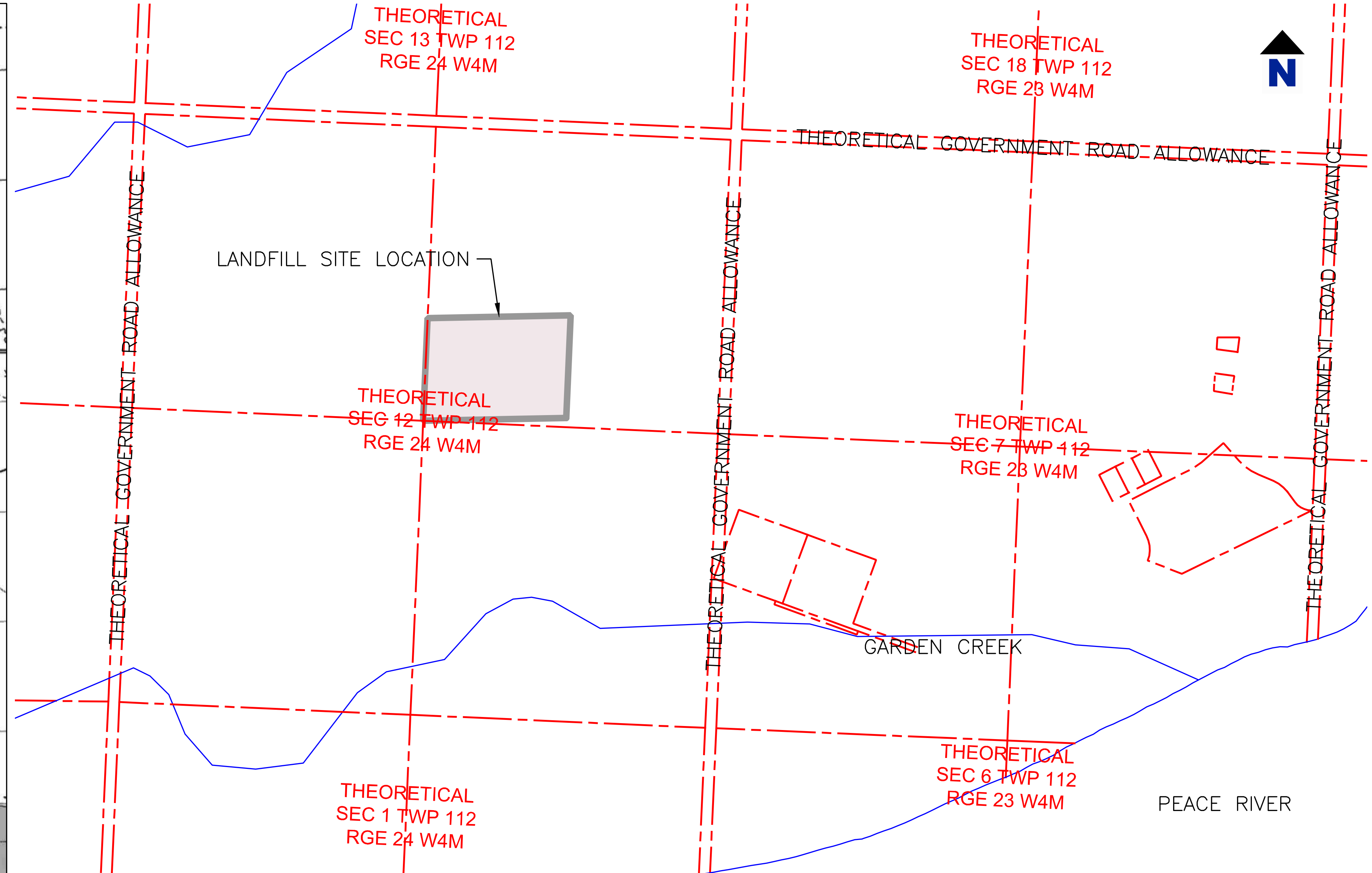
DRAWINGS

Parks Canada
Garden River Remediation Project – Detailed Landfill Design Report
Client Project Ref: 5P420-13-5137
SLR Project No.: 200.02005.00000



SCALE 1:50,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
0 0.5 1.0 2.0 3.0km

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.



