BINGO INDUSTRIES

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LANDFILL GAS MANAGEMENT PLAN

EASTERN CREEK RECYCLING ECOLOGY PARK (& LANDFILL)

Landfill Gas Management Plan

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ACRONYMS AND DEFINITIONS

Acronym / Term	Meaning
ADC	Alternative daily cover
AHD	Australian Height Datum
Bingo	Bingo Industries Limited
C&D	Construction and Demolition
C&I	Commercial and Industrial
Daily Cover	Material applied on the tipping face of the landfill upon close of business each day to reduce environmental and amenity impacts
DADEC	Dial-a-Dump (EC) Pty Ltd
DPIE	Department of Planning Industry and Environment
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence issued under the *Protection of the Environment Operations Act 1997* (NSW) to conduct any of the scheduled activities listed in Schedule 1 of the Act
GHG	Greenhouse Gas
LFG	Landfill Gas
LFGMP	Landfill Gas Management Plan
MOD	Modification
POEO Act	*Protection of the Environment Operations Act 1997*
POEO Regulations	Protection of the Environment Operations (Waste) Regulation 2014.
SEQ	Safety, Environment and Quality
SSD	State Significant Development
SW Act	Sydney Water Act 1994
SWLMP	Soil, Water and Leachate Management Plan
The Facility	Eastern Creek Recycling Ecology Park (& Landfill)
TPA	Tonnes per annum
VENM	virgin excavated natural materials.

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1 INTRODUCTION

1.1 Background

Bingo Industries Limited acquired the Eastern Creek Recycling Ecology Park (& Landfill) (the Facility) in February 2019 and took over the management of the Eastern Creek site in April 2019. The site was previously known as the Genesis Facility.

The Facility is located at Kangaroo Avenue, Eastern Creek in the central western suburbs of Sydney NSW, approximately 36 km west of the Sydney CBD, 18 km west of Parramatta and 12 km east of Penrith. The site is located wholly within the Local Government Area (LGA) of Blacktown, situated in the area known as the M7 Business Hub. The operational area is approximately 54 hectares (ha) and was a former breccia quarry that closed when it ceased extraction activities.

The existing Facility, including recycling centre/s and landfill were granted approval by the then Minister for Planning under Section 75J of the *Environmental Planning and Assessment (EP&A) Act 1979* on 22 November 2009 (MP 06_0139) and commenced operation in June 2012.

The Facility operates under two Environment Protection Licences (EPL) issued by the Environment Protection Authority (EPA); EPL 20121 focusses on resource recovery and EPL13426 covers landfill operations. The Facility has approval to:

- Accept up to two million tonnes per annum (Mtpa) of C&D (construction and demolition) and C&I (commercial and industrial) waste and landfilling of the quarry void of up to 1 Mtpa of non-putrescible waste (including asbestos and other non-recyclable waste), excluding residual chute waste from the material processing centre;
- Crushing, grinding and separating works to process waste masonry material located in an area earmarked as the Segregated Materials Area (SMA);
- Stockpile up to 50 tonnes of waste tyres; and
- Stockpile up to 20,000 tonnes of green waste.

The Facility is operated by Dial-a-Dump (EC) Pty Ltd Industries (DADEC), a fully owned subsidiary of Bingo.

1.2 Purpose and Application

The purpose of this Landfill Gas Management Plan (**LFGMP**) is to provide a basis for the management, control and monitoring of LFG at the site to minimise the migration of emissions of LFG and ensure that there is no risk of harm to human health or the surrounding environment.

The Landfill Gas Management Plan has considered the following:

- The Project Approval as modified (MP 06_0139); and
- EPL 13426, EPL 20121.

This Plan has been prepared to address EPL13426 requirements for the management of LFG, including the requirement for submission of this LFGMP.

This LFGMP is focused on:

- the short-term implementation of an LFG pumping trial that targets LFG emissions to quantify the production of LFG and target odours; and
- ongoing progressive development of a sitewide LFG management system informed by the pumping trial and monitoring.

1.3 Objectives and Targets

Table 1 below outlines the objectives and targets set out for the Facility to promote effective management of landfill gas, including potentially offensive odours.

Table 1: Objectives and Targets

Objective	Target
Install and commission a preliminary landfill gas extraction system to reduce H2S concentration and odorous emissions to atmosphere	Reduce the level and frequency of odorous emissions of landfill gas to atmosphere and at identified point sources to an acceptable[1] level.
Install and commission a preliminary landfill gas extraction system to reduce surface emissions of landfill gas to comply with relevant NSW EPA guidelines	Reduce to and maintain emissions of landfill gas (measured in parts per million (ppm) methane at 5cm above the landfill surface) at or below 500 ppm on intermediate and finally capped areas.
Undertake a pumping trial to collect suitable data to inform design requirements of future LFG management system	Develop a system design for the site LFG management system based on site characteristics.
Set out procedures and responsibilities for operation and maintenance of the LFG extraction system	Maintain effective LFG extraction operation.
Set out procedures and responsibilities for monitoring the effectiveness of the gas extraction system in reducing odorous emissions	Completion of ongoing management and operational procedures to demonstrate adequate[2] performance of the LFG management system in mitigating odorous emissions.
Set out contingency actions	Actions to be taken if the system does not perform adequately, is damaged, dangerous conditions occur or odour complaints occur related to LFG
Set out high level medium-long term LFG management and monitoring considerations	Describe expansion of the LFG extraction system as landfilling of waste continues, for which there will be updates to this LFGMP.
Community consultation	Use the Community Reference Group[3] as the primary vehicle to facilitate community liaison for: • effective communication during works which may affect the efficacy of the LFG management system; • determining reasonable frequency of detectable odours, and • notification of concerns or complaints.
Maintain Safe Working Conditions	Control emissions of LFG to acceptable workplace limits at the landfill surface[4] Contain and control migration of LFG to limit concentrations to acceptable levels in the subsurface and enclosed structures.

[1] As required under the sites EPL.

[2] Adequacy of the LFG management system is to be evaluated by odour monitoring within the site and at the site boundary. Where the results of odour monitoring indicate potential for site contribution beyond the site boundary these will feedback to the operational management of the system, with changes/improvements made as required in response to the results of odour monitoring.

[3] The Community Reference Groups is established and operated under the Community Engagement Plan.

[4] Safe Work Australia workplace exposure standards for airborne contaminants. 16 December 2019

1.4 Relevant Guidelines

The following regulator authored documents have been considered in the preparation of this LFG management plan:

- EPA NSW Environmental Guidelines Solid Waste Landfills. Second Edition 2016
- EPA NSW Assessment and management of hazardous ground gases. May 2020
- EPA Victoria Landfill Gas (Fugitive Emissions) Monitoring Guidelines. Publication 1684 (2018); and
- Environment Agency (England and Wales). LFTGN03 Guidance on the Management of Landfill Gas (2004).
- Environment Agency (England and Wales). TGN04 v.3 Guidance for monitoring Trace Components in Landfill Gas (2010).
- Environment Agency (England and Wales). TGN07 v.2 Guidance on Monitoring Landfill Gas Surface Emissions (2010).
- Safe Work Australia. Workplace exposure standards for airborne contaminants. 16 December 2019.

1.5 Responsible Parties

This document has been prepared by Bingo in consultation with Australian Environmental Auditors Pty Ltd (particularly Mr. Nick Simmons and Mr. Stuart Thurlow) and Mockinya Consulting (particularly Mr. Paul Lightbody) who have provided technical guidance and review support.

This document has been prepared using the information available at the time of preparation and will be progressively updated:

- as required, to meet the operational needs of the facility, reflecting additional data as it is acquired,
- following review of the short-term actions which include a LFG pumping trial, reflecting the sitewide LFG management system based on the data from the LFG pumping trial and further monitoring, and
- in consultation with NSW Environment Protection Authority.

2 SITE DESCRIPTION

The following sections provide details relating to the site history, background and current operations occurring at the site.

2.1 Facility Overview

The Facility covers an operational area of 54 hectares (ha) (including the surface area of the quarry) at Lot 1 DP 1145808; and Lot 2 DP 1247691, within an area being developed for commercial and industrial use under the *State Environmental Planning Policy (Western Sydney Employment Area) 2009 (the SEPP 2009*).

The Facility is accessed via Kangaroo Avenue located to the east and north-east of the site. The site is located within the Eastern Creek industrial precinct/M7 business hub and is bounded by the Western Motorway (M4) to the north, Kangaroo Avenue to the east and Honeycomb Drive to the south. The planned Archbold Road extension will run parallel to the western boundary of the site (Transport for NSW (TfNSW), 2019). The Eastern Creek REP is bounded by commercial and industrial buildings to the immediate north, east and south of the site. The closest residential receivers are located approximately 400 metres (m) to the north in the suburb of Minchinbury and approximately 1.2 kilometres (km) west in the suburb of Erskine Park. To the east of the Eastern Creek REP site is a 29-ha unoccupied site owned by Department of Planning Industry and Environment (DPIE) (see Figure 1):

The Facility as managed under the development consent MP 06_0139 (as modified) includes the following approved infrastructure:

- Site entrance with security gatehouse and weighbridge.
- Site offices and amenities.
- Parking for light vehicles, trucks, staff and visitors.
- Materials processing centres with equipment comprising:
  - screening areas with overhead gantry crane, screener and conveyors;
  - storage bays; and
  - load out area;
- Segregated Materials Area (crushing).
- General solid (non-putrescible) landfill.
- Wheel wash bay.

