翠谷工程有限公司
Green Valley Landfill, Limited

South East New Territories (SENT) Landfill Extension

Detailed Landfill Gas Hazard Assessment Report

December 2018

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South East New Territories (SENT) Landfill Extension

Environmental Certification Sheet
EP-308/2008/B and FEP-01/308/2008/B

Reference Document/Plan

Document/Plan to be Certified/Verified:	Detailed Landfill Gas Hazard Assessment Report for South East New Territories (SENT) Landfill Extension
Date of Report:	3 December 2018

Reference EP Condition

EP Condition: Condition No. 2.5

At least one month before the commencement of construction of the Project, four hard copies and one electronic copy of a detailed landfill gas hazard assessment shall be submitted to the Director for approval, 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 ET Leader and verified by the IEC. Additional copies of the submission shall be provided upon request by the Director.

ET Certification

I hereby certify that the above referenced document/plan complies with the above referenced condition of EP-308/2008/B and FEP-01/308/2008/B.

Frank Wan,
Environmental Team Leader,
Environmental Resources Management:

Date: 3 December 2018

IEC Verification

I hereby verify that the above referenced document/plan complies with the above referenced condition of EP-308/2008/B and FEP-01/308/2008/B.

Fredrick Leong,
Independent Environmental Checker,
Meinhardt Infrastructure and Environment Ltd:

Date: 4 Dec 2018

South East New Territories (SENT) Landfill Extension

Detailed Landfill Gas Hazard Assessment Report

Environmental Resources Management

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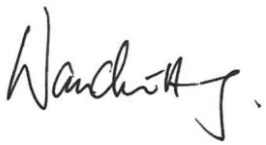
Client:	Project No:
Green Valley Landfill Ltd.	0464654
Summary:	Date: 3 December 2018
This document presents the Detailed Landfill Gas Hazard Assessment Report for *South East New Territories (SENT) Landfill Extension*	Approved by:  Frank Wan *Partner*

Revision	Description	By	Checked	Approved	Date
3	Detailed Landfill Gas Hazard Assessment Report	AL	FW	FW	3 Dec 2018
2	Detailed Landfill Gas Hazard Assessment Report	AL	FW	FW	5 Oct 2018
1	Detailed Landfill Gas Hazard Assessment Report	AL	FW	FW	19 Sep 2018
0	Detailed Landfill Gas Hazard Assessment Report	AL	FW	FW	30 Aug 2018

Distribution

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CONTENTS

1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

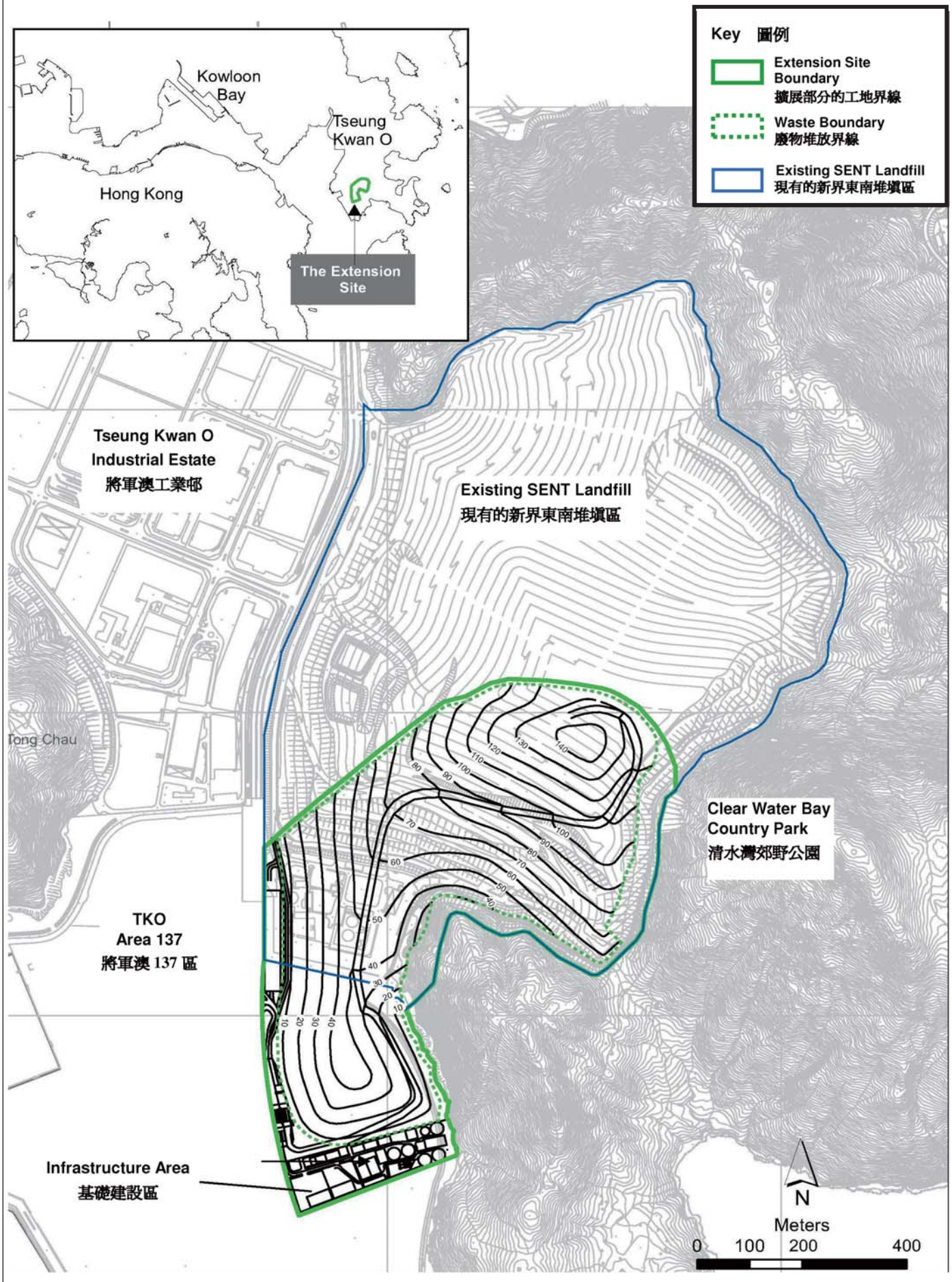
The South East New Territories Landfill Extension (SENTX) is located adjacent to the existing SENT Landfill with a portion piggybacking onto the south slope of the SENT Landfill. The Project location and layout plan shown is shown in *Figure 1.1*. SENTX will be a new source of landfill gas generation 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.

In 2008, the Environmental Impact Assessment (EIA) Report (AEIAR-117/2008) for the SENTX (hereafter referred to as the *approved EIA Report*) was approved under the *EIA Ordinance* (EIAO) and an Environmental Permit (EP) (EP-308/2008) based on the outline design proposed in the 2007 SENTX Feasibility Study was granted on 15 August 2008. Since then, the Hong Kong SAR Government has decided to reduce the scale of SENTX assessed in the *approved EIA Report* and SENTX will only receive construction waste.

The Design, Build and Operate (DBO) Contract of SENTX was awarded to Green Valley Landfill Limited (GVL). In line with the changes proposed by the Environmental Protection Department (EPD), GVL has reviewed the outline design and made a few changes to the scheme to develop a final scheme for SENTX (hereafter referred to "the latest scheme") in 2016. The changes, including the landfill profile and lining materials, site layout, design of the process equipment, construction method and sequence and filling operation were made taking into account GVL's expertise in landfill operation, practical site operation considerations and the availability of process equipment in the market. An VEP for the latest scheme was applied in December 2016 and a new EP was granted (EP-308/2008/B) on 20 January 2017.

Per requirement of EP Condition 2.5, 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).

ERM was appointed by GVL 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



Note : Figure 1 of Environmental Permit No. FEP-01/308/2008/B

Figure 1.1 Project Location and Layout Plan in Current Environment Permit No. FEP-01/308/2008/B

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methodology and building design at the infrastructure area of SENTX and to recommend appropriate measures to ensure SENTX can be constructed and operated without undue risk to safety.

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 GVL, 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 led the environmental team which include an experienced landfill gas hazard specialist.

For the purpose of this DLFGHA Report, the SENTX schemes assessed in the *approved EIA Report* and the latest SENTX 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].

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

1.2 PROCEDURES AND GUIDELINES

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 SENTX site falls within the SENT 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 SENT Landfill to the construction and operation of the SENTX. In addition, the operation of the SENTX will generate lower quantities of landfill gas which may pose risk to the operation of the infrastructure facilities of the SENTX. This assessment considered both landfill gas sources (i.e. existing SENT Landfill and SENTX).

A *Practice Note for Professional Person* (*ProPECC PN 3/96*) [2] and *Guidance Note* or the assessment of the hazards which landfill gas may present to developments close to landfills have been issued by the EPD.

(1) Landfill Gas Hazard Assessment Guidance Note, 1997, EPD.

(2) ProPECC PN3/96 Landfill Gas Hazard Assessment for Developments adjacent to Landfills, Dec 1996, EPD.

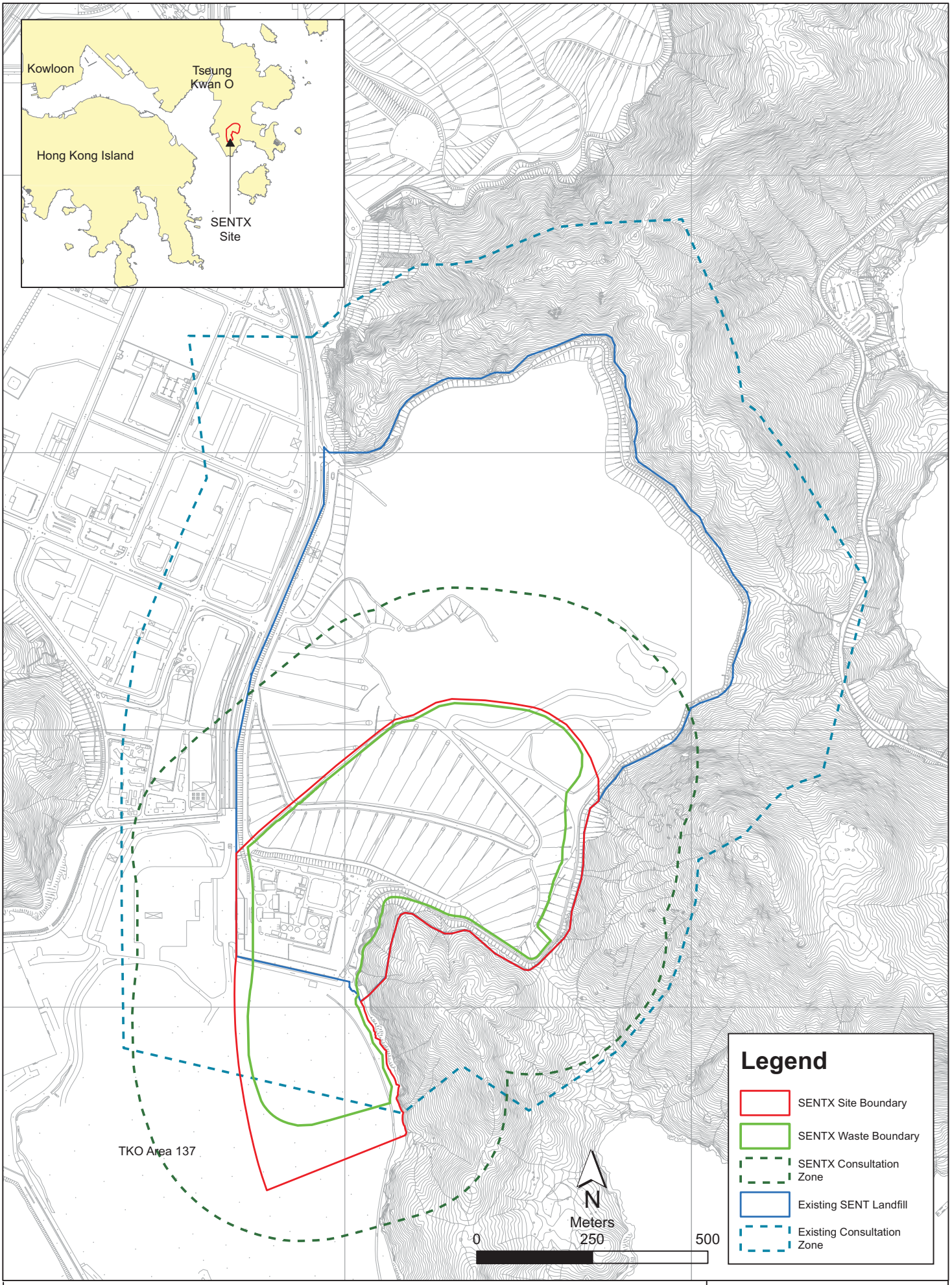

Figure 1.2 250m Consultation Zone of SENT Landfill and SENTX (the Latest Scheme)

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1.3 PREVIOUS STUDIES UNDERTAKEN AT THE SITE

A number of previous studies have been undertaken at the SENTX. The documents which have been used as background material for the preparation of this assessment include the following:

- *South East New Territories (SENT) Landfill Extension - Feasibility Study: Environmental Impact Assessment Report*, ERM-Hong Kong, Limited 2007;
- *Environmental Review of the Revised Scheme of SENT Landfill Extension: Environmental Review Report,* ERM-Hong Kong, Limited 2012;
- *South East New Territories (SENT) Landfill Extension: Environmental Review Report,* ERM-Hong Kong, Limited 2016; and
- *Landfill Gas Hazard Assessment: Guidance Note*, EPD 1997.

GVL has also provided the landfill gas monitoring data for the SENT Landfill covering the period from January 2017 to December 2017.

1.4 SCOPE OF THIS STUDY

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

- review of background information (including landfill gas monitoring data) and studies related to the SENT Landfill and the SENTX;
- identification of the nature and extent of the SENT Landfill and SENTX which might have potential impacts on the construction and operation of SENTX;
- 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 SENTX;
- identification of the potential receivers associated with the SENTX which are sensitive to the landfill gas risk;
- qualitative assessment on the degree of risk which the landfill gas migration may impose on the identified targets for each of the source-pathway-target combinations; and
- design of suitable level of precautionary measures and contingency plan for the SENTX and the potential targets, if needed.

1.5 REPORT STRUCTURE

The remainder of the report is structured as follows:

- *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 SENT Landfill and SENTX 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 SENTX 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 impact the SENTX site;

- *Section 8* provides further recommendations for precautionary and protection measures to be adopted during the design, construction and operation of the SENTX 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 SENTX; and

- *Section 10* concludes the findings and recommendations of this DLFGHA.

2 REVIEW OF PRELIMININARY QUALITATIVE LANDFILL GAS HAZARD ASSESSMENT

The source-pathway-target analysis in the *approved EIA Report* shows that landfill gas risk posed by the SENT Landfill and SENTX under the EIA Scheme (1) is medium to high within the SENTX Site boundary during both the construction and operation phases. Whereas the risk posed by SENTX to the adjacent developments ranges from very low to low depending on the nature and location of the adjacent developments.

The findings of the preliminary QLFGHA in the *approved EIA Report* are summarised in *Table 2.1.*

Table 2.1 Qualitative Assessment of Landfill Gas Hazard Associated with SENTX in the EIA Scheme

Source	Pathway	Target	Qualitative Risk
SENT 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 SENT Landfill and SENTX with potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 1 (Construction site of SENTX) – demolition and excavation at the existing infrastructure area and construction of trenches using open cut method **(category: medium sensitivity)**	**Medium**
SENT Landfill - potential for gas generation over time, but comprehensive and proven mitigation installed. **(category: medium)** SENTX - potential for low gas generation over time, comprehensive and proven mitigation to be installed. **(category: medium)**	Sub-surface soil, reclamation fill materials of the unsaturated zone between the SENT Landfill and SENTX with potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 2 (Tipping face of SENTX) – waste tipping in the open air, absence of confined space, access by drivers/operators of waste collection vehicles who may not have knowledge on landfill gas hazards **(category: medium sensitivity)**	**Medium**

(1) SENTX assumed to accept MSW, construction waste, sewage sludge and special waste

Source	Pathway	Target	Qualitative Risk
SENTX - potential for gas generation over time, comprehensive and proven mitigation to be installed **(category: medium)**	Sub-surface soil, reclamation fill materials, potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 3 (Infrastructure area of SENTX) – Ground level offices and pump rooms of unrestricted staff access, underground confined spaces with restricted access, some with source of ignition **(category: medium to high sensitivity)**	**Medium to High**
	Sub-surface soil, reclamation fill materials, no direct anthropogenic conducts - Distance to waste boundary <50m **(category: very short/direct)** - Distance to waste boundary between 50m to 100m **(category: moderate short/direct)** - Distance to waste boundary >100m **(category: long/indirect)**	Target 4 (Adjacent existing and new development) – according to *ProPECC PN 3/96*, project proponents and are required to carry out landfill gas hazard assessment and implement suitable landfill gas protection measures **(category: low sensitivity)**	**Very Low to Low**

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

At the design phase, recommended measures to be adopted to protect building against landfill gas ingress include a combination of passive (e.g. gas barrier and gas vents) and active control measures (e.g. creation of positive pressure zone below or within building structure and continuous ventilation of spaces with air by fan) and installation of landfill gas management system to contain, manage and control landfill gas. Detailed examples of these measures can be reference to EPD's Guidance Note.

Precautionary measures to be adopted during construction stage including safety measures, routine monitoring, actions in event of gas being detected and emergency management etc. are outlined in Paragraphs 8.3 to 8.49 of EPD's Guidance Note.

Taking account of the measures recommended in the preliminary qualitative landfill gas hazard assessment of the *approved EIA Report*, GVL will

incorporate appropriate control measures in the detailed design of the SENTX, which are described in *Section 6*. Under this detailed qualitative landfill gas hazard assessment, the updated risk assessment has taken account the accommodation schedule of the SENTX infrastructure area, and the appropriate landfill gas control measures incorporated in the detailed design.

3 LANDFILL GAS HAZARD ASSESSMENT METHODOLOGY

3.1 LANDFILL GAS HAZARD ASSESSMENT CRITERIA AND METHODOLOGY

3.1.1 General

In accordance with the *Guidance Note on Landfill Gas Hazard Assessment*, EPD, 1997, the risk due to landfill gas may be evaluated based upon the following three criteria:

- *Source* - the rate and concentration of landfill gas generation by the landfill;
- *Pathway* - the nature of and length of potential pathways through which landfill gas can migrate and leachate flow, such as geological strata, utility services; and
- *Target* - the level of vulnerability of various elements of the development to landfill gas.

Each of these criteria is further described in the subsections below.

3.1.2 Source

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

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 landfill gas control measures has not been assessed; or

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

Medium Landfill site at which some form of landfill 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 landfill gas; or

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

Minor Landfill sites at which landfill gas controls have been installed and proven to be effective by comprehensive monitoring which has demonstrated that there is no migration of landfill gas beyond the landfill boundary (or

any specific control measures) and at which control of landfill 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 6 months, is less than 5% (v/v).

3.1.3 Pathway

Generally, three types of pathway are considered for the transmission of landfill gas. They are:

- *Man-made* pathways e.g. utility connections, stormwater channels, etc.,
- *Natural* pathways such as rock jointing planes, fissures and other naturally occurring phenomena which may promote or give rise to the transmission of gas over distances; and
- A *combination* of the previous two categories. An example of the latter may be, for instance, where a specific geological feature promotes gas transmission but which stops short of directly linking the landfill and target. A man made connection, however may also co-exist near the edge of the geological feature, which in combination with the former, may act to link the two sites. In this instance, careful assessment of the likelihood of the mechanism acting to link the two pathways needs to be undertaken before assigning an appropriate pathway classification.

The broad classification of a Pathway 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
Moderately short/direct	Path length of 50 to 100m for unsaturated permeable soil or fissured rock or 100 to 250 m for man-made conduits
Long/indirect	Path length of 100 to 250m for unsaturated permeable soils and fissured rock

In classifying the pathway, however, adjustment to the above general guidelines will often be required to take account of other factors which will affect the extent of landfill gas migration including the following:

- a broad assessment of the specific permeability of the soil;
- spacing, tightness and direction of the fissures/joints;
- topography;

- depth and thickness of the medium through which the landfill gas may migrate (which may be affected by groundwater level);
- the nature of the strata over the potential pathway;
- the number of different media involved; and
- depth to groundwater table and groundwater flow patterns.

