MPG

Supporting Statement
Gale Moss
Ruttle Plant Ltd.

Document Reference: 305/2--R1.3 - Supporting Statement

MPG

Minerals
Waste
Environment

The Mineral Planning Group Ltd.
The Rowan Suite, Oakdene House,
Cottingley Business Park, Bingley,
West Yorkshire BD16 1PE

01274 884599/884699
headoffice@mpgyorks.co.uk

www.mpgyorks.co.uk

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SECTION 1: Introduction

1.1 General

1.1.1 *The Mineral Planning Group Ltd.* (MPG) have been commissioned by *Ruttle Plant Ltd.* (Ruttle) to prepare a planning application and accompanying supporting statement for the Prior Extraction of a known sand and gravel deposit at land known as Gale Moss ('The Site'), near Chorley.

1.2 Site Description

1.2.1 The Site is located immediately to the north-east of junction 8 of the M61, near Chorley, at grid ref: SD 59058 19763 (see Drawing refs: 305/2 - 1 and 305/2 - 2). The total site area is approximately 9.9ha.

1.2.2 The Site currently consists of agricultural fields, though it is also used to host car boot sales. Further details of The Site are provided in Section 2.

1.3 Proposal and Aims

1.3.1 The proposals have two primary aims:

- To extract some 300,000 tonnes of sand and gravel and prevent its sterilisation through non-minerals development. This best-practice principle is known as 'Prior Extraction'.
- To facilitate the development of an (already approved ref: 17/00713/OUTMAJ) industrial development upon The Site through the importation of suitable inert materials in order to construct an

engineered development platform.

1.3.2 It is noted that The Site is allocated for employment development in Policy EP1.3 of the Chorley Local Plan.

1.4 Regulations and the Supporting Statement

1.4.1 The Mineral Planning Authority (MPA – Lancashire County Council (LCC)), have confirmed that the proposals do not require an Environmental Impact Assessment (see Appendix A).

1.4.2 Nevertheless, the potential environmental impacts of the development have been investigated. Following pre-application advice from LCC, MPG have concluded that surveys and detailed consideration of the following matters were necessary:

- Ecology and Biodiversity
- Landscape / Visual Impact
- Dust and Air Quality
- Noise
- HGV Movements
- Hydrology

1.4.3 The supporting statement contains the following:

- Introduction
- Site Description
- Operational Details

- Planning Policy and Need Assessment
- Dust Management Scheme
- Flood Risk Assessment
- Restoration Scheme
- Hydrogeological Risk Assessment
- Slope Stability Assessment
- Landscape and Visual Statement
- Noise Survey
- Preliminary Ecological Assessment
- Supporting Plans and Drawings

1.5 The Applicant

1.5.1 Ruttle Plant Ltd. are a long-established, experienced, International minerals, waste and engineering operator based in Chorley, Lancashire.

SECTION 2: Site Description

2.1 General Description

2.1.1 The Site is located immediately to the north-east of junction 8 of the M61 motorway, close to Chorley (see Drawing refs: *305/2 - 1* and *305/2 - 2*). The Site's grid reference is SD 59058 19763.

2.2 Site Description

2.2.1 The Site occupies approximately 9.9ha and currently consists of agricultural fields, which are also occasionally used to host car boot sales. The Site is bound to the:

- North by agricultural fields and a 'peaty area' (Gale Moss)
- East by the Leeds-Liverpool Canal
- South by the A674 (Millennium Way)
- West by the M61 Motorway

2.2.2 The Site is accessed from the A674 by a modern, existing roundabout from which it is just 250m to junction 8 of the M61 Motorway.

2.2.3 On the southern and western boundaries are hedgerows with sporadic hedgerow trees. A small area of mature trees in the southwest occupies the motorway embankment but is outside of The Site's boundary.

2.3 Topography

2.3.1 Elevation at The Site varies from approximately 87m AOD to 91m AOD, though The Site's profile is generally flat, with a gentle slope towards the north. The Site is lower in elevation than the M61 Motorway and its adjoining slip-roads, which have embankments abutting the western and southwestern boundaries up to approximately 6m in height.

2.4 Hydrology and Hydrogeology

2.4.1 There are two drainage channels crossing The Site. One drain crosses from east to west, towards the peat area (see drawing ref: *305/2 – 3*), which would be unaffected by the proposals, save for a culvert to allow a vehicle crossing point (see section 3).

2.4.2 The drainage ditch that flows south to north, some of which is currently culverted, would be diverted around the edge of The Site for the lifetime of the works, and retained as a diversion post-restoration (after which the industrial development's design would determine the final route of this ditch).

2.4.3 The area of peat to the northwest of The Site (see drawing ref: *305/2 – 3*) is partly fed by the drainage ditches and would be afforded a suitable stand-off during operations of at least 10m.

2.4.4 The bedrock and the superficial deposits (see section 2.5) beneath The Site are classed as a Secondary A aquifer. The Site is not, however, in a Drinking Water Protection Zone (for surface or groundwater).

2.4.5 Trial pits show that groundwater is approximately 4.5m below surface in most areas of The Site. In the northern element of The Site (north of the drainage ditch), groundwater approximately 3.5m below ground, and no extraction would be carried out in this area. All mineral would be extracted, therefore, from above the water table, leaving a minimum of 1m stand-off between the base of extraction and groundwater.

2.4.6 A hydrogeological risk assessment is provided in chapter 8.

2.5 Geology

2.5.1 The bedrock beneath The Site is the *Rossendale Formation* in the western area of The Site, consisting of sandstones, siltstones and mudstones. In the eastern area of The Site, is the *Lower Haslington Flags*, consisting of sandstones. The two geological units are separated by a (minor) fault[1].

2.5.2 The Site is located within an area of relatively complex structural (bedrock) geology, with several faults shown on British Geological Survey (BGS) maps.

2.5.3 However, the mineral to be extracted at The Site is the superficial deposit of glaciofluvial sand and gravel overlying the bedrock. This mineral reserve has been proven by trial pits dug to some 5m below the current surface.

2.5.4 Trial pits show that soil depth at The Site is very limited, often less than 0.5m.

[1] Note that the British Geological Survey (BGS) label this fault as 'inferred'.

2.6 Rights of Way

2.6.1 A public footpath crosses The Site (9-2-FP 26). This footpath would be diverted during operations. The design of the industrial development would, ultimately, determine the permanent route for this footpath post-development. The diversion would ensure that the footpath remains as, or more, commodious and would seek to retain the existing access and egress routes if possible.

2.7 Recent Planning History

2.7.1 17/00713/OUTMAJ – *Outline planning application for employment floorspace (Use Classes B2 and B8) with associated highways, landscaping provision and any ancillary development thereto. All matters reserved except for access which is proposed off the existing A674 roundabout.* **GRANTED** – 21/10/2019

2.7.2 97/00819/OUT - *Erection of steel fabrication works and offices and ancillary works including new roundabout to A674.* **REFUSED** 25/03/1998

SECTION 3: Operational Details

3.1 General

3.1.1 The proposals are for the prior extraction of some 300,000 tonnes of sand and gravel. The sand and gravel would be extracted to a depth of approximately 3.5m below surface (retaining a 1m stand-off from the local groundwater table).

3.1.2 The Site would be restored with approximately 300,000 tonnes of suitable inert materials to provide an engineered construction platform for the approved (outline) B2 industrial development at The Site and, should the industrial development not go ahead, create agricultural land with biodiversity set-aside areas.

3.2 Operations

3.2.1 The proposed prior extraction operations would be carried out in three phases, starting in the eastern extent of The Site and moving westwards (see drawing ref: 305/2 – 4). The northern area (see Drawing ref: 305/2 – 3) would be used for storage of plant and equipment, or, stockpiling of materials, and would not be worked.

3.2.2 Soil stripping would also be carried out in a phased manner. All stripped soils would be stored in amenity bunds as shown on Drawing ref: 305/2 – 3, and be retained for use in restoration. It is noted that there is a limited (often less than 0.5m) depth of soil across The Site.

3.2.3 All soils bunds that would stay in place for 6 months or longer would be seeded

with a grass seed mix to reduce their visual impact during the lifetime of the works. The locations of the bunds are shown schematically on Drawing ref: *305/2 – 3*. The bunds provide visual screening and have been calculated to use the total amount of soil stripped (approx. 14,000m^3). Therefore, because not all of the soils are to be stripped at once, and rolling restoration would be carried out, not all bunds would exist at the same time. However, the easternmost section of bund that runs parallel to the canal would be maintained throughout the lifetime of the works, or, until its soil materials are required for final restoration.

3.2.4 As stated, all extraction of sand and gravel would take place above the water table, using a loading shovel or hydraulic excavator.

3.2.5 It is intended that, in order to reduce the total number of HGV movements, once restoration has commenced, HGVs arriving with restoration materials would leave The Site loaded with sand and gravel, if possible.

3.2.6 Restoration would be carried out using inert materials to achieve an engineered restoration platform, ready for the industrial development. If construction of the industrial development does not commence within 12 months of the final restoration contours being achieved, The Site would be restored in accordance with the design features described in Section 7, to allow The Site to be used for agricultural pasture in the interim period between restoration and construction of the industrial development. The restoration scheme aims to also provide a net gain in biodiversity with enhancements such as tree planting and wildflower meadow seeding. See Section 7 for further details.

3.3 Rate of working

3.3.1 It is anticipated that extraction would take 2-4 years to complete, extracting 75,000 to 150,000 tonnes per year. Restoration would, equally take 2-4 years to complete. However, it is intended that restoration should commence at the earliest opportunity after entering Phase 2 of extraction (see Drawing ref: *305/2 – 4*.

3.3.2 Therefore, it is anticipated that operations at The Site would be completed within some 6-8 years.

3.4 Hours of Working

3.4.1 The proposed working hours are as follows:

07.00 – 18.00 Weekdays
07.30 – 13.00 Saturdays

3.4.2 No extractive, or, infilling operations would be carried out on Sundays or Bank Holidays, when only emergency repairs and maintenance would be carried out.

3.5 Site Access / Vehicle Movements

3.5.1 It is anticipated that it will take some six to eight years to complete extraction and restoration operations. This timescale would require approximately 30 two-way HGV movements per-day. However, as not all HGVs arriving with inert materials

for restoration would leave loaded with sand and gravel[1], it is recommended that a limit of 50 two-way HGV movements per-day is applied by condition.

3.5.2 Site access would be from the existing roundabout on the A674. This roundabout is located only 250m (approx.) from the junction with the M61 motorway. The Site is, therefore, ideally located to serve a wide geographical market.

3.6 Mineral Quantities

3.6.1 It is estimated that approximately 300,000 tonnes of sand and gravel would be extracted from The Site. This calculation is based on a viable deposit of 3.5m of sand and gravel[2] available for extraction whilst maintaining a stand-off of at least 1m from groundwater[3]. All mineral would, therefore, be worked dry. The tonnage calculations utilise an extraction area (see drawing ref: *305/2 – 4*) based on the stand-offs recommended by the slope stability report (see Chapter 9).

3.6.2 It is anticipated that an equivalent volume and tonnage of inert materials would be required for restoration. The nature of these materials and any required engineering would be determined and controlled by an Environmental Permit or Materials Management Plan, which would be secured from the Environment Agency for the restoration of The Site.

[1] Some contracts or customers of The Site would not be able to carry out both of these operations.

[2] See Drawing refs: *305/2 – 5*, *305/2 – 6*, and *305/2 – 7*.

[3] Note that the slope stability report uses a depth of 4.5m to allow for 'worst case scenario'.

3.7 Water Management / Hydrology

3.7.1 The drainage ditch crossing east to west would be culverted along a short stretch to allow plant and machinery to cross to the northern area (where no extraction would take place), as shown on Drawing ref: *305/2 – 3*.

3.7.2 A Flood Risk Assessment (FRA) has been produced – see Chapter 6, and a qualitative Hydrogeological Risk Assessment (HRA) is provided in Chapter 8.

3.8 Security

3.8.1 The Site's entrance would include a gate that would be locked outside of operating hours and any necessary security fencing would be erected on The Site's boundaries. Suitable warning signs would also be placed to warn of deep excavations.

3.9 Exporting Materials

3.9.1 The excellent transport links that The Site benefits from allow it to supply markets across the northwest. The only processing that would take place on-site would be washing and sorting, after which the sand and gravel would be loaded to HGVs.

3.10 Importing Materials

3.10.1 All imported inert materials would arrive by HGV and be directed immediately to the infilling area(s) to be deposited. Whilst the importation of materials would be strictly controlled by an Environmental Permit or Materials Management Plan, it is

noted that rigorous controls on acceptance of materials would be implemented at The Site and all operations would be carried out in compliance with an Environmental Management System.

3.11 Noise

3.11.1 Due to the proximity to the major road network and lack of sensitive receptors, it is not anticipated that any noise generated by operations would have a significant impact. This is reflected in the pre-app advice for the proposals. Nevertheless, a Noise Survey was carried out and is presented in Chapter 11.

3.12 Dust / Air Quality

3.12.1 Whilst it is not anticipated that The Site would generate significant quantities of dust, as with all mineral extraction sites, it may be necessary to implement measures to prevent significant quantities of dust becoming mobilised in the air during prolonged dry periods.

3.12.2 A dust mitigation strategy has been produced – see Chapter 5.

3.13 Final Restoration

3.13.1 The restoration of The Site would create an engineered development platform for the approved industrial development. As the industrial planning permission is (currently) only an outline permission, the final design of the industrial development has not been determined. The prior extraction restoration scheme, primarily, aims to return The Site to agricultural usage, with features that would generate a net gain in biodiversity. However, the restoration of The Site has also

been designed to be conducive to the implementation of the industrial development, by creating a generally level area with no major topographic features, whilst assimilating into the surrounding land.

3.13.2 An aftercare scheme for The Site, which would be required by condition, would be produced to cover 5 years after final restoration. The scheme would incorporate a plan to be actioned in the event that the industrial development is not implemented.

3.13.3 Full details of the restoration scheme can be found in Section 7, and Drawing refs: *305/2 – 8*, *305/2 – 9*, and *305/2 – 10*.

3.14 Ecology

3.14.1 The ecology survey (Chapter 12) has informed both the operational layout and restoration scheme. The installation of Bat Boxes has been recommended, primarily along the eastern boundary of The Site. These will be retained post-restoration. The location of the bat boxes will be informed by the bat survey (see Chapter 12).

SECTION 4: Policy Review and Need Assessment

4.1 Introduction

4.1.1 The provision of the Town and Country Planning Act (1990) as amended, indicates a presumption in favour of development proposals which are in accordance with the Development Plan.

4.2 The Development Plan

4.2.1 The Development Plan for this proposal is a combination of the following adopted policy documents so far as they are relevant:

- The National Planning Policy Framework (NPPF) (2019)
- The Joint Lancashire Minerals and Waste Local Plan (JMWLP) (2009)
- The Chorley Local Plan 2012 – 2026 (2015)

4.2.2 The Site is located within a Mineral Safeguarding Area for sand and gravel as defined by the JMWLP in 2013 (note: the Core Strategy document was adopted in 2009). This allocation requires that, unless it can be proven that a non-minerals development [1] would not sterilise a viable resource, prior extraction of the safeguarded mineral should take place. The following analysis of planning policy has, therefore, been carried out on the basis that this development constitutes the 'prior extraction'[2] of safeguarded minerals.

[1] In this case, the approved industrial development.

[2] As per Paragraph 204 (d) of the NPPF and Paragraph 3 of the Minerals Chapter to the NPPG.

4.3 National Policy

4.3.1 The National Planning Policy Framework (2019) was adopted in 2012 with updates in 2018 and 2019 and is supplemented by National Planning Policy Guidance (NPPG). Its purpose is to set out the Government's planning policies for England and how these should be applied on a 'local' level.

4.3.2 NPPF Paragraph 1 states a presumption in favour of Sustainable Development. In this instance, the most sustainable course of action would be to extract the known mineral resource before the construction of the employment development platform (Ref: 17/00713/OUTMAJ).

4.3.3 The definition of a Mineral Safeguarding Area in the NPPF is "*An area designated by minerals planning authorities which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development*". As The Site is within a mineral safeguarding area, National planning policy indicates that prior extraction should take place.

4.4 Regional Policy (Joint Lancashire Minerals and Waste Local Plan (2009))

4.4.1 The Joint Lancashire Minerals and Waste Local Plan (JLMWLP) was adopted in 2009, with the development management and allocations document adopted in 2013, which contains policies relating to the development and management of minerals and waste sites in Lancashire. The plan is currently under review, with a new JLMWLP scheduled to be submitted to the Secretary of State in late 2020[3].

[3] Currently, no further updates are available.

4.4.2 Policy DM1 provides the Council's position on the management of wastes and extraction of minerals. As discussed, The Site is within a mineral safeguarding area and prior extraction should be carried out if a viable resource is proven.

4.4.3 Policy DM2 provides a list of considerations that should be taken into account in order to support minerals and waste applications. The Site has historically been agricultural pasture and as such, the local biodiversity, geodiversity and landscape character is unlikely to be significantly impacted by the prior extraction of minerals. There are few residential dwellings in the immediate surrounds with the closest being over 210m away from The Site and it is considered that the proposals would have little effect on residential amenity. Because The Site is so close to the M61, HGVs will cover shorter distances on minor roads than a typical minerals site (reducing overall CO2 emissions).

4.4.4 Policy M2 lists scenarios in which prior extraction of mineral within a Mineral Safeguarding Area would be refused, however, none of these apply to The Site.

4.4.5 Paragraph 6.7.12 of the core strategy, and its associated table, describe the need to reduce the volumes of waste sent to landfill. It is proposed that the infilling of The Site to construct the development platform could constitute a recovery operation. The JMWLP has a target of 35% of construction and demolition waste arising in the area to be treated and recovered by 2020. Whilst this date has now passed, it is not known if the target has been realised. Nevertheless, it is considered that The Site would contribute to this ongoing target to increase recovery.

4.5 Local Policy (Chorley Local Plan 2012 – 2026)

4.5.1 Whilst the Chorley Local Plan does not directly consider minerals matters, it is noted that Policy EP1.3 allocated The Site for employment development. It is the, already approved, employment development that the prior extraction facilitates.

4.6 Need

4.6.1 The need for this development is defined by the requirement to prevent the sterilisation of a known mineral resource by non-minerals development.

4.6.2 Policy M1 of The Joint Lancashire Minerals and Waste Local Plan (JLMWLP) states "*development will not be supported for any new extraction of sand and gravel, limestone, gritstone or shale.* [...]". Paragraph 6.1.6 of the JLMWLP clarifies policy M1, stating that the landbank was at 18 years for sand and gravel as of September 2013, and therefore, no new sand and gravel sites were required due to the landbank being above the 7-year requirement. The most recent Local Aggregate Assessment (2019) states that the current landbank is at 12 years.

4.6.3 However, the 7-year landbank stipulated in the National Planning Policy Framework (NPPF) is a minimum. It should not be regarded as a target that, once met, would dictate that there is no need for new deposits to be brought forward. Sound forward planning requires provision for future sand and gravel sites to be permitted in order to maintain the landbank throughout the plan period.

4.6.4 Overriding the above considerations of Policy M1, as extraction would be taking place as 'prior extraction', The Site would not necessarily be supporting an immediate need for sand and gravel to support the existing landbank. The

working of The Site would prevent the future sterilisation (by the approved industrial development) of a viable sand and gravel resource, which would have prejudiced future landbanks.

SECTION 5: Air Quality and Dust Mitigation Strategy

5.1 Introduction

5.1.1 The primary potential air quality issue associated with operations at The Site is mineral / soil dust emissions. However, the operations at The Site are not considered likely to be a major source of dust, especially beyond The Site's boundaries.

5.2 Sources of Dust

5.2.1 It is considered that there are three potential sources of unacceptable dust levels at The Site:

- Stockpiles of fine processed minerals,
- HGV / plant movements across internal haulage routes,
- The working and processing of mineral.

5.2.2 Notably, these potential sources only exist during prolonged dry weather conditions, when dust may be mobilised by wind.

5.3 Dust Mitigation Strategy

5.3.1 Dust monitoring would be carried out daily through visual inspection by the Site Manager. This would constitute an on-going procedure that is continuously monitored during operational hours. Where, in the opinion of the Site Manager, dust is being generated beyond an acceptable level, mitigation measures would

be implemented.

5.3.2 In addition, when weather conditions have included unusually long periods of dry and / or windy weather, the Site Manager may decide to implement mitigation measures before operations have begun each day.

5.3.3 Wetting down of Haul Roads

The internal haul routes may be a source of dust, either through being disturbed by HGVs, or, potentially mobilised by wind. During prolonged dry weather, the haul roads would be wetted down using an on-site water bowser (or equivalent).

5.3.4 Suspension of Operations

Whenever, in the opinion of the Site Manager, dust emissions have reached an unacceptable level at The Site's boundaries, the activities generating the dust will be suspended. If necessary, remedial action may be carried out to reduce the dust, such as use of water to dampen the area(s) where dust is being generated. All plant and equipment on-site would be fitted with dust suppression equipment where applicable.

5.3.5 Wetting-Down of Stockpiles / Working Areas

During extended dry and / or windy conditions, and, at the discretion of the Site Manager, stockpiles (or other areas) that are generating, or, have the potential to generate dust shall be wetted-down. This will be carried out as often as is necessary to prevent excessive dust generation. During such exceptional weather conditions, the stockpiles may be wetted-down before closing The Site each day,

if it is considered that dust may be generated outside of operational hours.

5.3.6 Dust Prevention Measures

10mph speed limits would be enforced on all internal haul roads to prevent excessive dust being generated by moving vehicles. Daily dust checks would be carried out to determine if any mitigation measures are required. Additionally, weather forecasts will be used to ensure enough water is available when dry and / or windy conditions are predicted.

SECTION 6: Flood Risk Assessment

6.1. Introduction

6.1.1. This Flood Risk Assessment (FRA) assesses the risk of flooding at, and as a result of, a proposed sand and gravel quarry off junction 8 of the M61, near Chorley ('The Site'). The proposals involve the prior extraction of sand and gravel before restoration infilling with inert materials to create an engineered development platform for a previously approved (outline) industrial development (Ref: 17/00713/OUTMAJ).

6.1.2. This FRA will consider whether The Site is at risk of flooding from any source, and whether the proposals will increase flood risk elsewhere.

6.2. Site Description

6.2.1. The Site covers an area of approximately 9.9ha. The topography of The Site is generally flat, with only a gentle slope towards the north. There are two drainage ditches cross-cutting The Site and an area of peat in the north-west corner. Surface water in the drainage ditches flows north-westwards towards the peaty area (see Drawing ref: *305/2 – 3*).

6.2.2. The bedrock consists of sandstones, siltstones and mudstones overlain by superficial glaciofluvial sand and gravel deposits. Trial pits show that groundwater is approximately 4.5 – 5m below the surface within the proposed extraction area.

6.3. Risk Assessment

6.3.1. The Site is entirely within Flood Zone 1 and is not within an area with critical

drainage problems as notified by the Environment Agency. However, as The Site's surface area is over 1ha, an FRA is required.

6.3.2. Surface water currently drains towards the north and the north west of the site. The east-west orientated drainage ditch would have a small section culverted[1] to allow vehicle access across the site. During mineral extraction, surface water would percolate through the permeable quarry floor [2].

6.3.3. The proposed operations would reduce the volume of surface water run-off away from The Site, as the ground level would be lower than the surroundings as a result of extractive operations. The rate of surface water flow into The Site would increase nominally as a result of extraction, due to the extracted area being lower than the adjacent topography. The Government's flood risk maps for flooding from surface water (see Appendix B) show some areas of The Site to be at low risk (up to 1 in 100 year events), with some areas at medium risk (between 1 and 3.3 in 100 year events)[3]. However, the vast majority of the proposed extraction area is labelled as very low risk.

6.3.4. The potential flow of surface water into The Site, and slightly elevated risk of surface water flooding as described above, would be managed by a migrating sump. The sump would act as a collection point for surface water in which it could be temporarily stored whilst it naturally percolates into the sand and gravel underlying The Site. The sump would migrate, as necessary, alongside extraction so that it would always be at the lowest point in The Site.

6.3.5. The original rate and volume of surface water flow across the site would be

[1] With a suitably large diameter pipe to not restrict the existing flow rate

[2] Glaciofluvial sand and gravel deposits

[3] Some very isolated high-risk areas are shown, but these are extremely small.

reinstated upon restoration. As the temporary changes in the rate and volume of surface water flow across the site would be mitigated by way of the rolling sump there is considered to be a low risk of surface water flooding from the proposed operations

6.3.6. The only residual risk of on-site flooding from surface water would be as a result of 'flash flood' water from storm events[4]. However, the migrating sump would serve to attenuate a 'flash flood' and, should the sump be overwhelmed, the quarry floor would be sacrificed and affected areas of The Site evacuated until water levels have receded. As such, it is considered that flooding due to a storm event would constitute a low risk.

6.3.7. Central Lancashire has a low risk of groundwater flooding according to the Strategic Flood Risk Assessment published in 2007 [5]. As such, it is considered that there would be low to negligible risk of groundwater flooding at The Site.

6.3.8. "*Whilst there are a few recorded incidents of flooding from the canal network*" [4], there is no history of it at The Site. As a result, the risk of flooding from the canal along the eastern boundary of The Site is considered to be negligible. Additionally, the proposals would have no effect upon the operation of the canal and would, therefore, cause no increased risk of flooding from the canal away from The Site.

[4] 1 in 10-year storm events

[5] Central Lancashire Strategic Flood Risk Assessment (2007)- https://www.preston.gov.uk/media/1693/CL-Flood-risk-assessment/pdf/EVL-08-Central-Lancs-Strategic-Flood-Risk-Assessment-Level-1-Final-Report-Dec-2007 (1).pdf?m=636977626435930000

6.4. Conclusions

6.4.1. There is considered to be negligible risk of flooding due to surface water (including from the canal) or groundwater at, or away from, The Site as a result of the proposed development. The only residual risk of flooding at The Site would be due to a storm event or 'flash' flood. However, this is also considered to constitute a very low risk.

6.4.2. Surface water management would primarily consist of a migrating sump at the deepest point of extraction. One of the drainage ditches would be partially culverted to allow vehicle movements across the site. Evacuation or restricted working in the event of flooding would be at the Site Manager's discretion.

6.4.3. It is concluded, through the above considerations, that the risk of flooding at, or, away from The Site as a result of the proposed development would not increase and is **very low.**

SECTION 7: Restoration Scheme

7.1 Introduction

7.1.1 The Site would be restored in order to facilitate the construction of the approved industrial development (ref: 17/00713/OUTMAJ). However, there is nonetheless a requirement to design a restoration scheme that provides a suitably restored site, whether the industrial development planning permission is implemented or not.

7.1.2 This restoration scheme, therefore, provides an engineered development platform that could be readily utilised for the construction of the industrial development. However, it would also generate suitable agricultural land, with additional net gains in biodiversity, that could be used in perpetuity should the industrial development not come to fruition[1].

7.1.3 It is proposed that the landforms proposed would be created regardless of whether the industrial development is constructed. However, seeding and / or planting would only be carried out if construction of the industrial development does not commence within one year of the final landform being achieved.

7.1.4 This document is intended to be read in conjunction with Plans ref: *305/2 – 8* and *305/2 – 9*.

[1] Or, be used as agricultural land until the industrial development is begun.

7.2 Restoration Scheme Aims

7.2.1 The restoration scheme has two primary aims:

- To restore the site using inert materials to create an engineered development platform, or, create suitable agricultural land similar to existing.
- To generate a net gain in biodiversity through the implementation of several features.

7.3 Restoration Scheme Features

7.3.1 General

7.3.1.1 The following paragraphs describe the different features proposed at The Site, as shown on Drawing ref: *305/2 – 9*. These features are those that would be created should there be no construction of the industrial development. Consultation and coordination with the industrial developer may dictate that some of these features may not be created as construction of the industrial development may have commenced.

7.3.1.2 Nevertheless, the following features should be regarded as the proposed final restoration scheme, and for the purposes of its assessment, all should be considered together on the assumption that all features would be created.

7.3.2 Agricultural Grassland

7.3.2.1 The central and southern areas of The Site would be seeded with an agricultural

grass seed mix (see drawing ref: *305/2 – 9*). This area would cover approximately 5.3ha and would enable The Site to return to its former uses of general agriculture (livestock grazing etc.) and car boot sales.

7.3.3 Wildflower Meadow

7.3.3.1 Areas bordering the existing and diverted drainage ditch, as well as the area to the north of the east-west drainage ditch would be seeded with an appropriate wildflower meadow seed mix. This feature is intended to, in-part, generate a net gain in biodiversity by providing approximately 1.5ha of wildflower meadow that would significantly benefit pollinating insects.

7.3.3.2 The wildflower meadows would also provide a more interesting visual feature for users of the footpath crossing The Site[2], and for transient views from the motorway and A674.

7.3.4 Woodland Boundaries

7.3.4.1 On the western boundary, an existing strip of trees borders The Site. However, these trees are predominantly outside of The Site's boundary, and are somewhat sporadic. It is proposed that this strip of trees would be enhanced through additional planting, as well as the removal of any dead, diseased or severely damaged trees[3]. The planting of these trees would commence when the drainage ditch and footpath have been diverted, prior to extraction in Phase 3.

[2] Whether this has been permanently diverted or returned to its original route through post-approval arrangements.

[3] Where these are on land within the applicant's control.

7.3.4.2 The enhancement of the trees on The Site's boundary would lead to an improved wildlife corridor, improving connectivity with trees and wooded habitat north of The Site, as well as those on the southwestern boundary, and contributing to the net gains in biodiversity.

7.4 Final Landform

7.5.1 The final restoration contours are shown on plan ref: *305/2 – 11*. The proposed final landform would provide a generally level engineered development platform that could facilitate the approved industrial development. However, as with all the proposed features, the landform would also be suitable for the agricultural and biodiversity proposed end-uses for The Site.

7.5.2 The final levels would be achieved using inert materials to infill the extraction void through rolling restoration (following the extraction phases shown in Drawing ref: *305/2 – 4*.

7.5.2 As shown, the landform is generally level from the A674, before sloping towards the drainage ditches. The sloped areas are proposed to be seeded with the wildflower meadow seed mix.

7.5.3 There would be no landform changes to the areas north of the drainage ditches. The peaty area would be unaffected by both extraction and restoration.

7.5 Summary

7.5.1 The Site is proposed to be infilled using inert materials to form a generally level landform, sloping in the north towards the retained drainage ditch. North of the

drainage ditches, there would be no changes to the landform.

7.5.2 The central and southern parts of The Site would be seeded with a suitable agricultural grass seed mix, whilst areas in the north and the west would be seeded with an appropriate wildflower meadow seed mix.

7.5.3 The tree belt on the western boundary would be enhanced with additional planting to improve the connectivity with other woodland habitats and provide a more substantial wildlife corridor.

SECTION 8: Hydrogeological Risk Assessment

8.1 Introduction

8.1.1 This document will qualitatively assess the risk of pollution from the proposed development to groundwater and surface water. The assessment is primarily desk-based, but also uses results from on-site exploratory trial pits and historic borehole data.

8.1.2 Plan ref: *305/2 – 11* shows a schematic summary of the conclusions of this document.

8.2 Proposed Development and Site Description

8.2.1 A detailed description of The Site and the proposals are provided in Chapters 1 – 3. However, the following summary is provided as context for this Hydrogeological Risk Assessment (HRA).

8.2.2 The Site is located just off Junction 8 of the M61, north of Chorley and currently consists of agricultural fields, occasionally used to host car boot sales. There are two drainage ditches crossing The Site, and a peaty area in the northwest.

8.2.3 The proposed development involves the prior extraction of sand and gravel before restoration using inert materials to create a development platform for an already approved industrial development. Should the industrial development not be implemented, the restoration scheme has been designed such that The Site can be returned to agricultural usage, with biodiversity set aside areas.

8.2.4 The extraction area is shown in Plan ref: *305/2 – 4*. No extraction would take place in the peaty area, or the area to the north of the drainage ditch, as shown on Plan ref: *305/2 – 3*. The western drainage ditch would be diverted prior to extraction in that area. All extraction would take place above the water table.

8.3 Risk Assessment

8.3.1 Methodology

8.3.1.1 The following assessment(s) have been carried out on a Source – Pathway – Receptor (SPR) basis. A theoretical SPR model allows for analysis of the dynamic interactions of Sources (of potential contaminants), Pathways (routes that contaminants may take) and Receptors (aspects of the hydrological environment that may receive contaminants), and whether these exist. A resulting analysis of residual risk has then been made.

8.3.1.2 In the context of this HRA, there are two Receptors that must be considered – surface water and groundwater. For each, an analysis of potential pathways and sources has been made.

8.3.2 Surface Water

8.3.2.1 There are two surface water courses within The Site. These are the two drainage ditches, one of which is to be diverted prior to extraction taking place in those phases affecting it.

8.3.2.2 A single potential pathway for contaminants to reach the surface water courses has been identified:

- Surface water management at The Site draining to water courses

8.3.2.3 There are three potential sources of contaminants that have been identified:

- Extraction operations
- Infilling operations
- Spillages of fuels or other fluids associated with site plant and machinery

8.3.2.4 The nature of extraction operations means that the only potential contaminant that could enter surface water from extractive operations would be suspended solids.

8.3.2.5 To prevent suspended solids entering the surface water courses, it is proposed to manage all surface water within the 'live' extraction areas by way of a migrating[1] sump. Surface water could be temporarily stored in the sump whilst it naturally percolates through the permeably underlying strata. No surface water from extraction areas of The Site would be directed to the surface water courses.

8.3.2.6 The same methodology for managing surface water would be employed during infilling operations. The uppermost layers of infill material would consist only of inert soils / soil forming material (to allow for the restoration scheme to be achieved). The hydrological regime would, therefore, match

[1] The sump would not be in a fixed location, and instead would be moved to a low point during extraction as needed.

those existing at The Site prior to any extraction and infilling. There is considered, therefore, to be no risk associated with surface water run-off once the final contours are achieved.

8.3.2.7 There is, therefore, no viable Pathway for (theoretically) contaminated surface water to reach the identified receptors, and the risk is concluded to be extremely low.

8.3.2.8 With regards to fuel and fluid spillages, as above, there can be no Pathway for any fuel spillages to take to surface water. Further information in section 8.3.7 of this document discusses mitigation of fuel spillages.