Mounds of overburden material (amenity berms) which act as impervious barriers and visual screens are located around the Facility operational area. A Conservation Area shown in Figure 1 is also located at the north-western corner of the operations area which is fenced and maintained as required by the Consent.

The landfill is located within the operational Boundary (see Figure 1) within a former quarry void. **Appendix A** shows the layout of the Facility.

Licensed operational area

Figure 1: Facility Location

2.2 Operating Hours

Table 2 details the operating hours as approved under *Schedule 3 Condition 39* of MP 06_0139 Modification 6.

Table 2: Approved operating hours

Activity	Day	Time
Construction	Monday to Friday	7:00am to 6:00pm
	Saturday	8:00am to 4:00pm
	Sunday and Public Holidays	Nil
Material Processing Centre (MPC1 and MPC2) Operation, waste receival, chute use and maintenance	Monday to Friday	24 hours
	Saturday	24 hours
	Sunday and Public Holidays	24 hours
Segregated Material Area (SMA): Crushing and screening	Monday to Friday	6:00am to 6:00pm
	Saturday	8:00am to 4:00pm
	Sunday and Public Holidays	8:00am to 4:00pm
Segregated Material Area (SMA): Receipt of segregated material	Monday to Friday	24 hours
	Saturday	8:00am to 4:00pm
	Sunday and Public Holidays	8:00am to 4:00pm
Landfill: truck deliveries	Monday to Friday	5am to 9pm
	Saturday	5am to 9pm
	Sunday and Public Holidays	5am to 9pm

3 LANDFILL GAS CONTEXT

The following sections provide details relating to the factors that affect the production and management of LFG within the site-specific context.

3.1 Waste Received

The Facility is licensed to landfill up to 1 Mtpa of non-putrescible waste per calendar year plus residual wastes from on-site processing, as set out in the Licence (and listed in Table 3 below).

Prior to June 2019 waste soils comprised more than 50% of landfilled wastes. Soils are understood to have formed more than 60% of waste from 2017-2019 and a higher percentage prior to 2017.

During 2020 and 2021, mixed waste organic material (MWOO) was diverted to landfill, and there were unseasonal influxes of fire debris from regional fires (2019-2020) and flood debris from regional flooding events (2021).

Total waste landfilled to June 2020 was approximately 4M cubic metres of a total capacity of 12M cubic metres.

Table 3: Accepted Waste Types

Waste	Description	Limits
General solid waste (non-putrescible)	Acid Sulphate Soil and Potentially Acid Sulphate Soil that has been treated and meets the definition of General Solid waste (non-putrescible)	The soil must be treated in accordance with the neutralising techniques in the Acid Sulfate Soil Manual (ASSMAC, 1988), then chemically assessed in accordance with Step 5 in Part 1 of the Waste Classification Guidelines
	As defined in Schedule 1 of the POEO Act, as in force from time to time.	N/A
Asbestos Waste	As defined in Schedule 1 of the POEO Act, as in force from time to time	N/A
Tyres	The tyre has a diameter of 1.2 metres or more; and/or the tyre has been shredded or had its walls removed; and/or the tyre was delivered to the premises as part of a domestic load. Tyres are taken to be shredded only if the tyres are in pieces measuring no more than 250mm in any direction; and domestic load means a load containing no more than 5 tyres having a diameter of less than 1.2 metres.	N/A

The EPL also explicitly allows disposal of:

- all outputs produced from the waste processing and/or resource recovery facility on site, subject to Environment Protection Licence 20121, except for
  - Recyclables extracted and delivered off-site for resource recovery purposes;
  - Hazardous wastes extracted from the input waste stream and lawfully disposed of off-site; and
  - Output waste derived materials approved for use under the Protection of the Environment Operations Act, 1997 and Regulations
- Immobilised waste which has been assessed as General Solid Waste (non-putrescible) and is subject to the general immobilisation approvals as set out in the following:

- "2009/07 Metallurgical furnace slag or metallurgical furnace slag contaminated natural excavated materials"
- "1999/05 Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials".

3.2 Site hydrogeology

The hydrogeology is described by IGGC (2009) in some detail. The hydrogeological setting comprises a layered aquifer system including a perched aquifer in the upper weathered profile and a series of aquifers in the more transmissive horizons of the underlying bedrock (See the preliminary CSM at Figure).

- The upper weathered profile shows low to moderate hydraulic conductivity. Groundwater levels are around 67m AHD and the hydraulic connection between the shallow aquifer and the quarry appears limited;
- The intermediate Wianamatta Group aquifer layers (i.e., the upper to middle zones in the bedrock, c.30 m to 100 m depth) show generally negligible or very low hydraulic conductivities with occasional zones of higher values of up to 0.04 m/d. Stabilised groundwater levels are around 55 mAHD; natural levels would be expected to be slightly below those of the shallow groundwater zone and this shows the effect of depressurisation caused by pumping of groundwater from the quarry;
- The deep Wianamatta Group aquifer layers (c.100 m to 150m depth) show generally negligible or very low hydraulic conductivity values with occasional zones of higher values of up to 0.01 m/d. Stabilised groundwater levels are around 31 mAHD showing the effect of depressurisation.

Although groundwater levels ranging from between approximately 31m AHD to 67m AHD and the depth of waste in the landfill ranging from approximately -60m AHD to 35-40m AHD (in December 2020), groundwater inflows giving rise to leachate generation from groundwater ingress into the waste are reportedly small due to the low hydraulic conductivity of the lower Wianamatta group aquifer layers.

IGGC (2009) estimated:

- the existing groundwater inflows are 26 m3/day (observed) and 67 m3/day (modelled)
- rainfall recharge of 657 m3/day (modelled).
- the long-term groundwater inflow rate[5] is therefore estimated to be below 3 m^3 /day.

These estimates are averages and do not reflect seasonal variability but indicate rainfall inputs are the dominant variable affecting leachate generation rates.

3.3 Landfill hydrogeology

Leachate levels reported at the sump during May and June 2021 varied between +0.5 and -6.3 mAHD and were noted to lower 4 to 5m when the leachate pump is operating. The leachate level at the sump is likely to reflect the level in the sump only due to its limited perforated sections and blockages at depth.

Drilling logs of the gas wells which were drilled from 14 May to 30 June 2021 extend between 10 and 33 metres below the waste surface at the time of installation. Drill depths were limited to the maximum depth of the rig employed and to the presence of the pit sidewall / target depths at the sidewall wells.

Conditions within the waste reported in the gas well construction logs vary from dry to moist. Saturated conditions were reported at the base of the drilling logs of the two deepest gas wells located approximately 30m from the leachate sump and are consistent with the reported leachate

[5] With the final leachate level maintained at an appropriate margin below the regional groundwater level (c.50 mAHD) to ensure an inward hydraulic gradient, the hydraulic gradient will be reduced by at least an order of magnitude and will therefore result in an equivalent reduction in groundwater inflow.

level. The absence of saturated conditions and significant soil layers within the gas wells do not indicate leachate issues that would impact operation of the installed gas extraction at present.

Waste saturated with leachate is likely to be found within the deeper waste horizons (i.e., below the current extent of the gas wells) and will be a result of historic leachate generation from infiltration of precipitation and the operating practice of maintaining leachate at current levels which coincide with the leachate drainage layer installed to drain towards the sump at this level.

Landfill gas generation and extraction is impeded at lower levels due to saturated conditions. Leachate levels are below the level of the installed gas wells but has not currently been verified away from the leachate sump. More accurate location of the leachate level across the site will become available as future deeper LFG wells are installed.

Surface infiltration of precipitation remains the primary water source for leachate generation. It is not currently considered that the contribution of groundwater to leachate generation will have a deleterious effect on gas extraction or moderate the LFG generation rate beyond that of leachate generation from infiltration of precipitation.

Lowering leachate levels further is not recommended at this time until sufficient landfill gas extraction capacity is in place to cope with an expected increased production.