3.1.4 Target

Different levels of vulnerability or sensitivity of potential targets for landfill gas have been 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 landfill 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 landfill gas could pose potential problems.

The above examples of different categories within each criteria are to be used as a general guide only and specific aspects of a development may render it more or less sensitive than indicated. Account has been taken of any particular circumstances when assigning a target to one of the three indicated categories.

3.1.5 Assessment of Risk Criteria

Following the determination of the categories of source, pathway and target in which the landfill, pathway and development fall, a qualitative assessment of the overall risk may be made by reference to *Table 3.1* which is extracted from the Guidance Note. The potential implications associated with the various qualitative risk categories are summarised in *Table 3.2*. It should be noted that the different levels of risk determine the likely extent of the protection measures required to ensure the safety of a development, but with the possible exception of the very high risk category, development is not precluded for any of the assessed levels of risk.

Table 3.1 Classification of Risk Category

Source	Pathway	Target 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	Medium
		Medium	Low
		Low	Very low
Minor	Very short/direct	High	High
		Medium	Medium
		Low	Low
	Moderately short/direct	High	Medium
		Medium	Low
		Low	Very low
	Long/indirect	High	Medium
		Medium	Low
		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 SENT LANDFILL

4.1 LANDFILL HISTORY

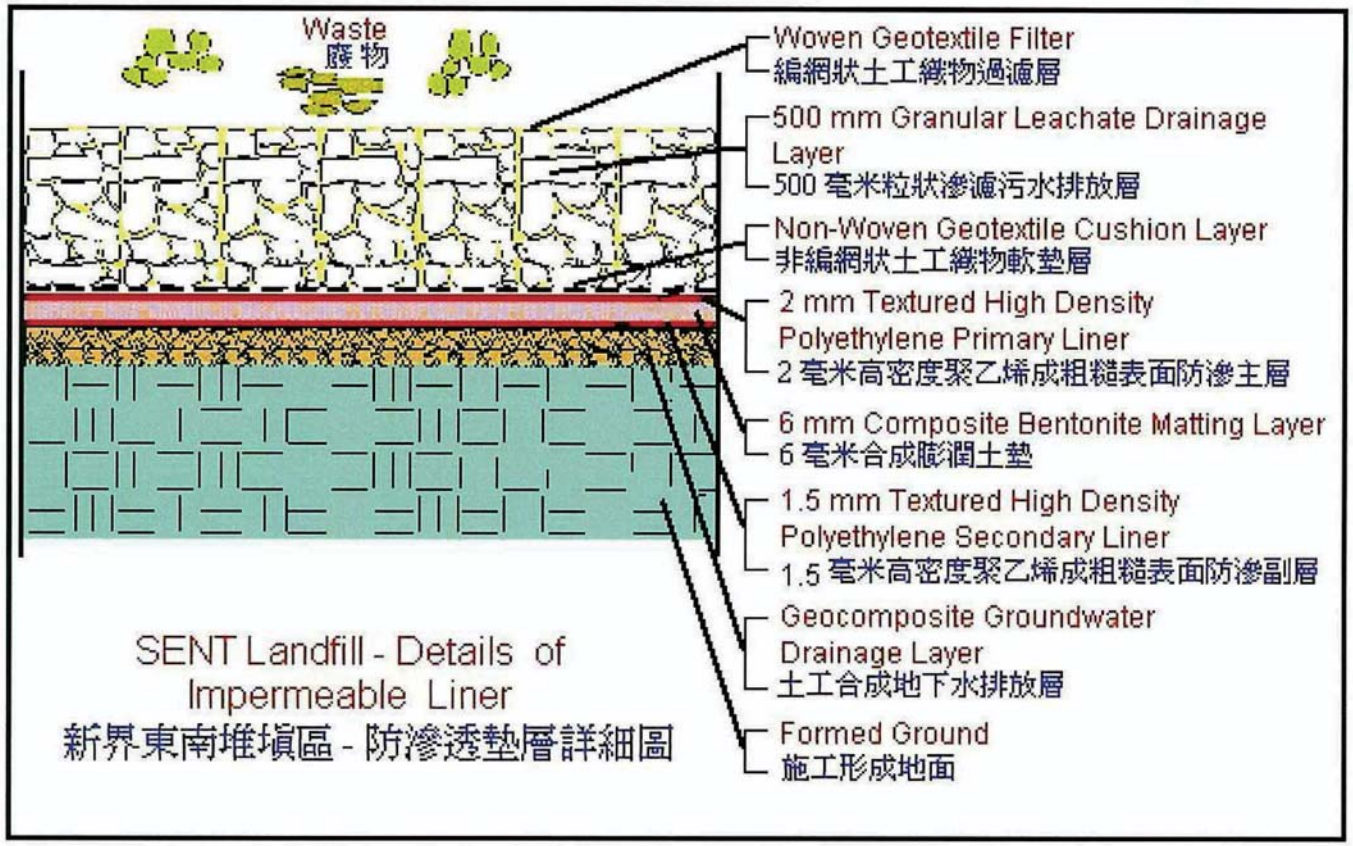
SENT Landfill is located on the western edge of Clear Water Bay Peninsula in the south-eastern corner of the New Territories. The site covers an area of about 100 ha, half of which has been reclaimed from Shek Biu Wan (Junk Bay). To the north and east of the site lies Clear Water Bay Country Park; to the west lies land reclaimed as industrial estate (TKO Industrial Estate, TKOIE) and to the south a reclamation (TKO Area 137) intended for industrial uses.

The landfill is one of the three strategic landfills in operation in the HKSAR and was designed with a capacity of approximately 43 Mm^3 of waste. The landfill commenced operation in 1994 and accepts domestic, commercial & industrial (C&I), construction, and clinical wastes, sewage sludge and stabilised incineration residues. However, since 6 January 2016, the SENT Landfill is designated to receive only construction waste to address the odour issues associated with the operation of the landfill and its landfill gas generation has diminished significantly.

4.2 HISTORICAL LANDFILL GAS AND LEACHATE CONTROL

The landfill has been designed to incorporate extensive measures to contain, collect, and treat/utilise (for landfill gas only) landfill gas and leachate. Such measures include the state-of-the-art technologies (including a composite liner systems, active landfill gas and leachate extraction, landfill gas and leachate treatment and landfill gas utilisation) in accordance with international best practices for landfill operations. The landfill gas extraction system contains three blowers, each with spare parts. While only one blower is in operation at one time, the other blowers serve as emergency backup. 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 SENT Landfill are presented in *Figure 4.1*.

A comprehensive environmental monitoring programme has been implemented to monitor landfill gas generated within the landfill and at the perimeter monitoring wells along the site boundary of the landfill. Under the existing contract, the landfill contractor 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 southern boundary of SENT Landfill (the boundary next to the SENTX) have been reviewed. *Figure 4.2* shows the locations of these monitoring wells and the landfill gas monitoring results are summarised in *Table 4.1* (see *Annex A* for details).



Source : EPD Website

Figure 4.1

Typical Details of Impermeable Liner at SENT Landfill

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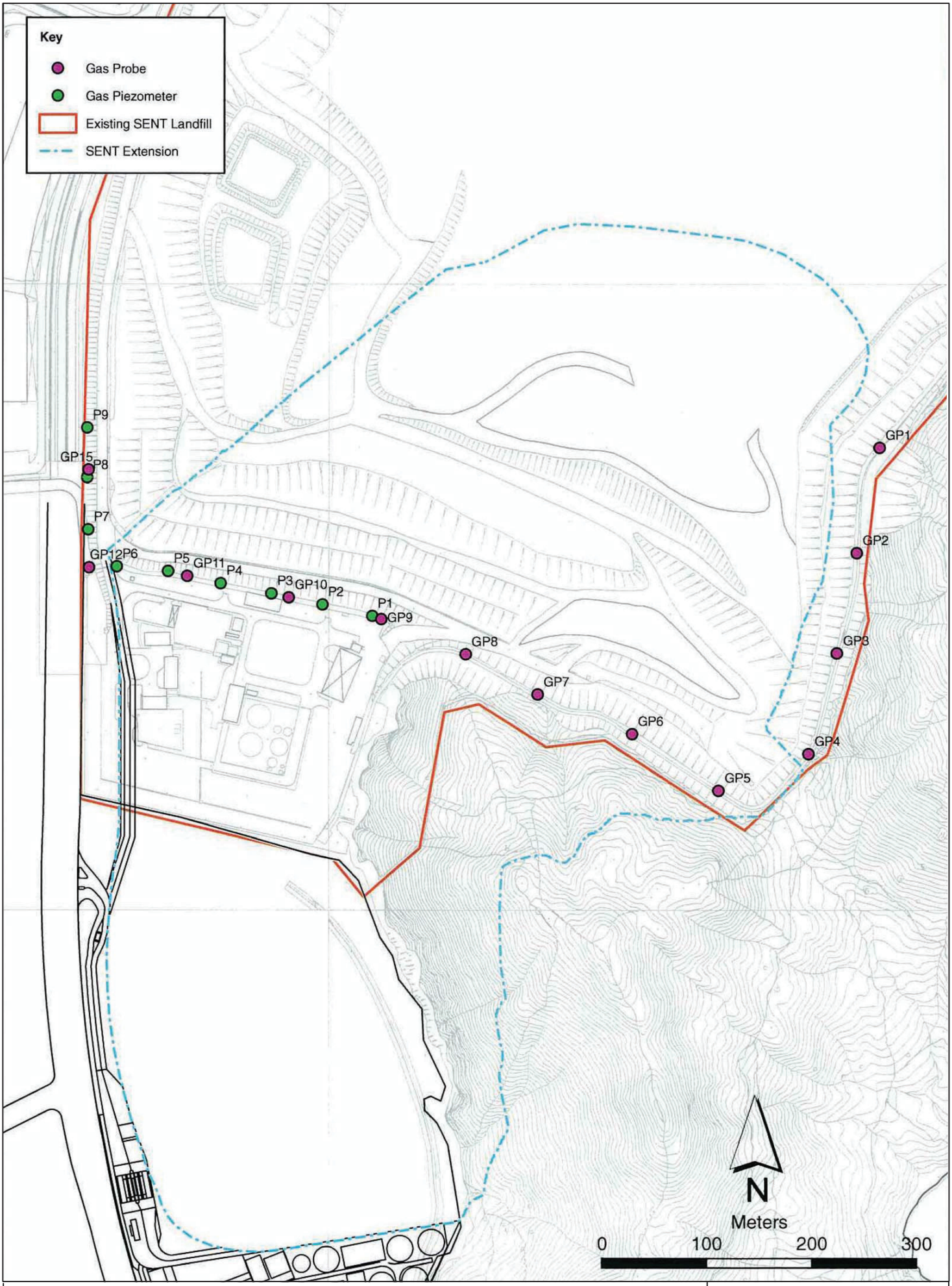

Figure 4.2 Location of Landfill Gas Monitoring Boreholes at SENT Landfill

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Table 4.1 ***Summary of Landfill Gas Monitoring Results of the Perimeter Monitoring Well of the SENT Landfill (From January 2017 to December 2017)***

Location	Methane (% gas)		Carbon Dioxide (% gas)	
	Range	Average	Range	Average
GP-1	0.0 – 0.0	0.0	0.0 – 3.7	1.4
GP-2 (deep)	0.0 – 0.1	0.0	0.0 – 2.3	0.2
GP-2 (shallow)	0.0 – 0.1	0.0	0.0 – 3.6	1.1
GP-3 (deep)	0.0 – 0.0	0.0	0.0 – 3.1	0.5
GP-3 (shallow)	0.0 – 0.0	0.0	0.0 – 1.9	0.4
GP-4 (deep)	0.0 – 0.0	0.0	0.0 – 2.4	0.7
GP-4 (shallow)	0.0 – 0.0	0.0	0.0 – 5.7	1.5
GP-5 (deep)	0.0 – 0.0	0.0	0.0 – 3.2	0.3
GP-5 (shallow)	0.0 – 0.0	0.0	0.0 – 3.3	1.2
GP-6	0.0 – 0.1	0.0	0.0 – 5.3	3.3
GP-7	0.0 – 0.0	0.0	0.0 – 3.5	0.7
GP-8	0.0 – 0.1	0.0	0.0 – 12.7	3.8
GP-9	0.0 – 0.0	0.0	0.0 – 0.2	0.1
GP-10	0.0 – 0.0	0.0	0.0 – 9.2	3.2
GP-11	0.0 – 0.1	0.0	0.0 – 4.4	1.0
GP-15	0.0 – 0.0	0.0	0.0 – 0.0	0.0
P-1	0.0 – 4.6	0.1	0.0 – 16.2	5.8
P-2	0.0 – 0.1	0.0	0.1 – 8.8	2.1
P-3	0.0 – 0.0	0.0	0.0 – 7.0	3.0
P-4	0.0 – 0.0	0.0	0.0 – 9.0	4.0
P-5	0.0 – 0.0	0.0	0.1 – 11.9	3.6
P-6	0.0 – 0.0	0.0	0.0 – 2.3	0.8
P-7	0.0 – 0.0	0.0	0.0 – 0.1	0.0
P-8	0.0 – 0.0	0.0	0.0 – 0.2	0.0
P-9	0.0 – 0.0	0.0	0.0 – 0.3	0.0

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

Positive carbon dioxide readings are not in themselves indicative of a landfill gas presence, however, it is acknowledged that under some circumstances, the methane component of landfill gas may be oxidised leaving reduced concentrations of oxygen and relatively high concentrations of carbon dioxide. Under these circumstances, elevated readings of carbon dioxide and reduced oxygen concentrations could be assumed to be associated with a potential landfill gas presence. Carbon dioxide concentrations in monitoring wells are generally expected to be of the order of 1% v/v, however, under some circumstances, according to geological and hydrogeological conditions, concentrations of 3% v/v or more may reasonably be expected. Oxygen concentrations in monitoring wells are typically 20% v/v.

Low concentrations of carbon dioxide have been observed in these monitoring wells. The average carbon dioxide concentrations detected in all the these perimeter monitoring wells ranged from 0.0% to 5.8% (v/v) while the maximum gas concentrations ranged from 0.1% to 16.2% (v/v). Elevated carbon dioxide concentration (over 15% v/v) was recorded in P-1.In summary, minimal concentrations of methane and low concentrations of carbon dioxide were detected in the perimeter monitoring wells along the southern boundary of SENT Landfill. This suggests that off-site landfill gas migration in this area is under effective control. In addition, as the landfill is lined and leachate is extracted for treatment, the leachate head within the landfill is controlled at low level overall. The groundwater monitoring results do not indicate that the groundwater is contaminated with leachate. As discussed above, the risk of landfill gas generation from groundwater will be very low.

4.3 SENTX

SENTX will occupy 13 ha in TKO Area 137 located immediately south of the existing infrastructure area of existing SENT Landfill. SENTX will piggyback onto the southern slope of the existing SENT Landfill.

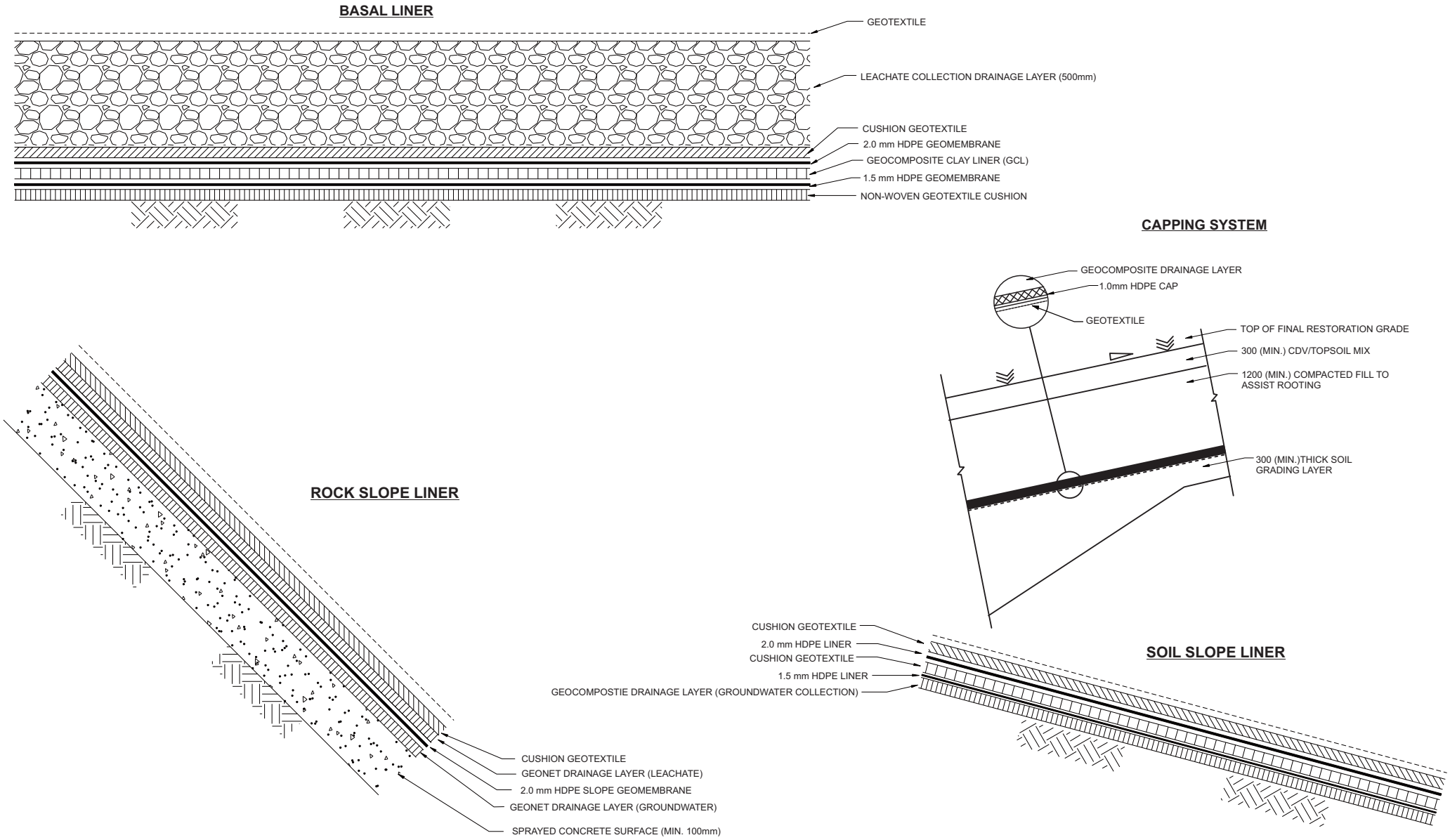
SENTX is designed to receive approximately 6.5 Mm^3 of construction waste over a period of approximately 6 years. It is anticipated that construction and operation of SENTX will commence in early 2019 and early 2021, respectively.

Although SENTX will only accept construction waste which contains much less organic materials which can be decomposed compared to municipal solid waste, low levels of landfill gas will still be generated from decomposition of the organic materials in construction waste and therefore could pose a low landfill gas risk to the operation of the SENTX infrastructure facilities.

4.4 LANDFILL GAS CONTROL FOR THE SENTX

Similar to the SENT Landfill, SENTX will be designed and constructed to incorporate extensive measures to contain, collect, and treat landfill gas and leachate. These measures include a composite liner systems, active landfill gas and leachate extraction and landfill gas treatment and utilisation system (1) in accordance with international best practices for landfill operation. These measures can effectively control sub-surface off-site migration of landfill gas and leachate, as demonstrated by the monitoring data at the existing SENT Landfill. The design of the composite liner system for the SENTX will be similar to those currently being used in the SENT Landfill. Details of the composite liner system designed for the SENTX is shown in *Figure 4.3*.

1) The landfill treatment /utiilsation plant to be provided under the SENTX contract will serve both the landfill gas generated from both the exiting SENT Landfill and SENTX.



