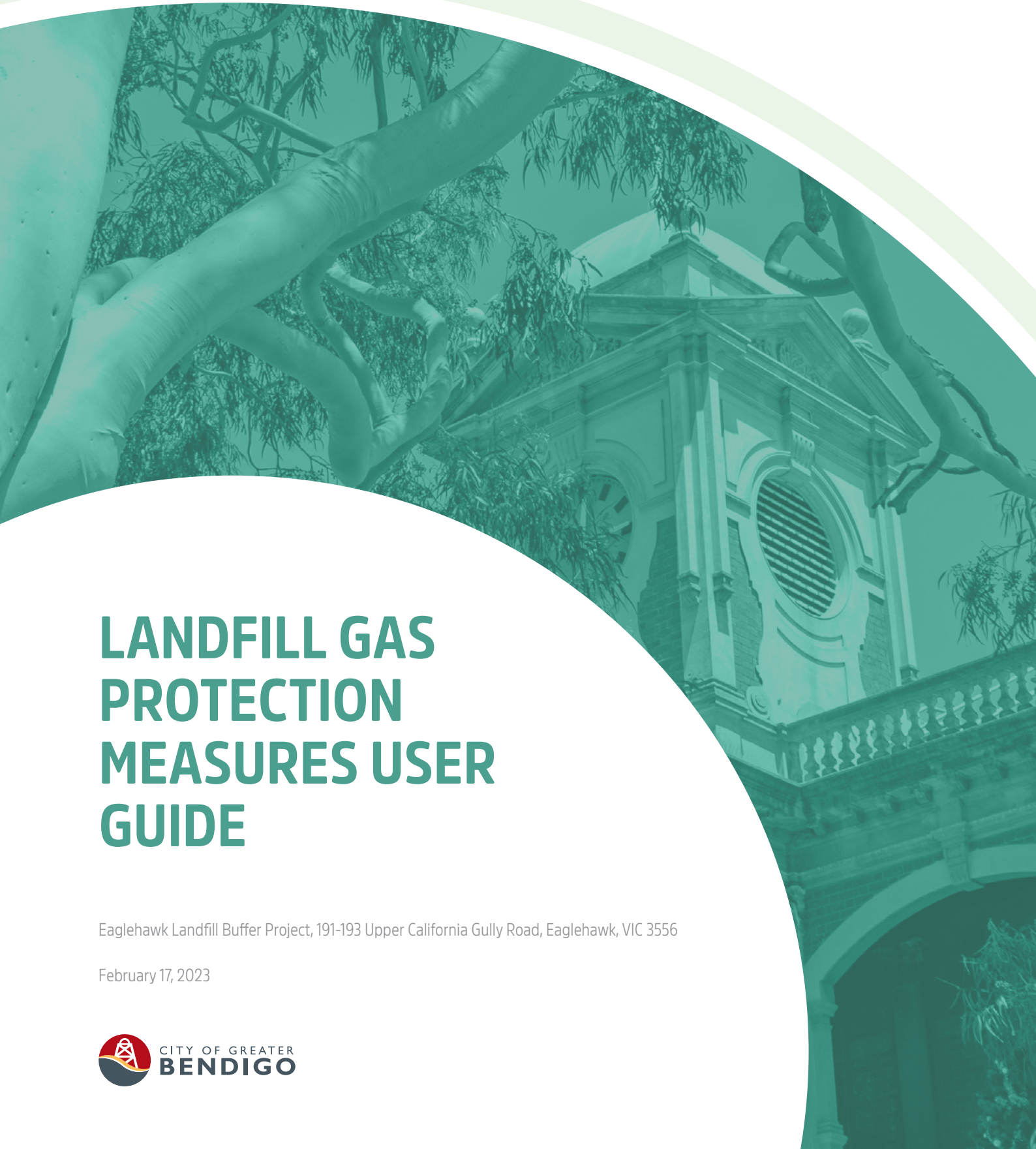


LANDFILL GAS PROTECTION MEASURES USER GUIDE

Eaglehawk Landfill Buffer Project, 191-193 Upper California Gully Road, Eaglehawk, VIC 3556

February 17, 2023

CITY OF GREATER BENDIGO

CONTENTS

APPENDICES

GLOSSARY

AECOM	AECOM Australia Pty Limited.
Applicant	Landowner or their nominated representative who submits an Application.
Application	Planning Permit Application. Required documents submitted to the City of Greater Bendigo when seeking a Planning Permit to use or develop land.
BAO1	Buffer Area Overlay Schedule 1 in the Greater Bendigo Planning Scheme.
BS8485	BSI Standards Publication British Standard BS8485:2015 + A1:2019 Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings.
Buffer Area	Land within 500m of the Eaglehawk Landfill and Transfer Station.
BDT	Building Design Team. Technical specialists normally involved in assisting Applicants with preparing a Planning Permit Application (e.g. Architect, Planner, Building Surveyor, Builder, etc) for a Proposal.
Building Permit	Document issued by a Building Surveyor to confirm that a Project is compliant with Building Regulations and allows work to commence.
Building Surveyor	A Building Surveyor is involved for the duration of the building work. They ensure that building work complies with legal requirements and issue the building permits that allow work to commence.
CEMP	Construction Environmental Management Plan. A CEMP describes how activities undertaken during the construction phase of a Project will be managed to avoid or mitigate environmental or nuisance impacts, and how those environmental management requirements will be implemented.
Characteristic gas situation (CS)	As defined in BS8485. Ground gas regime assumed for design of gas protective measures from the refined conceptual site model after an adequate site investigation. CS range between CS1 (very low hazard potential) to CS6 (very high hazard potential) and have a defined range of gas screening values.
Control Area 1	Residential land within 250m of Eaglehawk Landfill shown in red on Landfill gas control areas buffer map in BAO1.
Control Area 2	Residential land between 250m and 500m of Eaglehawk Landfill shown in blue on Landfill gas control areas buffer map in BAO1.
Control Area 3	Industrial land within 250m of Eaglehawk Landfill shown in orange on Landfill gas control areas buffer map in BAO1.
the City	City of Greater Bendigo.
CQAP	Construction Quality Assurance (CQA) Plan included in Design & Technical Specification (DTS) to ensure verification of Landfill Gas Protection Measures (LGPM) are completed during installation.
CS1	As defined in BS8485, a CS1 is very low hazard potential.
CS2	As defined in BS8485, a CS2 is low hazard potential.
DTS	Proposal specific Design & Technical Specification for Landfill Gas Protection Measures. The Design component documents what is required to theoretically limit the movement of landfill gas to the proposed building, structure or subdivision. The Technical Specification component documents how the gas protection measures are integrated into the proposed building, structure or subdivision.
EAS	Environmental Audit Statement prepared under the *Environment Protection Act 2017*. If a site or Proposal specific EAS has been undertaken it will supercede the recommendations of the Section 53V Audit of Risk of Harm – Landfill Buffer Eaglehawk Landfill, 191 – 193 Upper California Gully Road, Eaglehawk, Victoria (CARMS Ref: 60409-9), ERM (16 December 2019).

Enclosed Building	A building that has a roof and perimeter walls (nominally sealed) from floor to roof level in direct contact with the ground that may, if unprotected, allow uncontrolled accumulation of Landfill Gas. Doors and windows which can be closed, will be considered to be closed when determining if a building is enclosed.
Enclosed Space	A space that has a floor and ceiling and enclosing walls (full or partial height) on all sides.
ERM	Environmental Resources Management Australia Pty Limited.
Gas Protection Score	Gas Protection Scores have been determined based on the zoning of the land. A combination of two or more types of Landfill Gas Protection Measures will need to be installed to achieve the required score.
Ground Disturbance	Actions whereby greater than 300mm depth will be penetrated with the resultant hole giving potential to accumulate landfill gas. Such actions must be considered on a case-by-case basis and managed under relevant WHS legislation to mitigate any identified risks. Low Risk Activities are not considered Ground Disturbance.
Guide	Landfill Gas Protection Measures User Guide prepared for the City by BGL Nominees Pty Limited.
High Risk Construction Work Activity	As defined by the WHS Regulations and in Appendix A of: https://www.safeworkaustralia.gov.au/system/files/documents/1703/information-sheet-safe-work-method-statement.pdf Particularly as Work in an area that may have a contaminated or flammable atmosphere.
Landfill Gas	The microbial degradation of putrescible waste produces landfill gas. The composition of landfill gas varies according to conditions present within the landfill.
Landfill Gas Risk	The risk posed by uncontrolled accumulation of Landfill Gas.
Low Risk Activities	Where actions are conducted that are close to the surface in a well-ventilated area (e.g. mowing the lawn); shallow in nature (e.g. gardening within upper 300mm of the ground surface); or, are localised / well ventilated / temporary in nature (e.g. excavation of a hole to plant a shrub or tree that is backfilled to the original ground surface) they are classified as Low Risk Activities and DO NOT constitute Ground Disturbance.
LGPM	Landfill Gas Protection Measures. This is the collective term for the components of protection used to achieve the Gas Protection Score.
LTEMP	Long Term Environmental Management Plan. The LTEMP documents how the Landfill Gas Protection Measures will be protected and maintained for the life of the structure.
Occupancy Permit	Document issued by a Building Surveyor to confirm that the completed structure is fit for its intended purpose prior to occupancy.
Planning Permit	Planning permits give permission to develop or use land in a particular way. A planning permit may be required for development within the Buffer Area.
Project	Proposal is redefined as a Project once the Planning Permit has been granted.
Proposal	Proposed development on land or site which is the subject of a Planning Permit Application.
Salient	Salient GeoEnvironmental Consulting Pty Limited.
Subdivision	Subdivision is the process of dividing land or an existing building into two or more Lots. Each Lot then has a separate title and can be sold separately.
SWMS	Safe Work Method Statement. As defined by the Work Health and Safety Regulations. A SWMS sets out the High Risk Construction Work Activities to be carried out at a workplace, the hazards arising from these activities and the measures to be put in place to control the risks.
SQP	Suitably Qualified Professional(s). Defined in Section 9.3 of the Guide.
WHS Plan	Work Health & Safety Plan. Also can be referred to as an Occupational Health and Safety Plan. A site-specific health and safety management plan to be prepared in relation to works being undertaken.