3.4 Landfill Containment System

This landfills containment and leachate management system is comprised of the following key features listed below based on review of documentation and descriptions of operations provided by Licensee personnel:

- basal lining and leachate collection system (~RL-66mAHD), constructed on the pit floor prior to landfilling
- a leachate sump constructed from the lowest elevation of the pit basal leachate collection system comprising:
  - 1500 concrete riser filled with drainage aggregate & perforated at the basal leachate collection layer (below RL -60 mAHD) and at the installed Leachate Management Contingency System (LMCS) (approximately RL 0 mAHD)
  - HDPE casing within the concrete riser constructed, perforated at the basal leachate collection layer only.
  - extraction pumps within the HDPE casing (6 l/s) operated by level controls in the Leachate Treatment Plant tanks.
  - Current leachate level is currently maintained below the LGMS (0 to -2 mAHD). Drawdown at the sump when pumping is 4 to 5 m below these levels.
- Containment above the basal cell liner is provided by the natural geology (Wianamatta Shale Group strata).
- An intermediate leachate collection system (LGMS) at approximately RL 10mAHD draining to the leachate sump at approximately RL 0mAHD
- Containment in the upper portion of the geology, and in particular the weathered portion (currently assessed above 37 to 52mAHD), is subject to further detailed assessment and design, including:
  - a further assessment of hydrogeological conditions
  - assessment of current impacts and performance of the lower sidewall system

  - considering LFG migration under operating and closure conditions (including groundwater level changes), and the requirements of the lining as a barrier system for LFG control
  - delineation of the lower levels of the required lining system based on the above
  - sidewall design and performance.
- Waste surface levels surveyed December 2020.
- Daily application of cover (150 mm VENM or alternative daily cover) and interim cover after 90 days (300 mm).

Regular stripping of landfill cover (particularly interim cover) in advance of waste placement is required best practice to avoid compartmentalisation of waste (and the containment of LFG and formation of perched leachate with the waste mass) which increases the difficulty of LFG capture and control.

3.5 LFG Monitoring

Both subsurface monitoring around the landfill void and landfill surface monitoring are conducted by independent Consultants for the Licensee. Observations from recent monitoring reports include:

- Methane above 500 ppm at locations on the surface waste – sidewall interface (8,000 ppm) and localised surface emissions (10,000 ppm) (CES March & June 2019 in Bingo Annual Environmental Review, 2019)
- Methane detected in BH14S (1.2%) and BH19S (32.4%) (CES, April 2021)
- Methane (60%) and hydrogen sulphide (H2S) (1552 ppm) adjacent toe Northern sidewall (CES May 2021)[6].

LFG emissions are evident at both the landfill surface and within the surrounding geology (BH14s and BH19s) close to the landfill void.

LFG and H2S emissions were evident and detectable by their characteristic odour during inspections of the landfill surface in May 2021.

[6] These Field Analyser results suggest a point source emission of LFG. Field analyser results for hydrogen sulphide should be viewed with caution without conformation by laboratory analysis.

3.6 Conceptual Site Model

A preliminary Conceptual Site Model (CSM) for the landfill based on the summary above is presented in Figure 2

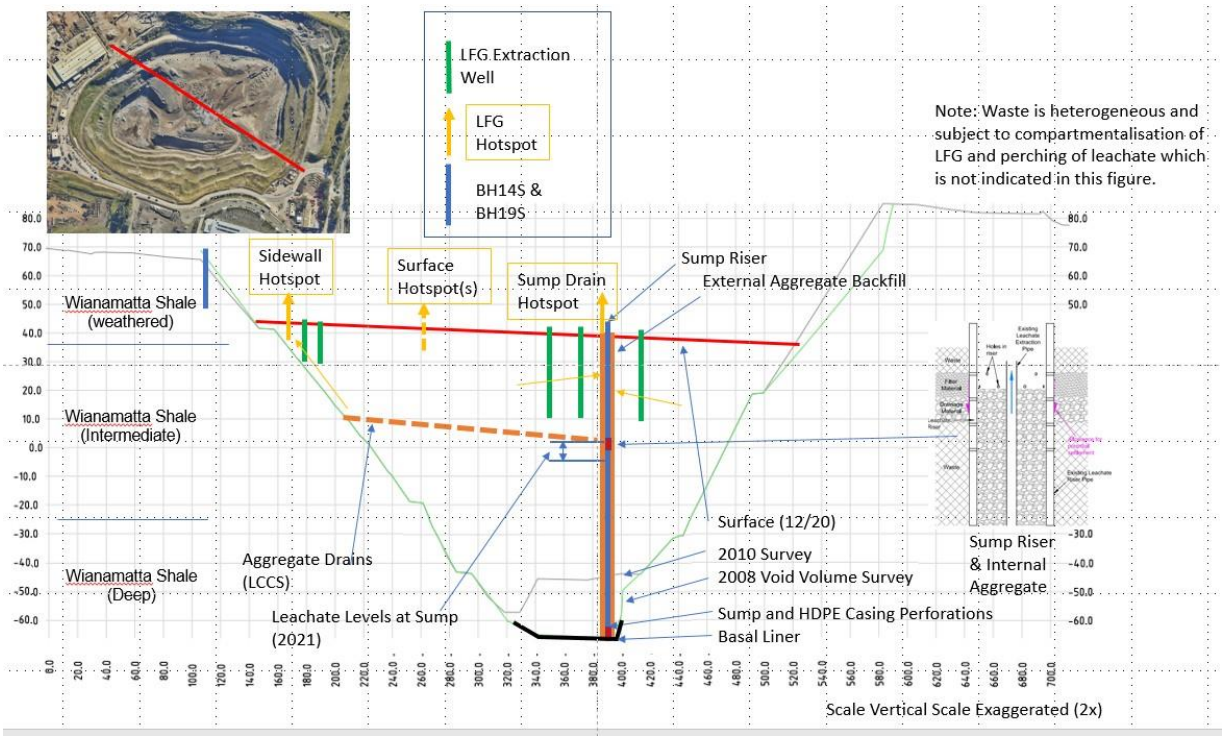


Figure 1: Landfill CSM

3.7 Factors influencing landfill gas production

The volume of LFG generated at a landfill is directly proportional to the amount of waste within the landfill. The total volume of LFG that will be produced is dependent on the type of waste and its volume.

The rate at what that LFG volume will be produced is influenced by:

- Moisture content and distribution
- Waste compaction
- Leachate management
- Waste composition changes over time
- pH and nutrient availability
- Temperature
- Presence of limiting factors (elevated temperatures or chemical inhibitors).

3.8 Predicted gas generation

The sites National Greenhouse and Energy Reporting (NGERS) return for 2019-20 reported 52,327 t-CO2-e. This equates to approximately 750 Nm^3/hr of LFG generation assuming 50% methane. The NGERS model was developed as a national reporting tool and has been found to provide poor estimates of site specific LFG generation when compared to estimates based on measured captured greenhouse gas emissions via installed LFG systems. The reported figures may significantly under or over-estimate

site specific generation of LFG and can vary by up to 35%[7]. Industry best practice is to develop more accurate site specific LFG production estimates from field pumping trials conducted over at least 3 months or until steady state conditions are achieved.

Given the remaining void capacity and rate of filling, generation can be anticipated to increase from current levels.

As noted in section 3.10 below, currently approximately 1800 Nm^3/hr is being extracted from the waste mass at the Eastern Creek landfill, which is a 140% increase on the NGERS model estimation.

3.9 LFG composition

Published literature values for the percentage of LFG that is made up of trace gases (i.e., not methane or carbon dioxide), and which give LFG its odour is less than 1%v/v and nominally around 0.5%v/v [8,9].

Hydrogen Sulphide (H_2S) is one such odourous trace gas and is known to be generated at the site through direct measurements with portable equipment and from laboratory analysed samples of LFG from the gas extraction system pipework. Though H_2S is a normal trace component of LFG and is found in early phase extraction of LFG at the Eastern Creek landfill within the ranges reported in US C&D landfills[10].

Hazardous concentrations of LFG may be present in excavations, depressions and at point source emissions at the landfill surface. Health and safety risks are to be assessed on an ongoing basis and the appropriate, plans procedures and safe work methods updated to account for the hazards associated with methane, carbon dioxide and hydrogen sulphide as a minimum. Where required the advice of a workplace health and safety specialist will be sought in relation to monitoring and maintaining a safe workplace[11].

3.10 Pumping trial update

Pumping trial gas extraction system performance

The installation of infrastructure for the extraction of LFG commenced on 15 May 2021, with an LFG pumping trial commencing on 17 May 2021 at the Eastern Creek landfill. The pumping trial required the progressive installation and operation of a LFG extraction system, initially this was with 6 landfill gas extraction wells and a single flare (500 m^3/hr), with a second flare (800 m^3/hr)[12] being commissioned on 26 May 2021 with 20 landfill gas wells in operation plus a connection to the leachate riser. In accordance with LGP-07 in Table 5 of this plan, the pumping trial LFG extraction system was expanded with the installation of another eleven landfill gas wells and a horizontal well at the leachate riser. This was completed on 29 May 2021, with a third flare (500 m^3/hr) being commissioned on 11 June.

The flares were reported as extracting a combined 1811 m^3/hr of LFG from the landfill on 26 June 2021. Since the commencement of the operation of the LFG extraction system, on 26 June 2021, a calculated total of 1,153,710 m^3 of LFG has been extracted and treated by combustion in the flares. Prior to the system being in operation all LFG was able to be emitted freely to atmosphere.

