Detailed Landfill Gas Hazard Assessment Report

aurecon

Bringing ideas to life

Document control record

Document prepared by:

Aurecon Hong Kong Limited
Unit 1608, 16/F, Tower B, Manulife Financial Centre,
223 – 231 Wai Yip Street, Kwun Tong, Kowloon
Hong Kong S. A. R.
T +852 3664 6888
F +852 3664 6999
E hongkong@aurecongroup.com
W aurecongroup.com

A person using Aurecon documents or data accepts the risk of:

a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.

b) Using the documents or data for any purpose not agreed to in writing by Aurecon.

Document control						aurecon
Report title		Detailed Landfill Gas Hazard Assessment Report				
Document ID			**Project number**			
File path						
Client		Veolia Environmental Services Hong Kong Limited				
Client contact			**Client reference**		NENTX-AURE-RP-ZZ-E-001-I-I02	
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
Draft	29 April 2022		Various	K.Chau		FL
1a	27 May 2022		Various	K.Chau		FL
1b	31 May 2022		Various	K.Chau		FL
1c	10 June 2022		Various	K.Chau		FL
1d	24 June 2022		Various	K.Chau		FL
1e	27 June 2022		Various	K.Chau		FL
1f	25 Aug 2022		Various	K.Chau		FL
1g	22 Sep 2022		Various	K.Chau		FL
2	20 Oct 2022		Various	K.Chau		FL
Current revision		2				

Approval			
Reviewer's signature		Approver's signature	
Name	Keith Chau	Name	Fredrick Leong
Title	Associate, Environmental	Title	Executive Director, Environment & Planning - Greater China

Contents

Figures

Appendices

1 INTRODUCTION

1.1 BACKGROUND TO THIS STUDY

1.1.1 The North East New Territories Landfill Extension (the NENTX Project) is located adjacent to the existing North East New Territories (NENT) Landfill at Ta Kwu Ling. The extension site is located in a valley covering mainly the existing NENT Landfill Stockpile and Borrow Area that was formed to the east of the existing landfill as part of the original site development of the landfill, project location and layout plan shown in **Figure 1.1**. NENTX will be a new source of landfill gas generation and there are potential risks associated with any development close to a landfill site relating to the generation and sub-surface migration of landfill gas.

1.1.2 The NENTX is a designated project. The Environmental Impact Assessment (EIA) Report (AEIAR-111/2007) and an Environmental Monitoring and Audit Manual were approved on 20 September 2007. The project is governed by an Environmental Permit (EP) (EP-292/2007) which was granted on 26 November 2007. A further of EP (FEP) was applied and the FEP (FEP-01/292/2007) was subsequently granted on April 2022.

1.1.3 As per requirement of EP condition 2.11 and FEP Condition 2.9, the Permit Holder shall, at least one month before the commencement of construction of the Project, submit to the Director of Environmental Protection for approval a detailed landfill gas hazard assessment, which shall include a review of the preliminary qualitative risk assessment in the approved EIA report, preparation of a detailed qualitative risk assessment, preparation of detailed design of gas protection measures and the establishment of maintenance and monitoring programmes to ensure the continued performance of the proposed control measures. The submissions shall be certified by the Environmental Team (ET) Leader and verified by the Independent Environmental Checker (IEC).

1.1.4 Aurecon Hong Kong Limited (Aurecon) was appointed by Veolia Environmental Services Hong Kong Limited (Veolia) as the ET to undertake the detailed landfill gas hazard assessment (DLFGHA). The assessment has included a review the preliminary qualitative risk assessment as presented in the approved EIA Report and taken into account the design changes of the latest scheme, to assess the potential risk due to landfill gas migration based on the latest construction methodology and building design at the infrastructure area of NENTX and to recommend appropriate measures to ensure NENTX can be constructed and operated without undue risk to safety.

1.1.5 The design of the landfill gas management system and the landfill gas precautionary measures to be adopted on-site have been performed by a landfill gas specialist consultant appointed by Veolia, who has comprehensive knowledge on landfill characteristics, potential landfill gas hazards and appropriate precautionary measures to minimise hazards. Moreover, the landfill gas management system and landfill gas precautionary measures will be checked and certified by the ET Leader who leads the environmental team which includes an experienced landfill gas hazard specialist.

1.1.6 For the purpose of this DLFGHA Report, the NENTX schemes assessed in the approved EIA Report and the latest NENTX scheme are referred to as “the EIA Scheme” and “the latest scheme” respectively. The assessment follows the “source-pathway-target” analysis approach adopted in the approved EIA Report and the EPD’s Guidance Note on Qualitative Landfill Gas Hazard Assessment (Guidance Note).

1.1.7 It should also be noted that this Report is related to the potential landfill gas hazards due to the operation of the existing NENT Landfill to the construction and operation of NENTX and the operation of NENTX to the infrastructure facilities of the NENTX and establishment of the necessary control measures to minimise the risks identified.

1.2 PROCEDURES AND GUIDELINES

1.2.1 Under Annex 7 of the Technical Memorandum on EIA Process (EIAO-TM), an evaluation of the potential risk posed by landfill gas is required for any development which is proposed within 250m of the edge of waste, known as Landfill Consultation Zone. As the NENTX site falls within the NENT Landfill Consultation Zone (see **Figure 1.2**), a Qualitative Landfill Gas Hazards Assessment (QLFGHA) is required to assess the potential risk due to landfill gas migration from the NENT Landfill to the construction and operation of the NENTX. This assessment considered both landfill gas sources (i.e. existing NENT Landfill and NENTX). A Practice Note for Professional Persons (ProPECC PN 3/96 "Landfill Gas Hazard Assessment for Development adjacent to Landfills") (2) and Guidance Note on the assessment of the hazards which landfill gas may present to developments close to landfills have been issued by the EPD.

1.3 PREVIOUS STUDIES UNDERTAKEN AT THE SITE

1.3.1 Number of previous studies have been undertaken at the NENTX. The documents which have been used as background material for the preparation of this assessment include the following:

- *Annex 7 and Annex 19 of the Technical Memorandum on EIAO (TM-EIAO);*
- *North East New Territories (NENT) Landfill Extension – Feasibility Study: Environmental Impact Assessment Report, Ove Arup & Partners Hong Kong Ltd. 2007*
- *Landfill Gas Hazard Assessment: Guidance Note, EPD 1997*
- *ProPECC PN 3/96 "Landfill Gas Hazard Assessment for Development adjacent to Landfills (2), EPD 1996*

1.4 SCOPE OF THIS STUDY

1.4.1 The following tasks have been undertaken as part this assessment:

- review of background information (including landfill gas monitoring data) and studies related to the NENT Landfill and the NENTX;
- identification of the nature and extent of the NENT Landfill and NENTX which might have potential impacts on the construction and operation of NENTX;
- identification of possible pathways through the ground, underground cavities, utilities or groundwater, and the nature of these pathways through which the landfill gas must traverse if they were to reach the NENTX; and
- identification of the potential targets associated with the NENTX which are sensitive to the landfill gas risk.

1.5 STRUCTURE OF THIS REPORT

1.5.1 Following this introductory section, the remainder of this Report is arranged as follow:

- Section 2 summarises the findings and recommendations of the preliminary QLFGHA in the approved EIA Report;

- Section 3 describes the methodology of the DLFGHA and the framework within which the identified levels of risk may be compared;
- Section 4 describes the NENT Landfill and NENTX site, including its history and the measures taken to control landfill gas;
- Section 5 reviews the geology and hydrogeology of the area and evaluates the potential pathways through which landfill gas may impact the targets;
- Section 6 describes the design of the infrastructure area of NENTX and reviews the sensitivity of key elements of the development to the possible presence of landfill gas;
- Section 7 evaluates the qualitative risk of landfill gas to the NENTX site;
- Section 8 provides further recommendations for precautionary and protection measures to be adopted during the design, construction and operation of the NENTX based on the findings of the hazard assessment;
- Section 9 describes the environmental monitoring and audit requirements with respect to landfill gas hazards associated with the construction, operation/restoration, and aftercare of the NENTX; and
- Section 10 concludes the findings and recommendations of this DLFGHA.

2 REVIEW OF PRELIMINARY QUALITATIVE RISK ASSESSMENT

2.1 APPROVED EIA REPORT

2.1.1 The source-pathway-target receiver analysis was identified in the approved EIA Report (AEIAR-111/2007) shows for the existing NENT Landfill and NENT Landfill Extension Site, the overall risk level of landfill gas (LFG) hazards to targets within the landfill extension site is categorised as 'High". A detailed preliminary qualitative risk assessment of LFG hazard in approved EIA Report is summarised in **Table 2.1** below.

Table 2.1 Qualitative risk assessment of LFG hazards associated with NENT Landfill Extension

Source	Pathway	Receiver Sensitivity	Risk
Within NENT Landfill Extension Site			
LFG from existing NENT Landfill and NENT Landfill Extension : Medium	Natural (faults): Very Short/ Direct	Excavation works during construction and landfill operation: High	High
	Man-made (services routes): Very Short/ Direct	Excavation works during construction and landfill operation: High	High
Outside NENT Landfill Extension Site			
From future NENT Landfill Extension : Medium	Natural (faults): Long/ Indirect	Adjacent residents: High	Medium
	Man-made (services routes): Long/ Indirect	Adjacent residents: High	Medium

2.1.2 Precautionary and protection measures during design, construction and operation/restoration phases of the NENTX have been recommended in the approved EIA Report.

2.1.3 The design phase of suitable level of significant engineering measures will be required to protect the planned development and activities within. According to the LFG Guidance Note, an active gas control system supported by gas barriers and monitoring systems will be required to protect the planned development for "High" risk level. Detailed examples of these measures can be reference to EPD's Guidance Note.

3 LANDFILL GAS HAZARD ASSESSMENT METHODOLOGY

3.1 GENERAL

3.1.1 A relatively simple procedure is used to evaluate the degree of risk which landfill gas may create for a particular development. The procedure is based on the Source - Pathway - Target method recommended in the Guidance Note on Landfill Gas Hazard Assessment, EPD, 1997 as described below:

- Source - the location, nature and likely quantities/ concentration of landfill gas which have the potential to affect the landfill extension.
- Pathway - the ground and groundwater conditions, through which the landfill gas must pass if they are to reach the development.
- Target - the elements of the development that are sensitive to the effects of the landfill gas.

3.1.2 The landfill gas source, pathway and targets are categorised for the hazard assessment. An assessment of the overall risk is made based on the risk category as summarised in below, following the combination of existing NENT Landfill and NENTX fall into during the construction, operation, restoration and aftercare stages.

3.2 SOURCE

3.2.1 The classification of the Source (i.e. the landfill) is determined as follows:

- **Minor** - Landfill sites at which gas controls have been installed and proven to be effective by comprehensive monitoring which has demonstrated that there is no migration of gas beyond the landfill boundary (or any specific control measures) and at which control of gas does not rely solely on an active gas extraction system or any other single control measure which is vulnerable to failure; or

  Old landfill sites where the maximum concentration of methane within the waste, as measured at several locations across the landfill and on at least four occasions over a period of at least 3 months (preferably longer), is less than 5 % by volume (v/v).

- **Medium** - Landfill site at which some form of gas control has been installed (e.g. lined site or one where vents or barriers have been retrospectively installed) but where there are only limited monitoring data to demonstrate its efficacy to prevent migration of gas; or

  Landfill site where comprehensive monitoring has demonstrated that there is no migration of gas beyond the landfill boundary but where the control of gas relies solely on an active gas extraction system or any other single control system which is vulnerable to failure.

- **Major** - Recently filled landfill site at which there is little or no control to prevent migration of gas or at which the efficacy of the gas control measures has not been assessed; or

  Any landfill site at which monitoring has demonstrated that there is significant migration of gas beyond the site boundary.

3.3 PATHWAY

3.3.1 The type of pathway can be broadly classified based on various geological features of the landfill extension site such as permeability of soil, spacing, tightness and direction of fissures/ joints; topography; depth and thickness of the medium through which the gas may migrate(also affected by groundwater level); nature of strata over the potential pathway; number of media involved; and depth to groundwater table and flow patterns, etc. In general, the type of pathway can be broadly classified is as follows:

- Very Short/Direct — Path length of less than 50m for unsaturated permeable strata and fissured rock or less than 100m for man-made conduits
- Moderate short/Direct — Path length of 50-100m for unsaturated permeable soil or fissured rock or 100-250m for man-made conduits
- Long/Indirect — Path length of 100-250m for unsaturated permeable soils and fissured rock

3.4 TARGET

3.4.1 Different types of targets may be broadly classified as follows:

- High Sensitivity — Buildings and structures with ground level or below ground rooms/voids or into which services enter directly from the ground and to which members of the general public have unrestricted access or which contain sources of ignition.

  This would include any developments where there is a possibility of additional structures being erected directly on the ground on an ad hoc basis and thereby without due regard to the potential risks.
- Medium Sensitivity — Other buildings, structures or service voids where there is access only by authorised, well trained personnel, such as the staff of utility companies, who have been briefed on the potential hazards relating to landfill gas and the specific safety procedures to be followed.

  Deep excavations.
- Low Sensitivity — Buildings/structures which are less prone to gas ingress by virtue of their design (such as those with a raised floor slab).

  Shallow excavations.

  Developments which involve essentially outdoor activities but where evolution of gas could pose potential problems.

3.4.2 The above examples of the different categories should be used as a general guide only and particular aspects of a building or development may render it more or less sensitive than indicated. Account should be taken of any particular circumstances when assigning a target to one of the three categories.

3.4.3 A qualitative assessment of the overall risk is made based on the risk category as summarised in **Table 3.1**, which is extracted from Guidance Note. For the purpose of categorising the landfill extension site, the category is based upon the highest level of risk

determined for any of the potential impacts identified in **Table 3.1**, in which the general implications fall into different overall risk categories as show in **Table 3.2**.

Table 3.1 Classification of Risk Category

Source	Pathway	Receiver Sensitivity	Risk Category
Major	Very Short/Direct	High	Very high
		Medium	High
		Low	Medium
	Moderately short/Direct	High	High
		Medium	Medium
		Low	Low
	Long/Indirect	High	High
		Medium	Medium
		Low	Low
Medium	Very Short/Direct	High	High
		Medium	Medium
		Low	Low
	Moderately short/Direct	High	High
		Medium	Medium
		Low	Low
	Long/Indirect	High	High
		Medium	Medium
		Low	Very Low
Minor	Very Short/Direct	High	High
		Medium	Medium
		Low	Low
	Moderately short/Direct	High	High
		Medium	Medium
		Low	Very Low
	Long/Indirect	High	High
		Medium	Medium
		Low	Very Low

Table 3.2 Summary of General Categorisations of Risk

Level of Risk	Implication
Very high	At the very least, extensive engineering measures and alarm systems are likely to be required. An emergency actions plan should also be developed so that appropriate actions may be immediately taken in the event of high landfill gas concentrations being detected within the development.
High	Significant engineering measures will be required to protect the planned development.
Medium	Engineering measures required to protect the development.
Low	Some precautionary measures will be required to ensure that the planned development is safe.
Very low	No protection or precautionary measures are required.

4 NATURE OF NENT LANDFILL

4.1 LANDFILL HISTORY

4.1.1 NENT Landfill is located at Ta Kwn Ling, New Territories and the landfill is one of the three strategic landfills in operation in the HKSAR and was designed with a capacity of approximately 35Mm^3 of waste. The landfill commissioned in 1995 and receives municipal waste, construction waste and special waste from the North East New Territories, and Yuen Long and Sha Tin Transfer Stations solely by road, with an occupying about 108ha total site area and 64ha landfilling area of land.

4.1.2 The Environmental Protection Department (EPD) of the HKSAR Government commissioned a study in Year 2000 on the Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites. Amongst the potential sites recommended in this territory-wide study is the extension of the existing NENT Landfill, with a target capacity of about 19 Mm^3. The proposed extension, of about 70 ha, is located immediately east of the existing NENT Landfill. A large proportion of the Extension area is in fact the Stockpile and Borrow Area of the existing landfill.

4.2 HISTORICAL LANDFILL GAS AND LEACHATE CONTROL

4.2.1 The existing NENT Landfill has been incorporated with an efficient and effective Landfill Gas (LFG) management system (**Appendix A**) in which a coordinated approach to LFG monitoring, collection, extraction, flaring and utilisation in accordance with international best practices for landfill operations. The LFG extraction system includes extraction wells and pipework installed within the landfill cap connecting a pumping station on-site. It also incorporates a separate collection system connected to perimeter extraction wells isolated from the main system so that it is operated independently for migration control. The landfill contractor is undertaking routine maintenance and checking of the landfill gas extraction system to ensure it is operating satisfactorily. As the site is lined and landfill gas and leachate are collected and treated, it effectively controls sub-surface off-site migration of landfill gas and leachate. Typical details of the composite liner system (including an impermeable liner) installed at the NENT Landfill are presented in **Figure 4.1**.

Under the existing contract, Veolia will be required to continue the control and monitoring of landfill gas and leachate following closure of the landfill for a period of 30 years. Recent monitoring results from the monitoring wells located along the boundary of NENT Landfill have been reviewed. **Figure 4.2** shows the locations of monitoring wells and the landfill gas monitoring results of the existing NENT Landfill are summarised in **Table 4.1**.

Table 4.1 Summary of Landfill Gas Monitoring Results of the Monitoring Wells for Existing NENT (From January 2017 to December 2021)

	Methane (% gas) *		Carbon Dioxide (% gas)	
Location	Range	Average	Range	Average
A1	0.0 - 0.0	0.0	0.1 - 3.4	0.7
A2	0.0 - 0.0	0.0	0.0 - 4.5	1.6
A3	0.0 - 0.0	0.0	0.1 - 7.2	2.1
A4	0.0 - 0.0	0.0	0.2 - 9.0	4.1
A5	0.0 - 0.0	0.0	0.2 - 8.1	2.3
A6	0.0 - 0.0	0.0	0.2 - 4.3	2.2
A7	0.0 - 0.0	0.0	0.1 - 5.2	0.6
A8	0.0 - 0.0	0.0	0.1 - 3.8	0.8
A9	0.0 - 0.0	0.0	0.1 - 9.0	1.9
A10	0.0 - 0.0	0.0	0.1 - 5.5	1.6
A11	0.0 - 0.0	0.0	0.1 - 4.4	1.0
B12	0.0 - 0.0	0.0	0.1 - 4.7	2.0
B13	0.0 - 0.0	0.0	0.0 - 4.7	2.0
B14	0.0 - 0.0	0.0	0.0 - 3.4	1.3
B15	0.0 - 0.0	0.0	0.2 - 4.0	1.3
B17	0.0 - 0.0	0.0	0.7 - 6.7	2.4
B18	0.0 - 0.0	0.0	0.1 - 2.8	1.1
B19	0.0 - 0.0	0.0	0.1 - 6.0	1.9
B20	0.0 - 0.0	0.0	0.2 - 2.9	1.5
B21	0.0 - 0.0	0.0	0.2 - 3.4	1.5
B22	0.0 - 0.0	0.0	0.1 - 2.9	1.1
B23	0.0 - 0.0	0.0	0.1 - 2.2	0.6
B24	0.0 - 0.0	0.0	0.1 - 2.9	1.0
B25	0.0 - 0.0	0.0	0.1 - 5.0	1.9
B26	0.0 - 0.0	0.0	0.1 - 4.8	1.6
B27	0.0 - 0.0	0.0	0.1 - 1.8	0.7
A28	0.0 - 0.0	0.0	0.1 - 6.9	1.2
A29	0.0 - 0.0	0.0	0.2 - 5.2	2.0
A30	0.0 - 0.0	0.0	0.1 - 2.3	1.2

Notes:
*For the gas concentration of Methane, <0.1% gas of monitoring result was detected for all monitoring wells which were under the detection limit therefore 0% of Methane gas concentration has been assumed for the **Table 4.1** calculation.

4.2.2 Nil or minimal concentration of methane have been observed for all monitoring wells along the boundary of NENT Landfill which indicate that there is no sub-surface off-site migration of methane of the landfill.