1. PURPOSE OF THIS GUIDE

The purpose of this Guide is to provide guidance to owners and developers (Applicants) or a Building Design Team (BDT) proposing to develop land within proximity of the Eaglehawk Landfill and Transfer Station, to which the Buffer Area Overlay Schedule 1 applies.

The Guide is intended to address the requirements of the Buffer Area Overlay Schedule 1 only. It does not address all requirements of the Greater Bendigo Planning Scheme that may apply to the use and development of the subject site.

The contents of this Guide are often technical and complex in nature and Applicants will need to appoint Suitably Qualified Professionals to satisfy the requirements of the Buffer Area Overlay Schedule 1. Depending on your development and the associated risks, you may require separate consultants to assist you at different stages of the process.

Suitably Qualified Professionals may include:

- Environmental Auditor
- Environmental Consultant
- Landfill Gas Protection Measures Designer
- Landfill Gas Protection Measures Installer

The Guide is intended to assist Applicants in understanding the Landfill Gas Protection Measures that may be required when proposing a development within the Buffer Area Overlay Schedule 1 and to support professionals in determining if they are suitably qualified to design, install and/or verify such measures.

The information contained in this Guide is general in nature and is not intended to replace site specific assessments and design solutions.

If you have any queries regarding the content of this Guide please contact the City of Greater Bendigo Statutory Planning Department or BGL Nominees Pty Limited for further information.

To assist with interpretation, boxes like this one can be found throughout the Guide to provide an overview of the content.

2. INTRODUCTION OF THE BUFFER AREA OVERLAY SCHEDULE 1 (BAO1)

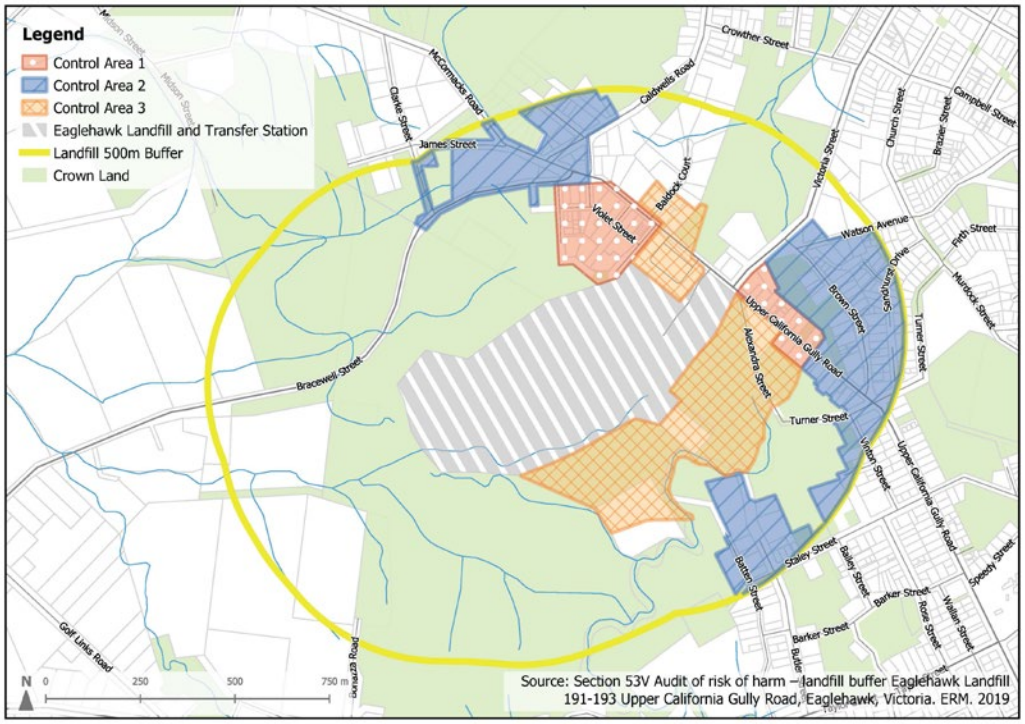
This section provides background as to why the BAO1 is required.

The Eaglehawk Landfill and Transfer Station is a waste and resource recovery facility which accepts putrescible, organic and solid inert waste that is classified as a hub of State significance in the *Statewide Waste & Resource Recovery Infrastructure Plan (2018)* and *Loddon Mallee Waste and Resource Recovery Implementation Plan (2016)*.

An Assessment[1] (AECOM) and subsequent Audit[2] (ERM) completed in 2019, found that the potential for off-site landfill gas migration within 500 metres of the landfill can potentially discharge for more than 30 years after the last acceptance of waste. Even when landfills are operating in accordance with all relevant statutory obligations, landfill gas can pose human health and safety risks, such as asphyxiation and explosion. The risks have been determined based on an analysis of the likelihood of the risk occurring and severity of the consequences for different receptor groups, based on the zoning of the land. The Assessment and Audit were peer reviewed[3] in July 2022 (Salient), which supported the original findings.

Protection measures have been determined for three 'Control Areas' shown in the Figure reproduced below. The levels of landfill gas risk in Control Areas 1 and 3 are generally low (CS2) but still require protection measures for most forms of development, due to the potential severity of the consequences. The levels of landfill gas risk in Control Area 2 and all other areas outside of the Control Areas, but within the Landfill BEPM 500m Buffer, are likely to be very low (CS1) but the level of risk needs to be checked with the City prior to development occurring and protection measures applied where necessary.

The BAO1 enables gas protection measures to be required as a condition of a planning permit being granted for development within the Landfill BEPM 500m buffer.