SURROUNDING LAND USE

SCALE 1:15,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
0 0.25 0.5 1.0km

NOTES

DRAWING COMPILED FROM ALTUS GEOMATICS AUTOCAD FILE NO. C010914S.DWG, SLR CONSULTING (CANADA) LTD. DRAWING NO. 200.02005.00000–01 REV. B, BING MAPS IMAGERY, ABACUS DATAGRAPHICS SATELLITE IMAGERY, NTS MAPS 84 I/12 TITLED "BUCHANAN LAKE" AND 84 I/13 TITLED "TRIDENT CREEK" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
THEORETICAL NE 1/4 SEC 12 TWP 112 RGE 24 W4M AND THEORETICAL SEC 7 & 8 TWP 112 RGE 23 W4M AND THE THEORETICAL GOVERNMENT ROAD ALLOWANCE BETWEEN SEC 7 & 8 TWP 112 RGE 23 W4M
GARDEN RIVER, ALBERTA

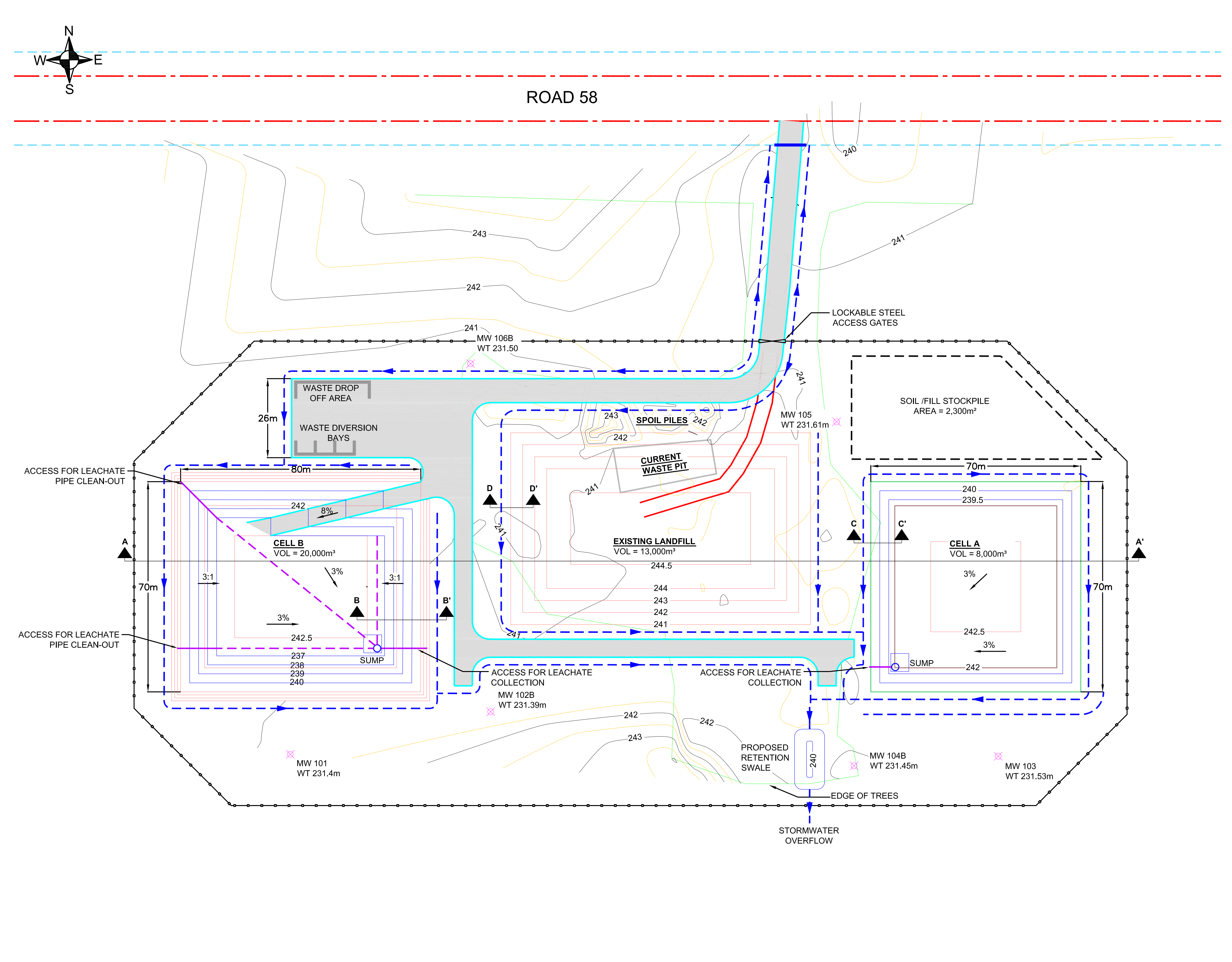
LEGEND

PROPERTY BOUNDARY
SITE LOCATION

PARKS CANADA
GARDEN RIVER LANDFILL
WOOD BUFFALO NATIONAL PARK
GARDEN RIVER, ALBERTA

Report	LANDFILL DESIGN REPORT		
Drawing	SITE LOCATION & SURROUNDING LAND USE		
Date: January 21, 2015	Scale: AS SHOWN	Drawing No. 00	