4.2.3 The average Carbon Dioxide (CO_2) concentrations detected in all the these monitoring wells ranged from 0.6% to 4.1% (v/v) while the maximum gas concentrations ranged from 1.8% to 9.0% (v/v). Abnormality of CO_2 level was record in some monitoring wells, the cause of abnormalities were the presence of the carbonate source and natural biological activities in the soil and it was considered due to natural source and not due to landfill activities and all the abnormalities has been reviewed by the IC and it was concluded that all of them were not originated from the existing NENT Landfill.

4.2.4 The Site is in a valley to the southeast of the existing NENT Landfill. The Valley is encircled by three ridgelines and exits to the southwest through a small gorge.

4.2.5 The valley has an area of about 70 ha and overlaps with the stockpile and borrow area of the existing NENT Landfill. NENTX is designed with an estimated void space of landfill capacity of not less than 19Mm^3 to receive Municipal Solid Waste (MSW) over a period of approximately 10 years. It is anticipated that construction and operation of NENTX will commence in 2022 and 2026, respectively.

4.3 LANDFILL GAS CONTROL FOR THE NENTX

4.3.1 The future landfill extension itself is a source to generate significant amount of LFG during the operation and aftercare phases. With the LFG control measures in the future NENTX, it is anticipated that the source of LFG will be properly controlled within the site similar to the operation in existing NENT Landfill.

4.3.2 NENTX will be designed and constructed to incorporate extensive measures to contain, collect, and treat landfill gas and leachate. These measures include a composite liner system, active gas extraction systems and gas control systems in accordance with international best practices for landfill operation. These measures can effectively control sub-surface off-site migration of landfill gas and leachate. The base liner systems are designed as secure contaminant systems consisting of multi-layer impermeable liners, to contain leachate and landfill gas, LFG generated during waste deposition. Details of the base liner system designed for the NENTX is shown in **Figure 4.3**.

4.3.3 A comprehensive environmental monitoring programme will be implemented during the construction, operation, restoration and aftercare of the NENTX to monitor landfill gas generated within the NENTX and at the gas monitoring wells along the site boundary of NENTX and off-site leachate migration/ groundwater contamination. With reference to the performance standard stipulated in the NENTX contract, Veolia is required to control the migration of landfill gas such that the concentration of methane and carbon dioxide at the perimeter monitoring wells shall not exceed 1% v/v and 1.5% v/v above the background concentration (measured before the operation of the NENTX), respectively. Veolia will be required to continue the control and monitoring of landfill gas and leachate following closure of the landfill for a period of 30 years.

4.3.4 In conclusion, the future landfill extension itself is a source to generate amount of LFG during the Operation and Aftercares phases and another source of LFG is associated with the decomposition of MSW landfilled at NENT Landfill, which is located within (from waste boundary) from some NENTX infrastructure area.

5 POTENTIAL FOR THE DEVELOPMENT TO INTERCEPT LANDFILL GAS

5.1 GEOLOGY AND HYDROGEOLOGY

5.1.1 The NENTX site has a variable thickness of superficial deposits across the majority of its area, comprising fill, colluvium and soil derived from in-situ weathering. The solid geology of the site comprises a mixture of volcanic tuff deposits, sightly metamorphosed volcanic tuff deposits and a small area of meta-sedimentary rock. The rockhead levels within the site are largely reflected by the topography, with low-lying valleys having been formed due to the presence of geological faults.

Four major faults are presented within the site (see **Figure 5.1**):

Fault 1 is a located along the northern boundary of the study area and striking approximately west-northwest.

Fault 2 strikes north-northeast through the study area, most likely extending through the existing waste reception area to the south of the site and then following the topographic valley northeast from this. Previous works has recorded this fault as dipping at 80^{O} to the southeast, with the material on the south eastern side having been downthrown.

Fault 3 follows the approximate alignment of the existing haul road through the centre of the site area, trending west-northwest to east-southeast, and extends beyond the site boundaries.

Fault 4 is mostly like a large splay fault associated with Fault 2. The main trend of the fault is north-northeast along the topographic valley to the east of Fault 2, with a small potion trending east-northeast to the south of the haul road before joining with Fault 2 in the low-lying area within the southern part of the site.

5.2 UTILITIES

5.2.1 It is known that underground utilities (landfill gas collection pipes, electricity, telecommunications etc.) exist in the existing infrastructure area of NENT Landfill in Portion D. Also, the new infrastructure area will integrate within the existing NENT supporting facilitates located in Portion D of the site in the future. The utilities to be provided from existing NENTX include electricity, telecommunication cables, water mains, sewer, storm water drains, landfill gas and leachate pipes etc. along the NENTX. Electricity and telecommunication cables will be laid underground in ducts which could provide a direct man-made pathway from NENT Landfill to NENTX. A preliminary layout plan for the proposed utility services to NENTX is presented in **Figure 5.2.**

6 DETAILED DESIGN

6.1 FOR INFRASTRUCTURE AREA

6.1.1 Based on the findings and recommendations of the preliminary QLFGHA of the approved EIA Report, Veolia has incorporated landfill gas control measures in the detailed design of the NENTX infrastructure facilities. This assessment has taken account of these control measures in the evaluation of the landfill gas hazard with respect to the nature and characteristics of the targets. The adequacy of these control measures will be evaluated and if necessary further control measures will be recommended in this Report.

6.2 DESCRIPTION OF THE INFRASRUCTURE AREA

6.2.1 In accordance with the EIA and Specification requirements, the new infrastructure area (see **Figure 6.1 -** Location of Proposed Infrastructure Buildings and **Figure 6.2a to 6.2e -** the proposed ground floor plan of the infrastructure area) will integrate within the existing NENT supporting facilities located in Portion D of the site. According to the consultation zone of Guidance Notes (GN), it should be noted that the new infrastructure area is located within 250m from the existing NENT and NENTX waste boundary. Therefore, the key risk source for the new infrastructure area is the NENT and NENTX. The infrastructure area includes the following building/ structures:

- Integrated Office Building
- Operations and Maintenance Building and Maintenance Workshop Building
- Fire Services Building
- Process Building

6.2.2 As the Portion D will also house other supporting arrangements such as car parking, vehicle maintenance yards and landfill vehicle wash bay are operated in open space or non-enclosed building, there will be no or very low potential for landfill gas cumulation at these facilities. Therefore, they are not further assessed in this report.

6.2.3 The approximate distance from the NENTX waste boundary defined in the GN to the each of the target facilities at the new infrastructure area are presented in **Table 6.1**. All facilities are operated/managed by Veolia.

Table 6.1 Key Target Facilities in the New Infrastructure Area

Key Facilities	**Approximately Distance from the NENTX**	**Distance from NENT**
Integrated Office Building	215m	135m
Fire Services Building	205m	165m
Operations and Maintenance Building and Maintenance Workshop Building	105m	100m
Process Building	195m	30m

Remarks: Under Annex 7 of the Technical Memorandum on EIA Process (EIAO-TM) and Landfill Gas Hazard Assessment: Guidance Note, EPD 1997, an evaluation of the potential risk posed by landfill gas is required for any development which is proposed within 250m of the edge of waste, known as Landfill Consultation Zone. As the NENTX proposed infrastructure area(Integrated Office Building, Fire Services Building, Operations and Maintenance Building and Maintenance Workshop Building and Process Building) are falls within the NENT and NENTX Landfill Consultation Zone, a Qualitative Landfill Gas Hazards Assessment (QLFGHA) is required to assess the potential risk due to landfill gas migration from the NENT Landfill/ NENTX(Assessment details please refer to the below Section).

6.3 CONSTRUCTION METHODOLOGY

6.3.1 Simple excavation and slope formations works will be carried out during the construction stage. The site formation works for the landfill lining system will require some open excavations works due to slightly lower formation level for the basal liner. The temporary works will involve the formation of temporary ditches along the sides of excavations and associated drainage works, and material storage areas.

6.4 SENSITIVE TARGET FACILITIES FOR LANDFILL GAS RISK

Integrated Office Building

6.4.1 The Integrated Office Building is designed as 3-storey building, ground floor covering a total area of approximately 500 m^2. Ground level rooms include Storage, Laboratory, Female/ Male Toilets, Shower & Lockers, Accessible Toilet, Pantry, M& E Room etc. (see **Figure 6.2a**). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room are presented in **Table 6.2**.

Table 6.2 Designed Air Change of the Ground Floor Rooms of Integrated Building

No.	Room	No. of Air Change Per Hour (*)
1.	Lobby & Waiting Area (Reception)	5
2.	Storage	6
3.	Laboratory	10
4.	Storage Room (1)	6
5.	Male Toilet, Shower & Lockers	15
6.	Female Toilet, Shower & Lockers	15
7.	Accessible Toilet	15
8.	Pantry	10
9.	Staff Rest Room	5
10.	Employer/ ER (Open Plan Office)	6
11.	Conference/ Meeting Room	6
12.	Conference/ Meeting Room	6
13.	Conference/ Meeting Room	6
14.	Interview Room	5
15.	M&E Room	10
16.	Special Storage Room cum Monitoring Room	6
Note: *Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.		

Fire & Water Services Building

6.4.2 The Fire Services Building is 2-story high structure, ground floor covering a total area of approximately 250 m^2. Ground level rooms include Fire Services Control Room, Fire Services Pump and Tank Room, Flushing Water and Tank Room and Sprinkler and Street Hydrant Pump and Tank Room. (see **Figure 6.2b**). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room is presented in **Table 6.3**.

Table 6.3 Designed Air Change of the Ground Floor Rooms of Fire & Water Services Building

No.	Room	No. of Air Change Per Hour (*)
1.	FS Control Room	5
2.	FS Pump and Tank Room	5
3.	Flushing Water and Tank Room	5
4	Sprinkler and Street Hydrant Pump and Tank Room	5
Notes: *Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.		

Operations and Maintenance Building and Maintenance Workshop Building

6.4.3 The Operations and Maintenance Building is functional, rectangular 3-storey building, ground floor covering a total area of approximately 200 m^2. Ground level rooms include Parts/ Tools Storage, Dry Gas Bottle Room, Plumbing Room, ELE Room and Pumping Room (see **Figure 6.2c**). These areas will be provided with mechanical ventilation. The designed air change for each room is presented in **Table 6.4**.

Table 6.4 Designed Air Change of the Ground Floor Rooms of Operations and Maintenance Building

No.	Room	No. of Air Change Per Hour (*)
1.	Workshop Area	6
2.	Parts/ Tools Storage	6
3.	Dry Gas Bottle Room	10
4.	Plumbing Room	10
5.	ELE Room	10
Notes: *Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.		

Process Building

6.4.4 The Process Building will be constructed with front and rear façades on two different site formation platform levels. The building's Lower Ground floor will be constructed abutting a retaining wall at its rear and partly adjacent to sloping ground on one side. However, all of the Process Building's rooms will be located above the respective ground level at the front and rear façades of the building, including the rooms of the Lower Ground floor. The building will house the electrical switch room and workshop in its lower ground floor level; blower room, toilets, changing room etc. on the ground floor. (see **Figure 6.2d&e**). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room is presented in **Table 6.5&Table 6.6**.

Table 6.5 Designed Air Change of the Lower Ground Floor Rooms of Process Building

No.	Room	No. of Air Change Per Hour (*)
1.	HV Switch Room	10
2.	CLP Room	10
3.	LV Room LFG	10
4.	Common Process Workshop	10
Notes: *Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.		

Table 6.6 Designed Air Change of the Ground Floor Rooms of Process Building

No.	Room	No. of Air Change Per Hour (*)
1.	Office	5
2.	Storage (1)	6
3.	Storage (2)	6
5.	Common Pantry	15
6.	Hose Reel Pump Room	10
7.	Blower Room for SBRS	10
8.	SNG Plant Control Room	10
9.	SNG MCC Room	10
10.	Males Showers, Toilets & Lockers	15
11.	Disable Toilet	15
Notes: *Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.		

7 QUALITATIVE ASSESSMENT OF RISK DUE TO LANDFILL GAS

7.1 INTRODUCTION

7.1.1 This section reviews the information presented in the preceding sections and evaluates the data presented with reference to the assessment definitions given in the Guidance Note on Landfill Gas Hazard Assessment. The qualitative assessment of the potential hazard from landfill gas to the proposed targets is then concluded.

7.2 SOURCE

7.2.1 The existing NENT Landfill and the NENTX will both be the source of potential risk of landfill gas migration. NENT and NENTX have the same potential for landfill gas generation. The source of LFG at the existing NENT landfill and extension NENT Landfill are categorised as Medium. The 250m consultation zones for the NENT Landfill and the NENTX are shown in **Figure 1.2**.

7.3 NENT LANDFILL

7.3.1 As the NENT Landfill is a large operating landfill, the landfill is a significant potential source of landfill gas. The NENT Landfill was designed and constructed to incorporate international best practices to contain, manage and control waste and landfill gas. It is operated by an experienced international waste management contractor.

7.3.2 The potential off-site migration of landfill gas is assessed taking into account the comprehensive and highly effective collection and management system installed and operated. It is acknowledged from the NENT Landfill Monthly Reports that the only justifiable exceedance recorded for surface gas monitoring in October to December 1997 were likely due to the proximities of monitoring locations to the active tipping faces. It was also recorded that the frequency of surface gas monitoring had been increased in accordance with the corrective actions when exceedances occurred. Hence, the potential of off-site migration of landfill gas cannot be eliminated. Given the size of the NENT Landfill, the multiple landfill gas controls implemented and the NENT Landfill was classified as a “Medium” source of potential landfill gas risk with reference to the LFG Guidance Note as presented in the approved EIA Report which is also applicable to the latest scheme.

7.4 NENTX

7.4.1 The future landfill extension itself is a source to generate significant amount of LFG during the operation and aftercare phases. LFG hazards may be hazard to front-line workers within the site especially where the LFG is extracted, transported, and processed. With the LFG control measures and Waste to Energy Facility in the future NENTX, it is anticipated that the source of LFG will be properly controlled within the site similar to the operation in existing NENT landfill.

7.4.2 The NENTX will be designed as a containment landfill with LFG collection and management systems to eliminate any off-site migration of LFG. By virtue of the effective control and utilisation of LFG being implemented in the existing NENT landfill based on the past monitoring data, it is likely that the NENTX will be designed to adopt similar LFG control measures so as to ensure future landfill extension compliance of environmental and safety requirements. The source of LFG at the future landfill extension was categorised as Medium.

7.5 PATHWAY

7.5.1 The potential pathways through which landfill gas may enter the NENTX Site are threefold, namely:

- through transmission along natural pathways such as fissures or joints in rock;
- man-made pathways such as through permeable backfill in utilities trenches; or
- a combination of both.

The likely potential for each mode of transmission are clearly dependent on the geological conditions, which are discussed below.

7.6 WITHIN LANDFILL EXTENSION SITE

NATURAL PATHWAYS

7.6.1 The major concern is the presence of Faults 1 and 3 as shown in **Figure 5.1** across the existing NENT Landfill towards the NENTX, which as natural pathways for preferential LFG migration. These pathways of fissured rock are less than 50m to the landfill extension site and are categorised as Very Short/Direct and the superficial deposits located below the formation level to the south of the landfill extension site may act as natural pathways for LFG migration towards the Waste Reception Area of the existing NENT Landfill. These pathways of unsaturated permeable strata are less than 50m to the landfill extension site and are categorised as Very Short/Direct as presented in the approved EIA.

MAN-MADE PATHWAYS

7.6.2 There are man-made pathways in the vicinity of the site consisting of services routes leading to the existing landfill. These pathways to sensitive receivers are classified as Very Short/Direct towards the landfill extension site in the approved EIA Report, as landfill workers could be the targets during landfill operation, piping/ conduit construction, and/ or drilling/ boring operation.

Also, the potential pathways or sub-surface migration of landfill gas from the NENTX waste boundary to the future infrastructure area are considered to comprise both reclamation fill and the future utilities connecting the infrastructure area. It is known that the new infrastructure area will integrate within the existing NENT supporting facilities located in Portion D of the site in the future and the underground utilities (landfill gas collection pipes, electricity, telecommunications etc.) to be provide to the NENTX. Among all utilities, electricity and telecommunications cables will provide a direct man-made pathway for the transmission of landfill gas from NENT to NENTX. Therefore, landfill gas control measures such as seal cable duct with bentonite will be implemented to minimise the potential risk.

7.6.3 Considering the distance and the presence of possible migration pathways between the NENTX waste boundary and NENTX infrastructure area. And based on the detailed design of the new infrastructure area, the pathway for landfill gas migration from the NENTX waste boundary to individual target at new infrastructure area should be classified as according to the presence of possible migration pathways and distance between the target and the NENTX waste boundary: <50m as Very Short/Indirect, 50-100m as Moderately Short/Indirect, 100-250m as Long/Indirect. (see **Table 7.1**)

7.7 OUTSIDE LANDFILL EXTENSION SITE

NATURAL PATHWAYS

7.7.1 The presence of faults lines in NENT Landfill Extension site are identified as the potential natural pathways for potential LFG migration to the vicinities of sensitive receivers as shown in **Figure 5.1**. Fault 4 is the nearest fault line to Tong To Shan Tsuen at a distance of ~280m which is classified as "Long/Indirect" pathway extending from the northern bound of the future landfill extension site. Mitigation measures will include installation of proper liner to act as barriers and sealing of faults line ends to prevent off-site LFG migration.

MAN-MADE PATHWAYS

7.7.2 Although there are man-made pathways in the vicinity of the site consisting of services routes leading to the existing landfill, they are far from sensitive receivers and are classified as Long/Indirect toward the adjacent occupied development in the approved EIA Report.

Table 7.1 Classification of Landfill Gas Migration Pathway

Targets	**Pathway Description**	**Classification**
1. Integrated Office Building	Path length of 100 to 250m for unsaturated permeable soil	Long/Indirect
2. Fire & Water Services building	Path length of 100 to 250m for unsaturated permeable soil	Long/Indirect
3.Operations and Maintenance Building and Maintenance Workshop Building	Path length of 100 to 250m for unsaturated permeable soil	Long/Indirect
4.Process Building	Path length of 100 to 250m for unsaturated permeable soil	Long/Indirect

7.8 TARGETS

WITHIN LANDFILL EXTENSION SITE

7.8.1 Potential receivers sensitive to LFG hazards associated with the NENT Landfill Extension include the workers and staff of NENT Landfill Extension Site. The targets identified in the latest scheme are presented below.

Target 1 - Construction Phase of the NENTX

7.8.2 As shown in **Figure 1.2**, some of NENTX infrastructure site falls within the 250m landfill consultation zone of the NENT Landfill. Excavation for construction of new landfill bowl and deep unventilated excavation works are expected. The excavation area and the minimal confined space and trenches, if any, are at a higher risk of exposure to landfill gas. However, in general, any excavation work or work involving the construction of trenches will use the open cut method, although there may be deep excavations. Landfill gas, if any, migrated to the site can easily be dispersed and diluted in the atmosphere. Construction works involving working in confined spaces will be undertaken by trained workers.

The temporary site office (see **Figure 7.1**) for construction phase will be provided with multiple landfill gas control measures (including provision of mechanical or natural ventilation and continuous gas monitoring system with gas alarm for all occupied on-site buildings). This target was thus classified as “High Sensitivity” in the approved EIA Report which is also applicable for the latest scheme.

Target 2 - Operation Phase of the NENTX (Infrastructure Area)

7.8.3 All of proposed new infrastructure area of NENTX will be within the 250m Landfill Consultation Zone of the NENTX and existing NENT. The assessment of potential targets for landfill gas sensitivity in the infrastructure area have been selected from the below ground and ground floor rooms of the buildings and structures. Services ducts or other confined spaces at basement or ground floor level and waste reception area of the existing NENT were classified as “high sensitivity” in the approved EIA Report.

OUTSIDE LANDFILL EXTENSION SITE

7.8.4 According to the Wo Keng Shan Outline Zoning Plan (OZP) S/NE-WKS/10 extracted from the “Statutory Planning Portal” of Planning Department (PlanD) website at https://www2.ozp.tpb.gov.hk/gos/default.aspx?planno=S%2fNE-WKS%2f10&lang=0#, the planned landuse to the south of the landfill extension site consist mainly of “Green Belt” with minor area for “Agriculture” and “Village” Type Development with the landuse governed by the Town Planning Ordinance.