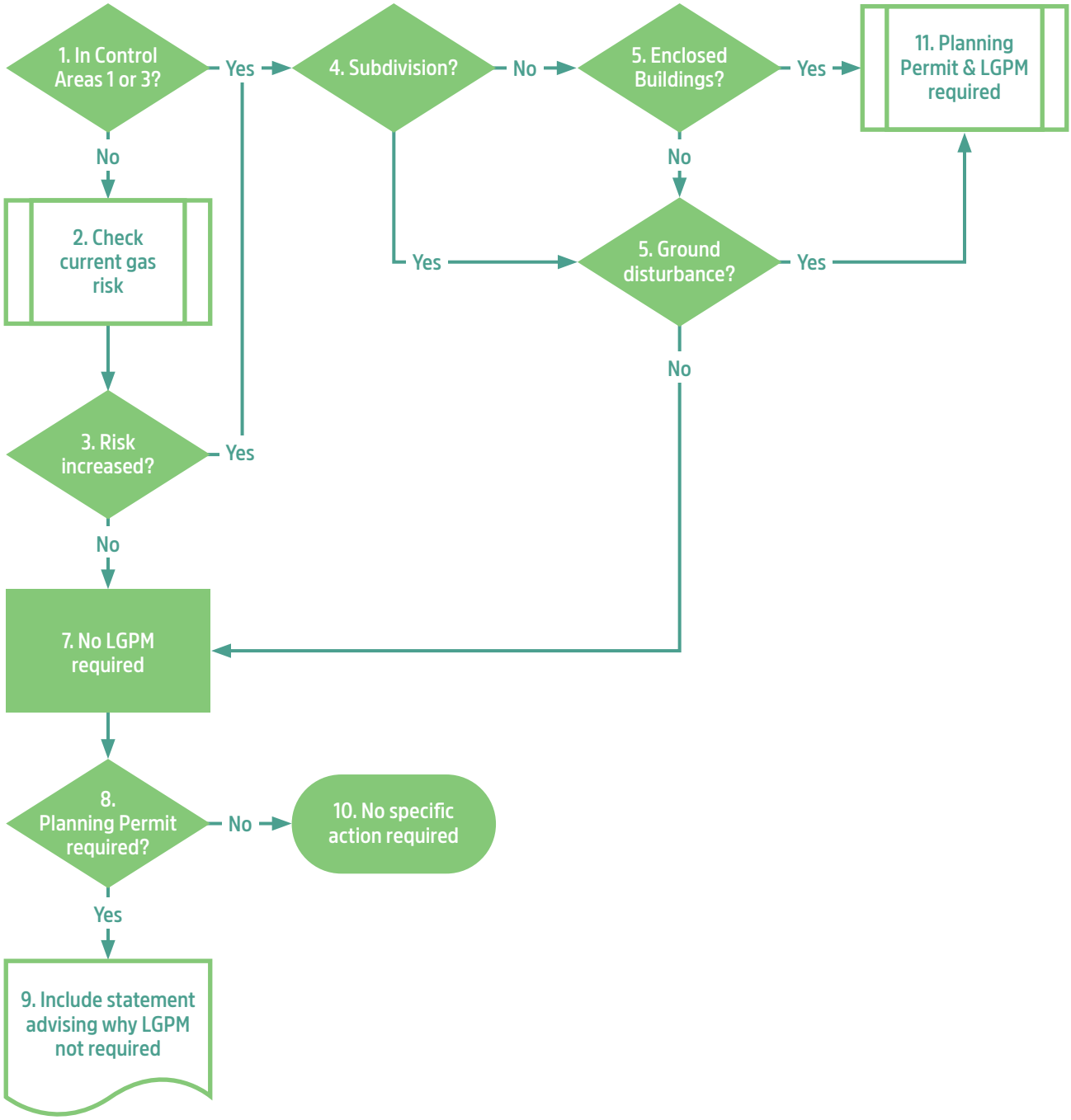


Map 1. Landfill gas control areas buffer map as per Buffer Area Overlay Schedule 1

1. AECOM (19 September 2019) Buffer Zone Landfill Gas Risk Assessment (LGRA) Eaglehawk Landfill (Ref: 60579200 Rev 2 Final)
2. ERM (16 December 2019) Section 53V Audit of Risk of Harm – Landfill Buffer Eaglehawk Landfill, 191 – 193 Upper California Gully Road, Eaglehawk, Victoria (CARMS Ref: 60409-9)
3. Salient (15 September 2022) Peer Review – Eaglehawk Landfill, Bendigo Vic for Proposed Amendment C242gben Buffer (Ref: Maddocks-M.FID4542567)

3. DETERMINING THE IMPACT OF THE BAO1 ON YOUR PROPOSAL

This section outlines the key considerations which determine the actions required to satisfy BAO1 for your Proposal.



The flow chart and following table should be consulted for any Proposal where the BAO1 applies (Further examples of Scenarios for application of BAO1 are presented in Appendix B):

1. In Control Areas 1 or 3?
Control Areas 1 (Residential Zone) and 3 (Industrial Zone) as shown on Map 1 of this Guide are located within 250m of Eaglehawk Landfill and are most likely to require LGPM due to the Low Risk (CS2) of landfill gas migration. Control Area 2 (Residential Zone more than 250m from Eaglehawk Landfill) and all other areas outside of the Control Areas but within the Buffer Area are less likely to require LGPM due to the Very Low Risk (CS1) of landfill gas migration.
Is the Proposal site in Control Areas 1 or 3? If no, please move to **2. Check Current Gas Risk** If yes, please move to **4. Subdivision**
2. Check current gas risk
As part of the Planning Permit pre-application process, the City will check the results of recent monitoring of landfill gas in proximity of the Proposal site and confirm if the landfill gas risk continues to be Very Low (CS1) based on the characteristic gas situation (CS). Written confirmation will be provided by the City which advises whether the characteristic gas situation has changed.
Once the outcome of the check is received in writing, please move to **3. Risk increased?**
3. Risk increased?
Review the written advice received from the City.
Has the landfill gas risk increased? If yes, please move to **4. Subdivision** If no, please move to **7. No Landfill Gas Protection Measures Required**
4. Subdivision?
Subdivision is the process of dividing land or an existing building into two or more lots. Each lot then has a separate title and can be sold separately. Subdivision can involve the creation of lot boundaries on paper only or it can involve the installation of services. A Planning Permit is always required for subdivision within the BAO1 area.
Does the Proposal include subdivision? If no, please move to **5. Enclosed Building or Space** If yes, please move to **6. Ground Disturbance**
5. Enclosed Building or Space
An Enclosed Building is one that has a roof and perimeter walls (nominally sealed) from floor to roof level in direct contact with the ground that may, if unprotected, allow uncontrolled accumulation of landfill gas. Doors and windows which can be closed, will be considered to be closed when determining if a building is enclosed. An Enclosed Space is one that has a floor and ceiling and enclosing walls (full or partial height) on all sides that may, if unprotected, allow uncontrolled accumulation of landfill gas.
Does the Proposal include construction of an Enclosed Building or Space? If no, please move to **6. Ground Disturbance** If yes, please move to **13. Planning Permit and Landfill Gas Protection Measures Required**

6. Ground Disturbance

Ground disturbance means actions whereby greater than 300mm depth will be penetrated with the resultant hole giving potential to accumulate landfill gas. Such actions must be considered on a case-by-case basis and managed under relevant WHS legislation to mitigate any identified risks.

Where actions are conducted that are close to the surface in a well-ventilated area (e.g. mowing the lawn); shallow in nature (e.g. gardening within upper 300mm of the ground surface); or, are localised / well ventilated / temporary in nature (e.g. excavation of a hole to plant a shrub or tree that is backfilled to the original ground surface) they are classified as Low Risk Activities and DO NOT constitute Ground Disturbance from the perspective of BAO1 and this Guide.

If you are in any doubt of whether your proposed actions constitute Ground Disturbance, then contact the City or a Suitably Qualified Professional for Proposal specific advice.

Does the Proposal include Ground Disturbance?

If no, please move to **7. No Landfill Gas Protection Measures Required**

If yes, please move to **11. Planning Permit and Landfill Gas Protection Measures Required**

7. No Landfill Gas Protection Measures Required

A Proposal that does not include construction of an Enclosed Building or Space, or Ground Disturbance will not require Landfill Gas Protection Measures to be installed, but may still require a Planning Permit.

Examples of common types of Proposals and whether they will likely require Landfill Gas Protection Measures or Planning Permits can be found in Appendix B.

When undertaking subdivision that does not involve Ground Disturbance, Applicants may choose to protect all future lots against potential landfill gas migration (e.g. cut off or venting wall between landfill and proposed development), however, any future Application to further develop the land must still satisfy all the relevant requirements of the BAO1.

Please move to **8. Planning Permit Required under BAO1?**

8. Planning Permit Required under BAO1?

A Planning Permit is not required for the use of the land.

A Planning Permit is not required for the construction of an unenclosed building or space, or works that do not require Ground Disturbance.

A Planning Permit is not required for an alteration to a building or structure that does not require Ground Disturbance.

All Subdivisions require a Planning Permit.

Any Proposal for construction of an Enclosed Building or Space, or for works that include Ground Disturbance will require a Planning Permit.

Examples of common types of Proposals and whether they will likely require a Planning Permit can be found in Appendix B.

Reminder: This Guide only addresses the requirements of the BAO1. It does not address all requirements of the Greater Bendigo Planning Scheme that may apply to the use and development of the site

Does the Proposal require a Planning Permit?

If yes, please move to **9. Include a statement advising why Landfill Gas Protection Measures are not required**

If no, please move to **10. No specific action required**

9. Include a statement advising why Landfill Gas Protection Measures are not required

Where a Planning Permit is required but Landfill Gas Protection Measures are not required, the application must be accompanied by a statement confirming the reason for which they are not required, from the following:

- The application is for subdivision which does not involve ground disturbance
- The land is outside Control Area 1 and Control Area 3 shown on the Landfill gas control areas buffer map and the landfill gas risk is very low based on the characteristic gas situation
- An environmental audit statement under the Environment Protection Act 2017 has recommended otherwise

The inclusion of this statement is intended to give confidence that consideration has been given to the risk presented by the proposed development within the Buffer Area.

10. No specific action required

As the Proposal does not require Landfill Gas Protection Measures or a Planning Permit, it is likely that no specific action is required to address the BAO1.

Please see the notation below this table regarding managing onsite risks presented by the potential for landfill gas in accordance with Work Health and Safety legislation and regulations.

If you are in any doubt, please contact the City or a Suitably Qualified Professional for site specific advice.

11. Landfill Gas Protection Measures required

A Planning Permit and Landfill Gas Protection Measures will be required for your Proposal

In addition to the standard requirements for a Planning Permit Application, an Application for a Proposal which require LGPM for an enclosed building must also be accompanied by the items outlined in Section 7 of this document.

A Planning Permit issued under BAO1 will include conditions requiring Landfill Gas Protection Measures to be installed in accordance with approved plans, and the installation be verified by a Suitably Qualified Professional.