8.3.3 Groundwater

8.3.3.1 Groundwater is known to be some 4.5m beneath the current surface at The Site. In the superficial deposits, groundwater is classified across The Site as a combination of Secondary A Aquifer and Secondary Undifferentiated Aquifer.

8.3.3.2 A single Pathway has been identified:

- Direct percolation through underlying strata

8.3.3.3 There are three potential Sources identified:

- Extractive operations (suspended solids)
- Infilling operations
- Spillages of fuels or other fluids associated with site plant and machinery

8.3.3.4 No extraction would take place within 1m of the water table. Therefore, there would be no direct interaction between extractive, or, infilling operations and groundwater at The Site.

8.3.3.5 Nevertheless, potential contaminants from infill materials could percolate through underlying strata to reach groundwater. However, the nature of materials used for restoration mean that the risk of unacceptable levels of potential contaminants is very low.

8.3.3.6 All imported materials would be inert, and strictly controlled by way of a Bespoke Permit from the Environment Agency (EA) or Materials Management Plan. Strict controls would prevent any potentially polluting materials from being imported to The Site.

8.3.3.7 Fuel and fluid spillages from the re-fuelling and maintenance of on-site plant and machinery could also percolate through underlying strata to reach groundwater. However, all re-fuelling and maintenance would be carried out on a designated, impermeable surface (such as concrete), and an on-site spillage kit would be available to control and spillages. These measures would also be detailed and controlled by way of the EA Permit.

8.3.3.8 It can therefore be concluded that, for infilling operations, the risk of a Source of contaminants existing is very low, and for fuel and fluid spillages, the Pathway has been effectively precluded. Both of these issues would be strictly controlled by way of an EA Permit. The risk to groundwater is, therefore, low.

8.4 Summary

8.4.1 An assessment of risk to both groundwater and surface water was carried out on a Source-Pathway-Receptor basis.

8.4.2 Sources and Pathways were identified that had the potential to cause pollution of either groundwater or surface water.

8.4.3 However, pathways to surface water could be eliminated, as well as the pathway for fuel and/or fluid spillages. The risk of a Source of contaminants from the infilling operations was concluded to be low.

8.5.4 The risk of pollution of either surface water, or, groundwater from the proposed operations is concluded to be low.

E3P
Taylor Road
Trafford Park
Urmston
Manchester
M41 7JQ

Manchester | London | Edinburgh

info@E3P.co.uk
www.E3P.co.uk

Ref: 14-244-L1-RevA
Date: 15th October 2020

C/O Ruttle Plant Hire Ltd

Mineral Planning Group
Oakdene House
Cottingley Business Park
Bingley
BD16 1PE

Dear Sirs,

ANALYSIS OF SLOPE STABILITY
GALE MOSS, CHORLEY

1. BACKGROUND

E3P Understands that the Mineral Planning Group (MPG) are assisting their client (Ruttle Plant Hire) who intend to win minerals through excavation and backfill with imported arisings to later prepare and divest the site for development. The site is located to the north of Chorley and the north of the A674 known as Gale Moss.

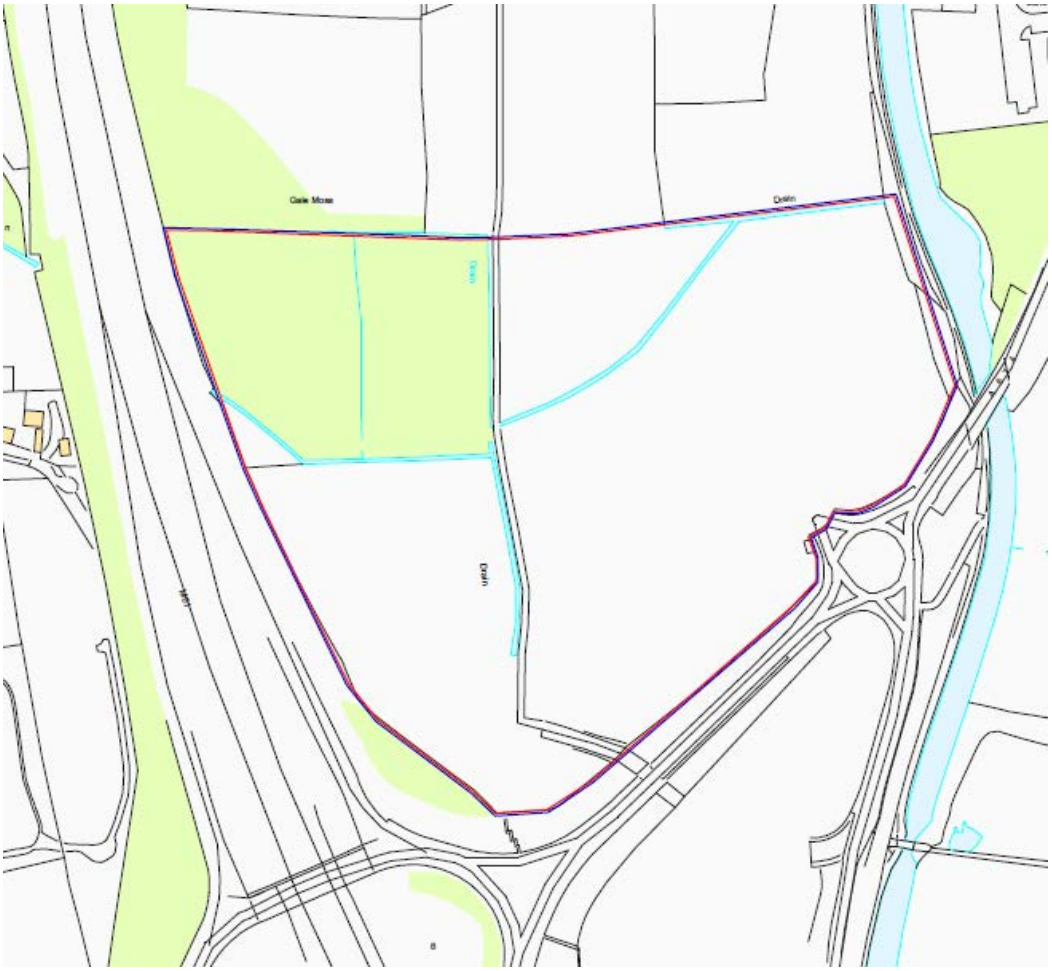
The site is currently agricultural land utilised for livestock grazing and is occasionally utilised as the location of a car boot sale during preferable summer months. The site is lined by the M61 motorway to the west.

To the periphery of the site there are a number of existing slopes but also following excavation there will be a high wall formed that also has the potential for slope failure and to induce failure in existing slopes. Furthermore, the Leeds-Liverpool Canal is present along the eastern boundary and the risk to infrastructure from any slope failure must be considered.

It is understood that the depth of excavation through the site will be limited to 4.5m, as such this value has been used to establish parameters for the model. In addition, E3P has been supplied with a topographical survey (Gale moss June 2020 survey) to provide existing levels and slope details to utilise in the model.

A location plan is presented within figure 1.1.

FIGURE 1.1 LOCATION PLAN



2. OBJECTIVES

The proposed site excavation and regrading will result in a significant alteration to the current topography with the subsequent formation of high walls along the boundaries of the site as well as then the current slopes at the boundary edges.

In light of the identified potential mechanism for slope failure to be induced by the proposed 4.5m deep excavation throughout the site, E3P has been commissioned to undertake further detailed slope stability analysis to assess the pertinent / relevant factor of Safety and potential failure mechanism in its current state and also the suitable distance from the boundary slope up to which any excavation can safely be advanced.

3. GEOMORPHOLOGY AND TOPOGRAPHY

The site is located within an area of natural and Man Made undulating landforms, with the site falling in topographical height from south east to north by circa 7 m down toward the drains through this area. In the south west of the site an artificially raised embankment is present that facilitates the M61 – Junction 8 slip road and the main A674 highway to the south of the site. To the east of the site the Leeds-Liverpool canal is present and an artificial build up is expected in the vegetation between the back of towpath and the site boundary.

3.1. GROUND CONDITIONS

Ruttle Group have previously completed a series of trial pits through the site and have provided the logs to assist in the completion of the slope stability assessment. During the intrusive investigation undertaken by Ruttle Group one location (BHE) identified peat (0.50-1.50m bgl) over clay (1.50m-3.50m bgl) though this is outside of the extraction area. Those completed through the remainder of the site identified sand and gravel with occasional sandy clay bands.

Groundwater was encountered at 4.50m bgl within the granular strata in the area of proposed excavation.

4. GEOTECHNICAL SLIP CIRCLE ANALYSIS

Based on our review of the proposed works, the primary risk associated with future instability within the embankment would be associated with the effective removal of the toe of the slope during excavation of minerals and introducing a failure through the above ground slopes and or failure in the canal which could be located within a 'Slip Circle' mode of failure or slip surface along two material boundaries.

Given that the slopes are formed from predominantly granular soils the potential for future failure associated with rotational slip is relatively high. Therefore, to ensure the potential risk is accurately appraised, E3P has developed a detailed slope stability model with induced loadings to assess any potential degree of risk.

To ensure the perceived risk is fully appraised, E3P have created a slope stability model to assess the perceived location of all slip circles, their zone of influence, Factor of Safety and thus the potential of negative impact on the proposed works following removal of materials.

This slope stability analyses involves Limit Equilibrium (LE) analysis due to its simplicity and accuracy. This method consists of cutting the slope into fine slices and applying appropriate equilibrium equations (equilibrium of the forces and/or moments). According to the assumptions made on the efforts between the slices and the equilibrium equations considered, many alternatives were proposed, such as the Bishop and Fellenius methods. In most cases, they are shown to give similar results. For this study, Oasys Slope, EC7 Ultimate Limit State (ULS) scenario slope stability analysis program has been used.

4.1. LIMITATIONS OF THE STUDY

The comments made and conclusions drawn concerning the proposed earthworks associated with existing slopes within the subject site are appropriate at this point in time only and are based on the information available to E3P at the time of writing. If more information becomes available or the site conditions alter then the aforementioned comments and conclusions may have to be re-assessed. If any ambiguity exists concerning any point, for the avoidance of doubt guidance should be sought from E3P, in all instances.

4.2. INPUT PARAMETERS & DATA

Appropriate soil mechanics parameters derived from site investigation & data obtained during the Ground Investigations were analysed and interpreted in the Oasys Slope software.

Furthermore, no detailed proposed levels for the proposed excavation have been provided, so this slope must be assessed cautiously. In the absence of information the detailed excavation depths has been modelled assuming a 4.5m invert level from existing ground level based on the instructions from the client.

For this assessment the Bishops method has been utilised.

An assessment of the slope has been undertaken at 10 critical sections as detailed within the E3P Drawing (ref: 14-244-001). The locations of for the slope assessment have been chosen along areas that are at a higher risk, such as steeper slopes, those that are close to roadways and/ or the canal in close proximity to the crest of the slope.

As well as assessing the slope in its existing form we have also modelled scenarios for a maximum load to fail the slope, the closest a 4.5m excavation can be made at the toe of the slope before failure and then this scenario including a moving temporary load to allow for any heavy machinery such as excavators which may be used during works. Lastly, a scenario has been modelled to include the expected benching required to safely form the excavations at the site.

No true on-site data has been obtained therefore, to ensure a suitably robust assessment, conservative values of the soil material property parameters were utilised in the development of the Slope Modelling as detailed below.

TABLE 4.1 GEOTECHNICAL INPUT PARAMETERS

Material Type	**C' – Effective Cohesion (kPa)**	**ø' (°) Angle of Effective Friction**	**γ (kN/m2) Bulk Unit Weight**
SAND and GRAVELS	0.0	35*	18.0

*value derived from Unified Soil Classification System (USCS)

5. SLOPE ANALYSIS RESULTS

E3P have completed detailed analysis on the proposed slope sections in their current state, the results of each of the 10 proposed sections are detailed below in Table 5.1.

TABLE 5.1 SUMMARY OF RESULTS FOR FOUR SCENARIOS

Section	**Factor of Safety**				
	Existing Conditions	Maximum Load Failure (FoS/Max Load kN/m^2)	With 4.5m Excavation at toe (FoS/Dist to slope m)	4.5m excavation + temporary works load	**4.5m excavation with benching and sloped to a safe 45° angle – temporary load**
1	1.800	1.072 / 600	1.257 / 15	1.213 / 420	**1.457**
2	1.707	1.072 / 300	1.291 / 17	1.291 / 434	**1.161**
3	1.665	1.007 / 200	1.221 / 20	1.204 / 413	**1.230**
4	2.240	1.089 / 300	1.043 / 17	1.043 / 0.82	**1.040**
5	2.691	1.058 / 300	1.330 / 16	1.084 / 242	**1.062**
6	1.243	1.041 / 300	1.076 / 19	1.076 / 5.98	**1.039**
7	1.024	1.024 / 300	1.098 / 15	1.098 / 0.49	**1.019**
8	1.836	1.023 / 300	1.104 / 14	1.104 / 1.46	**1.173**
9	17.791	2.389 / 900	1.020 / N/A	0.819 / 557	**N/A**
10	31.916	31.916 / 900	1.397 / N/A	1.196 / 458	**N/A**

Factory of Safety (FoS) as defined within EC7 ULS assessment suggests that all slopes below '1' demonstrate a failing slope. As such, all scenarios have been adjusted until a FoS just above 1 is reached. Sections have been modelled in this manner to demonstrate the minimum distance an excavation can be away from the slope before inducing failure and the maximum load that can be applied to the top of the slope before failure in order to understand the design limitations of an excavation across the entire site.

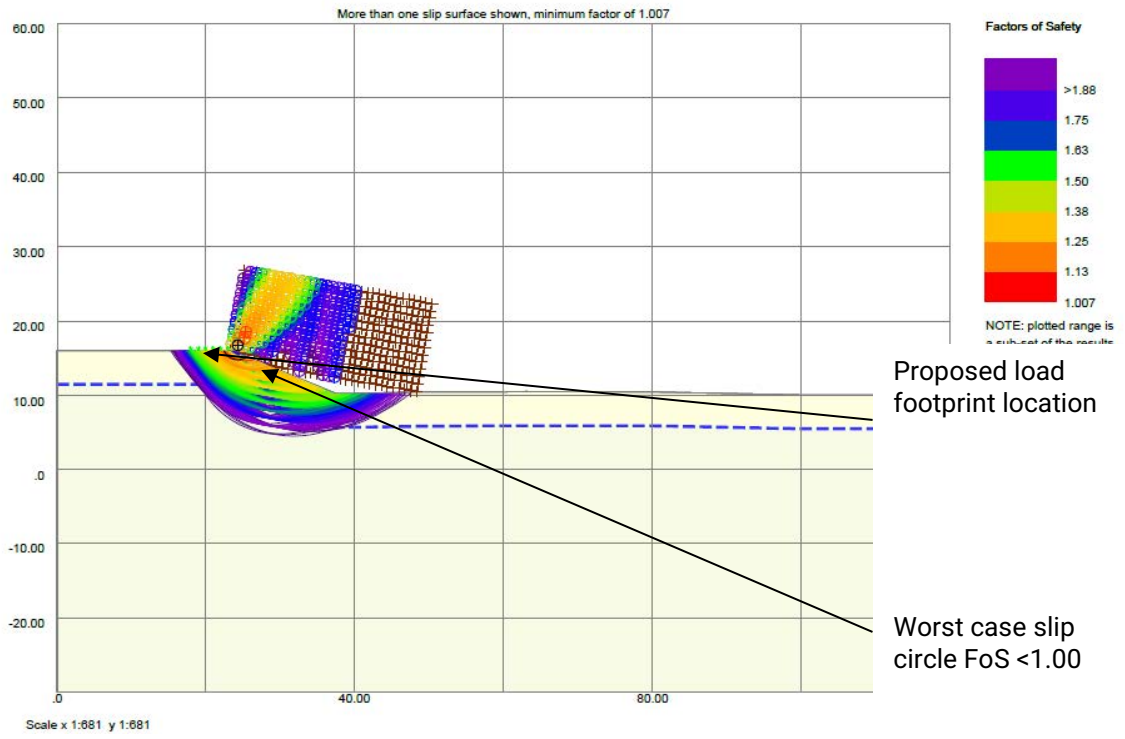
E3P have run the slope model with a maximum loading at the crest of the slope in order to gain an indication of how the slope would re-act to an excavator or dump-truck. The maximum load tolerable before the slope fails is detailed below.

TABLE 5.2 SUMMARY OF RESULTS FOR A MAXIUMUM APPLIED LOAD

Section	Maximum Applied Load kN/m^2	Factor of Safety
1	600	1.072
2	300	1.072
3	200	1.007
4	300	1.089
5	300	1.058
6	300	1.041
7	300	1.024
8	300	1.023
9	900	2.389
10	900	31.916

A snapshot of section 3 is presented in figure 5.1

FIGURE 5.1 – EXTRACT OF SLOPE STABILITY MODEL 200KN (SECTION 3)



In addition to the above the natural slope has been modelled with an excavation of 4.5m depth. The distance of the excavation from the toe of the slope has been adjusted to define the minimum easement before the slope will begin to fail.

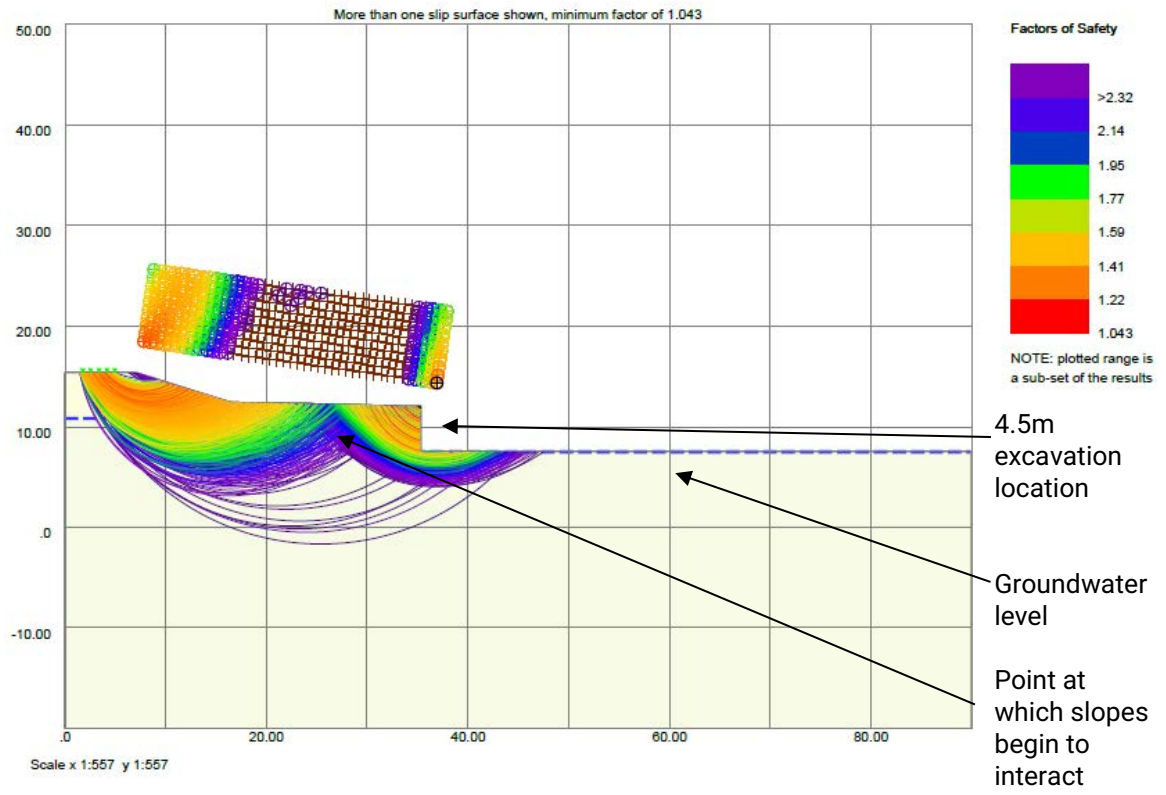
The results are presented in table 5.2 and an excerpt of a section model in figure 5.2.

TABLE 5.2 SUMMARY OF RESULTS FOR A 4.5M EXCAVATION AT THE TOE OF SLOPE

Section	Minimum Easement	Factor of Safety
1	15	1.257
2	17	1.291
3	20	1.221
4	17	1.043
5	16	1.330
6	19	1.076
7	15	1.098
8	14	1.104
9	N/A	1.020
10	N/A	1.397

A snapshot of section 3 is presented in figure 5.2

FIGURE 5.2 – EXTRACT OF SLOPE STABILITY MODEL 200KN (SECTION 4)



It should be noted that by design the newly formed slope will be unstable given the shear edge and it is expected that any such excavation will be battered back to a maximum 45degree angle to reduce potential for instability. This is scenario is modelled with the results presented in figure 5.4.

Furthermore, the slope in sections 9 and 10 are noted as N/A as the initial existing slope is not considered steep enough to be influenced by the secondary excavation. As such in these areas where the new slope is made safe by battering to a 45 degree angle the area should be suitably stable up to the boundary. To ensure the canal is not adversely affected by the works a 15m easement from the canal edge is recommended.

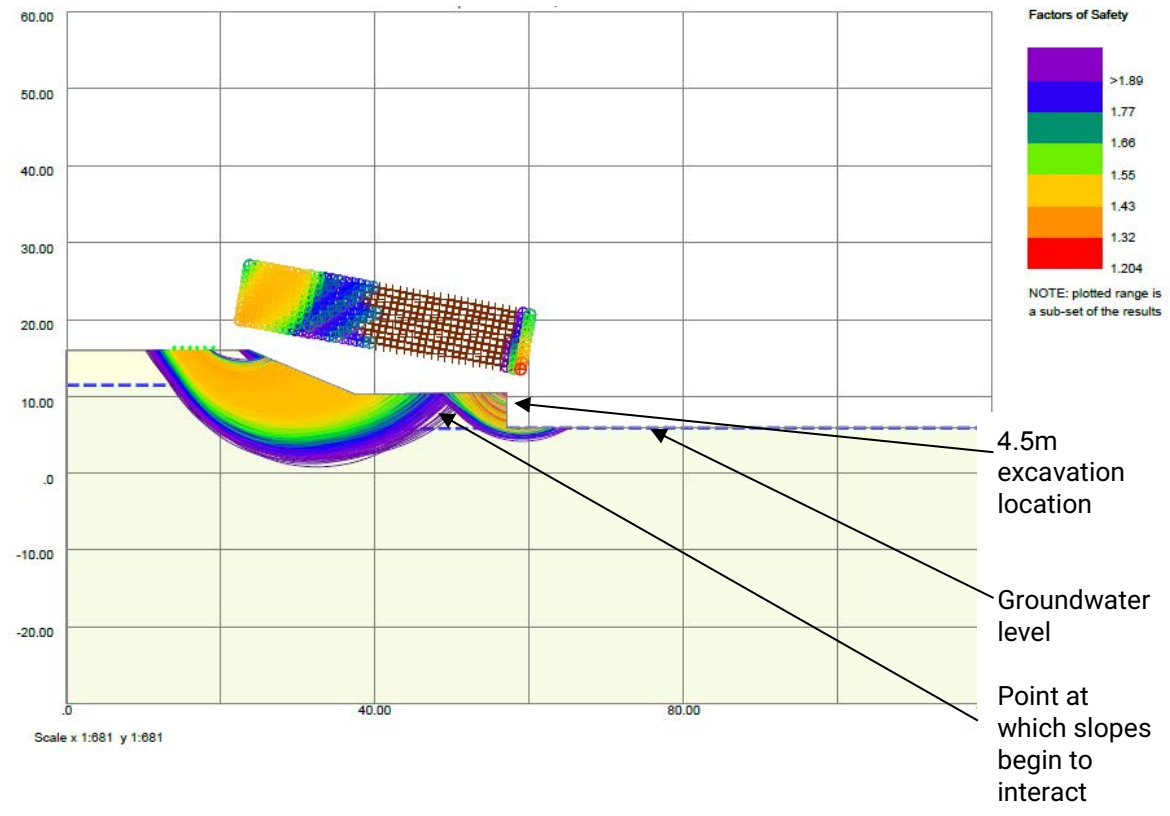
A temporary load was applied to the top of the slope to replicate any tracked plant crossing during the works.

TABLE 5.3 SUMMARY OF RESULTS FOR A 4.5M EXCAVATION AT THE TOE OF SLOPE

Section	Maximum temporary load	Factor of Safety
1	420	1.213
2	434	1.291
3	413	1.204
4	0.82	1.043
5	242	1.084
6	5.98	1.076
7	0.49	1.098
8	1.46	1.104
9	557	0.819
10	458	1.196

A snapshot of section 3 is presented in figure 5.3

FIGURE 5.3 – EXTRACT OF SLOPE STABILITY MODEL 200KN (SECTION 3)



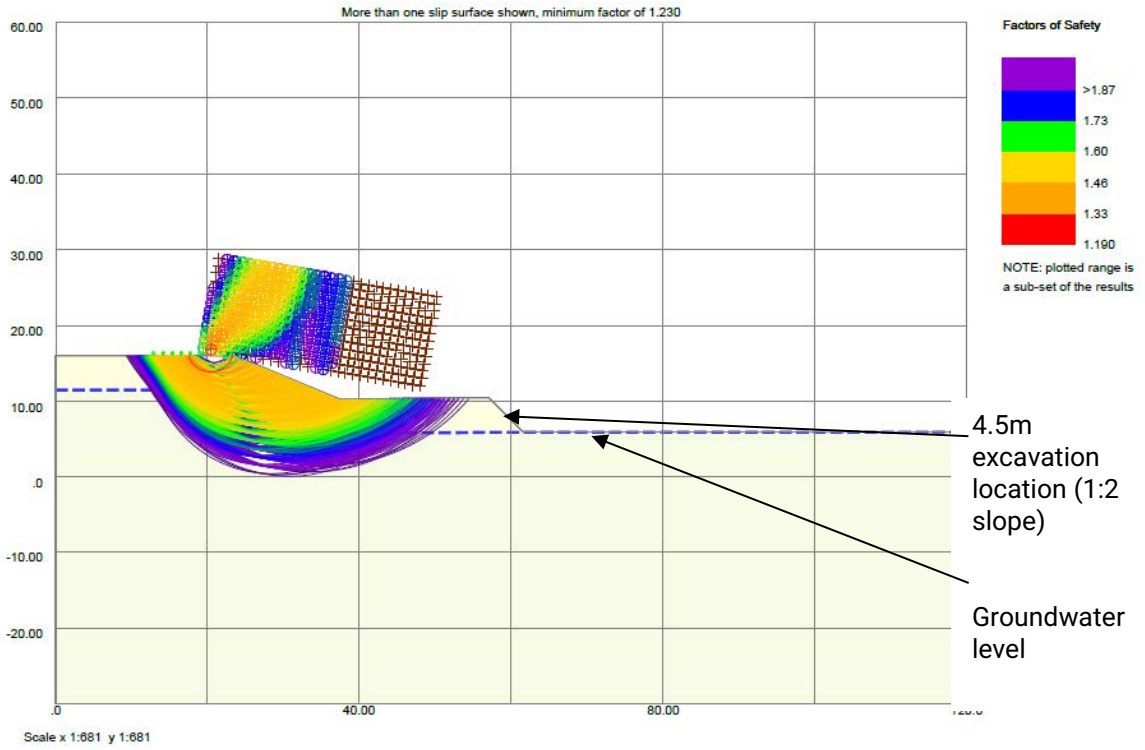
Lastly, the expected safe construction parameters are included to demonstrate required benching and 45˚ safe angle of repose on the excavation.

TABLE 5.4 SUMMARY OF RESULTS FOR A 4.5M EXCAVATION AT THE TOE OF SLOPE WITH TEMPORARY LOADING

Section	Factor of Safety	Factor of Safety (with Temp Load)
1	1.775	**1.457**
2	1.707	**1.161**
3	1.665	**1.230**
4	2.238	**1.040**
5	2.697	**1.062**
6	1.214	**1.039**
7	1.019	**1.019**
8	1.885	**1.173**
9	N/A	**N/A**
10	N/A	**N/A**

A snapshot of section 3 is presented in figure 5.4

FIGURE 5.4 – EXTRACT OF SLOPE STABILITY MODEL 4.5M EXCAVATION BATTERED TO 45° (SECTION 3)



The calculus was performed following the Bishop's Method utilising the calculus for Design Approach 1 according to EN 1997:2004 Eurocode 7: Geotechnical Design which requires the compliance with the following partial FoS for a ULS analysis for DA1 to be >1.

Within section 4, 6, 7 and 8 E3P would note that the potential temporary load at the top of the slope is directly underlain by the slip circle with a factor of safety (FOS) below 1 when under a temporary loading greater than those detailed in table 5.3.

6. CONCLUSIONS & RECOMMENDATIONS

6.1. EXISTING SLOPES

Based on the slopes in their existing manner it has been modelled that they are inherently stable and significant loadings can be applied without inducing slope failure issues.

6.2. 4.5M EXCAVATION AT THE BASE OF SLOPES

When applying a 4.5m excavation to the toe of the slope in order to replicate materials extraction, it is calculated that a minimum easement of 14-20m should be applied. Within this easement the new excavation is likely to interact with the existing slope and induce a failure mechanism.

Within sections 9 and 10 the original slope is not considered to be sufficiently steep to slip or slump when an excavation is advanced through it and so is not applicable in this regard. These sections are along the line of the canal however and so an easement is still recommended to ensure works do not impact the canal structure.

In this scenario no loading has been applied to the top of the slope however, the movement of mechanical excavators and plant has been modelled in the final scenario to include temporary works.

6.3. TEMPORARY WORKS LOADINGS

It is evident from the review of the proposed construction drawings, scaled cross sections and slope stability modelling that the slope has potential failure mechanisms where the FOS falls below 1 at very low loads within section 4,6,7 and 8.

6.4. RECOMMENDATIONS

It must be noted that detailed levels for the proposed excavations through the site, as well as any temporary or permanent future loadings have not been provided. Given that the slope from the highway toward the western and southern boundary of site appears to be fairly steep, in its current state this is modelled to be inherently stable. Following excavations slopes may require redesigning at the perimeter to ensure a safe angle is provided that would not impose any future geotechnical failures induced through slip circles; this includes the proposed excavations that may require benching and should be constructed using safe slope angles depending on the extraction depths at each and every location through the site.

It is recommended for design purposes that the base of the slope is mapped and sufficient easement placed around the periphery of the site to suitably manage the risk from slope instability and mark out the extents in order to calculate volumetrics for viability.

A suitably qualified supervising geotechnical engineer should be appointed for the duration of the land enabling works and as such weekly inspection of the embankment will be made to ensure that should any evidence of slope failure be observed, appropriate mitigation and corrective action can be agreed with the client.

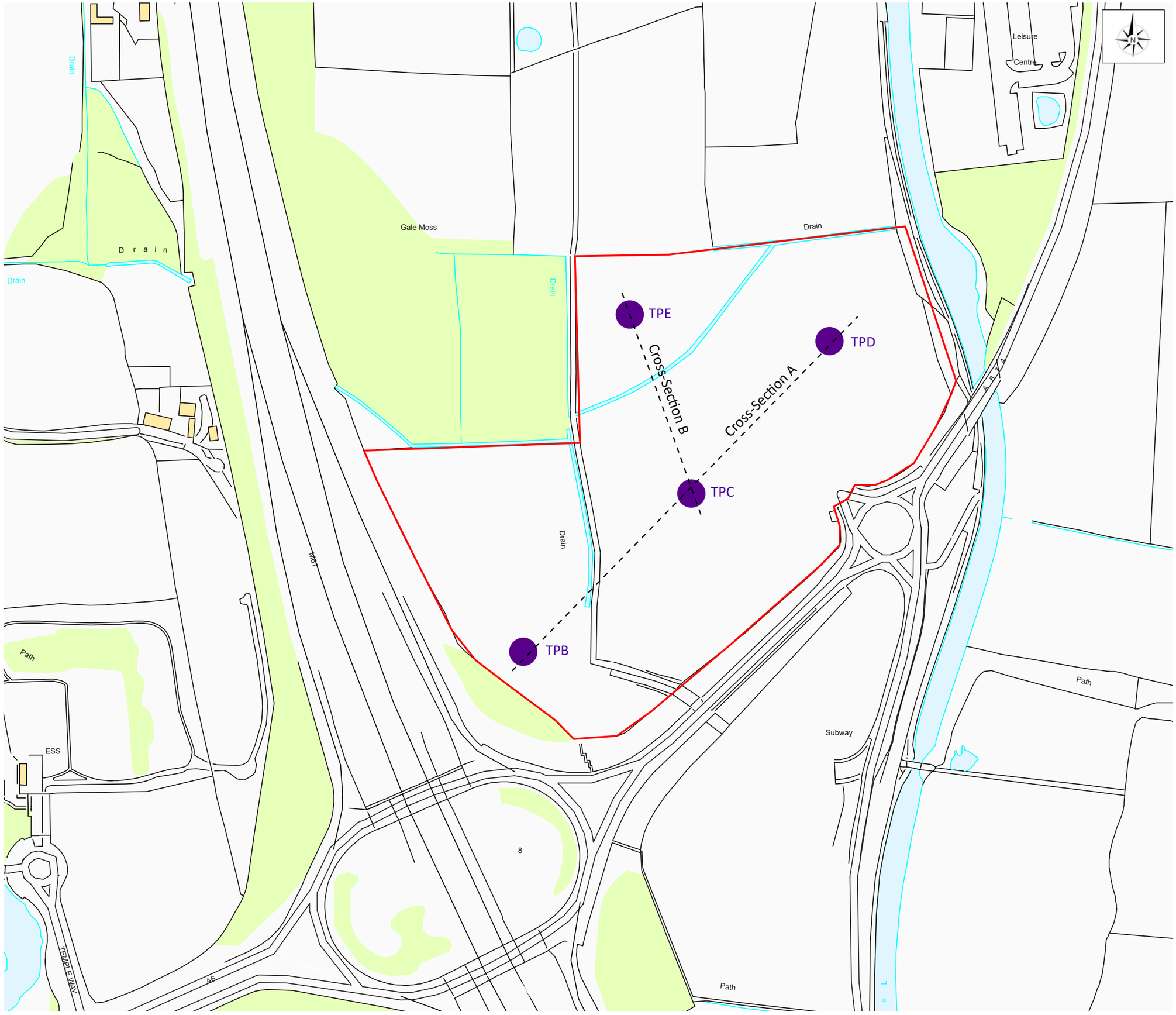
I trust that the above information is sufficient at this time and if you require anything further please do not hesitate to contact me.