[7] NGER, 2020, Estimating emissions and energy from solid waste and landfill biogas management guideline, Section 4.9, p33
[8] Environment Agency (England and Wales), 2010, LFTGN04v3: Guidance for Monitoring Trace Components in Landfill Gas, section 1.2.3, p6
[9] UK Landfill Gas, Industry Code of Practise: The Management of Landfill Gas, Brindley, 2012, section 3, p3
[10] EPA/600/R-14/039, August 2014, Section 2.6.2 H2S Concentrations Measured at C&D Landfills.
[11] Safe Work Australia workplace exposure standards for airborne contaminants. 16 December 2019
[12] Nameplate capacity of flare 2 is 1000 m3/hr. Actual performance reported here is the measured flow.

Landfill gas composition

Methane concentrations have generally been ≥ 50% v/v with carbon dioxide concentrations between 40 to 50% v/v. As gas extraction has continued and vacuum slowly increased, the ratio of methane to carbon dioxide has slowly increased to around 1.2:1 to 1.3:1 towards the end of June, indicating that the gas generation is beginning to settle into a stable anaerobic state under gas extraction.

Vacuum applied at most gas wells remains low, indicating that the well field is capable of producing more gas while sustaining stable anaerobic conditions. This supported by the near zero oxygen and balance (nitrogen and argon) concentrations, indicating that the slightly positive gas pressure within the waste mass relative to atmospheric pressure has purged all atmospheric gases, and the low vacuum applied by the gas extraction system is insufficient to draw any atmospheric gases into the waste mass.

The pumping trial should continue to be operated until steady state conditions are reached and maintained for a minimum of two weeks. A steady state is where the gas flow rate in the extraction system equals the landfill gas generation rate. A steady state is identified as constant methane concentrations with oxygen concentrations less than 2% v/v, balance gases less than 20% and a ratio of methane to carbon dioxide of at least 1.3:1.

System Effectiveness

EPA have installed dedicated H_2S monitors at locations surrounding the site and in Minchinbury. Data downloaded from these monitors indicate that with the expanded LFG extraction and flaring system installed for the trial operational, H_2S concentrations recorded at the nearest locations in Minchinbury are below the odour threshold[13].

[13] https://www.epa.nsw.gov.au/working-together/community-engagement/community-news/minchinbury-odours Accessed July 2021

4 LANDFILL GAS ACTION PLAN

The following sections detail the installation, management, performance and environmental monitoring required to extract LFG from the waste at the facility to the extent that offensive offsite odour is mitigated.

4.1 Overview

An overview of the LGMP is outlined below in Table 4.

The LFG management plan includes short term actions as well medium- and longer-term considerations for LFG management. The LFGMP assumes that landfill operation and daily and interim cover application is occurring in accordance with licence conditions as a primary control measure which minimises direct emissions, leachate generation and enhances LFG recovery.

The short-term action plan establishes a pumping trial and ensures sufficient gas is available to operate the flares in the short term to sustain extraction and odour control from point source emissions. The pumping trial will be undertaken until sufficient information is gathered to inform the capacity required for the permanent LFG extraction system.

The medium to long term action plan includes development of an LFG extraction system aligned with longer term landfill development/filling requirements based on the outcomes from the pumping trial.

Table 4: LFGMP Overview

LFGMP Aspect	Where Addressed?	Timing
Short Term Action Plan	(Section 4.2 and Table 5)	System steady state achieved[14]
Contingency Measures and Actions	(Section 4.3 and Table 6)	Ongoing
Medium and Long Term Action Plan	(Section 4.4 and Table 7)	Estimated to be 4 months from completion of pumping trial[15]
Monitoring and Review	(Section 5)	Ongoing

4.2 Short Term Action Plan - Updated

Initially, a preliminary LFG extraction system will be installed and commissioned to reduce odorous emissions of LFG to atmosphere. **Table 5** provides a summary of the initial actions to be taken to manage LFG at the Facility to prevent odorous emissions to atmosphere.

The current LFG extraction system layout is shown in **Figure 3.** The system targets extraction from areas of identified elevated LFG emissions along the northern waste / sidewall interface and the main leachate sump.

The current LFG extraction system includes 31 LFG extraction wells, sealing and connection of the leachate sump to the LFG flares, interconnecting pipework, a HDPE main header line, barometric condensate control (J-traps); x2 500 nm^3/hr gas flares (with a 10:1 turndown ratio) and x1 800 nm^3/hr gas flare and associated auxiliary infrastructure including generator and telemetry alarm system.

[14] A steady state is identified as constant methane concentrations with oxygen concentrations less than 2% v/v, balance gases less than 20% and a ratio of methane to carbon dioxide of at least 1.3:1. The pumping trial duration is dependent on availability of sufficient sustained flare capacity to achieve steady state conditions at the wells under vacuum.
[15] Subject to the design, approval, procurement and commissioning timeframe.

Typical details are provided in Appendix B for LFG well design, J-trap design, typical gas well, J-trap and interconnecting pipework cross section, and horizontal collection well.

Subject to adequate performance and the monitoring data collected during the initial pumping trial period the preliminary system will be expanded based upon the data collected.

The perimeter wells, leachate sump and ring main connections are currently installed.

Provision is being made to install additional wells through the centre of the site to 30m depth, plus installation of horizontal wells below future waste lifts to allow gas capture to continue during filling and the disconnection and raising of vertical wells.

Beyond the preliminary extraction system trial operational phase, it is anticipated that installation and connection, as required, of additional LFG extraction wells to reduce LFG emissions at the waste/quarry wall interface and elsewhere will occur. This is detailed in Section 4.4 Medium- and Long-Term Action Plan.

Close attention will continue to be directed towards sealing the intermediate capping layer at the sidewall interface, around well infrastructure and at the surface due to the occurrence of settlement. Additional capping and capping repairs are being guided by frequent inspection and monitoring for LFG emissions using a surface gas survey (methane specific in spectra laser instrument with incorporated GPS). Additional measures that may also be trialled include:

- Compost biofilters (with moisture application) at hotspots to scrub odorous emissions, and
- Installation of horizontal wells and / or pin wells targeting extraction at persistent emission hotspots.

Figure 3: Preliminary LFG extraction system layout - As installed late June 2021 (Nearmap photo May 2021).

Figure 4: Landfill gas no.1 flare installation at EC REP for pumping trial purposes

Table 5: Landfill gas management actions

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
Install and commission preliminary LFG extraction system	LGP-01	Install LFGLFG wells 1 - 6 (ref Figure 3), associated J-traps (barometric traps), connecting pipework to 160mm HDPE main header line, lay and weld section 1 of 160mm main header line. Position, set up and commission LFG flare, flare condensate knock out pot (KOP), ancillary equipment, autodialer/ telemetry and generator. Connect 160mm main header line to flare	COMPLETE	Run Energy	-
	LGP-02	Ignite flare and perform initial gas well balancing. Record LFG balance per well, wellhead vacuum and gas flow, vacuum and gas flow at flare (pre-blower/booster).	COMPLETE	Run Energy	-
	LGP-03	Lay and weld 160mm main header line for connection to wells 7-15	COMPLETE	Run Energy	-
	LGP-04	Install LFG wells 7 - 15, associated J-traps (baro traps) and connecting pipework to 160mm header.	COMPLETE	Run Energy	-
	LGP-05	Connect temporarily sealed leachate sump to the LFG extraction main header line, applying a low vacuum to bleed the sump headspace and prevent air ingress into the LFG extraction system. Upgrade seal and gas specific connections to sump at next riser lift. Seal annulus of leachate sump on the outside of the concrete chamber at the waste surface using bentonite and clay. Collect LFG sample from leachate sump and submit to NATA accredited lab for analysis or direct into appropriate Drager tubes for on-site analysis. Manage surface water & leachate. Pump must have means to prevent blockage with waste materials.	COMPLETE As soon as feasible. COMPLETE & to be undertaken for subsequent lifts. COMPLETE As soon as feasible and operations allow As soon as feasible and operations allow	Run Energy/Bingo Bingo/Run Energy Bingo Run Energy Bingo Bingo	-