7.8.5 The northern part of the consultation zone of NENTX falls within the Tong To Shan Archaeological Site which also imposes restrictions on any proposed development/ re-development.

7.8.6 There are 2 nearest LFG receivers outside the NENTX including LFG1 (Wo Keng Shan Tsuen) and LFG2 (Tong To Shan Tsuen. And LFG1 lies within the original 250m consultation zone (at ~100m from the landfill site boundary). It is therefore categorised under “High Sensitivity”) mentioned in approved EIA Report.

7.8.7 LFG2 is a village house marginally outside the proposed new demarcation of 250 consultation zone corresponding to the latest footprint of NENTX site area (at ~270m from the NENTX site boundary). Although it is currently abandoned and unoccupied, it will be prudent to pay due attention to the implementation of all necessary protective measures if LFG2 were occupied in future.

7.8.8 Based on the guidance given in EPD’s Guidance Note, the sensitivity of all targets in the infrastructure area is summarised in **Table 7.2**. Multiple options for landfill gas control measures will be utilised in the detailed design, for example:

(a) Gas barrier

- impermeable gas membrane to be installed below the base slab of the building; or

- the internal floor slab of the ground floor rooms will be painted with low gas permeability paints (see **Appendix B** for the proposed products to be used); and

(b) Ventilation

- ground floor rooms will be provided with mechanical or natural ventilation to prevent potential accumulation of landfill gas; and

(c) Gas alarm

- all occupied on-site buildings will be provided with gas alarm (see **Appendix C** for the common type product to be used);
- check the fixed gas detector by the calibration gas at least once per quarter in order to

verify the accuracy and alarm function of the fixed gas detector;
- clear calibration / checking record will be maintained; and
- 2 action trigger levels will be set up (If the first action trigger level to be set at 10% LEL is triggered, the Registered Safety Officer (RSO) will be informed. If the second action trigger level to be set at 20% LEL is trigger, all personnel within the permanent building will be evacuated.

7.8.9 Specification of gas protection measures are shown in **Figure 7.2**. Taking into account the combination of landfill gas control measures that has been incorporated in the detailed design of the NENTX infrastructure area, Veolia's expertise in landfill operation who is fully aware of the potential landfill gas hazards and with their staff well trained on the potential hazards relating to landfill gas and the specific safety procedures, the targets in the NENTX infrastructure area is conservatively classified as low.

Table 7.2 Sensitivity of all Targets in the Infrastructure Area

Targets	**Description/ Proposed Mitigation Measures**	**Sensitivity**	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 2.1a - Storage Room, Employer/ ER Office, Conference/ Meeting Room and Special Storage Room cum Monitoring Room of Integrated Office Building	Mitigation Measures: - Above ground room - Air conditioning with natural ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel	High	Low
Target 2.1b - Lobby & Waiting Area, Staff Rest Room and Interview Room of Integrated Office Building	Mitigation Measures: - Above ground room - Air conditioning with natural ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel	High	Low
Target 2.1c - Female/ Male Changing Room & Toilets, Accessible Toilet of Integrated Office Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access to staff only	High	Low
Target 2.1d - Laboratory and Pantry of Integrated Office Building	Mitigation Measures: - Above ground room - - Air conditioning with natural ventilation and with mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access to Veolia and EPD staff and invited guests/ visitors	High	Low
Target 2.1e - M&E Room of Integrated Office Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on	High	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
	top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel		
Target 2.2a - Fire Services Control Room, Fire Services Pump & Tank Room and Sprinkler and Street hydrant Pump & Tank Room of Fire & Water Services Building	Mitigation Measures: - Above ground room - With mechanical ventilation as per Fire Services Department requirement - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel	High	Low
Target 2.2b - Flushing Water & Tank Room and Sprinkler & Street Hydrant Pump & Tank Room of Fire & Water Services Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel	High	Low
Target 2.3a - Workshop Area, Parts/ Tools Storage of Operation & Maintenance Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised personnel	High	Low
Target 2.3b - Dangerous Goods Storeroom, Dry Gas Bottle Room, Plumbing Room and ELE Room of Operation & Maintenance Building	Mitigation Measures: - Above ground room - With mechanical ventilation for Plumbing Room and ELE Room - Air conditioning with natural ventilation for Dangerous Goods Storeroom and Dry Gas Bottle Room - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low

Targets	**Description/ Proposed Mitigation Measures**	**Sensitivity**	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 2.4a - HV Switch Room of Process Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With underground utilities connection - With ignition source - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low
Target 2.4b – CLP Room of Process Building	Mitigation Measures: - Above ground room - With ventilation system as per CLP requirement - With underground utilities connection - With ignition source - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low
Target 2.4c - LV Room LFG of Process Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With underground utilities connection - With ignition source - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low
Target 2.4d - Common Process Workshop of Process Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low

Targets	**Description/ Proposed Mitigation Measures**	**Sensitivity**	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 2.4e - (Infrastructure Area of the NENTX - Office of Process Building) (category: Low sensitivity)	Mitigation Measures: - Above ground room - Air conditioning with natural ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access to staff only	High	Low
Target 2.4f - Storage Room of Process Building	Mitigation Measures: - Above ground room - Air conditioning with natural ventilation and with mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by authorised person	High	Low
Target 2.4g - Common Pantry, Males Showers, Toilets & Locker and Disable Toilet of Process Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access to staff only	High	Low
Target 2.4h - Hose Reel Pump Room, Blower Room, SNG Plant Control Room, SNG MCC Room of Process Building	Mitigation Measures: - Above ground room - With mechanical ventilation - With gas-proofing coating apply on top of all ground floor slabs - With gas alarm - Restricted access by competent person	High	Low

7.9 SOURCE-PATHWAY-TARGET ANALYSIS

7.9.1 On the basis of the source, pathways and targets identified above, a source-pathway-target analysis for the latest scheme has been undertaken and is presented in **Table 7.3** according to the assessment framework described in EPD's Guidance Notes. Different combination of source, pathway, and target result in a range of overall potential hazards.

7.9.2 The source-pathway-target analysis shows that landfill gas risk posed by the NENT Landfill and the NENTX under the latest scheme is low to high within the NENTX waste boundary during both the construction and operation phases. Whereas the risk posed by the NENTX to NENTX infrastructure area is low with respect to the nature of the targets and the gas control measures incorporated in the detailed design of the buildings of the new infrastructure area.

Table 7.3 Qualitative Assessment of Landfill Gas Hazard Associated with the NENTX in the Latest Scheme

Source	**Pathway**	**Target**	**Qualitative Risk**
NENT Landfill - potential for gas generation over time, but comprehensive and proven mitigation installed. (category: medium)	Fissured rock, Fault 1 and 3 across the NENT Landfill towards the NENTX with potential natural pathways for preferential LFG migration, distance <50m Superficial deposits below the formation level to the south of the landfill extension fill for LFG migration towards the Waste Reception Area of the existing NENT landfill, distance <50m (category: Very short/Direct)	Target 1a - Construction Phase of the NENTX – • Excavation for construction of new landfill bowl (category: High sensitivity)	High
NENT Landfill - potential for gas generation over time, but comprehensive and proven mitigation installed. (category: medium)	Fissured rock, Fault 1 and 3 across the NENT Landfill towards the NENTX with potential natural pathways for preferential LFG migration, distance <50m Superficial deposits below the formation level to the south of the landfill extension fill for LFG migration towards the Waste Reception Area of the existing NENT landfill, distance <50m (category: Very short/Direct)	Target 1b - Construction Phase of the NENTX – • Deep unventilated excavations and trenches for utility installation and basement excavation (category: High sensitivity)	High
NENT Landfill - potential for gas generation over time, but comprehensive and proven mitigation installed. (category: medium)	Fissured rock, Fault 1 and 3 across the NENT Landfill towards the NENTX with potential natural pathways for preferential LFG migration, distance about 100-250m Superficial deposits below the formation level to the south of the landfill l extension fill for LFG migration towards the Waste Reception Area of the existing NENT landfill, distance about 100-250m (category: Long/Indirect)	Target 1c - Construction Phase of the NENTX – • Outbuilding, sheds and temporary structures such as construction site offices (category: Low sensitivity)	Very Low

Source	**Pathway**	**Target**	**Qualitative Risk**
NENT Landfill - potential for gas generation over time, but comprehensive and proven mitigation installed. (category: medium)	Sub-surface soil, reclamation fill materials of the unsaturated zone between the NENT Landfill and NENTX with potential direct anthropogenic conducts, distance to waste boundary, about 100-250m (category: Long/Indirect)	Target 2.1a - (Infrastructure Area of the NENTX - Storage Room, Employer/ ER Office, Conference/ Meeting Room and Special Storage Room cum Monitoring Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1b - (Infrastructure Area of the NENTX - Lobby & Waiting Area, Staff Rest Room and Interview Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1c - (Infrastructure Area of the NENTX - Female/ Male Changing Room & Toilets, Accessible of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1d - (Infrastructure Area of the NENTX - Laboratory, Pantry and M&E Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1e - (Infrastructure Area of the NENTX - M&E Room of Integrated Office Building) (category: Low sensitivity	Very Low
		Target 2.2a - (Infrastructure Area of the NENTX - Fire Services Control Room, Fire Services Pump & Tank Room and Sprinkler & Street hydrant Pump & Tank Room of Fire & Water Services Building) (category: Low sensitivity)	Very Low

Source	Pathway	Target	Qualitative Risk
		Target 2.2b - (Infrastructure Area of the NENTX - Flushing Water & Tank Room and Sprinkler & Street Hydrant Pump & Tank Room of Fire & Water Services Building) (category: Low sensitivity)	Very Low
		Target 2.3a - (Infrastructure Area of the NENTX - Workshop Area, Parts/ Tools Storage of Operation & Maintenance Building) (category: Low sensitivity)	Very Low
		Target 2.3b - (Infrastructure Area of the NENTX - Dry Gas Bottle Room, Plumbing Room and ELE Room of Operation & Maintenance Building) (category: Low sensitivity)	Very Low
	Sub-surface soil, reclamation fill materials of the unsaturated zone between the NENT Landfill and NENTX with potential direct anthropogenic conducts, distance to waste boundary, about <50m (category: Very short/Direct)	Target 2.4a - (Infrastructure Area of the NENTX - HV Switch Room of Process Building) (category: Low sensitivity)	Low
		Target 2.4b - (Infrastructure Area of the NENTX - CLP Room of Process Building) (category: Low sensitivity)	Low
		Target 2.4c - (Infrastructure Area of the NENTX – LV Room LFG of Process Building) (category: Low sensitivity)	Low
		Target 2.4d - (Infrastructure Area of the NENTX - Common Process Workshop of Process Building) (category: Low sensitivity)	Low

Source	Pathway	Target	Qualitative Risk
		Target 2.4e - (Infrastructure Area of the NENTX – Office of Process Building) (category: Low sensitivity)	Low
		Target 2.4f - (Infrastructure Area of the NENTX - Storage Room of Process Building) (category: Low sensitivity)	Low
		Target 2.4g - (Infrastructure Area of the NENTX - Common Pantry and Males Showers, Toilets & Locker and Disable Toilet of Process Building) (category: Low sensitivity)	Low
		Target 2.4h - (Infrastructure Area of the NENTX - Hose Reel Pump Room, Blower Room, SNG Plant Control Room, SNG MCC Room of Process Building) (category: Low sensitivity)	Low
NENTX - potential for gas generation over time, but comprehensive and proven mitigation installed. (category: medium)	Sub-surface soil, reclamation fill materials of the unsaturated zone between the NENTX waste boundary and NENTX infrastructure area, potential direct anthropogenic conducts, distance to waste boundary, about 100 - 250m (category: Long/Indirect)	Target 2.1a - (Infrastructure Area of the NENTX - Storage Room, Employer/ ER Office, Conference/ Meeting Room and Special Storage Room cum Monitoring Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1b - (Infrastructure Area of the NENTX - Lobby & Waiting Area, Staff Rest Room and Interview Room of Integrated Office Building) (category: Low sensitivity)	Very Low

Source	Pathway	Target	Qualitative Risk
		Target 2.1c - (Infrastructure Area of the NENTX - Female/ Male Changing Room & Toilets, Accessible of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1d - (Infrastructure Area of the NENTX - Laboratory, Pantry and M&E Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.1e - (Infrastructure Area of the NENTX - M&E Room of Integrated Office Building) (category: Low sensitivity)	Very Low
		Target 2.2a - (Infrastructure Area of the NENTX - Fire Services Control Room, Fire Services Pump & Tank Room and Sprinkler & Street hydrant Pump & Tank Room of Fire & Water Services Building) (category: Low sensitivity)	Very Low
		Target 2.2b - (Infrastructure Area of the NENTX - Flushing Water & Tank Room and Sprinkler & Street Hydrant Pump & Tank Room of Fire & Water Services Building) (category: Low sensitivity)	Very Low
		Target 2.3a - (Infrastructure Area of the NENTX - Workshop Area, Parts/ Tools Storage of Operation & Maintenance Building) (category: Low sensitivity)	Very Low
		Target 2.3b - (Infrastructure Area of the NENTX - Dry Gas	Very Low

Source	Pathway	Target	Qualitative Risk
		Bottle Room, Plumbing Room and ELE Room of Operation & Maintenance Building) (category: Low sensitivity)	
		Target 2.4a - (Infrastructure Area of the NENTX - HV Switch Room of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4b - (Infrastructure Area of the NENTX - CLP Room of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4c - (Infrastructure Area of the NENTX - LV Room LFG of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4d - (Infrastructure Area of the NENTX - Common Process Workshop of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4e - (Infrastructure Area of the NENTX - Office of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4f - (Infrastructure Area of the NENTX - Storage Room of Process Building) (category: Low sensitivity)	Very Low
		Target 2.4g - (Infrastructure Area of the NENTX - Common Pantry and Males Showers, Toilets & Locker and Disable Toilet of Process Building)	Very Low

Source	Pathway	Target	Qualitative Risk
		(category: Low sensitivity)	
		Target 2.4h - (Infrastructure Area of the NENTX - Hose Reel Pump Room, Blower Room, SNG Plant Control Room, SNG MCC Room of Process Building) (category: Low sensitivity)	Very Low

8 RECOMMENDATIONS

8.1 GENERAL HAZARDS RELATED TO LANDFILL GAS

8.1.1 The detailed design of the NENTX infrastructure area has taken into account the findings and recommendations of the preliminary qualitative landfill gas hazard assessment and the potential risk associated with sub-surface migration of landfill gas from the NENTX and various measures have been incorporated to minimise the potential risks.

8.1.2 This section of the Report provides advice and recommendations for further control measures in addition to those measures being incorporated by Veolia in the detailed design of the NENTX and other general good practices to be implemented during the construction, operation, aftercare and restoration of the NENTX to ensure that the NENTX development is safe with respect to landfill gas hazard.

8.1.3 According to the LFG Guidance Note, engineering measures will be required to protect the planned development with risk category at “High” Level (**Table 3.2**). Recommendations for protection and precautionary measures for implementation in NENT Landfill Extension during the various Project phases are discussed as follows.

8.1.4 All contractors participating in the works and operational staff should be made aware of the potential of methane and carbon dioxide present in the soil and all works should be undertaken on the basis of an "assumed presence of landfill gas". In addition, the following properties of landfill gas should be noted.

- Methane is odourless and colourless, although in landfill gas it is typically associated with numerous highly odoriferous compounds which gives some warning of it presence. However, the absence of odour should not be taken to mean that there is no methane. Methane levels can only be reliably confirmed by using appropriately calibrated portable methane detectors.

- Methane is a flammable gas and will burn when mixed with air between approximately 5 and 15% (v/v). If a mixture of methane and air with a composition between these two values is ignited in a confined space, the resulting combustion may give rise to an explosion. Methane is also an asphyxiant.

- Carbon dioxide, the other major component of landfill gas is an asphyxiating gas and causes adverse health effects at relatively low concentrations. The long-term Occupational Exposure Limit (OEL) is 0.5% (v/v). Like methane, it is odourless and colourless and its presence (or absence) can only be confirmed by using appropriately calibrated portable detectors.

- Gas density. Methane is lighter than air whereas carbon dioxide is heavier than air. Typical mixtures of landfill gas are likely to have a density close to or equal to that of air. However, site conditions may result in a ratio of methane to carbon dioxide which may make the gas mixture lighter or Heavier than air. As a result, landfill gas may accumulate in either the base or top of any voids or confined spaces.

8.2 PRECAUTIONARY AND PROTECTION MEASURE - DESIGN PHASE (FOR THE CONSTRUCTION OF NENTX)

8.2.1 Based on the source-path-target analysis in Section 7, the risk category at the NENT during construction is high. This implies that significant engineering measures will be required during the detailed design stage to ensure that the construction at the NENTX is safe. As the NENTX will be designed, built, and operated by an experienced landfill contractor (Veolia), relevant engineering measures will be identified and implemented in accordance with the NENTX Contract Specification requirements. These measures will

include the placement of liner and installation of landfill gas management system to contain, manage and control landfill gas. The implementation of the recommended landfill gas control measures will be reviewed and checked by the Independent Consultant jointly employed by the Veolia and EPD under the NENTX Contract.

8.3 PRECAUTIONARY AND PROTECTION MEASURE - DESIGN PHASE (FOR THE OPERATION OF INFRASTRUCTURE AREA AT NENTX)

8.3.1 The infrastructure area at the NENTX is considered to have low risk with the incorporation of the landfill gas control measures in the design of the NENTX infrastructure area. (see **Table 7.2)**

8.3.2 Proposed landfill gas monitoring wells (see **Figure 8.1)** will be installed between the NENTX waste boundary and the NENTX infrastructure area to monitor the migration of landfill gas, if any.

8.3.3 For the control measures in the detailed design of the NENTX infrastructure area and with continuous landfill gas monitoring, the level of resulting landfill gas hazards of the identified target will be low. Therefore, no further control measures will be required.

8.4 PRECAUTIONARY AND PROTECTION MEASURE - CONSTRUCTION PHASE

8.4.1 The construction works to be undertaken at the NENTX Site will involve construction workers and others with risks resulting from contact with landfill gas. According to the LFG Guidance Note, engineering will be required to protect the planned development with risk category at" High" level (**Table 3.2**). Recommendations for protection and precautionary measures for implementation in NENTX are discussed as follows.

- Special precautions should be taken in all respects of works against the possible presence of LFG due to proximity of the landfill extension site to the existing NENT Landfill. Potential hazards of exposure to LFG, e.g. Ignition, explosion, asphyxiation, toxicity, etc. should be fully aware and alerted.

- Prominent LFG safety warning signs should be erected on-site to alert all personnel and visitors of the hazards during excavation works. "No smoking or burning should be permitted on-site in the working area", and prominent "No smoking" and "No Naked Flames" signs should be erected on-site where appropriate. No worker should be allowed to work alone at any time in excavated trenches or confined area on-site.

- Those staff who work in, or have responsibility for 'at risk' areas, including all excavation workers, supervisors and engineers working within the Consultation Zone, should receive appropriate training on working in areas susceptible to landfill gas, fire and explosion hazards.

- Adequate firefighting equipment should be provided on-site. Construction equipment should be equipped with a vertical exhaust at least 0.6m above ground installed with spark arrestors. Electrical motors and extension cords should be explosion-proof and intrinsically safe when being used on-site.

- Welding, flame-cutting or other hot works may only be carried out in confined spaces when controlled by a "permit to work" procedure, properly authorised by the Safety Officer. The permit to work procedure should set down clearly the requirements for continuous monitoring of methane, carbon dioxide and oxygen throughout the period during which the hot works are in progress. The procedure should also require the presence of an appropriately qualified person who shall be responsible for reviewing the gas measurements as they are made, and who shall have executive responsibility for suspending the work in the event of unacceptable or hazardous conditions. Only

those workers who are appropriately trained and fully aware of the potentially hazardous conditions which may arise should be permitted to carry out hot works in confined areas.

- For piping assembly or conduit construction, all valves and seals should be closed immediately after installation to avoid accumulation and migration of LFG. If installation of large diameter pipes (Diameter>600m) is required, the pipe ends should be sealed on one side during installation. Forced ventilation is required prior to operation of the installed pipeline. Force ventilation should also be required for works inside trenches deeper than 1m.