NOT TO SCALE

Note : Figure 3 of Environmental Permit No. FEP-01/308/2008/B

Figure 4.3

Multi-layer Composite Liner System

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A comprehensive environmental monitoring programme will be implemented during the construction, operation, restoration and aftercare of the SENTX to monitor landfill gas generated within the SENTX and at the perimeter monitoring wells along the site boundary of SENTX and off-site leachate migration/ groundwater contamination. With reference to the performance standard stipulated in the SENTX contract, GVL 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 SENTX), respectively. GVL 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.

In conclusion, the potential for landfill gas generation from SENTX is low and the most significant source of landfill gas is associated with the decomposition of municipal solid waste (MSW) landfilled at SENT Landfill, which is located over 500 m away (from waste boundary) from the SENTX infrastructure area.

5 POTENTIAL FOR THE DEVELOPMENT TO INTERCEPT LANDFILL GAS

5.1 GEOLOGY AND HYDROGEOLOGY

SENTX is located partly on reclaimed land in TKO Area 137 and partly on the southern slope of the existing SENT Landfill.

It is understood that TKO Area 137 was formed by public fill (inert construction waste, e.g. soils, rock, broken concretes, bentonite, asphaltic concrete, etc.) generated from construction projects in Hong Kong as it has been operating as a fill bank since 2002. The future final level of TKO Area 137 is at approximately +5.5mPD. Based on records of the ground investigation, the level of groundwater table is approximately at +2.8mPD, leaving an unsaturated layer of 2.7m. Although there is a very small potential for landfill gas dissolved in groundwater to be released at remote locations, it is considered that this permeable layer between the SENT Landfill, SENTX and the adjacent existing and future development should be conservatively considered as conducive to landfill gas migration, noting that the level of groundwater may vary with time . Sections through the SENT Landfill and SENTX are presented in *Figures 5.1* and *5.2*.

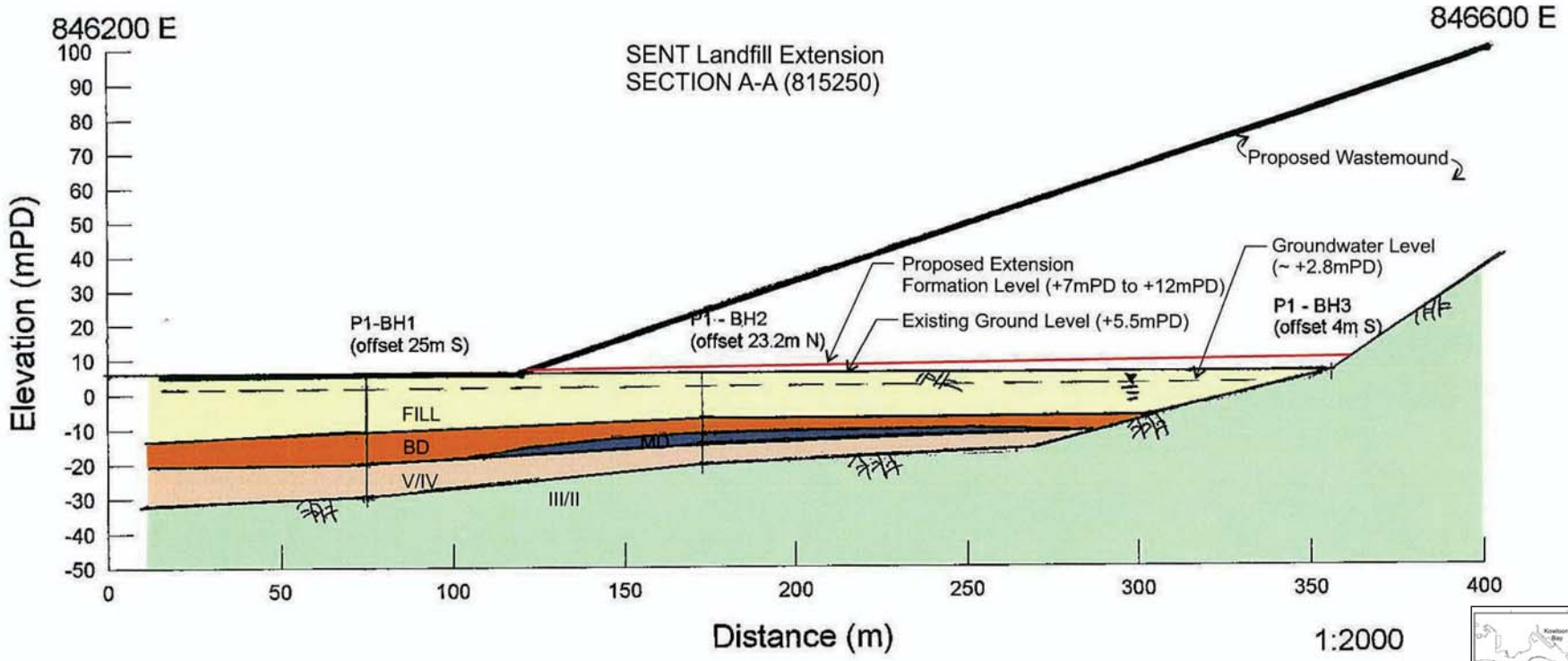
5.2 UTILITIES

It is known that underground utilities (landfill gas collection pipes, electricity, telecommunications and Towngas) exist in the existing infrastructure area of SENT Landfill. However, these underground utilities do not connect to TKO Area 137. It is also understood that currently there are no man-made underground utilities in TKO Area 137, except a surface water box culvert to connect the existing SENT Landfill and the berthing area in TKO Area 137. Layout plan for the utility services in the infrastructure area of the existing SENT Landfill is presented in *Figure 5.3*.

At present, services (electricity, telecommunications and Towngas) exist running parallel to Wan Po Road near TKOIE and there are no man-made underground service channels, tunnels or culverts run contiguously to SENTX.

In future, the utilities to be provided from existing SENT Landfill site to the SENTX site include electricity, telecommunication cables, water mains, sewers, storm water drains, Towngas, Fire Services, landfill gas and leachate pipes along the existing SENT landfill access road. A preliminary layout plan for the proposed utility services to SENTX is presented in *Figure 5.4*.

Electricity and telecommunication cables will be laid underground in ducts which could provide a direct man-made pathway from SENT Landfill to SENTX.



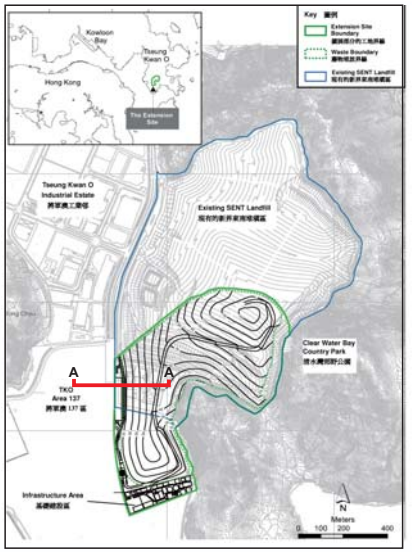


Figure 5.1

Geological Profile (1/2)

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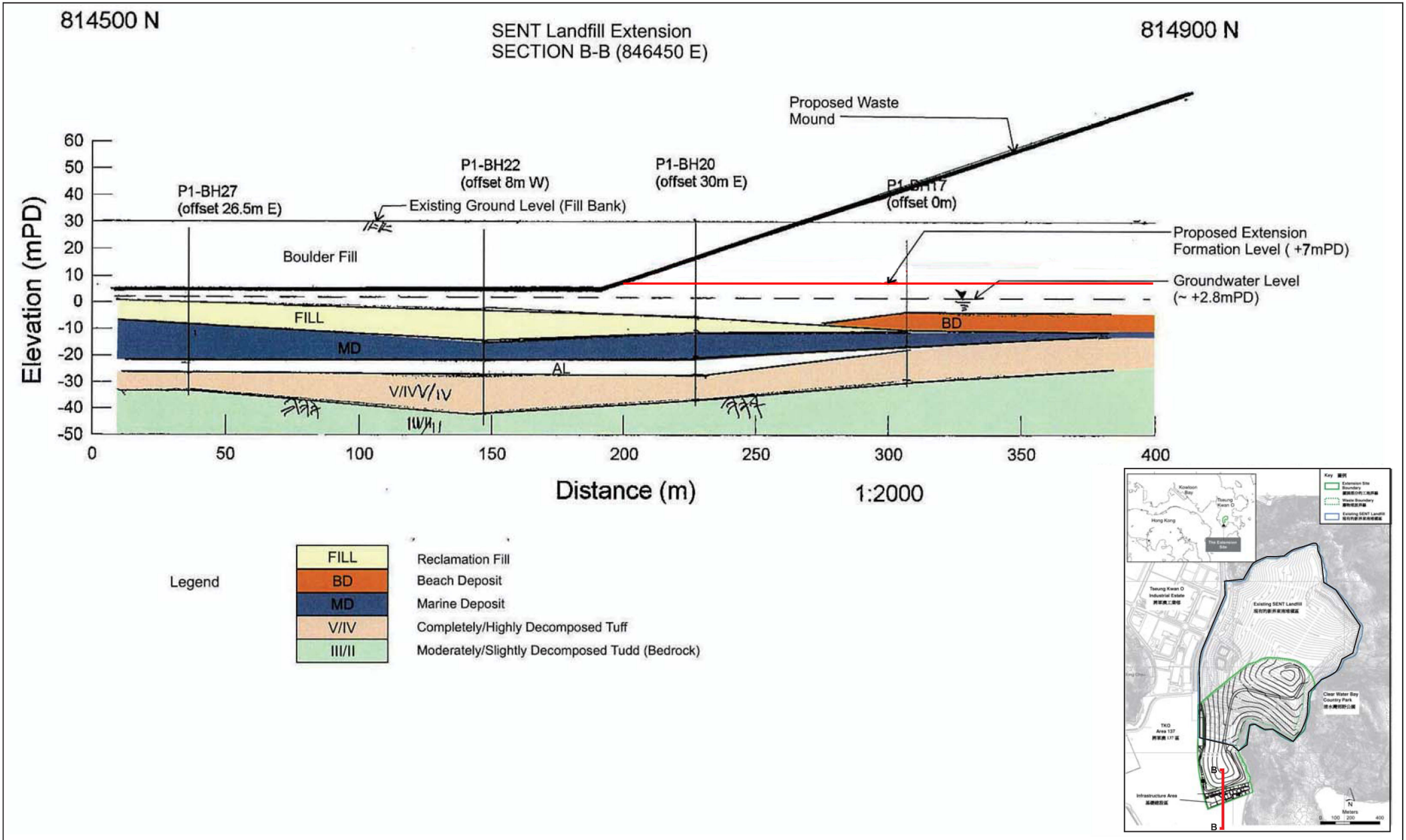

Figure 5.2

Geological Profile (2/2)

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Figure 5.3

Layout Plan for the Utility Services in the Infrastructure Area of the Existing SENT Landfill

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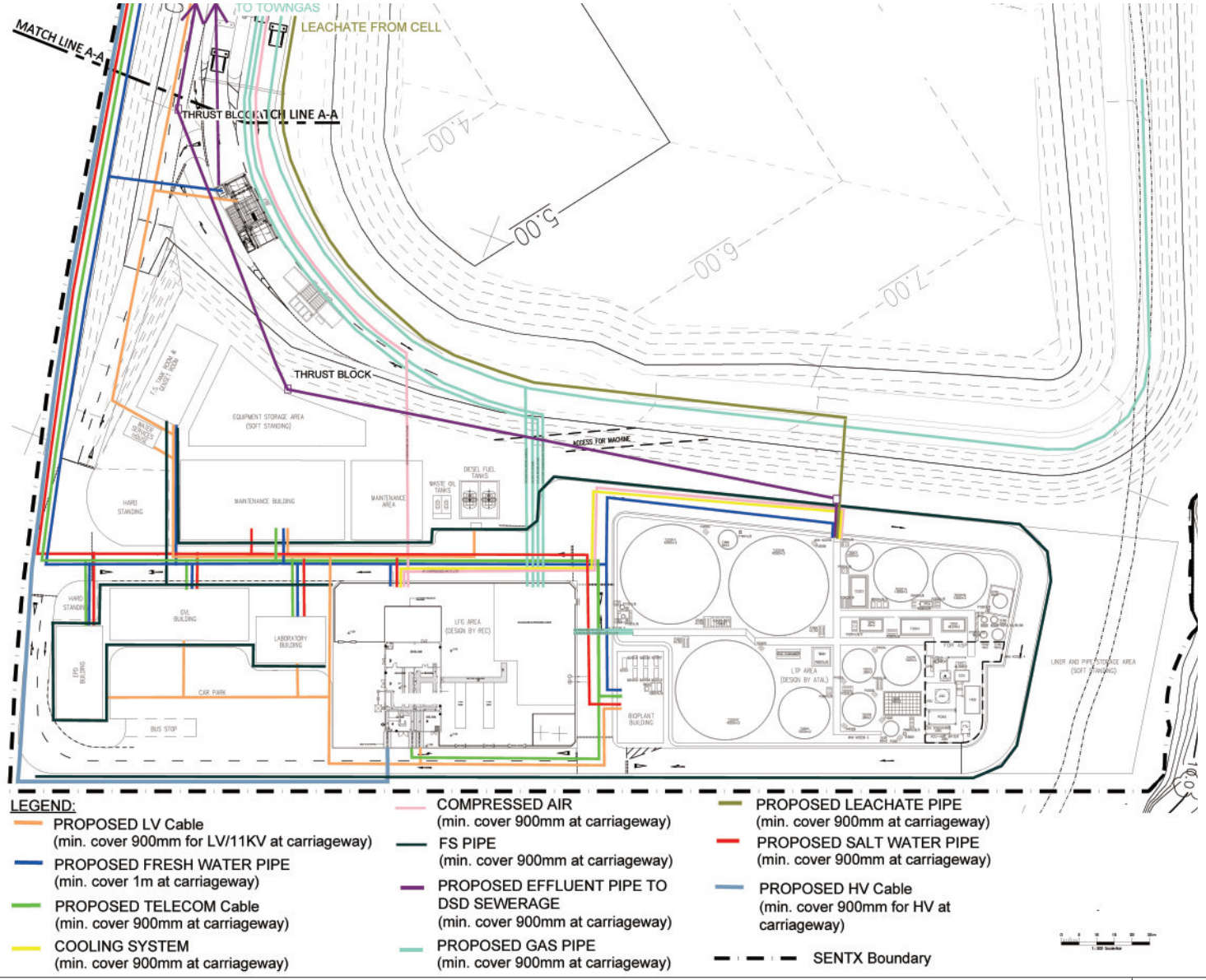

Figure 5.4

Preliminary Layout Plan for the Proposed Utility Services to SENTX (1 of 2)

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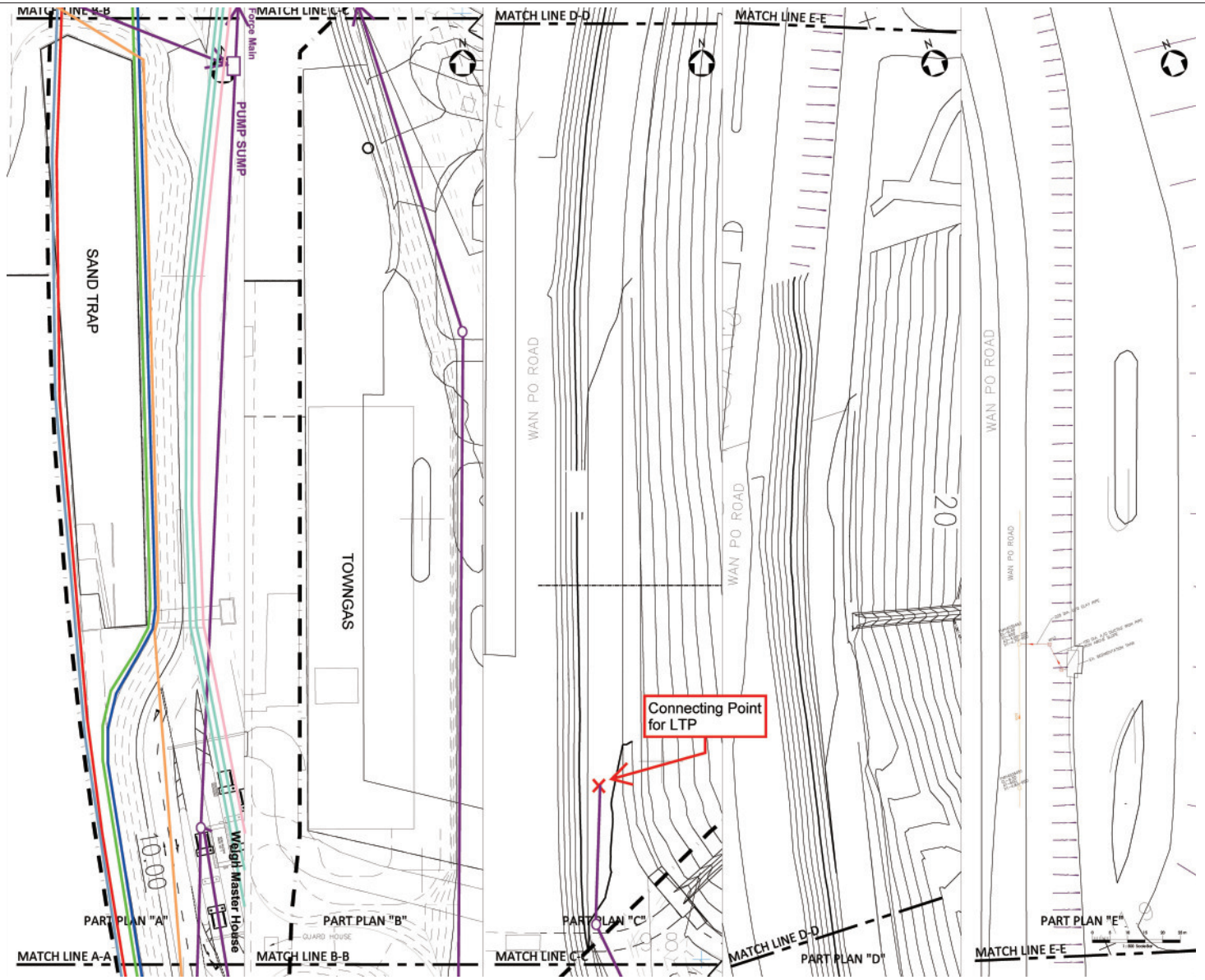

Figure 5.4a

Preliminary Layout Plan for the Proposed Utility Services to SENTX (2 of 2)

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For fresh water (including Fire Services pipes) and salt water pipes (force mains), it is anticipated that the pipes will be filled with water at all the time and there is no risk of landfill gas migration through these pipes.

A proposed effluent pipe to DSD sewerage connection at SENT Landfill will also be a force main and it is anticipated that the pipe will be filled with effluent at all the time and there is no risk of landfill gas migration through this pipe.

Stormwater drains will be connected to gullies and open to atmosphere and the risk of landfill gas migration through this route to the buildings of the SENTX infrastructure area will be low.

Groundwater manhole MH-01 will be relocated from the existing location to the proposed new location close to Wan Po Road (see *Figure 5.5*) with a gravity connection drain which is not directly connected to the infrastructure area of the SENTX or the temporary construction site office.

Landfill gas collection pipes will not act as a potential man-made migration pathway for sub-surface landfill gas migration.