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
	LGP-06	Connect wells 7 – 15 to flare and perform initial LFG well balancing. Record gas balance per well, wellhead vacuum and gas flow, vacuum and gas flow at flare (pre-blower/booster).	COMPLETE	Run Energy	
	LGP-06a	Extend system in response to LGP-07. To date this has included - Connection of 27 vertical wells and 1 horizontal well - Expansion of flaring capacity (Addition of 2 more flares)	COMPLETE	Run Energy	
	LGP-07	Evaluate the function of the LFG extraction system to date and its impact on reducing odorous emissions. If deemed to be required, lay and weld remaining sections of header and install further LFG wells and connect to header.	From LFG extraction commencement (for the trial duration)	Run Energy	
Set out procedures and responsibilities for ongoing operation and maintenance of the LFG management system	LGP-08	LFG well balancing, flow and vacuum (per well and at flare); Methane, carbon dioxide, oxygen, balance (% v/v) Methane**:**carbon dioxide and oxygen**:**balance (ratios) Carbon monoxide Flow (m^3) Vacuum (mb or hPa) Atmospheric pressure (mb or hPa) measurement of H2S concentration in landfill surface Hydrogen Sulphide (ppm) (gas analyser with no H2S/carbon/charcoal filter) Hydrogen Sulphide (ppm) in gas wells reporting over range on gas analyser. Monitor H_2S with Drager short-term tube	From 17.05.21 *Per well:* Multiple times daily until stable conditions reached. Minimum weekly after stable. *At flare*: daily. Monitor left leg and right leg of 'T' junction in pipework pre-flare. Weekly Weekly Weekly	Run Energy Run Energy *Bingo* Run Energy Run Energy	

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
		Compile gas well field balancing, vacuum and flow data and produce trend analysis. Leachate level in gas wells using liquid level tube Leachate level in leachate sump using liquid level tube Trace gas analysis for priority trace gases (Environment Agency TGN04 v.3, 2010)	Weekly Weekly Weekly By July 31, then annually	Run Energy Run Energy Bingo Bingo appointed consultant	
		Daily flare checks (including generator and generator fuel supply), condensate control/removal, operational checks as per manufacturer/suppliers recommendations (blower, UV sensor blinding etc.), telemetry operation	Daily	Bingo (if Bingo generator used)	
		Visual inspection of all LFG wells (leaks, damage or blockages), interconnecting pipework (leaks, falls, damage or condensate build up), 160mm main header (leaks, connections, damage, fall, condensate build up), J-traps, flare, blower, flare KOP and leachate sump operation. Visual inspection of LFG well field area for differential settlement around wells or beneath pipework. Check pipework connections for tension/strain damage, check well annulus seals.	Daily Weekly	Run Energy Run Energy	

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
Set out procedures and responsibilities for monitoring the effectiveness of the gas extraction system in reducing odorous emissions	LGP-09	Undertake odour monitoring in accordance with requirements set out in the EC REP Air Quality, Odour and Greenhouse Gas Management Plan. Undertake odour monitoring (olfactometry) to provide feedback to the operation of the gas extraction system and other odour controls: - ambient air beyond site boundary at fixed monitoring locations. - on site at the boundary – fixed locations upwind and downwind of prevailing conditions on the day of monitoring. - on site within the landfill to evaluate odour reduction from gas extraction system operation. - Install a continuous air quality monitoring device at <location> and evaluate monitoring data at <frequency>	Following observation of offensive odour Daily Daily Daily As per frequency in column to left	Bingo Bingo Bingo Bingo or AQ contractor/consultant	
	LGP-10	Undertake LFG surface emissions monitoring; - within landfill area around the LFG wells and pipework to check for leaks. - within the landfill along transects to identify areas of high emissions of LFG (methane) to aid additional well placement for odour reduction and need for placement of additional cover material. - at the waste/quarry wall interface to identify areas of high emissions of methane to aid additional future LFG well placement for odour reduction and need for placement of additional cover material. – landfill surface in system area & to target expansion of system (**it is recommended that for targeted and operational investigation, transect spacings are reduced).**	Daily Weekly Weekly Weekly	Bingo or Bingo appointed consultant Bingo or Bingo appointed consultant Bingo or Bingo appointed consultant	EPA Victoria Publication 1684 Section 4.2 for appropriate instrumentation and methodology* to monitor Methane at the landfill surface. ***
	LGP-11	LFG composition sampling using sampling train and sorbent trains or suitable alternatives comprising: *Field (H_2S and CO)* - Analyse gas from each gas well using a potable LFG analyser *Field (H_2S)* - Obtain samples from all gas wells – draw into short term Drager	Weekly for 1 month after commencement (evaluation of	Run Energy or Bingo appointed consultant	Section 4.1 and 4.2 of Environment Agency (England and Wales) LFTGN04 Guidance for Monitoring Trace

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
		tubes and record result. *Lab – bulk gases incl' H_2S and CO* - obtain a gas sample from the main header line at each flare using an LFG analyser with a tedlar bag attached to the exhaust hose. Gas sample to be analysed for analytes below: • Methane • Carbon dioxide • Oxygen • Nitrogen • Argon • Carbon monoxide • Hydrogen sulphide *Lab – Trace compounds* Priority trace gases as per Environment Agency TGN04 v.3, 2010	results will determine future monitoring requirements) Fortnightly for 1 month after commencement (evaluation of results will determine future monitoring requirements) As per LGP-08	Run Energy or Bingo appointed consultant Run Energy or Bingo appointed consultant	Components in LFG.
	LGP-12	Undertake ongoing evaluation/estimation of LFG generation based on the sustained performance of the preliminary LFG extraction system (sustained LFG composition and flow).	Ongoing	Run Energy	-
	LGP-13	Undertake subsurface monitoring from existing monitoring wells. Review adequacy of existing monitoring locations and update as necessary.	Ongoing (Weekly)	Run Energy Bingo	-

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
	LGP-14	Review performance of capture from the sump. Adjust applied vacuum as necessary, noting the need to balance this with preventing air ingress into the LFG extraction system. Design new sealed cover based operation needs to improve connection to extraction system and the flows achieved from the sump, and associated drainage layer and nearby LFG extraction wells.	Daily (First week of operation) then TBA (Ongoing)	Run Energy & Bingo	-
	LGP-15	Bingo safe work methods, procedures and training documents to be updated to address the hazards and risks and controls required to manage and mitigate hazardous conditions associated with landfill gas. All staff operating the LFG extraction system or working on the leachate sump to have personal multi gas alarms for LEL (methane), carbon dioxide, oxygen, carbon monoxide, hydrogen sulphide. Comply with appropriate SWMS.	In progress COMPLETE Ongoing	Bingo (Occupational Hygienist) Run Energy and Bingo All	
	LGP-16	Update Air Quality, Odour & Greenhouse Gas Management Plan to refer to this LFGMP in relation to management of LFG emissions.	In progress	Bingo	
	LGP-17	Update subsurface monitoring plan to comply with Section 5.3 of EPA Landfill Guidelines.	In progress	Bingo (Consultant)	

Objective	ID	Action	Timing	Responsibility	Reference (Where applicable)
	LGP-18	Undertake design, assessment and modelling necessary for design, approval, procurement and installation of a permanent flare to provide additional and permanent flare capacity.	In progress TBC based on	Bingo Bingo (Consultant)	

4.3 Contingency Measures and Actions

This section describes contingency measures and actions for foreseeable operational problems that could affect the operation of the preliminary LFG system or failures that can be reasonably anticipated.

Table 6: Contingency Measures and Actions

Problem or failure	Action	Responsibility
Well or pipework blockages	Pipework: Routinely check pipework for low points and condensate blockages, manually drain to closest J-trap if found by raising pipe. Re-set pipework fall so condensate drains to J-trap. If required install manual drainage point and manually drain to surface. LFG well: check leachate level in well. Check flexible hose from wellhead to connecting pipework for condensate blockages. If leachate levels are such that limited perforations are available, consider installation of a pump to well to reduce and maintain leachate head to allow LFG extraction.	Run Energy Run Energy Run Energy
Well or pipework damaged or destroyed	Report to LFG Contractor Pipework: isolate affected wells and replace pipework. Well: isolate well and fix damage. If well unserviceable, seal in appropriately with bentonite slurry and replace well. Re-balance well field if any wells are offline for repair or replacement.	Bingo Run Energy Run Energy Run Energy
Gas flow reductions, gas flow surging	Pipework: Check pipework for low points and condensate blockages, manually drain to closest J-trap if found by raising pipe. Re-set pipework fall so condensate drains to J-trap. Confirm smooth gas flow after pipework cleared of condensate	Run Energy Run Energy Run Energy
Gas main header blocked by condensate	Pipework: Check pipework for low points and condensate blockages, manually drain to closest J-trap if found by raising pipe. Re-set pipework fall so condensate drains to J-trap. Confirm smooth gas flow after pipework cleared of condensate. If above, do not resolve blockages install pumped condensate drainage pots	Run Energy Run Energy Run Energy Run Energy
Flare failure	Telemetry autodialer to be utilised and automatically call to alert. Critical spare serviceable parts to be available at all times	Run Energy/ Bingo Run Energy/ Bingo
Power failure	Attempt re-start of generator Switch to backup generator	Run Energy/ Bingo Run Energy/Bingo
Significant increase in odour complaints or recommencement of odour complaints if previously none	Check LFG well field for any operational issues Check flares is operating If flares out – check slam shut valve is closed. Diagnose issue and re-ignite flares. If field operating as normal – rebalance field.	Run Energy Run Energy/ Bingo Run Energy/ Bingo Run Energy