- During construction, adequate fire extinguishing equipment, fire-resistant clothing and breathing apparatus (BA) sets should be made available on site.

  a) At larger developments, fire drills should be organised at not less than six monthly intervals.

  b) The developer should formulate a health and safety policy, standards and instructions for site personnel to follow.

8.5 MONITORING

8.5.1 The frequency and location of LFG monitoring within the excavation area should be determined prior to commencement of works. The monitoring requirements and procedures specified in Paragraphs 8.23 to 8.28 of EPD's Guidance Note are below. The monitoring frequency and areas to be monitored should be set down prior to commencement of groundworks either by the Safety Officer or by an appropriately qualified person. Routine monitoring should be carried out in all excavations, manholes and chambers and any other confined spaces that may have been created by, for example, the temporary storage of building materials on the site surface. All measurements in excavations should be made with the monitoring tube located not more than 10mm from the exposed ground surface. Monitoring of excavations should be undertaken as follows:

For excavation works deeper than 1m, measurements should be made:

- at ground surface prior to excavation;
- immediately before any worker enters the excavation;
- at the beginning of each working day for the entire period the excavation remains open; and
- periodically through the working day whilst workers are in the excavation.

For excavation between 300mm and 1m deep, measurements should be made:

- directly after the excavation has been completed; and
- periodically whilst the excavation remains open.

For excavations less than 300mm deep, monitoring may be omitted, at the discretion of the Safety Officer or other appropriately qualified person.

Actions in the Event of Gas Being Detected

8.5.2 Depending on the results of the measurements, actions required will vary and should be set down by the Safety Officer or other appropriately qualified person. As a minimum these should encompass those actions specified in **Table 8.1**.

Table 8.1 Action plan for LFG monitoring during construction phase

Parameter	Monitoring Result	Action
O_2	<19%	Ventilate trench/ void to restore O_2 level to>19%
	<18%	Stop works, evacuate all personnel/ prohibit entry, and increase ventilation to restore O_2 level to >19%
CH_4	>10% LEL	Post "No smoking" signs, prohibit hot works, and ventilate to attenuate CH_4 level to <10% LEL
	>20%LEL	Stop works, evacuate personnel/ prohibit entry, and ventilate to attenuate CH_4 level to <10%LEL
CO_2	>0.5%	Ventilate to attenuate CO_2 level to<0.5%
	>1.5%	Stop works, evacuate personnel/ prohibit entry increase ventilation to restore CO_2 to <0.5%

8.5.3 The monitoring requirements and procedures specified in Paragraphs 8.23 to 8.28 of EPD's Guidance Note are highlighted below:

- Periodically during ground-works construction, the works area should be monitored for methane, carbon dioxide and oxygen using appropriately calibrated portable gas detection equipment. The equipment should be intrinsically safe and calibrated according to the manufacturer's instructions.

- The monitoring frequency and areas to be monitored should be set down prior to commencement of works either by the Safety Officer or by an appropriate qualified person.

- Routine monitoring should be carried out in all excavations, manholes and chambers and any other confined spaces that may have been created by, for example, the temporary storage of building materials on the site surface.

- All measurements in excavations should be made with the monitoring tube located not more than 10mm from the exposed ground surface.

- A standard form, detailing the location, time of monitoring and equipment used together with the gas concentrations measured, should be used when undertaking manual monitoring to ensure that all relevant data are recorded.

8.6 PRECAUTIONARY AND PROTECTION MEASURE – OPERATION, RESTORATION AND AFTERCARE PHASES

8.6.1 Veolia will be responsible to train and to ensure that their staff take appropriate precautions at all times when entering enclosed spaces or plant rooms. Veolia will also undertake regular monitoring of landfill gas at the perimeter monitoring wells to detect if there are any signs of off-site landfill gas migration. Veolia will be responsible to prepare and implement an emergency plan in case off-site landfill gas migration is detected.

8.6.2 A continuous permanent gas monitoring system with alarms will be installed and operated in all occupied on-site buildings. Any proposed modifications or additions to the building structure in the infrastructure area should be subject to a further assessment of landfill gas hazard.

9 ENVIRONMENTAL MONITORING AND AUDIT

9.1.1 According to the approved EM&A Manual, Veolia should undertake regular monitoring of landfill gas within the NENTX and along the NENTX waste boundary, it is recommended that designated monitoring locations at the gas monitoring boreholes, supplemented by monthly site surveys of the surrounding environment including natural cracks and fissures, services drains, area with sign of vegetation death, and any below ground enclosed spaces during the operation, restoration and aftercare of the NENTX.

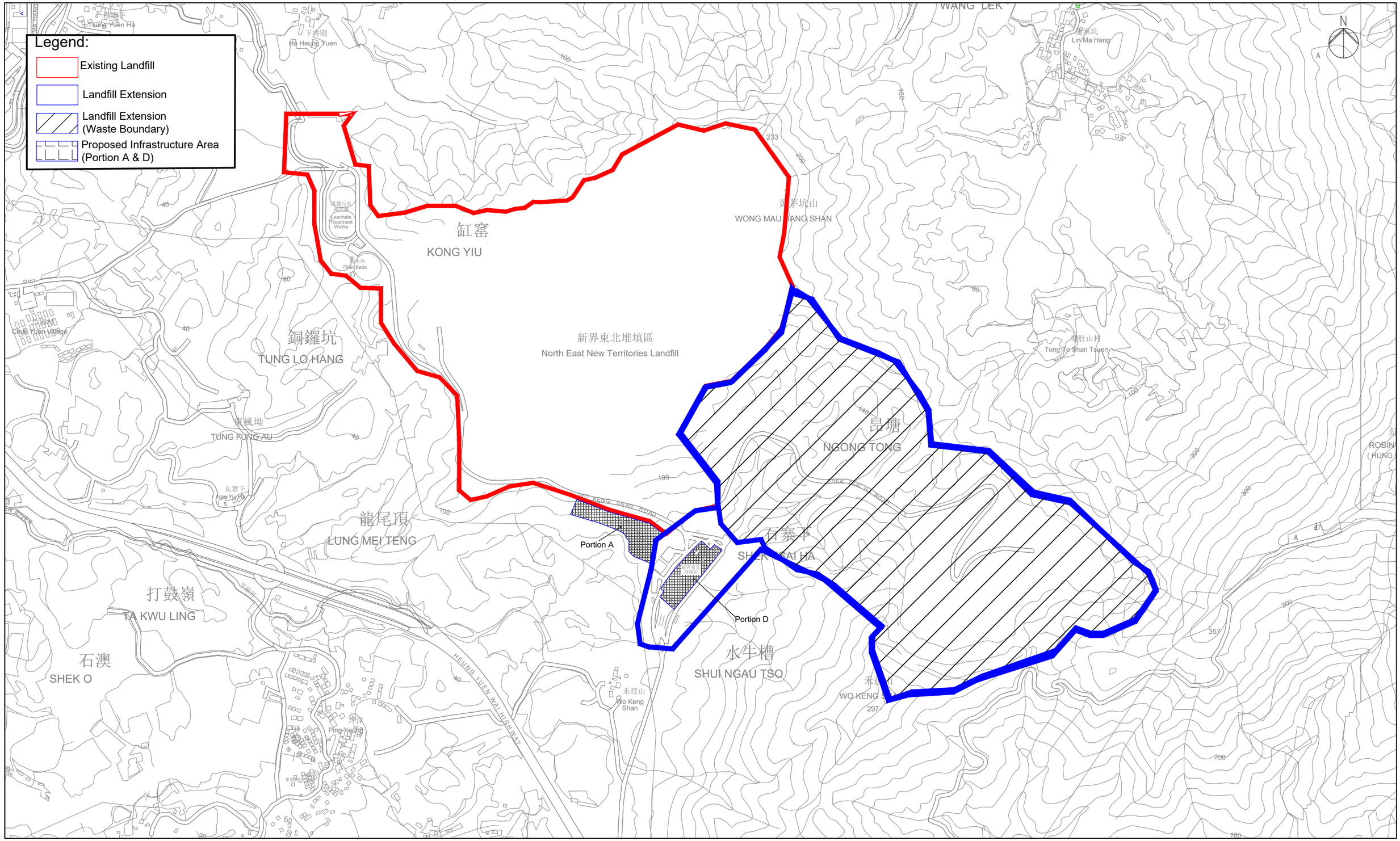
9.1.2 If the monitoring results indicate evidence of gas migration, the monitoring frequency should be increased accordingly, with the implementation of appropriate measures under the Event and Action Plan.

10 CONCLUSION

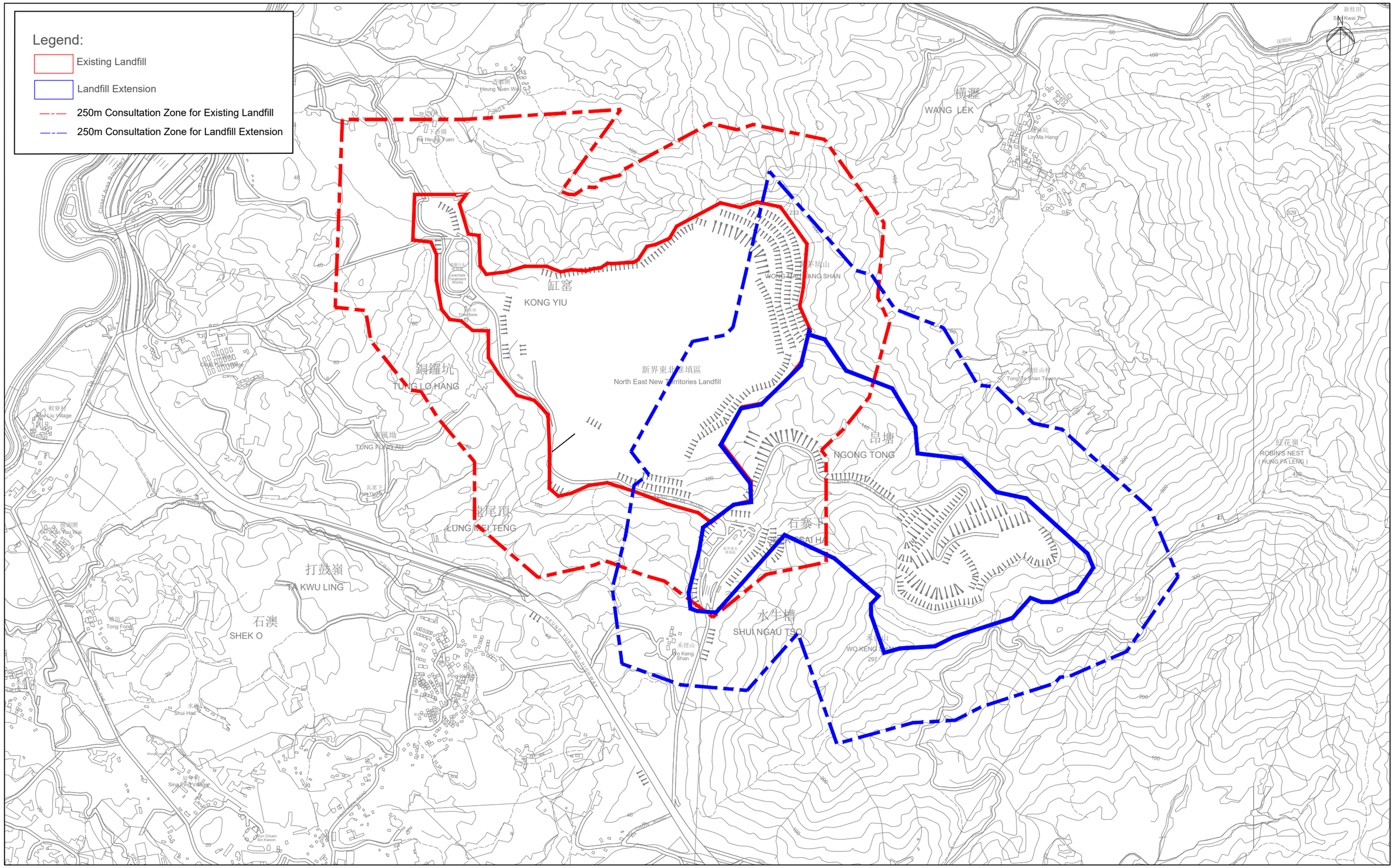
10.1.1 The source-pathway-target analysis in the approved EIA Report shows that landfill gas risk posed by the NENT Landfill and the NENTX is high during both construction and operation phases within the NENTX site under the EIA Scheme.

10.1.2 Based on the **Table 7.1**, the pathway classification between the NENTX waste boundary and NENTX infrastructure area has changed from Very Short/Direct for path length less that 50m in approved EIA Report to Long/Indirect for path length of 100-250m with latest design and the source-pathway-target analysis shows that the risk levels associated with the latest scheme is low to high within the NENTX Site boundary during the construction and operation phases. With the proposed landfill gas control measures and precautionary measures including engineering design (e.g., gas-proofing coating apply on top of all ground floor slabs, gas alarm, with air conditioning/ mechanical ventilation/ natural ventilation etc.) in place, the potential risk of landfill gas migration to the respective targets will be minimal.

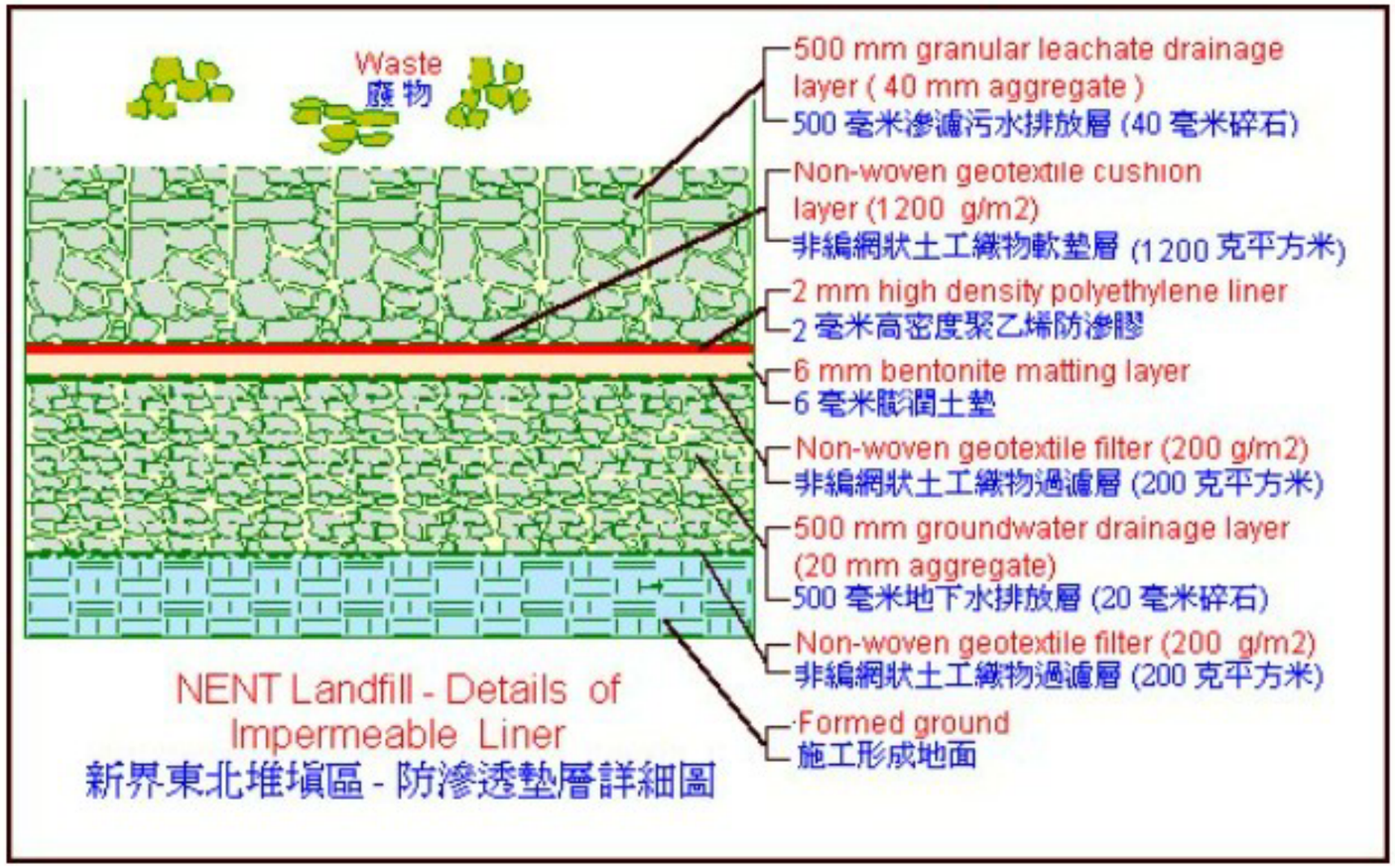
Figures



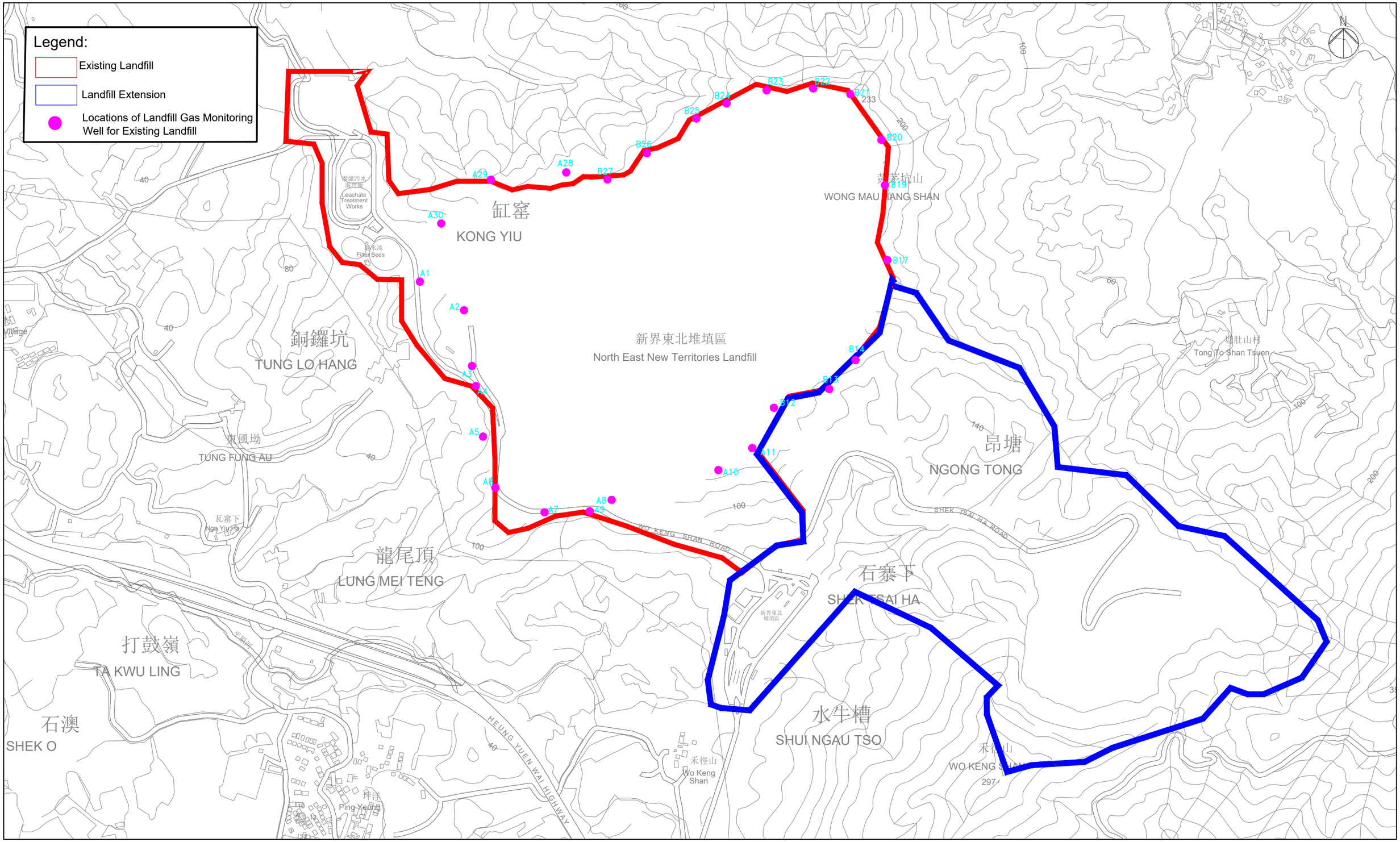
aurecon Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension Project Layout Plan	Figure 1.1 Scale: 1:10000



Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension 250m Consultation Zone of NENTX Landfill	Figure 1.2

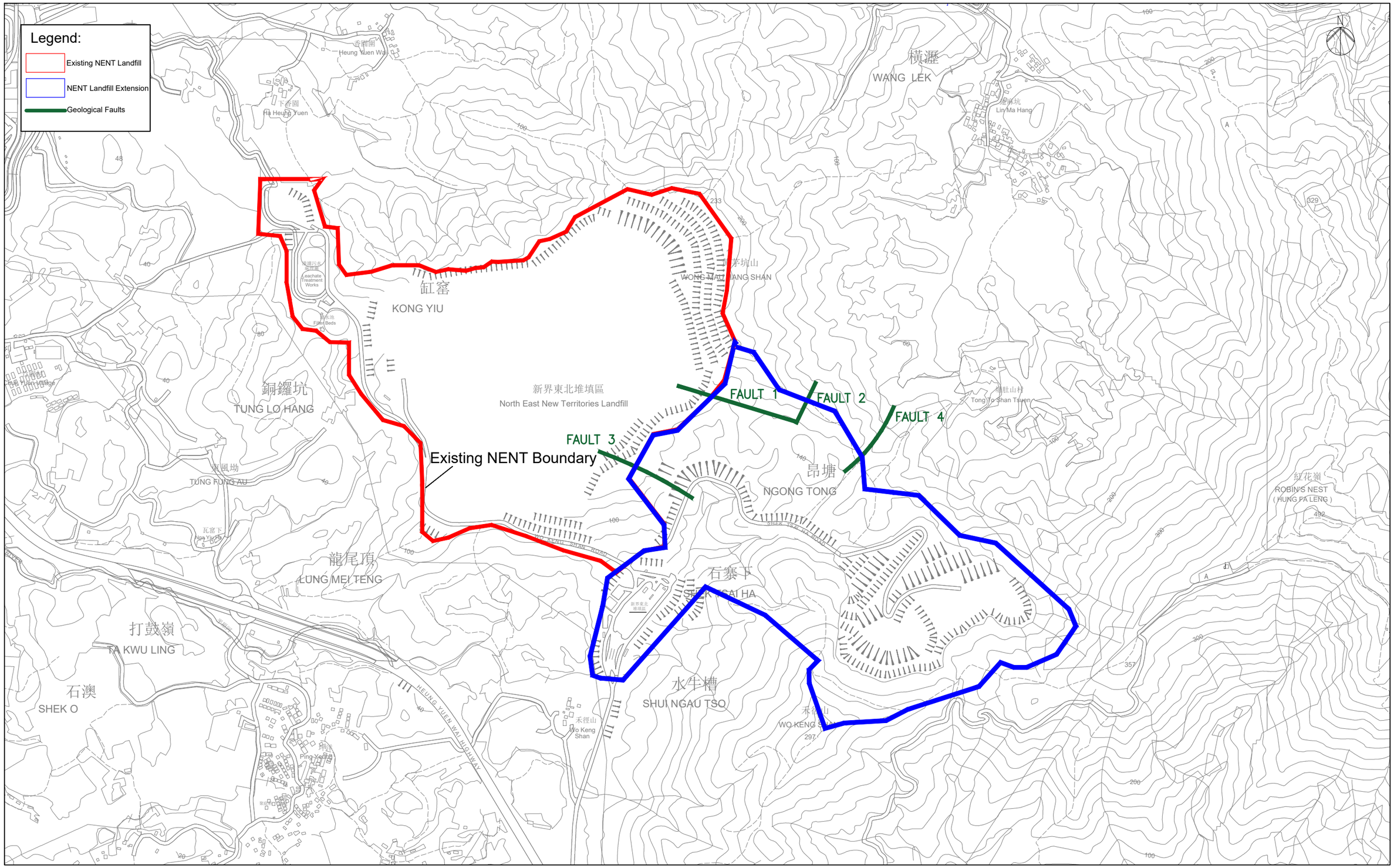


aurecon Aurecon Hong Kong Limited	North East New Territories (NENT) Landfill Extension Typical Detail of the Composite Liner System	Figure 4.1

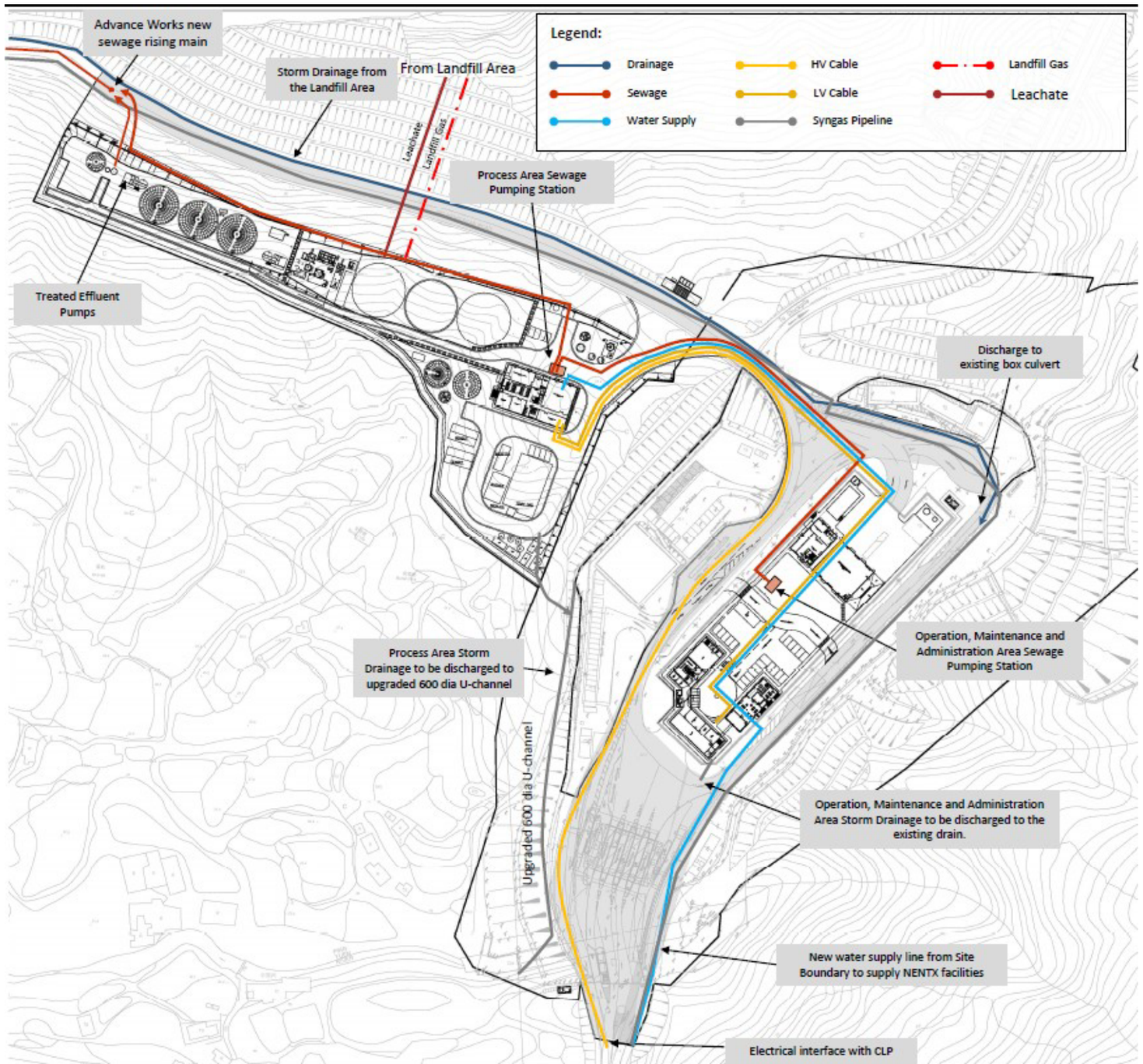


Aurecon Hong Kong Limited	North East New Territories (NENT) Landfill Extension Proposed Location of Landfill Gas Monitoring Wells of NENTX	Figure 4.2 Scale: 1:8000

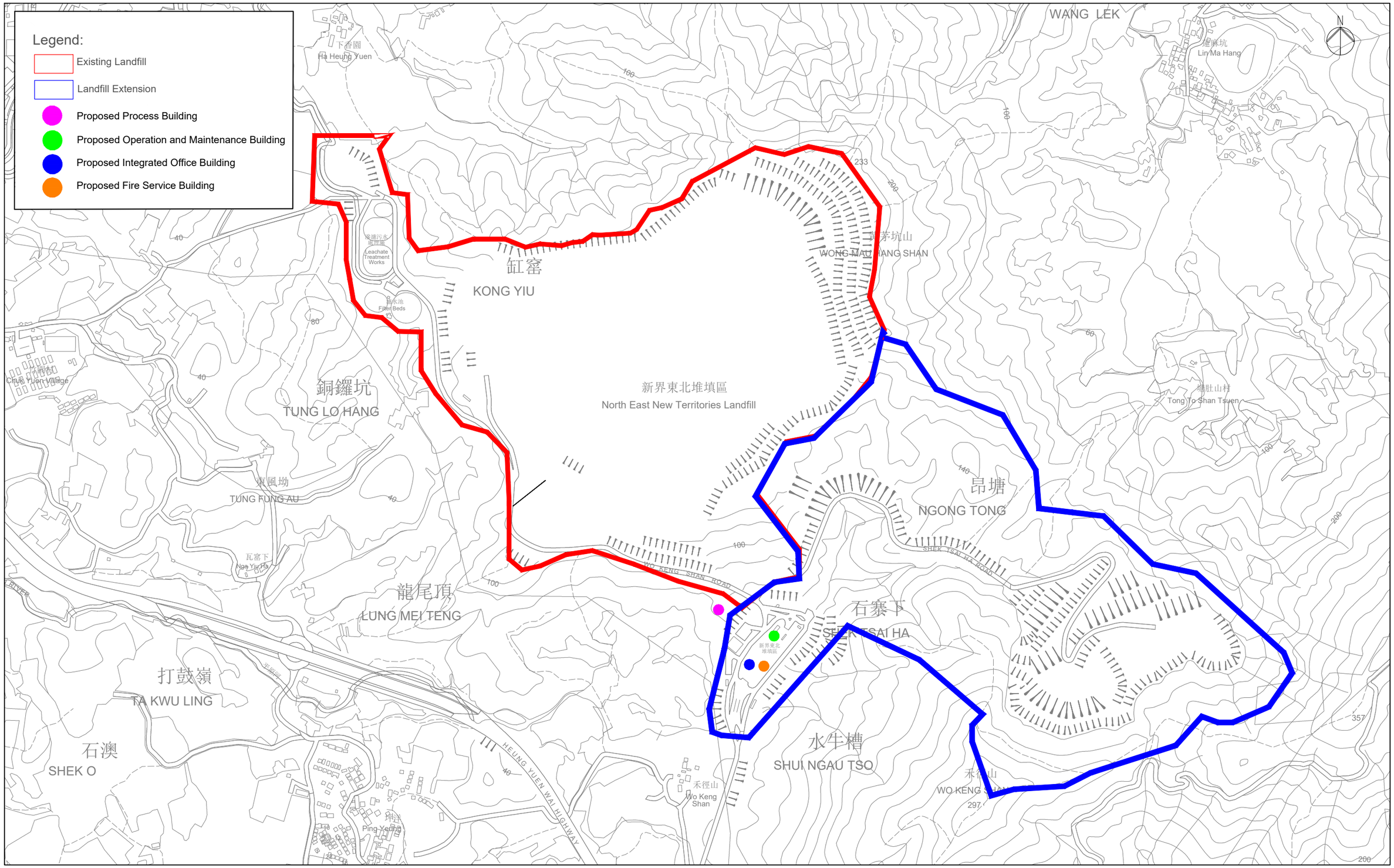
aurecon Aurecon Hong Kong Limited	North East New Territories (NENT) Landfill Extension NENT Landfill Extension Base Liner System	Figure 4.3



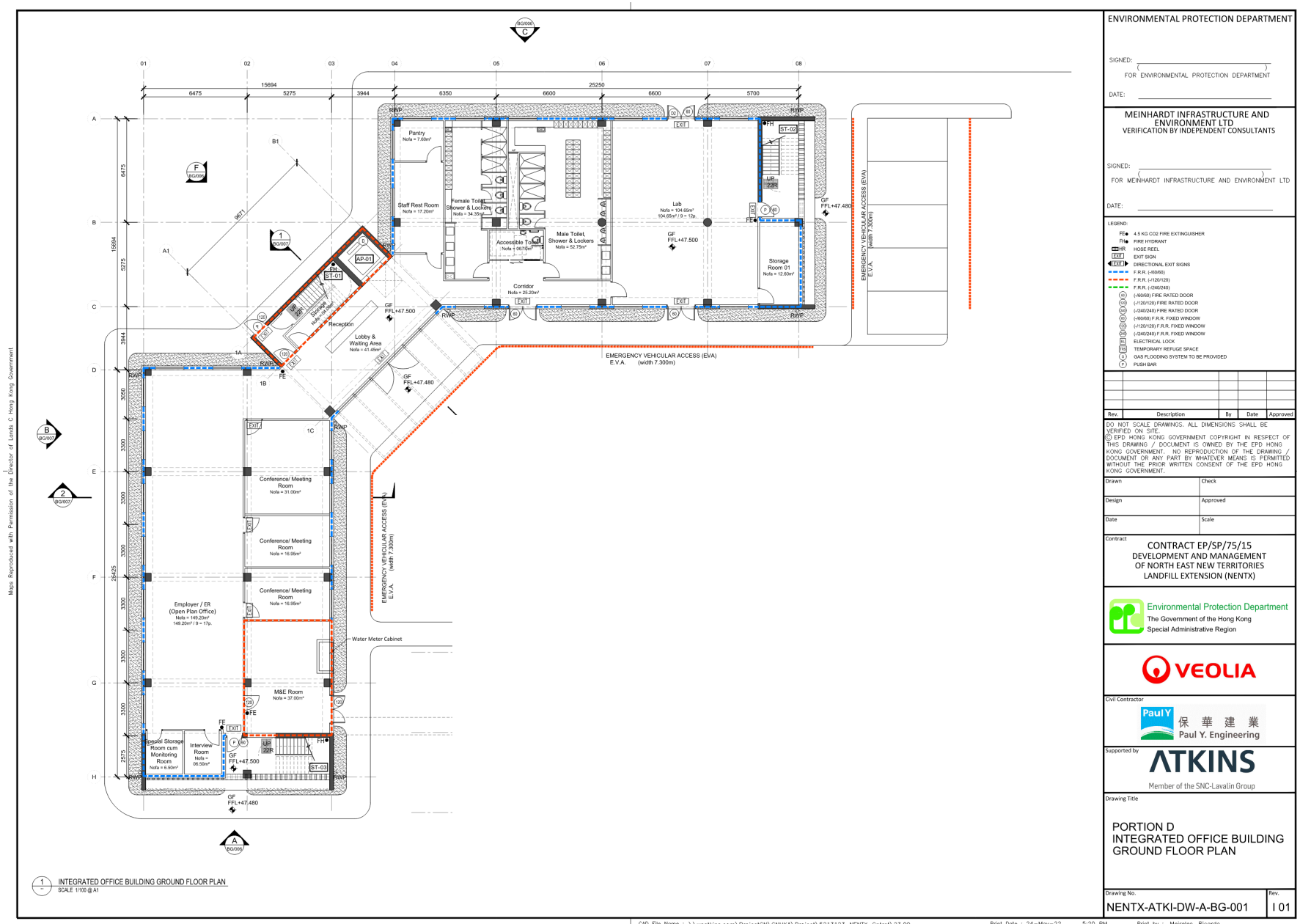
Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension Geological Map of NENT Landfill Extension Site	Figure 5.1 Scale: 1:10000



aurecon Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension Preliminary Layout Plan of Proposed Utility Services of NENTX	Figure 5.2



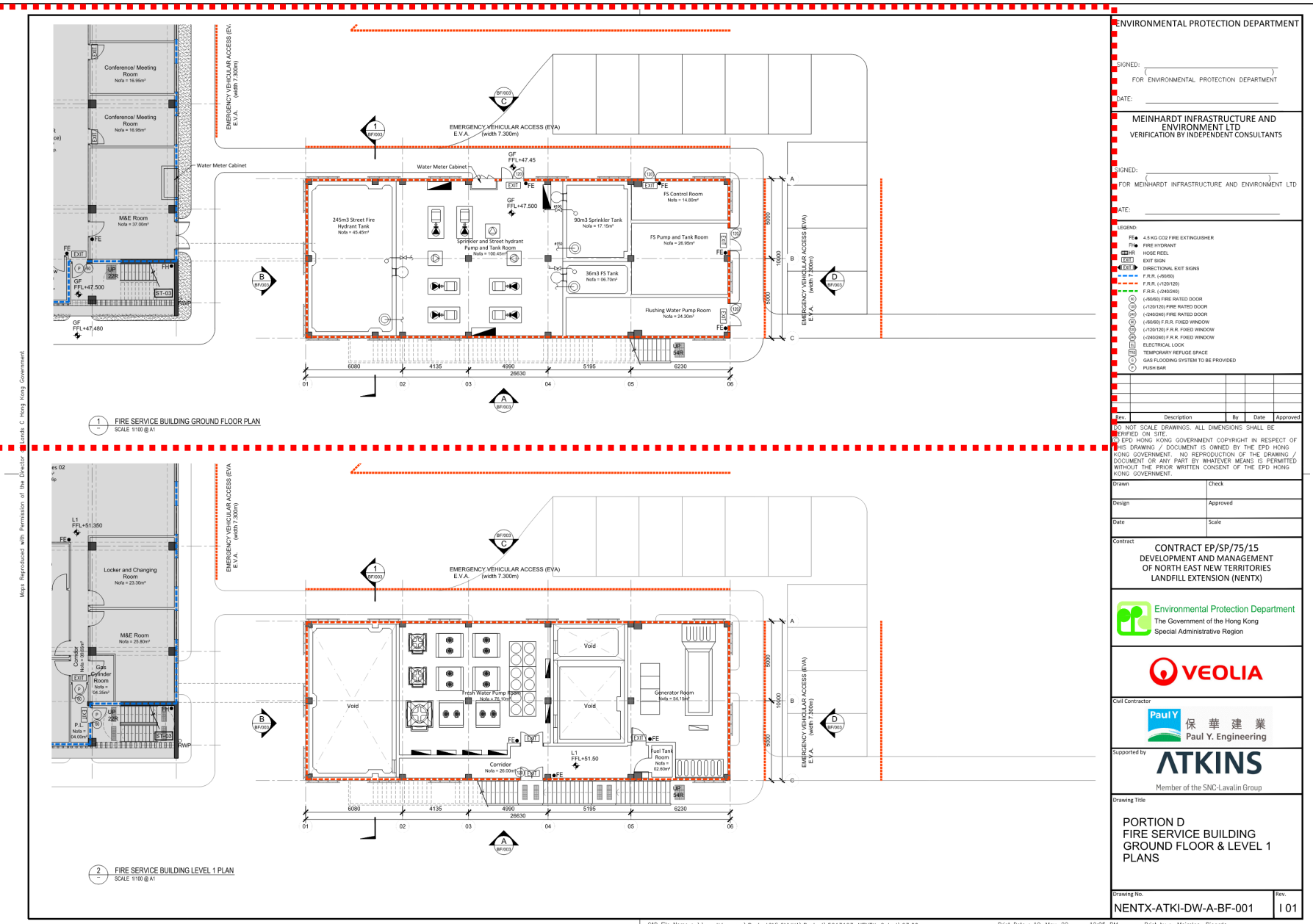
aurecon Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension Location of Proposed Infrastructure Buildings	Figure 6.1 Scale: 1:10000