See Appendix C for examples of possible permit conditions.

To proceed with this Proposal, Suitably Qualified Professionals will need to be engaged to assist with the preparation of the Landfill Gas Protection Measures Design and Technical Specification.

Please refer to the rest of this Guide for general advice as to the next steps in this process.

Please Note:

Landfill gas can pose human health and safety risks, such as asphyxiation and explosion. All on-site workers (including future below ground maintenance workers) must be informed of the potential presence of landfill gas so that they can manage these risks appropriately.

Even if specific Landfill Gas Protection Measures are not required, onsite works may be considered a **High Risk Construction Activity** as defined by the WHS Regulations and in Appendix A of: https://www.safeworkaustralia.gov.au/system/files/documents/1703/information-sheet-safe-work-method-statement.pdf

The risk of landfill gas, along with proposed control measures, should be considered as part of any onsite Safe Work Method Statement, in accordance with the relevant Work Health and Safety legislation and regulations.

4. PROCESS TO SATISFY BAO1 REQUIREMENTS

This section outlines the steps of a typical planning permit process and explains how the BAO1 should be considered at each step.

Typical planning permit	BAO1 specific activities	Relevant sections within this user guide	Documents required
Research Your Property	Applicant becomes aware of BAO1	Sections 1 to 3 inclusive	-
Obtain Pre-application Advice	Applicant engages with the City, their Building Design Team and SQP to understand implications of BAO1 on their Proposal	Section 3 and 5 to 9 inclusive and Appendices A to C inclusive	-
Prepare Application	Applicant commissions Building Design Team and SQP to prepare the necessary documentation in support of a Planning Permit Application (Application) for the Proposal	Sections 4 to 9 inclusive and Appendices A to C inclusive	LGPM Design & Technical Specification
Submit Planning Permit Application	Applicant provides the City with an Application that satisfies the requirements of BAO1 and this Guide. Further information may be requested if the application does not include all required materials.	Sections 3, 7 and 9	Planning permit application that addresses the requirements of BAO1
Referral of Application	The Application will be referred to the EPA for advice	-	-
Public Notification (if required)	Whilst the BAO1 does not require public notification, other planning controls that apply to the site may.	-	-
Planning Permit Decision	If a planning permit is issued, permit conditions relating to the installation, verification and ongoing maintenance of LGPM, may be included.	-	Planning Permit issued by the City
Building Permit	Applicant commissions a Building Surveyor to issue a Building Permit which confirms that all plans and relevant documentation are approved before construction commences	-	Building permit issued by the Building Surveyor
Construction	Integration of LGPM as part of overall Construction works in accordance with the approved DTS	Sections 5 to 9 inclusive Appendix A	Validation Report Long Term Environmental Management Plan (LTEMP)
Occupancy Permit	Validation Report and LTEMP provided to the City's Statutory Planning Department to satisfy Planning Conditions. Building Surveyor issues Occupancy Permit	-	-
Ongoing	Property owner to comply with Planning Conditions relating to ongoing maintenance of LGPM	-	-

5. TYPICAL LANDFILL GAS PROTECTION MEASURES FOR ENCLOSED BUILDINGS

This section provides information to SQP regarding selection of BAO1 compliant LGPM for different land uses.

Examples of LGPM construction details are presented in Appendix A.

5.1. RESIDENTIAL

To comply with the requirements of BAO1 and BS8485, typical LGPM must consider the following (noting that the protection elements must be selected on a site-specific basis):

5.1.1. SLABS

- Slabs would need to be minimum 150mm thick with top and bottom reinforcement
- Flat plate slabs are likely to provide the most cost-effective integration with LGPM
- Monolithic slab pour with service penetrations cast in
- Any breaches of the floor slab (e.g. service penetrations) must be effectively sealed

5.1.2. MEMBRANE

- Membrane rated to methane transmission rate <40ml/day/m2/atm measured as required by ASTM D1434-82 (2015) or equivalent
- Membrane selection must also include consideration of its quality and robustness to withstand the rigours of installation and maintenance of long-term performance in the Project setting

5.1.3. QUALITY ASSURANCE

- LGPM installed in accordance with manufacturers specification by a SQP (e.g. LGPM Installer) under construction quality assurance (CQA) and integrity testing as detailed in the site specific DTS
- Independent verification of installation by a SQP (e.g. Environmental Auditor or Consultant)

5.2. COMMERCIAL AND INDUSTRIAL

To comply with the requirements of BAO1 and BS8485, typical LGPM must consider the following (noting that the protection elements must be selected on a site-specific basis):

5.2.1. SLABS

- Any floor slab may be considered
- However, flat plate slabs are likely to provide the most cost-effective integration with LGPM
- Any breaches of the floor slab (e.g. service penetrations) must be effectively sealed

5.2.2. MEMBRANE

- Membrane rated to methane transmission rate <40ml/day/m2/atm measured as required by ASTM D1434-82 (2015) or equivalent
- Membrane selection must also include consideration of its quality and robustness to withstand the rigours of installation and maintenance of long-term performance in the site setting
- Coordination of service penetrations with LGPM designer to ensure compatibility with membrane installation
- Coordination of piles / pier design with LGPM designer to ensure compatibility with membrane installation

5.2.3. QUALITY ASSURANCE

- LGPM installed in accordance with manufacturers specification by a SQP under CQA and integrity testing as detailed in the site specific DTS

5.3. SUBFLOOR AND BUILDING VENTILATION

Whilst subfloor and building ventilation may be considered as an element of any possible LGPM solution under BS8485; design, verification, ongoing management and maintenance must form part of this consideration. For example:

- Inlet and outlet locations and pipe routings can be complex on certain building types thus reducing venting efficiency if not designed correctly
- Confirmatory monitoring is usually required prior to occupancy to demonstrate the design intent has been met
- Seasonal monitoring (usually quarterly for minimum 12 months then annually) is typically required to confirm the design intent continues to be met
- Inlets can become inundated, blocked or obscured by vegetation in residential settings if not protected and maintained
- Outlets can become damaged in commercial / industrial environments if not provided with collision protection
- Whirly bird bearings can seize and fail to operate after a period of time if not maintained

It is noted that BS8485 states that *"Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems."*. The requirement to install a pressure relief pathway or not must be considered on a site-by-site basis but in the majority of cases may not be necessary for the following reasons:

- The landfill gas source does not lie beneath the proposed development
- The characteristic situation is CS2 "Low Risk" indicating an absence of significant gas pressure
- Pressure relief systems require protection and maintenance to operate efficiently

Given that the use of a slab and membrane are likely to be of equivalent cost but are likely to provide greater long-term reliability, venting solutions have been excluded from this Guide.

Where venting solutions are proposed, they must be designed, installed, verified and maintained in accordance with BS8485; conditions of any Planning Permit; and, the LTEMP. Specific comment must be provided by the Applicant to confirm how the above points have been, and will continue to be, addressed for the life of the proposed structure.

5.4. OTHER STRUCTURES

Where an Enclosed Building or Space is only intended for periodic human occupation (e.g. stand alone garage, sheds and outbuildings, cubby houses, etc), the City may accept alternative methods of mitigating landfill gas risks providing that they are appropriately justified by an SQP.

For example, the structures could be constructed on a monolithic concrete floor slab and / or are well ventilated (i.e. open structure, windows and / or high level of natural ventilation). The creation of an air gap (i.e. placed on floor joists, pads or stilts) between the ground and underside of the structure (e.g. a cubby house or small shed) may also be a suitable alternative. It is recommended that such decisions are made in consultation with a SQP.

6. TYPICAL CONSTRUCTION METHODS

This section provides information to the Building Design Team and SQP regarding selection of construction methods and their compatibility for integration of LGPM.

6.1. SUBDIVISION CONSTRUCTION CONSIDERATIONS

Where the construction of roads, parking and services is proposed to facilitate subdivision, the Planning Permit Application should include a Proposal specific assessment to determine whether the works or installed infrastructure has the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. For example:

- Construction of extensive areas of roads or hardstanding that were not previously present may facilitate below ground accumulation and / or lateral migration of landfill gas depending upon its proximity to the source
- Water and gas services are pressurised and are unlikely to permit gas ingress but preferential migration may occur within trench backfill (of any services) where it is more permeable than the surrounding ground
- Communication and electrical service conduits are typically sealed to prevent water ingress thus making gas ingress unlikely. However, communication and electrical pits are usually unvented and sealing of conduit penetrations into these features may be required to prevent gas ingress and uncontrolled accumulation in the future
- If present, below ground tanks will need to be assessed on an individual basis to determine connectivity with a potential gas source or drainage infrastructure such that preferential gas migration pathways are mitigated (e.g. membrane lining and / or reflux valves)
- Sewer infrastructure is typically designed to manage potential risks associated with accumulation of methane and protection measures are not usually required
- Drainage pipes are typically sealed to ensure they carry water effectively and are likely to prevent gas ingress. Drainage pits are typically ventilated to atmosphere and are unlikely to facilitate uncontrolled accumulation of landfill gas. However, some drainage pits (typically at junctions) are sealed and will probably require some form of external lining and / or ventilation to ensure uncontrolled gas accumulation does not occur.