File Name: S_200-02005-00000-A2	Project No. 200.02005.00000		

SLR



NOTES

SCALE 1:1,250

WHEN PLOTTED ON A 11" x 17" SHEET

0 25 50 75m

LEGEND

- EXISTING 1m CONTOUR JUNE 2014
- EXISTING 0.5m CONTOUR JUNE 2014
- EXISTING SITE ROAD
- PROPOSED SITE ROAD
- MW 105 WT 231.61 EXISTING MONITORING WELLS INSTALLED BY SLR WATER TABLE LEVELS OBSERVED ON MAY 21 2014
- EXISTING TREE/BUSHLINE
- EXISTING WASTE PIT
- PROPOSED 1m CONTOURS BELOW GRADE
- PROPOSED 1m CONTOURS ABOVE GRADE
- EXISTING DITCHING
- PROPOSED DITCHING
- PROPOSED CULVERT
- PROPOSED SOLID LEACHATE PIPE
- PROPOSED PERFORATED LEACHATE PIPE
- PROPOSED WILDLIFE FENCING

Revision	By	Chk'd By	Date	Comments
C	AJC	BA	26/01/15	CLIENT REVIEW
B	AJC	BA	29/09/14	CLIENT REVIEW
A	AJC	MS	26/09/14	INTERNAL REVIEW

Parks Canada Parcs Canada

SLR
101-260 TOWN CENTRE BLVD
MARKHAM
ON L3R 8H8
T: 905.415.7248
F: 905.415.1019
www.slrconsulting.com