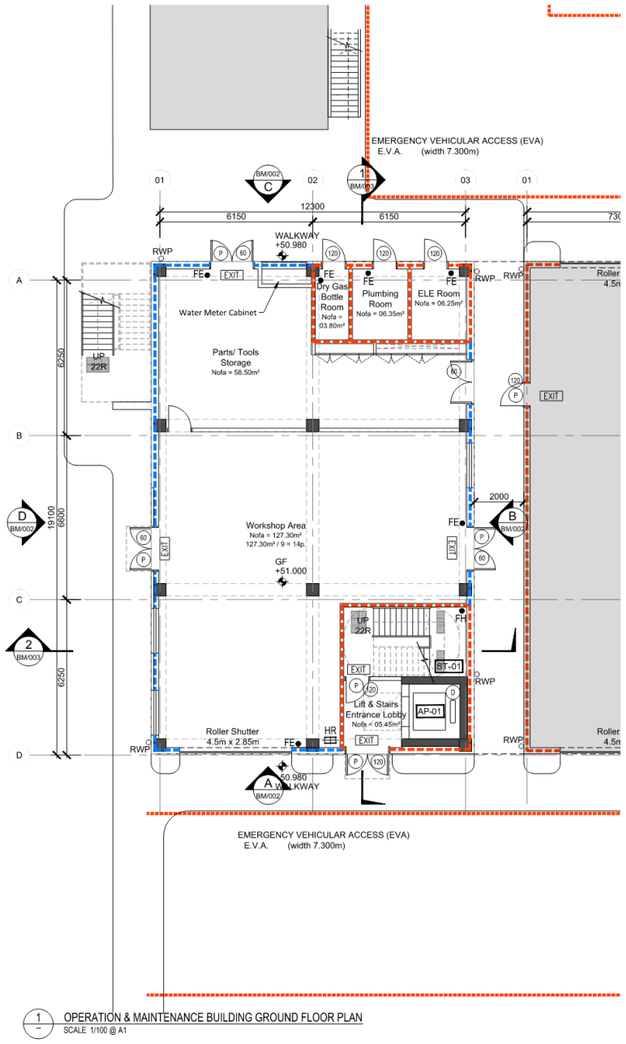


aurecon
Aurecon Hong Kong Limited

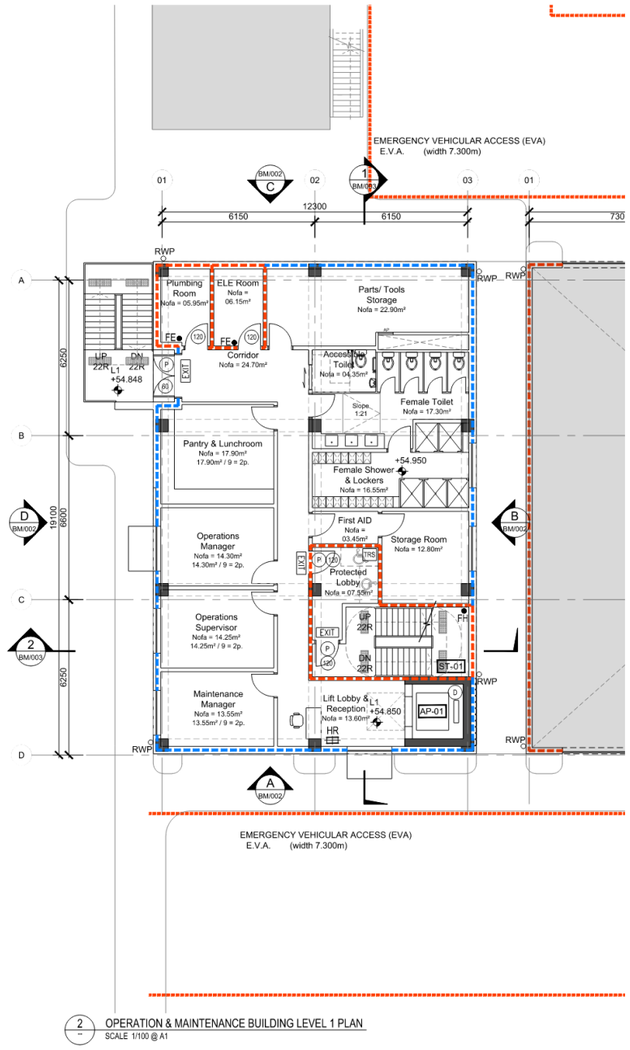
North- East New Territories (NENT) Landfill Extension
Ground Floor Plan of Integrated Service Building

Figure 6.2a


ENVIRONMENTAL PROTECTION DEPARTMENT
SIGNED:
FOR ENVIRONMENTAL PROTECTION DEPARTMENT
DATE:
MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
VERIFICATION BY INDEPENDENT CONSULTANTS
SIGNED:
FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
DATE:
LEGEND:
4.5 KG CO2 FIRE EXTINGUISHER
FIRE HYDRANT
HOSE REEL
EXIT SIGN
DIRECTIONAL EXIT SIGNS
F.R.R. (-/60/60)
F.R.R. (-/120/120)
F.R.R. (-/240/240)
(-/60/60) FIRE RATED DOOR
(-/120/120) FIRE RATED DOOR
(-/240/240) FIRE RATED DOOR
(-/60/60) F.R.R. FIXED WINDOW
(-/120/120) F.R.R. FIXED WINDOW
(-/240/240) F.R.R. FIXED WINDOW
ELECTRICAL LOCK
TEMPORARY REFUGE SPACE
GAS FLOODING SYSTEM TO BE PROVIDED
PUSH BAR
Rev. Description By Date Approved
DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE VERIFIED ON SITE.
© EPD HONG KONG GOVERNMENT COPYRIGHT IN RESPECT OF THIS DRAWING / DOCUMENT IS OWNED BY THE EPD HONG KONG GOVERNMENT. NO REPRODUCTION OF THE DRAWING / DOCUMENT OR ANY PART BY WHATEVER MEANS IS PERMITTED WITHOUT THE PRIOR WRITTEN CONSENT OF THE EPD HONG KONG GOVERNMENT.
Drawn
Check
Design
Approved
Date
Scale
Contract
CONTRACT EP/SP/75/15
DEVELOPMENT AND MANAGEMENT OF NORTH EAST NEW TERRITORIES LANDFILL EXTENSION (NENTX)
Environmental Protection Department
The Government of the Hong Kong Special Administrative Region
VEOLIA
Civil Contractor
Paul Y. Engineering
Supported by
ATKINS
Member of the SNC-Lavalin Group
Drawing Title
PORTION D
FIRE SERVICE BUILDING
GROUND FLOOR & LEVEL 1
PLANS
Drawing No.
NENTX-ATKI-DW-A-BF-001
Rev.
I 01
1 FIRE SERVICE BUILDING GROUND FLOOR PLAN
SCALE 1\100 @ A1
2 FIRE SERVICE BUILDING LEVEL 1 PLAN
SCALE 1\100 @ A1
Maps Reproduced with Permission of the Director of Lands © Hong Kong Government
CAD File Name : \\wsatkins.com\ProjectCN\CNHKA\Project\5213123_NENTX_Cntrct\23.00 CAD\23.20 Drawing\ARC\NENTX_ATKI_DW_A_BF_001.dwg
Print Date : 19-May-22 12:05 PM
Print by : Meireles, Ricardo



1 OPERATION & MAINTENANCE BUILDING GROUND FLOOR PLAN
SCALE 1/100 @ A1



2 OPERATION & MAINTENANCE BUILDING LEVEL 1 PLAN
SCALE 1/100 @ A1

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED: _____
(FOR ENVIRONMENTAL PROTECTION DEPARTMENT)
DATE: _____

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
VERIFICATION BY INDEPENDENT CONSULTANTS

SIGNED: _____
(FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD)
DATE: _____

LEGEND:
- FE● 4.5 KG CO2 FIRE EXTINGUISHER
- FH● FIRE HYDRANT
- HR HOSE REEL
- EXIT EXIT SIGN
- EXIT DIRECTIONAL EXIT SIGNS
- F.R.R. (-/60/60)
- F.R.R. (-/120/120)
- F.R.R. (-/240/240)
- (60) (-/60/60) FIRE RATED DOOR
- (120) (-/120/120) FIRE RATED DOOR
- (240) (-/240/240) FIRE RATED DOOR
- (60) (-/60/60) F.R.R. FIXED WINDOW
- (120) (-/120/120) F.R.R. FIXED WINDOW
- (240) (-/240/240) F.R.R. FIXED WINDOW
- ELECTRICAL LOCK
- RD TEMPORARY REFUGE SPACE
- G GAS FLOODING SYSTEM TO BE PROVIDED
- P PUSH BAR

Rev.	Description	By	Date	Approved

Drawn	Check
Design	Approved
Date	Scale

Contract
CONTRACT EP/SP/75/15
DEVELOPMENT AND MANAGEMENT OF NORTH EAST NEW TERRITORIES LANDFILL EXTENSION (NENTX)

Environmental Protection Department
The Government of the Hong Kong Special Administrative Region

VEOLIA

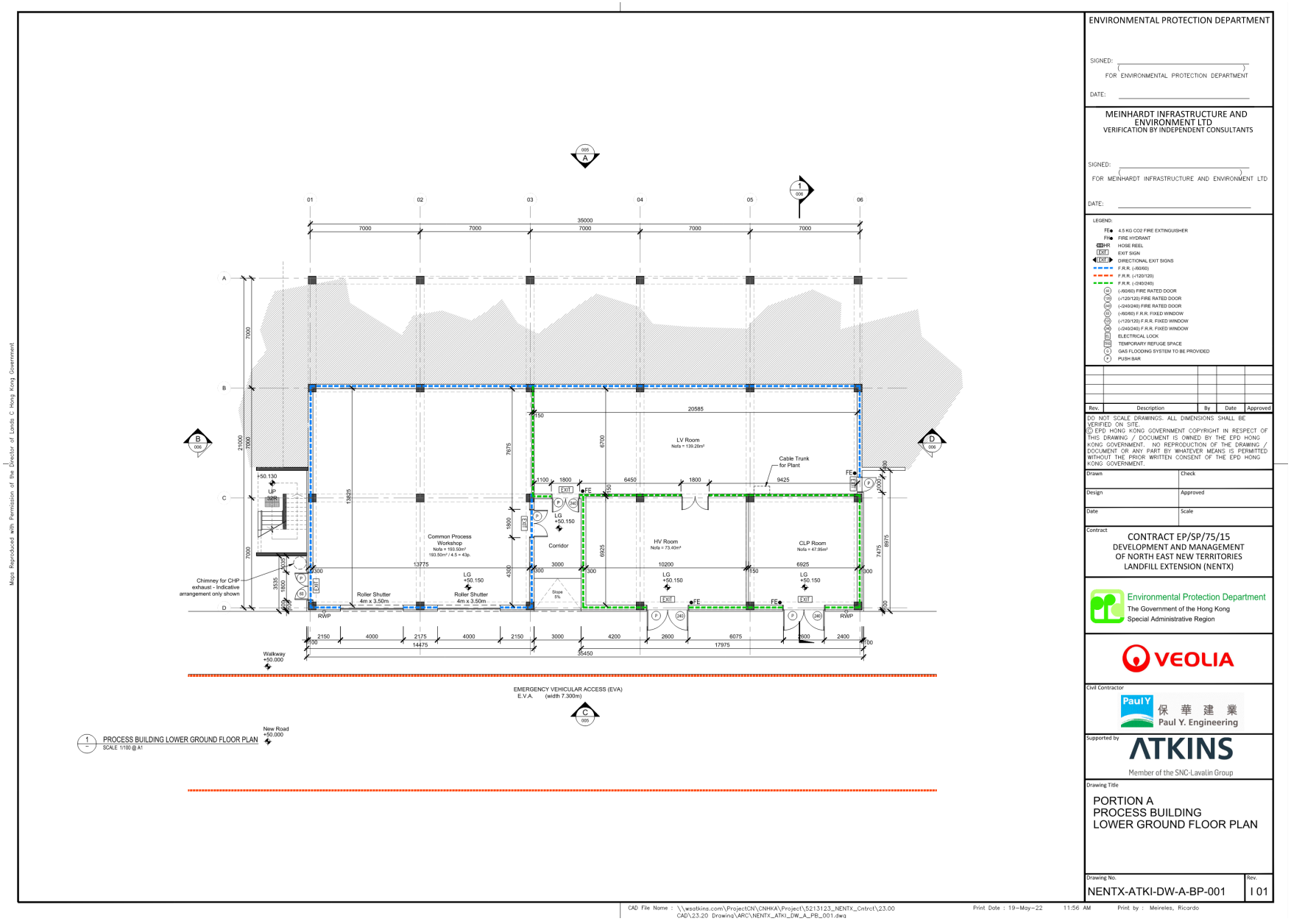
Civil Contractor
Paul Y 保華建業 Paul Y. Engineering

Supported by
ATKINS
Member of the SNC-Lavalin Group

Drawing Title
PORTION D
OPERATION & MAINTENANCE BUILDING PLANS

Drawing No.	Rev.
NENTX-ATKI-DW-A-BM-001	I 01

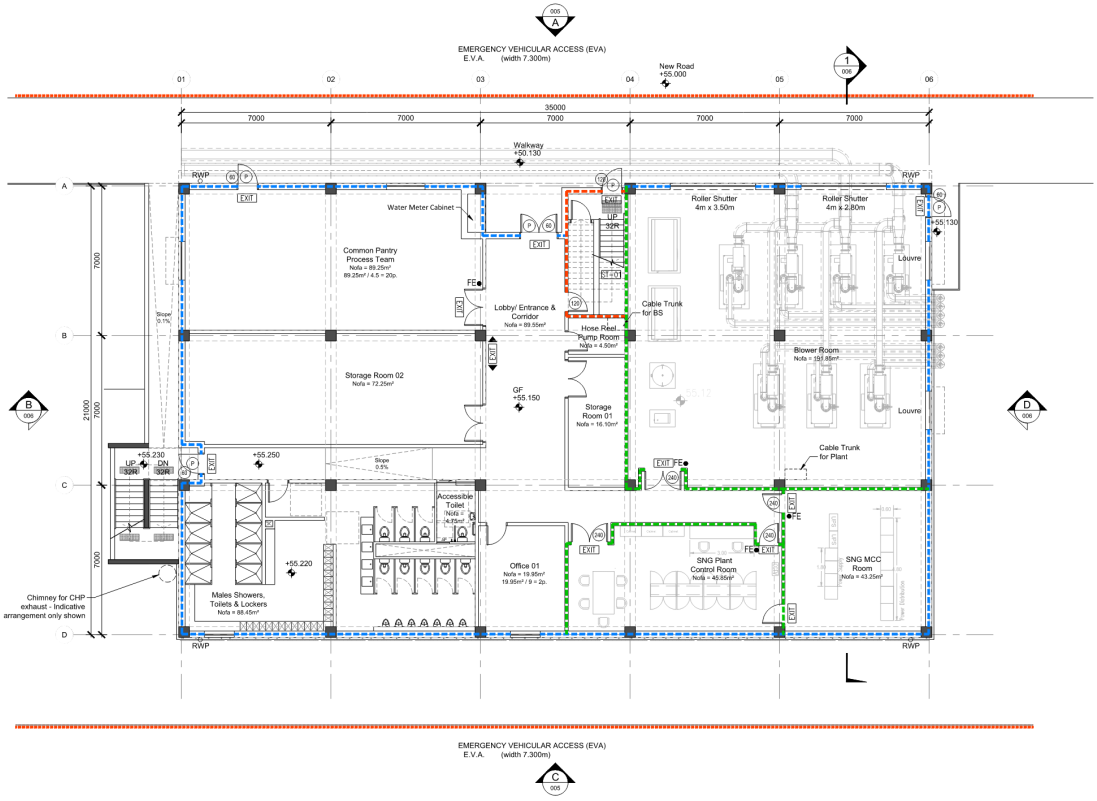
CAD File Name : \\wsatkins.com\ProjectCN\CNHKA\Project\5213123_NENTX_Cntrct\23.00 CAD\23.20 Drawing\ARC\NENTX_ATKI_DW_A_BM_001.dwg
Print Date : 20-May-22 5:41 PM Print by : Meireles, Ricardo



aurecon
Aurecon Hong Kong Limited

North- East New Territories (NENT) Landfill Extension
Lower Ground Floor Plan of Process Building

Figure 6.2d



1 PROCESS BUILDING GROUND FLOOR PLAN
SCALE 1/100 @ A1

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED: _____
( )
FOR ENVIRONMENTAL PROTECTION DEPARTMENT

DATE: _____

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
VERIFICATION BY INDEPENDENT CONSULTANTS

SIGNED: _____
( )
FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

DATE: _____

LEGEND:

- FE● 4.5 KG CO2 FIRE EXTINGUISHER
- FH● FIRE HYDRANT
- HR HOSE REEL
- EXIT EXIT SIGN
- EXIT DIRECTIONAL EXIT SIGNS
- F.R.R. (-/60/60)
- F.R.R. (-/120/120)
- F.R.R. (-/240/240)
- (-/60/60) FIRE RATED DOOR
- (-/120/120) FIRE RATED DOOR
- (-/240/240) FIRE RATED DOOR
- (-/60/60) F.R.R. FIXED WINDOW
- (-/120/120) F.R.R. FIXED WINDOW
- (-/240/240) F.R.R. FIXED WINDOW
- ELECTRICAL LOCK
- TEMPORARY REFUGE SPACE
- GAS FLOODING SYSTEM TO BE PROVIDED
- PUSH BAR

Rev.	Description	By	Date	Approved

Drawn	Check
Design	Approved
Date	Scale

Contract

CONTRACT EP/SP/75/15
DEVELOPMENT AND MANAGEMENT OF NORTH EAST NEW TERRITORIES LANDFILL EXTENSION (NENTX)

Environmental Protection Department
The Government of the Hong Kong Special Administrative Region