Yours sincerely,
For and on behalf of E3P Ltd

Roy Walker
Senior Geoenvironmental Consultant

Enclosed:

MPG Exploratory Borehole Logs; and,
MPG Exploratory Location Plan
E3P Slope Stability Cross Section Plan
E3P Slope Stability Cross Section and Easement Plan
E3P Slope Stability Analysis Output Plans



Drawing Title:
X-Section Plan

Key:

Proposed site boundary

Trial Pit Location

Notes:

Drawn by:	MS
Checked by:	
Approved by:	

The Mineral Planning Group Ltd.
The Rowan Suite
Oakdene House
Cottingley Business Park
Bingley, West Yorkshire
BD16 1PE
Tel: 01274 884599
headoffice@mpgyorks.co.uk
www.mpgyorks.co.uk

MPG

Scale:
1:2500 @ A3

Client:
Ruttle Plant Hire Ltd.

Site:
Gale Moss

Drawing Number:	Rev:
305/2 - 3	1.0

Date:
30/04/2020

Legend

Line of Cross Section

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	19.08.2020	CB	RJW
P1	REVA	23.07.2020	CB	RJW

Client: The Mineral Planning Group

Job No: 14-244

Date: 19.08.2020

Drawing No: 001

Scale: 1:2000 @ A3

Job Title: Gale Moss, Chorley

Drawing Title: Section Location Plan

e3p
Environmental Engineering Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
E-mail: info@e3p.co.uk
Website: www.e3p.co.uk

Legend

- Line of Cross Section
- Bottom of Slope

Notes:

Client:	*Job No:*	*Date:*
The Mineral Planning Group	14-244	24.09.2020
	Drawing No: 002	*Scale:* 1:2000 @ A3

Phase	Issue	Date	Drawn	Checked
P1	REVA	24.09.2020	HM	RJW

Job Title: Gale Moss, Chorley

Drawing Title: Bottom of Slope Plan

e3p
Environmental Engineering Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
E-mail: info@e3p.co.uk
Website: www.e3p.co.uk

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->							
	5.3974	**21.966**	**22.809**	**29.129**	**30.546**	**31.494**	**33.101**
1	19.286	.	19.286	16.784	16.259	15.908	15.286
GW	14.786	14.786	.	.	.	.	.
Stratum X -->							
	34.939	**37.210**	**38.488**	**40.890**	**41.636**	**44.473**	**44.714**
1	.	.	.	.	12.012	.	10.800
GW	.	.	.	.	.	.	.
Stratum X -->							
	45.430	**46.218**	**47.343**	**49.036**	**49.283**	**49.303**	**49.335**
1	.	10.202	10.202	.	10.184	10.185	.
GW	5.6807	.	.	.	.	.	.
Stratum X -->							
	50.313	**50.390**	**50.453**	**51.426**	**51.533**	**51.625**	**51.706**
1	.	.	.	10.224	10.227	.	10.232
GW	.	.	.	.	.	.	.
Stratum X -->							
	51.777	**51.841**	**51.897**	**51.948**	**51.986**	**60.636**	**60.693**
1	.	.	.	10.239	.	10.565	.
GW	.	.	.	.	.	.	6.0650
Stratum X -->							
	65.134	**100.55**					
1	.	.					
GW	.	6.0650					

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

No.	Material	Water table	Piezo Set/ Ru value

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	13.000	17.000	390.00	0.0	Permanent	UnFavourable	No

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 22.00000 m y = 22.00000 m
Inclination of grid: -10.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 40 in x direction at 1.00000m spacing
10 in y direction at 1.00000m spacing
Grid extended to find minimum FoS
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (19.046m,22.521m) Radius 5.0000m
Iterations: 26 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.043235 *Slip weight [kN/m] 226.77*
Net horiz force [kN/m]: -0.15863 Disturbing moment [kN/m]: 2725.9
Restoring moment [kNm/m]: 3896.9
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.4296

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates Point	x [m]	y [m]	Pore Pressure L [kN/m²]	R [kN/m²]	Interslice forces [kN/m] T	E	E(u)
1	15.233	19.286	-	-45.000	0.0	0.0	0.0
2	15.419	19.079	-42.927	-42.927	21.716	30.981	0.0
3	15.616	18.882	-40.961	-40.961	38.953	60.977	0.0
4	15.824	18.697	-39.108	-39.108	51.362	88.798	0.0
5	16.042	18.523	-37.374	-37.374	58.800	113.21	0.0
6	16.270	18.362	-35.764	-35.764	61.333	132.99	0.0
7	16.505	18.214	-34.283	-34.283	59.238	146.94	0.0
8	16.749	18.080	-32.935	-32.935	52.992	153.96	0.0
9	17.000	17.959	-31.725	-31.725	43.263	153.05	0.0
10	17.294	17.838	-30.516	-30.516	33.248	151.73	0.0
11	17.596	17.736	-29.497	-29.497	24.233	149.13	0.0
12	17.904	17.653	-28.671	-28.671	16.519	145.29	0.0
13	18.216	17.590	-28.043	-28.043	10.382	140.37	0.0
14	18.531	17.547	-27.615	-27.615	6.0565	134.56	0.0
15	18.849	17.525	-27.388	-27.388	3.7181	128.16	0.0
16	19.167	17.522	-27.364	-27.364	3.4674	121.49	0.0
17	19.485	17.540	-27.543	-27.543	3.0878	113.66	0.0
18	19.801	17.578	-27.923	-27.923	2.4418	104.65	0.0
19	20.114	17.636	-28.504	-28.504	1.6973	94.608	0.0
20	20.423	17.714	-29.283	-29.283	0.99986	83.788	0.0

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point	x [m]	z [m]				F(x)
21	20.726	17.812	-30.257	-30.257	0.46022	72.472	0.0
22	21.022	17.928	-31.421	-31.421	0.14492	60.980	0.0
23	21.310	18.063	-32.772	-32.772	0.070837	49.645	0.0
24	21.589	18.216	-34.303	-34.303	0.20433	38.794	0.0
25	21.858	18.387	-36.009	-36.009	0.46560	28.729	0.0
26	22.115	18.574	-38.461	-38.461	0.73626	19.708	0.0
27	22.360	18.778	-41.445	-41.445	0.87198	11.933	0.0
28	22.592	18.996	-44.529	-44.529	0.71727	5.5336	0.0
29	22.809	19.229	-47.700	-47.700	0.12225	0.56598	0.0
30	22.846	19.271	-48.267	-	-0.043235	-0.15863	0.0

Slice No.	Strength Parameters c' [kN/m²]	Tan phi	Average Pore Pressure [kN/m²]	Slice Weight [kN/m]	Forces on base [kN/m] Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.46851	74.292	52.020	36.389
2	0.0	0.70021	0.0	1.4649	83.584	58.526	40.940
3	0.0	0.70021	0.0	2.5087	92.852	65.016	45.480
4	0.0	0.70021	0.0	3.5792	101.96	71.396	49.943
5	0.0	0.70021	0.0	4.6557	110.79	77.577	54.266
6	0.0	0.70021	0.0	5.7181	119.20	83.465	58.385
7	0.0	0.70021	0.0	6.7469	127.08	88.979	62.242
8	0.0	0.70021	0.0	7.7236	134.30	94.035	65.779
9	0.0	0.70021	0.0	9.9320	17.953	12.571	8.7935
10	0.0	0.70021	0.0	10.988	18.116	12.685	8.8734
11	0.0	0.70021	0.0	11.891	17.941	12.563	8.7878
12	0.0	0.70021	0.0	12.622	17.418	12.196	8.5316
13	0.0	0.70021	0.0	13.163	16.549	11.587	8.1056
14	0.0	0.70021	0.0	13.502	15.345	10.744	7.5160
15	0.0	0.70021	0.0	13.633	13.833	9.6860	6.7755
16	0.0	0.70021	0.0	13.552	14.348	10.047	7.0278
17	0.0	0.70021	0.0	13.262	14.885	10.422	7.2905
18	0.0	0.70021	0.0	12.768	15.115	10.584	7.4034
19	0.0	0.70021	0.0	12.081	15.035	10.528	7.3642
20	0.0	0.70021	0.0	11.217	14.651	10.259	7.1763
21	0.0	0.70021	0.0	10.196	13.983	9.7907	6.8488
22	0.0	0.70021	0.0	9.0388	13.057	9.1428	6.3955
23	0.0	0.70021	0.0	7.7736	11.913	8.3419	5.8353
24	0.0	0.70021	0.0	6.4291	10.596	7.4196	5.1901
25	0.0	0.70021	0.0	5.0370	9.1573	6.4120	4.4853
26	0.0	0.70021	0.0	3.6307	7.6508	5.3571	3.7474
27	0.0	0.70021	0.0	2.2449	6.1328	4.2943	3.0039
28	0.0	0.70021	0.0	0.91482	4.6578	3.2614	2.2814
29	0.0	0.70021	0.0	0.025418	0.67210	0.47061	0.32920

Slice No.	Surface Load [kN/m_hor/m] Vert	Horiz	Point Load [kN/m] Vert	Horiz	Water Pressure on ground surface [kN/m_hor/m] Vert	Horiz
1	526.50	0.0	0.0	0.0	0.0	0.0
2	526.50	0.0	0.0	0.0	0.0	0.0
3	526.50	0.0	0.0	0.0	0.0	0.0
4	526.50	0.0	0.0	0.0	0.0	0.0
5	526.50	0.0	0.0	0.0	0.0	0.0
6	526.50	0.0	0.0	0.0	0.0	0.0
7	526.50	0.0	0.0	0.0	0.0	0.0
8	526.50	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0

Slice No	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
21	*0.0*	*0.0*	0.0	0.0	0.0	0.0
22	*0.0*	*0.0*	0.0	0.0	0.0	0.0
23	*0.0*	*0.0*	0.0	0.0	0.0	0.0
24	*0.0*	*0.0*	0.0	0.0	0.0	0.0
25	*0.0*	*0.0*	0.0	0.0	0.0	0.0
26	*0.0*	*0.0*	0.0	0.0	0.0	0.0
27	*0.0*	*0.0*	0.0	0.0	0.0	0.0
28	*0.0*	*0.0*	0.0	0.0	0.0	0.0
29	*0.0*	*0.0*	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum	X -->						
	7.5791	16.962	17.848	27.019	27.413	33.425	34.319
1	18.691	.	18.691	14.943	14.782	.	11.947
GW	14.191	14.191	.	.	.	7.4504	.

Stratum	X -->					
	38.419	49.580	52.354	52.363	56.800	97.071
1	.	.	.	.	.	.
GW	.	.	7.3770	.	.	7.3770

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	10.000	15.000	390.00	0.0	Variable	UnFavourable	No

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 18.00000 m y = 21.00000 m
Inclination of grid: -10.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 40 in x direction at 0.80000m spacing
10 in y direction at 1.00000m spacing
Grid extended to find minimum FoS

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (16.077m,19.308m) Radius 2.0000m
Iterations: 27 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.017908 *Slip weight [kN/m] 93.447*
Net horiz force [kN/m]: -0.0025920 Disturbing moment [kN/m]: 719.95
Restoring moment [kNm/m]: 768.94
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.0681

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point	x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1	14.175	18.691	-	-45.000	0.0	0.0	0.0
2	14.227	18.547	-43.564	-43.564	16.953	10.380	0.0
3	14.291	18.408	-42.173	-42.173	33.579	23.528	0.0
4	14.365	18.274	-40.835	-40.835	48.471	38.841	0.0
5	14.449	18.147	-39.557	-39.557	60.406	55.395	0.0
6	14.542	18.026	-38.346	-38.346	68.424	71.998	0.0
7	14.645	17.912	-37.211	-37.211	71.886	87.262	0.0
8	14.756	17.807	-36.158	-36.158	70.518	99.692	0.0
9	14.874	17.710	-35.192	-35.192	64.429	107.78	0.0
10	15.000	17.623	-34.320	-34.320	54.099	110.10	0.0
11	15.143	17.540	-33.487	-33.487	41.765	109.24	0.0
12	15.293	17.469	-32.775	-32.775	30.290	107.08	0.0
13	15.447	17.410	-32.189	-32.189	20.218	103.80	0.0
14	15.606	17.364	-31.734	-31.734	12.026	99.681	0.0
15	15.769	17.332	-31.411	-31.411	6.0831	95.136	0.0
16	15.933	17.313	-31.224	-31.224	2.6166	90.631	0.0
17	16.099	17.308	-31.173	-31.173	1.6951	86.666	0.0
18	16.264	17.317	-31.260	-31.260	1.1921	82.238	0.0
19	16.428	17.339	-31.483	-31.483	0.091569	76.562	0.0
20	16.590	17.375	-31.841	-31.841	-1.3358	69.723	0.0
21	16.748	17.424	-32.331	-32.331	-2.8173	61.914	0.0
22	16.901	17.486	-32.950	-32.950	-4.1097	53.414	0.0
23	17.049	17.560	-34.052	-34.052	-5.0246	44.575	0.0
24	17.190	17.647	-35.494	-35.494	-5.4483	35.783	0.0
25	17.324	17.745	-37.018	-37.018	-5.3502	27.427	0.0
26	17.449	17.853	-38.615	-38.615	-4.7812	19.861	0.0
27	17.565	17.972	-40.273	-40.273	-3.8616	13.373	0.0
28	17.670	18.099	-41.981	-41.981	-2.7594	8.1552	0.0
29	17.765	18.235	-43.727	-43.727	-1.6623	4.2906	0.0
30	17.848	18.378	-45.499	-45.499	-0.74654	1.7444	0.0
31	17.910	18.509	-47.062	-47.062	-0.22222	0.49418	0.0
32	17.963	18.644	-48.627	-	-0.017908	-0.0025920	0.0

Slice No.	Strength Parameters		Average Pore Pressure	Slice Weight	Forces on base [kN/m]		
	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)

Slice No.	Strength Parameters		Average Pore	Slice Weight	Forces on base [kN/m]		
1	0.0	0.70021	0.0	0.091973	14.564	10.198	9.5483
2	0.0	0.70021	0.0	0.32908	20.632	14.447	13.526
3	0.0	0.70021	0.0	0.62856	27.441	19.214	17.990
4	0.0	0.70021	0.0	0.98067	34.806	24.372	22.819
5	0.0	0.70021	0.0	1.3746	42.529	29.779	27.881
6	0.0	0.70021	0.0	1.7985	50.396	35.288	33.039
7	0.0	0.70021	0.0	2.2403	58.195	40.748	38.152
8	0.0	0.70021	0.0	2.6874	65.710	46.011	43.079
9	0.0	0.70021	0.0	3.1273	72.741	50.934	47.688
10	0.0	0.70021	0.0	3.8576	13.560	9.4946	8.8895
11	0.0	0.70021	0.0	4.3106	13.324	9.3295	8.7350
12	0.0	0.70021	0.0	4.7097	12.663	8.8665	8.3015
13	0.0	0.70021	0.0	5.0423	11.590	8.1153	7.5982
14	0.0	0.70021	0.0	5.2980	10.140	7.1002	6.6478
15	0.0	0.70021	0.0	5.4688	8.3685	5.8597	5.4863
16	0.0	0.70021	0.0	5.5492	6.3467	4.4440	4.1608
17	0.0	0.70021	0.0	5.5370	6.2631	4.3855	4.1060
18	0.0	0.70021	0.0	5.4324	7.2377	5.0679	4.7449
19	0.0	0.70021	0.0	5.2387	7.9864	5.5921	5.2358
20	0.0	0.70021	0.0	4.9618	8.4668	5.9285	5.5507
21	0.0	0.70021	0.0	4.6106	8.6536	6.0593	5.6732
22	0.0	0.70021	0.0	4.1960	8.5385	5.9787	5.5977
23	0.0	0.70021	0.0	3.7311	8.1319	5.6940	5.3312
24	0.0	0.70021	0.0	3.2306	7.4627	5.2254	4.8924
25	0.0	0.70021	0.0	2.7107	6.5753	4.6041	4.3107
26	0.0	0.70021	0.0	2.1880	5.5282	3.8709	3.6242
27	0.0	0.70021	0.0	1.6799	4.3894	3.0735	2.8776
28	0.0	0.70021	0.0	1.2033	3.2327	2.2636	2.1193
29	0.0	0.70021	0.0	0.77475	2.1323	1.4931	1.3979
30	0.0	0.70021	0.0	0.35713	1.0546	0.73842	0.69137
31	0.0	0.70021	0.0	0.10083	0.42416	0.29700	0.27807

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	585.00	0.0	0.0	0.0	0.0	0.0
8	585.00	0.0	0.0	0.0	0.0	0.0
9	585.00	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->							
	8.3301	**22.481**	**22.596**	**22.639**	**23.653**	**23.726**	**25.448**
1	16.066	.	16.066	.	16.012	16.006	15.284
GW	11.566	11.566	.	11.558	.	.	.
Stratum X -->							
	26.031	**27.229**	**30.407**	**31.094**	**36.573**	**37.453**	**38.205**
1	15.039	14.535	13.198	12.909	.	10.234	.
GW	.	.	.	. 5.7237		.	.
Stratum X -->							
	39.283	**48.456**	**57.121**	**57.147**	**61.570**	**105.01**	
1	10.255	.	.	.	.	.	
GW	.	.	. 5.9569		. 5.9569		

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	13.000	19.000	390.00	0.0	Variable	UnFavourable	No

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 20.00000 m y = 20.00000 m

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Inclination of grid: -10.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 30 in x direction at 1.00000m spacing
10 in y direction at 1.00000m spacing
Grid extended to find minimum FoS
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (20.638m,17.857m) Radius 3.0000m
Iterations: 28 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.018054 *Slip weight [kN/m] 98.644*
Net horiz force [kN/m]: -0.033869 Disturbing moment [kN/m]: 910.87
Restoring moment [kNm/m]: 1084.2
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.1902

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1 18.231	16.066	-	-45.000	0.0	0.0	0.0
2 18.340	15.927	-43.613	-43.613	15.884	18.798	0.0
3 18.458	15.795	-42.293	-42.293	28.499	37.058	0.0
4 18.583	15.670	-41.044	-41.044	37.491	53.871	0.0
5 18.716	15.553	-39.872	-39.872	42.673	68.284	0.0
6 18.855	15.444	-38.779	-38.779	44.037	79.333	0.0
7 19.000	15.343	-37.771	-37.771	41.752	86.080	0.0
8 19.174	15.238	-36.719	-36.719	34.339	86.205	0.0
9 19.355	15.145	-35.787	-35.787	27.202	85.589	0.0
10 19.542	15.064	-34.980	-34.980	20.562	84.218	0.0
11 19.733	14.996	-34.302	-34.302	14.635	82.130	0.0
12 19.929	14.941	-33.755	-33.755	9.6261	79.413	0.0
13 20.129	14.900	-33.342	-33.342	5.7116	76.201	0.0
14 20.330	14.873	-33.065	-33.065	3.0283	72.672	0.0
15 20.533	14.859	-32.926	-32.926	1.6630	69.035	0.0
16 20.737	14.858	-32.924	-32.924	1.6452	65.520	0.0
17 20.939	14.872	-33.060	-33.060	1.3627	61.287	0.0
18 21.141	14.899	-33.333	-33.333	0.90213	56.377	0.0
19 21.340	14.940	-33.742	-33.742	0.37137	50.887	0.0
20 21.536	14.995	-34.286	-34.286	-0.13310	44.954	0.0
21 21.728	15.062	-34.961	-34.961	-0.53456	38.743	0.0
22 21.915	15.142	-35.764	-35.764	-0.78257	32.440	0.0
23 22.096	15.235	-36.692	-36.692	-0.85679	26.239	0.0
24 22.270	15.340	-37.741	-37.741	-0.76780	20.331	0.0
25 22.437	15.457	-38.906	-38.906	-0.55488	14.888	0.0
26 22.596	15.584	-40.239	-40.239	-0.28084	10.057	0.0
27 22.713	15.690	-41.633	-41.633	-0.082178	6.8038	0.0
28 22.824	15.803	-43.221	-43.221	0.053063	4.0317	0.0
29 22.929	15.921	-44.841	-44.841	0.086025	1.7536	0.0
30 23.028	16.044	-46.488	-	-0.018054	-0.033869	0.0

Slice No.	Strength Parameters	Average Pore	Slice Weight	Forces on base [kN/m]

	c' [kN/m²]	Tan phi	Pressure [kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.18490	44.815	31.380	26.364
2	0.0	0.70021	0.0	0.58547	51.439	36.018	30.261
3	0.0	0.70021	0.0	1.0141	58.119	40.696	34.191
4	0.0	0.70021	0.0	1.4613	64.755	45.342	38.095
5	0.0	0.70021	0.0	1.9178	71.244	49.886	41.912
6	0.0	0.70021	0.0	2.3741	77.485	54.255	45.583
7	0.0	0.70021	0.0	3.2813	9.2182	6.4546	5.4229
8	0.0	0.70021	0.0	3.8439	9.4793	6.6375	5.5765
9	0.0	0.70021	0.0	4.3637	9.5582	6.6927	5.6230
10	0.0	0.70021	0.0	4.8276	9.4423	6.6115	5.5548
11	0.0	0.70021	0.0	5.2239	9.1253	6.3896	5.3683
12	0.0	0.70021	0.0	5.5430	8.6088	6.0279	5.0644
13	0.0	0.70021	0.0	5.7770	7.9011	5.5324	4.6481
14	0.0	0.70021	0.0	5.9202	7.0185	4.9144	4.1289
15	0.0	0.70021	0.0	5.9692	5.9839	4.1899	3.5202
16	0.0	0.70021	0.0	5.9227	6.4742	4.5333	3.8087
17	0.0	0.70021	0.0	5.7820	6.8451	4.7930	4.0269
18	0.0	0.70021	0.0	5.5503	7.0605	4.9438	4.1536
19	0.0	0.70021	0.0	5.2334	7.1133	4.9808	4.1847
20	0.0	0.70021	0.0	4.8390	7.0034	4.9039	4.1200
21	0.0	0.70021	0.0	4.3768	6.7372	4.7174	3.9634
22	0.0	0.70021	0.0	3.8584	6.3276	4.4306	3.7224
23	0.0	0.70021	0.0	3.2967	5.7934	4.0566	3.4082
24	0.0	0.70021	0.0	2.7061	5.1586	3.6121	3.0348
25	0.0	0.70021	0.0	2.1020	4.4508	3.1165	2.6183
26	0.0	0.70021	0.0	1.2101	2.9350	2.0551	1.7266
27	0.0	0.70021	0.0	0.83954	2.4642	1.7254	1.4497
28	0.0	0.70021	0.0	0.48554	2.0009	1.4010	1.1771
29	0.0	0.70021	0.0	0.15408	1.5556	1.0893	0.91517

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->	1.4522	6.1613	6.8290	7.2570	12.000	15.567	15.797
1	15.397	.	15.397	15.337	13.853	12.737	.
GW	10.897	10.897	.	.	.	.	7.9731

Stratum X -->	16.511	16.562	16.733	19.458	21.173	22.349	23.208
1	12.459	12.444	12.441	12.396	12.368	12.348	12.334
GW	.	.	.	.	.	.	.

Stratum X -->	23.861	24.376	24.791	25.159	28.661	31.829	35.304
1	12.324	12.315	12.308	12.294	12.208	12.142	.
GW	.	.	.	.	.	.	7.5608

Stratum X -->	35.351	39.896	86.001
1	.	.	.
GW	.	.	7.5608

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	3.0000	5.0000	390.00	0.0	Variable	UnFavourable	No

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 8.00000 m y = 18.00000 m
Inclination of grid: -7.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 40 in x direction at 0.70000m spacing
10 in y direction at 1.00000m spacing
Grid extended to find minimum FoS
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (6.3667m,16.186m) Radius 2.0000m
Iterations: 29 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.010112 *Slip weight [kN/m] 73.550*
Net horiz force [kN/m]: -0.0069324 Disturbing moment [kN/m]: 448.16
Restoring moment [kNm/m]: 465.90
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.0396

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1 4.5287	15.397	-	-45.000	0.0	0.0	0.0
2 4.5873	15.272	-43.754	-43.754	15.635	11.194	0.0
3 4.6544	15.152	-42.551	-42.551	30.017	23.950	0.0
4 4.7295	15.037	-41.397	-41.397	42.269	37.620	0.0
5 4.8125	14.927	-40.298	-40.298	51.671	51.382	0.0
6 4.9028	14.823	-39.258	-39.258	57.696	64.285	0.0
7 5.0000	14.725	-38.283	-38.283	60.035	75.293	0.0
8 5.1061	14.633	-37.358	-37.358	52.439	76.475	0.0
9 5.2184	14.548	-36.510	-36.510	44.620	77.016	0.0
10 5.3365	14.471	-35.743	-35.743	36.807	76.846	0.0
11 5.4596	14.403	-35.061	-35.061	29.245	75.938	0.0
12 5.5872	14.344	-34.467	-34.467	22.184	74.316	0.0
13 5.7187	14.293	-33.964	-33.964	15.865	72.054	0.0
14 5.8534	14.253	-33.555	-33.555	10.507	69.279	0.0
15 5.9907	14.221	-33.242	-33.242	6.2887	66.157	0.0
16 6.1298	14.200	-33.026	-33.026	3.3413	62.891	0.0
17 6.2701	14.188	-33.239	-33.239	1.7382	59.706	0.0
18 6.4108	14.186	-33.647	-33.647	1.4894	56.834	0.0
19 6.5514	14.194	-34.154	-34.154	1.2372	53.509	0.0
20 6.6910	14.212	-34.757	-34.757	0.77095	49.544	0.0
21 6.8290	14.240	-35.453	-35.453	0.20261	44.998	0.0
22 6.9391	14.269	-36.082	-36.082	-0.26092	40.977	0.0
23 7.0474	14.305	-36.768	-36.768	-0.68093	36.744	0.0
24 7.1535	14.347	-37.509	-37.509	-1.0181	32.381	0.0
25 7.2570	14.395	-38.301	-38.301	-1.2434	27.972	0.0
26 7.3738	14.458	-39.285	-39.285	-1.3572	22.932	0.0
27 7.4861	14.528	-40.332	-40.332	-1.3230	18.143	0.0
28 7.5935	14.606	-41.436	-41.436	-1.1600	13.728	0.0
29 7.6956	14.691	-42.594	-42.594	-0.90437	9.7931	0.0

Slip surface coordinates			Pore Pressure		Interslice forces [kN/m]		
30	7.7917	14.782	-43.800	-43.800	-0.60533	6.4170	0.0
31	7.8816	14.880	-45.048	-45.048	-0.31928	3.6510	0.0
32	7.9649	14.983	-46.334	-46.334	-0.10365	1.5142	0.0
33	8.0411	15.092	-47.651	-	-0.010112	-0.0069324	0.0

Slice No.	Strength Parameters		Average Pore Pressure	Slice Weight	Forces on base [kN/m]		
	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.088742	18.107	12.679	12.196
2	0.0	0.70021	0.0	0.30101	23.385	16.374	15.751
3	0.0	0.70021	0.0	0.55267	29.070	20.355	19.580
4	0.0	0.70021	0.0	0.83676	35.045	24.539	23.604
5	0.0	0.70021	0.0	1.1458	41.181	28.836	27.737
6	0.0	0.70021	0.0	1.4718	47.349	33.154	31.892
7	0.0	0.70021	0.0	1.8509	7.8965	5.5292	5.3186
8	0.0	0.70021	0.0	2.2019	8.3229	5.8278	5.6058
9	0.0	0.70021	0.0	2.5451	8.5923	6.0164	5.7873
10	0.0	0.70021	0.0	2.8720	8.6869	6.0826	5.8510
11	0.0	0.70021	0.0	3.1747	8.5953	6.0185	5.7893
12	0.0	0.70021	0.0	3.4460	8.3128	5.8207	5.5990
13	0.0	0.70021	0.0	3.6792	7.8413	5.4905	5.2814
14	0.0	0.70021	0.0	3.8691	7.1901	5.0346	4.8428
15	0.0	0.70021	0.0	4.0110	6.3754	4.4641	4.2941
16	0.0	0.70021	0.0	4.1017	5.4191	3.7945	3.6500
17	0.0	0.70021	0.0	4.1389	4.3496	3.0456	2.9296
18	0.0	0.70021	0.0	4.1219	4.5572	3.1910	3.0695
19	0.0	0.70021	0.0	4.0510	4.9852	3.4907	3.3577
20	0.0	0.70021	0.0	3.9279	5.3024	3.7128	3.5714
21	0.0	0.70021	0.0	3.0373	4.4221	3.0964	2.9784
22	0.0	0.70021	0.0	2.8599	4.4409	3.1095	2.9911
23	0.0	0.70021	0.0	2.6627	4.3919	3.0752	2.9581
24	0.0	0.70021	0.0	2.4488	4.2763	2.9943	2.8803
25	0.0	0.70021	0.0	2.5330	4.7213	3.3059	3.1800
26	0.0	0.70021	0.0	2.1567	4.3442	3.0418	2.9260
27	0.0	0.70021	0.0	1.7787	3.8985	2.7298	2.6258
28	0.0	0.70021	0.0	1.4064	3.4003	2.3809	2.2902
29	0.0	0.70021	0.0	1.0475	2.8677	2.0080	1.9315
30	0.0	0.70021	0.0	0.70921	2.3204	1.6248	1.5629
31	0.0	0.70021	0.0	0.39869	1.7784	1.2452	1.1978
32	0.0	0.70021	0.0	0.12262	1.2616	0.88335	0.84971

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0

Slice No	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
24	*0.0*	*0.0*	0.0	0.0	0.0	0.0
25	*0.0*	*0.0*	0.0	0.0	0.0	0.0
26	*0.0*	*0.0*	0.0	0.0	0.0	0.0
27	*0.0*	*0.0*	0.0	0.0	0.0	0.0
28	*0.0*	*0.0*	0.0	0.0	0.0	0.0
29	*0.0*	*0.0*	0.0	0.0	0.0	0.0
30	*0.0*	*0.0*	0.0	0.0	0.0	0.0
31	*0.0*	*0.0*	0.0	0.0	0.0	0.0
32	*0.0*	*0.0*	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->	3.5850	8.1861	8.7620	9.6920	9.9100	10.303	11.156
1	13.740	.	13.740	13.497	13.438	13.336	13.114
GW	9.2400	9.2400	.	.	.	.	.