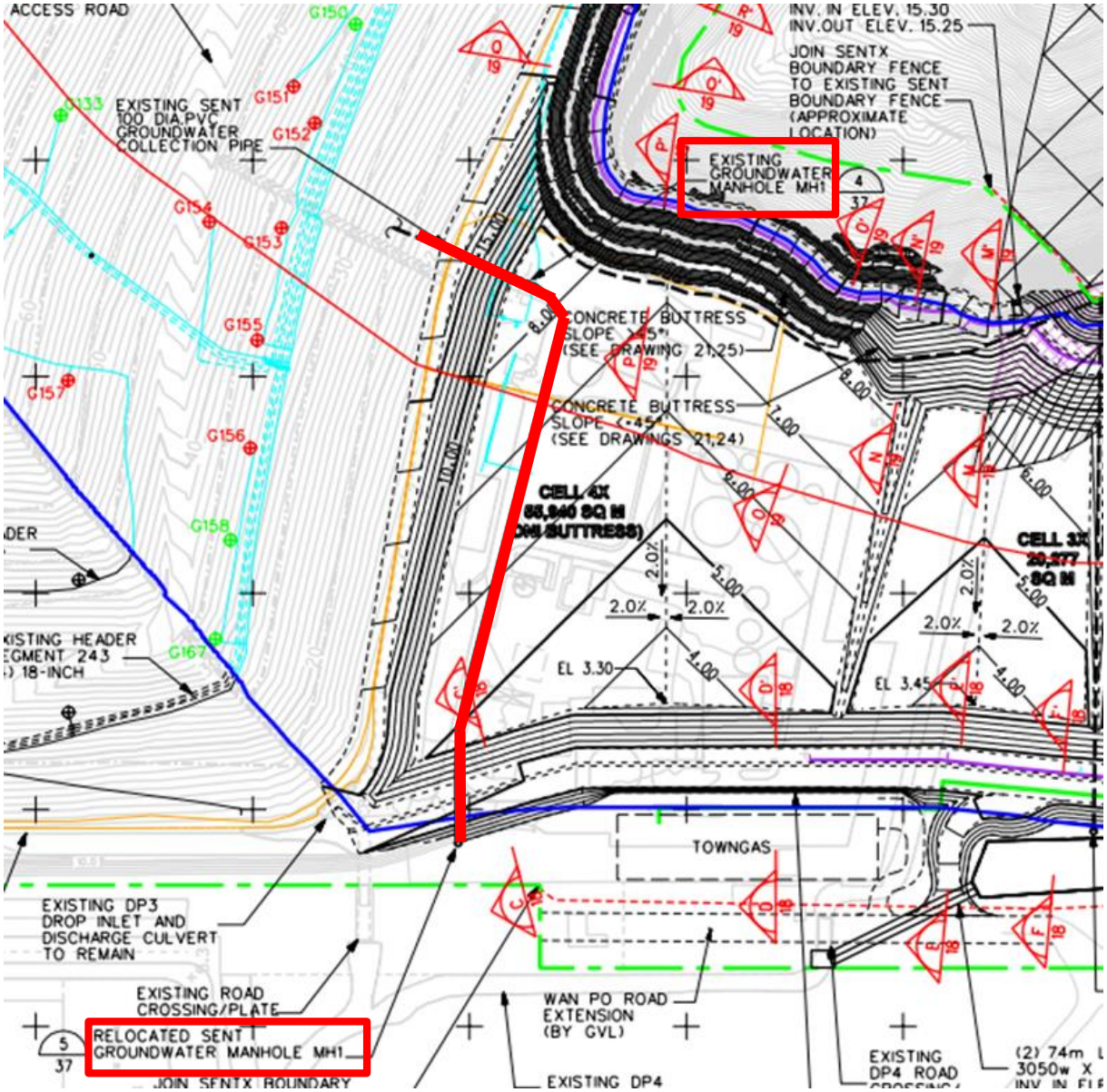

Figure 5.5

Relocation of Groundwater Manhole MH-01

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6 DETAILED DESIGN OF INFRASTRUCTURE AREA

Based on the findings and recommendations of the preliminary QLFGHA of the *approved EIA Report* and the 2011 ERR, GVL has incorporated landfill gas control measures in the detailed design of the SENTX 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*.

6.1 DESCRIPTION OF THE INFRASTRUCTURE AREA

The new infrastructure area will be located immediately south of the SENTX waste boundary (see *Figure 1.1*) and the proposed layout plan of the infrastructure area is presented in *Figure 6.1*. It should be noted that the new infrastructure area is located over 250m from the SENT Landfill site boundary. Therefore, the key risk source for the new infrastructure area is the SENTX.

The infrastructure area includes the following buildings/ structures:

- Fire Service Building;
- Equipment Storage Area;
- Vehicle Washing Area;
- Maintenance Area;
- Maintenance Building;
- EPD Building;
- GVL Building;
- Workshop/Laboratory Building;
- Gas Plant Building;
- Bioplant Building;
- Dangerous Goods Storage Area;
- Security Office; and
- Weighbridge Office.

As the Vehicle Washing Area, Equipment Storage Area, Maintenance Area and Dangerous Goods Storage Area are operated in open space or non-enclosed building, there will be no or very low potential for landfill gas accumulation at these facilities. Therefore, they are not further assessed in this report.

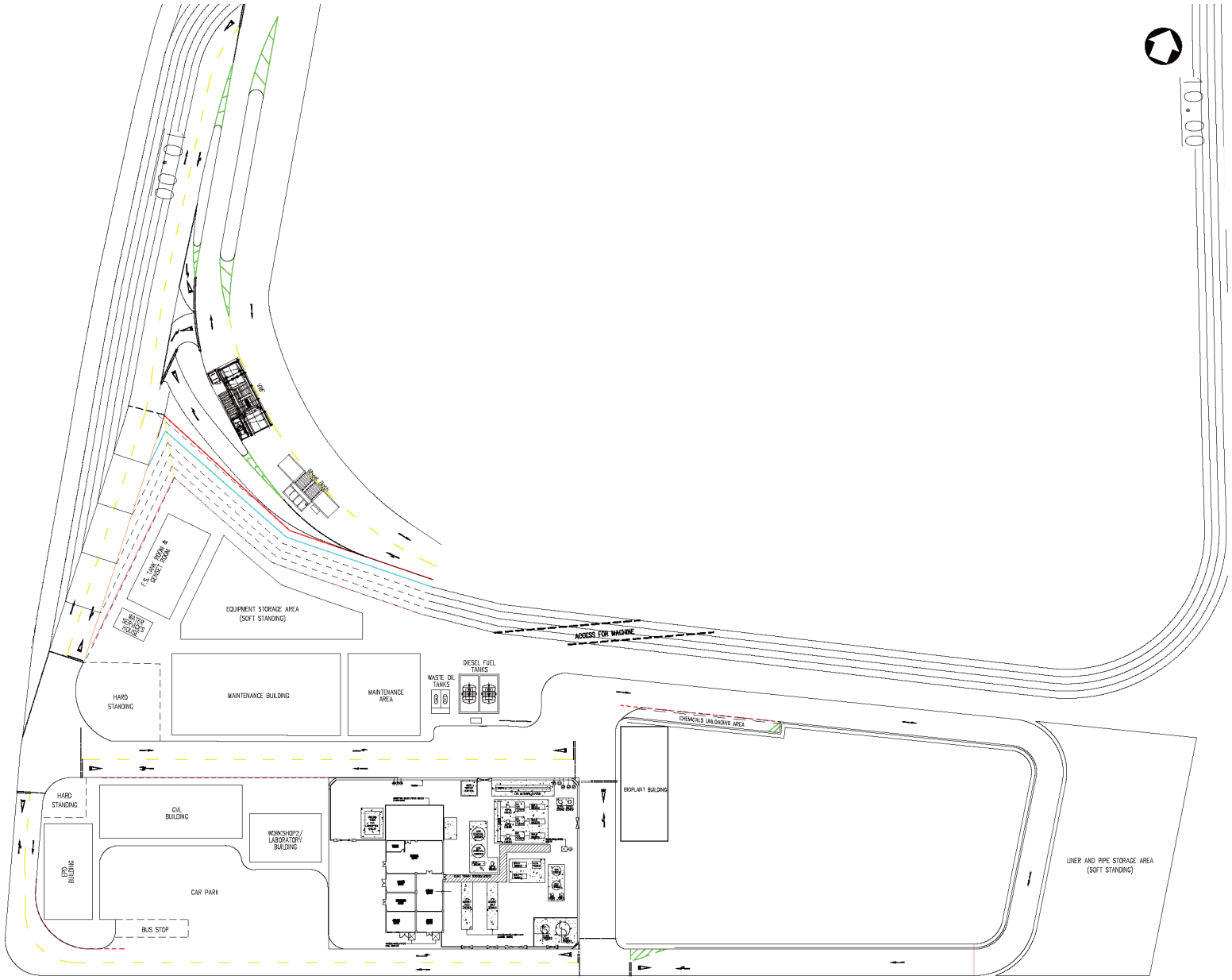

Figure 6.1

Proposed Layout Plan of the SENTX Infrastructure Area

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

Table 6.1 Key Target Facilities in the New Infrastructure Area

Key Facilities		Approximate Distance from the SENTX (Waste Boundary)	Distance from SENT (Waste Boundary)
1.	Weighbridge Office	9 m	500 m
2.	Security Office	20 m	
3.	Bioplant Building	37 m	>500 m
4.	Maintenance Building	41 m	
5.	Fire Service Building	46 m	
6.	Gas Plant Building	71 m	
7.	Workshop/Laboratory Building	81 m	
8.	GVL Building	86 m	
9.	EPD Building	119 m	

6.2 CONSTRUCTION METHODOLOGY

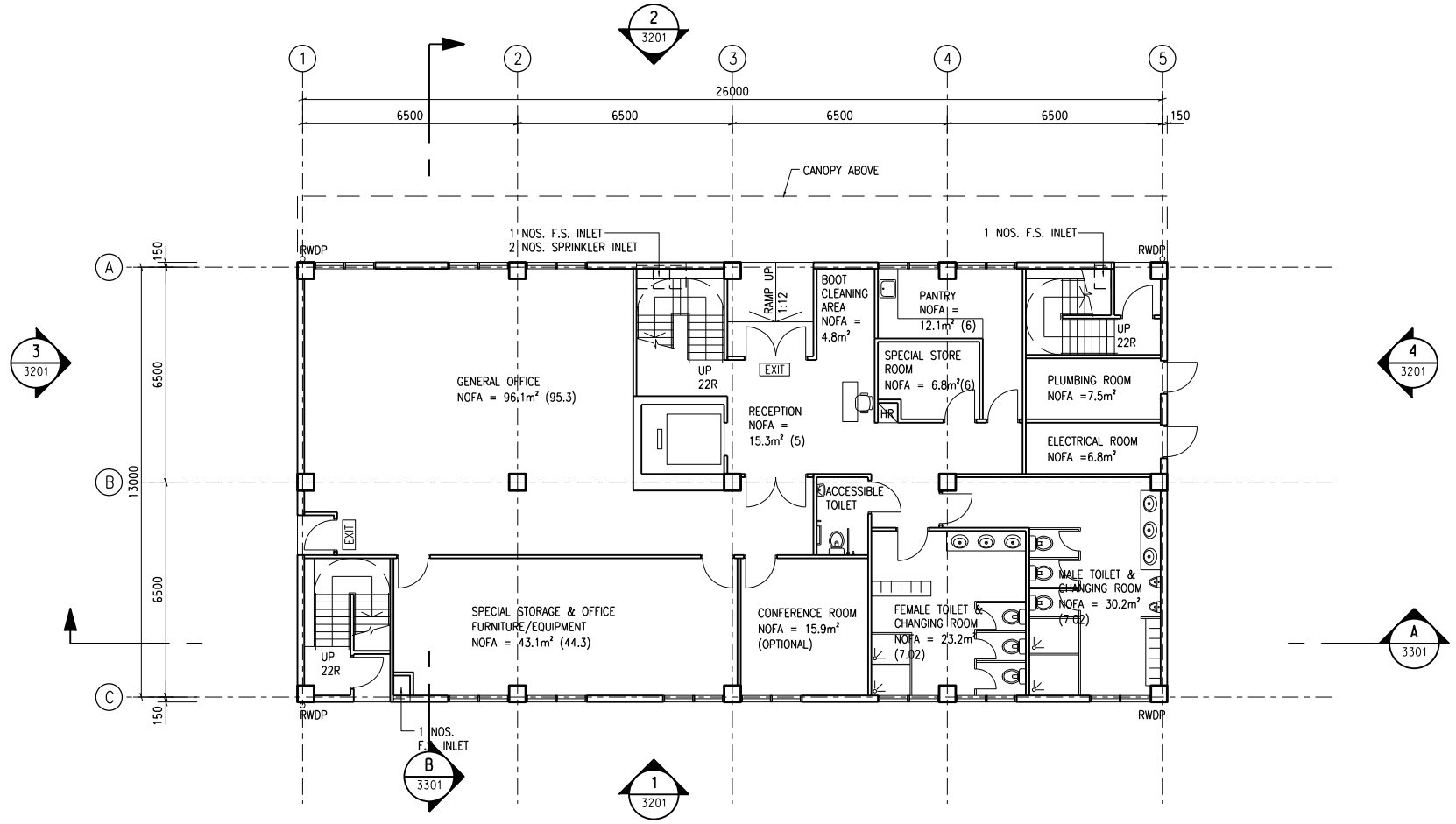
Blasting and slope formation works at the hillside for the infrastructure area is not required under the latest scheme. The site formation works for the landfill lining system will require some open excavation works due to slightly lower formation level for the basal liner and the handling of the stockpile material above +6mPD tentatively left within the SENTX site boundary at the time of site handover (1).

6.3 SENSITIVE TARGET FACILITIES FOR LANDFILL GAS RISK

6.3.1 EPD Building

The EPD building is a two-storey building covering a total area of approximately 350 m^2. Ground level rooms include general office, reception, boot cleaning area, pantry, store rooms, conference room, plumbing room, electrical room and toilets & changing rooms (see *Figure 6.2*). 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*.

(1) The exact quantity of stockpile material from fill bank to be left within the SENTX boundary is still subject to further review by CEDD and EPD.



GROUND FLOOR PLAN 1
SCALE 1:100

Figure 6.2

Ground Floor Plan of EPD Building

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

No.	Room	No. of Air Change Per Hour [(a)]
1	General office	5
2	Reception	5
3	Boot cleaning area	5
4	Pantry	7
5	Special storage & office furniture/equipment	5
6	Conference room	6
7	Special store room	5
8	Plumbing room	5
9	Electrical room	5
10	Male toilet & changing room	10
11	Female toilet & changing room	10
12	Accessible toilet	10

Note:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

6.3.2 GVL Building

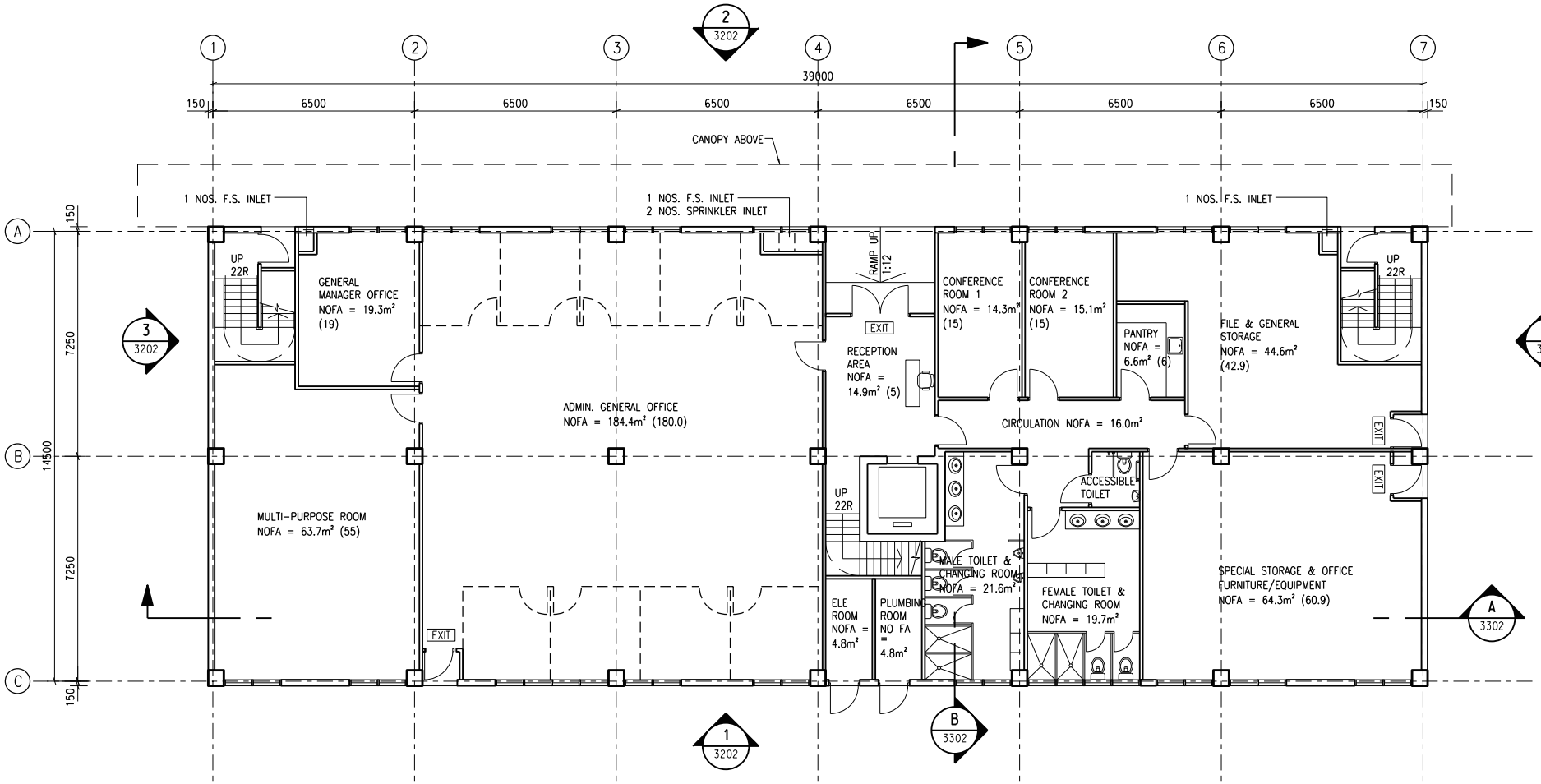
The GVL building consists of two floors and covers a total area of approximately 580 m^2. Ground level rooms include offices, multi-purpose room, conference rooms, reception, electrical room, pantry, store rooms, plumbing room and toilets & changing rooms (see *Figure 6.3*). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change of the ground floor rooms of the GVL Building are presented in *Table 6.3*.

Table 6.3 Designed Air Change of the Ground Floor Rooms of the GVL Building

No.	Room	No. of Air Change Per Hour [(a)]
1	General manager office	5
2	Multi-purpose room & Conference room	6
3	Administration general office	5
4	Reception	5
5	Electrical room	5
6	Conference room 1	6
7	Conference room 2	6
8	Pantry	7
9	File & general storage	5
10	Special storage & office furniture/equipment	5
11	Plumbing room	5
12	Male toilet & changing room	10
13	Female toilet & changing room	10
14	Accessible toilet	10

Note:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.



GVL BUILDING - GROUND FLOOR PLAN 1
SCALE 1:100

Figure 6.3

Ground Floor Plan of GVL Building

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6.3.3 *Workshop/ Laboratory Building*

The Workshop/laboratory building is a two-storey building covering a total area of approximately 260 m^2. Ground level rooms include reception, store rooms, electrical room, plumbing room, workshop, toilets & changing rooms and hose reel pump room (see *Figure 6.4*). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each ground floor room are presented in *Table 6.4*.