Problem or failure	Action	Responsibility
	Undertake rapid response odour monitoring following LGP-09 procedure.	Bingo
	Undertake inspection of landfill to identify any areas of increased odour	Bingo
	Check for pooled leachate at landfill surface	Bingo
	Check surface water ponds/dams within waste (if in use)	Bingo
	Check leachate treatment plant is functioning as required.	Bingo
Significant increase in LFG surface emissions	Undertake inspection of landfill to identify any areas of increased odour	Bingo
	Check for pooled leachate at landfill surface	
	Check surface water ponds/dams within waste (if in use)	
	Check leachate treatment plant is functioning as required.	
	Apply additional cover material in the affected areas	
	Rebalance LFG well field if within LFG extraction system area	Run Energy
	Undertake odour monitoring as per LGP-09 procedure.	Bingo
Surface gas or enclosed space monitoring detects methane concentrations above 1.25% (v/v)	Notify EPA within 24 hours via the EPA Pollution Line 131 555 (as per EPL condition R2.1)	Bingo
	Complete incident record	Bingo
	Increase frequency of monitoring to daily (until EPA determines otherwise)	Bingo
	Submit written assessment to EPA within 14 days detailing the emissions and management controls to prevent further emissions	Bingo
Gas balance indicates the presence of a sub-surface hotspot	If a gas well indicates CO over 100ppm evaluate methane: carbon dioxide ratio and oxygen : nitrogen ratio.	Run Energy
	Monitor gas temperature	Run Energy
	If gas temperature or gas balance results indicate a hotspot take an LFG bag sample or sample into Drager short term tubes (CO) to confirm CO concentrations, then shut off the gas well.	Run Energy
	Ensure that cover material in the area is adequate and no waste is visible, apply additional cover as required.	Bingo
Surface fire	Respond in accordance with Emergency Response Plan.	Bingo
	Notify LFG Contractor	

4.4 Medium- and Long-Term Action Plan

The medium and long term plan focuses on development of an LFG extraction system aligned with longer term landfill development/filling requirements to ensure odorous emissions of LFG do not occur.

In the medium term (following establishment of steady state conditions and maintained for a minimum of two weeks)[16] consideration of the expansion of the LFG extraction system to include active leachate extraction using dual purpose LFG and leachate extraction wells. Note all wells to be installed as outlined above will be installed so as to also be suitable for conversion to dual purpose via replacement suitable wellheads and pumps.

[16] A steady state is where the gas flow rate in the extraction system equals the landfill gas generation rate. A steady state is identified as constant methane concentrations with oxygen concentrations less than 2% v/v, balance gases less than 20% and a ratio of methane to carbon dioxide of at least 1.3:1.

Pending review of pumping trial, expansion of the LFG extraction system, and design of future LFG management system, future wells may attempt to intercept and dewater the leachate drainage layer installed at approximately 0 to 2 mAHD, if it is identified that it has potential to act as a LFG pathway for LFG to move to the edges of the waste body and escape up the waste-quarry wall interface and a reservoir for LFG. The updated LFG extraction and combustion system will be designed to have sufficient capacity to treat and dispose of via incineration by flaring, the anticipated increases in LFG generation as/after the system expansion and dewatering occurs.

In the longer term, ongoing expansion of the LFG extraction system, and raising of the preliminary LFG system along with any upgrades of sidewall lining and leachate extraction infrastructure as landfilling continues will be required to occur, to reduce emissions of LFG to atmosphere for odour management and prevent risks associated with subsurface lateral migration of LFG through the geological strata. This will likely include increasing the available flaring capacity as the gas well field expands. As the waste height increases, additional LFG monitoring bores at the landfill perimeter will be required to be installed to monitor for LFG risk associated with migration through subsurface geology.

An ongoing environmental monitoring program for LFG must be developed for the facility that builds upon and expands the LFG monitoring presented in this management plan.

Table 7: Proposed action plan – Expansion of the Landfill Gas Extraction System

Objective	ID	Action	Timing	Responsibility	Reference
Expand LFG extraction system to align with landfill development and filling	ELGP-01	Install dual purpose LFG and leachate extraction wells to improve leachate extraction volumes from the waste and improve LFG collection efficiency. Dual purpose wells to be installed to approx' 0 – 2m AHD to target leachate drainage layer. Install associated leachate storage/transfer tank within landfill (storage prior to ongoing transfer to leachate treatment plant).	TBC – linked to ELGP-03 below. Subject to drill rig availability to drill 40m+ BGL. Post drilling of wells	LFG Contractor LFG Contractor Bingo	
	ELGP-02	Install dual purpose LFG and leachate extraction to at least the LGMS layer and reduction of leachate head at the 0-2m leachate drainage blanket as necessary to allow effective LFG extraction	TBC (post short term actions).	LFG Contractor / Bingo	
	ELGP-03	Sequentially and progressively raise existing and any future LFG wells and associated interconnecting pipework, leachate and condensate removal systems to enable further lifts of waste to be landfilled, with LFG extraction resuming once the lift is complete around the wells.	As required as landfilling progresses	LFG Contractor – gas well field works Bingo – sequencing waste filling with gas well field works.	

Objective	ID	Action	Timing	Responsibility	Reference
	ELGP-04	Install further LFG wells and associated pipework as landfilling progresses to increase LFG capture. Install additional flaring capacity as required to combust estimated increases in LFG extraction volumes. Based on LFG field performance and estimates of gas generation volumes, consider the viability of installation of an LFG engine and generator and associated electrical interconnection.	Determined by actions under LGP-08 and LGP-12 in Table 3.	LFG Contractor LFG Contractor Bingo and LFG Contractor	
	ELGP-05	Establish sidewall lining LFG containment functional requirements.		Bingo	Landfill Plan
	ELGP-06	Establish permanent flaring or other combustion system, including necessary approvals.	TBA	Bingo	
Representative monitoring of landfill gas in subsurface geology	ELGP-07	Monitor LFG in the subsurface geology and subsurface services/pits/conduits/enclosures on or near the landfill in accordance with the subsurface landfill gas monitoring plan. Develop an updated environmental monitoring program (EMP) for landfill gas in the subsurface geology and subsurface services/pits/conduits/enclosures on or near the landfill.	Ongoing In accordance with EPA variation to EPL 13426	Bingo and monitoring contractor Bingo	Current plan, though in need of an update is appended to this LFGMP at <appendix xx>. The final subsurface landfill gas monitoring EMP will be incorporated into this LFGMP.

5 MONITORING AND REVIEW

As noted previously, this LFGMP will be reviewed and updated progressively in response to performance of the LFG pumping trial.

Specific internal operational and performance monitoring requirements for this plan are described under the actions in the short-term action plan (Section 4.2).

This plan will be reviewed following the pumping trial[17]; and earlier where:

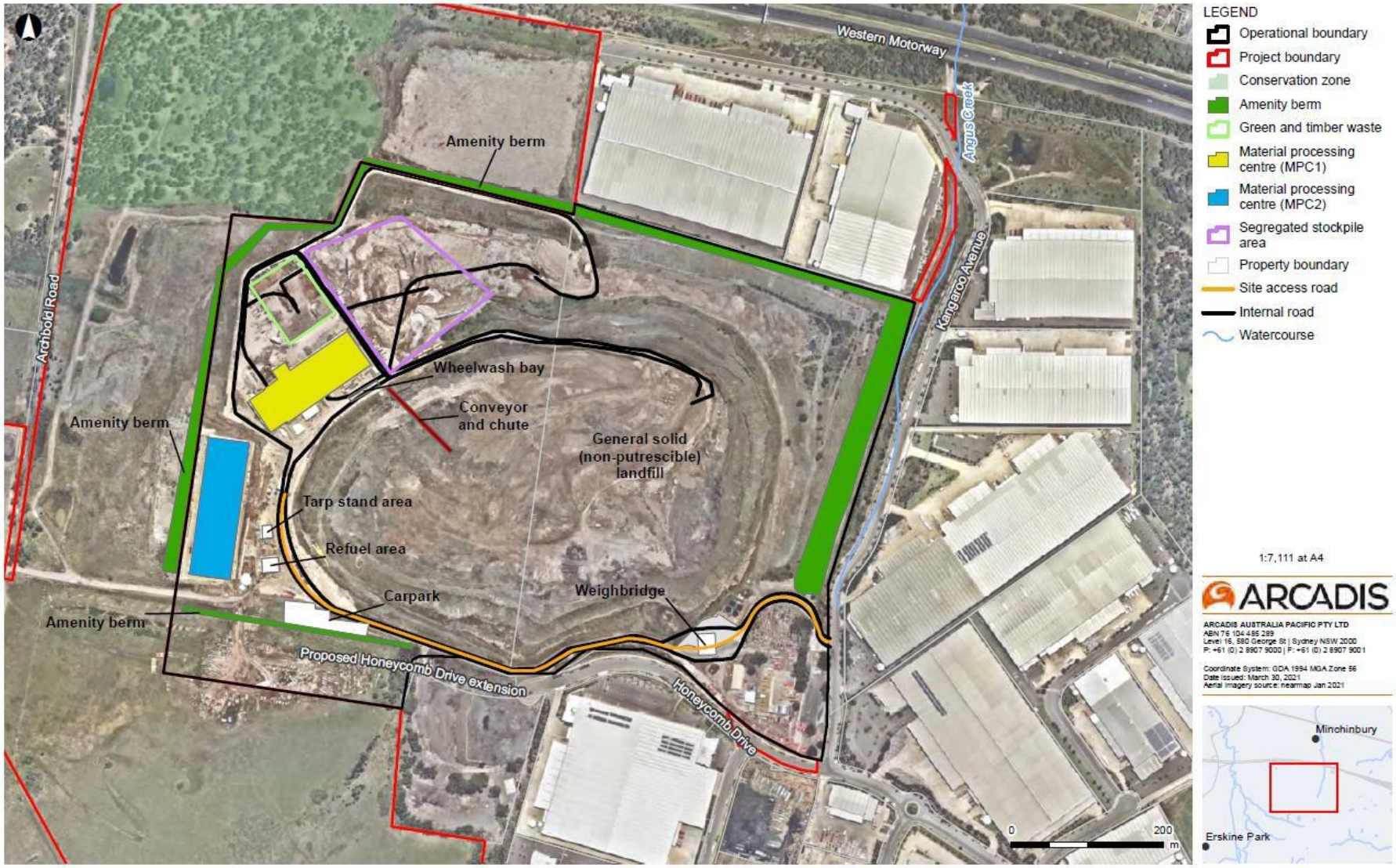
- If significant volumes of leachate are encountered or condensate drainage becomes problematic
- The LFG extraction system is expanded
- The LFG extraction system function is compromised
- Any material parts of the LFG extraction system are to be decommissioned
- Changes to operations which have the potential to materially affect LFG generation
- Performance of the LFG system is not meeting the objectives of this plan (Section 1.3).