Stratum X -->	14.000	14.390	15.552	16.141	18.359	20.087	21.151
1	12.376	12.275	.	11.820	11.810	11.802	.
GW	.	.	7.3235	.	.	.	7.2892

Stratum X -->	21.193	22.005	22.629	23.063	23.121	26.909	34.433
1	11.789	11.779	11.771	.	11.765	11.674	.
GW	.	.	7.2654	.	.	.	7.1114

Stratum X -->	34.464	38.904	88.247
1	11.611	7.1114	.
GW	.	.	7.1114

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	4.5000	7.0000	390.00	0.0	Variable	UnFavourable	No

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 8.00000 m y = 16.00000 m
Inclination of grid: -5.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 40 in x direction at 0.60000m spacing
10 in y direction at 0.60000m spacing
Grid extended to find minimum FoS
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (7.8954m,14.805m) Radius 2.0000m
Iterations: 28 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.017599 *Slip weight [kN/m] 52.420*
Net horiz force [kN/m]: -0.023079 Disturbing moment [kN/m]: 606.80
Restoring moment [kNm/m]: 644.66
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.0624

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1 6.2023	13.740	-	-45.000	0.0	0.0	0.0
2 6.2698	13.639	-43.994	-43.994	11.972	11.571	0.0
3 6.3434	13.543	-43.031	-43.031	21.916	23.211	0.0
4 6.4226	13.451	-42.115	-42.115	29.460	34.305	0.0
5 6.5072	13.365	-41.248	-41.248	34.354	44.184	0.0
6 6.5970	13.283	-40.434	-40.434	36.477	52.150	0.0
7 6.6915	13.208	-39.675	-39.675	35.847	57.502	0.0
8 6.7904	13.138	-38.976	-38.976	32.612	59.561	0.0
9 6.8934	13.074	-38.337	-38.337	27.054	57.699	0.0
10 7.0000	13.016	-37.762	-37.762	19.570	51.359	0.0
11 7.1184	12.962	-37.217	-37.217	15.168	50.360	0.0
12 7.2400	12.915	-36.750	-36.750	11.188	48.965	0.0
13 7.3645	12.876	-36.363	-36.363	7.7497	47.232	0.0
14 7.4912	12.846	-36.058	-36.058	4.9554	45.246	0.0
15 7.6196	12.824	-35.837	-35.837	2.8851	43.108	0.0
16 7.7492	12.810	-35.699	-35.699	1.5917	40.938	0.0
17 7.8794	12.805	-35.646	-35.646	1.0973	38.862	0.0
18 8.0096	12.808	-35.678	-35.678	1.0300	36.762	0.0
19 8.1394	12.820	-35.795	-35.795	0.82285	34.270	0.0
20 8.2682	12.840	-36.210	-36.210	0.53455	31.420	0.0
21 8.3953	12.868	-36.825	-36.825	0.22305	28.262	0.0
22 8.5204	12.905	-37.517	-37.517	-0.059235	24.867	0.0
23 8.6428	12.949	-38.283	-38.283	-0.26954	21.320	0.0
24 8.7620	13.002	-39.119	-39.119	-0.37788	17.717	0.0
25 8.8759	13.061	-40.009	-40.009	-0.39011	14.246	0.0
26 8.9858	13.128	-40.960	-40.960	-0.33523	10.984	0.0
27 9.0911	13.201	-41.968	-41.968	-0.23354	8.0079	0.0
28 9.1916	13.281	-43.030	-43.030	-0.11459	5.3821	0.0
29 9.2867	13.368	-44.141	-44.141	-0.013951	3.1536	0.0

Slip surface coordinates			Pore Pressure		Interslice forces [kN/m]		
30	9.3760	13.460	-45.296	-45.296	0.030411	1.3496	0.0
31	9.4593	13.558	-46.491	-	-0.017599	-0.023079	0.0

Slice No.	Strength Parameters		Average Pore Pressure	Slice Weight	Forces on base [kN/m]		
	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.082562	25.018	17.517	16.489
2	0.0	0.70021	0.0	0.26574	29.485	20.646	19.433
3	0.0	0.70021	0.0	0.46726	34.075	23.860	22.458
4	0.0	0.70021	0.0	0.68254	38.713	27.107	25.515
5	0.0	0.70021	0.0	0.90691	43.327	30.338	28.556
6	0.0	0.70021	0.0	1.1356	47.840	33.498	31.530
7	0.0	0.70021	0.0	1.3639	52.183	36.539	34.392
8	0.0	0.70021	0.0	1.5873	56.284	39.410	37.095
9	0.0	0.70021	0.0	1.8012	60.078	42.067	39.596
10	0.0	0.70021	0.0	2.1602	5.5425	3.8809	3.6530
11	0.0	0.70021	0.0	2.3699	5.4280	3.8007	3.5775
12	0.0	0.70021	0.0	2.5532	5.2073	3.6462	3.4320
13	0.0	0.70021	0.0	2.7059	4.8827	3.4189	3.2181
14	0.0	0.70021	0.0	2.8247	4.4598	3.1228	2.9394
15	0.0	0.70021	0.0	2.9070	3.9477	2.7642	2.6019
16	0.0	0.70021	0.0	2.9511	3.3584	2.3516	2.2135
17	0.0	0.70021	0.0	2.9559	3.0738	2.1523	2.0259
18	0.0	0.70021	0.0	2.9215	3.3390	2.3380	2.2007
19	0.0	0.70021	0.0	2.8484	3.5385	2.4777	2.3322
20	0.0	0.70021	0.0	2.7385	3.6652	2.5664	2.4156
21	0.0	0.70021	0.0	2.5938	3.7145	2.6009	2.4481
22	0.0	0.70021	0.0	2.4177	3.6850	2.5803	2.4287
23	0.0	0.70021	0.0	2.2141	3.5785	2.5057	2.3585
24	0.0	0.70021	0.0	1.9192	3.3155	2.3215	2.1852
25	0.0	0.70021	0.0	1.6051	3.0148	2.1110	1.9870
26	0.0	0.70021	0.0	1.2882	2.6741	1.8724	1.7624
27	0.0	0.70021	0.0	0.97497	2.3049	1.6139	1.5191
28	0.0	0.70021	0.0	0.67183	1.9199	1.3443	1.2653
29	0.0	0.70021	0.0	0.38509	1.5318	1.0726	1.0096
30	0.0	0.70021	0.0	0.12092	1.1538	0.80791	0.76046

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	585.00	0.0	0.0	0.0	0.0	0.0
8	585.00	0.0	0.0	0.0	0.0	0.0
9	585.00	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0

Slice No	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
28	*0.0*	*0.0*	0.0	0.0	0.0	0.0
29	*0.0*	*0.0*	0.0	0.0	0.0	0.0
30	*0.0*	*0.0*	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->	**-0.0025648**	**0.0**	**5.8099**	**7.0100**	**7.0180**	**8.7186**	**10.366**
1	.	19.939	.	19.939	19.935	.	18.000
GW	15.439	.	15.436	.	.	13.755	.
Stratum X -->	**35.948**	**38.471**	**41.602**	**43.343**	**43.795**	**47.086**	**51.902**
1	.	11.922	.	.	.	.	10.788
GW	.	.	.	6.1480	.	.	.
Stratum X -->	**54.644**	**56.414**	**57.650**	**58.563**	**59.266**	**59.822**	**60.274**
1	.	.	.	10.897	.	.	.
GW	.	.	.	.	.	.	.
Stratum X -->	**60.648**	**60.963**	**61.232**	**61.269**	**65.810**	**84.325**	
1	.	.	.	.	.	6.4410	
GW	.	.	.	6.4410	.	6.4410	

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	2.0000	5.0000	390.00	0.0	Variable	UnFavourable	No

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 7.00000 m y = 22.00000 m
Inclination of grid: -10.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 40 in x direction at 0.80000m spacing
10 in y direction at 0.50000m spacing
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (7.7878m,21.861m) Radius 4.0000m
Iterations: 43 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.012865 *Slip weight [kN/m] 164.31*
Net horiz force [kN/m]: -0.028573 Disturbing moment [kN/m]: 1469.6
Restoring moment [kNm/m]: 1452.4
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 0.98826

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1 4.2799	19.939	-	-45.024	0.0	0.0	0.0
2 4.3798	19.767	-43.305	-43.305	21.514	16.950	0.0
3 4.4881	19.600	-41.637	-41.637	40.975	34.678	0.0
4 4.6046	19.439	-40.025	-40.025	57.811	52.587	0.0
5 4.7289	19.284	-38.474	-38.474	71.539	69.997	0.0
6 4.8609	19.135	-36.986	-36.986	81.785	86.165	0.0
7 5.0000	18.993	-35.565	-35.565	88.290	100.30	0.0
8 5.1538	18.851	-34.147	-34.147	81.367	101.69	0.0
9 5.3148	18.717	-32.812	-32.812	74.125	102.59	0.0
10 5.4826	18.592	-31.563	-31.563	66.649	102.89	0.0
11 5.6567	18.476	-30.403	-30.403	59.043	102.51	0.0
12 5.8366	18.369	-29.490	-29.490	51.427	101.35	0.0
13 6.0218	18.272	-29.588	-29.588	43.937	99.377	0.0
14 6.2119	18.185	-29.812	-29.812	36.717	96.542	0.0
15 6.4063	18.107	-30.162	-30.162	29.919	92.844	0.0
16 6.6045	18.040	-30.637	-30.637	23.696	88.308	0.0
17 6.8059	17.983	-31.234	-31.234	18.192	82.987	0.0
18 7.0100	17.937	-31.953	-31.953	13.544	76.965	0.0
19 7.0180	17.936	-31.984	-31.984	13.382	76.718	0.0
20 7.2308	17.900	-32.856	-32.856	9.6789	70.049	0.0
21 7.4453	17.876	-33.852	-33.852	7.1563	63.311	0.0
22 7.6607	17.863	-34.971	-34.971	5.8486	56.760	0.0
23 7.8765	17.862	-36.208	-36.208	5.7439	50.660	0.0
24 8.0921	17.873	-37.560	-37.560	5.6242	44.360	0.0
25 8.3068	17.895	-39.023	-39.023	5.3970	37.906	0.0
26 8.5199	17.929	-40.592	-40.592	5.0749	31.437	0.0
27 8.7310	17.974	-42.220	-42.220	4.6551	25.096	0.0
28 8.9392	18.030	-43.243	-43.243	4.1198	19.027	0.0
29 9.1442	18.098	-44.369	-44.369	3.4362	13.365	0.0
30 9.3452	18.177	-45.597	-45.597	2.5584	8.2345	0.0

Slip surface coordinates			Pore Pressure		Interslice forces [kN/m]		
Point	x [m]	z [m]			T	E	T/E
31	9.5416	18.266	-46.922	-46.922	1.4299	3.7417	0.0
32	9.7330	18.366	-48.341	-	-0.012865	-0.028573	0.0

Slice No.	Strength Parameters		Average Pore Pressure	Slice Weight	Forces on base [kN/m]		
	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.20876	33.304	23.319	23.597
2	0.0	0.70021	0.0	0.67230	39.143	27.408	27.734
3	0.0	0.70021	0.0	1.1872	45.254	31.687	32.064
4	0.0	0.70021	0.0	1.7456	51.573	36.112	36.541
5	0.0	0.70021	0.0	2.3393	58.033	40.635	41.118
6	0.0	0.70021	0.0	2.9596	64.565	45.209	45.746
7	0.0	0.70021	0.0	3.8020	8.8245	6.1790	6.2524
8	0.0	0.70021	0.0	4.5190	9.6241	6.7389	6.8190
9	0.0	0.70021	0.0	5.2361	10.375	7.2647	7.3510
10	0.0	0.70021	0.0	5.9428	11.060	7.7441	7.8361
11	0.0	0.70021	0.0	6.6291	11.661	8.1653	8.2624
12	0.0	0.70021	0.0	7.2851	12.164	8.5171	8.6183
13	0.0	0.70021	0.0	7.9017	12.553	8.7898	8.8943
14	0.0	0.70021	0.0	8.4701	12.818	8.9751	9.0818
15	0.0	0.70021	0.0	8.9827	12.948	9.0663	9.1740
16	0.0	0.70021	0.0	9.4324	12.937	9.0588	9.1665
17	0.0	0.70021	0.0	9.8128	12.782	8.9499	9.0562
18	0.0	0.70021	0.0	0.38886	0.49260	0.34492	0.34902
19	0.0	0.70021	0.0	10.113	12.518	8.7652	8.8694
20	0.0	0.70021	0.0	9.7037	11.391	7.9759	8.0707
21	0.0	0.70021	0.0	9.1951	10.100	7.0720	7.1560
22	0.0	0.70021	0.0	8.5933	8.6686	6.0698	6.1420
23	0.0	0.70021	0.0	7.9050	8.3244	5.8288	5.8981
24	0.0	0.70021	0.0	7.1384	7.9905	5.5950	5.6615
25	0.0	0.70021	0.0	6.3027	7.5549	5.2900	5.3528
26	0.0	0.70021	0.0	5.4086	7.0268	4.9202	4.9787
27	0.0	0.70021	0.0	4.4675	6.4171	4.4933	4.5467
28	0.0	0.70021	0.0	3.4917	5.7394	4.0188	4.0665
29	0.0	0.70021	0.0	2.4943	5.0087	3.5072	3.5488
30	0.0	0.70021	0.0	1.4888	4.2417	2.9700	3.0053
31	0.0	0.70021	0.0	0.48918	3.4558	2.4198	2.4485

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0

Slice No	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
27	*0.0*	*0.0*	0.0	0.0	0.0	0.0
28	*0.0*	*0.0*	0.0	0.0	0.0	0.0
29	*0.0*	*0.0*	0.0	0.0	0.0	0.0
30	*0.0*	*0.0*	0.0	0.0	0.0	0.0
31	*0.0*	*0.0*	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->	**2.0938**	**2.0952**	**2.5368**	**2.8408**	**3.5858**	**3.7888**	**4.6348**
1	12.005	.	12.005	12.005	12.005	12.005	12.005
GW	7.5050	7.5050	.	.	.	.	.
Stratum X -->	**4.7878**	**5.6408**	**7.3046**	**7.4658**	**7.8448**	**8.2218**	**8.3200**
1	12.005	12.005	.	12.007	12.007	12.007	.
GW	.	.	7.5067	.	.	.	6.8103
Stratum X -->	**8.5198**	**8.5378**	**9.8918**	**11.842**	**15.132**	**15.271**	**16.229**
1	12.130	12.120	11.189	10.969	.	10.714	10.743
GW	.	.	.	.	6.2087	.	.
Stratum X -->	**22.336**	**22.353**	**25.319**	**25.361**	**29.820**	**62.558**	
1	10.901	.	.	10.844	6.3445	6.3445	
GW	.	6.3999	6.3445	.	.	6.3445	

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	3.0000	6.0000	390.00	0.0	Variable	UnFavourable	No

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 8.00000 m y = 15.00000 m
Inclination of grid: -6.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 25 in x direction at 0.70000m spacing
10 in y direction at 0.80000m spacing
Grid extended to find minimum FoS
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (14.851m,19.911m) Radius 10.000m
Iterations: 5 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: 0.0 *Slip weight [kN/m] 0.029487*
Net horiz force [kN/m]: 0.0 Disturbing moment [kN/m]: 0.16703
Restoring moment [kNm/m]: 0.17017
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.0188

The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1 8.9702	11.823	-	-50.698	0.0	0.0	0.0
2 8.9839	11.813	-50.610	-50.610	1.4041E-6	2.2088E-6	0.0
3 8.9977	11.803	-50.523	-50.523	5.5911E-6	8.2733E-6	0.0
4 9.0115	11.793	-50.436	-50.436	11.966E-6	17.395E-6	0.0
5 9.0253	11.783	-50.349	-50.349	19.954E-6	28.796E-6	0.0
6 9.0391	11.773	-50.262	-50.262	29.067E-6	41.809E-6	0.0
7 9.0529	11.763	-50.176	-50.176	38.815E-6	55.760E-6	0.0
8 9.0667	11.753	-50.090	-50.090	48.793E-6	70.085E-6	0.0
9 9.0806	11.744	-50.004	-50.004	58.612E-6	84.235E-6	0.0
10 9.0945	11.734	-49.919	-49.919	67.911E-6	97.700E-6	0.0
11 9.1083	11.724	-49.833	-49.833	76.440E-6	110.12E-6	0.0
12 9.1223	11.714	-49.748	-49.748	83.911E-6	121.07E-6	0.0
13 9.1362	11.705	-49.663	-49.663	90.160E-6	130.30E-6	0.0
14 9.1501	11.695	-49.579	-49.579	94.935E-6	137.45E-6	0.0
15 9.1641	11.685	-49.494	-49.494	98.241E-6	142.51E-6	0.0
16 9.1781	11.676	-49.410	-49.410	99.895E-6	145.19E-6	0.0
17 9.1920	11.666	-49.326	-49.326	99.846E-6	145.40E-6	0.0
18 9.2060	11.656	-49.243	-49.243	98.213E-6	143.30E-6	0.0
19 9.2201	11.647	-49.160	-49.160	94.935E-6	138.78E-6	0.0
20 9.2341	11.637	-49.076	-49.076	90.130E-6	132.00E-6	0.0
21 9.2482	11.628	-48.994	-48.994	83.914E-6	123.11E-6	0.0
22 9.2622	11.618	-48.911	-48.911	76.488E-6	112.40E-6	0.0
23 9.2763	11.609	-48.829	-48.829	68.052E-6	100.14E-6	0.0
24 9.2904	11.599	-48.747	-48.747	58.798E-6	86.622E-6	0.0
25 9.3045	11.590	-48.665	-48.665	49.073E-6	72.347E-6	0.0
26 9.3187	11.580	-48.583	-48.583	39.181E-6	57.765E-6	0.0
27 9.3328	11.571	-48.502	-48.502	29.520E-6	43.478E-6	0.0
28 9.3470	11.562	-48.421	-48.421	20.464E-6	30.055E-6	0.0
29 9.3612	11.552	-48.340	-48.340	12.487E-6	18.221E-6	0.0

Slip surface coordinates			Pore Pressure		Interslice forces [kN/m]		
30	9.3754	11.543	-48.260	-48.260	6.0536E-6	8.6969E-6	0.0
31	9.3896	11.534	-48.179	-48.179	1.7098E-6	2.3368E-6	0.0
32	9.4038	11.525	-48.099	-	0.0	0.0	0.0

Slice No.	Strength Parameters		Average Pore Pressure	Slice Weight	Forces on base [kN/m]		
	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	87.555E-6	71.022E-6	49.730E-6	48.814E-6
2	0.0	0.70021	0.0	257.33E-6	208.68E-6	146.12E-6	143.43E-6
3	0.0	0.70021	0.0	415.67E-6	337.39E-6	236.24E-6	231.89E-6
4	0.0	0.70021	0.0	562.81E-6	457.34E-6	320.23E-6	314.33E-6
5	0.0	0.70021	0.0	698.30E-6	568.07E-6	397.76E-6	390.44E-6
6	0.0	0.70021	0.0	822.56E-6	669.94E-6	469.10E-6	460.46E-6
7	0.0	0.70021	0.0	935.36E-6	762.72E-6	534.06E-6	524.22E-6
8	0.0	0.70021	0.0	0.0010367	846.31E-6	592.59E-6	581.68E-6
9	0.0	0.70021	0.0	0.0011261	920.47E-6	644.52E-6	632.65E-6
10	0.0	0.70021	0.0	0.0012042	985.44E-6	690.01E-6	677.30E-6
11	0.0	0.70021	0.0	0.0012707	0.0010411	729.00E-6	715.57E-6
12	0.0	0.70021	0.0	0.0013255	0.0010873	761.31E-6	747.29E-6
13	0.0	0.70021	0.0	0.0013685	0.0011239	786.95E-6	772.45E-6
14	0.0	0.70021	0.0	0.0013999	0.0011509	805.89E-6	791.05E-6
15	0.0	0.70021	0.0	0.0014196	0.0011685	818.21E-6	803.14E-6
16	0.0	0.70021	0.0	0.0014268	0.0011758	823.34E-6	808.17E-6
17	0.0	0.70021	0.0	0.0014226	0.0011737	821.85E-6	806.72E-6
18	0.0	0.70021	0.0	0.0014065	0.0011618	813.50E-6	798.52E-6
19	0.0	0.70021	0.0	0.0013782	0.0011397	798.05E-6	783.35E-6
20	0.0	0.70021	0.0	0.0013375	0.0011074	775.43E-6	761.15E-6
21	0.0	0.70021	0.0	0.0012857	0.0010657	746.24E-6	732.49E-6
22	0.0	0.70021	0.0	0.0012212	0.0010134	709.58E-6	696.51E-6
23	0.0	0.70021	0.0	0.0011453	951.52E-6	666.26E-6	653.99E-6
24	0.0	0.70021	0.0	0.0010561	878.41E-6	615.07E-6	603.74E-6
25	0.0	0.70021	0.0	955.21E-6	795.45E-6	556.98E-6	546.72E-6
26	0.0	0.70021	0.0	841.96E-6	701.93E-6	491.50E-6	482.45E-6
27	0.0	0.70021	0.0	716.27E-6	597.85E-6	418.62E-6	410.91E-6
28	0.0	0.70021	0.0	578.64E-6	483.54E-6	338.58E-6	332.34E-6
29	0.0	0.70021	0.0	428.38E-6	358.42E-6	250.97E-6	246.35E-6
30	0.0	0.70021	0.0	265.65E-6	222.57E-6	155.84E-6	152.97E-6
31	0.0	0.70021	0.0	90.691E-6	76.173E-6	53.337E-6	52.355E-6

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0

Slice No	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
26	*0.0*	*0.0*	0.0	0.0	0.0	0.0
27	*0.0*	*0.0*	0.0	0.0	0.0	0.0
28	*0.0*	*0.0*	0.0	0.0	0.0	0.0
29	*0.0*	*0.0*	0.0	0.0	0.0	0.0
30	*0.0*	*0.0*	0.0	0.0	0.0	0.0
31	*0.0*	*0.0*	0.0	0.0	0.0	0.0

General Parameters

Direction of slip: DOWNHILL
Minimum slip weight [kN/m] : 0.00000
Type of analysis : STATIC

Analysis Options

Partial Factor Analysis
Minimum number of slices: 25
Method: Bishop (Variably inclined interslice forces)
Maximum number of iterations: 300
Reinforcement: NOT ACTIVE

Method Partial Factors

Current selection: BS EN 1997-1:2011 DA1-1
Factor on FAVOURABLE PERMANENT LOAD: 1.00000
Factor on UNFAVOURABLE PERMANENT LOAD: 1.35000
Factor on FAVOURABLE VARIABLE LOAD: 0.00000
Factor on UNFAVOURABLE VARIABLE LOAD: 1.50000
Factor on SOIL UNIT WEIGHT: 1.35000
Factor on DRAINED SOIL COHESION: 1.00000
Factor on UNDRAINED SOIL COHESION: 1.00000
Factor on SOIL FRICTION ANGLE: 1.00000
Factor on reinforcement pullout: 1.50000
Economic ramification of failure: 1.00000
Sliding along reinforcement: 1.50000

Material properties

No	Description	Unit Weight Above GWL [kN/m3]	Unit Weight Below GWL [kN/m3]	Shear Strength Parameters Condition	Phi or Phi0 [°]	c or c0' [kN/m²]
1	Sand and Gravel	18.000	18.000	Drained - linear strength	35.000	0.0

Coordinates of top of soil strata

The units of the following coordinates are in m

Stratum X -->	3.8864	4.0561	5.8251	10.291	11.181	13.191	13.947
1	.	11.660	11.582	.	11.391	10.604	.
GW	7.1632	.	.	6.9214	.	.	5.5634

Stratum X -->	14.111	14.652	15.005	15.719	23.088	23.152	25.945
1	10.288	10.102	10.106	10.133	10.503	.	10.448
GW	.	.	.	.	.	6.0009	.

Stratum X -->	26.041	28.142	28.281	32.684	66.012
1	.	10.584	.	6.0838	.
GW	5.9453	.	6.0838	.	6.0838

Piezometers

Stratum-linked data

No.	Material	Water table	Piezo Set/ Ru value
1	Sand and Gravel	GW	-

Surface Loads

No.	Limits of loaded area X1 [m]	X2 [m]	Distributed load Vert [kN/m²]	Horiz [kN/m²]	Permanent / Variable load	Favourable / UnFavourable load	Use in pull-out calc
1	5.0000	8.0000	390.00	0.0	Variable	UnFavourable	No

Slip Surface Specification

Circle centre specification: GRID
Bottom left of grid: x = 8.00000 m y = 14.00000 m

No. Limits of loaded area Distributed load Permanent / Favourable / Use in

Inclination of grid: -6.00000 deg
(positive anticlockwise direction about bottom left of grid)
Centres on grid: 24 in x direction at 0.80000m spacing
8 in y direction at 0.80000m spacing
Initial radius of circle 1.00000 m
Incremented by 1.00000 m until all possible circles considered

NOTE on EC7 DA1-1 analyses

The approach used here follows Simpson, B (2011) Concise Eurocodes: Geotechnical design. BS EN 1997-1: Eurocode 7, Part 1. BSI.
Commenting on EC7 11.5.1(12), this states:
Paragraph (12) makes it clear that no attempt should be made to partition the sliding mass into favourable and unfavourable ground. Even when the Design Approach or Combination in use requires different factors on favourable or unfavourable permanent actions, the weight of the ground is to be considered as a single source in the terms of 2.4.2(9).

This is at variance with the proposals of Driscoll, R, Scott, P & Powell, J (2008) EC7 - implications for UK practice. CIRIA Report C641.

WORST CASE

Centre at (10.387m,13.749m) Radius 4.0000m
Iterations: 33 Horiz acceleration [%g]: 0.0
Net vertical force [kN/m]: -0.035071 *Slip weight [kN/m] 166.33*
Net horiz force [kN/m]: -0.085225 Disturbing moment [kN/m]: 1645.1
Restoring moment [kNm/m]: 1859.5
Reinf.Rest.Moment [kNm/m]: 0.0
Over-Design Factor: 1.1303

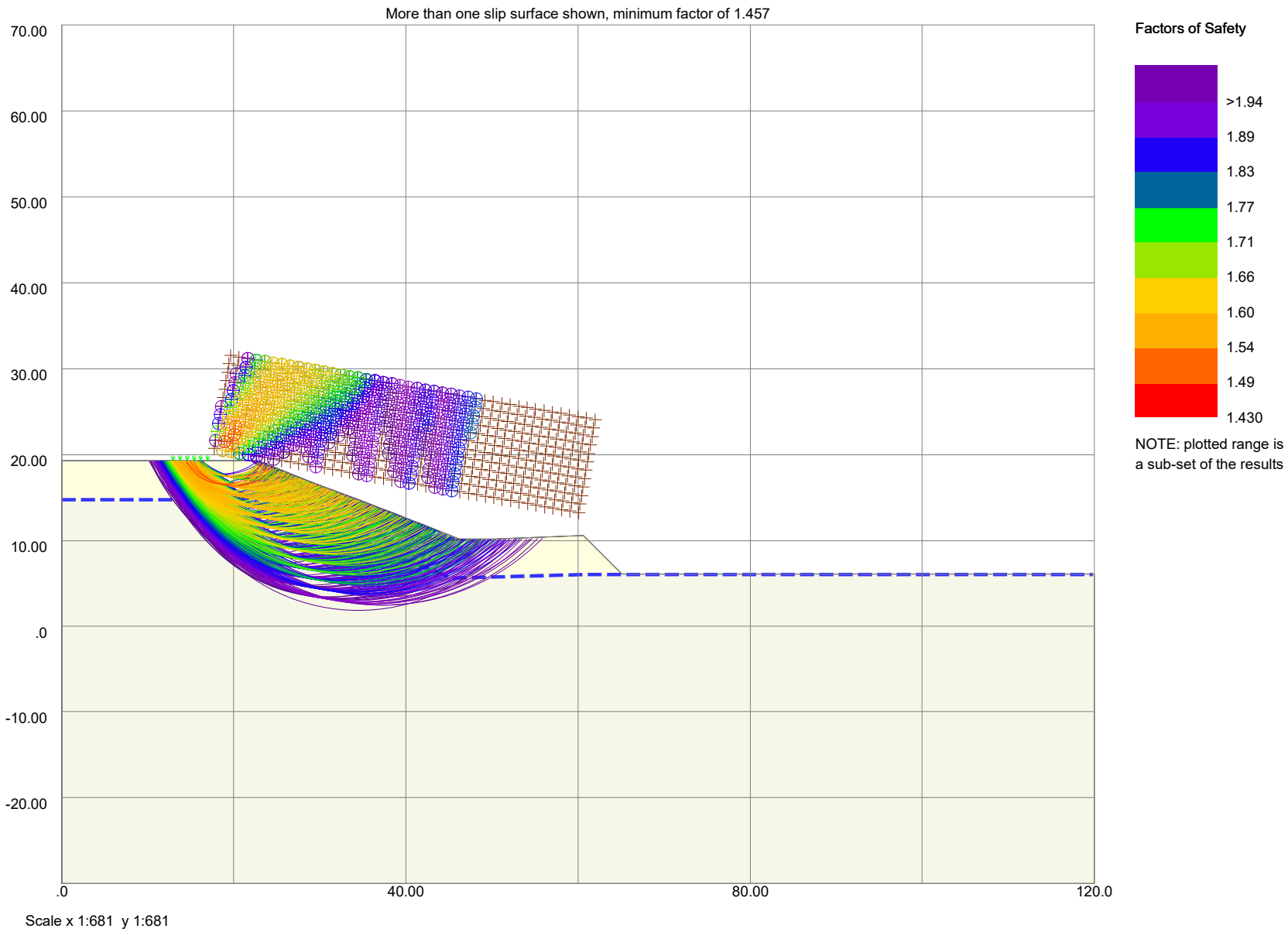
The system of interslice and base forces are in equilibrium when the strengths available at the bases are divided by the computed over-design factor. The interslice forces shown in the following table are in equilibrium with the factored strengths of the soil at the bases of slices.

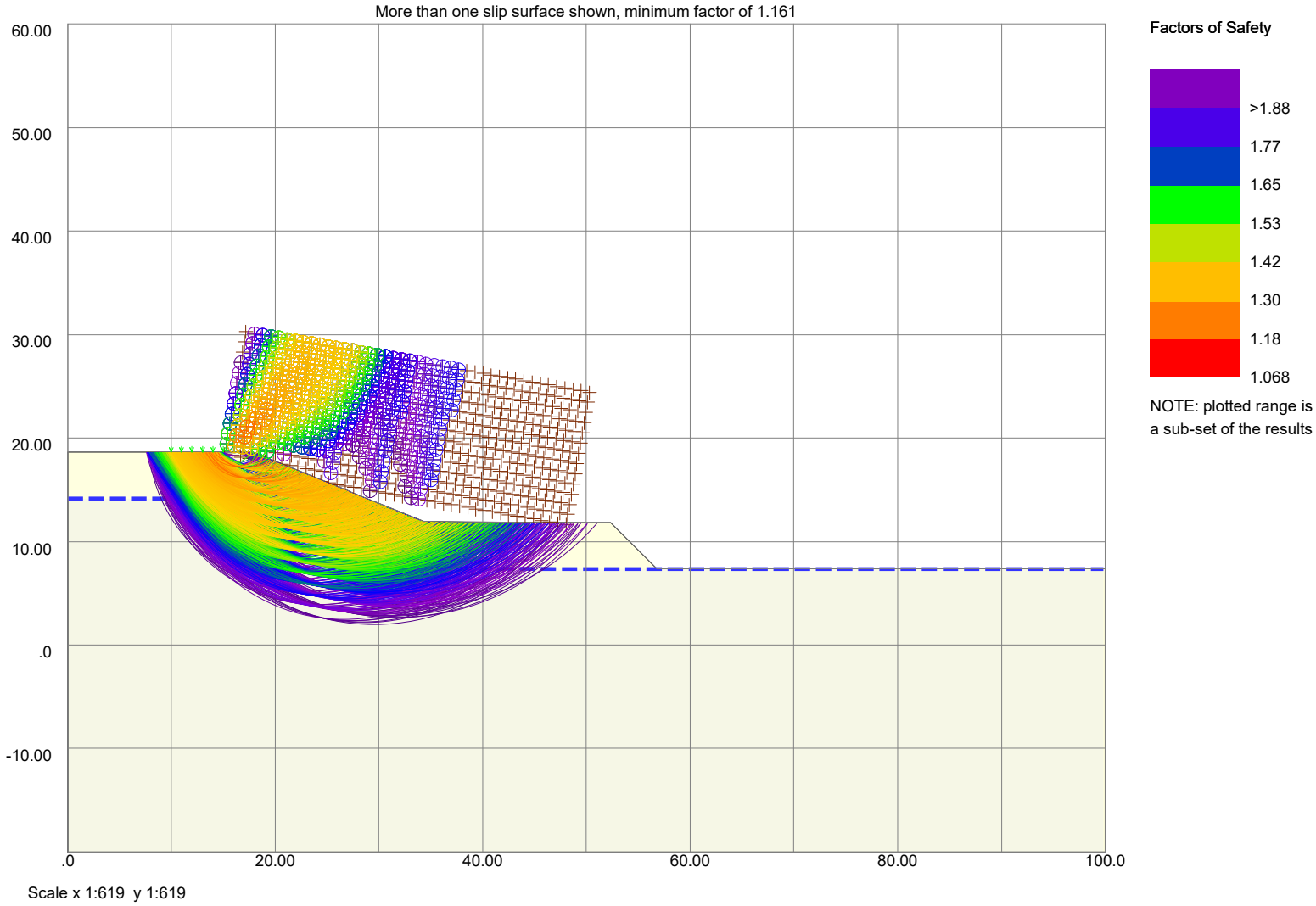
Slip surface coordinates		Pore Pressure		Interslice forces [kN/m]		
Point	x [m]	y [m]	L [kN/m²]	R [kN/m²]	T	E	E(u)
1	7.0534	11.538	-	-44.946	0.0	0.0	0.0
2	7.1863	11.350	-43.113	-43.113	23.575	23.133	0.0
3	7.3298	11.170	-41.363	-41.363	43.716	46.337	0.0
4	7.4834	10.998	-39.703	-39.703	59.817	68.558	0.0
5	7.6467	10.835	-38.139	-38.139	71.466	88.653	0.0
6	7.8191	10.682	-36.674	-36.674	78.455	105.43	0.0
7	8.0000	10.539	-35.314	-35.314	80.792	117.69	0.0
8	8.1966	10.402	-34.016	-34.016	70.470	118.52	0.0
9	8.4011	10.277	-32.841	-32.841	60.153	118.44	0.0
10	8.6127	10.164	-31.794	-31.794	50.051	117.36	0.0
11	8.8307	10.064	-30.877	-30.877	40.390	115.24	0.0
12	9.0542	9.9776	-30.096	-30.096	31.403	112.08	0.0
13	9.2826	9.9046	-29.451	-29.451	23.320	107.95	0.0
14	9.5149	9.8453	-28.946	-28.946	16.354	102.95	0.0
15	9.7504	9.8001	-28.583	-28.583	10.691	97.242	0.0
16	9.9881	9.7691	-28.362	-28.362	6.4826	91.018	0.0
17	10.227	9.7523	-28.285	-28.285	3.8323	84.515	0.0
18	10.467	9.7499	-28.940	-28.940	2.7918	77.992	0.0
19	10.707	9.7619	-29.949	-29.949	2.0234	70.802	0.0
20	10.945	9.7882	-31.098	-31.098	1.3541	62.889	0.0
21	11.181	9.8288	-32.381	-32.381	0.87461	54.400	0.0
22	11.398	9.8790	-33.689	-33.689	0.62479	46.323	0.0
23	11.612	9.9413	-35.105	-35.105	0.53064	38.403	0.0
24	11.822	10.015	-36.625	-36.625	0.56707	30.815	0.0
25	12.027	10.101	-38.244	-38.244	0.68875	23.720	0.0
26	12.228	10.198	-39.958	-39.958	0.83241	17.266	0.0
27	12.422	10.306	-41.760	-41.760	0.92055	11.577	0.0
28	12.611	10.424	-43.645	-43.645	0.86588	6.7511	0.0
29	12.792	10.553	-45.608	-45.608	0.57714	2.8533	0.0
30	12.966	10.692	-47.643	-	-0.035071	-0.085225	0.0