The Planning Permit Application should demonstrate how human health will be protected and safety risks will be managed through the provision of an appropriate work health and safety plan (WHS Plan) and construction environmental management plan (CEMP) prepared to manage risks during construction and a Long Term Environmental Management Plan (LTEMP) that includes post construction health and safety procedures and maintenance procedures to manage residual risks including asphyxiation or explosion to structures, their occupants and maintenance workers.

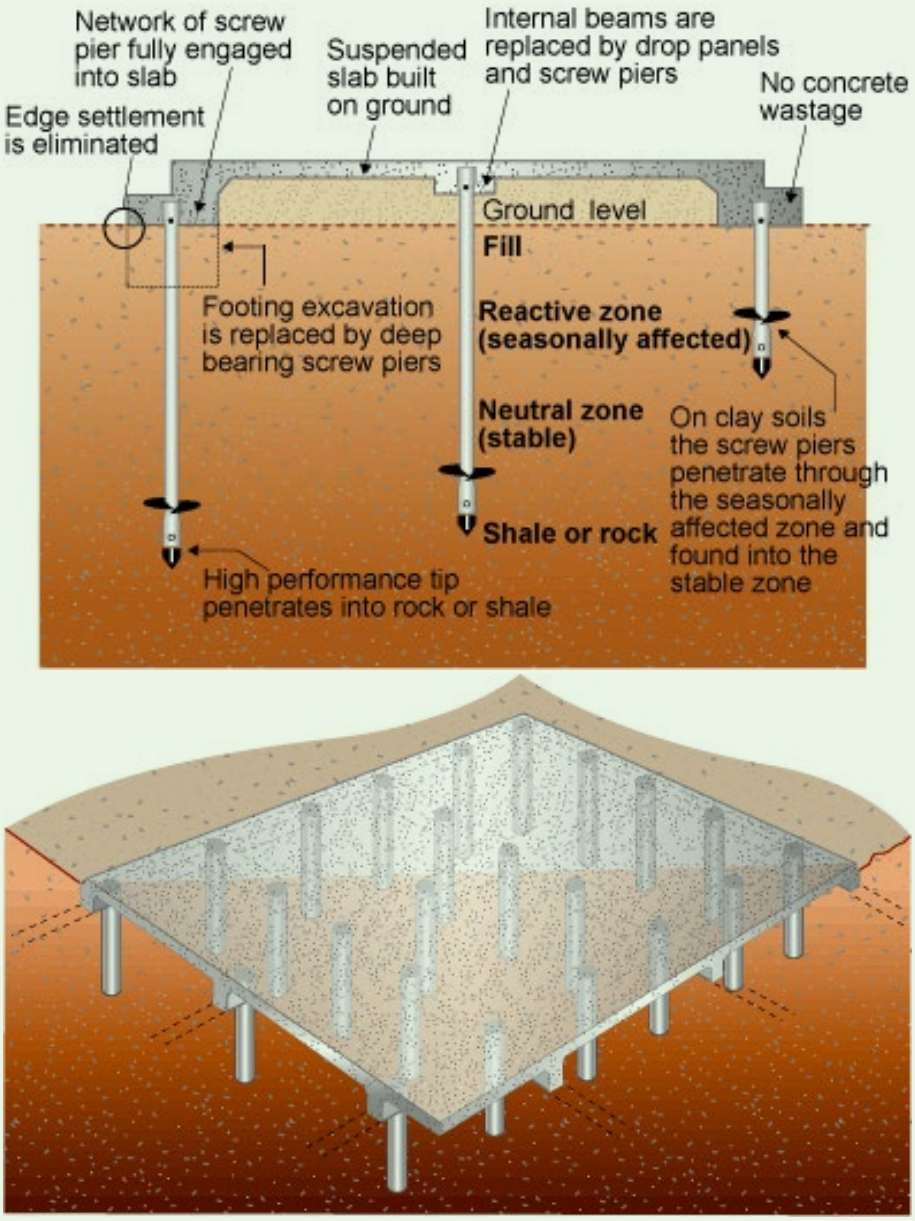
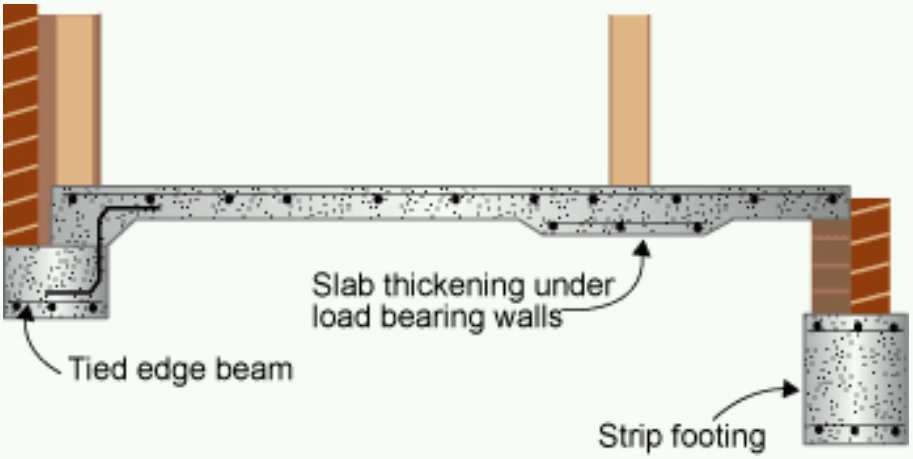
6.2. GROUND DISTURBANCE CONSIDERATIONS

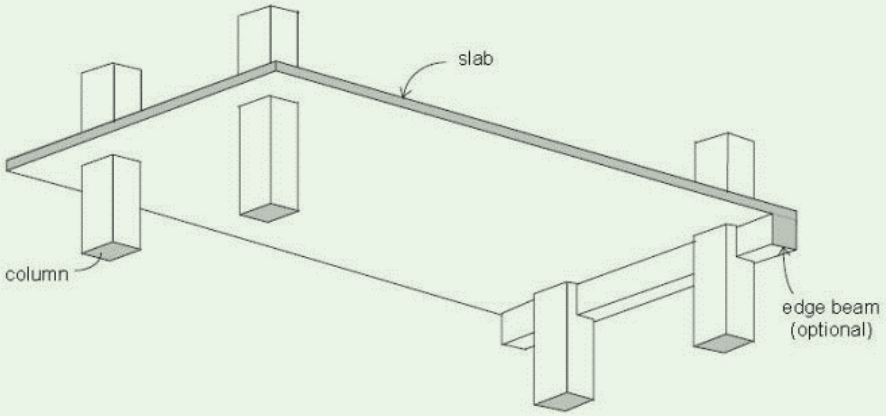
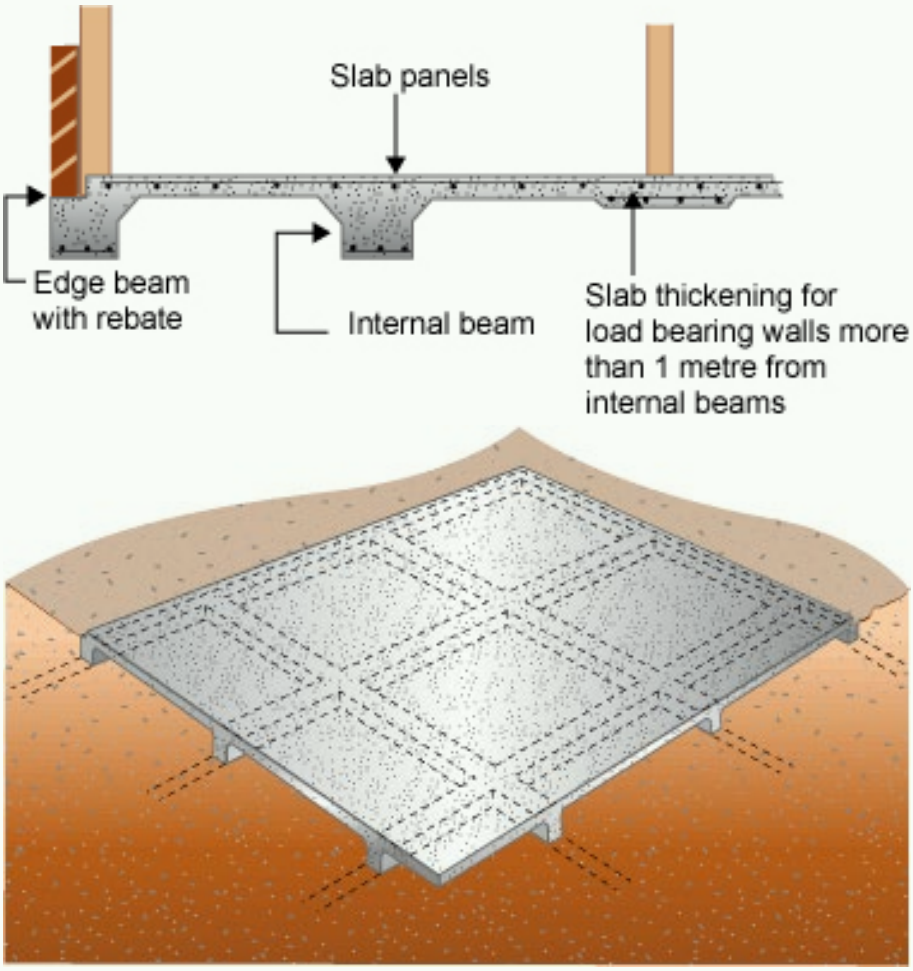
Where the Proposal does not include construction of an enclosed building or structure but does include Ground Disturbance (excluding that defined as a Low Risk Activity), the Planning Permit Application should include a Proposal specific assessment to determine whether the works has the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas.