Site: GARDEN RIVER

Project: CONTAMINATED SITE REMEDIATION PROJECT

Drawing Title: PROPOSED SITE LAYOUT

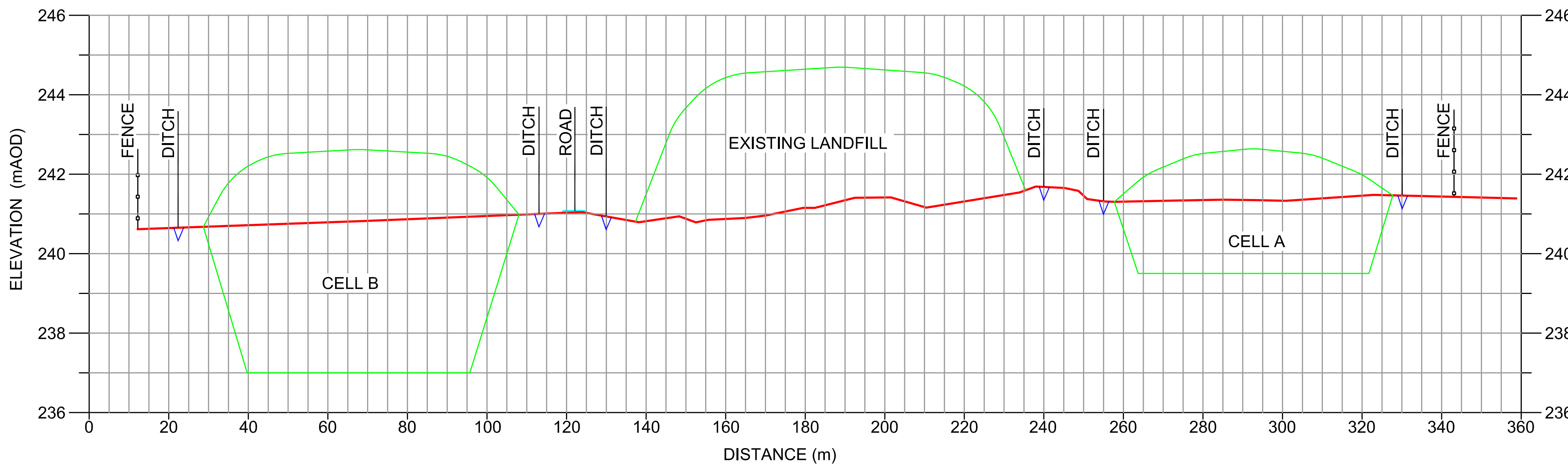
Scale: AS SHOWN

Date: JULY 30th, 2014

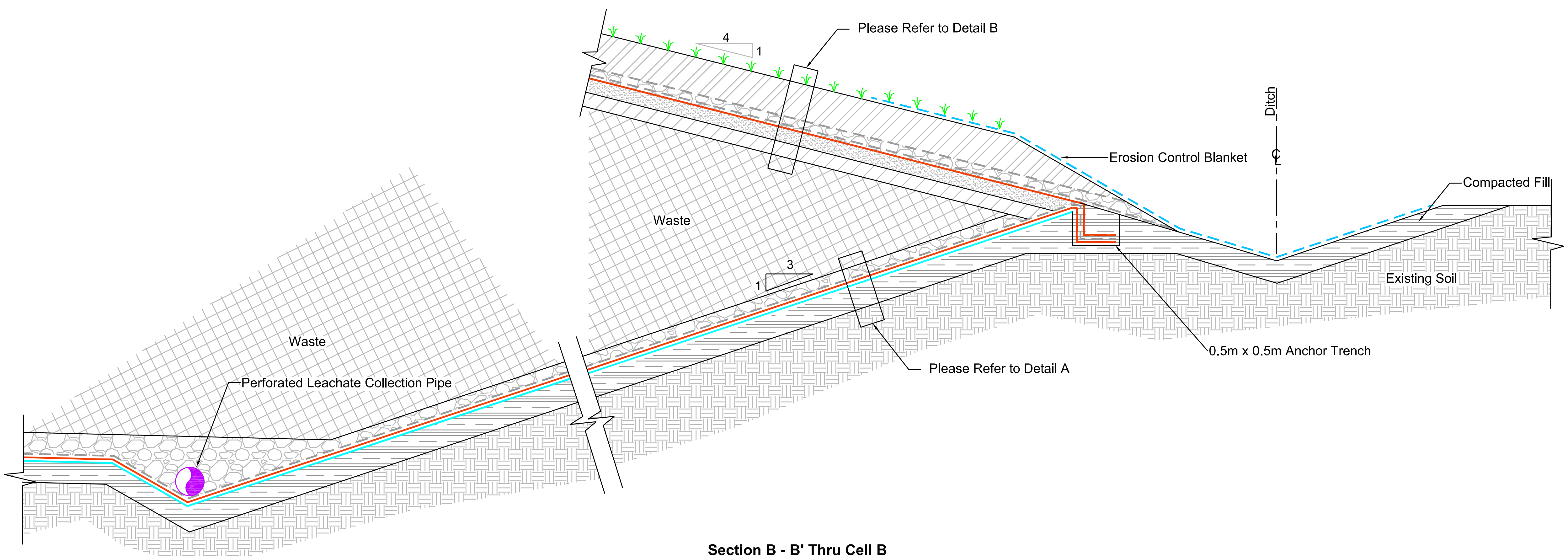
Drawing Number: 200.02005.00000-01

Rev: C

DRAFT



Section A - A'
Scale: Hor1:1,500 Ver 1:150
(10x Vertical Exaggeration)



Section B - B' Thru Cell B
Not to scale

NOTES

LEGEND

- EXISTING GROUND LEVEL
- PROPOSED CELL
- PROPOSED DITCH
- PROPOSED ROAD
- PROPOSED WILDLIFE FENCE

Revision	By	Chk'd By	Date	Comments
B	AJC	BA	29/09/14	CLIENT REVIEW
A	AJC	MS	06/08/14	INTERNAL REVIEW

Parks Canada Parcs Canada

SLR
101-260 TOWN CENTRE BLVD
MARKHAM
ON L3R 8H8
T: 905.415.7248
F: 905.415.1019
www.slrconsulting.com