Table 6.4 Designed Air Change of the Ground Floor Rooms of the Workshop/ Laboratory Building

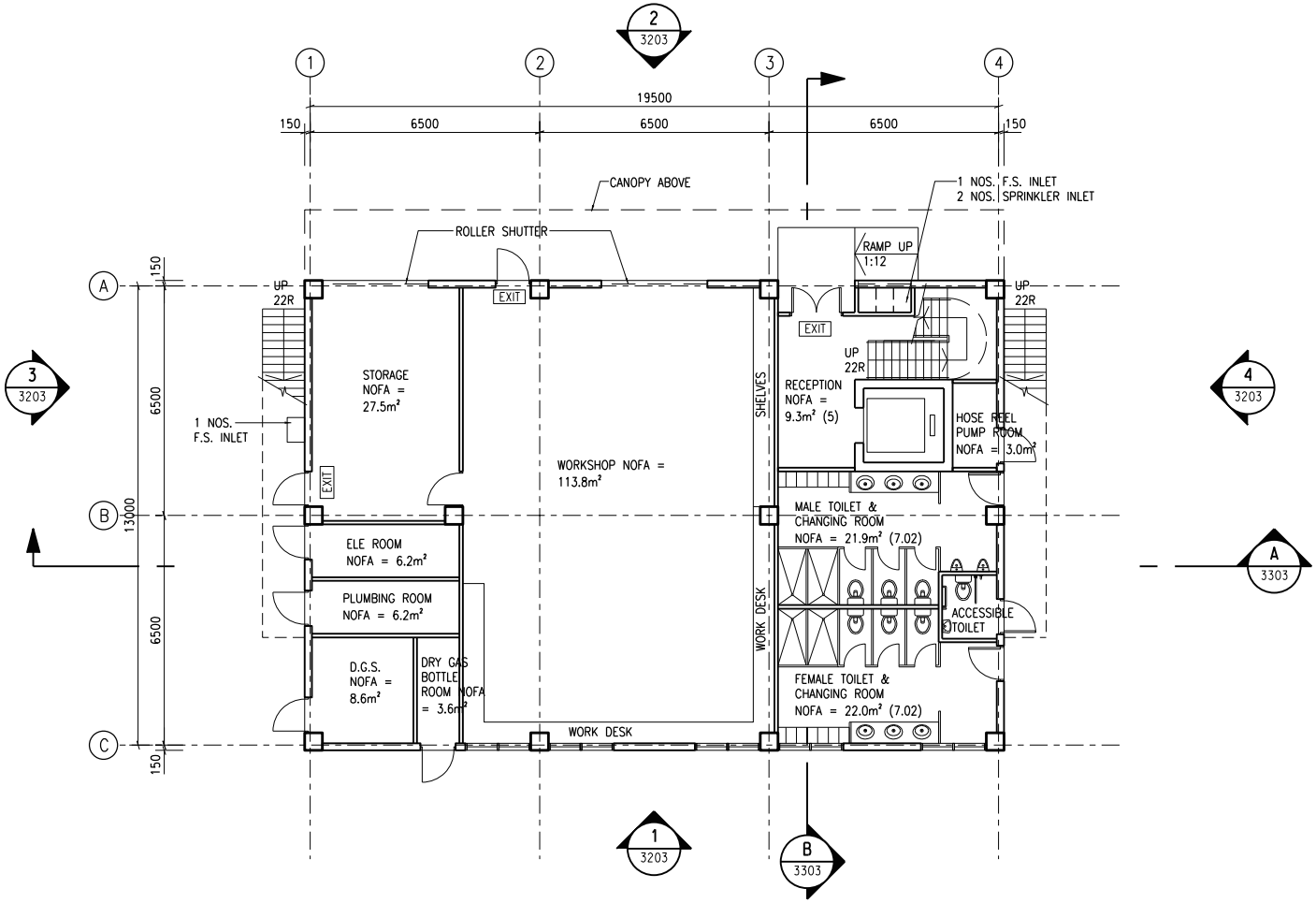
No.	Room	No. of Air Change Per Hour [(a)]
1	Reception	6
2	Dangerous goods storage room	6
3	Dry gas bottle room	6
4	Storage	7
5	Electrical room	5
6	Plumbing room	5
7	Workshop	Natural ventilation
8	Male toilet & changing room	10
9	Female toilet & changing room	10
10	Accessible toilet	10
11	Hose reel pump room	5

Note:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

6.3.4 *Maintenance Building*

The Maintenance building is a two-storey building covering a total area of approximately 980 m^2. The maintenance area is designed with two-storey headroom, where other rooms are single storey in height. Ground level rooms include maintenance area, managers and supervisor's room, reception, pantry and lunch room, plumbing & electrical room, toilets & showers, first aid room, parts/tools storage and hose reel pump room (see *Figure 6.5*). 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 6.5*.



GROUND FLOOR PLAN 1
SCALE 1:100

Figure 6.4

Ground Floor Plan of Workshop/ Laboratory Building

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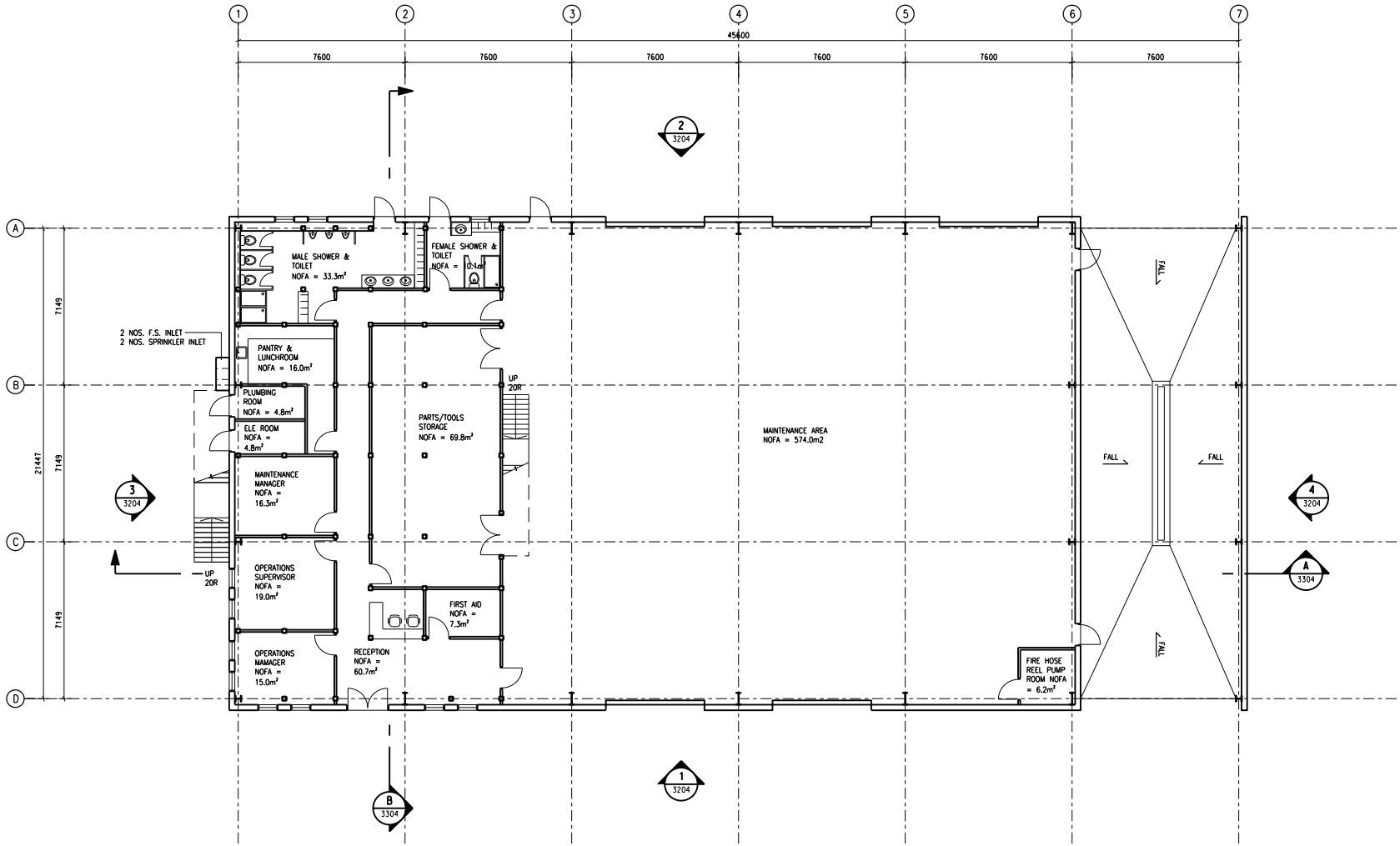

Figure 6.5

Ground Floor Plan of Maintenance Building

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Table 6.5 Designed Air Change of the Ground Floor Rooms of the Maintenance Building

No.	Room	No. of Air Change Per Hour [a]
1	Maintenance area	- [b]
2	Maintenance manager's room	5
3	Operations supervisor's room	5
4	Operations manager's room	5
5	Reception	5
6	Pantry and lunch room	7
7	Plumbing & electrical room	5
8	Female toilet & shower	10
9	Male toilet & shower	10
10	First aid room	8
11	Parts/tools storage	5
12	Fire hose reel pump room	4

Notes:
(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.
(b) Not a confined room

6.3.5 *Bioplant Building*

The Bioplant building consists of two floors and covers a total area of approximately 340 m^2. Ground level rooms include blower room, chemical storage room, workshop and FM200 cylinder room (see *Figure 6.6*). These rooms will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change of the ground floor rooms of the GVL Building are presented in *Table 6.6*.

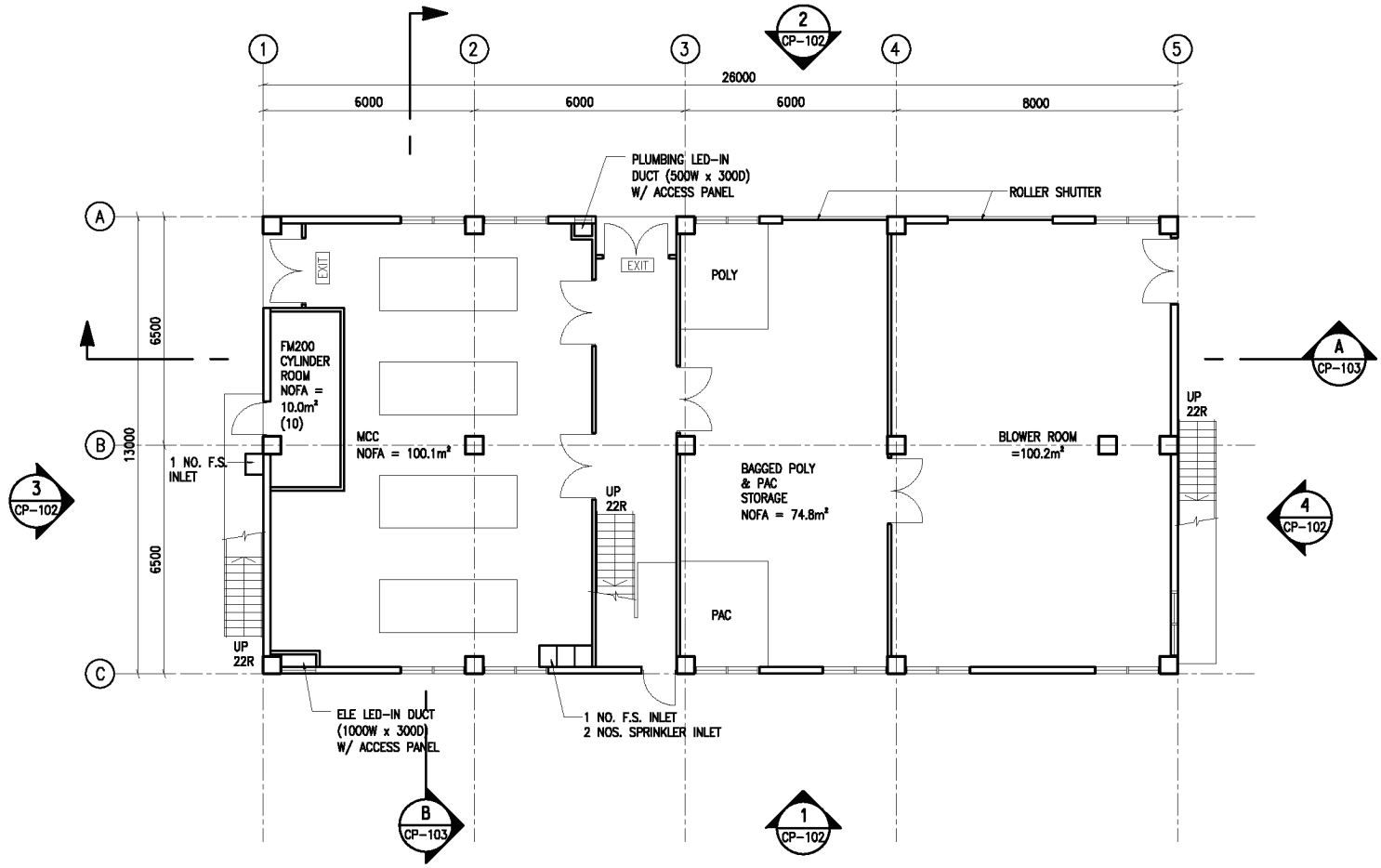
Table 6.6 Designed Air Change of the Ground Floor Rooms of the Bioplant Building

No.	Room	No. of Air Change Per Hour [a]
1	Blower room	5
2	Chemical storage room	6
3	Workshop	10
4	FM200 cylinder room	6

Note:
(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

6.3.6 *Fire Service Building*

The Fire service building covers a total area of approximately 340 m^2. Ground level rooms include fire service pump room, fire service control room and store room (see *Figure 6.7*). These areas will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change of the ground floor rooms of the Fire Service Building are presented in *Table 6.7*.



BIOPLANT BUILDING - GROUND FLOOR PLAN 1

SCALE 1:100

Figure 6.6

Ground Floor Plan of Bioplant Building

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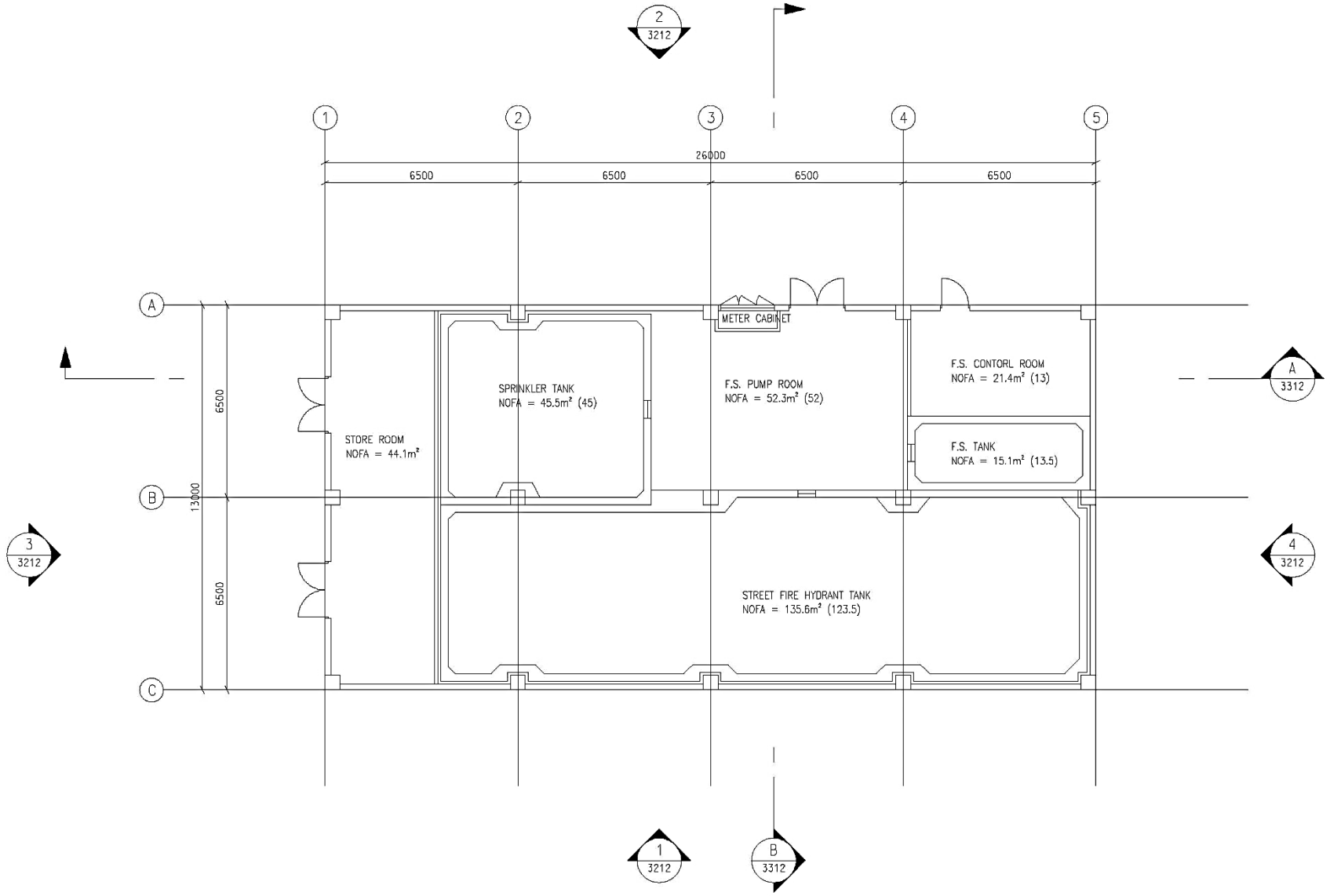

Figure 6.7

Ground Floor Plan of Fire Service Building

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Table 6.7 Designed Air Change of the Ground Floor Rooms of the Fire Service Building

No.	Room	No. of Air Change Per Hour [(a)]
1	Fire Service pump room	5
2	Fire Service control room	5
3	Store room	5

Note:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

6.3.7 Gas Plant Building

The Gas plant building is a single-storey building covering a total area of approximately 390 m^2. Ground level rooms include switch and transformer rooms, control room, toilet and store room (see *Figure 6.8*). These rooms will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room are presented in *Table 6.8*.

Table 6.8 Designed Air Change of the Ground Floor Rooms of the Gas Plant Building

No.	Room	No. of Air Change Per Hour [(a)]
1	LV main switch room	10 – 30
2	CLP transformer room	10 – 30
3	HV switch and transformer room	10 – 30
4	Rec transformer room	10 – 30
5	Control room	6
6	Toilet	10
7	Store room	7

Note:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

6.3.8 Weighbridge Office

The weighbridge office is the closest facility to the SENTX site. It covers a total area of approximately 45 m^2 and consists of the control room and toilet (see *Figure 6.9*). These rooms will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room are presented in *Table 6.9*.