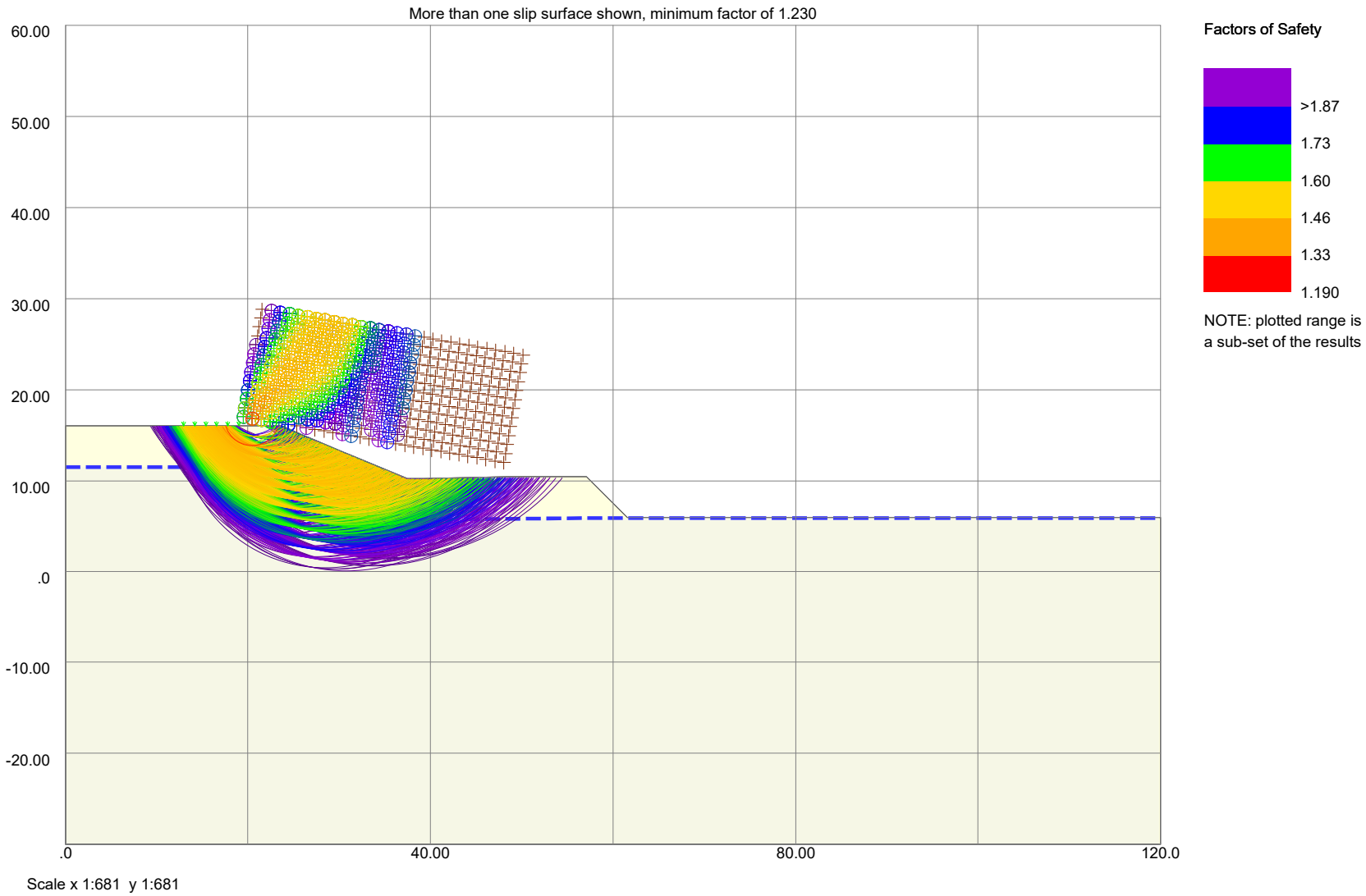
Slice No.	Strength Parameters	Average Pore Pressure	Slice Weight	Forces on base [kN/m]

	c' [kN/m²]	Tan phi	[kN/m²]	[kN/m]	Normal	Shear (capacity)	Shear (mobilised)
1	0.0	0.70021	0.0	0.29637	50.294	35.216	31.156
2	0.0	0.70021	0.0	0.94564	58.473	40.943	36.223
3	0.0	0.70021	0.0	1.6501	66.849	46.808	41.412
4	0.0	0.70021	0.0	2.3947	75.299	52.725	46.646
5	0.0	0.70021	0.0	3.1641	83.700	58.607	51.850
6	0.0	0.70021	0.0	3.9430	91.925	64.367	56.946
7	0.0	0.70021	0.0	4.9219	12.978	9.0875	8.0397
8	0.0	0.70021	0.0	5.7353	13.647	9.5556	8.4539
9	0.0	0.70021	0.0	6.5091	14.152	9.9091	8.7667
10	0.0	0.70021	0.0	7.2277	14.470	10.132	8.9639
11	0.0	0.70021	0.0	7.8768	14.584	10.212	9.0346
12	0.0	0.70021	0.0	8.4439	14.482	10.140	8.9713
13	0.0	0.70021	0.0	8.9177	14.156	9.9121	8.7693
14	0.0	0.70021	0.0	9.2891	13.606	9.5271	8.4287
15	0.0	0.70021	0.0	9.5509	12.838	8.9892	7.9528
16	0.0	0.70021	0.0	9.6979	11.864	8.3072	7.3495
17	0.0	0.70021	0.0	9.7271	10.702	7.4939	6.6299
18	0.0	0.70021	0.0	9.6378	10.752	7.5288	6.6608
19	0.0	0.70021	0.0	9.4312	10.907	7.6373	6.7568
20	0.0	0.70021	0.0	9.1114	10.887	7.6232	6.7443
21	0.0	0.70021	0.0	7.8769	9.7389	6.8193	6.0331
22	0.0	0.70021	0.0	7.0330	9.0555	6.3407	5.6097
23	0.0	0.70021	0.0	6.1373	8.2755	5.7946	5.1265
24	0.0	0.70021	0.0	5.2026	7.4163	5.1929	4.5942
25	0.0	0.70021	0.0	4.2425	6.4971	4.5493	4.0248
26	0.0	0.70021	0.0	3.2711	5.5388	3.8783	3.4312
27	0.0	0.70021	0.0	2.3033	4.5633	3.1953	2.8269
28	0.0	0.70021	0.0	1.3538	3.5929	2.5158	2.2258
29	0.0	0.70021	0.0	0.43768	2.6498	1.8554	1.6415

Slice No.	Surface Load [kN/m_hor/m]		Point Load [kN/m]		Water Pressure on ground surface [kN/m_hor/m]	
	Vert	Horiz	Vert	Horiz	Vert	Horiz
1	585.00	0.0	0.0	0.0	0.0	0.0
2	585.00	0.0	0.0	0.0	0.0	0.0
3	585.00	0.0	0.0	0.0	0.0	0.0
4	585.00	0.0	0.0	0.0	0.0	0.0
5	585.00	0.0	0.0	0.0	0.0	0.0
6	585.00	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0


More than one slip surface shown, minimum factor of 1.457
70.00
60.00
50.00
40.00
30.00
20.00
10.00
.0
-10.00
-20.00
.0
40.00
80.00
120.0
Scale x 1:681 y 1:681
Factors of Safety
>1.94
1.89
1.83
1.77
1.71
1.66
1.60
1.54
1.49
1.430
NOTE: plotted range is a sub-set of the results


More than one slip surface shown, minimum factor of 1.161
60.00
50.00
40.00
30.00
20.00
10.00
.0
-10.00
.0
20.00
40.00
60.00
80.00
100.0
Scale x 1:619 y 1:619
Factors of Safety
>1.88
1.77
1.65
1.53
1.42
1.30
1.18
1.068
NOTE: plotted range is
a sub-set of the results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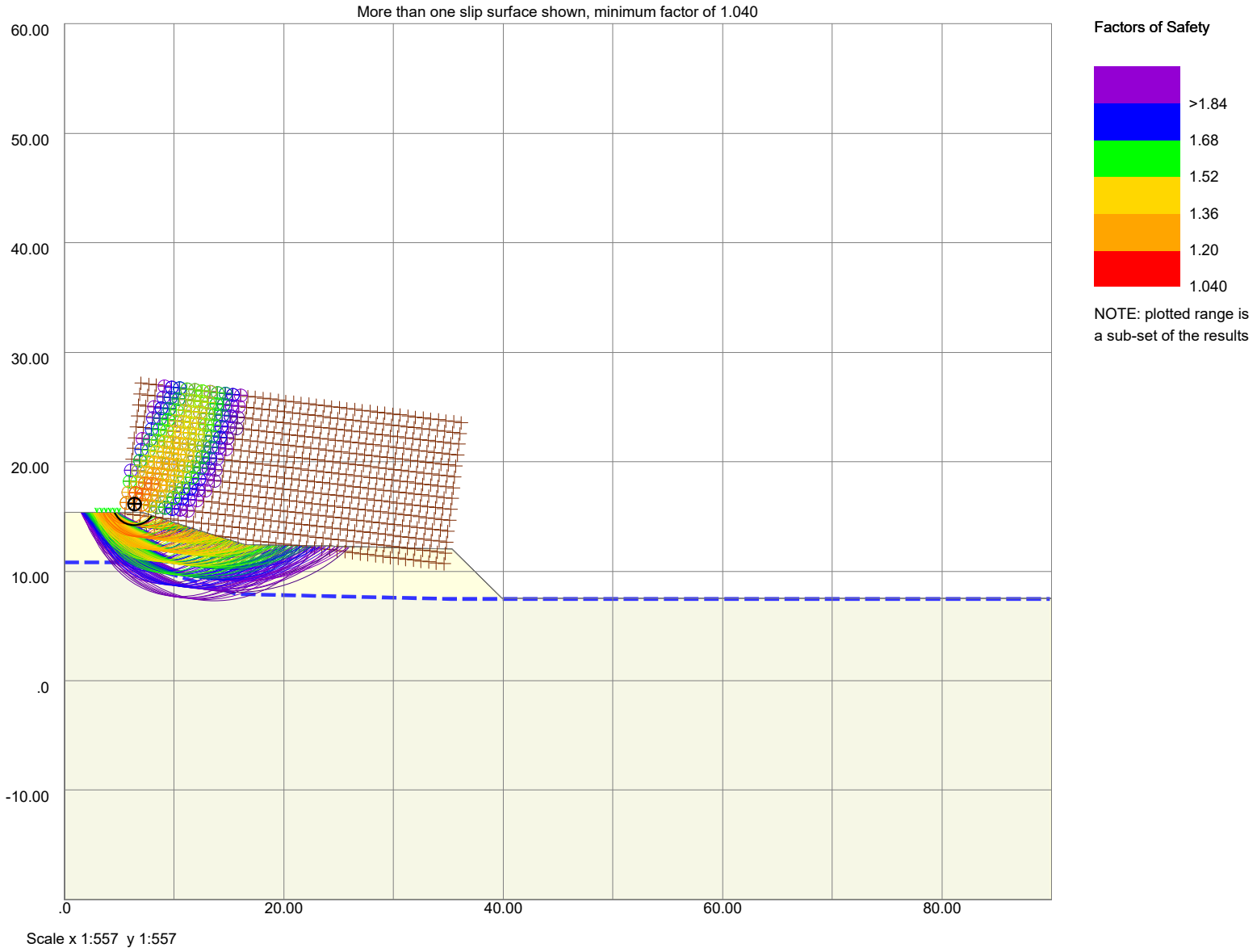
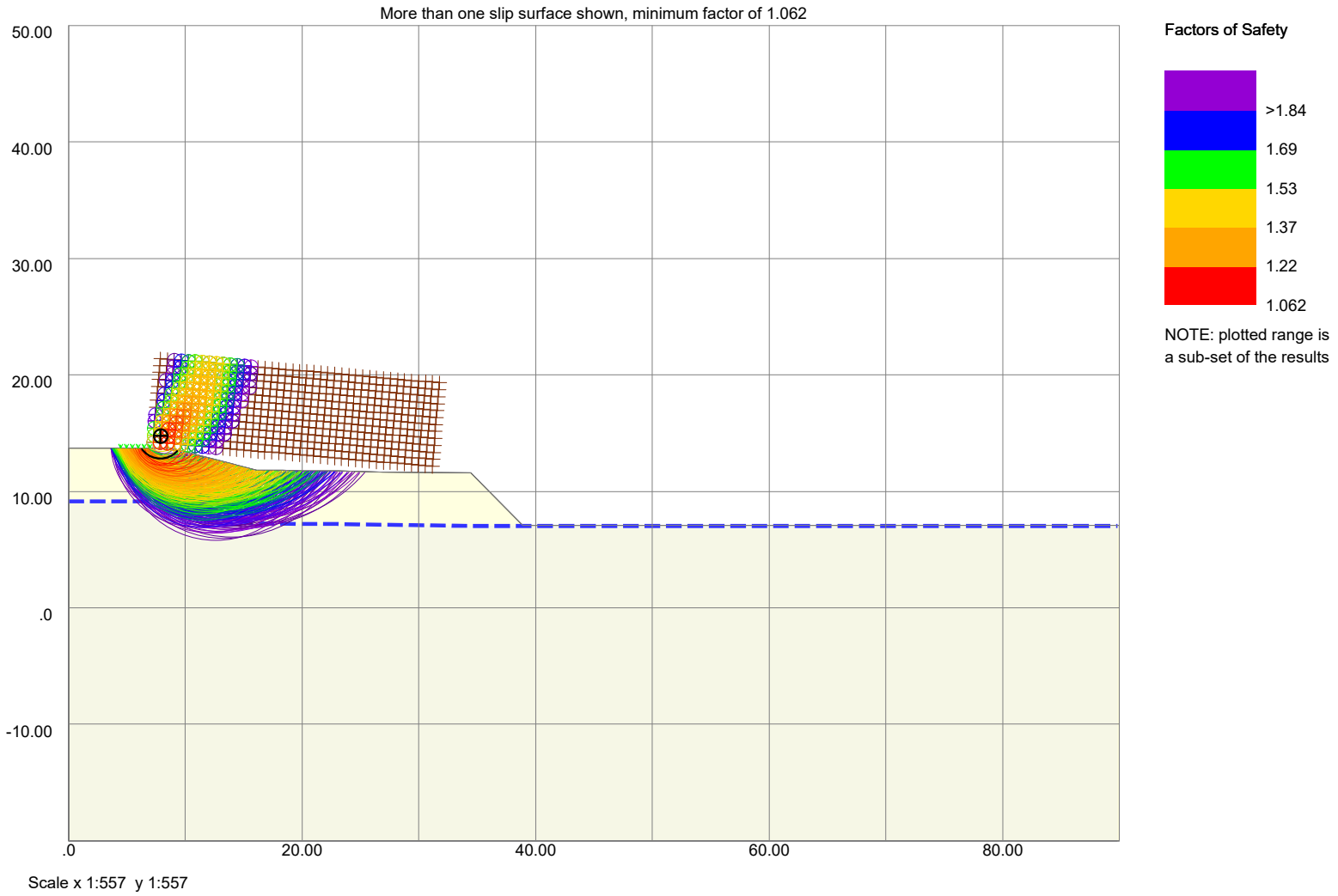
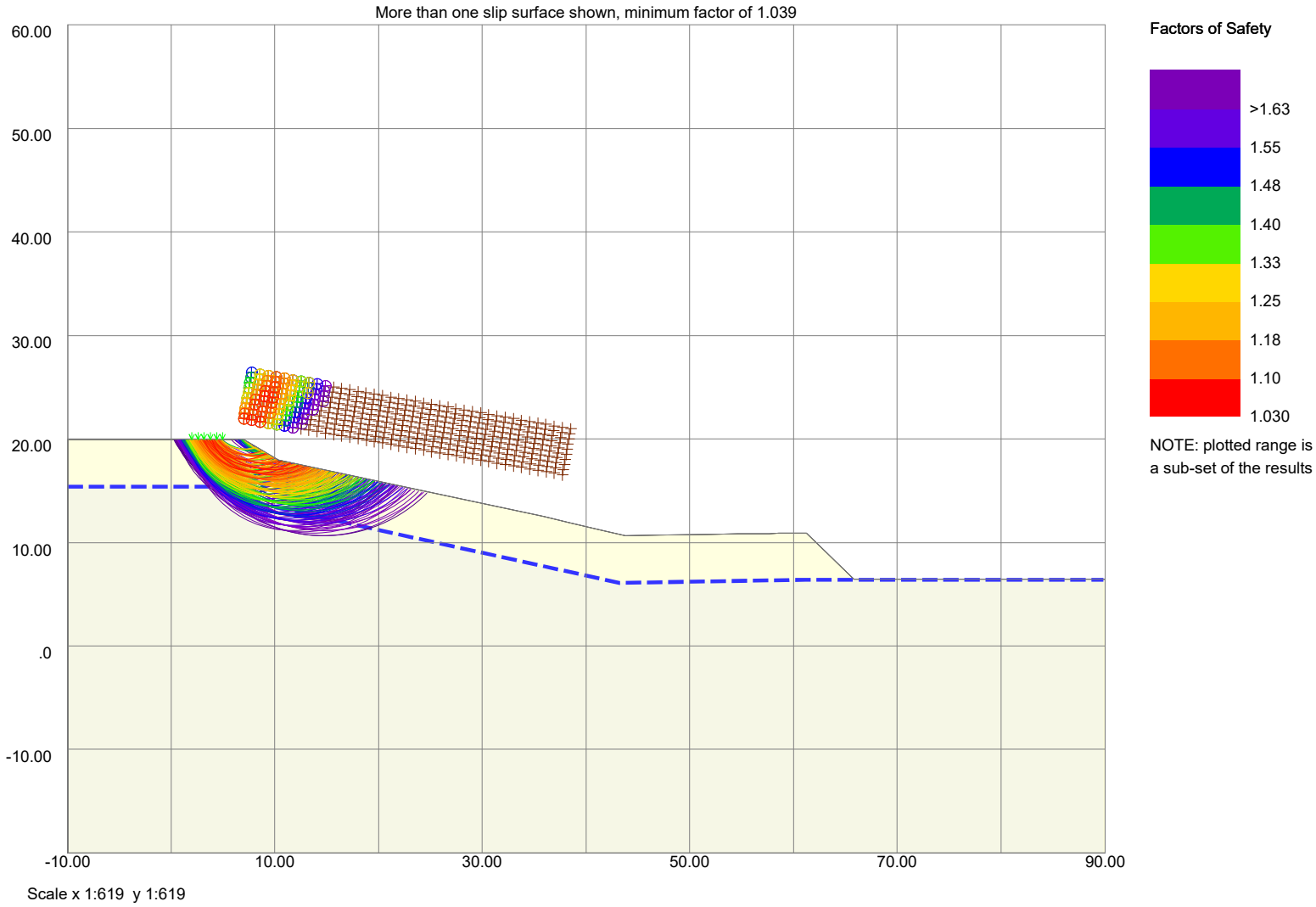
60.00
50.00
40.00
30.00
20.00
10.00
.0
-10.00
-20.00
.0
40.00
80.00
120.0
Scale x 1:681 y 1:681
Factors of Safety
>1.87
1.73
1.60
1.46
1.33
1.190
NOTE: plotted range is a sub-set of the results


More than one slip surface shown, minimum factor of 1.040
60.00
50.00
40.00
30.00
20.00
10.00
.0
-10.00
.0
20.00
40.00
60.00
80.00
Scale x 1:557 y 1:557
Factors of Safety
>1.84
1.68
1.52
1.36
1.20
1.040
NOTE: plotted range is
a sub-set of the results


More than one slip surface shown, minimum factor of 1.062
50.00
40.00
30.00
20.00
10.00
.0
-10.00
.0
20.00
40.00
60.00
80.00
Scale x 1:557 y 1:557
Factors of Safety
>1.84
1.69
1.53
1.37
1.22
1.062
NOTE: plotted range is
a sub-set of the results


More than one slip surface shown, minimum factor of 1.039
60.00
50.00
40.00
30.00
20.00
10.00
.0
-10.00
-10.00
10.00
30.00
50.00
70.00
90.00
Scale x 1:619 y 1:619
Factors of Safety
>1.63
1.55
1.48
1.40
1.33
1.25
1.18
1.10
1.030
NOTE: plotted range is
a sub-set of the results

Oasys

E3P

Gale Moss, Chorley

Slope Stability Assessment

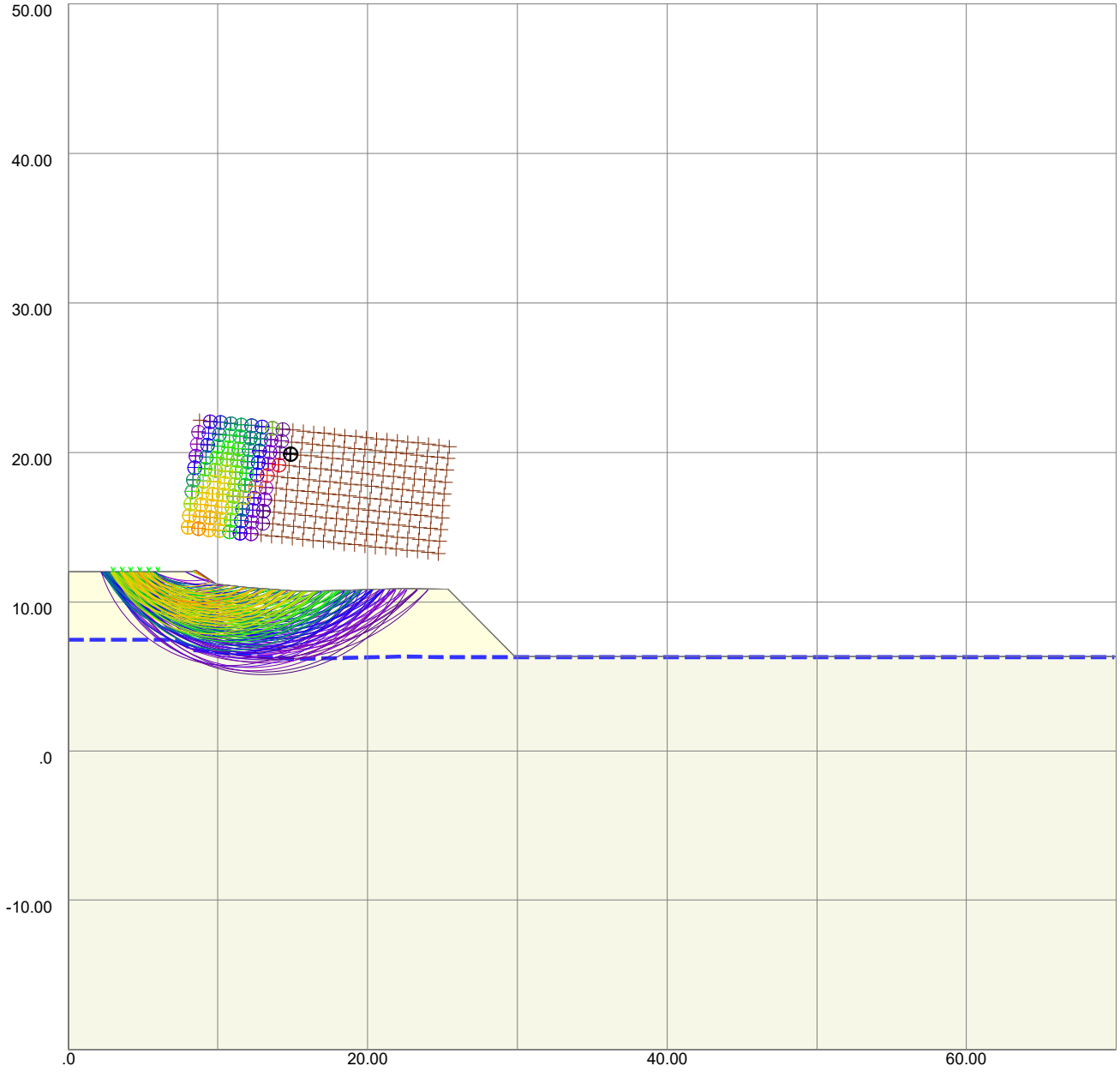
Section 7

Job No.	Sheet No.	Rev.
14-244		

Drg. Ref.

Made by	Date	Checked
CB	23-Oct-2020	

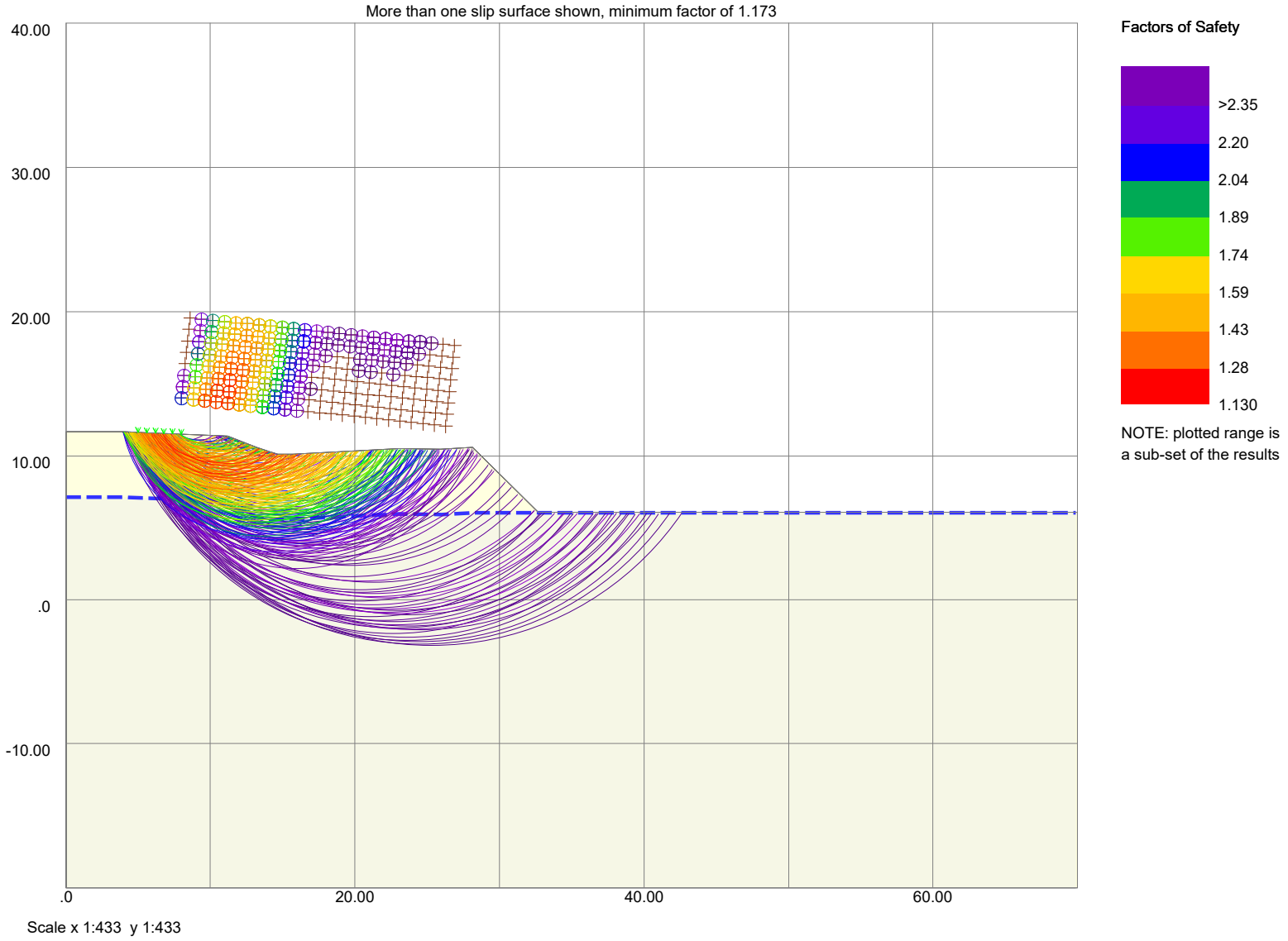
More than one slip surface shown, minimum factor of 1.019



Factors of Safety

>1.89
1.78
1.67
1.56
1.45
1.35
1.24
1.13
1.019

NOTE: plotted range is a sub-set of the results


More than one slip surface shown, minimum factor of 1.173
40.00
30.00
20.00
10.00
.0
-10.00
.0
20.00
40.00
60.00
Scale x 1:433 y 1:433
Factors of Safety
>2.35
2.20
2.04
1.89
1.74
1.59
1.43
1.28
1.130
NOTE: plotted range is a sub-set of the results

Noise Impact Assessment of Proposed Sand and Gravel Extraction

Client:	Ruttle Plant Hire Limited
Address:	Gale Moss, North of the A674, Chorley, PR6 8AA
Date:	06/11/2020

Version	1	2
Authored By	Mr P Soler, BEng, AMIOA	--
Approved By	A T Martin MSc, MIOA, MIET, MInstSCE	--
Date	06/11/2020	--
Project Number	4678RP	--

Disclaimer

The opinions and interpretations presented in this report represent our best technical interpretation of the data made available to us. However, due to uncertainty inherent in the estimation of all parameters, we cannot, and do not guarantee the accuracy or correctness of any interpretation and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, cost, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. If additional information becomes available which may affect our comments, conclusions or recommendations, the author reserves the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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Contents

Tables

Figures

Executive Summary

A noise impact assessment has been undertaken to assess the impact of the proposed sand and gravel extraction at Gale Moss, North of the A674, Chorley, PR6 8AA. The measured sound levels have allowed BS4142:2014 and IEMA noise assessments to be carried out.

A BS4142 assessment shows that the noise emissions associated with each phase of the Proposed Development fall below the operational period background sound level on all the Noise Sensitive Receptors (NSRs) 1 to 3. However, the background is exceeded at NSRS 4 and 5 by 4-6 dB. However, given the development is temporary and government guidance on mineral extraction states the following it is assumed that the site is suitable for the development and low impact will occur.

"Mineral planning authorities should aim to establish a noise limit, through a planning condition, at the noise-sensitive property that does not exceed the background noise level (LA90,1h) by more than 10dB(A) during normal working hours (0700-1900)."

An IEMA 'Increase in Ambient Noise Level' assessment shows that the specific sound level emissions from the proposed site are predicted to have a no impact on the amenity of the surrounding NSRs. This also equates to 'No Observe Effect Level' (NOEL), when assessed with the NPSE and the NPPF. Thus, giving more context to the BS4142:2014 assessment.

The findings of this report will require written approval from the Local Authority prior to work commencing.

1. Introduction

1.1 Overview

NOVA Acoustics Ltd has been commissioned to prepare a noise assessment for the proposed sand and gravel extraction ('the Proposed Development') at Gale Moss, North of the A674, Chorley, PR6 8AA ('the Site').

The Applicant is preparing a full planning application ('the Application') to Lancashire County Council. Accordingly, the following technical noise assessment has been produced to accompany the Application to the Local Authority.

This report details the existing background sound climate at the nearest receptors, as well as the sound emissions associated with the Proposed Development.

This noise assessment is necessarily technical in nature; therefore, a glossary of terms is included in Appendix A to assist the reader.

1.2 Scope & Objectives

The scope of the noise assessment can be summarised as follows:

- Baseline sound monitoring survey to evaluate the prevailing sound levels at the nearest sensitive receptor ('NSR') to Site;
- Detailed sound modelling, acoustic calculation and analysis in accordance with ISO9613 – 1 prediction methodology to predict sound levels at the NSR;
- A detailed assessment of the suitability of the Site, in accordance with relevant standards in respect of sound from the proposed sources; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of the National Planning Practice Guidance in England and Wales, BS4142:2014, and other relevant Standards.

1.3 Legislation, Policy and Guidance

This report is to be primarily based on the following legislation, policy, and guidance.

- National Planning Policy Framework (2019)
- Noise Policy Statement for England
- IEMA Guidelines on Noise Impact Assessments
- BS4142:2014 'Methods for rating and assessing industrial and commercial sound'
- ISO 9613-2 Attenuation of sound during propagation outdoors
- BS EN 12354-4 Building Acoustics

2. Site Description & Background Information

2.1 Site & Surroundings

The Proposed Development is located on the land next to Junction 8, M61, Chorley, PR6 8AA, Lancashire. The immediate area is predominantly farmland with some residential and commercial premises. The east boundary of the site is adjacent to the M61 motorway. Across the M61, about 130m away is a farm with a residential dwelling associated. 250m to the north are commercial units and residential dwellings. To the south, runs A674 Road, which facilitates medium traffic flow levels. About 300m away is a residential area named Great Knowley. To the south and west, the are commercial areas with several premises which typically operate from 08:00 to 18:00 Monday to Friday. To the south-west, approximately 320m away, there is another residential area, and to the west, approximately 270m from site, there is another residential dwelling. Due to their proximity, the 5 residential premises mentioned above are considered as Noise Sensitive Receptors (NSRs). During the site visits, the engineers found that the acoustic environment at the NSRs was of a moderate level, with road traffic noise presenting as dominant sources. The main noise source incident on all the NSRs was found to be the M61 Motorway.

Figure 1.0 – Site and Surroundings

2.2 Background

The proposals are for the prior extraction of some 300,000 tonnes of sand and gravel. The sand and gravel would be extracted to a depth of approximately 4m below the surface (retaining a 1m stand-off from the local groundwater table).

The Site would be restored with approximately 300,000 tonnes of suitable inert materials to provide an engineered construction platform for the approved (outline) B2 industrial development at The Site and, should the industrial development not go ahead, create agricultural land with biodiversity set-aside areas.

The proposed prior extraction operations would be carried out in three phases, starting in the eastern extent of The Site and moving westwards (see figure).

Soil stripping would also be carried out in a phased manner. All stripped soils would be stored in amenity bunds and be retained for use in restoration. It is noted that there is limited (less than 0.5m) of soils at The Site. The northern area would not be worked, instead only being used for storage of plant and equipment, or stockpiling of materials.

All soils bunds would be seeded with a grass seed mix to reduce their visual impact during the lifetime of the works. The bunds provide visual screening and have been calculated to use the approximate total amount of soil stripped (approx. 14,000m^3). It is noted, therefore, that because not all the soil is to be stripped at once, and rolling restoration would be carried out, not all bunds would co-exist at the same times. However, the easternmost section of bund that runs parallel to the canal would be maintained throughout the lifetime of the works, or, until its soil materials are required for the final restoration.

As stated, all extraction of sand and gravel would take place above the water table, using a loading shovel or hydraulic excavator.

It is intended that to reduce the total number of HGV movements, once restoration has commenced, HGVs arriving with restoration materials would leave The Site loaded with sand and gravel, if possible.

The operational hours of the development are intended to be 07:30 – 18:00 Monday to Friday, and 08:00 to 13:00 on Saturdays. The site is expected to have a maximum of 50 two way HGV deliveries/collections per 10.5 hour working day, which equates to approximately 5-6 HGV movements per hour.

Location plans and site plans are included in Appendices C and D respectively.

3. Environmental Noise Survey

To characterise the sound profile of the area a long-term noise survey was carried out from the 26th June to the 29th June 2020.

3.1 Measurement Methodology

For the long-term monitoring, a sound level meter was attached to a lamppost approximately 3.5m from the ground and away from any other reflective surface. Furthermore, two short term measurements were taken near the NSRs. The monitoring positions were chosen in order to collect representative sound levels of the area during the proposed operational period. The measurement positions can be found in Figure 1.0.

3.2 Measurement Equipment

Piece of Equipment	Serial No	Calibration Deviation
CESVA SC310 Class 1 Sound level meter	T221722	≤0.5
CESVA CB006 Class 1 Calibrator	37771	

Table 1.0 – Measurement Equipment

All equipment used during the survey was field calibrated at the start and end of the measurement period with a negligible deviation of ≤0.5 dB. All sound level meters are calibrated every 24 months and all calibrators are calibrated every 12 months, by a third-party calibration laboratory. All microphones were fitted with a protective windshield for the entire measurements period. Calibration certificates can be provided upon request.

3.3 Weather Summary

As the environmental noise survey was carried out over a long un-manned period no localised records of weather conditions were recorded. All measurements have been compared with met office weather data of the area, specifically the closest weather station at Meteoware, Farington Moss, approximately 10.6 km to the north-west of the site. When reviewing the time history of the noise measurements, any time period that was thought to be affected by the local weather conditions has been omitted. The analysis of the noise data includes statistical and percentile analysis and review of minimum and maximum values, which aids in the preclusion of any periods of undesirable weather conditions. The weather conditions were deemed suitable for the measurement of environmental noise in accordance with BS7445 Description and Measurement of Environmental Noise. The table below presents the average temperature, wind speed and rainfall range for each 24-hour measurement period.