VEOLIA

Civil Contractor

Paul Y. Engineering 保華建業

Supported by

ATKINS
Member of the SNC-Lavalin Group

Drawing Title

PORTION A
PROCESS BUILDING
GROUND FLOOR PLAN

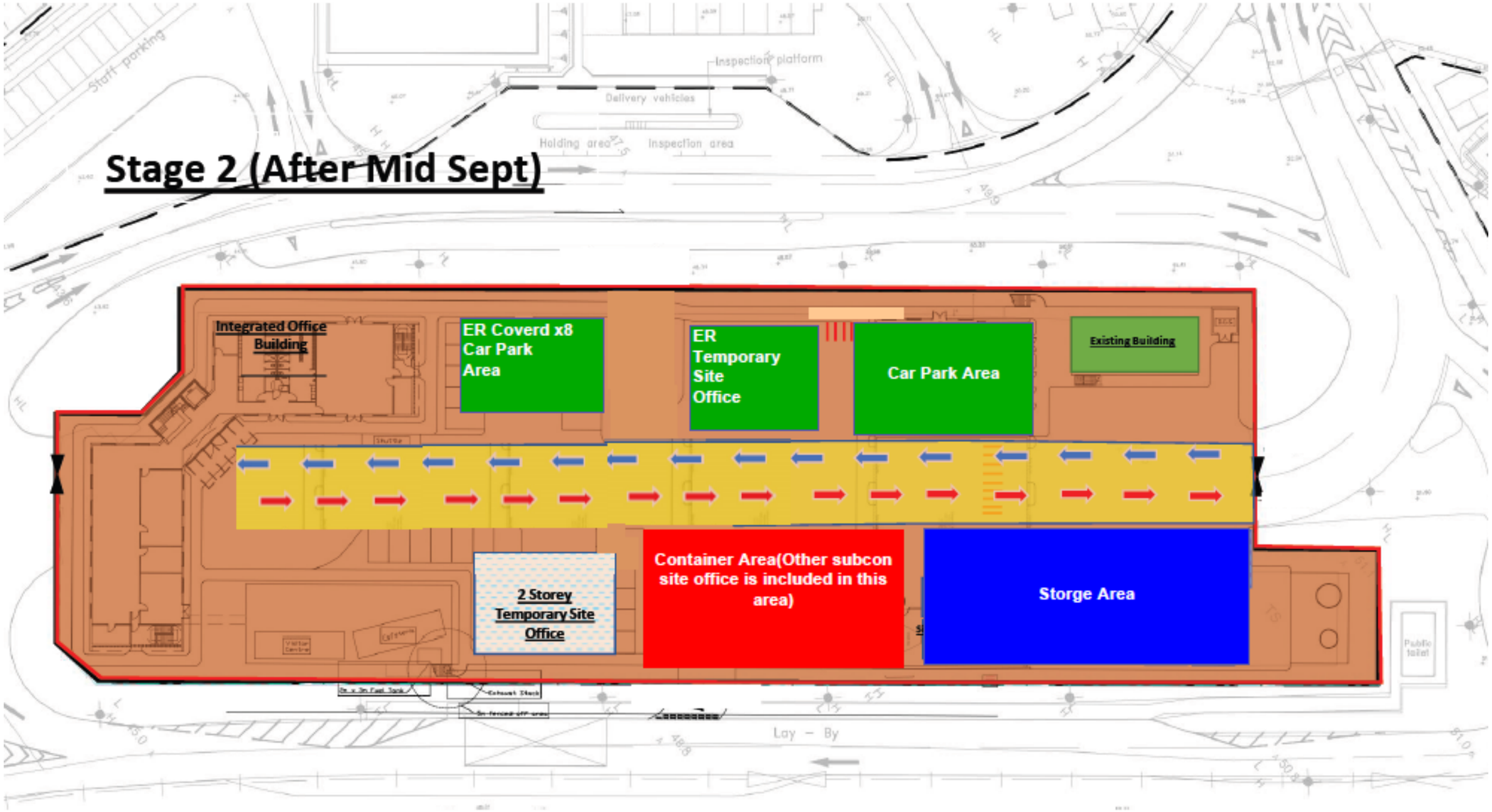
Drawing No.	Rev.
NENTX-ATKI-DW-A-BP-002	I 01

CAD File Name : \\wsatkins.com\Project\CN\CNHKA\Project\5213123_NENTX_Cntrct\23.00 CAD\23.20 Drawing\ARC\NENTX_ATKI_DW_A_PB_002.dwg
Print Date : 19-May-22 11:56 AM Print by : Meireles, Ricardo

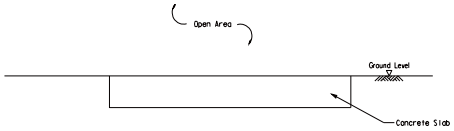
aurecon
Aurecon Hong Kong Limited

North- East New Territories (NENT) Landfill Extension
Ground Floor Plan of Process Building

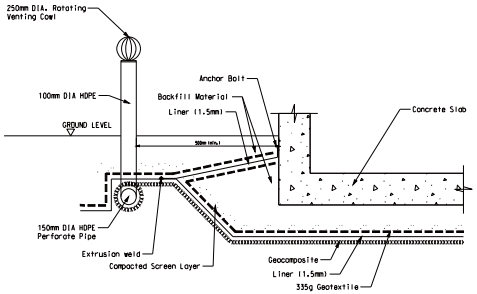
Figure 6.2e



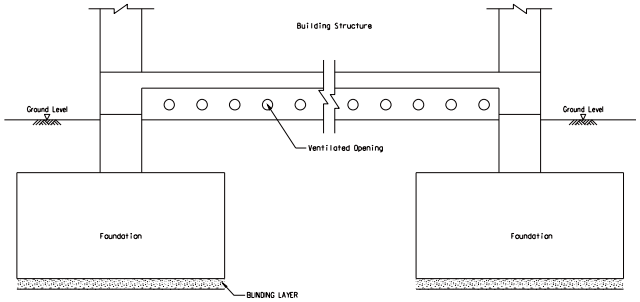
aurecon Aurecon Hong Kong Limited	North- East New Territories (NENT) Landfill Extension Layout Plan of the NENTX Temporary Site Office	Figure 7.1



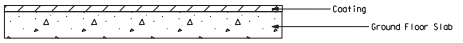
1. Typical Detail of Hardstanding (eg. Bioplant) - No Liner



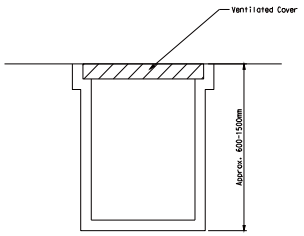
2. Occupied Office Building + Closed Buildings - Liner Protection



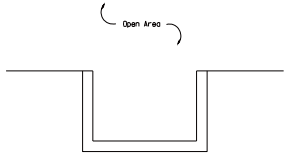
3. Open Sided Building - Raised Floor



2.3 Occupied Office Building + Closed Buildings: Coating Protection



4. Utility Conduit - No Liner

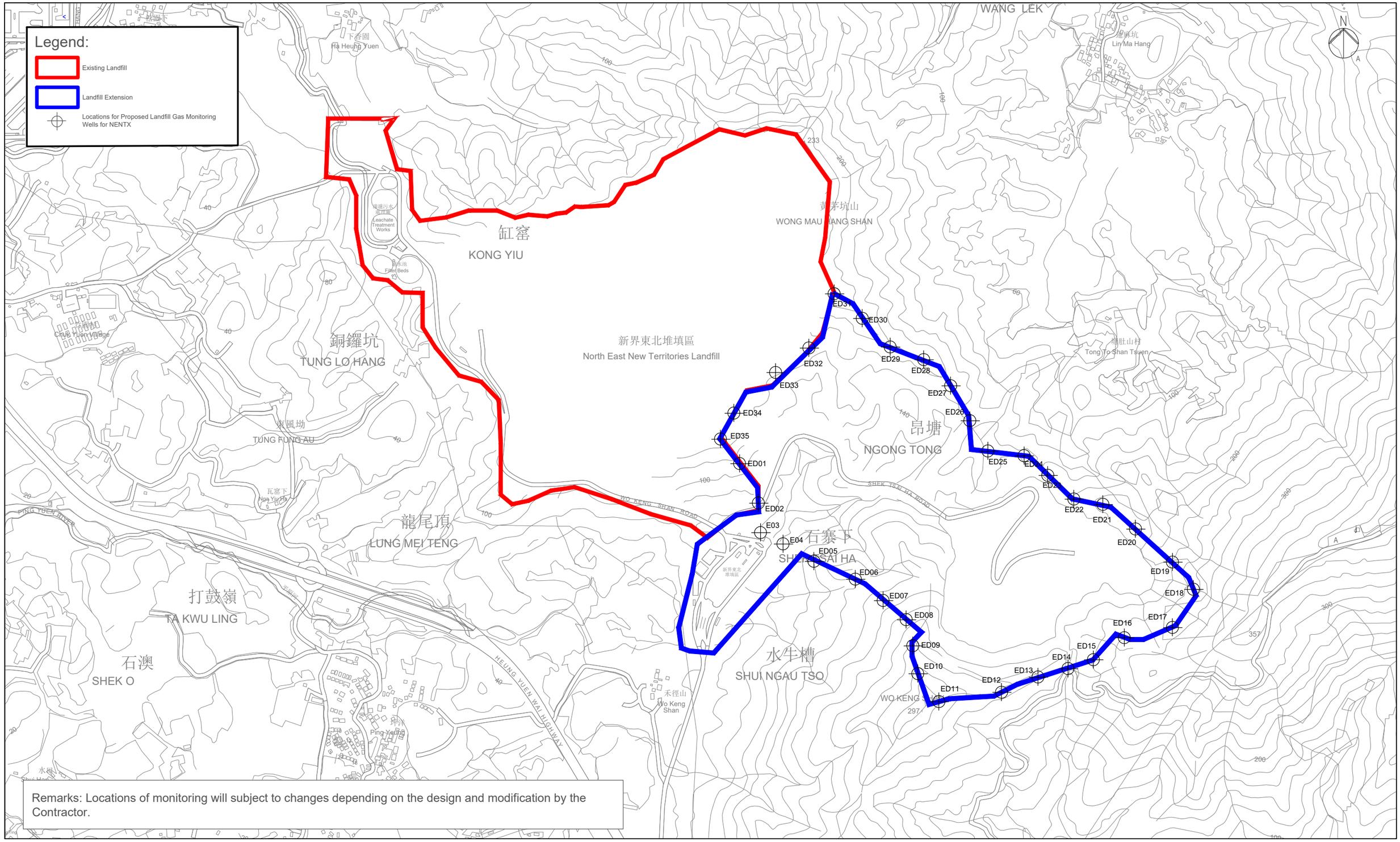


5. Shallow Open Trench

Aurecon Hong Kong Limited

North-East New Territories (NENT) Landfill Extension
Typical Details of Gas Protection for Buildings

Figure 7.2



aurecon Aurecon Hong Kong Limited	North-East New Territories (NENT) Landfill Extension Location Landfill Gas Monitoring Wells of NENTX	Figure 8.1 Scale: 1:10000

Appendix A

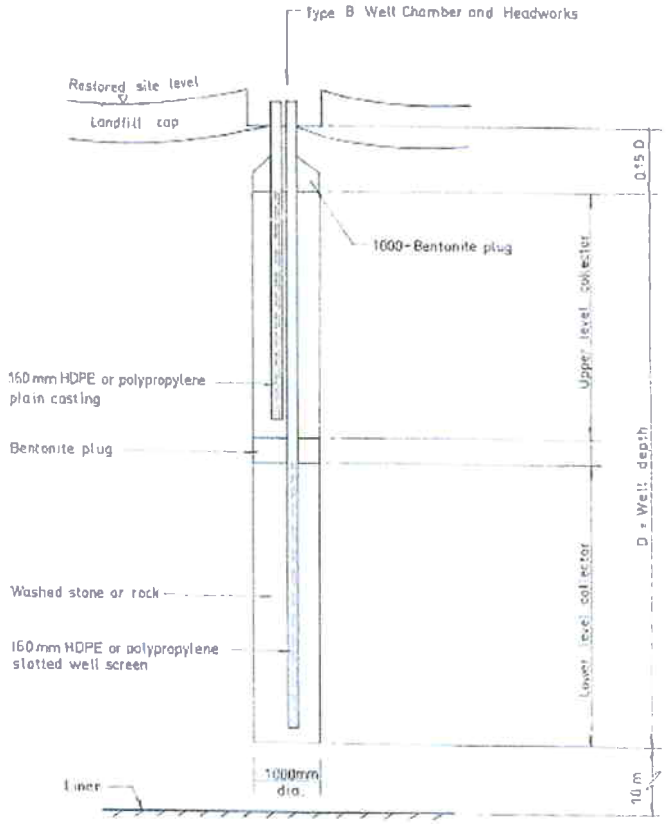
LFG barrier

Cross-section of lining and leachate collection system

Liner system as LFG barrier (from top down)

1. Non-woven geotextile cushion (1200g)
2. 2mm high density polyethylene (HDPE) liner
3. 6mm bentonite matting
4. Non-woven geotextile filter (200g)

LFG collection & extraction systems



Cross-section of gas abstraction well

Well head & pipeline for extraction and conveyance of LFG

LFG treatment system

Flare for combustion of LFG

LFG utilisation systems

Gensets for power generation using LFG

Ammonia stripping plant using LFG to heat up raw leachate

Appendix B

A-Tech Hydra-Block Penetrating Concrete & Masonry Sealer

Description and Uses

A-Tech Hydra-Block penetrating concrete and masonry sealer is a ready to use water-based solution of sodium silicate. Hydra-Block penetrates into the concrete or masonry substrate and fills microspcopic capillairies. Sodium silicate reacts with free lime in the substrate to form a chemically hardened surface. This prevents water, water vapor and gas from being transmitted through the substrate. Reduces substrate dusting. Sodium silicates have been used to aid in the curing process for surfaces scheduled to receive subsequent penetrating treatments and/or specialty coatings. No surface preparation is required when using Hydra-Block as a curing aid. Apply Hydra-Block to freshly poured concrete immediately following the final finish operations when the surface has stiffened sufficiently to support applicator. The substrate color will not change or have a shiny appearance.

Hydra-Block Prevents and Inhibits

- Moisture penetration
- Vapor transimission
- Dusting
- High humidity
- Spalling
- Efflorescence

Advantages

- Water-based
- Vapor impermeable
- VOC compliant
- Substrate traction remains the same
- No color change
- Chemical bond to substrate

Where to use

- Concrete basement interior walls and floors
- Concrete block basement interior walls and floors
- Interior masonry

Active Content: Water-based sodium silicate

Limitations

Test a 3' x 3' sample of the substrate to be sprayed with Hydra-Block for compatibility. 12 month shelf life in a sealed container. Will not seal cracks in concrete, masonry or mortar.

Not for use on colored concrete. Will stain glass, metal and other trim. Clean immediately with water. Not for use in areas where vapor permeability is desired. If vapor permeability is desired, use A-Tech Concrete Sealer or A-Tech Brick and Masonry Sealer.

Coverage (Sq. Ft/Gal)

Clay brick	150-200
Stucco, Rough Stone	100-200
Concrete	150-200
Precast Concrete	150-200
Concrete Block	100-140

Drying Time

Will dry clear and transparent in 1-2 hours @72^0 F.

Clean Up

Equipment- Soapy water
Cover and protect all glass, metal and vegetation from overspray.
Clean overspray immediately with soap and water

Application Instructions

Air and surface temperature must be above freezing during application and for three days after application. Do not apply to hot surfaces or in direct sunlight. Ready to use. Do not dilute. Apply using a low pressure sprayer with fan pattern tip.

1. Remove any paint, sealers, or adhesives on substrate. Clean off any oil, dirt, rust or wax. Remove existing efflorescence or laitance. Mask glass, metal, tiles and plants to prevent
overspray.

2. Lightly dampen substrate with water using a mop or sprayer.

3. Shake or stir Hydra-Block before using

4. Concrete Application-Use 2 -3 light coats. Concrete Block Application-Use 3-4 light coats. Clay Brick Application-Use 2-3 light coats.

5. Spray a section at a time. After spraying for 20-30 minutes return to original area and re-apply when surface is still damp.

6a. **Horizontal Application**-Spray sealer in a fine mist until the surface is saturated. Re-apply to fast drying areas to maintain a wet look. Do not allow to puddle or run. Spread any puddles with a roller. Wipe off excess with a wet rag within 10 minutes of application.

6b. **Wall Application**- Begin at bottom and work your way up the wall. Do not allow product to run. Spray sealer in a fine mist until the surface is saturated. Re-apply to fast drying areas to maintain a wet look. Wipe off excess with a wet rag within 10 minutes of application.

Drying Time

Will dry clear and transparent in 1-2 hours @72^0 F. Allow to dry 24 hours before allowing traffic.

Clean Up

Equipment- Soapy water

Warning

- Use with adequate ventilation
- Keep out of reach of children
- Do not take internally
- In case of ingestion call a physician, do not induce vomiting

Warranty

Applied Technologies warrants that for a period of 12 months from the date of manufacture or for the duration of the published shelf life, whichever is less, that at the time of shipment, the product is free of manufacturing defects and conforms to published specifications in force on the date of acceptance by “the company” of the order. Applied Technologies shall only be held liable under this warranty if the material has been stored, used and applied in accordance with Applied’s instructions in the products technical data sheet.

If Applied Technologies, in its sole discretion determines that the product breached the above warranty it will in its sole discretion replace the non-conforming product, refund the purchase price or issue a credit to the buyer of the product. The dollar value of Applied's liability and the buyer's remedy under this limited warranty shall not exceed the purchase price of the material in question. This is the only warranty extended by Applied. There are no other warranties including implied warranties of merchantability and fitness for a particular use and purpose. Applied specifically disclaims liability for any incidental, consequential or other damages including but not limited to, loss of profits or damages to a structure or its contents.

THE FOREGOING WARRANTY SHALL BE EXCLUDSIVE AND IN LIEU OF AN OTHER WARRANTY, EXPRESS OR IMPLIED INCLUDING WARRANTIES OF MERCHANTIBLITY AND FITNESS FOR A PARTICULAR USE AND PURPOSE AND ALL OTHER WARRANTIES OTHERWISE ARISING BE OPERATION OF LAW, COURSE OR DEALING, CUSTOM, TRADE OR OTHERWISE

RadonSeal

800-472-0603 Penetrating Concrete Sealers | Brick & Paver Sealers | Basement Waterproofing and Concrete Repairs

RadonSeal Deep-Penetrating Concrete Sealers

Your Damp Basement Solution

RadonSeal Deep-Penetrating Concrete Sealer has been the leading concrete sealer for commercial and residential projects since the late 1990's. It is a reactive, internal sealer, for poured concrete, heavyweight concrete blocks, mortar, and other cementitious materials. Unlike the majority of concrete sealers sold in stores, RadonSeal is not a surface sealant. It seals the matrix of concrete without coating the surface and can be safely used on heavy foot-and-vehicular traffic areas.

RadonSeal works by being absorbed by porous concrete, penetrating deep below the surface (up to 4"), chemically reacting with free lime and alkali, expanding inside the pores and capillaries, and curing as a hardened silicate mineral. It is like injecting more cement into the concrete!

Once cured, the sealer is permanent and will protect basement, slab-on-grade, and subteranean concrete against capillary water seepage, efflorescence, water vapor, and even radon gas. RadonSeal also strengthens, densifies, and hardens outdoor concrete, protecting surfaces against freeze-thaw, cracking, crazing, spalls, and minor defects.

RadonSeal is the Only Concrete Sealer Backed by a Lifetime Money-Back Guarantee!

RadonSeal does not change the appearance or friction of the concrete (slip-resistant). Unlike common sealers (topical clear sealers) and waterproofing paints, RadonSeal can never peel, delaminate, or wear away. It cannot be pushed out from inside the pores by negative-side pressure. The seal becomes integral to the concrete itself and no reapplication is ever needed! Applying RadonSeal to indoor and outdoor concrete surfaces provides several important benefits:

- **Concrete Waterproofing** - Mitigates capillary water seepage, protects outdoor concrete against freeze-thaw and road salts.
- **Efflorescence** - Reacts with alkalis and can stop or reduce unsightly "white powder" and salt deposits.
- **Eco-Friendly** - No solvents, zero VOCs, no fumes or noxious odors.
- **User-Friendly** - Safe to use indoors. Easily applied by a common hand-pump "garden" sprayer.
- **Vapor Transmission** – Reduces humidity by restricting water vapor inflow.
- **Radon Mitigation** - Restricts the infiltration of soil gasses through concrete capillaries and pores.
- **Musty Odors** - Helps to alleviate musty basement odors by reducing humidity.
- **Mold Remediation** – Aids in the prevention of mold and mildew growth.
- **Reduces Cracking** – Bonds and strengthens concrete, prevents the rusting and expansion of rebar.
- **Concrete Hardener** - Hardens the surface "flint-hard", greatly reduces dusting and crazing.
- **Neutralizes Alkalis** - Ideal for high pH fish and koi ponds, dog kennels, and stables.
- **Deep-Cleans** – Purges contaminants, minor oil spills, old efflorescence, and animal urine from inside concrete slabs.
- **Nuetralizes Alkali** – Use in fish ponds, kennel floors, and stables because it neutralizes alkalis and surfaces caustic to animals.

Unsure if RadonSeal is not the correct sealer for your project? Review our Sealers Guide

Order Today

RadonSeal® Standard and Plus Concrete Sealers

Item	Size	Price	Shipping	
RadonSeal® Standard	5-gal.	$159	**FREE**	ORDER NOW
	2.5-gal.	$89	$12	
RadonSeal® Plus	5-gal.	$179	**FREE**	ORDER NOW
	2.5-gal.	$99	$12	

Review detaield Same Day Shipping and Ordering Terms

Most Recent Reviews Online

June 21

Great customer service and very…

Great customer service and very knowledgeable about product.