Where the assessment determines that the works do have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas, the Planning Permit Application must include gas protection measures designed by a suitably qualified professional to create a preferential pathway for gas to escape.

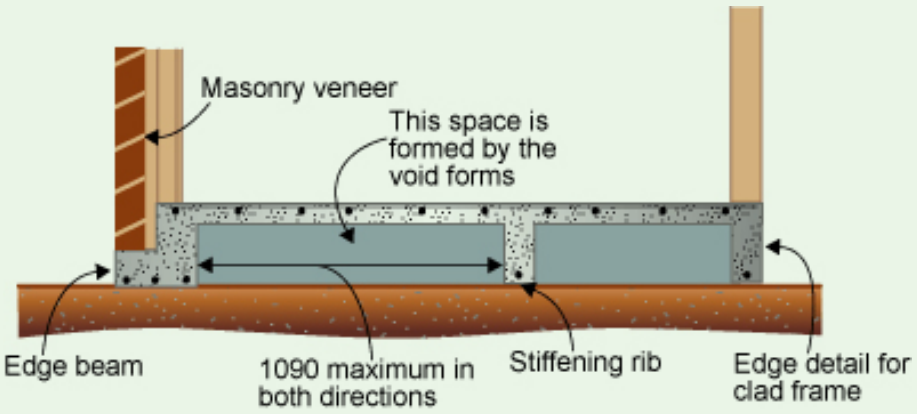
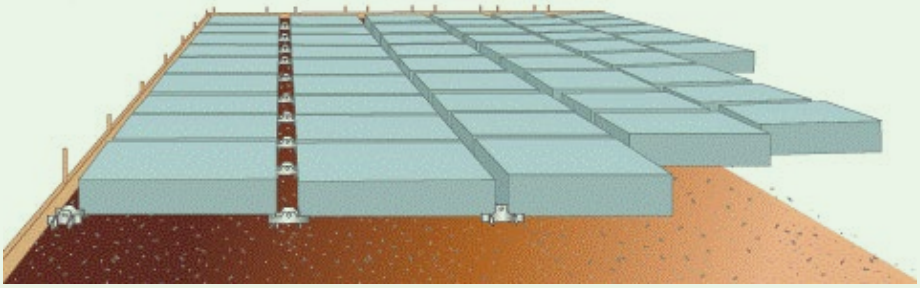
As with Section 6.1, the Planning Permit Application should demonstrate how human health will be protected and safety risks will be managed through the provision of an appropriate work health and safety plan (WHS Plan) and construction environmental management plan (CEMP) prepared to manage risks during construction and a Long Term Environmental Management Plan (LTEMP) that includes post construction health and safety procedures and maintenance procedures to manage residual risks including asphyxiation or explosion to structures, their occupants and maintenance workers.

6.3. BUILDING CONSTRUCTION METHODS COMPATIBLE WITH LGPM

Description	Example
Foundations: Piers / Piles	
Foundations: Strips / Pads	

Description	Example
Floor Slabs: Flat Plate (min 150mm thick with top and bottom reinforcement required in a residential setting)	
Floor Slabs: Raft with edge and internal ground beams (min 150mm thick with top and bottom reinforcement required in a residential setting)	

6.4. BUILDING CONSTRUCTION METHODS NOT COMPATIBLE WITH LGPM

Description	Example
Floor Slabs: Waffle Pod (Typically 75-130mm thick with single layer of reinforcement)	 View of a waffle raft slab being set up, showing the cardboard void forms 

NOTE: Given that waffle pod slabs are typically less than 150mm thick with single layer of reinforcement and will not attain the required gas protection score in accordance with BS8485 in a residential setting.

7. INFORMATION TO SUPPORT AN APPLICATION

This section provides a summary of information which must be provided to support an Application which requires Landfill Gas Protection Measures for an enclosed building or structure.

In addition to standard requirements for a planning permit application, an application within the BAO1 which requires LGPM for an enclosed building or structure must also be accompanied by:

- Design and Technical Specifications (DTS) (refer Section 9.1.1) prepared by a SQP (e.g. LGPM Designer), which includes:
  - A statement that describes how the proposed LGPM will meet the gas protection score as specified in Table 1 of BAO1 and BS8485
  - A statement of how the design and proposed LGPM protects human health and minimises safety risks
  - Proposal specific plans showing the design of the LGPM and how it will be incorporated into the proposed structures
- A statement from an independent SQP (e.g. Environmental Auditor or Consultant) confirming that the LGPM has been designed in accordance with BS8485; the recommendations of the EAS for the Property; conditions of the Planning Permit; and, this Guide
- A statement which demonstrates that all parties involved in the design, installation and independent verification works are SQP as defined in this Guide with demonstrated experience in LGPM
- Where a specific Environmental Audit Statement is prepared under the *Environment Protection Act 2017*, it must be provided to the City as part of any Application

8. CONSTRUCTION AND VERIFICATION OF LANDFILL GAS PROTECTION MEASURES

This section provides a summary of key steps typically completed after issue of a Planning Permit.

- Building Surveyors issue Building Permit to confirm that the Project is compliant with Victorian Building Regulations and other relevant codes or statutes
- Construction commences with relevant hold points agreed in advance by all parties to ensure the LGPM can be installed into the structure as planned and that Independent Verification is completed as detailed in the CQAP within the DTS
- Preparation of a Validation Report by a SQP (e.g. Environmental Auditor or Consultant) that the LGPM has been installed in accordance with the DTS and that the site is suitable for its intended use provided that the LTEMP is implemented
- Validation Report and LTEMP are provided to the City's Statutory Planning Department to demonstrate that Conditions relating to LGPM on the Planning Permit have been satisfied PRIOR to issue of an Occupancy Permit or Statement of Compliance
- Applicant complies with requirements of any Planning Conditions which relate to the LTEMP for the LGPM and allocation of these responsibilities to any future owners

9. AVAILABLE RESOURCES

This section collates additional information to assist in the successful execution of a BAO1 compliant LGPM Project.

9.1. PROJECT SPECIFIC INTEGRATION / CONSULTATION

Current best practice associated with the design and installation of LGPM typically comprises the following stages:

9.1.1. PREPARE APPLICATION

LGPM DTS is prepared by a SQP (e.g. LGPM Designer):

- Preparation in accordance with relevant guidelines and legislation
- Determine the key elements of the LGPM products to use
- Discuss why the LGPM products should be used
- Present how the required level of gas protection is to be achieved
- Provide justification that the selected design is theoretically appropriate to limit the movement of landfill gas to the proposed building, structure or subdivision
- Provide construction methodologies for protection of slab joints / penetrations (e.g. services, pits, tanks, etc) and LGPM components required by the design
- Prescribe CQA, validation and minimum documentation requirements for the LGPM including a CQA Plan (CQAP)
- Provision of construction / engineering drawings for integration of LGPM into the proposed building, structure or subdivision

9.1.2. CONSTRUCTION

Installation: A SQP (e.g. LGPM Installer) installs the LGPM in accordance with the LGPM DTS

Independent Verification: A SQP (e.g. Environmental Consultant) conducts periodic inspections during construction and installation to independently confirm that the intent of the DTS has been met

Validation Report: A SQP (e.g. LGPM Installer and Environmental Consultant) prepares a Validation Report to document the above stages and demonstrate compliance. Includes as-built drawings of the LGPM

Long Term Environmental Management Plan (LTEMP): A SQP (e.g. Environmental Consultant) prepares an LTEMP to document what management, maintenance and testing is required post installation to ensure the LGPM continues to operate as intended for the life of the proposed development. The LTEMP must include reference to potential landfill gas risks to future below ground construction and maintenance workers.

9.1.3. ONGOING MANAGEMENT

Implementation of the LTEMP: This is the responsibility of the Applicant, with support from SQP (e.g. Environmental Consultant), as required.