Weather Conditions - 26/06/2020 – 29/06/2020 - Meteoware, Farington Moss				
Time period	Air temp (^{0}C)	Rainfall mm/h	Wind Speed (m/s)	Wind Direction
26/06/20 – 00:00 – 23:59	16.7– 27.0	0.5	0.0 – 1.1	SSE
27/06/20 - 00:00 – 23:59	13.0 – 20.9	1.2	0.3 – 4.2	SSE

28/06/20 - 00:00 – 23:59	11.3 – 14.2	0.1 – 1.3	0.3 – 4.2	SW
29/06/20 - 00:00 – 23:59	11.3 – 14.1	0.1 – 1.6	0.3 – 3.6	SSE

Table 2.0 – Meteorological Data

3.4 Results

3.4.1 Summary Results

The following table shows a summary of the sound survey results; L_{Aeq}, L_{Amax}, L_{A90} and the L_{A10} for the measurement period.

Measurement Position MP1				
Measurement Time Period ('t')	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A90,t}$	$L_{A10,t}$
Day 1 – 26/06/20 – 09:30 – 23:00	66.0	97.0	58.0	69.0
Night 1 – 26/06/20 – 23:00 – 07:00	59.0	95.0	49.0	62.0
Day 2 – 27/06/20 – 07:00 – 23:00	66.0	97.0	62.0	68.0
Night 2 – 27/06/20 – 23:00 – 07:00	58.0	85.0	50.0	60.0
Day 3 – 28/06/20 – 07:00 – 23:00	67.0	91.0	59.0	69.0
Night 3 – 28/06/20 – 23:00 – 07:00	65.0	87.0	52.0	70.0
Measurement Position MP2				
Measurement Time Period ('t')	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A90,t}$	$L_{A10,t}$
Day 1 – 26/06/20 – 10:30 – 11:00	61.0	87.0	60.0	62.0
Measurement Position MP3				
Measurement Time Period ('t')	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A90,t}$	$L_{A10,t}$
Day 1 – 26/06/20 – 09:30 – 10:00	61.0	85.0	56.0	63.0

Table 3.0 – Sound Survey Summary Results

The following table shows a summary of the sound survey results; L_{Aeq}, L_{Amax}, L_{A90} and the L_{A10} for the proposed operational periods at MP1.

Measurement Position MP1				
Measurement Time Period ('t')	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A90,t}$	$L_{A10,t}$
Day 1 – 26/06/20 – 07:30 – 18:00	67.0	97.0	65.0	69.0
Day 2 – 27/06/20 – 07:30 – 13:00	66.0	86.0	65.0	68.0

Table 4.0 – Sound Survey Summary Results – Operational Hours

3.4.2 Background Sound Level Summary Results

The following table shows a summary of the background sound levels measured during the proposed operational hours.

Measurement Position MP1				
Measurement Period ('t')	$L_{A90,t}$	Statistically most Repeated $L_{A90,t}$	Min. $L_{A90,t}$	Max. $L_{A90,t}$
Day 1 – 26/06/20 – 07:30 – 18:00	57.0	58.0	52.0	61.0
Day 2 – 27/06/20 – 07:30 – 13:00	57.0	57.0	56.0	59.0
Measurement Position MP2				
Measurement Period ('t')	$L_{A90,t}$	Statistically most Repeated $L_{A90,t}$	Min. $L_{A90,t}$	Max. $L_{A90,t}$
Day 1 – 26/06/20 – 10:30 – 11:00	60.0	59.0	57.0	62.0
Measurement Position MP3				
Measurement Period ('t')	$L_{A90,t}$	Statistically most Repeated $L_{A90,t}$	Min. $L_{A90,t}$	Max. $L_{A90,t}$
Day 1 – 26/06/20 – 09:30 – 10:00	56.0	51.0	49.0	61.0

Table 5.0 – Background Sound Level Summary Results

3.5 Subjective impression & Context

Whilst on site it was found that the acoustic environment of the area surrounding the site was of a moderate to high level, dominated by traffic noise from the M61 Motorway.

3.6 Assumptions

It is assumed that if the noise emissions are acceptable at the closest NSRs then the noise level will be acceptable in all other locations.

3.7 Uncertainty

BS4142:2014 section 10.0 states that uncertainty in the calculation of sound levels during the assessment process can arise from both the measured values and calculation methods.

To ensure the accuracy of the assessment consideration has been taken for the level of uncertainty in the measured data and associated calculations in the proposed methodology used to undertake the assessment. Where the level of uncertainty could affect the conclusion, reasonably practicable steps have been taken to minimise the level of uncertainty. Where the level of uncertainty is excessive, additional measurements and site visits have been conducted to increase the confidence in the results. In all instances the following steps have been taken to address the uncertainty;

1) Measured Values; A detailed understanding of the source of noise under investigation has been conducted including consideration for the complexity, variability over time and location,

the character and effect of the residual sound level in comparison with the source, the measurement location, quantity of measurements and distance/intervening ground conditions, measurement time interval and the range of times measurement were taken, the suitability of weather conditions, the level of rounding and the classification of the instrumentation used to conduct the assessment.

2) Calculation Methods; Consideration has been taken for the accuracy of the measured sound levels, the character of the sound emissions in question, the calculation method and the simplification of the real situation to "fit" the modelled situation. Recognised standards and validated methods and processes have been used to establish accurate values during the calculation process.

For the avoidance of doubt, the level of uncertainty will not be quantified. If appropriate consideration is taken for points 1 and 2 during the collection of data and analysis thereof, then the influence of uncertainty in the final result is at its lowest practical value.

4. Noise Assessment

4.1 BS4142:2014 Noise Assessment

In the following section, the noise emissions from on-site activities will be defined and assessed.

4.1.1 On-Site Activities

The activities that are proposed to be undertaken on site are as follows:

Gravel and Sand Extraction

Firstly, excavators and bulldozers will strip the soil (about 0.5m deep) and store it in amenity bunds for use in restoration. Moreover, excavators will remove the gravel and sand on the site and load it into HGVs. The HGVs will take the material off the site. The HGVs will come to the site via M61 and enter and exit the site via the A674.

Ground Restoration

HGVs will deliver suitable inert materials to the site via A674. The material will be then unloaded on the Proposed Site and distribute around the site and level the ground. The HGVs will exit the site via A674 as well.

4.1.2 Development Phases

The client has stated that the proposed on-site activities have been divided into three phases. The following assumptions have been made:

- Phase 1: gravel and sand extraction is carried out in the eastern area.
- Phase 2: gravel and sand extraction takes place in the centre area while restoration activities start in the eastern area.
- Phase 3: gravel and sand extraction is carried out at the western area while the centre area is under restoration activities.

4.1.3 Specific Sound Level

Machinery

The table below shows the noise levels of the equipment which is to be used for the Proposed Development. It is noted that it is unlikely that all plant machinery will be operational simultaneously, and as such, the following assessment is deemed to be a worst-case scenario. The noise levels have been taken from BS5228:2009. Exact models of equipment are currently unknown, and as such, appropriate models have been chosen to provide example data.

The A-weighted sound levels for the plant equipment can be seen in the following table.

Description	Source of Information	Sound Pressure Level at 1m (dBA)	Calculated Sound Power Level (dBA)
Ground removal with a Diesel Powered Face Shovel	BS5228:2009	102.0	110.0
Levelling ground	BS5228:2009	96.0	104.0

Loading Gravel/Stone to Lorry	BS5228:2009	95.0	103.0
Unloading Gravel/Stone	BS5228:2009	104.0	112.0

Table 6.0 – Plant Equipment Noise Data

On-time corrections are then applied as shown in the following table to account for predicted usage per hour.

Description	Calculated Sound Power Level (dBA)	On-Time Per Hour (Mins)	Corrected Sound Power Level (dBA)
Ground removal with a Diesel Powered Face Shovel	110.0	60 (Continuous)	110.0
Levelling ground with a Dozer	104.0	60 (Continuous)	104.0
Loading Gravel/Stone to Lorry	103.0	30	100.0
Unloading Gravel/Stone	112.0	30	109.0

Table 7.0 – Plant Equipment Noise Data with On-Time Correction

HGV Movements

It is expected there will be 50 or fewer HGV movements per 10-hour working day, which equates to approximately 6 movements per hour (3 in and 3 out). The table below shows the noise levels for HGV movements, taken from BS5228:2009. Corrections have subsequently been applied to account for movement time per hour, considering a site speed limit of 10 mph (16 kph), an access road speed limit of 20 mph (32 kph), and the distance travelled in total. Each movement time has been rounded up to the nearest minute and a correction has been applied to account for time spent on the weighbridge.

Description	L_w (dB)	Maximum No. of Movements Per Hour	Maximum Distance (m)	Speed (km/h)	Approximate Movement Time (mins/hour)	Time Corrected L_w (dB)
HGVs Moving on Site – Phase 1	98.0	10	100	16	1	80.0
HGVs Moving on Site – Phase 2	98.0	10	150	16	2	83.0
HGVs Moving on Site – Phase 3	98.0	10	200	16	2	83.0
HGVs on Access Road	98.0	10	300	32	2	83.0

Table 8.0 – HGV Time Corrected Movement Noise Levels

The specific sound levels at the NSRs have been calculated using SoundPlan 8.1, which undertakes its calculations in accordance with the guidance given in IS09613 – 1:1993 and ISO9613 – 2:1996.

The following assumptions have been made within the calculation software:

- To accurately model the land surrounding the development the topographical data has been taken from Google Maps, it is assumed this has an accuracy within the last 3 years.
- The ground between the site and receivers is a mix of acoustically 'soft' and 'hard' surfaces.
- The sound levels presented above have been inputted into the software.
- The HGV movement noise emissions have been modelled as line sources at heights of 1.5m.
- Screening, crushing, telehandler, and loading operations have been modelled at source heights of 2m.
- The grid height of the noise map is set to 1.5m.

The following figures show the grid noise maps for Phase 1, Phase 2 and Phase 3.

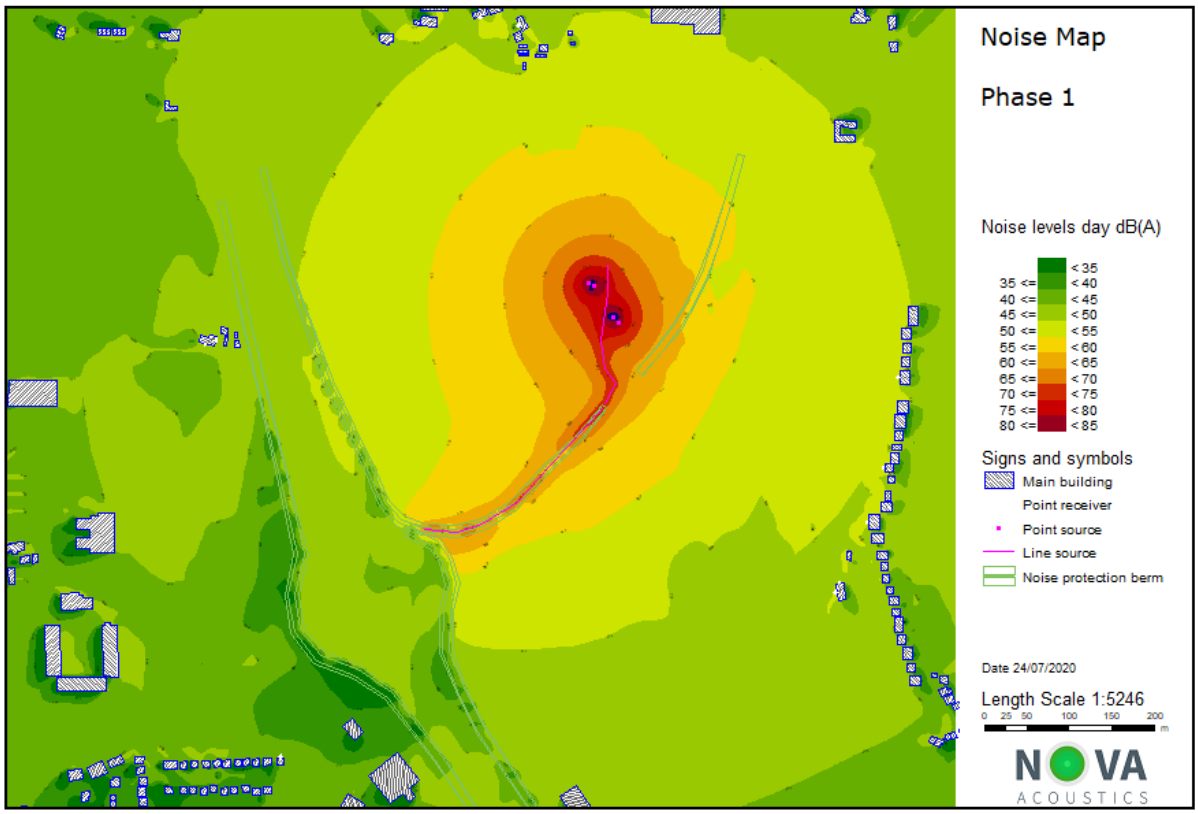


Figure 2.0 – Specific Sound Level Map – 1.5m Grid Height – Phase 1

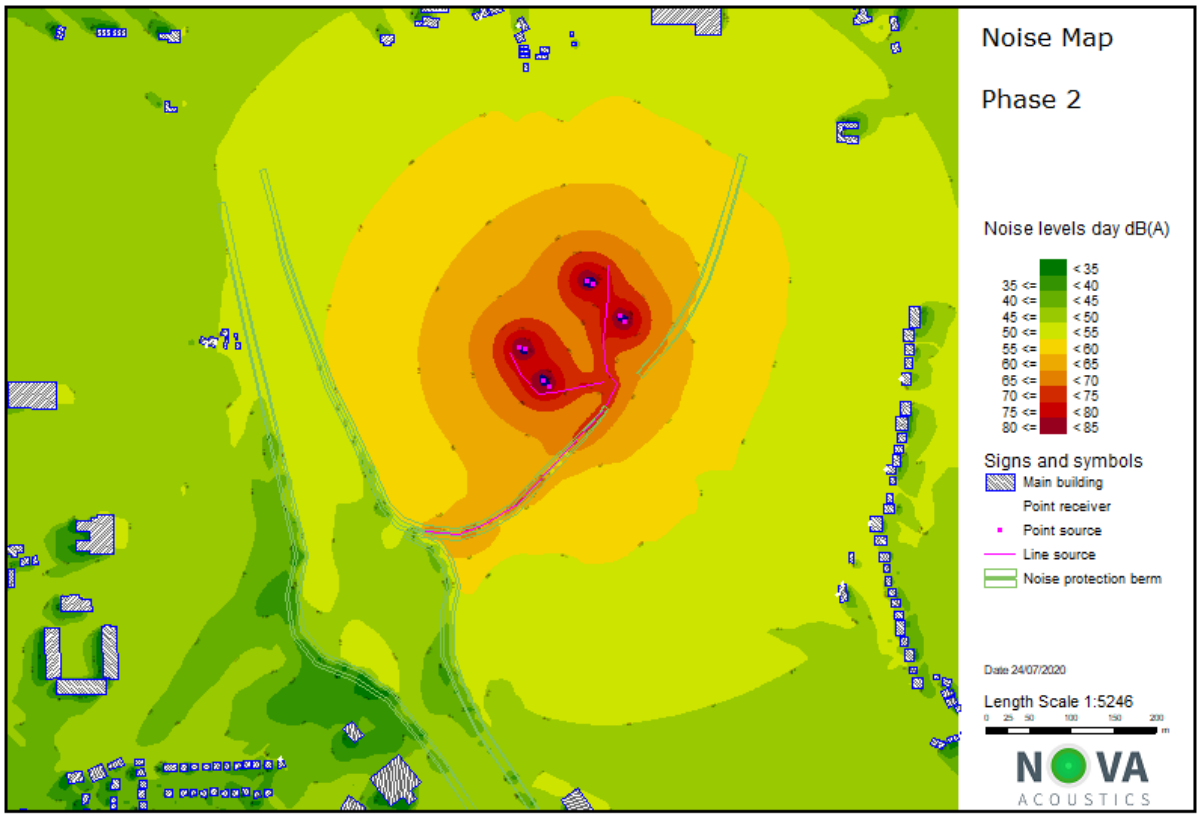


Figure 3.0 – Specific Sound Level Map – 1.5m Grid Height – Phase 2

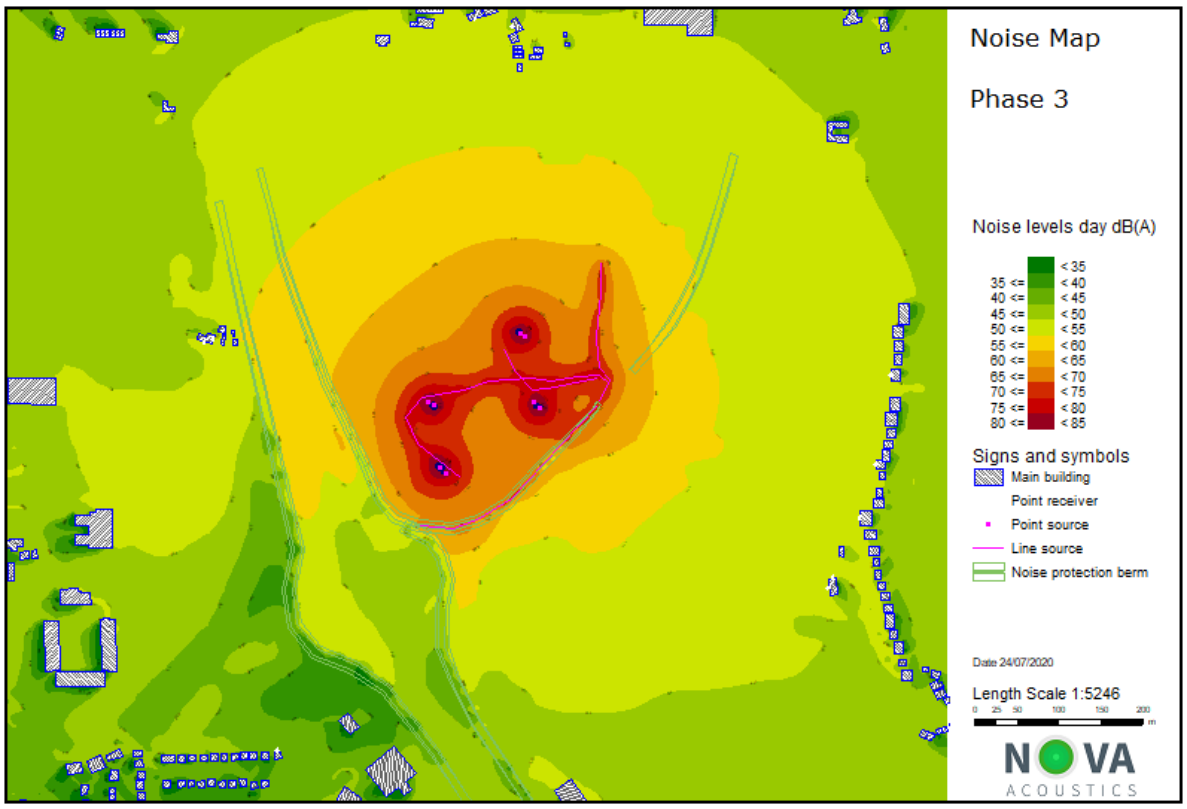


Figure 4.0 – Specific Sound Level Map – 1.5m Grid Height – Phase 3

A summary of the specific sound levels at the NSRs based on the sound map shown in Figure 2.0, 3.0 & 4.0 can be seen in the following table.

NSR	Specific Sound Level (dBA)		
	Phase 1	Phase 2	Phase 3
1	48.0	52.0	51.0
2	46.0	50.0	52.0
3	43.0	46.0	44.0
4	50.0	53.0	52.0
5	51.0	53.0	51.0

Table 9.0 – Specific Sound Levels at NSRs Summary

4.1.4 Rating Level

Rating Penalty

Section 9 of BS4142:2014 describes how the rating sound level should be derived from the specific sound level, by deriving a rating penalty.

BS4142:2014 states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level. This can be approached in three ways:

a) subjective method;
b) objective method for tonality;
c) reference method."

Due to the nature of the development, the subjective method has been adopted to derive the rating sound level from the specific sound level. This is discussed in Section 9.2 of BS4142:2014, which states:

"Where appropriate, establish a rating penalty for sound based on a subjective assessment of its characteristics. This would also be appropriate where a new source cannot be measured because it is only proposed at that time, but the characteristics of similar sources can subjectively be assessed. Correct the specific sound level if a tone, impulse or other characteristics occurs, or is expected to be present, for new or modified sound sources."

BS4142:2014 defines four characteristics that should be considered when deriving a rating penalty, namely; tonality; impulsivity; intermittency; and other sound characteristics, which are defined as:

a) Tonality

A rating penalty of +2 dB is applicable for a tone which is "just perceptible", +4 dB where a tone is "clearly perceptible", and +6 dB where a tone is "highly perceptible".

b) Impulsivity

A rating penalty of +3 dB is applicable for impulsivity which is "just perceptible", +6 dB where it is "clearly perceptible", and +9 dB where it is "highly perceptible".

c) Other Sound Characteristics

BS4142:2014 states that where "the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinct against the residual acoustic environment, a penalty of +3 dB can be applied."

d) Intermittency

BS4142:2014 states that when the "specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied."

Rating Penalty Assessment

Considering the requirements of the rating penalty, an assessment of the various sound sources associated with the site, in terms of whether any rating penalties are applicable, and has been detailed in the following table.

Source	Tonality	Impulsivity	Intermittency	Other Sound Characteristics	Discussion
Internal Operations and HGV Movements	+2	+3	--	--	Possible perceptible tonality of vehicle engines. Possible perceptible impulsivity of loading and crushing operations.

Table 10.0 – Rating Penalty Assessment

Rating Level

Incorporating the rating penalties with the specific sound levels, the rating sound levels have been derived and have been detailed in the following table.

NSR	Rating Sound Level (dBA)		
	Phase 1	Phase 2	Phase 3
1	53.0	57.0	56.0
2	51.0	55.0	57.0
3	48.0	51.0	49.0
4	55.0	58.0	57.0

5	56.0	58.0	56.0

Table 11.0 – Rating Sound Levels at NSRs Summary

4.1.5 Background Sound Level

The background sound level is the underlying level of sound over a period, T, and is indicative of the relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

To ensure the background sound level values used within the assessment are reliable and suitably represent both the particular circumstance and periods of interest, efforts have been made to quantify a 'typical' background sound level for a given period. The purpose has not been to simply select the lowest measured value. Diurnal patterns have also been considered as they can have a major influence on background sound levels, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night time period for sleep purposes.

Since the intention is to determine a background sound level in the absence of the specific sound that is under consideration, it is necessary to understand that the background sound level can in some circumstances legitimately include industrial and/or commercial sounds that are present as separate to the specific sound.

The table below outlines a summary of the background sound level for the quietest operational period at MP1, which was Saturday morning, and the background sound level measured at MP2 and MP3.

Operational Hours ('t')	$L_{A90,t}$	Statistical $L_{A90,t}$	Min. $L_{A90,t}$	Max. $L_{A90,t}$
MP1 Day 2 – 27/06/20 – 07:30 – 13:00	57.0	57.0	56.0	59.0
MP2 Day 1 – 26/06/20 – 10:30 – 11:00	60.0	59.0	57.0	62.0
MP3 Day 1 – 26/06/20 – 09:30 – 10:00	56.0	51.0	49.0	61.0

Table 12.0 – Summary of Background Sound Levels

Discussion:

According to the statistical analysis the most repeated $L_{A90,t}$ value during the proposed operational period at MP1 was 57.0 dBA. As can be seen in the table above the range of L_{A90} during this period is relatively low and the statistically most repeated value sits in the bottom of the range. As such, it is deemed to be 'robust' and 'conservative'. For this reason, this value will be used for the following assessment.

The statistical analysis shows that the most repeated $L_{A90,t}$ value during measurement period at MP2 was 59.0 dBA. However to ensure a 'robust' and 'conservative' analysis the lowest measured value of 57.0 dBA will be used for the following assessment.

At MP3, the statistical analysis shows that the most repeated $L_{A90,t}$ value during the proposed operational period was 51.0 dBA. As can be seen in the table above the range of L_{A90} during this

period is relatively high and the statistically most repeated value sits in the bottom of the range. As such, it is deemed to be 'robust' and 'conservative'. For this reason, this value will be used for the following assessment.

4.1.6 BS4142 Assessment

The rating sound level has been assessed in accordance with BS4142:2014 at all NSRs. The BS4142:2014 assessment at the most affected NSRs during the operational periods can be seen below. As shown in the section above the Operational Period Background Sound Level used for the assessment is 57.0 dBA. The following table shows the Excess of Rating over Background Sound Level for each NSR and each Phase.

NSR	Background Sound Level	BS4142:2014 Assessment - Excess of Rating over Background Sound Level		
		Phase 1	Phase 2	Phase 3
1	57.0	- 4.0	- 0.0	- 1.0
2	57.0	- 6.0	- 2.0	- 0.0
3	57.0	- 9.0	- 6.0	- 8.0
4	51.0	+4.0	+7.0	+6.0
5	51.0	+5.0	+7.0	+5.0

Table 13.0 – BS4142:2014 Assessment

Discussion

As can be seen in the assessment above, the noise emissions associated with each phase of the Proposed Development at NSR 1, 2 and 3 falls below the operational period background sound level.

However, the noise emissions at NSR 4 and 5 falls up to 7.0 dB above the prevailing background, thus showing there is potential for a 'Significant Adverse Impact, depending on context' at the NSR. However further investigation into eath bunding and screening indicates a marginal reduction in noise levels at theses NSRs. BS4142 states that when assessing the impact of development the context should also be taken in to account. Given that this a temporary development the actual impact is reduced somewhat. Further to this government guidance on noise from mineral extraction states the following:

"Mineral planning authorities should aim to establish a noise limit, through a planning condition, at the noise-sensitive property that does not exceed the background noise level (LA90,1h) by more than 10dB(A) during normal working hours (0700-1900)."

As can be seen, the assessment indicates the rating noise level falls less than 10 dB above the background sound levels and thus the development falls within government guidance.

4.2 Increase in Ambient Noise Level Assessment

The following section analyses the expected increase in ambient noise levels in the surrounding area due to the operations of the Proposed Development. The specific sound emissions associated with the site are logarithmically added to the lowest measured residual sound level. The higher the increase in noise levels the higher the impact.

Description	L_p (dBA)				
	NSR1	NSR2	NSR3	NSR4	NSR5
Lowest Measured Ambient Noise Level	64.0	61.0	61.0	61.0	61.0
Specific Noise Level*	52.0	52.0	46.0	53.0	53.0
Resulting Noise Level	64.0	61.0	61.0	61.0	61.0
Increase in Noise Level	0.0				
Expected impact	None				

Table 14.0 – Increase in Ambient Noise Level Assessment

** Highest specific sound level of the three phases.*

Discussion

As can be seen in the assessment above, the specific sound level emissions from the proposed site are predicted to have a 'none' impact on the amenity of the surrounding NSRs. This also equates to 'Not Observe Effect Level' (NOEL), when assessed with the NPSE and the NPPF. Thus, giving more context to the BS4142:2014 assessment.

Appendix A – Acoustic Terminology

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20μPa (20x10-6 Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L10 can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided. The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take-off
140dB(A)	Threshold of Pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source. A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the

time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}.

This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound. To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows, represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS4142:2014 specifies background noise measurement periods of 1 hour during the day and 15 minutes during the night. The noise levels are commonly symbolised as $L_{A90,1hour}$ dB and $L_{A90,15mins}$ dB. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125ms.

Appendix B – Legislation, Policy and Guidance

This report is to be primarily based on the following legislation, policy and guidance.

National Planning Policy Framework (2019)

Government policy on noise is set out in the National Planning Policy Framework (NPPF), published in 2019. This replaced all earlier guidance on noise and places an emphasis on sustainability. In section 15, Conserving and enhancing the natural and local environment, paragraph 170e, it states:

Preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans;

Paragraph 180 states:

Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) *Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
b) *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
c) *Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.*

Noise Policy Statement for England

Paragraph 123 of the NPPF also refers to advice on adverse effects of noise given in the Noise Policy Statement for England (NPSE). This document sets out a policy vision to:

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

To achieve this vision the Statement identifies the following three aims:

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life;*
- *Where possible, contribute to the improvement of health and quality of life.*

In achieving these aims the document introduces significance criteria as follows:

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur. It is stated that "significant adverse effects on health and quality of life should be avoided while also considering the guiding principles of sustainable development".

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected. It is stated that the second aim above lies somewhere between LOAEL and SOAEL and requires that: "all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also considering the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur."

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise. This can be related to the third aim above, which seeks: "where possible, positively to improve health and quality of life through the pro-active management of noise while also considering the guiding principles of sustainable development, recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim."

The NPSE recognises that it is not possible to have a single objective noise-based measure that is mandatory and applicable to all sources of noise in all situations and provides no guidance as to how these criteria should be interpreted. It is clear, however, that there is no requirement to achieve noise levels where there are no observable adverse impacts but that reasonable and practicable steps to reduce adverse noise impacts should be taken in the context of sustainable development and ensure a balance between noise sensitive and the need for noise generating developments.

Any scheme of noise mitigation outlined in this report will, therefore, aim to abide by the above principles of the NPPF and NPSE whilst recognizing the constraints of the site.

IEMA Guidelines on Noise Impact Assessments

The IEMA Guidelines for Environmental Noise Assessment address the key principles of noise impact assessment and are applicable to all development proposals where noise effects may occur. The guidelines set out key principles for noise impact assessment relevant to all types of project regardless of size. The guidance provides advice with regards to the collection of baseline noise data, prediction of noise levels and how noise should be assessed. The guidance recognizes that the effect associated with a noise impact will be dependent on a number of factors including but not limited to the sensitivity of the receptor, frequency and duration of the noise source and time of day. The Guidelines accept that a simple change in noise levels using a single noise indicator may fail to adequately reveal the actual noise impact of the proposal. The character of the noise must be considered and the Guidelines suggest comparing several noise indicators such as the LAeq, LAmax and LA90 as a more rigorous approach.

Absolute levels such as those set out in WHO Guidelines are also considered and the Guidelines suggest that a change in noise levels in an area where the existing levels are above WHO Guidelines should be considered as having more of an adverse effect than a change in noise levels in an area where existing levels are well below.

The Guidelines stop short of providing specific assessment criteria which developments should achieve but instead suggests that the methodology adopted should be selected on a site by site basis regarding relevant national and local standards.

The Guidelines contain effect descriptors for changes in noise levels and for noise effect levels. These are summarized below:

Effect Descriptors	
Very substantial	Greater than 10 dB L_{Aeq} change in sound level perceived at a receptor of great sensitivity to noise
Substantial	Greater than 5 dB L_{Aeq} change in sound level at a noise sensitive receptor, or a 5 to 9.9 dB LAeq change in sound level at a receptor of great sensitivity to noise
Moderate	A 3 to 4.9 dB L_{Aeq} change in sound level at a sensitive or highly sensitive noise receptor, or a greater than 5dB LAeq change in sound level at a receptor of some sensitivity
Slight	A 3 to 4.9 dB L_{Aeq} change in sound level at a receptor of some sensitivity
None/Not Significant	Less than 2.9 dB L_{Aeq} change in sound level and/or all receptors are of negligible sensitivity to noise or marginal to the zone of influence of the proposals

Table 15.0 – IEMA Guidelines Effect Descriptors

Noise Effect Level		
Time	Lowest Observed Adverse Effect Level	Significant Observed Adverse Effect Level
07:00 - 23:00	50 dB $L_{Aeq,16\ hour}$	60 dB $L_{Aeq,16\ hour}$
23:00 - 07:00	40 dB $L_{Aeq,8\ hour}$	55 dB $L_{Aeq,8\ hour}$
	60 dB L_{AFMax} (at the facade)	80 dB L_{AFMax} (at the facade)

Table 16.0 – IEMA Guidelines Noise Effect Level

The Guidelines are not prescriptive as to how a noise impact assessment should be carried out, and allow assessors to consider factors such as frequency spectra, days and times of operation, frequency of operation and any other factor which allows the noise to be assessed in context.

BS4142:2014 **'Methods for rating and assessing industrial and commercial sound'**

BS4142:2014 sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS4142:2014 for assessing the effect of sound on residential receptors is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ 'specific sound level', immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ 'rating sound level'. A correction to include the consideration of a level of uncertainty in sound measurements, data and calculations can also be applied when necessary.

BS4142:2014 states: "The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs". An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

- "Typically, the greater this difference, the greater the magnitude of the impact."
- "A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context."
- "A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context."
- "The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a negligible impact, depending on the context."

Interpreting the guidance given in BS4142:2014, with consideration of the guidance given in the NPSE and NPPG Noise, an estimation of the impact of the rating sound is summarised in the following text:

- A rating sound level that is +10 dB above the background sound level is likely to be an indication of a Significant Observed Adverse Effect Level;
- A rating sound level that is +5 dB above the background sound level is likely to be an indication of a Lowest Observed Adverse Effect Level;
- The lower the rating sound level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating sound level does not exceed the background sound level, this is an indication of the specific sound source having a negligible impact, and would therefore classified as a No Observed Adverse Effect Level.

During the daytime, the assessment is carried out over a reference time period of 1-hour. The periods associated with day or night, for the purposes of the Standard, are 07.00 to 23.00 and 23.00 to 07.00, respectively.

ISO 9613-2 Attenuation of sound during propagation outdoors

The ISO 1996 series of standards specifies methods for the description of noise outdoors in community environments. Part 2 of ISO 9613 is intended to enable noise levels in the community to be predicted from sources of known sound emission. The method is general in the sense that it may be applied to a wide variety of noise sources, and cover most of the major mechanisms of attenuation.