Lane

June 16

It's pricey up front

It's pricey up front, but a reasonable price for RadonSeal and their Plus version, if...

craig

Crack

The Cra
product

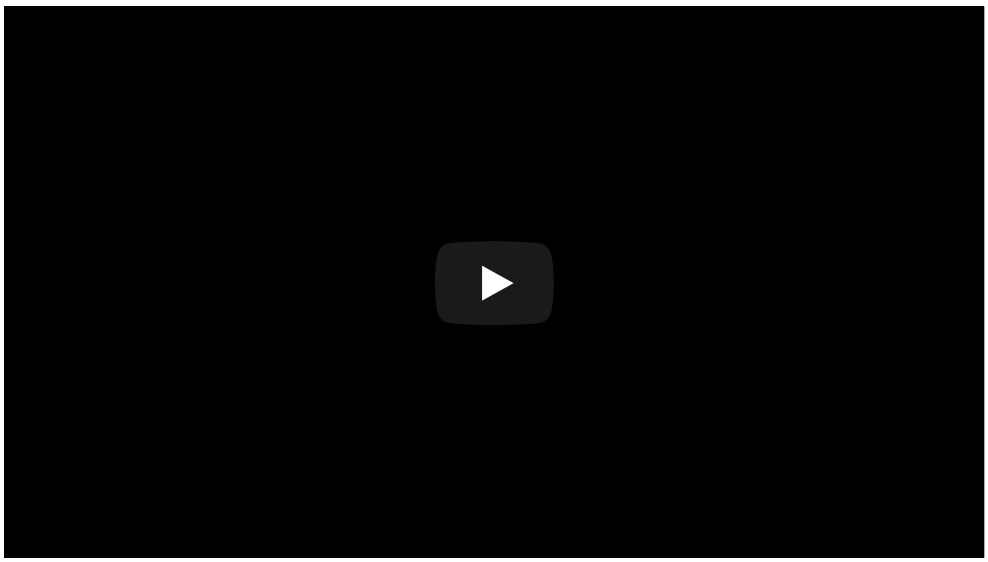
Stephen C

Rated **8.8** out of 10 based on **595** reviews. See some of the reviews here

RadonSeal Standard and RadonSeal Plus

STANDARD – Recommended for indoor poured concrete such as basement floors and walls, foundation slabs, and garage floors less than 20 years old. Also use on outdoor concrete (driveways, sidewalks, walls, rooftops, decks) less than 2 years old.

PLUS – Recommended for sealing older and more porous concrete, such as concrete blocks, cinder blocks, poured indoor concrete over 20 years old or poured outdoor concrete more than 2 years old. It carries more active minerals for larger pores in concrete.



Coverage

The approximate coverage rates below take into account the number of recommended applications. Coverage rate varies depending on the porosity and composition of the concrete. Concrete with larger pores or more alkalis will consume more sealer. Cinder blocks being much more porous, have the lowest coverage per pail.

- **POURED CONCRETE** – 1,000 sq. ft./5-gal. pail in 2 applications,
- **HEAVYWEIGHT CONCRETE BLOCKS –** 500 sq. ft./5-gal. pail in 3 applications,
- **CINDER BLOCKS –** 400 sq. ft./5-gal. pail in 4 applications.

EXAMPLE 1 – A typical basement (floor 800-1,000 sq. ft., 8-ft. POURED CONCRETE WALLS) would need TWO (2) 5-gallon pails to cover both the floor and foundation walls.

EXAMPLE 2 – A typical basement (floor 800-1,000 sq. ft., 8-ft. CONCRET BLOCK WALLS) will need TWO (2) 5-gallon pails of RadonSeal Plus for the walls and ONE (1) 5-gallon pail of RadonSeal Standard or Plus for the floor.

Application

Conditions – The concrete must be dry inside. After a heavy rain, let outdoor concrete dry for at least 2 days. Avoid heavy rain for 24 hours after the application. Air and surface temperatures must be above freezing during the application and for three days after. Mask or remove glass, aluminum, metals, tiles, and plants.

Preparation – To apply RadonSeal, the concrete surface must be bare and porous – paint, old sealers, adhesives, oil, efflorescence, grease, etc., must be removed prior to application. Vacuum excessive dust, dirt, or loose particles. Allow concrete to dry for 3 days after power washing. If the concrete is polished or troweled very hard, you have to make the surface porous by acid etching or grinding.

How To Remove Efflorescence Safely

RadonSeal can applied with a low-pressure sprayer like the hand-pump "garden sprayer," a paint roller *(3/4" nap)*, or with a brush**.** Adjust nozzle on pump sprayer to a fan pattern. Shake or roll the pail before use. Pull out the pouring spout and fill the pump sprayer.

1. Dampen the Concrete - use the sprayer or a mop and a bucket to dampen the concrete surface with water *(it breaks surface tension)*.

2. Apply RadonSeal in a Continuous Glistening Film – avoid puddles, do not over-apply. Spread out any puddles with a roller.

3. Apply the Next Application - after about 30 minutes of spraying, return to the beginning of the section while still damp and apply a second coat. **Concrete blocks require 3 back-to-back applications and cinder blocks 4 applications.**

The sealer should absorb within about 10 minutes (the surface still looks damp but there is no glistening film). If the concrete is unusually porous or alkaline, it will absorb very fast, letting you know that it needs more sealer – spray on another application.

4. Wash the Concrete Floor - Two to three hours after the final application, rinse the surface with water and scrub with a stiff-bristle brush or push broom, shop vac and let dry. Washing the concrete will remove any unabsorbed sealer which would leave glassy or whitish areas. It will also ensure that the surface will remain porous for painting, coating, adhesives, and surface levelers. If needed, sweep off any efflorescence or contaminants purged by RadonSeal in a couple days.

- RadonSeal Application Instructions
- RadonSeal Standard Pail Label
- RadonSeal Plus Pail Label

What People Are Saying

Rated **4.2** out of 5
based on **16** reviews.

Powered by TRUSTPILOT

Don

January 17

Excellent sealer for my new concrete block foundation walls. Hard to believe, but the water seepage has stopped.

Ian

January 6

No problems so far. Application was just as described and worked well. Not sure how well product seals so far but the basement does not have a dungeon smell any more.. But that may also be due to the extensive cleaning prior to application:)

Don

January 5

Fast delivery. A BREEZE TO APPLY !!! And works as advertised. Excellent performance products.

Product Uses

RadonSeal Concrete Sealer is most commomly applied to mitigate moisture in basement concrete and to strengthen commericial/industriall concrete, but is effecitve for sealing and preserving a wide range of cementitious materials; retaining walls, garage floors, driveways, sidewalks, patios, koi ponds, carports, parking garages, building facades, concrete rooftops, decking, concrete columns, warehouse floors, storage tanks, concrete curbs, cooling towers, water treatment plants, and concrete bridges.

- **POURED CONCRETE –** New or old, basement walls and floors, building facades, fish/koi ponds, retaining walls, seawalls.
- **CONCRETE SLABS** – Warehouse floors, garage slabs, carports, driveways, sidewalks, curbs, parking lots, patios.
- **CONCRETE BLOCKS, CINDER BLOCKS –** Foundation walls, retaining walls, building walls.
- **MORTAR –** Mortar between blocks, porous mortar in older stone foundations.
- **LIMESTONE –** Walls, floors, building blocks, facades, interior or exterior.
- **STUCCO –** Porous stucco applied over concrete.

Limitations

RadonSeal does seal hydraulic cement, patching compounds, surface levelers, lightweight blocks, decorative blocks, split-face blocks, "popcorn" blocks, haydite blocks, and is not intended for use on stamped concrete, acid-stained concrete, and colored concrete.

RadonSeal may be less effective when applied to fiber reinforced concrete, thin concrete floors (<2"), cinder blocks, and unsound concrete. Concrete over sinkholes and/or channelized underground streams that cause continious dampness.

Please review RadonSeal Uses, Limitations, and Application detailed webpage.

Reduce Basement Humidity, Efflorescence, and Water Vapor

RadonSeal is the strongest formulated silicate-based sealer because it penetrates deeper, carries more active minerals, and seals tighter than other concrete sealers. Penetration does not depend on gravity because RadonSeal penetrates by capillary action – also used on walls and ceilings.

In case of basement walls, it is commonly applied from the inside to seal against capillary water seepage, water vapor, and soil gas from the ground. However, if there is an opportunity to apply it to both sides, it has the added advantage of preserving the exterior surface of the concrete and extending the life of any waterproofing coating by protecting it against saponification caused by alkalis from the concrete.

Waterproofing Guarantee

Please review the RadonSeal Waterproofing Guarantee in detail.

Protect Your Home Against Radon

Radon gas gets in through the concrete and openings in basements, crawlspace, or foundation slab. Radon gas kills over 21,000 people in the U.S. every year. After smoking, radon is the second leading cause of lung cancer deaths in the U.S. "Radon in homes causes more deaths than fires, drownings and airplane crashes combined" - EPA

The health risks are proportional to the radon level in your home. There is no "safe" radon level. Seventy-percent of radon-attributed deaths are caused by homes with radon below 4 pCi/L, which is the US EPA's "Action Level." The health risk is proportional to the radon level in your home. Always reduce radon to a practical minimum! RadonSeal provides an effective mitigation method that can help aid and/or reduce radon levels in your home. In comparison to fan-based mitigation, it can sometimes save on the initial cost and operating costs year after year.

Radon Reduction Guarantee

Please review the RadonSeal Radon Reduction Guarantee in detail.

Use RadonSeal Before Painting or Installing Flooring

RadonSeal leaves the surface paintable. It is recommended for sealing concrete before applying paints, adhesives, epoxy or urethane coatings, "wet-look" sealers, concrete overlays, surface levelers, or moisture-sensitive flooring. RadonSeal can help to greatly reduce the wicking of water, water vapor, and efflorescence from pushing off or cracking paints and coatings. As it purges minerals from inside the capillaries, it opens up the pores and is often used by flooring contractors as a primer.

For more info on how RadonSeal® works, efflorescence, the "alkali attack," how to protect concrete, paints, and flooring against deterioration, visit RadonSeal - Your First Choice for Sealing Concrete.

Use as a Concrete Densifier

RadonSeal will make concrete denser and stronger (up to 40% in flexural strength). It makes concrete surfaces resistant to abrasion and surface defects. Use on concrete to reduce concrete dusting, concrete crumbling, and overall wear.

Feedback from Customers

"...water was actually puddling in the middle of the room, coming up from under the concrete floor. I used the Radon seal and to my amazement...no more water in fact no more moisture! That was 5 years ago." – Tom F., Atlanta, GA

"My cinder block wall was seeping water, so I sealed it with Drylock. But after several months, efflorescence pushed it out ...painted it again two times, but it always peeled and leaked again...your RadonSeal...pushed out rivers of efflorescence from the concrete and it is now bone-dry" – Brian D., NC

"...finishing my basement and had great concerns about damp basement air, mold and mildew, and of course radon. Particularly, since we have a newborn in the house. My radon is now very low and the basement feels dry." – Mark W., MA

"...relative humidity in the basement rooms would constantly hover between low 80% to high 70%...a definite "musty smell"...Since applying the RadonSeal...humidity is holding at 44 to 46% without the use of the dehumidifier!" – Jim M., GA

"...RadonSeal Plus to the block walls and (2) coats to the floor of my very damp basement...went from 5.1 pCi/L to 0.3 pCi/L" – Traci T., DE

See more Testimonials

SDS | PDS | BROCHURE

- RadonSeal Concrete Sealer - SDS
- RadonSeal Concrete Sealer - PDS
- RadonSeal Product Brochure

The Chemistry Behind RadonSeal

The history of penetrating silicate concrete sealers dates back to Germany in World War II, when they were used to strengthen quickly poured, thin military runways. After the war, the Army Corps of Engineers started using the sealers for the preservation of concrete dams and bridges. As the technology evolved, the use of silicate concrete sealers expanded from preserving structural concrete to waterproofing outdoor and indoor concrete. Somewhat diluted, they are also used as "surface hardeners."

During the last couple of decades, penetrating silicate concrete sealers have become widely used in the US and abroad, be it at Disney World or Sydney Opera House. Many architects specify them for major buildings. The sealers have been successfully used on thousands of major concrete structures and buildings.

How Does RadonSeal Work? When concrete cures, it produces "free lime" as a by-product of hydration. RadonSeal reacts with the free lime and alkalis inside concrete and expands inside the capillaries. It forms a silicate mineral – **it's like injecting Portland cement into the concrete.** Simply, it results in a **higher grade of concrete that is denser, stronger, and tighter.**

RadonSeal waterproofs concrete internally but usually it **does not make its surface "bead" water,** it does not make it slippery when wet, and leaves it paintable. It will absorb individual water drops *(it "wets")* but larger puddles will remain, because the concrete is waterproof.

RadonSeal - Your First Step When Moving

The RadonSeal spray-on application makes it easy for a do-it-yourself home repair or home improvement project.

Selling Your Home

Before putting the house on the market, seal all the concrete in your basement with RadonSeal® to avoid any last-minute glitches at closing! Buyers are wary of fresh paint. Stop moisture problems and musty odors. Play it safe and reduce radon to a minimum – radon levels fluctuate widely and a bad short-term radon test could scuttle the closing.

Buying A Home

If there is a radon or moisture problem, negotiate a discount for conventional radon mitigation or waterproofing. Then, do it yourself with RadonSeal and save! In any case, protect your family's health by reducing dampness and radon to a practical minimum.

Newly Built Homes

Now is the best time to preserve the concrete and prevent future moisture or radon problems. In a finished basement, the floor-to-wall joints are unreachable. Sealing the basement is particularly important in today's energy-efficient homes, which draw not-so-fresh air from the ground through the porous concrete.

Architects | Builders | Contractors

RadonSeal prevents or solves problems with moisture, molds, and radon in residential, institutional or commercial buildings like schools, apartments, hospitals, and hotels. It preserves commercial and industrial concrete assets indoors and outdoors – warehouses, factory floors and walls, cooling towers, water treatment plants, and bridges.

It also protects parking areas, garages, and factory floors against oil spills and most chemicals. Info for builders and contractors on RadonSeal Commercial Applications. RadonSeal reduces costs and warranty callbacks, improves results, adds value, and increases customer satisfaction for a variety of contractors:

- Waterproofing Contractors
- Radon Mitigation Contractors
- Building Contractors
- Basement Remodeling Contractors
- Flooring Contractors
- Architects
- Painting Contractors

How RadonSeal Can Help with LEED Certification

RadonSeal's state-of-the-art concrete and masonry sealers can earn your project valuable credits towards LEED certification.

Appendix C

FOUR CHANNEL WALL MOUNT CONTROLLER

Gas Detection For Life

Beacon™ 410A Model

Features

- Simultaneously control up to 4 gas monitoring channels
- OLED display of all 4 channels
- LEL / O2 / CO2 / toxic direct connect sensors
- Accepts any 4-20 mA transmitter, 2 or 3 wire
- Up to 3 programmable alarm levels per channel
- Up to 3 configurable alarm relays per channel
- 4-20 mA analog & Modbus digital output standard
- 115 / 220 VAC or 24 VDC operation
- Audible alarm with silence feature
- RFI / EMI Resistant
- Alarm reset switch
- Built in trouble alarm with relay
- Weather and corrosion resistant NEMA 4X enclosure

Applications

- Petrochemical plants
- Refineries
- Water & wastewater treatment plants
- Pulp & paper mills
- Gas, telephone, & electric utilities
- Parking garages
- Manufacturing facilities
- Steel

The Beacon 410A is a highly configurable, microprocessor-based, flexible and easy to use 4 channel gas monitoring controller. It simultaneously displays the gas type, readings, and status for four channels of gas detection. It can monitor any combination of direct connect sensors (LEL, O2, CO2, and toxic gas sensors), as well as any 4-20mA transmitter.

Each channel has up to three fully configurable alarm points. A built-in silenceable audible alarm alerts you to alarm conditions. Each channel also has two dedicated fully configurable relays and there is a bank of common relays as well. The common relays can optionally be configured as additional relays allowing up to 3 alarm relays per channel. Each channel provides a 4-20mA output signal. A digital Modbus interface for remote logging of data via a Modbus network is standard. A Min-Max feature retains high & low peak readings for review at any time.

Optional Strobe Light

A fully configurable, high visibility strobe is available as an option. The unit can be powered from 115/220 VAC, or an external 24 VDC source. A trickle charging battery backup feature with battery assembly is also available as an option.

All features and functions of the Beacon 410A are controlled by easy to use menus on the OLED display. All features including form-C relay contacts of the Beacon 410A are built into the unit so you never need to purchase or maintain any “add-on” cards or components.

RKI Instruments, Inc. • 33248 Central Ave. Union City, CA 94587 • Phone (510) 441-5656 • (800) 754-5165 • Fax (510) 441-5650

Beacon™ 410A Model

Physical

Dimensions	Height: 12.5” (31.8 cm) x Width: 11” (27.9 cm) x Depth: 6.4” (13.6 cm)
Enclosure	NEMA 4X Fiberglass / polyester with lexan window for indoor and outdoor locations
Conduit Connection	3/4” NPT conduit hubs, 4 provided, for sensor, power, & relay wiring
Wiring Termination	Screw Type terminal block, 14 gauge max
Power	115 VAC, 220 VAC, or 24 VDC nominal. Battery backup option available
Optional Accessories	Strobe light, and Battery Backup Assembly
Controls	Display PCB Control Switches: • UP/YES push button switch • ESCAPE push button switch • External reset switch • DOWN/NO push button switch • ENTER push button switch • On/Off toggle switch

Environmental

Operating Temperature	-4°F to 122°F (-20°C to 50°C)
Storage Temperature	-40°F to 158°F (-40°C to 70°C)
Enclosure Rating	NEMA-4X enclosure, chemical and weather resistant. Suitable for indoor and outdoor installations

Inputs

Direct Wired Sensors	LEL, Oxygen, Carbon Dioxide, and toxic gas sensors. Remote amp not required for less than 500 feet
4-20 mA	Accepts any 4-20 mA transmitter (24 VDC, 2 or 3 wire). A wide variety of RKI/Riken sensors are available with 4-20 mA signals. Wiring distances up to 8,000 feet
Sampling Methods	Diffusion and sample draw heads available

Outputs

Relays	Two flexible, programmable Form-C (C, NO, NC) relays per channel, plus five common relays (Fail, Alarm-1, Alarm-2, Alarm-3, Alarm-Any). Common relays may optionally be assigned to function as additional channel alarm relays, providing for up to three alarm relays per channel. 10A contact rating, 250V.
4-20 mA	Signal output, 4-20 mA (maximum load impedance 500 ohms), per channel
RS-485	Modbus format RS-485 serial output of all channel data, including gas reading and alarm status.
Display	Four line OLED display
Audible	Built-in audible alarm, 94 dB, mounted on enclosure Coded output: pulsing = gas alarm, steady = fail
Visual	1. Alarm LED’s (on Display PCB) • Alarm 1 = yellow • Alarm 2 = orange • Alarm 3 = red • Fail = yellow 2. Green Pilot LED to indicate AC power connected (on Display PCB) 3. An optional 24 VDC NEMA 4X strobe mounted to top of case.

Approvals	CSA Certified to CSA C22.2 No. 61010-1-12 and UL61010-1
Warranty	One year materials and workmanship

RKI INSTRUMENTS

RKI INSTRUMENTS, INC. UL REGISTERED FIRM ISO 9001 10000363

• Toll Free: (800) 754-5165 • Phone: (510) 441-5656
• Fax: (510) 441-5650 • www.rkiinstruments.com

Authorized Distributor:

Northeast New Territories (NENT) Landfill Extension
Detailed Landfill Gas Hazard Assessment Report

Prepared by:

Aurecon Hong Kong Limited

Unit 1608, 16/F, Tower B, Manulife Financial Centre,

223 – 231 Wai Yip Street, Kwun Tong,

Kowloon Hong Kong S. A. R.

T: +852 3664 6888

F: +852 3664 6999

E: **hongkong@aurecongroup.com**

aurecon

Bringing ideas to life

Sep 2022