9.2. SUPPORTING DOCUMENTS

The following supporting documents should be considered, as required, by SQP when preparing LGPM DTS to support a Planning Permit Application under BAO1:

- Construction Industry Research and Information Association (CIRIA) Report C735 (2014) Good Practice on the Testing and Verification of Protection Systems for Buildings against Hazardous Ground Gases
- Victorian Building Regulations (3 August 2018) Authorised Version No.017 (Ref: S.R. No. 38/2018)
- The British Standards Institution (BSI) Publication BS8485:2015+A1:2019 (January 2019) Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings
- AECOM Australia Pty Limited (AECOM) (19 September 2019) Buffer Zone Landfill Gas Risk Assessment (LGRA) Eaglehawk Landfill (Ref: 60579200 Rev 2 Final)
- Environmental Resources Management Australia Pty Limited (ERM) (16 December 2019) Section 53V Audit of Risk of Harm – Landfill Buffer Eaglehawk Landfill, 191 – 193 Upper California Gully Road, Eaglehawk, Victoria (CARMS Ref: 60409-9)
- CIRIA Report C801 (2021) Hazardous Ground Gas – A Site Management Guide
- Salient GeoEnvironmental Consulting Pty Limited (Salient) (15 September 2022) Peer Review – Eaglehawk Landfill, Bendigo Vic for Proposed Amendment C242gben Buffer (Ref: Maddocks-M.FID4542567)

9.3. SUITABLY QUALIFIED PROFESSIONALS

Management of site contamination (including landfill gas) in Victoria is typically assessed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended (16 May 2013).

Schedule B9 of NEPM (2013) describes the competencies / experience that are essential for professionals involved in contaminated site assessment and provides a framework for the appointment or acceptance by regulatory authorities of contaminated land professionals who are required under statute to certify site assessments.

Section 4, Schedule B9 of NEPM (2013) states that *"Professionals involved in the assessment of site contamination need to demonstrate appropriate competence, knowledge and experience relative to their role and the complexity of site contamination."*, including the following:

- Qualifications consistent with the task being undertaken
- Competencies relevant to the work to be undertaken
- Demonstrate relevant experience in the work to be undertaken
- Knowledge of relevant literature for the work to be undertaken

SQP should be able to demonstrate individual membership of and / or accreditation from one or more relevant professional societies. For example, Engineers Australia, the Royal Australian Chemical Institute, the Australian Institute of Geoscientists, the Environment Institute of Australian and New Zealand. Further guidance is provided in Section 6.6, Schedule 9 of NEPM (2013)

In the context of this Guide, four types of SQP who could be appointed by the Applicant are defined as follows:

9.3.1. ENVIRONMENTAL AUDITORS

Environmental Auditors provide independent advice demonstrating compliance with legislation and guidelines throughout the entire LGPM process.

As registered under EPA Victoria (https://www.epa.vic.gov.au/about-epa/public-registers/epa-appointments#land).

9.3.2. ENVIRONMENTAL CONSULTANTS

Environmental Consultants typically provide independent advice demonstrating compliance with legislation and guidelines throughout the entire LGPM process.

EIANZ Certified Environmental Practitioner – Site Contamination (CEnvP-SC) with relevant experience in landfill gas protection measures (https://www.cenvp.org/directory/) or similar to comply with the intent of Schedule 9 of NEPM (2013) outlined above.

9.3.3. LGPM DESIGNERS

LGPM Designers can be Environmental Consultants or industry professionals who specialise in preparation of DTS and provision of related services.

EIANZ Certified Environmental Practitioner – Site Contamination (CenvP-SC) with relevant experience in landfill gas protection measures (https://www.cenvp.org/directory/) or similar to comply with the intent of Schedule 9 of NEPM (2013) outlined above.

9.3.4. LGPM INSTALLERS

LGPM Installers are industry professionals who specialise in coordination and installation of LGPM into structures.

Certification from the manufacturer demonstrating competence with specified products (e.g. CETCO Approved Applicator with refresher training conducted regularly) or similar to comply with the intent of Schedule 9 of NEPM (2013) outlined above.

9.4. INDICATIVE BUDGET ESTIMATES ASSOCIATED WITH LGPM

A. Costs associated with the installation of LGPM can vary markedly as a result of the many possible permutations of ground conditions and building design. Consequently, it is important that you engage with SQP to obtain site specific costs for the various stages of work associated with LGPM

B. It is important to recognise that the table below presents typical orders of magnitude for the various stages of LGPM installation for the scenarios and assumptions stated and that site specific costs may be different

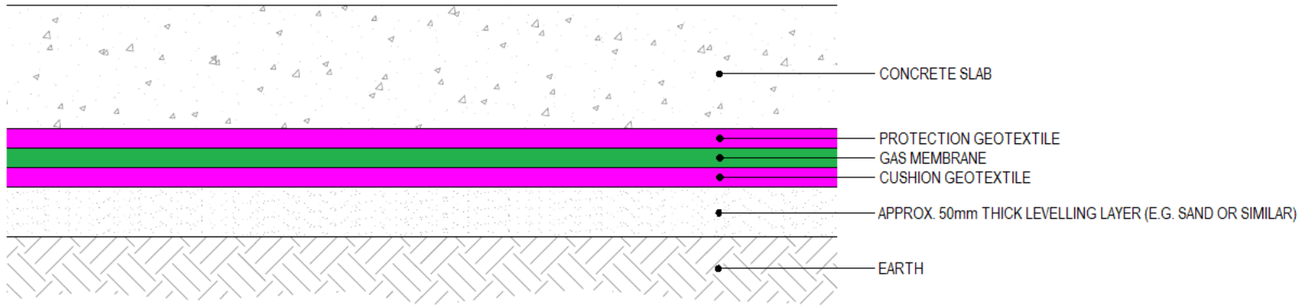
C. Notwithstanding the above, we provide the following budget estimates that are based on typical industry rates to end of December 2022

Neither BGL nor the City accepts any liability resulting in decisions made based on the budget estimates provided in the table below.

Stage	Residential (Ex. GST)	Commercial (Ex. GST)	Industrial (Ex. GST)
Design & Technical Specification[4]	$5,000 - $10,000	$5,000 - $15,000	$5,000 - $15,000
Supply & Installation[5]	$70 - $95/m2[6]	$70 - $95/m2[7]	$55[8] - $95/m2[9]
Independent Verification Inspections	$6,000 - $8,500[10]	$5,000 - $15,000[13]	$5,000 - $15,000[11]
Validation Report[12]	$5,000 - $10,000	$5,000 - $20,000	$5,000 - $20,000
Long Term Environmental Management Plan[13]	$5,000 - $10,000	$5,000 - $10,000	$5,000 - $10,000

4. Membrane and slab only, excludes quantitative venting design; budget estimate ranges assume simple (low) to complex (high) nature of proposed development
5. Budget estimate ranges are based on good (low) to poor (high) geotechnical ground conditions and flat plate slab design
6. Based on average Victorian house size of 240m2 and single pour construction including garage (if applicable)
7. Based on 240m2 commercial footprint and single pour construction
8. Best cost efficiencies for large concrete pour sizes (up to 750m2) with no settlement issues
9. Assumes 250m2 industrial warehouse footprint that may experience settlement issues
10. Assumes 3no. separate inspections by SQP travelling from Melbourne CBD; low to high budget estimate range is to account for varying hourly rates commonly charged by SQP; and, assumes visits are for either Environmental Consultant (e.g. 2no.) or Environmental Auditor (1no.)
11. Assumes 5no. separate inspections by SQP travelling from Melbourne CBD; low to high budget estimate range is to account for varying hourly rates commonly charged by SQP; and, assumes visits are for either Environmental Consultant (e.g. 3no.) or Environmental Auditor (2no.)
12. Budget estimate ranges are based on small scale / simple (low) to large scale / complex (high) slab and membrane only; excludes venting validation
13. Budget estimate ranges are based on small scale / simple (low) to large scale / complex (high) slab and membrane only; excludes venting management and maintenance

A. EXAMPLES OF LANDFILL GAS PROTECTION MEASURES CONSTRUCTION DETAILS



INFORMATION ONLY
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	BY	CHECK	DESIGN	VERIFY