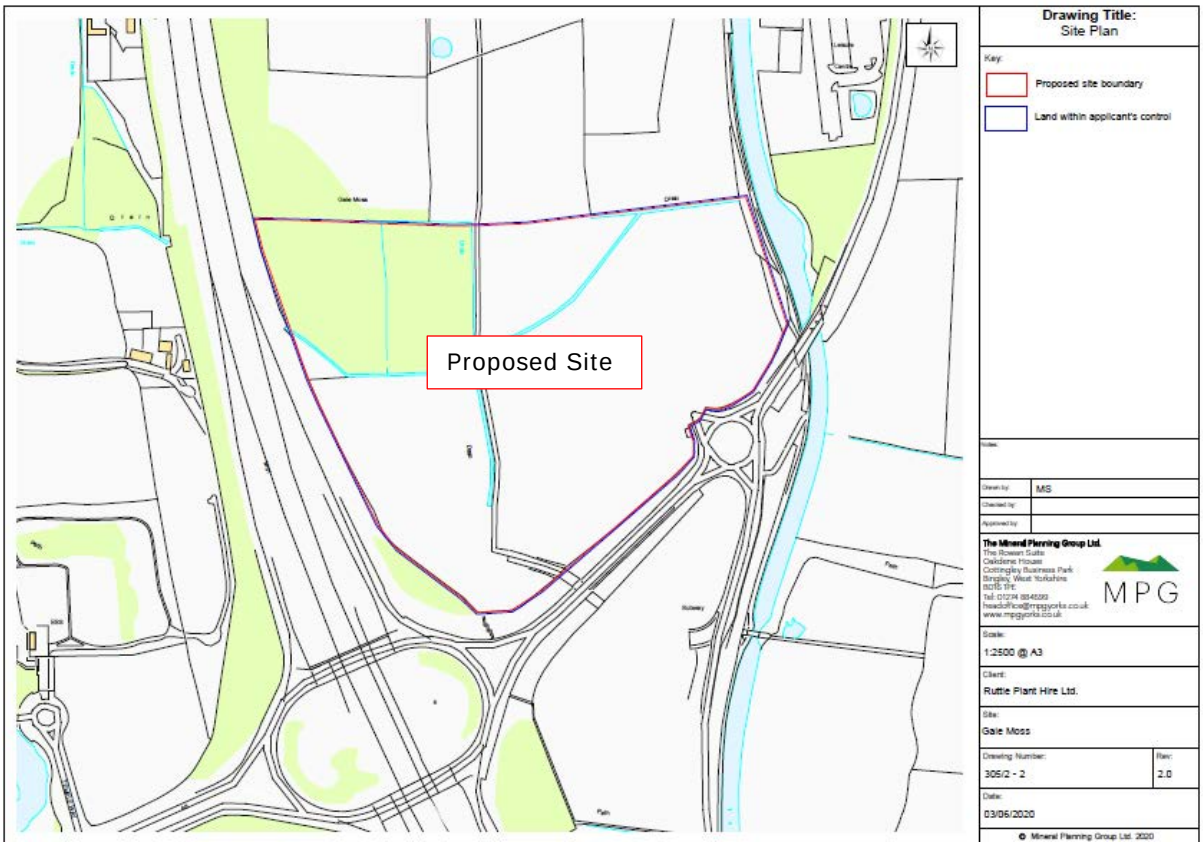
This standard provides guidance on the outdoor propagation of sound. It is widely used to establish the different attenuations that occur during the transmission of the sound from the sources to the receivers. The total attenuation is the sum of the following: geometrical divergence, atmospheric absorption, ground effect, barriers, and miscellaneous other effects.

BS EN 12354-4 Building Acoustics

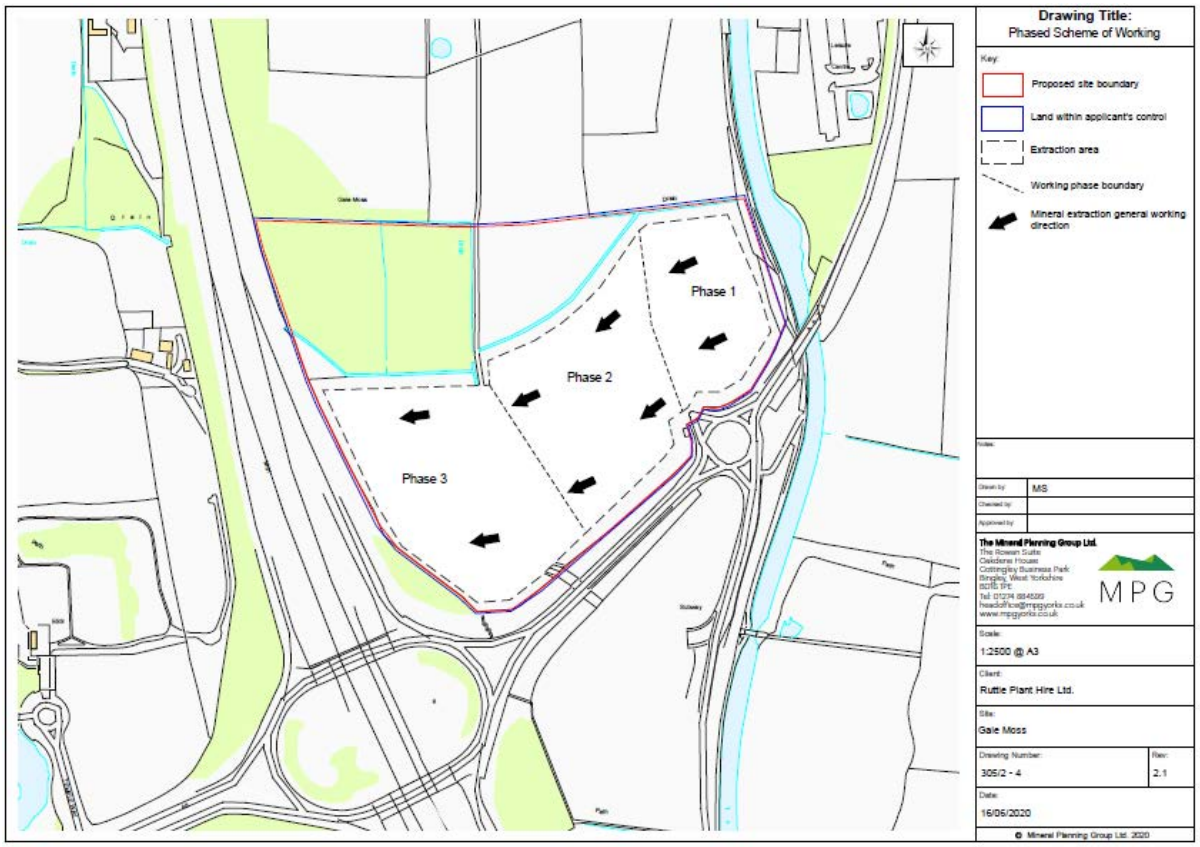
Estimation of acoustic performance of buildings from the performance of elements − Transmission of indoor sound to the outside

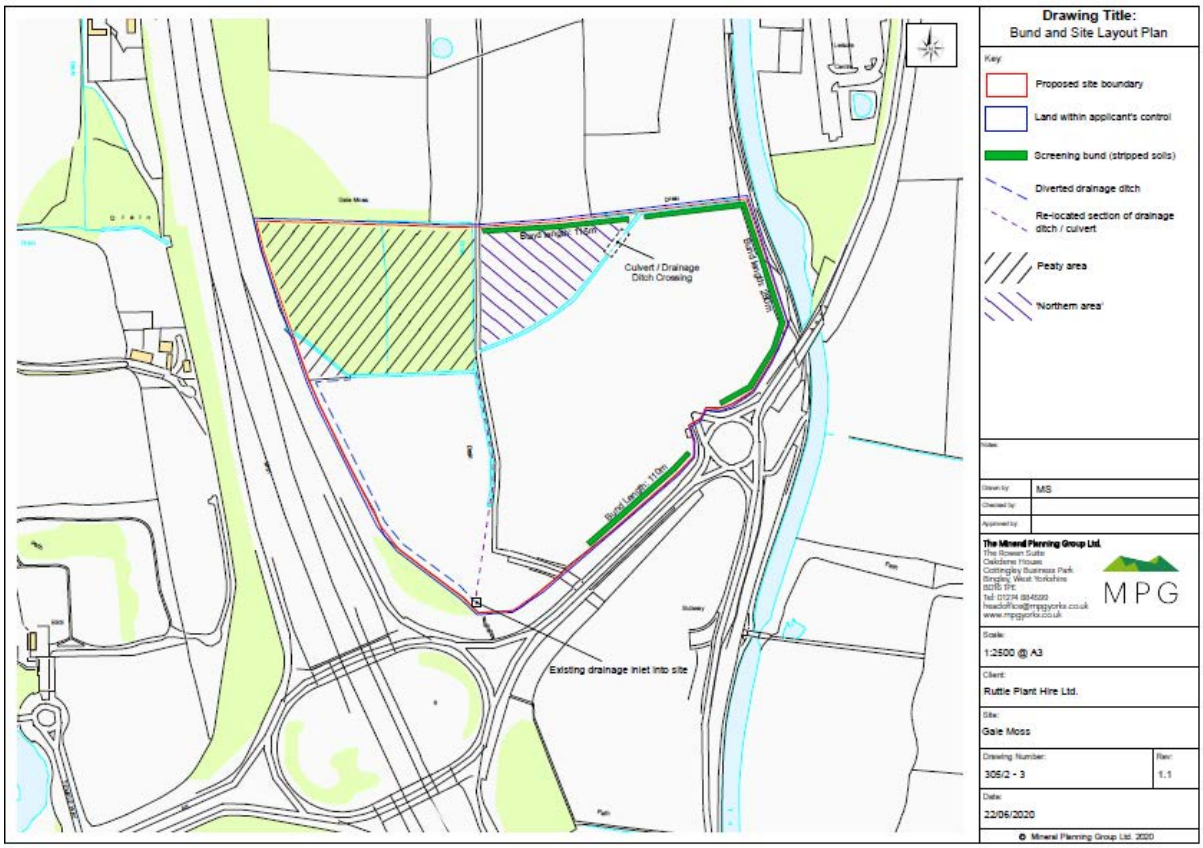
This European Standard describes a calculation model for the sound power level radiated by the envelope of a building due to airborne sound inside that building, primarily by means of measured sound pressure levels inside the building and measured data which characterize the sound transmission by the relevant elements and openings in the building envelope. These sound power levels, together with those of other sound sources in or in front of the building envelope, form the basis for the calculation of the sound pressure level at a chosen distance from a building as a measure for the acoustic performance of buildings.

Appendix C - Location Plan

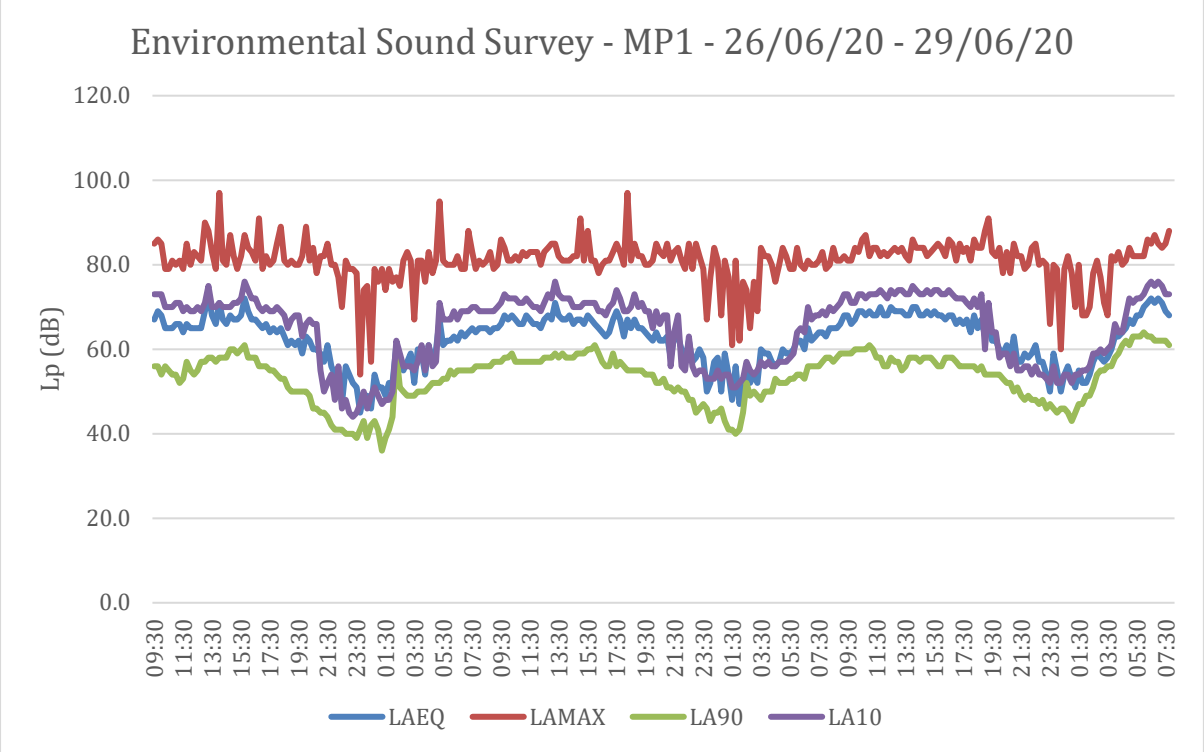


Appendix D – Site Plans





Appendix E – Environmental Sound Survey



Brooks Ecological
Grounded advice

Preliminary Ecological Appraisal Report

Land off Millennium Way, Chorley

Ruttle Group Ltd.

Report Reference: ER-4862-01A

22/10/2020

Report Title:	Preliminary Ecological Appraisal Report Land off Millennium Way, Chorley
Report Reference:	ER-4862-01A
Written by:	Joshua Birchall BSc (Hons) Grad CIEEM Ecologist
Technical Review:	Peter Brooks BSc (Hons), MA, MCIEEM, CEnv Managing Director
QA:	Victoria Bajer BSc (Hons) MSc GradCIEEM Ecologist
Approved for Issue:	Peter Brooks BSc (Hons), MA, MCIEEM, CEnv Managing Director
Date:	28.08.2020 Amended: 22.10.20

Unit A, 1 Station Road, Guiseley,
Leeds, LS20 8BX
01943 884451
admin@brooks-ecological.co.uk
www.brooks-ecological.co.uk
Registered in England Number 5351418

Contents

Summary

This report is produced to inform Ruttle Group Ltd. of potential ecological constraints associated with the proposed development site.

Methodology

The report is based on a desk study of designated wildlife sites and records of protected or notable species, and an extended Phase 1 Habitat Survey carried out in August 2020.

Findings - Key Points

- The site has been assessed as having a Biodiversity Unit score of 17.5 Habitat Units. Proposals should consider the NPPF hierarchy of Avoid - Mitigate – Compensate in minimising any loss of biodiversity. The LPA may be seeking gains for biodiversity. Efforts should be made to achieve this on Site but where this is not feasible the LPA could request that a contribution is made to address any residual shortfall in biodiversity gain, off-Site.

- Further bat survey has been recommended prior to a planning application being made.

- Some standard pre-commencement precautions have been recommended, whilst additional pre-commencement water vole survey has been recommended.

- Himalayan Balsam is present on site and adjacent areas, further precaution will be necessary to prevent the risk of spreading this species.

- A CEMP and BMP are recommended to protect and enhance habitats through and post development.

Introduction

1. Brooks Ecological Ltd was commissioned by Ruttle Group Ltd. to carry out a Preliminary Ecological Appraisal (PEA) of Land off Millennium Way, Chorley.
2. This report is produced with reference to British Standard BS:42020 'Biodiversity Code of Practice for Planning and Development' and the CIEEM (2017) Guidelines for Preliminary Ecological Appraisal.
3. In anticipation of the adoption of DEFRA's Biodiversity Metric 2.0 we have used the UK Habitat Classification descriptions rather than the long established JNCC codes. These habitat classifications and 'the metric' are work in progress and could be subject to future change.

Purpose of a PEA

4. A PEA is an *initial assessment* of the baseline for a proposed development site and establishes whether the Site is likely to be constrained by ecology, and whether more information is needed to identify the ecological baseline.
5. The subsequent Preliminary Ecological Appraisal Report (PEAR) is intended to give guidance to a developer and assist with the early stages of project planning and design. Where a site is not complex or constrained, and no additional ecological input is necessary the PEAR *may* be sufficient, and suitable to support a planning application.
6. Biodiversity Accounting metrics are used to quantify the value of a Site in Biodiversity Units - which helps in the later stage of assessing the ecological impacts of the proposed development.
7. Biodiversity Units can help to inform avoidance, or on-Site mitigation levels required; or as a last resort can translate to a direct monetary value where compensation (off-Site) is required. Please be aware that they *can* significantly impact on costs and viability.

The Site

8. The application site 'the Site' is an open area of grassland intermittently used to host a car boot sale, on the northern fringe of Chorley.
9. The assessment uses a 2km area of search around the Site for records of protected and notable species and locally or nationally designated wildlife sites.

Figure 1 The proposed extraction boundary.

Desk Study

Landscape

10. The site is located on the northern periphery of Chorley, with the M61 running north-south between the site and the residential and industrial units associated with the town. Further east and north the landscape opens up to a more rural, pastoral setting with occasional villages.

11. The site's underlying geology is comprised of a mix of sandstone and mudstone deposits, with a superficial glaciofluvial deposits and small area of peat adjacent to the northern boundary. The peat deposits are likely to be associated with wet, acidic conditions. An area to the north west of the site is shown on mapping as 'Gale Moss'.

Wildlife Corridors

12. The Leeds- Liverpool Canal cuts north to south through the area, located just off the eastern boundary of the site. This will act as a corridor to some wildlife as well as a boundary to other species trying to cross it.

13. Higher value habitat in the area consists of occasional woodland pockets, though these are only loosely connected to the site.

14. The M61 runs north – south along the western boundary of the site, this will act as a major barrier to the movements of many species.

Figure 2 Analysis of wildlife corridors and higher value habitat in relation to the Site

Waterbodies

15. There are nine ponds shown on mapping within 500m of the site however only pond 1 is located within an area functionally linked to the site.
16. Pond 1 is located c. 150m north of the site, this being a seemingly large and well-established field pond.
17. Pond 2 is located within landscaping for a leisure centre car park, it is found c.115m to the east though separated from the site in relation to amphibian movement by the Leeds - Liverpool canal which has steep stone capped banks in this area.
18. Pond 3 is found c.150m south of the site but again separated from it by the Leeds – Liverpool canal and a road.
19. Ponds 4 and 5 are c.400m north but separated from the site by another road.
20. Whilst ponds 6 – 9 are found c. 400m, in close proximity to one another within the landscaping of a religious compound, these are separated from the site by the M61.

Figure 3 Local waterbodies

Designated Sites

Statutory Designations

21. A search has been made to identify any nationally designated sites within a 2km radius of the Site, or internationally designated sites within a 10km radius.

22. There are no internationally or nationally designated sites shown on mapping within 10km or 2km respectively.

SSSI Impact Risk Zones (IRZs)

23. The Site lies within the IRZ for the West Pennine Moors SSSI but does not fall into any of the highlighted categories which require the LPA to consult with Natural England in relation to potential impacts.

Non-Statutory Designations

24. There are five Lancashire Biological Heritage Sites (BHS) in the search area. Of these none are functionally linked to the site or of particular relevance to the application:

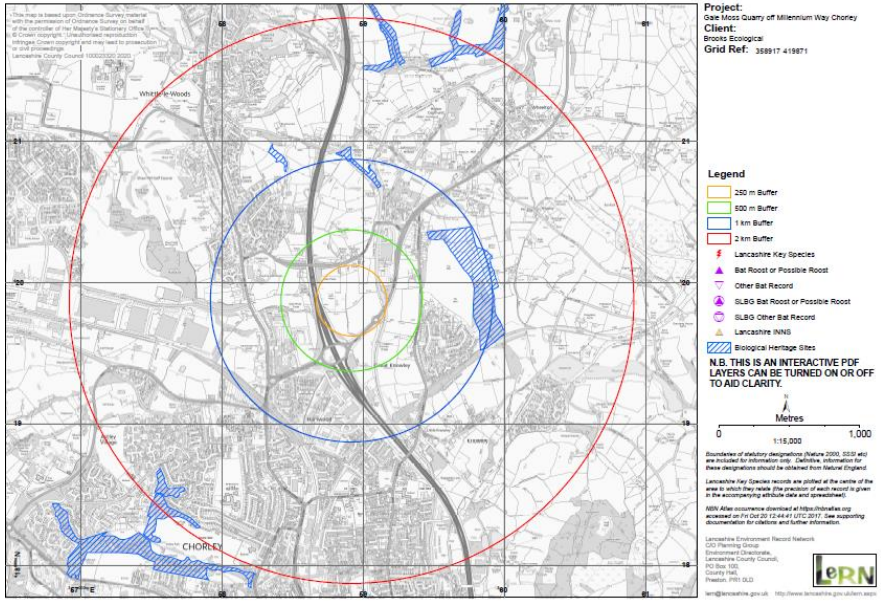
25. The nearest of the BHS's is Tan House Valley c. 500m east at its nearest point. The remaining sites are as follows; Ackhurst, Great, Jude, Damhead and Dog Trap Woods, the Leeds – Liverpool canal at Walton summit, Denham Wood and Lucas Lane Pasture.

26. Direct and indirect impacts on all the above sites as a result of this development are unlikely due to the sites' separation and distance.

Granted EPSM Licenses

27. There are no granted licenses within 1km of the Site.

Figure 4 Locally designated sites in relation to the application site.



Survey

Method

28. The survey was carried out during August 2020[1] and followed the principles of Extended Phase 1 Habitat Survey methodology (JNCC, 2010).

Limitations

29. Enough time was afforded the surveyor to carry out the survey. The survey was not constrained by poor weather.

30. Whilst the majority of the Site was accessible, at least 5% of the Site was inaccessible due to dense vegetation or water hazards, which could not be closely inspected. This could have concealed invasive species or protected species evidence.

Habitat Appraisal

Habitats identified

31. The Site supports of the following habitats:

- Modified Grassland
- Mixed Scrub
- Neutral Grassland (Other)
- Ditches

32. Each habitat is discussed in the following pages and the estimated area of these listed[2]. The areas can be used to quantify the impacts of development in an Ecological Impact Assessment if this is required by the Local Planning Authority.

Condition Assessment

33. Our condition assessment for each habitat described references where available the criteria set out in The Biodiversity Metric 2.0 auditing and accounting for biodiversity TECHNICAL SUPPLEMENT Beta Edition.

Habitats Summary Evaluation

34. The habitats are ascribed our own qualitative value, based on their plant community make up. This evaluation is independent of faunal value which is considered in later sections.

[1] This Report has been prepared during August 2020 following a visit to the site in August 2020 and our findings are based on the conditions of the site that were reasonably visible and accessible at that date. We accept no liability for any areas that were not reasonably visible or accessible, nor for any subsequent alteration, variation or deviation from the site conditions which affect the conclusions set out in this report.

[2] The location and areas of habitats in this report are estimated and should not be relied on as a definite location and extent of any habitat or feature.

G4 Modified Grassland

Area estimate: 7.1 ha

Figure 5a Approximate location and extent of habitat

35. The site primarily comprises a large, open expanse of highly improved and modified grassland. The sward is dominated by coarse, competitive grass species including perennial rye-grass (Lolium perenne), timothy (Phleum pratense), cocksfoot (Dactylis glomerata) and Yorkshire fog (Holcus lanatus), with red fescue (Festuca rubra) also noted though rarely.

36. Forb cover amongst the sward is limited but includes occasional common species such as: dandelion (Taraxacum agg.), white clover (Trifolium repens), broad-leaved dock (Rumex obstusifolius), red clover (Trifolium pratense), greater plantain (Plantago major), ragwort (Senecio jacobea) and meadow buttercup (Ranunculus acris).

37. There are some areas of compaction noted at the entrance to the south where the site has been previously used to host car boot sales, this supports species such as knotgrass (Polygonum aviculare), marsh cudweed (Gnaphalium uliginosum) and pineapple weed (Matricaria discoidea). Whilst a small number of immature hawthorn (Crataegus monogyna) are found around the peripheries.

Summary Evaluation

38. This is a highly disturbed habitat with low species diversity, unlikely to support any scarce or notable species.

Figure 5b Typical structure and composition of this habitat

Defra Metric Condition Assessment ***Poor***

39. Meets 3 out of 6 criteria.

	Condition Assessment Criteria Grassland habitat type	Meets criteria?
1	Clearly and easily recognizable as a good example of this type of habitat.	**No**
2	Appearance and composition very closely matches the characteristics for the specific Priority Habitat	**No**
3	Wildflowers, sedges and indicator species for the specific Priority grassland habitat are very clearly and easily visible throughout the sward and occur at high densities in high frequency.	**No**
4	Undesirable species and physical damage is below 5% cover.	**Yes**
5	Cover of bare ground greater than 10%	**Yes**
6	Cover of bracken less than 20% & cover of scrub and bramble less than 5%.	**Yes**

H3h Mixed Scrub

Area estimate: 0.044 ha

Figure 6a Approximate location and extent of habitat

40. A small strip of scrub is present along the eastern boundary of the site, which continues further off site. A limited variety of immature tree species and competitive forbs are present in this area including; hawthorn (Crataegus monogyna), goat willow (Salix caprea), Himalayan balsam (Impatiens glandulifera), bracken (Pteridium aquilinum), bramble (Rubus fruticosus), nettle (Urtica diocia), thistles (Cirsium sp.), cocksfoot (Dactylis glomerata) and false oat grass (Arrehenatherum elatius).

Summary Evaluation

41. This a common and widespread habitat, supporting a limited array of common and ubiquitous species alongside invasives. It is unlikely to be of any significant ecological value.

Figure 6b Typical structure and composition of this habitat

Defra Metric Condition Assessment ***Poor***

42. Meets 0 out of 5 criteria

	Condition Assessment Criteria: Scrub broad habitat type	Meets criteria?
1	There are at least three woody species, with no one species comprising more than 75% of the cover	**No**
2	There is a good age range – a mixture of seedlings, saplings, young shrubs and mature shrubs	**No**
3	Pernicious weeds and invasive species make up less than 5% of the ground cover.	**No**
4	Well-developed edge with un-grazed tall herbs	**No**
5	There are many clearings and glades within the scrub.	**No**

G3c Neutral Grassland (Other)

Area estimate: 0.531 ha

Figure 7a Approximate location and extent of habitat

43. These are primarily unmanaged sections of less accessible ground adjacent to ditches, slopes or fences. The reduced access has allowed more common competitive species to establish. Grasses are similar to those previously noted though false oat grass (Arrhenatherum elatius) is abundant and compact rush (Juncus conglomeratus) is also found frequently.

44. Forbs are more abundant in this area than the neighbouring improved grassland, though still restricted to common species often associated with agricultural improvement. Hogweed (Heracleum sphondylium) was the most abundant, with nettle (Urtica diocia), tufted vetch (Vicia cracca), bush vetch (Vicia sativa), chickweed (Stellaria media), creeping thistle (Cirsium arvense), marsh woundwort (Stachys palustris), goats beard (Tragopogon pratensis), meadow vetchling (Latyhrus pratensis), common orache (Atriplex patula), red shank (Persicaria maculosa) and creeping buttercup (Ranunculus repens) also noted throughout.

Summary Evaluation

45. This represent species poor grassland, greatly influenced by adjacent agricultural improvement.

Figure 7b Typical structure and composition of this habitat

Defra Metric Condition Assessment ***Poor***

46. Meets 3 out of 6 criteria

	Condition Assessment Criteria Grassland habitat type	Meets criteria?
1	Clearly and easily recognizable as a good example of this type of habitat.	**No**
2	Appearance and composition very closely matches the characteristics for the specific Priority Habitat	**No**
3	Wildflowers, sedges and indicator species for the specific Priority grassland habitat are very clearly and easily visible throughout the sward and occur at high densities in high frequency.	**No**
4	Undesirable species and physical damage is below 5% cover.	**Yes**
5	Cover of bare ground greater than 10%	**Yes**
6	Cover of bracken less than 20% & cover of scrub and bramble less than 5%.	**Yes**

R1 Ditches

Area estimate: 0.088 ha

Figure 8a Approximate location and extent of habitat

47. The ditches appear to be maintained, with open water present throughout, they are varied in depth with steep banks along the length throughout. The water is mostly clear, with peat visible along the bases of the ditch in several areas.

48. The ditches and immediately adjacent banks support an array of aquatic, marginal and riparian vegetation. The following species were all noted occurring sporadically throughout the standing water areas of the ditch; reed mace (Typha latifolia), water mint (Mentha aquatica), flote grass (Glyceria fluitans), watercress (Nastursium officinale), forget me not (Myosotis scorpoides), duckweed (Lemnoideae sp.), starwort (Callitriche sp.) and unbranched bur - reed (Sparganium ermersum). Wetland and marginal forb species more associated with the banks include; reed canary grass (Phalaris arundinacea), marsh thistle (Cirsium palustre), angelica (Angelica archangelica), gypsywort (Lycopus europaeus), purple loosestrife (Lythrum salicaria), meadowsweet (Filipendula ulmaria), sharp flowered rush (Juncus acutiflorus) and cyperus sedge (Carex pseudocyperus). Whilst a number of common competitive species are also present more frequently along the banks including; false oat grass (Arrhenatherum elatius), bramble (Rubus fruticosus), goosegrass (Galium aparine), fox glove (Digitalis purpurea), horsetail (Aquisetum sp.) and clustered doc (Rumex conglomeratus). Himalayan Balsam (Impatiens glandulifera) is present at the eastern periphery of the ditch.

Summary Evaluation

49. Fairly diverse wetland vegetation. The most ecologically valuable habitat on site.

Figure 8b Typical structure and composition of this habitat

Defra Metric Condition Assessment ***Moderate***

50. Meets 5 out of 9 criteria

51.	**Condition Assessment Criteria Ditches habitat type**	**Meets criteria?**
1	Good water quality, with no signs of pollution (water should not be green or turbid).	**Yes**
2	Clear water is dominated by plants, be they submerged or floating (note dominance of duckweed is a sign of eutrophication).	**Yes**
3	A range of submerged and floating leaved plants are present (at least 10 species per 20m of ditch, or 7 spp. Per 150m of canal).	**No**
4	A marginal fringe of emergent vegetation is present.	**Yes**
5	Water body is not impacted by use of riparian land.	**No**
6	If a fish assemblage is present, it comprises of a range of native spp.	**No**
7	Sufficient water levels are maintained; i.e. a minimum summer depth of c.50cm in minor ditch and 1m in main drain.	**Yes**
8	Less than 10% of ditch is heavily shaded.	**Yes**
9	Absence of non-native species.	**No**
10	Less than 10% cover of filamentous algae and/ or duckweed.	**No**

DEFRA Metric (Baseline)[3]

52. This metric sets out the baseline for the Site - proposals should seek to achieve at least a 'no net loss' situation through **Avoiding** areas of higher value, **Mitigating** any loss on-Site through retention and enhancement, or habitat creation. The Local Planning Authority *may* require you to **Compensate** any residual loss elsewhere - either through direct works or an off-setting contribution.

	Habitats and areas			Habitat distinctiven	Habitat conditio	Ecologica l	Strategic significance	Suggested action to address habitat losses	Ecologica l baseline
Ref	Broad Habitat	Habitat type	Area (hectare s)	Distinctive ness	Conditio n	Ecologica l connectiv	Strategic significance		Total habitat units
1	Grassland	Grassland - Modified grassland	7.1	Low	Poor	Low	Area/compensation not in local strategy/ no local strategy	Same distinctiveness or better habitat required	14.20
2	Heathland and shrub	Heathland and shrub - Mixed scrub	0.044	Medium	Poor	Medium	Area/compensation not in local strategy/ no local strategy	Same broad habitat or a higher distinctiveness habitat required	0.19
3	Lakes	Lakes - Ditches	0.088	Medium	Moderate	Medium	Area/compensation not in local strategy/ no local strategy	Same broad habitat or a higher distinctiveness habitat required	0.77
4	Grassland	Grassland - Other neutral grassland	0.531	Medium	Poor	Medium	Area/compensation not in local strategy/ no local strategy	Same broad habitat or a higher distinctiveness habitat required	2.34
5									
6									
7									
8									
9									
		Total site area ha	7.76					Total Site baseline	17.50

[3] Our report provides an estimate of the sites value in Biodiversity Units. This is based on thorough assessment at the time of survey and using the information available at this time. In this assessment we have used the latest version of DEFRA's Biodiversity Metric Tool, the UK Habitats Classification and relevant guidance. This assessment requires subjective judgments to be made in terms of habitat type and condition and could be open to other interpretations. Reliance on the Unit Score, or conversion of this into a monetary value, would be at the developer's own risk.

Faunal Appraisal

The following pages discuss only the groups and species that could be reasonably expected to be found on the type of habitats present on, or adjacent to, the site.

Amphibians

Records

53. A total of 59 amphibian records have been returned for a combination of common frog, common toad, smooth newt, palmate newt and great crested newt (GCN).

54. Fifteen of the records are of GCN, though the most recent is from 2001 with the rest being from mid-80's to early 90's. These are primarily centred on Tan House Wood c.400m east of the site at its closest, as shown on the adjacent figure. A single isolated record is found c.350m west of the site. All these records are in locations separated from the site by roads.

55. Two records with four figure grid references are centred 80m north of the site but also dated to 1982 and 1983.

56. Ponds 1 and 2, as well as the on-site ditches were subject to four presence / absence amphibian surveys, carried out by Bowland Ecology in 2017, though no GCN were found.

Field Evidence

57. None found.

Summary Evaluation

58. The site largely appears isolated from surrounding habitats by a road c. 230m to the north, the Leeds – Liverpool Canal off the eastern boundary, the A674 along the southern boundary and the M61 along the western boundary.

59. Great crested newt is historically well recorded within the wider area, however more recent survey of the site ditches and nearby ponds in 2017 has shown an absence of this species. Given the site is largely isolated from surrounding areas by roads and a canal, the risk of colonisation of the site appears low and a likely absence of this species is concluded.

60. More common species of amphibian, such as frog and smooth newt, were recorded during surveys undertaken in 2017, though they may find some suitable habitat on site, impacts upon these species are unlikely to be significant.

Further Surveys

61. No further surveys are recommended.

Figure 9 GCN records in relation to the Site

Bats

Records

62. A total of 80 records have been returned for the area, the vast majority of which are of common pipistrelle or pipistrelle species, with few records of brown long eared, daubenton's, noctule, serotine and myotis species. None of the records are centred upon the site or immediately adjacent.