Site:
GARDEN RIVER

Project:
CONTAMINATED SITE REMEDIATION PROJECT

Drawing Title:
SECTION A - A' THRU SITE,
SECTION B - B' THRU CELL B

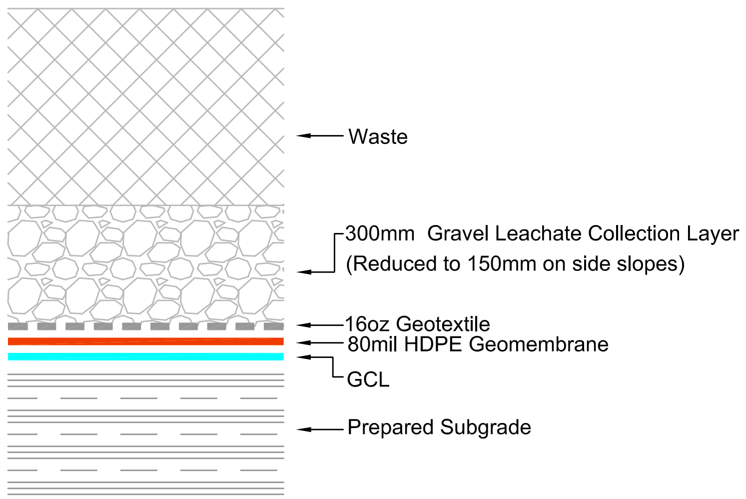
Scale: AS SHOWN

Date: SEPTEMBER 25th, 2014

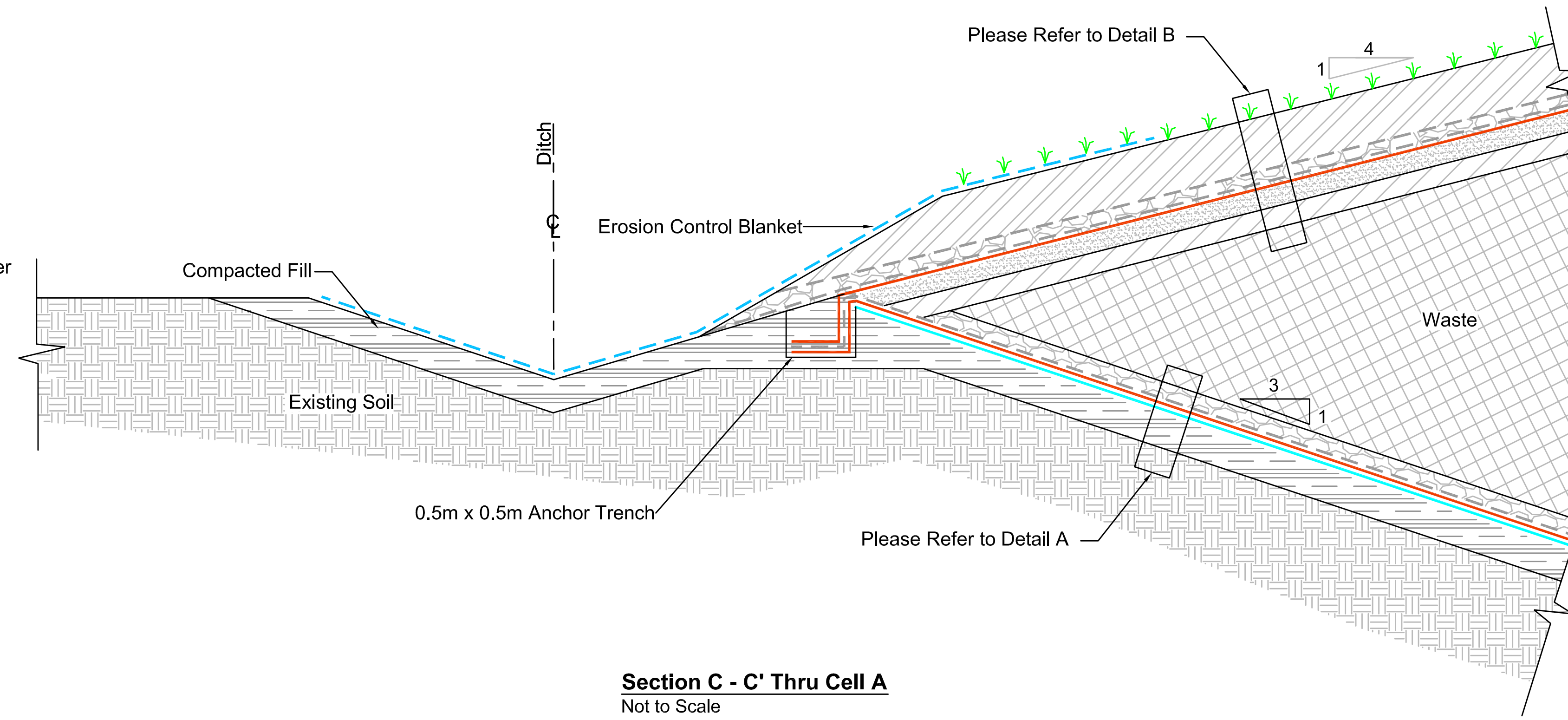
Drawing Number: 200.02005.00000-02

Rev: B

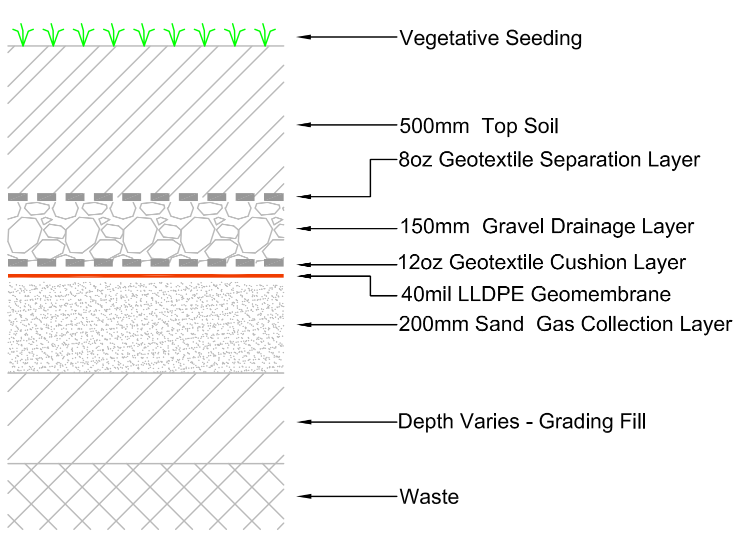
DRAFT