Table 6.9 Designed Air Change of the Ground Floor Rooms of the Weighbridge Office

No.	Room	No. of Air Change Per Hour [(a)]
1	Control room	6
2	Toilet	10

Notes:

(a) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

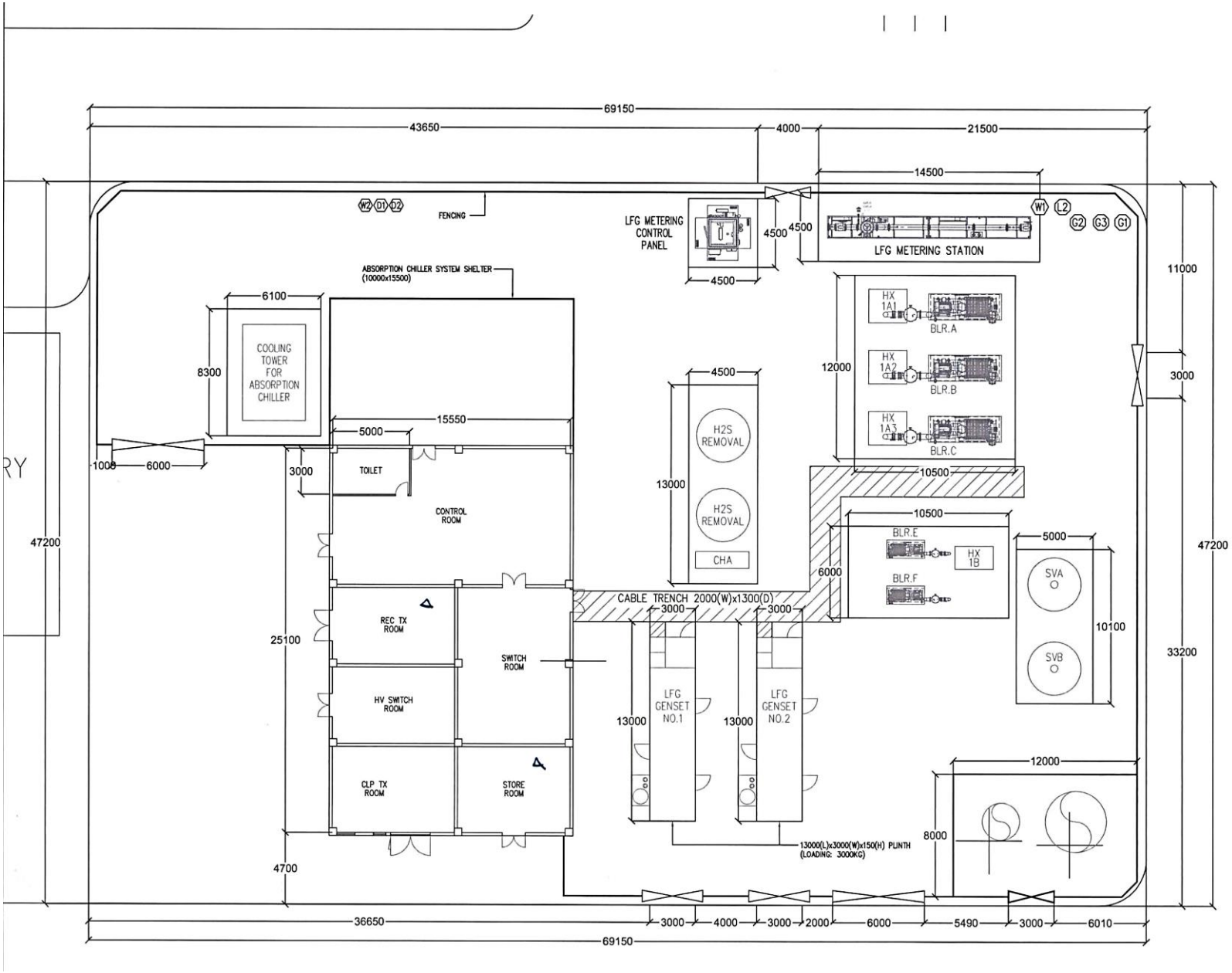

Figure 6.8

Ground Floor Plan of Gas Plant Building

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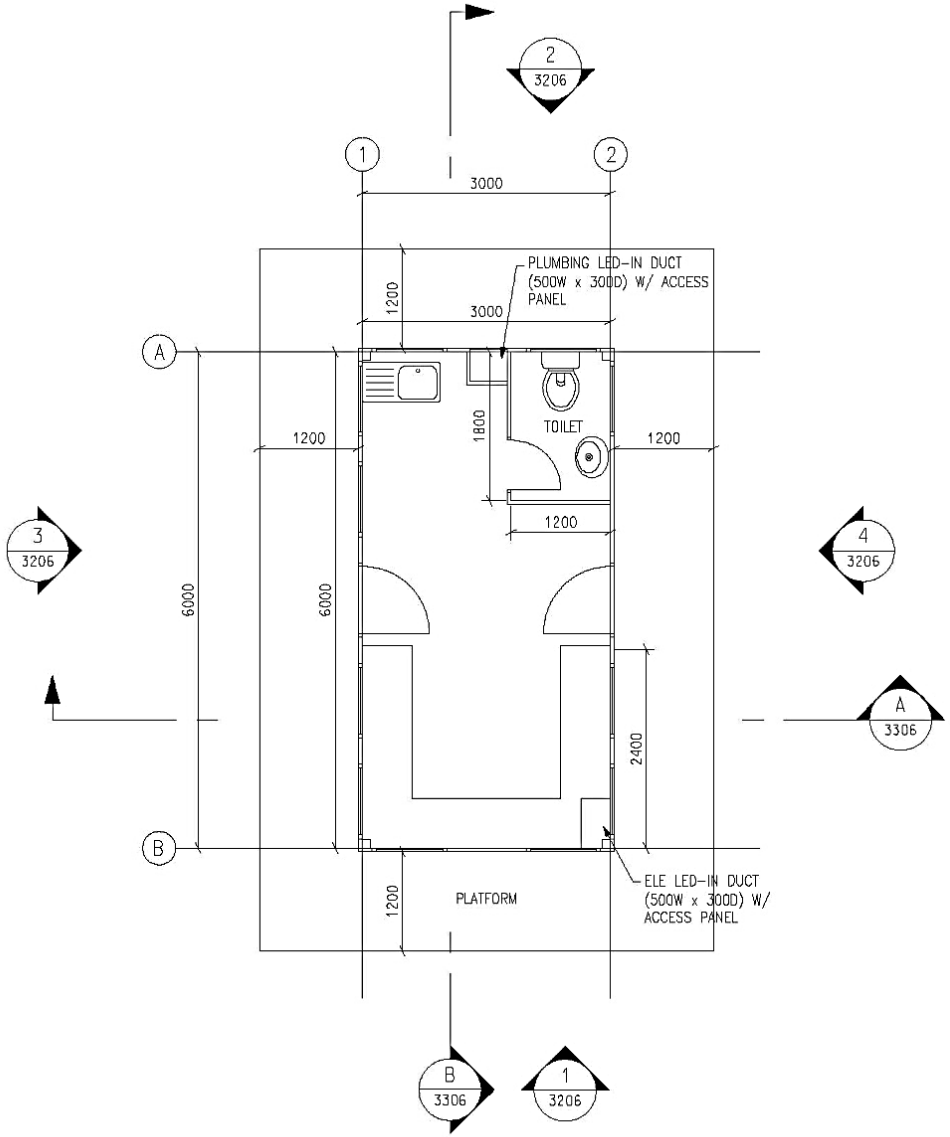

Figure 6.9

Ground Floor Plan of Weighbridge Office

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6.3.9 Security Office

The security office consists of the control room and toilet (see *Figure 6.10*) covering a total area of approximately 16 m^2. These rooms will be provided with mechanical ventilation or air conditioning with natural ventilation. The designed air change for each room are presented in *Table 6.10*.

Table 6.10 Designed Air Change of the Ground Floor Rooms of the Security Office

No.	Room	No. of Air Change Per Hour [(a)]
1	Control room	6
2	Toilet	10

Notes:

(b) Refer to fresh air change rate. A higher air change rate is maintained with air re-circulation.

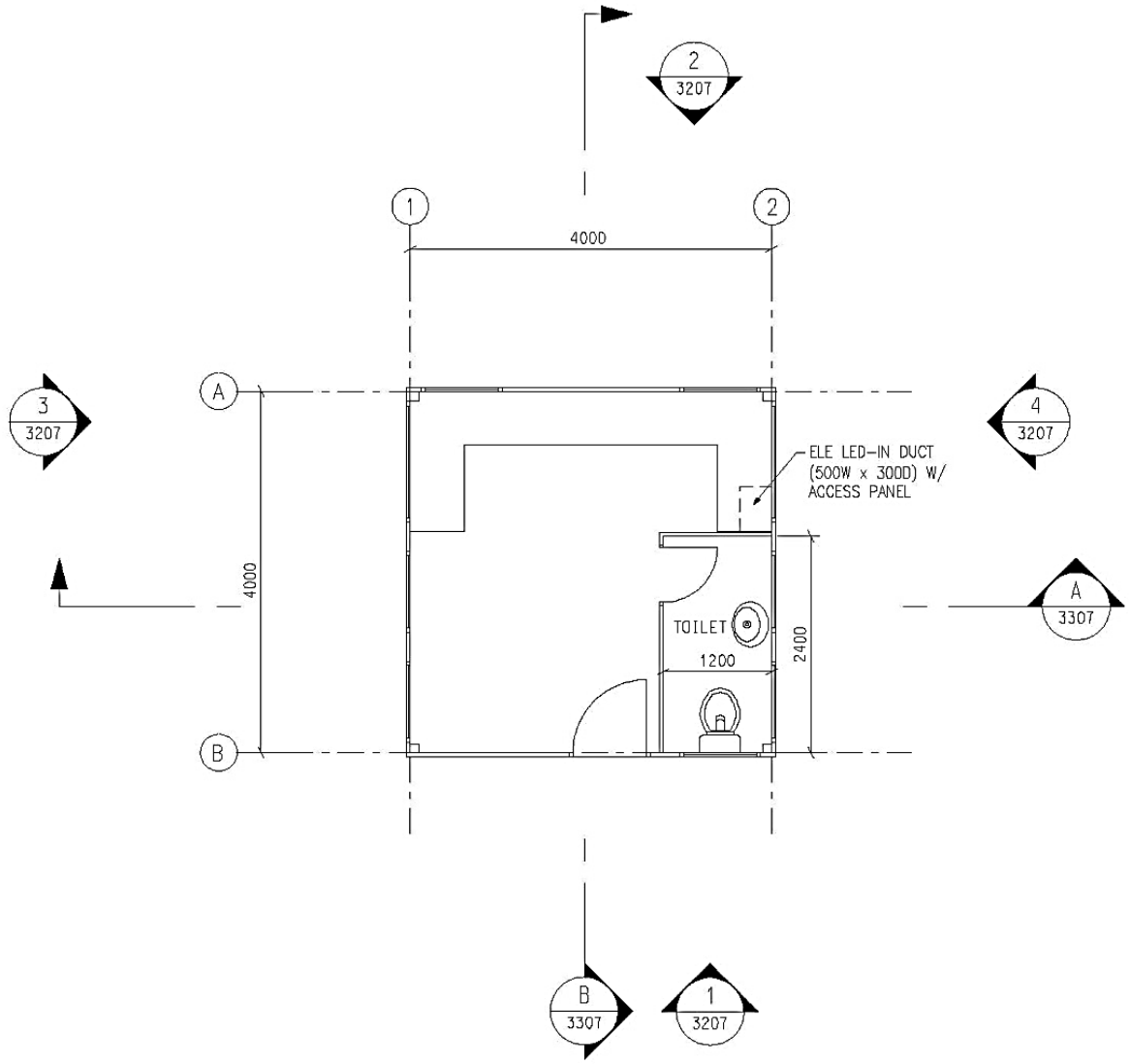

Figure 6.10

Ground Floor Plan of Security Office

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7 QUALITATIVE ASSESSMENT OF RISKS DUE TO LANDFILL GAS

7.1 INTRODUCTION

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

The existing SENT Landfill and the SENTX will both be the source of potential risk of landfill gas migration. However, SENTX has a low potential for landfill gas generation and SENT Landfill is considered to be the most significant potential source. The 250m consultation zones for the SENT Landfill and the SENTX are shown in *Figure 1.2*.

7.2.1 SENT Landfill

As the SENT Landfill is a large operating landfill, the landfill is a significant potential source of landfill gas. The SENT 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.

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. The regular landfill gas monitoring results at the perimeter monitoring wells undertaken by the landfill contractor indicate that an insignificant amount of methane was recorded in the perimeter monitoring wells along the southern boundary. However, according to the *Guidance Note*, a carbon dioxide concentration greater than 5% v/v above background levels in any monitoring well indicates significant migration. Hence, the potential of off-site migration of landfill gas cannot be eliminated.

Given the size of the SENT Landfill, the multiple landfill gas controls implemented and the recent landfill gas monitoring data, the SENT Landfill was classified as a "medium" source of potential landfill gas risk as presented in the *approved EIA Report* which is also applicable to the latest scheme.

7.2.2 SENTX

The original EIA Scheme for SENTX with a void space of about 17 Mm^3 would have occupied 15 ha in TKO Area 137, located immediately to the south of the existing infrastructure area of the SENT Landfill. Under the SENTX contract requirements, the contractor will be required to control off-site landfill gas migration such that the methane and carbon dioxide concentration at the perimeter wells will not exceed 1% v/v and 1.5% v/v above the background

levels, respectively. A gas collection and management system will be installed and operated. As presented in the *approved EIA Report*, SENTX (which will accept MSW, sludge and construction waste) was classified as a "medium" source taking into account the multiple landfill gas control measures to be installed, the recent landfill gas monitoring data of the SENT Landfill, and stringent contract requirements for controlling off-site landfill gas migration.

The latest scheme of SENTX with a void space of about 6.5 Mm^3 will occupy 13 ha in TKO Area 137 and be located immediately to the south of the existing infrastructure area of the SENT Landfill. SENTX in the latest scheme is a lot smaller than the EIA Scheme and will only receive construction waste. It is envisaged that construction waste (with high portion of inert materials) will generate minimal quantities of landfill gas compared to MSW and sludge. Hence, the quantity of landfill gas generated in the latest scheme is expected to be much lower. Nevertheless, landfill gas control measures will still be implemented to ensure that any landfill gas generated can be collected and treated in a controlled and safe manner. Taking into account the nature of waste to be received in the latest scheme, the landfill gas control measures to be installed, the recent landfill gas monitoring data of the SENT Landfill and the stringent contract requirements for controlling off-site landfill gas migration, the SENTX in the latest scheme is conservatively classified as a "minor" source.

7.3 *PATHWAY*

The potential pathways through which landfill gas may enter the SENTX 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 and hydrogeological conditions, which are discussed below.

7.3.1 *Classification of Pathways – from SENT Landfill to SENTX*

At present, the potential pathways for migration of landfill gas from the SENT Landfill to the SENTX Site in TKO Area 137 are considered to comprise mainly natural features and reclamation fill. The formation drain below the base liner system of SENT Landfill provides a direct anthropogenic landfill gas migration pathway connecting the SENT Landfill to the SENTX Site. However, this drain is to be extended as part of the SENTX construction with a gravity connection drain which is not directly connected to the infrastructure area of SENTX or the temporary construction site office (see *Figure 5.5*). The

design of the SENTX will piggyback onto the southern slope of the SENT Landfill where part of the SENT Landfill capping system will be removed and will form a migration pathway for landfill gas to migrate to the portion of SENTX directly over the southern slope of the SENT Landfill. As presented in the *approved EIA Report*, the pathway for landfill gas migration from the SENT Landfill to the SENTX was classified as "very short/direct" taking into account the distance between the SENT Landfill and the SENTX and the presence of possible migration pathways between the two landfills.

Similar to the EIA Scheme, the latest scheme also share a similar footprint at the piggyback section of the SENT Landfill and TKO Area 137. Whilst it is known that underground utilities to be provided from existing SENT Landfill site to the SENTX site will include electricity, telecommunication cables, water mains, sewers, storm water drains, Towngas, Fire Services, landfill gas and leachate pipes. Among all utilities, electricity and telecommunication cables will provide a direct man-made pathway for the transmission of landfill gas from SENT Landfill to SENTX. Nevertheless, landfill gas control measures e.g. seal cable duct with bentonite will be implemented to minimise the potential risks. Based on the latest scheme, the pathway is classified as "very short/direct" for SENTX construction site and tipping face but "long/indirect" for SENTX infrastructure area.

7.3.2 *Classification of Pathways – from the SENTX Waste Boundary to the SENTX Infrastructure Area*

The potential pathways for sub-surface migration of landfill gas from the SENTX waste boundary to the future infrastructure area are considered to comprise both reclamation fill and the future utilities connecting the infrastructure area. At present, no direct anthropogenic migration pathways (man-made underground utilities) have been identified as connecting the SENTX to the adjacent TKO Area 137. Taking into account the distance and the presence of possible migration pathways between the SENTX waste boundary and the SENTX infrastructure area, the pathway for landfill gas migration from the SENTX waste boundary to the future infrastructure area was classified as "very short/direct" in the *approved EIA Report*.

Based on the detailed design of the new infrastructure area, the pathway for landfill gas migration from the SENTX 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 SENTX waste boundary: <50m as very short/direct, 50-100m as moderately short/indirect, 100-250m as long/indirect (see *Table 7.1*).

Table 7.1 Classification of Landfill Gas Migration Pathway

Targets		Pathway Description	Classification
1.	Weighbridge Office	Path length of less than 50m for unsaturated permeable strata or less than 100m for man-made conduits	Very short/direct
2.	Security Office		
3.	Bioplant Building		
4.	Maintenance Building		
5.	Fire Service Building		
6.	Gas Plant Building	Path length of 50 to 100m for unsaturated permeable soil or 100 to 250 m for man-made conduits	Moderately short/direct
7.	Workshop/Laboratory Building		
8.	GVL Building		
9.	EPD Building	Path length of 100 to 250m for unsaturated permeable soils	Long/indirect

7.4 TARGETS

Landfill gas related impacts may occur in areas at or below ground, at the SENTX. The targets identified in the latest scheme are presented below.

7.4.1 Target 1 – Construction Site of the SENTX

As shown in *Figure 1.2*, the majority of the SENTX Site falls within the 250m Landfill Consultation Zone of the SENT Landfill. Demolition and minor excavation at the existing infrastructure area are expected. The excavation area and the areas of 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 main 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 ground floor rooms). While for other temporary site offices located within the SENTX site boundary but outside the 250m Landfill Consultation Zone of the SENT Landfill (see *Figure 7.2*), safety measures given in *Section 8.3* would not be required as the proposed offices will be constructed and subsequently removed prior to the operation of SENTX, which is considered that the SENTX Landfill Consultation Zone would not be in force.

This target was thus classified as "medium sensitivity" in the *approved EIA Report* which is also applicable for the latest scheme.

7.4.2 Target 2 – Operation of the SENTX (Tipping Face)

The majority of the waste tipping face will be carried out within the 250m Landfill Consultation Zone of the SENT Landfill. Waste tipping will be in