[17] Establishment of steady state conditions where the gas flow rate in the extraction system equals the landfill gas generation rate.

6 REFERENCES

- IGGC, Ian Grey Groundwater Consulting Pty Ltd (2009), Proposed Light Horse Landfill Site, Eastern Creek: Detailed Hydrogeological Investigation and Assessment
- NSW Environment Protection Authority (2016) Environmental Guidelines: Solid waste landfills (2nd Edition). Sydney.
- EPA Victoria (2018) Landfill Gas Fugitive Emissions) Monitoring Guidelines, Publication 1684.
- Environment Agency (England and Wales) 2004. LFTGN03 Guidance on the Management of Landfill Gas.
- Environment Agency (England and Wales) 2010. LFTGN04 v 3.0 Guidance for the Monitoring of Trace Components in Landfill Gas.
- Environment Agency (England and Wales) 2010. LFTGN07 v2 Guidance on Monitoring of Landfill Gas Surface Emissions.
- Safe Work Australia. Workplace exposure standards for airborne contaminants. 16 December 2019.

APPENDIX A FACILITY OVERVIEW



Appendix A - Site Layout

Date: 30/03/2021 Path: H:\AAP_GIS\Publishers\Workspace\B_Workshop\2020\20200720_30056657\L-GIS\A_Current\B_Maps\MgmtPlan\30056657_MgmtPlan_002_SiteLayout_A4L_v5.mxd
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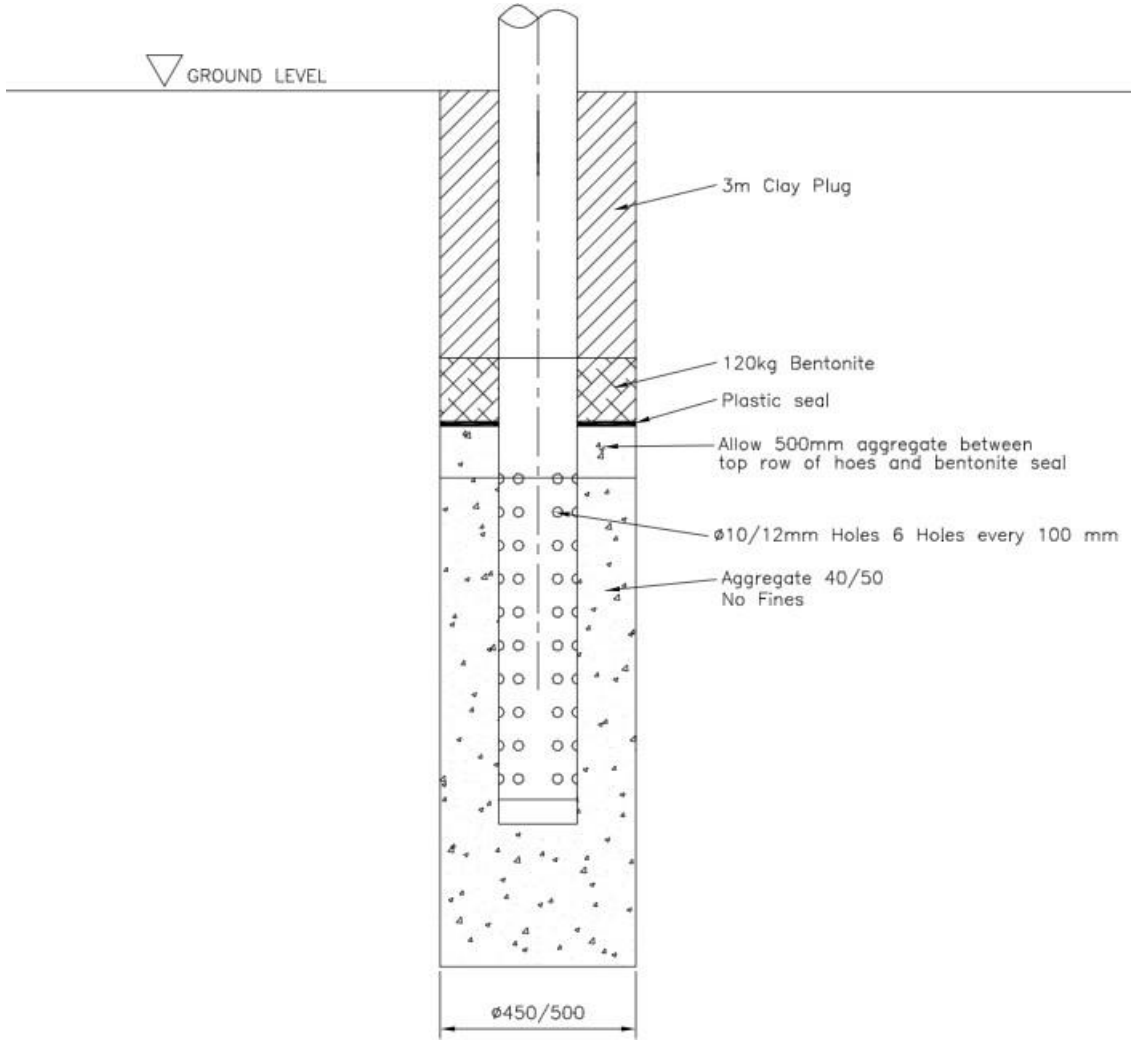
APPENDIX B LFG SYSTEM DETAILS



NB: Preliminary well to be installed ~ 0.5 m above base of drilled bore

Figure B1: Typical gas well installation (Run Energy, 2021)