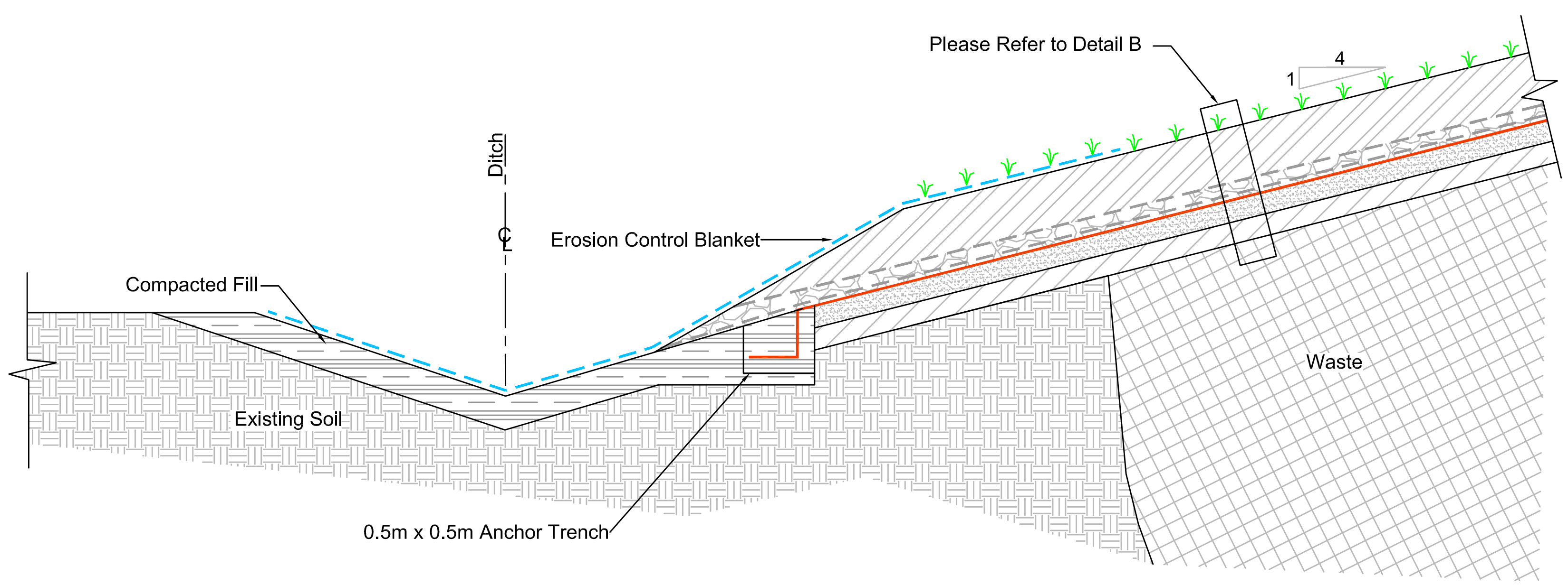
Detail A - Typical Base Liner Section
Not to Scale



Section C - C' Thru Cell A
Not to Scale



Detail B - Typical Final Cover Section
Not to Scale



Section D - D' Thru Proposed Cap over Existing Landfill
Not to Scale

NOTES

LEGEND

Revision	By	Chk'd By	Date	Comments
B	AJC	BA	29/09/14	CLIENT REVIEW
A	AJC	MS	26/09/14	INTERNAL REVIEW