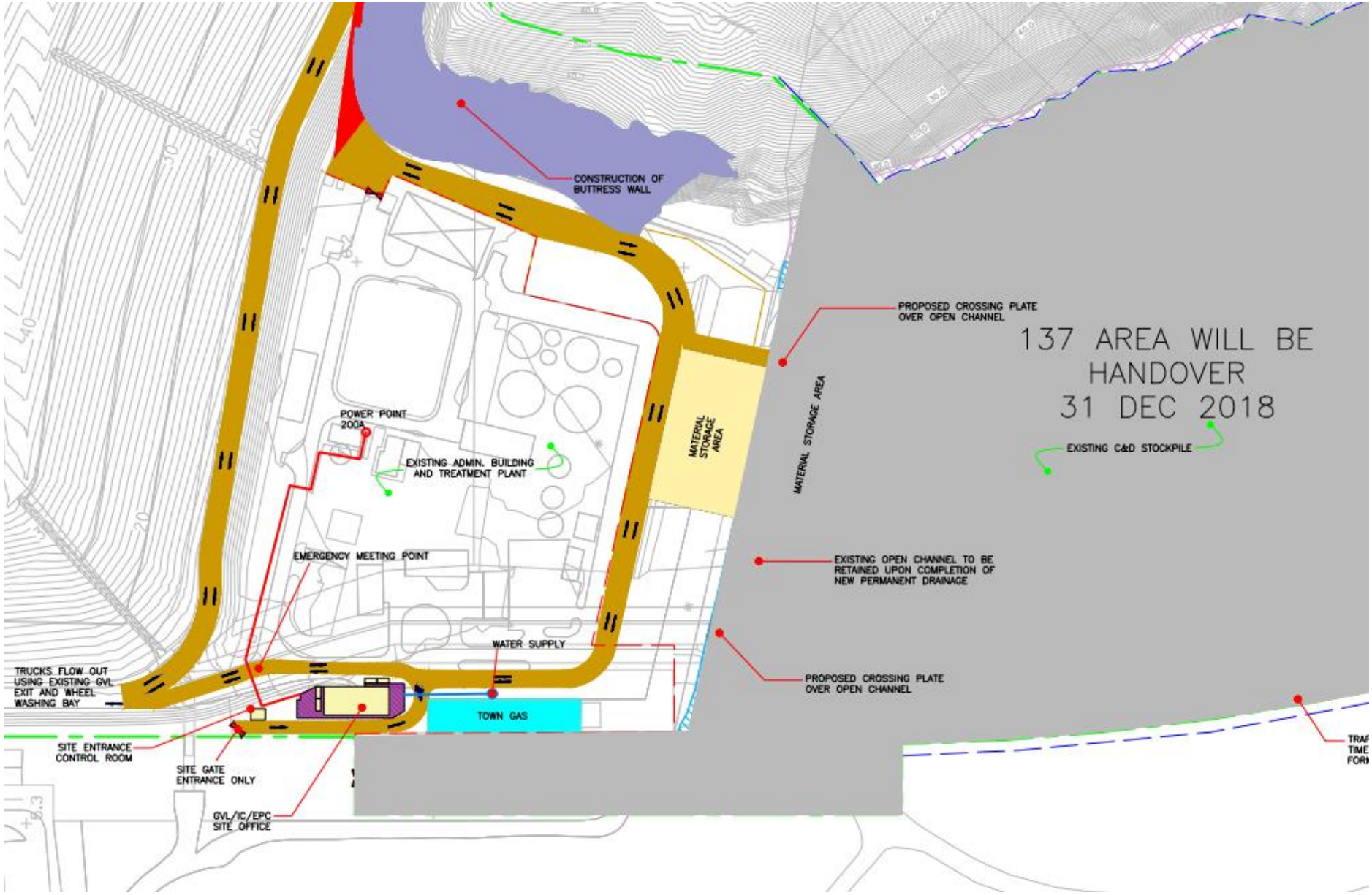

Figure 7.1

Layout Plan of the SENTX Main Temporary Site Office

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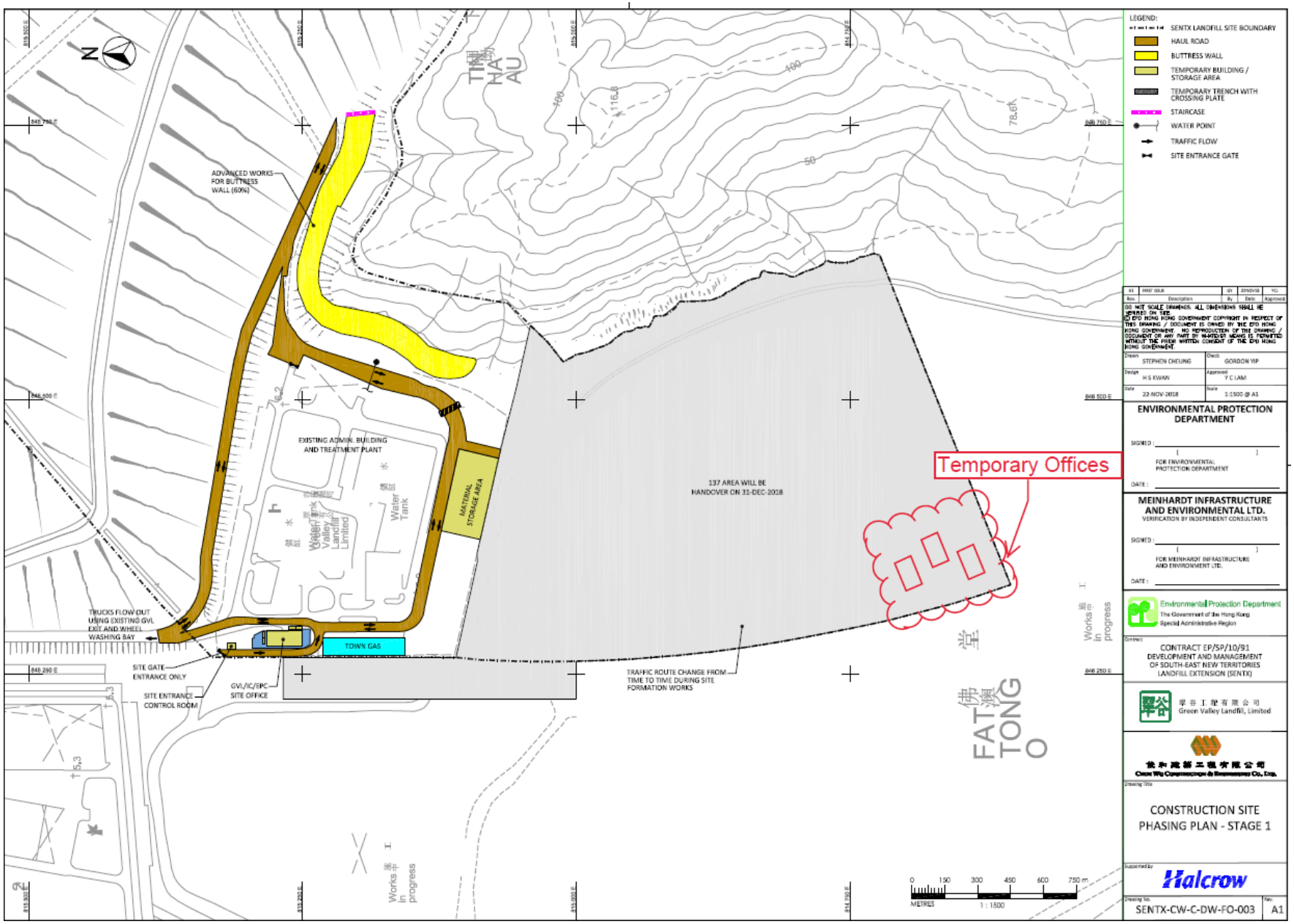

Figure 7.2

Layout Plan of Other SENTX Temporary Site Offices

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the open air which will not involve working at confined spaces and by definition, the SENTX is also a source of landfill gas, thus any migration of landfill gas to the SENTX will either be dispersed and diluted upon contact with the atmosphere or be captured in the landfill gas collection system of the SENTX. In addition, all landfill equipment is designed to work under conditions where flammable gas may present. However, it is also noted that drivers/operators of waste collection vehicles will have access to the waste tipping face for disposal of waste and they may not have knowledge on landfill gas hazards. In view of the above, this target was thus classified as "medium sensitivity" in the *approved EIA Report* which is also applicable for the latest scheme.

7.4.3 Target 3 - Operation of the SENTX (Infrastructure Area)

The proposed new infrastructure area of the SENTX will be outside the 250m Landfill Consultation Zone of the SENT Landfill but within the 250m Landfill Consultation Zone of the SENTX. Landfill gas related impacts are most likely to occur in areas at, or below grade, at the SENTX site. The assessment of potential targets for landfill gas sensitivity in the infrastructure area have thus been selected from the below ground and ground floor rooms of the buildings and structures. Ground level offices and pump rooms with underground utility connections and restricted access by authorised and well trained personnel, and ground level offices and rooms with unrestricted staff access were classified as "medium" and "high" sensitivity in the *approved EIA Report* respectively.

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 *Annex B* for the proposed products to be used) (1); or
- building are raised above ground with sufficient ventilation to prevent accumulation of landfill gas; and

(b) Ventilation

- ground floor rooms will be provided with mechanical or natural ventilation (1) to prevent potential accumulation of landfill gas; and

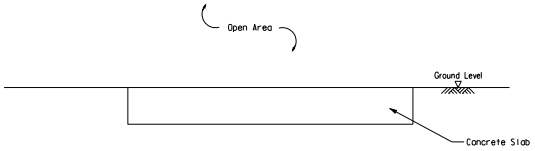
(1) The application of the low gas permeability paints to be submitted with the Material submission in the detailed design stage for IEC's and EPD's approval

(c) Gas alarm

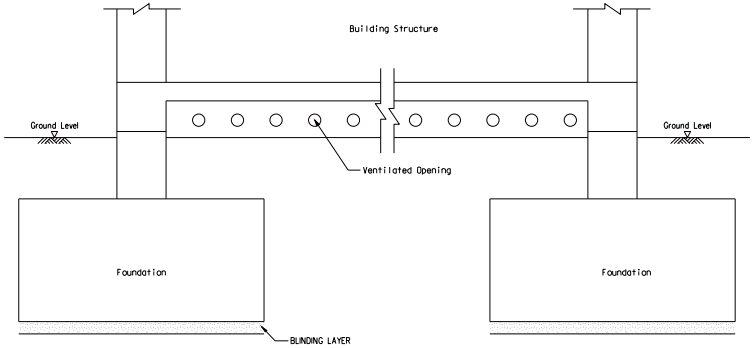
- all occupied on-site buildings will be provided with gas alarm.

Typical details of gas protection measures are shown in *Figure 7.3*. Taking into account the combination of landfill gas control measures that has been incorporated in the detailed design of the SENTX infrastructure area, GVL'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 SENTX infrastructure area are conservatively classified as "very low to low" sensitivity.

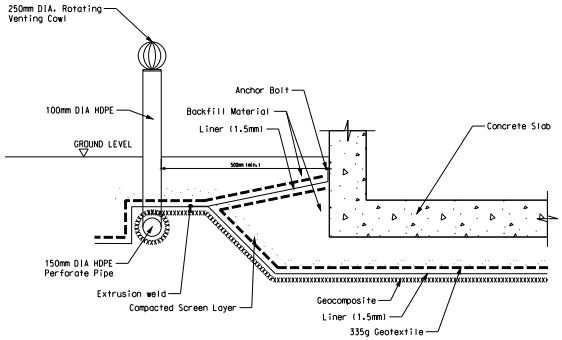
(1) According to CLP's information, CLP Power Hong Kong Limited maintains an electricity supply reliability of over 99.999% under the Scheme of Control Agreement (SCA). Nevertheless, in the event of power failure (for a very short period of time) which cause the mechanical ventilator to stop, the chances of accumulation of explosive levels of landfills gas are minimal.



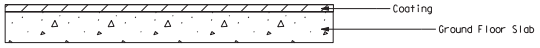
1. Typical Detail of Hardstanding (eg. Bioplant) - No Liner



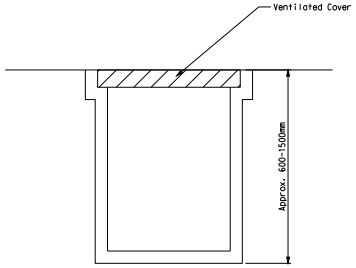
3. Open Sided Building - Raised Floor



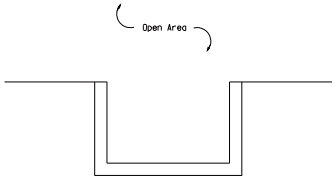
2. Occupied Office Building + Closed Buildings - Liner Protection



2.3 Occupied Office Building + Closed Buildings: Coating Protection



4. Utility Conduit - No Liner



5. Shallow Open Trench

Figure 7.3

Typical Details of Gas Protection for Buildings

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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 3.1a – Control room of Weighbridge Office	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [(a)]	Low
Target 3.1b – Toilet of Weighbridge Office	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [(a)]	Low
Target 3.2a – Control room of Security Office	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [(a)]	Low
Target 3.2b – Toilet of Security Office	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [(a)]	Low
Target 3.3a – Blower room, Chemical storage room, Workshop and FM200 cylinder room of Bioplant Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.4a - Maintenance area of Maintenance Building	• Above ground room • Open area • With natural ventilation • Restricted access by competent person	Medium to High [a]	Low
Target 3.4b - Maintenance manager's room, Operations supervisor's room and Operations manager's room of Maintenance Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [a]	Low
Target 3.4c - Female toilet & shower and Male toilet & shower of Maintenance Building	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [a]	Low
Target 3.4d - Parts/tools storage of Maintenance Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [a]	Low
Target 3.4e - Plumbing & electrical room of Maintenance Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [a]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.4f – Reception and Pantry and lunch room of Maintenance Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [a]	Low
Target 3.4g - First aid room of Maintenance Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted to access staff only	Medium to High [a]	Low
Target 3.4h - Fire hose reel pump room of Maintenance Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [a]	Low
Target 3.5a – Fire Service pump room of Fire Service Building	• Above ground room • With mechanical ventilation (5 air changes per hour) • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [a]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.5b – Fire Service control room and store room of Fire Service Building	• Above ground room • With ventilation system as per Fire Services Department requirement • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [a]	Low
Target 3.6a – Toilet of Gas Plant Building	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [a]	Low
Target 3.6b – Store room and Control room of Gas Plant Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [a]	Low
Target 3.6c – LV main switch room of Gas Plant Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [a]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.6d – CLP transformer room of Gas Plant Building	• Above ground room • With ventilation system as per CLP requirement • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low
Target 3.6e – HV switch and transformer room and Rec transformer room of Gas Plant Building	• Above ground room • With air conditioning and natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low
Target 3.7a - Reception of Workshop/ Laboratory Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [(a)]	Low
Target 3.7b - Dangerous goods storage room and Dry gas bottle room of Workshop/Laboratory Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.7c – Storage of Workshop/ Laboratory Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [a]	Low
Target 3.7d –Workshop of Workshop/ Laboratory Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [a]	Low
Target 3.7e – Female toilet & changing room, Male toilet & changing room and Accessible toilet of Workshop/Laboratory Building	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [a]	Low
Target 3.7f - Electrical room and Plumbing room of Workshop/ Laboratory Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [a]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.7g - Hose reel pump room of Workshop/Laboratory Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [(a)]	Low
Target 3.8a - General manager office, Administration general office, File & general storage and Special storage & office furniture/equipment of GVL Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [(a)]	Low
Target 3.8b - Male toilet & changing room, Female toilet & changing room and Accessible toilet of GVL Building	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to staff only	Medium to High [(a)]	Low
Target 3.8c - Electrical room and Plumbing room of GVL Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.8d - Multi-purpose room & Conference room, Reception, Conference room 1, Conference room 2 and Pantry of GVL Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to GVL and EPD staff and invited guests/ visitors	Medium to High [(a)]	Low
Target 3.9a - Special storage & office furniture/equipment of EPD Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [(a)]	Low
Target 3.9b - Special store room of EPD Building	• Above ground room • With natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by authorised personnel	Medium to High [(a)]	Low
Target 3.9c - Male toilet & changing room, Female toilet & changing room and Accessible toilet of EPD Building	• Above ground room • With mechanical ventilation (10 air changes per hour) • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to EPD staff or invited guests or visitors	Medium to High [(a)]	Low

Targets	Description/ Proposed Mitigation Measures	Sensitivity	
		Preliminary analysis	**With incorporation of Control Measures in the Detailed Design**
Target 3.9d - Plumbing room and Electrical room of EPD Building	• Above ground room • With natural ventilation • With underground utilities connection • With ignition source • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access by competent person	Medium to High [(a)]	Low
Target 3.9e - General office, Reception, Boot cleaning area, Pantry and Conference room of EPD Building	• Above ground room • With air conditioning and natural ventilation • With gas-proofing coating or liner protection or raised floor • With gas alarm • Restricted access to EPD staff and invited guests or visitors	Medium to High [(a)]	Low

Note:

(a) During the preliminary assessment there is not detailed of the accommodation schedule of the buildings within the infrastructure area and therefore the target categorisations is conservative assumed to be medium and high. This has been re-assessed based on the natural of the room or area presented in the detailed design.

7.5 SOURCE-PATHWAY-TARGET ANALYSIS

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 7.2* 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.

The source-pathway-target analysis shows that landfill gas risk posed by the SENT Landfill and the SENTX under the latest scheme is very low to medium within the SENTX Site boundary during both the construction and operation phases. Whereas the risk posed by the SENTX to SENTX infrastructure area ranges from very low to 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 7.2 Qualitative Assessment of Landfill Gas Hazard Associated with the SENTX in the Latest Scheme

Source	Pathway	Target	Qualitative Risk
SENT 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 SENT Landfill and SENTX with potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 1 (Construction site of the SENTX) – demolition and excavation at the existing infrastructure area and construction of temporary site office and trenches using open cut method **(category: medium sensitivity)**	**Medium**
SENT 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 SENT Landfill and SENTX with potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 2 (Tipping face of the SENTX) – waste tipping in the open air, absence of confined space, access by drivers/operators of waste collection vehicles who may not have knowledge on landfill gas hazards **(category: medium sensitivity)**	**Medium**
SENT 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 SENT Landfill and SENTX with potential direct anthropogenic conducts, distance to waste boundary, about 250m **(category: long/indirect)**	Target 3.1a (Infrastructure area of the SENTX - Control room of Weighbridge Office) **(category: low sensitivity)**	**Very low**
		Target 3.1b (Infrastructure area of the SENTX - Toilet of Weighbridge Office) **(category: low sensitivity)**	**Very low**
		Target 3.2a (Infrastructure area of the SENTX - Control room of Security Office) **(category: low sensitivity)**	**Very low**
		Target 3.2b (Infrastructure area of the SENTX - Toilet of Security Office) **(category: low sensitivity)**	**Very low**
		Target 3.3a (Infrastructure area of the SENTX - Blower room, Chemical storage room, Workshop and FM200 cylinder room of Bioplant Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
		Target 3.4a (Infrastructure area of the SENTX - Maintenance area of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4b (Infrastructure area of the SENTX - Maintenance manager's room, Operations supervisor's room and Operations manager's room of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4c (Infrastructure area of the SENTX - Female toilet & shower and Male toilet & shower of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4d (Infrastructure area of the SENTX - Parts/tools storage of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4e (Infrastructure area of the SENTX - Plumbing & electrical room of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4f (Infrastructure area of the SENTX - Reception and Pantry and lunch room of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4g (Infrastructure area of the SENTX - First aid room of Maintenance Building) **(category: low sensitivity)**	**Very low**
		Target 3.4h (Infrastructure area of the SENTX - Fire hose reel pump room of Maintenance Building) **(category: Low sensitivity)**	**Very low**
		Target 3.5a (Infrastructure area of the SENTX - Fire Service pump room of Fire Service Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
		Target 3.5b (Infrastructure area of the SENTX - Fire Service control room and store room of Fire Service Building) **(category: low sensitivity)**	**Very low**
		Target 3.6a (Infrastructure area of the SENTX - Toilet of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6b (Infrastructure area of the SENTX - Store room and Control room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6c (Infrastructure area of the SENTX - LV Main switch room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6d (Infrastructure area of the SENTX - CLP transformer room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6e (Infrastructure area of the SENTX - HV switch and transformer room and Rec transformer room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.7a (Infrastructure area of the SENTX - Reception of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7b (Infrastructure area of the SENTX - Dangerous goods storage room and Dry gas bottle room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7c (Infrastructure area of the SENTX - Storage of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7d (Infrastructure area of the SENTX - Workshop of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
		Target 3.7e (Infrastructure area of the SENTX - Female toilet & changing room, Male toilet & changing room and Accessible toilet of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7f (Infrastructure area of the SENTX - Electrical room and Plumbing room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7g (Infrastructure area of the SENTX - Hose reel pump room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.8a (Infrastructure area of the SENTX - General manager office, Administration general office, File & general storage and Special storage & office furniture/equipment of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8b (Infrastructure area of the SENTX - Male toilet & changing room, Female toilet & changing room and Accessible toilet of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8c (Infrastructure area of the SENTX - Electrical room and Plumbing room of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8d (Infrastructure area of the SENTX - Multi-purpose room & Conference room, Reception, Conference room 1, Conference room 2 and Pantry of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.9a (Infrastructure area of the SENTX - Special storage & office furniture/equipment of EPD Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
		Target 3.9b (Infrastructure area of the SENTX - Special store room of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9c (Infrastructure area of the SENTX - Male toilet & changing room, Female toilet & changing room and Accessible toilet of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9d (Infrastructure area of the SENTX - Plumbing room and Electrical room of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9e (Infrastructure area of the SENTX - General office, Reception, Boot cleaning area, Pantry and Conference room of EPD Building) **(category: low sensitivity)**	**Very low**
The SENTX - potential for gas generation over time, comprehensive and proven mitigation to be installed **(category: minor)**	Sub-surface soil, reclamation fill materials of the unsaturated zone between the SENTX waste boundary and SENTX infrastructure area, potential direct anthropogenic conducts, distance to waste boundary <50m **(category: very short/direct)**	Target 3.1a (Infrastructure area of the SENTX - Control room of Weighbridge Office) **(category: low sensitivity)**	**Low**
		Target 3.1b (Infrastructure area of the SENTX - Toilet of Weighbridge Office) **(category: low sensitivity)**	**Low**
		Target 3.2a (Infrastructure area of the SENTX - Control room of Security Office) **(category: low sensitivity)**	**Low**
		Target 3.2b (Infrastructure area of the SENTX - Toilet of Security Office) **(category: low sensitivity)**	**Low**
		Target 3.3a (Infrastructure area of the SENTX - Blower room, Chemical storage room, Workshop and FM200 cylinder room of Bioplant Building) **(category: low sensitivity)**	**Low**