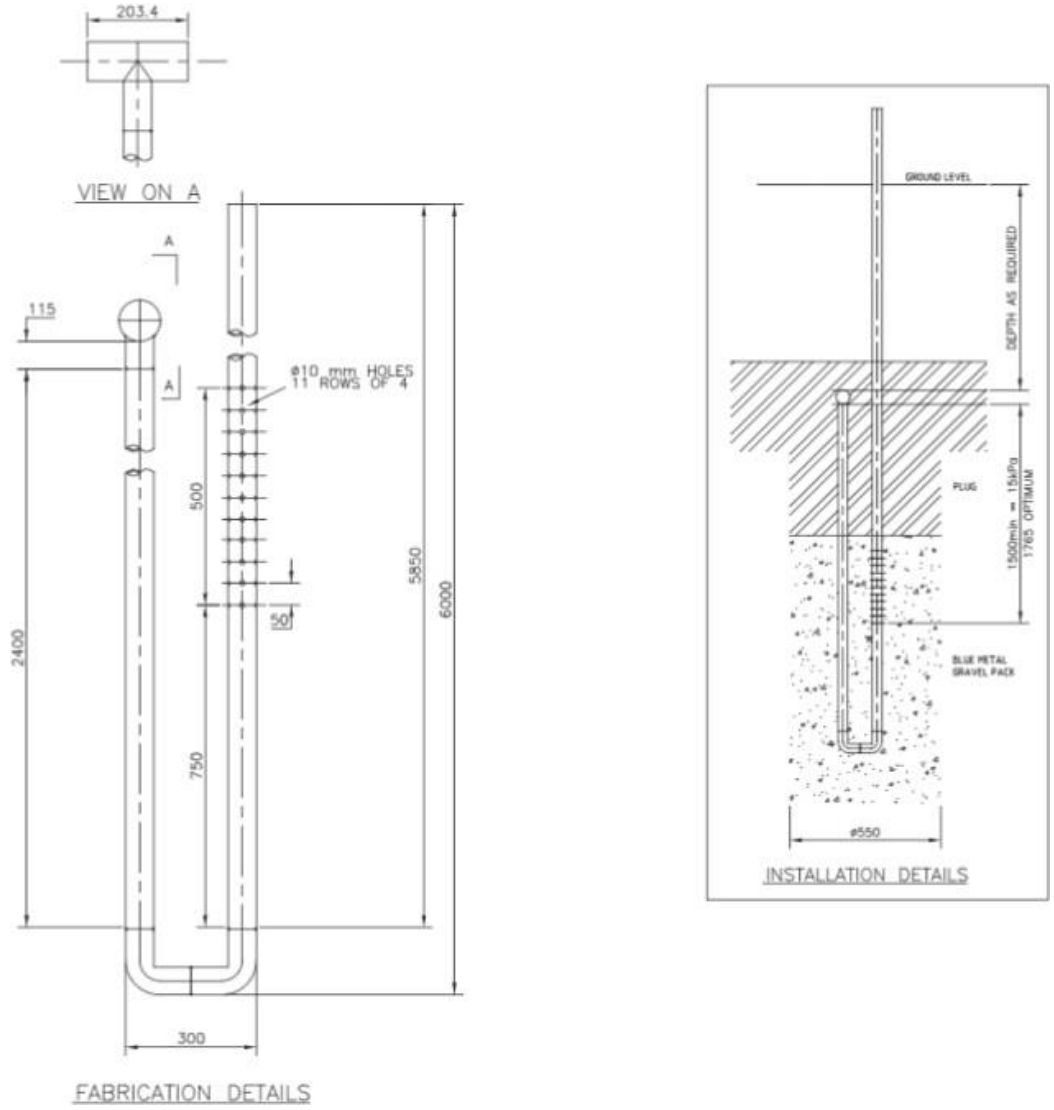


Figure B2: Typical J-trap (Barometric trap) installation for condensate control (Run Energy, 2021)

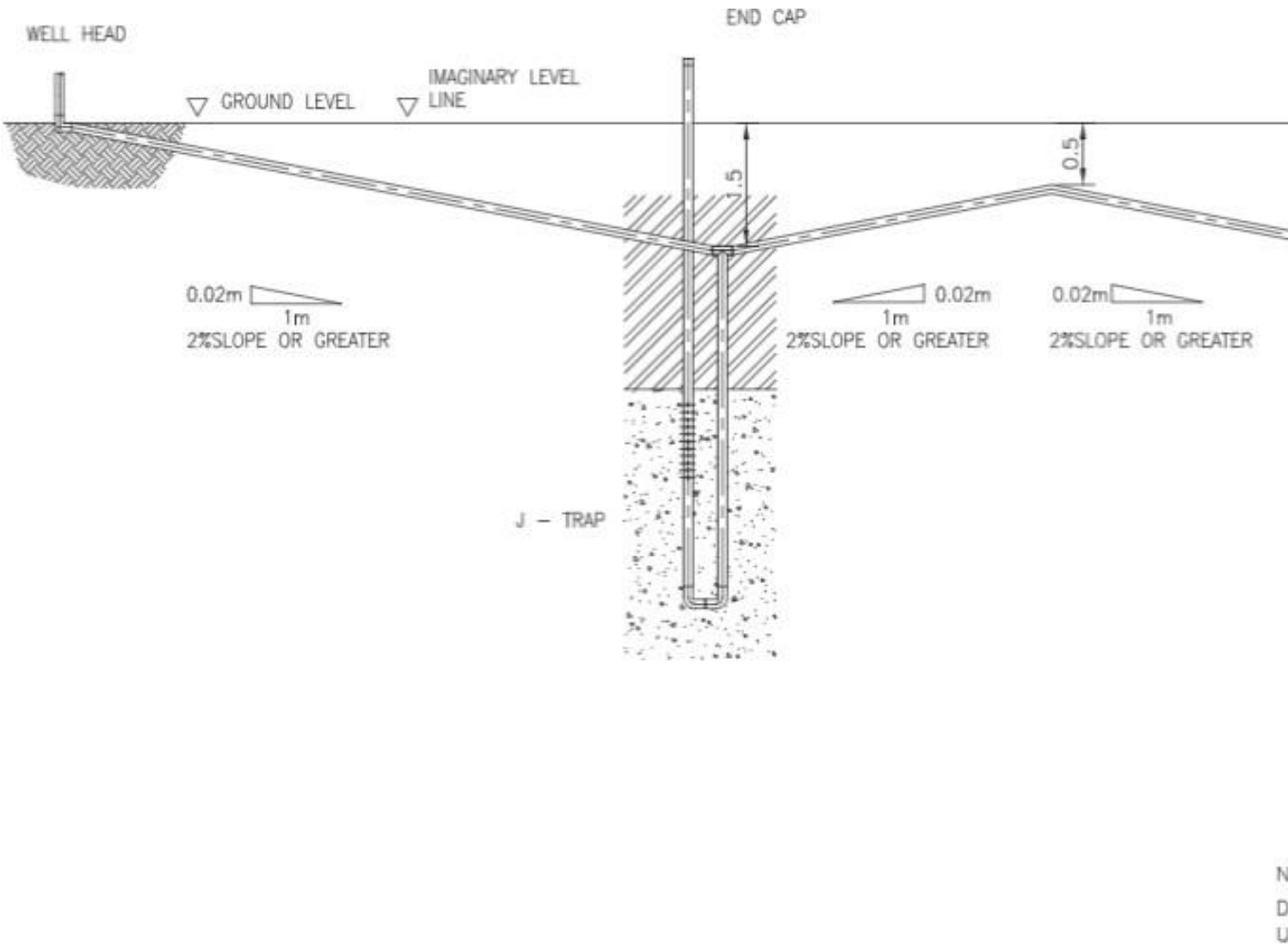
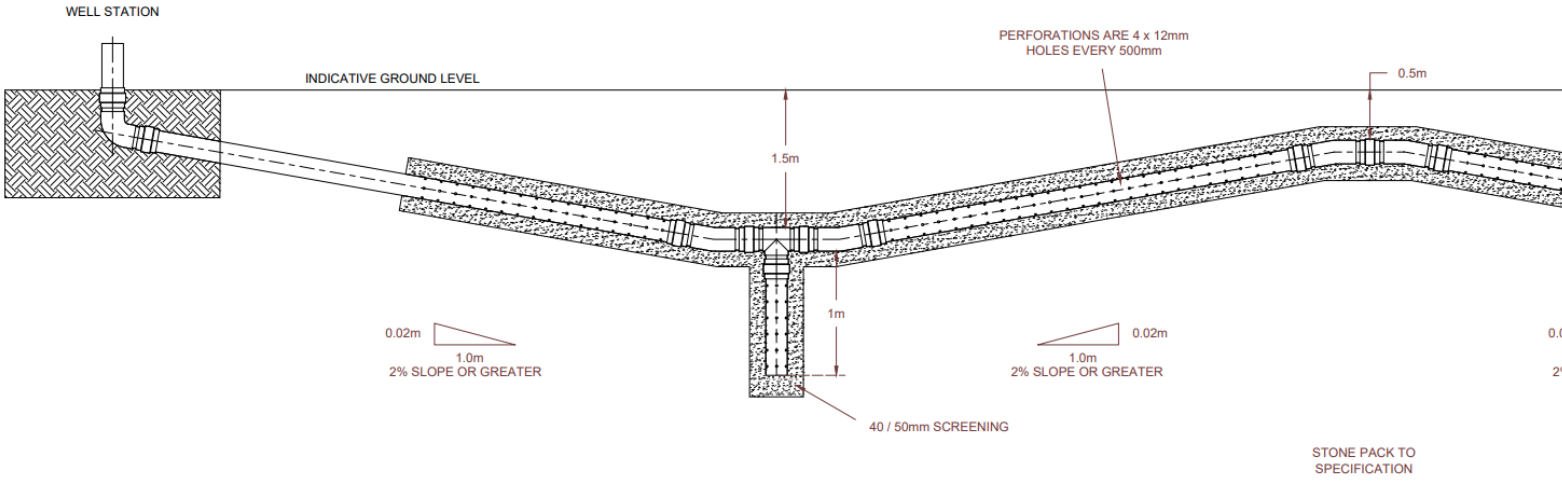


Figure B3: Typical gas well, connecting pipework and J-trap installation (Run Energy, 2021)



FRONT ELEVATION
SCALE (DNS)

Figure B4: Horizontal Well Set – General Arrangement (Run Energy, 2021)