SCALES: N.T.S

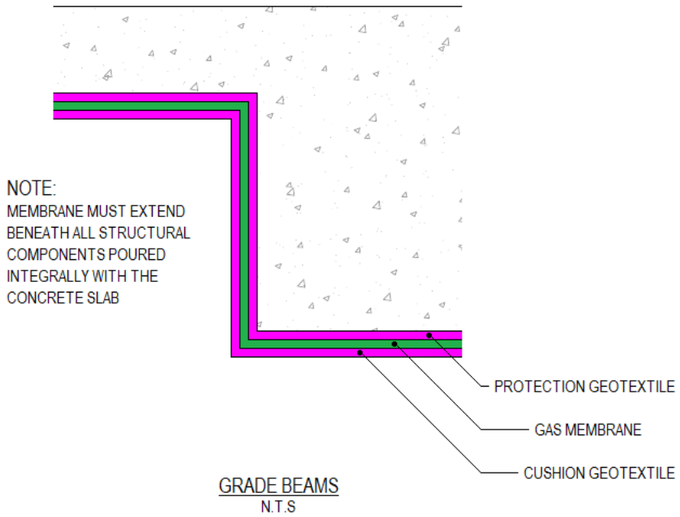
BGL
BELOW GROUND LEVEL

PROJECT: EAGLEHAWK LANDFILL BUFFER PROJECT

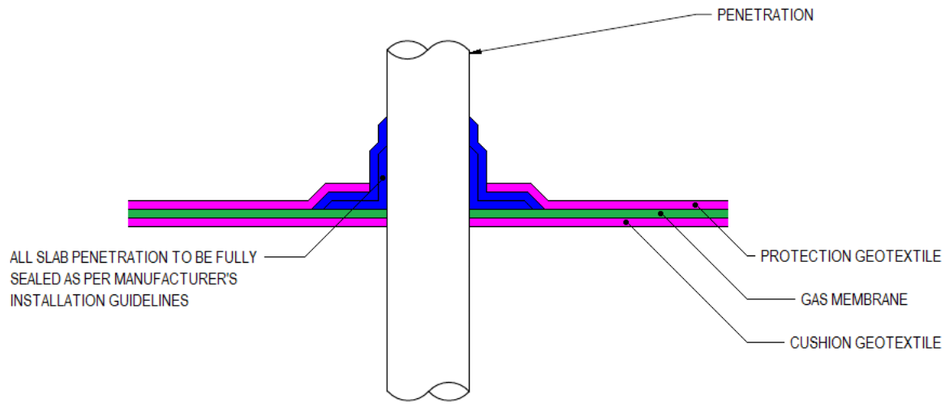
GAS MEMBRANE
CROSS SECTION

DRAWING NO.: 01

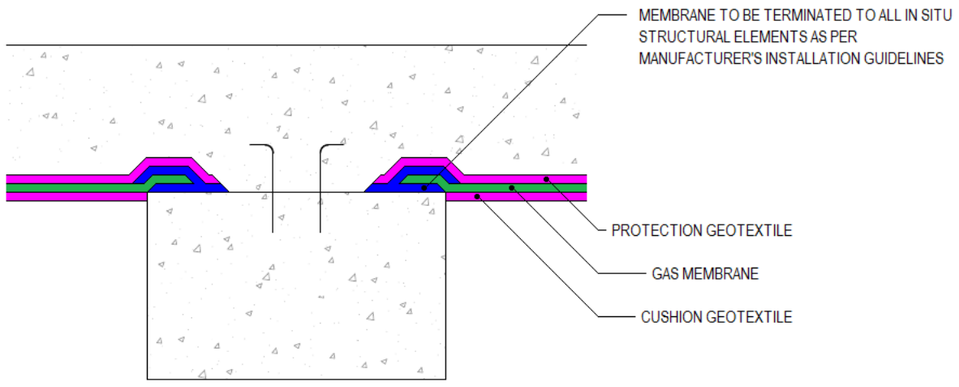
REVISION:



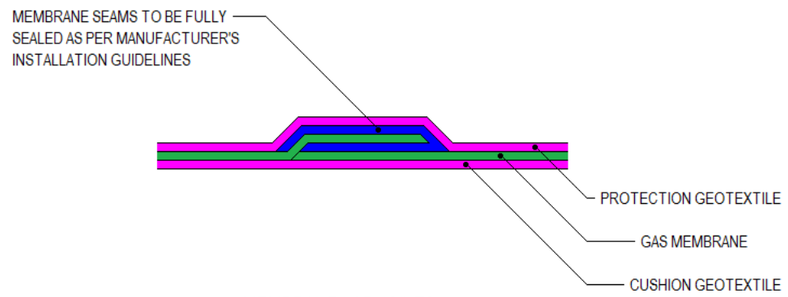
GRADE BEAMS
N.T.S



PENETRATIONS
N.T.S



FOOTINGS AND PILE CAPS
N.T.S



MEMBRANE LAP JOINTS
N.T.S

INFORMATION ONLY
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	BY	CHECK	DESIGN	VERIFY

SCALES
N.T.S

BGL
BELOW GROUND LEVEL

PROJECT
EAGLEHAWK LANDFILL BUFFER PROJECT

GAS MEMBRANE
GENERAL DETAILING

DRAWING NO.
02

REVISION

B. SCENARIOS FOR APPLICATION OF BAO1

These scenarios are intended to assist in interpretation of Section 3. Determining the Impact of the BAO1 on your Proposal in Control Areas 1 and 3 or in other parts of the Buffer Area where the risk has increased above Very Low, as defined by Characteristic Gas Situation:

What do you want to do?	Is a planning permit likely to be required under BAO1?	Are Landfill Gas Protection Measures likely to be required?
Changing the use of the land (such as setting up a new business within an existing building)	No – BAO1 does not control use	No – LGPM are not intended to be installed retrospectively and are triggered by modification of an existing structure or construction of new building
Subdivision of land	Yes – always	Yes – But the nature of LGPM and the timing of their installation will be dependent on the proposed works
Construction of a dwelling	Yes – always	Yes – Enclosed Building
Construction of a multi-unit residential development	Yes – always	Yes – Enclosed Building
Construction of a new commercial or industrial building	Yes - always	Yes – Enclosed Building
Demolishing an existing building to ground level with no current plans for further development	No	No – However, potential for gas accumulation must be considered as part of the SWMS
Demolishing an existing building including below ground foundations and services etc with no current plans for further development	Yes	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP
Construction of an extension to an existing Enclosed Building	Yes	Yes – Enclosed Building
Construction of outbuildings (sheds)	Yes	Potentially – Depending on the nature of construction (refer to Section 5.4) Seek Project specific advice from SQP
Constructing a below ground swimming pool	Yes	Potentially – Depending on the nature and extent of below ground infrastructure including electricity, drainage, etc. Seek Project specific advice from SQP
Constructing an above ground swimming pool	Yes, if the works require Ground Disturbance.	Potentially – Depending on the nature and extent of below ground infrastructure including electricity, drainage, etc. Seek Project specific advice from SQP
Construction of a pergola, carport or other structure with open sides	Yes, if the works require Ground Disturbance.	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP

What do you want to do?	Is a planning permit likely to be required under BAO1?	Are Landfill Gas Protection Measures likely to be required?
Concreting at ground level	Yes, if the works require Ground Disturbance.	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP
Constructing a tennis court	Yes, if the works require Ground Disturbance.	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP
Replacing or building a new fence	Yes, if the works require Ground Disturbance.	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP
Construction of a retaining wall	Yes, if the works require Ground Disturbance.	Potentially – Depending on whether the works have the potential to create preferential migration pathways or facilitate uncontrolled accumulation of landfill gas. Seek Project specific advice from SQP

Reminder: This Guide only addresses the requirements of the BAO1. It does not address all requirements of the Greater Bendigo Planning Scheme that may apply to the use and development of the Project site.

C. DRAFT PERMIT CONDITIONS

The following conditions should be included on all planning permits issued for Subdivision where Landfill Gas Protection Measures are required:

VERIFICATION OF GAS PROTECTION MEASURES
Prior to the issue of a Statement of Compliance for the subdivision, written confirmation from a suitably qualified professional with demonstrated experience in gas protection measure installation, must be provided stating that any required gas protection measures have been verified to ensure they are fit for purpose and installed correctly in accordance with the manufacturer's instructions.

ONGOING MAINTENANCE
The landfill gas protection measures forming part of this permit or shown on the endorsed plans, including those relating to design, verification, installation, ongoing management and maintenance, must be maintained to the satisfaction of the responsible authority on a continuing basis. This condition continues to have force and effect after the development authorised by this permit has been completed.

The following conditions should be included on all planning permits issued for Buildings and Works where Landfill Gas Protection Measures are required:

VERIFICATION OF GAS PROTECTION MEASURES
Before a building is occupied or works are completed, written confirmation from a suitably qualified professional with demonstrated experience in gas protection measure installation, must be provided stating that any required gas protection measures have been verified to ensure they are fit for purpose and installed correctly in accordance with the manufacturer's instructions.

ONGOING MAINTENANCE
The landfill gas protection measures forming part of this permit or shown on the endorsed plans, including those relating to design, verification, installation, ongoing management and maintenance, must be maintained to the satisfaction of the responsible authority on a continuing basis. This condition continues to have force and effect after the development authorised by this permit has been completed.

The following notation should be included on all planning permits issued for Subdivision or Buildings and Works:

Landfill gas risk must be considered as part of any onsite assessment of risks or hazards. Works may constitute a High Risk Activity as defined by the WHS Regulations and in Appendix A of: https://www.safeworkaustralia.gov.au/system/files/documents/1703/information-sheet-safe-work-method-statement.pdf