Source	Pathway	Target	Qualitative Risk
		Target 3.4a (Infrastructure area of the SENTX - Maintenance area of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4b (Infrastructure area of the SENTX - Maintenance manager's room, Operations supervisor's room and Operations manager's room of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4c (Infrastructure area of the SENTX - Female toilet & shower and Male toilet & shower of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4d (Infrastructure area of the SENTX - Parts/tools storage of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4e (Infrastructure area of the SENTX - Plumbing & electrical room of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4f (Infrastructure area of the SENTX - Reception and Pantry and lunch room of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4g (Infrastructure area of the SENTX - First aid room of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.4h (Infrastructure area of the SENTX - Fire hose reel pump room of Maintenance Building) **(category: low sensitivity)**	**Low**
		Target 3.5a (Infrastructure area of the SENTX - Fire Service pump room of Fire Service Building) **(category: low sensitivity)**	**Low**

Source	Pathway	Target	Qualitative Risk
		Target 3.5b (Infrastructure area of the SENTX - Fire Service control room and store room of Fire Service Building) **(category: low sensitivity)**	**Low**
	Sub-surface soil, reclamation fill materials of the unsaturated zone between the SENTX waste boundary and SENTX infrastructure area, potential direct anthropogenic conducts, distance to waste boundary 50 - 100m **(category: moderately short/direct)**	Target 3.6a (Infrastructure area of the SENTX - Toilet of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6b (Infrastructure area of the SENTX - Store room and Control room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6c (Infrastructure area of the SENTX - LV Main switch room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6d (Infrastructure area of the SENTX - CLP transformer room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.6e (Infrastructure area of the SENTX - HV switch and transformer room and Rec transformer room of Gas Plant Building) **(category: low sensitivity)**	**Very low**
		Target 3.7a (Infrastructure area of the SENTX - Reception of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7b (Infrastructure area of the SENTX - Dangerous goods storage room and Dry gas bottle room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7c (Infrastructure area of the SENTX - Storage of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7d (Infrastructure area of the SENTX - Workshop of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
		Target 3.7e (Infrastructure area of the SENTX - Female toilet & changing room, Male toilet & changing room and Accessible toilet of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7f (Infrastructure area of the SENTX - Electrical room and Plumbing room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.7g (Infrastructure area of the SENTX - Hose reel pump room of Workshop/Laboratory Building) **(category: low sensitivity)**	**Very low**
		Target 3.8a (Infrastructure area of the SENTX - General manager office, Administration general office, File & general storage and Special storage & office furniture/equipment of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8b (Infrastructure area of the SENTX - Male toilet & changing room, Female toilet & changing room and Accessible toilet of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8c (Infrastructure area of the SENTX - Electrical room and Plumbing room of GVL Building) **(category: low sensitivity)**	**Very low**
		Target 3.8d (Infrastructure area of the SENTX - Multi-purpose room & Conference room, Reception, Conference room 1, Conference room 2 and Pantry of GVL Building) **(category: low sensitivity)**	**Very low**
	Sub-surface soil, reclamation fill materials of the unsaturated zone between the SENTX waste boundary and SENTX infrastructure area, potential direct	Target 3.9a (Infrastructure area of the SENTX - Special storage & office furniture/equipment of EPD Building) **(category: low sensitivity)**	**Very low**

Source	Pathway	Target	Qualitative Risk
	anthropogenic conducts, distance to waste boundary 100 - 250m **(category: long/indirect)**	Target 3.9b (Infrastructure area of the SENTX - Special store room of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9c (Infrastructure area of the SENTX - Male toilet & changing room, Female toilet & changing room and Accessible toilet of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9d (Infrastructure area of the SENTX - Plumbing room and Electrical room of EPD Building) **(category: low sensitivity)**	**Very low**
		Target 3.9e (Infrastructure area of the SENTX - General office, Reception, Boot cleaning area, Pantry and Conference room of EPD Building) **(category: low sensitivity)**	**Very low**

8 RECOMMENDATIONS

The detailed design of the SENTX 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 SENT Landfill and the SENTX, and various measures have been incorporated to minimise the potential risks.

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

8.1 GENERAL HAZARDS RELATED TO LANDFILL GAS

All contractors participating in the works and operational staff during the operation/restoration and aftercare phases 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 its 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 GENERAL RECOMMENDED PRECAUTIONARY AND PROTECTION MEASURES – DESIGN PHASE

8.2.1 For the Construction and Operation of the SENTX

According to the source-path-target analysis in *Section 7*, the risk category at the SENTX during construction and operation (waste tipping) is medium. This implies that engineering measures will be required during the detailed design stage to ensure that the construction and waste tipping at the SENTX is safe. As the SENTX will be designed, built and operated by an experienced landfill contractor (i.e. GVL who has extensive experience in management landfill in Hong Kong and overseas), relevant engineering measures will be identified and implemented in accordance with the SENTX 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. Migration of landfill gas from the SENT Landfill to the SENTX will be captured by the landfill gas management system at the SENTX. The implementation of the recommended landfill gas control measures will be reviewed and checked by the Independent Consultant jointly employed by the GVL and EPD under the SENTX Contract.

8.2.2 For the Operation of the Infrastructure Area at the SENTX

The infrastructure area at the SENTX is considered to have very low to low risk with the incorporation of the landfill gas control measures in the design of the SENTX infrastructure area. These measures include a combination of passive and active systems and are summarised in *Table 7.2*.

In addition to the control measures listed in *Table 7.2*, landfill gas monitoring wells will be installed between the SENTX waste boundary and the SENTX infrastructure area to monitor the migration of landfill gas, if any.

After the incorporation of the control measures in the detailed design of the SENTX infrastructure areas and with continuous landfill gas monitoring in all occupied on-site buildings, the resulting landfill gas hazards of the identified targets will be low. It is therefore considered that no further control measures (as those described in *Table 7.2*) will be required.

8.3 GENERAL RECOMMENDED PRECAUTIONARY AND PROTECTION MEASURES – CONSTRUCTION PHASE

The construction works to be undertaken at the SENTX Site will involve construction workers and others with risks resulting from contact with landfill gas. For example, when laying of underground pipes/utilities in trenches or other situations, personnel may have to enter confined spaces. Precautionary measures to be adopted by GVL during construction at the SENTX Site are outlined in Paragraphs 8.3 to 8.49 of EPD's *Guidance Note.* With respect to the nature of the construction works for SENTX, the following recommendations referenced from the *Guidance Note* should be adopted:

Safety Measures

- During all works, safety procedures should be implemented to minimise the risks of fires and explosions and asphyxiation of workers (especially in confined space).

- Safety officers, specifically trained with regard to landfill gas related hazards and the appropriate actions to take in adverse circumstances, should be present on the site throughout the works, in particular, when works are undertaken below grade.

- All personnel who work on site and all visitors to the site should be made aware of the possibility of ignition of gas in the vicinity of the works.

- Those staff who work in, or have responsibility for "at risk" areas, including bore piling and excavation works, should receive appropriate training on working in areas susceptible to landfill gas.

- Any offices/quarters set up on site should take precautions against landfill gas ingress, such as landfill gas monitoring and alarm devices. Other storage premises, e.g. shipping containers, where this is not possible should be well ventilated prior to entry.

- Adequate precautions to prevent the accumulation of landfill gas under site buildings and within storage shed should be taken by raising buildings off the ground where appropriate and "airing" storage containers prior to entry by personnel and ensuring adequate ventilation at all times.

- Smoking and naked flames should be prohibited within confined spaces. "No Smoking" and "No Naked Flame" notices in Chinese and English should be posted prominently around the construction site. Safety notices should be posted warning of the potential hazards.

- During the construction works, adequate fire extinguishers and breathing apparatus sets should be made available on site and appropriate training given in their use.

- During piping assembly or conduiting construction, all valves/seals should be closed immediately after installation. As construction progresses, all valves/seals should be closed as installed to prevent the migration of gases through the pipeline/conduit. All piping/ conduiting should be capped at the end of each working day.

- 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.

Monitoring

Monitoring will be undertaken when construction works are carried out in confined space within the consultation zone. 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.

- Monitoring of excavations should be undertaken as follows:

  For excavations deeper than 1m, measurements should be made:

  - at the ground surface before excavation commences;

  - 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 excavations 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.

- If methane (flammable gas) or carbon dioxide concentrations are in excess of the trigger levels or that of oxygen is below the levels specified in the *Emergency Management* in the following section, then evacuation will be initiated.

Actions in the Event of Gas Being Detected

Depending on the results of the measurements, actions required will vary and should be set down by the Safety Officer or another appropriately qualified person. As a minimum these should encompass those actions specified in *Table 8.2*.

Table 8.2 Actions in the Event of Gas Being Detected

Parameter	Measurement	Action
O_2	< 19% v/v	Increase underground ventilation to restore O_2 to >19% v/v
	< 18% v/v	Stop works
		Evacuate all personnel
		Increase ventilation further to restore O_2 to >19% v/v
CH_4	> 10% LEL	Prohibit hot works
		Increase ventilation to restore CH_4 to <10% LEL
	>20% LEL	Stop works
		Evacuate all personnel
		Increase ventilation further to restore CH_4 to <10% LEL
CO_2	>0.5% v/v	Increase ventilation to restore CO_2 to <0.5% v/v
	> 1.5% v/v	Stop works
		Evacuate all personnel
		Increase ventilation further to restore CO_2 to <0.5% v/v

Emergency Management

In order to ensure that evacuation procedures are implemented in the event of the trigger levels specified in *Table 8.2* above being exceeded, it is recommended that a person, such as the Safety Officer, is nominated, with deputies, to be responsible for dealing with any emergency which may occur due to landfill gas.

In an emergency situation, the nominated person or his deputies, shall have the necessary authority and shall ensure that the confined space is evacuated and the necessary works implemented for reducing the concentrations of gas. The following organisations shall also be contacted as appropriate:

- Hong Kong Police Force;
- Fire Services Department; and
- Environmental Protection Department.

8.4 *GENERAL RECOMMENDED PRECAUTIONARY AND PROTECTION MEASURES – OPERATIONAL, RESTORATION AND AFTERCARE PHASES*

The SENTX Contractor

GVL will be responsible to train and to ensure that their staff take appropriate precautions at all times when entering enclosed spaces or plant rooms. GVL 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. GVL will be responsible to prepare and implement emergency plan in case off-site landfill gas migration is detected and the trigger levels specified in *Table 8.3* are being exceeded.

Table 8.3 Actions in the Event of Gas Being Detected

Parameter	Measurement	Action
O_2	< 19% v/v	Increase ventilation of the concerned room(s) to restore O_2 to >19% v/v
	< 18% v/v	Stop works
		Evacuate all personnel
		Increase ventilation further to restore O_2 to >19% v/v
CH_4	> 10% LEL	Prohibit hot works
		Increase ventilation of the concerned room(s) to restore CH_4 to <10% LEL
	>20% LEL	Stop works
		Evacuate all personnel
		Increase ventilation of the concerned room(s) further to restore CH_4 to <10% LEL
		Investigate the potential landfill gas ingress points and sources, and undertake remedial actions (if necessary) to stop the gas ingress
CO_2	>0.5% v/v	Increase ventilation of the concerned room(s) to restore CO_2 to <0.5% v/v
	> 1.5% v/v	Stop works
		Evacuate all personnel
		Increase ventilation further to restore CO_2 to <0.5% v/v

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, particularly in areas where a gas membrane has been installed or involving excavation or penetration beneath the floor slab. Any penetrations

of the membrane must be repaired as soon as possible after detection or works completion using similar products.

GVL should undertake regular monitoring of landfill gas within the SENTX and along the SENTX waste boundary as required by the SENTX Contract Specification and the approved EM&A Manual.

Since SENTX will receive construction waste only, it is recommended that monitoring of landfill gas at the perimeter landfill gas monitoring wells will be required at monthly intervals during the operation, restoration and aftercare of the SENTX. Bulk gas analysis for at least 2 of the perimeter wells should be undertaken at quarterly intervals throughout the operation, restoration and aftercare of the SENTX. In addition, monitoring of service voids, utilities and manholes along the SENTX site boundary and within the SENTX site should be undertaken at monthly intervals throughout the operation, restoration and aftercare of the SENTX. GVL should also undertake surface emission monitoring of methane gas (or flammable gas) in areas between the SENTX site boundary and the waste boundary and location of vegetation stress at quarterly intervals throughout the operation, restoration and aftercare phases. Actions described in *Table 8.3* will be taken if an abnormal level of landfill gas is detected.

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

Since then, the Hong Kong SAR Government has decided to reduce the scale of SENTX assessed in the *approved EIA Report* and SENTX will only receive construction waste. Hence, SENTX has a low potential for landfill gas generation and SENT Landfill is considered to be the most significant potential source. The source classification of SENTX has changed from medium to minor.

Since the source-pathway-target analysis shows that the risk levels associated with the latest scheme (SENTX will accept construction waste only, with the incorporation of the landfill gas control measures adopted in this report) is very low to medium within the SENTX Site boundary during both the construction and operation phases and the risk posed by the SENTX to SENTX infrastructure area ranges from very low to low, no further control measures will be required in addition to those described in *Table 7.2*. With the proposed landfill gas control measures in place, the potential risk of landfill gas migration to the respective targets will be minimal.

Annex A

Landfill Gas Monitoring Results at SENT Landfill (Jan 2017 – Dec 2017)

Location	Jan					Feb					Mar					Apr					May					Jun				
	Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)			
Methane (%gas)																														
GP-1	0					0					0					0					0					0				
GP-2 (deep)	0					0					0					0					0					0.1				
GP-2 (shallow)	0					0					0					0					0					0				
GP-3 (deep)	0					0					0					0					0					0				
GP-3 (shallow)	0					0					0					0					0					0				
GP-4 (deep)	0					NA					NA					NA					0					0				
GP-4 (shallow)	0					NA					0					0					0					0				
GP-5 (deep)	0					0					0					0					0					0				
GP-5 (shallow)	0					0					0					0					0					0				
GP-6	0					0.1					0					0					0					0				
GP-7	0					0					0					0					0					0				
GP-8 (S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
GP-9	0					0					0					0					0					0				
GP-10 (S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-11	0					0					0					0					0.1					0				
GP-15	0					0					0					0					0					0				
P-1 (S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.6	0	0	0
P-2	0					0.1					0.1					0					0					0				
P-3	0					0					0					0					0					0				
P-4	0					0					0					0					0					0				
P-5	0					0					0					0					0					0				
P-6	0					0					0					0					0					0				
P-7 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P-8 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P-9 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 (% gas)																														
GP-1	0					0					3.7					0					2.9					0				
GP-2 (deep)	0					0.1					0					0					0					0.1				
GP-2 (shallow)	0.1					0					1.7					0.3					3					0.3				
GP-3 (deep)	0.3					0					0					0					0					0.4				
GP-3 (shallow)	0.5					0					0					1.3					0					1				
GP-4 (deep)	0					NA					NA					NA					NA					0.1				
GP-4 (shallow)	0					NA					4.3					5.7					5.1					0				
GP-5 (deep)	0					0					0					0					0					3.2				
GP-5 (shallow)	0.1					0					0					0					0.7					0.1				
GP-6	5.1					0.4					3.1					3.5					3.9					3.6				
GP-7	0.3					1.2					3.5					2.5					0					0				
GP-8 (S)	0.1	1.7	0.1	2.1	0.3	2.4	6.2	4.3	5.1	2.4	0	4.1	2.6	2.4	1.2	0	0	0	2.1	0	0	0	6.8	0.5	0	0.1	0.1	0	1.2	2.1	0.3	10.5
GP-9	0					0.2					0					0					0.1					0				
GP-10 (S)	0.1	0.6	0.1	2.8	4.6	3.4	4.9	4.3	4.3	3.4	0	0.7	5.9	6.8	5.2	0	0	2.1	3.8	4.2	0	2	5.8	4	3.9	2	0.2	4.2	2.1	4.3	2.4	0.2
GP-11	0					4.4					2.1					0.5					0.5					0.1				
GP-15	0					0					0					0					0					0				
P-1 (S)	0	7.2	0	0	0.2	12.1	15.2	16.2	0	12.1	0.4	0.1	15.5	0	12.4	0.4	0.2	4.5	0.1	2.1	0.2	0.2	0.1	4.2	4	0.2	0	2.7	6.4	3.7	3.2	0
P-2	0.1					8.8					0.3					0.9					0.9					2.8				
P-3	0					5					3.2					3.6					5.1					2.2				
P-4	6.8					0.3					0.1					0.9					3.6					0				
P-5	1.2					1.2					2					3.3					5					0.1				
P-6	0.5					0.2					0.5					0.5					0.3					0				
P-7 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P-8 (W)	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P-9 (W)	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0.1	0.3	0.2	0.3	0	0	0.1	0.3	0.1	0	0	0

Location	Jul					Aug					Sep					Oct					Nov					Dec					Range		Average
	Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Monthly	Weekly(W) / SEMP (S)				Min	Max	
Methane (%gas)																																
GP-1	0					0					0					0					0					0					0	0	0.0
GP-2 (deep)	0.1					0.1					0					0					0					0					0	0.1	0.0
GP-2 (shallow)	0					0.1					0					0					0					0					0	0.1	0.0
GP-3 (deep)	0					0					0					0					0					0					0	0	0.0
GP-3 (shallow)	0					0					0					0					0					0					0	0	0.0
GP-4 (deep)	0					0					0					0					0					0					0	0	0.0
GP-4 (shallow)	0					0					0					0					0					0					0	0	0.0
GP-5 (deep)	0					0					0					0					0					0					0	0	0.0
GP-5 (shallow)	0					0					0					0					0					0					0	0	0.0
GP-6	0					0					0.1					0					0					0					0	0.1	0.0
GP-7	0					0					0					0					0					0					0	0	0.0
GP-8 (S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.0
GP-9	0					0					0					0					0					0					0	0	0.0
GP-10 (S)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
GP-11	0.1					0					0					0					0					0					0	0.1	0.0
GP-15	0					0					0					0					0					0					0	0	0.0
P-1 (S)	4.6	0	0	0	4.6	0.9	0.3	0.1	0	0.9	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	4.6	0.1
P-2	0					0					0					0					0.1					0.1					0	0.1	0.0
P-3	0					0					0					0					0					0					0	0	0.0
P-4	0					0					0					0					0					0					0	0	0.0
P-5	0					0					0					0					0					0					0	0	0.0
P-6	0					0					0					0					0					0					0	0	0.0
P-7 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
P-8 (W)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
P-9 (W)	0.1	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.3	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.0

NA - Probe blocked, can't take measurements

Results are excluded from the calculation as SEMP/weekly monitoring results duplicate with the monthly monitoring results

Annex B

Specifications of Low Gas Permeability Paints

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

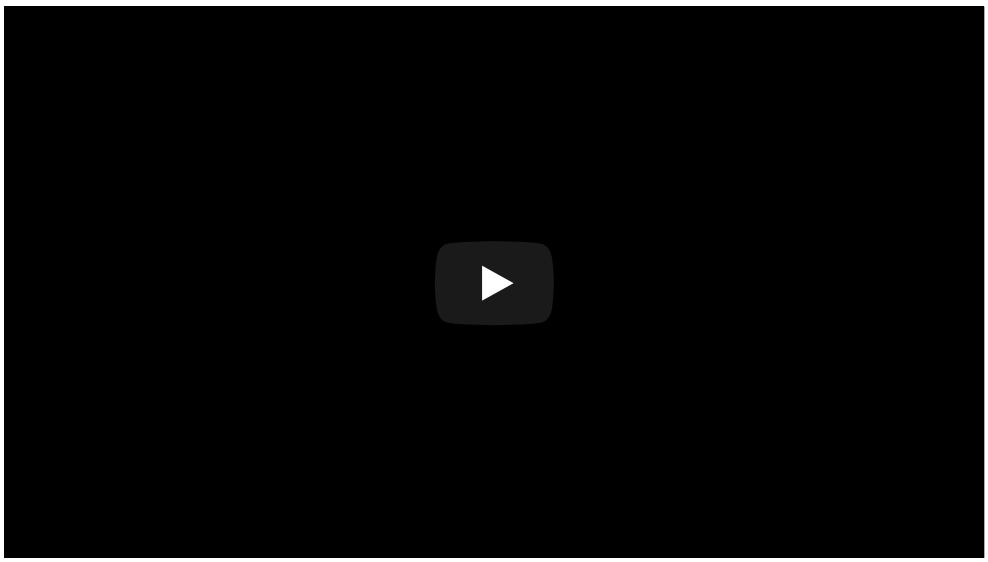
Stephen C

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.