Parks Canada Parcs Canada

SLR
101-260 TOWN CENTRE BLVD
MARKHAM
ON L3R 8H8
T: 905.415.7248
F: 905.415.1019
www.slrconsulting.com

Site:
GARDEN RIVER

Project:
CONTAMINATED SITE REMEDIATION PROJECT

Drawing Title:
SECTIONS & TYPICAL DETAILS

Scale: NOT TO SCALE
Date: SEPTEMBER 25th, 2014

Drawing Number: 200.02005.00000-03
Rev: B

DRAFT

global environmental solutions

Calgary, AB
134-12143 40 Street SE
Calgary, AB T2Z 4E6
Canada
Tel: (403) 266-2030
Fax: (403) 263-7906

Calgary, AB
1140-10201 Southport Rd SW
Calgary, AB T2W 4X9
Canada
Tel: (403) 259-6600
Fax: (403) 259-6611

Edmonton, AB
6940 Roper Road
Edmonton, AB T6B 3H9
Canada
Tel: (780) 490-7893
Fax: (780) 490-7819

Fort St. John, BC
9943 100 Avenue
Fort St. John, BC V1J 1Y4
Canada
Tel: (250) 785-0969
Fax: (250) 785-0928

Grande Prairie, AB
10015 102 Street
Grande Prairie, AB T8V 2V5
Canada
Tel: (780) 513-6819
Fax: (780) 513-6821

Halifax, NS
115 Joseph Zatzman Drive
Dartmouth, NS B3B 1N3
Canada
Tel: (902) 420-0040
Fax: (902) 420-9703

Kamloops, BC
8 West St. Paul Street
Kamloops, BC V2C 1G1
Canada
Tel: (250) 374-8749
Fax: (250) 374-8656

Kelowna, BC
200-1475 Ellis Street
Kelowna, BC V1Y 2A3
Canada
Tel: (250) 762-7202
Fax: (250) 763-7303

Markham, ON
200 - 300 Town Centre Blvd
Markham, ON L3R 5Z6
Canada
Tel: (905) 415-7248
Fax: (905) 415-1019

Nanaimo, BC
9-6421 Applecross Road
Nanaimo, BC V9V 1N1
Canada
Tel: (250) 390-5050
Fax: (250) 390-5042

Prince George, BC
1586 Ogilvie Street
Prince George, BC V2N 1W9
Canada
Tel: (250) 562-4452
Fax: (250) 562-4458

Regina, SK
1048 Winnipeg Street
Regina, SK S4R 8P8
Canada
Tel: (306) 525-4690
Fax (306) 525-4691

Saskatoon, SK
620-3530 Millar Avenue
Saskatoon, SK S7P 0B6
Canada
Tel: (306) 374-6800
Fax: (306) 374-6077

Sydney, NS
PO Box 791, Station A
122-45 Wabana Court
Sydney, NS B1P 6J1
Canada
Tel: (902) 564-7911
Fax: (902) 564-7910

Vancouver, BC (Head Office)
200-1620 West 8th Avenue
Vancouver, BC V6J 1V4
Canada
Tel: (604) 738-2500
Fax: (604) 738-2508

Victoria, BC
6-40 Cadillac Avenue
Victoria, BC V8Z 1T2
Canada
Tel: (250) 475-9595
Fax: (250) 475-9596

Winnipeg, MB
1353 Kenaston Boulevard
Winnipeg, MB R3P 2P2
Canada
Tel: (204) 477-1848
Fax: (204) 475-1649

Whitehorse, YT
6131 6th Avenue
Whitehorse, YT Y1A 1N2
Canada
Tel: (867) 689-2021

Yellowknife, NT
Unit 44, 5022 49 Street
Yellowknife, NT X1A 3R8
Canada
Tel: (867) 765-5695