Field Evidence

Potential Roost sites

63. No potential roost features have been identified within site boundaries.

Foraging and commuting habitat

64. The site is open and featureless and presents limited opportunities for foraging or commuting. A tree band is present along the southern boundary and the canal running north – south off the eastern boundary, which will offer some increased opportunities for foraging and commuting, though these features are of reduced value adjacent to the site due to lighting from adjacent roads.

Summary Evaluation

65. The site appears to be of very limited value to this group for both commuting and foraging, and of no value to roosting.

Further Surveys

66. As the site appears to be of such limited value to bats a single bat activity survey is recommended to confirm this or otherwise indicate the need for any further survey should activity levels be notable. This should be undertaken during the optimal bat activity period.

Birds

Records

67. A limited, though fairly diverse array of bird records have been returned, representative of the mix of the pastoral, upland and urban environments present in the area. Many of the records are associated with general four figure grid references, with non-associated with the site itself or otherwise being particularly noteworthy.

Field Evidence

68. A small number of common bird species were noted during the survey, mainly limited to low numbers of corvid and columbidae bird families around the peripheries of the site. A single buzzard was also noted in adjacent areas.

Summary Evaluation

69. The site will support a limited number of bird territories, many of which will be associated with its peripheries. Impacts in these areas will be limited but displacement of some territories is inevitable. However, the site is highly unlikely to support key or otherwise notable species and the significance of this is low and it is unlikely.

Further Surveys

70. No further surveys are considered necessary to demonstrate current baseline in respect of birds.

71. Standard precautions apply in relation to pre-clearance.

Otters

Records

72. No otter records have been returned for the area.

73. The site and adjacent was surveyed, by Bowland Ecology, for the presence of otter in 2017 though none was found.

Field Evidence

74. None found.

Summary Evaluation

75. It is possible otter have an occasional presence in the area and may intermittently pass through the nearby canal and could also cross over land on to the site. However, the ditches are highly unlikely to be of any specific value to otter and the risk of the above scenario appears highly unlikely. Accordingly otter presence on the site is likewise considered highly unlikely.

Further Surveys

76. Further survey for this species is not recommended.

Water vole

Records

77. A total of six records have been returned. None of the records are centred on the site, with the nearest and most recent located c. 220m to the south along the Leeds – Liverpool Canal and dated 2005.

78. The site and adjacent ditches were subject to water vole survey by Bowland Ecology in 2017 though none, or evidence thereof, was found.

Field Evidence

79. None was found despite walking the length of the ditches on site.

Summary Evaluation

80. The ditches on site do offer suitable water vole habitat and are loosely connected to areas supporting a limited number of historic water vole records. The ditches on site appear to drain into a culvert c.15m from the canal banking but otherwise occupy somewhat of a 'dead end' of potential habitat for this species due to the presence of surrounding roads elsewhere. Furthermore, survey in 2017 has found an absence of this species and as such the current risk of presence at the site would appear reduced.

Further Surveys

81. Much of the ditch length on site will be outside of the development footprint and the risk of presence and subsequent impacts upon this species appears low. A pre – commencement check is recommended of impacted areas to confirm the continued absence of this species.

Badger

Records

82. A total of 6 badger records have been returned for the area. Whilst all are recent from 2018 and 2019, they are all separated by either the motorway or Leeds – Liverpool Canal.

Field Evidence

83. No signs were noted during the walkover survey.

Summary Evaluation

84. The site does support some suitable habitat for this species but it is unlikely to be of any specific value to badger and is not linked to areas that are likely to be of higher value to this group. The relatively wet nature of the site suggests that it may be less suitable to support setts.

Further Surveys

85. The risk of badger presence at the site appears low and further survey in respect of this species is not recommended.

Hedgehog

Records

86. Hedgehogs are recorded within the search area.

Field Evidence

87. No evidence of hedgehogs was found on site.

Summary Evaluation

88. The Site provides suitable habitat for this species and measures to allow them to access gardens need to be planned for.

Further Surveys

89. Presence assumed no further surveys are considered necessary.

Reptiles

Records

90. A total of three reptile records have been returned, all located c.1.8 or 2.4km south west of the site within parkland. Two are records of slow worm dated to 2008 and common lizard record dated to 1998.

Field Evidence

91. No field evidence was found.

Summary Evaluation

92. The site is primarily comprised of open grassland of limited value to the above species or other reptiles. The site's limited connectivity for reptiles within the landscape further reduces its value to this group.

Further Surveys

93. No further surveys or precautions are considered necessary.

White clawed crayfish

Records

94. No records in search area.

Field Evidence

95. No evidence of this species was noted. The ditches are likely to offer sub – optimal habitat for this species and it is generally considered to be extinct in many low land areas throughout much of England

Summary Evaluation

96. Absence of records makes it very unlikely that this species is present or is at risk from development activities.

Further Surveys

97. Further surveys for this species is not recommended.

Invasive Non-Native Species (INNS)

98. INNS are species listed on Schedule 9 of the Wildlife and Countryside Act (1981), for which it is an offence to cause or allow it to grow in the wild. The following species were noted[4]:

    - Himalayan balsam

Survey constraints

99. This site presents a low risk of supporting undetected INNS based on the following factors:

    - Areas of site inaccessible to survey
    - Potential for recent earthworks or management which may have obscured viable material
    - Proximity to nearby potential sources of infection
    - Potential for tipping of material

100. Should further assurances be needed in relations to INNS you should commission a dedicated Invasive Weed Survey.

Figure 10 Invasive Himalayan Balsam stand at the north eastern corner of the site.

[4] Whilst our ecologists are trained in the identification of invasive species this report is not a dedicated invasive species survey. Detectability of invasive plant species can be affected by several factors, and conclusive determination status, or extent, is not possible through preliminary survey alone. As the presence of invasive species can generate significant costs to development, the client may wish to instruct a dedicated invasive species survey prior to entering into contracts.

Ecological Constraints

101. There is a considerable and apparently well – established Himalayan Balsam growth towards the north eastern boundary - care will need to be taken to prevent the spread of this species.

102. There is a risk of pollution via site run-off or spillage of chemicals into the ditches and precautions should be taken to prevent this.

103. An area shown on mapping as 'Gale Moss' is located off the north western boundary. These areas often support bog type habitats, although from a brief visual inspection this area appears dominated by rank grassland. However, plans should be drawn up to mitigate any drawn down of the water table to reduce the risk of impacting upon this area.

104. Measures need to be put in place to address the small risk of the presence of water vole during the first stages of clearance. Suitable precautions would comprise of:

    - A pre-start water vole survey to confirm the continued absence of this species.

105. These measures could be secured by standard condition.

Figure 11 Constraints identifiable at the PEA stage*

*(further constraints may be identified by any additional surveys recommended in this or other reports.

Ecological Opportunities

106. The Gale Moss area to the north west lies within the blue line. This area may present opportunities for enhancement to offset impacts within the red line boundary. Any offsetting would need to be proceeded by a survey of the area to confirm the suitability of this.

107. The ditches on site support a good array of wetland flora. Future management could incorporate a wider buffer strip from the bank tops and managed sympathetically to encourage the proliferation of such flora and further protect the ditches from agricultural run – off in future.

Figure 12 Ecological Opportunities

Conclusions and Recommendations

108. The site is made up of a limited number of common habitats of limited ecological value, unlikely to present a significant constraint development. The ditches are of some elevated value relative to much of the site and should be retained and protected where possible.

109. Riparian mammal and great crested newt (GCN) surveys were undertaken of the site in 2017. These found an absence of water vole, otter and GCN respectively. As the site presents marginal otter habitat and appears well separated from any surrounding GCN populations further updating survey for these species has not been recommended. Similarly, water vole appears unlikely to be presence at the site however due to a slightly elevated risk of colonising the site a pre-commencement check for this species has been recommended.

Planning considerations		
Recommendation	**Rationale**	**When**
R1 Further survey	Further detailed survey will be required into the following species/ groups, to confirm presence or likely absence and collect an accurate baseline for the Site. • Bat Activity (Scoping survey)	Optimal activity period May – August
R2 Produce a layout which minimises loss of biodiversity.	The site has been assessed as having a Biodiversity Unit score of 17.5 Habitat Units. Proposals will need to consider the NPPF hierarchy of Avoid - Mitigate – Compensate in minimising any loss of biodiversity. The LPA is likely to be seeking at least a no-net-loss situation and could request that a contribution is made to address any residual loss here, off-Site. Engage with the Constraints and Opportunities set out above, involve your ecologist in designs at an early stage.	During the design process
R3 Produce a CEMP (Biodiversity)	To show how the site will be remediated and built without affecting surrounding habitats. The CEMP will detail protection measures, dealing with invasive species and pre/during clearance ecology checks for protected species or additional Invasive species.	Suitable for planning condition.
R4 Updating Water Vole survey	To confirm continued absence of this species: can be included in the CEMP.	Pre-start.
R5 Produce a Biodiversity Management Plan	To specify in detail how the development will cater for biodiversity on site and to show how habitats will be maintained in the condition that the Biodiversity Calculations were based on.	Suitable for planning condition.

* Due to the increasing adoption of biodiversity net gain Brooks Ecological has taken the step of providing our own in-house landscape design team, we are in a position to help you produce any of the landscape plans needed for submission. Please contact our team for further details.

Other considerations (managing legal or financial risks)		
Issue	**Rationale**	**When**
R6 Nesting bird management	As with most sites the standard precaution in relation to birds would apply: To prevent the proposed works impacting on nesting birds, any clearance of vegetation will need to be undertaken outside of the breeding bird season which is 1st March – 31st August inclusive. Any clearance required during the breeding bird season should be preceded by a nesting bird survey to ensure that the law is not contravened through the destruction of nests and that any active nests are identified and adequately protected during the construction phase of the development. Nesting management can be set out in the CEMP if one is produced.	Pre- and during -clearance
R7 INNS Management Plan	Likely to be light touch at this Site - this provides a formal INNS Survey and sets out management prescriptions and timings in detail. It can provide security for the Main Contractor and assurance for future Site operators / purchasers / owners.	Best initiated at an early stage (INNS Survey would ideally be complete April - October)

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Appendix 1 Habitats and Ecological Features

Appendix 2 Explanatory Notes and Resources Used

Site Context

Aerial photographs published on commonly used websites were studied to place the site in its wider context and to look for ecological features that would not be evident on the ground during the walkover survey. This approach can be very useful in determining if a site is potentially a key part of a wider wildlife corridor or an important node of habitat in an otherwise ecologically poor landscape. It can also identify potentially important faunal habitat (in particular ponds) which could have a bearing on the ecology of the application site. Ponds may sometimes not be apparent on aerial photographs so we also refer to close detailed maps that identify all ponds issues and drains.

Designated Sites

A search of the MAGIC (Multi-Agency Geographic Information for the Countryside) website was undertaken. The MAGIC site is a Geographical Information System that contains all statutory (e.g. Sites of Special Scientific Interest [SSSI's]) as well as many non-statutory listed habitats (e.g. ancient woodlands and grassland inventory sites). It is a valuable tool when considering the relationship of a potential development site with nearby important habitats. In addition, information from the local record holders was referred to on locally designated sites.

Functional linkage with off-Site habitats

When assessing these we consider whether the Site could be functionally linked to them, considering links such as;

- Hydrological links - is the Site upstream downstream, or could ground water issues affect it?
- Physical links - is the site in close proximity and could it be directly or indirectly affected by construction and operational effects? Conversely it may be that despite proximity major barriers separate the two.
- Recreational links - do footpaths and roads make it likely that increased recreational pressure could be felt?
- Habitat links - is the site part of a network of similar habitat types in the wider area? These could be joined by linear corridors or could simply be 'stepping stones of habitat of similar form or function.

Method

Phase 1 habitat survey methodology (JNCC, 2010). This involves walking the site, mapping and describing different habitats (for example: woodland, grassland, scrub). The survey method was "Extended" in that evidence of fauna and faunal habitat was also recorded (for example droppings, tracks or specialist habitat such as ponds for breeding amphibians). This modified approach to the Phase 1 survey is in accordance with the approach recommended by the Guidelines for Baseline Ecological Assessment (IEA, 1995) and Guidelines for Preliminary Ecological Appraisal (CIEEM 2017).

Faunal Appraisal

This section first looks at the types of habitat found on Site or within the sphere of influence of potential development, then considers whether these could support protected, scarce or NERC Act 2006 Section 41 species (referred to collectively as 'notable species').

Records of notable species supplied from a 2km area of search by Lancashire Environmental Records Network are used to inform this appraisal.

We discuss further only notable species or groups which could be a potential constraint due to the presence of suitable habitat and their presence (or potential presence) in the wider area. We screen out and do not present accounts of notable species or groups which do not meet these criteria – in some cases it may be necessary to explain this reasoning.

Species/group	Habitat
Black-tailed Godwit	Arable Farmland
Farmland Birds	Broadleaved and Mixed Woodlands
Hen Harrier	Calcareous Grassland
Lapwing	Limestone Pavement
Reed Bunting	Moorland and Fell
Skylark	Mossland
Song Thrush	Reedbed
Twite	Rivers and Streams
Bats	Salt Marsh and Estuarine Rivers
Brown Hare	Sand Dune
Otters	
Red Squirrel	
Water Vole	
Belted Beauty Moth	
Dorus Profuges- a hoverfly	
High Brown Fritillary	
Large Heath Butterfly	
Northern Brown Argus	
Pearl-bordered Fritillary	
Shining Guest Ant	
Southern Wood Ant	
Wall Mason Bee	
Freshwater Pearl Mussel	
Freshwater White-clawed Crayfish	
Jennings Proboscis Worm	
Whorl Snails	
Birds-eye Primrose	
Black Poplar	
Dwarf Cornel	
Flat-Sedge	
Great Butterfly Orchid	
Lady's-slipper Orchid	
Lancaster Whitebeam	
Narrow Small-Reed	
Purple Ramping-fumitory	
Rock Sea Lavender	
Sea Bindweed	

Bats

Bat roosting potential is classified according to the following criteria set out below, taken from the Bat Conservation Trust Good Practice Guidelines (2016).

Bat Roosting Suitability of Buildings and Trees

Suitability	Criteria
Negligible	Negligible habitat features on site likely to be used by roosting bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions, and/or suitable surrounding habitat to be used on a regular basis or by a larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation). A tree of sufficient size and age to contain PRFs but with none seen from the ground or features seen with only very limited roosting potential.
Moderate	A structure or tree with one or more potential roost sites that could be used due to their size, shelter, protection, conditions, and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only - the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protections, conditions and surrounding habitats.

Evaluation

In evaluating the Site, the ecologist will take into account a number of factors in combination, such as;

- the baseline presented above,
- the site's position in the local landscape,
- its current management and
- its size, rarity or threats to its integrity.

There are a number of tools available to aid this consideration, including established frameworks such as Ratcliffe Criteria or concepts such as Favourable Conservation Status. Also of help is reference to Biodiversity Action Plans in the form of the Local BAP and Section 41 of the NERC Act (2006) to determine if the site supports any Priority habitats or presents any opportunities in this respect.

The assessment of impacts considers the generic development proposals from which potential effects include:

- Vegetation and habitat removal
- Direct effects on significant faunal groups or protected species
- Effects on adjacent habitats or species such as disturbance, pollution and severance
- Operation effects on wildlife such as noise and light disturbance

Appendix 3 Bat Activity Survey Rationale

The Bat Conservation Trust Guidelines (BCTG) (Collins 2016) is now widely accepted as providing a basis and rationale for scoping and conducting bat surveys. It is acknowledged that the guidelines provide a wealth of background and are a very useful tool in standardising approaches to survey, it is also felt that an over reliance on some of the guidelines within this document can result in the provision of complicated surveys where they have significant consequences for the cost, or timescale of a large project, but could never deliver positives for bat conservation.

Taking the BCTG document as a whole, Chapter 2 helps the reader understand whether or not surveys are required, and that in the context of planning and development survey is required in relation to ensure;

- the avoidance of legal offences, and;

- the provision of a sufficient level of information - such that will allow the Local Planning Authority to make an informed decision on the proposals and their potential impacts on the Favourable Conservation Status (FCS) of bats.

Attendance at seminars presented by, and discussions with, those involved in production of the BCTG document has emphasised the point that it is within the remit of the consultant ecologist to make a decision on the necessity and scope of surveys - they will use the guidelines in doing so but are not in any way bound by them: this is reflected in Section 1.1 of the guidelines -

> *'The Guidelines do not aim to either override of replace knowledge and experience. It is accepted that departures from the guidelines (e.g. either decreasing or increasing the number of surveys carried out or using alternative methods) are often appropriate. However, in this scenario an ecologist should provide documentary evidence of (a) their expertise in making this judgement and (b) the ecological rationale behind the judgement. '*

Such decisions require a consideration of the potential of the project to impact on bat habitat, alongside analysis of the value of habitat on and around the site and of local records and the likelihood that bats might occur in significant numbers. Our reports aim to present information on how we have arrived at our decision on the Site, what assumptions we have based this on, and where further survey is recommended we indicate what the objective of this survey should be and how best this would be achieved.

The site lacks features generally considered to be of value to bats, dominated by habitat of minimal value to both commuting and foraging bats and being open and featureless. Furthermore, the adjacent motorway and A- Road will sever bat movements through the area, whilst there is also considerable light spill onto the site from the A-road further reducing its value. Due to the perceived very low value of the site to bats, a single scoping survey has been recommended to ascertain if activity levels align with this. If such survey reveals higher levels of bat activity, notable species assemblage or both then further survey will be recommended in line with guidance.

Appendix 4 Wildlife Legislation, Policy and Guidance

This is not an exhaustive list but sets out briefly the relevance of Legislation, Policy and Guidance in terms of planning applications and this assessment.

Legislation

Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (EC Habitats Directive).

Provides framework at an international (EU) level for the consideration / protection of European Protected Species (EPS), and habitats through the designation of sites.

Council Directive 79/409/EEC on the Conservation of wild birds (EC Birds Directive) and The Ramsar Convention on Wetlands of International Importance (1971)

Provides framework at an international (EU) level for the consideration / protection of important bird populations and the sites on which they are dependant.

The Conservation of Habitats and Species Regulations (2010)

This transposes 1) into UK law and provides the basis on which all EPS are protected and impacts on them can be licensed in the UK.

The Wildlife and Countryside Act (1981) as amended

This provides the basis on which UK species are legally protected or restricted and confers protection on Sites of Special Scientific Interest SSSIs. It contains annexes of plants and animals which are legally protected as well as those which are considered to be invasive or harmful. It provides the basis on which impacts on such species can be licensed in the UK and provides controls on work on or near SSSIs.

The Countryside and Rights of Way Act 2000 (CRoW)

Provides a statutory basis for nature conservation, strengthens the protection of SSSIs and UK protected species and requires the consideration of habitats and species listed on the UK and Local Biodiversity Action Plans (UKBAP / LBAP).

Natural Environment and Rural Communities Act 2006 (NERC)

Sets out the responsibilities of Local Authorities in conserving biodiversity. Section 41 of the Act requires the publishing of lists of habitats and species which are "of principal importance for the purpose of conserving biodiversity". At present these largely reflect those making up the UKBAP lists.

Hedgerows Regulations (1997)

Define and provide protection for Important Hedgerows.

Protection of Badgers Act (1992)

Protects badgers from persecution, this includes excavation / development in the proximity of setts.

Protected Sites

Statutory EU / International Protected Sites

Special Areas of Conservation (SACs); and Special Protection Areas (SPAs) and Ramsar Sites contain examples of some of the most important natural ecosystems in Europe. Work on or near these sites is strictly protected and Local Authorities will be expected to carry out 'Appropriate Assessment' of development in proximity of them. In this case there is often an increased burden on the developer in relation to provision of information and assessment.

Statutory UK Protected Sites

Local Nature Reserves (LNRs); National Nature Reserves (NNRs); Sites of Special Scientific Interest (SSSIs) all receive strict protection under UK legislation. Work in or in proximity to these sites would be restricted with any needing to be agreed with Natural England. Natural England now provide guidance on the nature of development which could impact on SSSIs through Impact Risk Zones.

Locally Protected Sites

Local Authorities have a variety of protected wildlife sites designated at a local or regional level. These are gradually being brought under the banner of Local Wildlife Sites (LWS) but at present a plethora of different designations exist - all subject to local policy.

Protected Species

European Protected Species

A number of species (most relevantly bats, great crested newts [GCN], and otters) receive strict protection from killing, injury and disturbance under The Conservation of Habitats and Species Regulations (2010). Protection is also conferred on the habitats on which they rely such as roost space in the case of bats and ponds and fields etc. in the case of GCN.

UK Protected Species

A number of species (including bats, GCN, watervole and white clawed crayfish) are strictly protected under The Wildlife and Countryside Act (1981) as amended, from killing, injury, disturbance and damage or destruction of their resting places etc. Certain species (such as reptiles) and some birds (such as barn owl) receive partial protection e.g. at certain times of the year or form certain activities only. All nesting bird species are protected from damage or destruction of their nests - whilst active.

Invasive species

Schedule 9 of the Wildlife and Countryside Act (1981) as amended, lists these species and makes it an offence to cause or allow their spread in the wild. This often has impacts on development and planning in relation to the presence of invasive plant species such as: himalayan balsam (*Impatiens glandulifera),* japanese knotweed (*Fallopia japonica*) and giant hogweed *(Heracleum mantegazzianum*).

Planning Policy / Guidance

The National Planning Policy Framework (NPPF):
The National Planning Policy Framework was updated in February 2019. The most relevant paragraphs from the NPPF are set out below.

The approach to assessing the natural environment is now embedded within the definition of what 'sustainable development' is and this falls under one of three objectives of the planning system – the 'environmental objective' applying in this case. Paragraph 8c (P8c) of the NPPF states that sustainable development should "*contribute to protecting and enhancing our natural environment*" and "*help to improve biodiversity*". P10 sets out the Framework's presumption in favour of sustainable development.

Section 11 of the NPPF details making effective use of land. The Framework states that planning policies and decisions should "*take opportunities to achieve net environmental gains – such as developments that would enable new habitat creation*" and should "*recognise that some undeveloped land can perform functions for wildlife*" (P118).

Section 15 details conserving and enhancing the natural environment; policies and decisions should be "*protecting and enhancing sites of biodiversity value*", "*recognise the intrinsic character and beauty of the countryside*" and contribute to conserving and enhancing the natural environment and reducing pollution (P170). Allocations of land for development should, "*prefer land of lesser environmental value, where consistent with other policies in this Framework and take a strategic approach to maintaining and enhancing networks of habitats*" (P171).

The Framework sets out ways to minimise the impacts on biodiversity through "*identifying, mapping and safeguarding components of local wildlife rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity*" and the "*conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and (the need to) identify and pursue opportunities for securing measurable net gains for biodiversity*" (P174).

It is made clear in P175 that local planning authorities should apply principles when determining planning applications. Planning permission should be refused "*if significant harm to biodiversity resulting in development cannot be avoided, adequately mitigated, or, as a last resort, compensated for*". Development should not normally be permitted where an adverse effect on a SSSI is likely and "*opportunities to incorporate biodiversity improvements in and around developments should be encouraged, especially where this can secure measurable net gains for biodiversity*".

Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services.
This strategy builds on the Natural Environment White Paper (June 2011) - Setting out the current UK Government's approach to nature conservation. It promotes a more coherent and inclusive approach to conservation and the valuing in economic and social terms of economic resources.

The strategy promotes initiatives such as Biodiversity Offsetting, Nature Improvement Areas and a focus on well-connected natural networks and introduces the concept of securing a 'no net loss' situation with regard to UKBAP / Section 41 habitats and species.

ODPM circular 06/05 (2005) Biodiversity and Geological Conservation - Statutory Obligations and Their Impact Within the Planning System
Provides guidance to Local Authorities on their obligations to biodiversity – particularly in relation to assessing planning applications and ensuring the adequacy of information.

BSI (2013) British Standards Institute BS 42020:2013 Biodiversity — Code of Practice for Planning and Development.
Provides a standard for the biodiversity assessment and development industries and decision makers such as Local Planning Authorities to work to.

Bat Activity Survey

Land off Millennium Way, Chorley

Ruttle Group Ltd.

Report Reference: ER-4862-02

21/10/2020

Report Title:	Bat Activity Survey Land off Millennium Way, Chorley
Report Reference:	ER-4862-02
Written by:	Josh Birchall BSc (Hons) Grad CIEEM Ecologist
Technical Review:	Christopher Shaw BSc (Hons) MCIEEM Senior Ecologist
QA:	Olivia Benson BSc (Hons) Assistant Ecologist
Approved for Issue:	Christopher Shaw BSc (Hons) MCIEEM Senior Ecologist
Date:	21/10/2020

Unit A, 1 Station Road, Guiseley,
Leeds, LS20 8BX
01943 884451
admin@brooks-ecological.co.uk
www.brooks-ecological.co.uk
Registered in England Number 5351418

Summary Statement

The Site appears to support limited levels of bat activity on an ad-hoc basis, by a limited range of common bat species.

Significant impacts associated with proposals would not be anticipated provided some standard precautions are implemented to mitigate impacts.

Introduction

1. Brooks Ecological was commissioned by the Ruttle Group ltd. to carry out detailed Bat Activity Survey at the proposed development Site at land off Millennium Way, Chorley.
2. Survey is required to provide evidence of the baseline use of the Site by the local bat population, which in turn will then enable mitigation and enhancement strategies to be devised to support a planning application.
3. The scope of the survey has been devised based on an assessment of the habitats present and in accordance with current best practice guidelines (BCT, 2016). It was concluded that in this instance given the very low value of much of the site for bat activity, a single survey would likely be sufficient during the peak bat activity period to assess bat activity.

Figure 1 Site location plan

Method

4. Surveys were directed by Joshua Birchall BSc (Hons) Grad CIEEM. Josh has over 5 years of professional bat survey experience, is a member of the South Lancashire Bat Group and is also registered to use the Class Survey Licence WML CL17 (Level 1).
5. The objective of the survey was to collect up to date information on the Site's use by local bat populations, so that an accurate assessment of the potential impacts of development could be made. A transect and remote monitoring survey was carried out to collect the following data (BCT survey guidelines 2016):
    - The assemblage of bat species using the site;
    - The relative frequency with which the site is used by different species;
    - The nature of activity for different bat species, for example foraging, commuting and roosting.

<u>Survey Conditions</u>

6. Walked transects were undertaken during optimal survey conditions, as summarised below:

Table 1 Survey Conditions

Date	Sunset	Weather	Invertebrate Activity
24.08.20	20:15	18^{0}C, 80% cloud cover and dry. Beaufort 1.	High

Transects

7. Transects began around sunset and continued up to two hours after when all bats were thought to have emerged, and thus were actively foraging and commuting.

8. The transects were walked by a team of two surveyors, equipped with a heterodyne detector as well as a Titley Scientific Anabat Express, used to track the transect route and aid species identification. Notes taken during the survey were then used to produce the activity 'heat map' seen in the below figures.

Remote Monitoring

9. To supplement data collected during the walked transect, a static monitoring device (Wildlife Acoustic SM4) was deployed in a strategic location within the centre of the Site prior to the start of the walked transect.

10. Data collected during the period of remote monitoring has been run through Kaleidoscope Pro software, which can identify bat calls down to species level (except for *Myotid*). Identification is generally correct when using this software; however, results are double checked to ensure accurate data analysis.

11. Every effort is made to split up *Myotid* calls down to species level. This is done by analysing calls on Analook software and looking at parameters such as inter-pulse interval, call duration, slope and maximum / minimum / peak call frequency. However, this can often be difficult when registrations are short in duration, faint or distorted by cluttered environments.

Limitations

12. Static monitoring can only reliably provide information on what species of bat are regularly making use of a site. More detailed information on bat activity, such as frequency of bats, nature of activity (foraging, commuting, flight path), etc. can only be gleaned through walked transects.

13. The frequency of calls recorded can, to some extent, suggest whether activity on site is low, moderate or high, by comparing data collected with that of similar sites that have been surveyed.

14. A single registration can account for up to 15 seconds of continuous bat call. Large batches of registrations can be interpreted in several different ways, i.e. a single bat foraging continuously for only an hour can result in many hundreds of registrations being logged; similarly, many hundreds of bats commuting quickly past the detector can result in the same number of registrations.

Results

Walkover Transect

15. The transect began at the field access off Millennium Way along the southern boundary. It then proceeded in an anticlockwise direction, taking in any areas which are likely to attractive bat activity including boundaries and ditches.

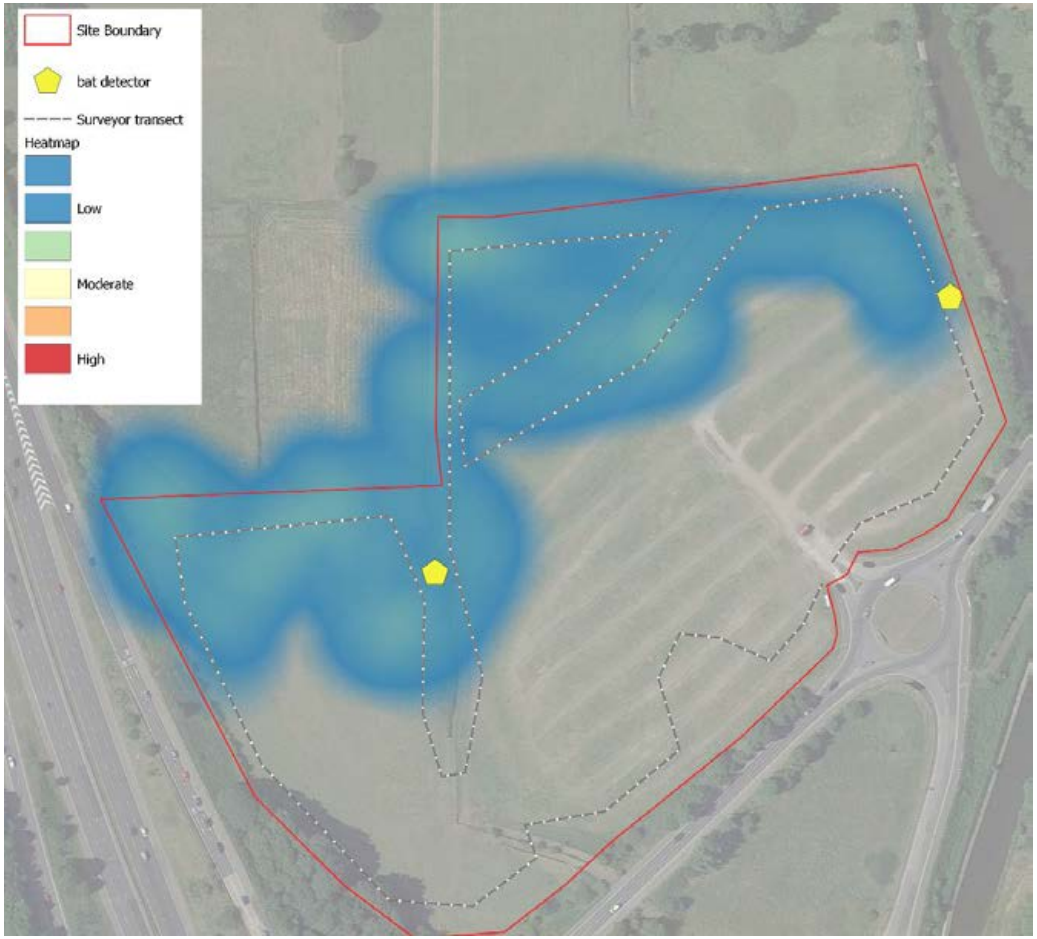
16. The first bat encountered was a common pipistrelle heard but not seen along the western boundary at 20:46, foraging somewhere offsite. A single bat was observed in this area again later in the survey at 21:11, possible the same individual.

17. The next encounter was of another common pipistrelle, again heard but not seen along the northern boundary, activity appearing similar to the previous encounter. This activity was then observed extending further south at 21:25 with a single common pipistrelle seen foraging.

18. The next bat contact was made at 21:31, when two common pipistrelle were observed foraging at the north-western corner of the site.

19. Activity overall can be considered low, and focused along Site boundaries/ immediately adjacent land.

Figure 2 Summary of bat activity observed during walked transect



Results

Remote Monitoring

20. Two remote detectors (Anabat SMZC) were deployed in locations as shown in Figure 2, with one approximately at the site's centre and one at the eastern boundary. These were left to run for 6 consecutive nights, from the 24th to the 30th August 2020. Results from the eastern boundary are shown overleaf.

21. Activity recorded at the central location can be considered very low, and is likely to be attributed to solitary or low numbers of individuals foraging over the site – as was seen during the transect.

22. The number of registrations per hour are higher earlier in the evening before dropping off to zero/ very low numbers. This suggests that bats are briefly foraging/ passing through the site soon after emergence, before heading to better habitat elsewhere in the wider landscape.

23. Activity is dominated by common pipistrelle, with limited numbers of other species.

Table 2 Total number of registrations logged for each bat species, per day at the site's centre.

Species	24th	25th	26th	27th	28th	29th	30th
C. pipistrelle	72	11	4	30	1	10	2
S. pipistrelle	0	0	0	0	0	1	0
Noctule	1	0	1	1	0	0	0
Brandt's/ Whiskered	0	0	2	0	0	0	0

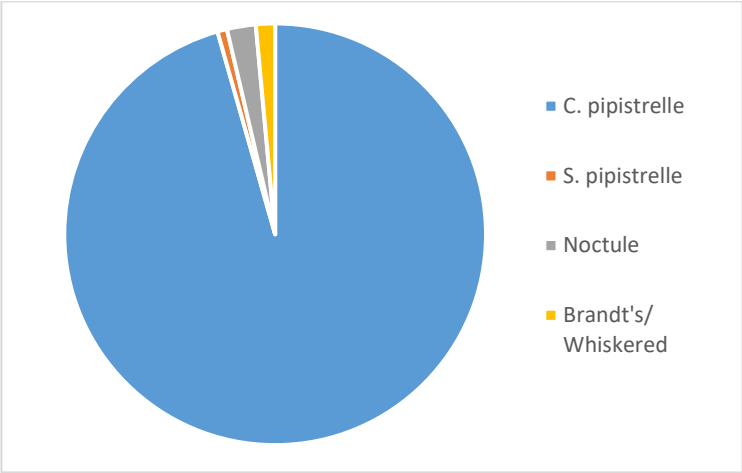


Figure 3a

Proportion of bat activity attributed to each bat species.

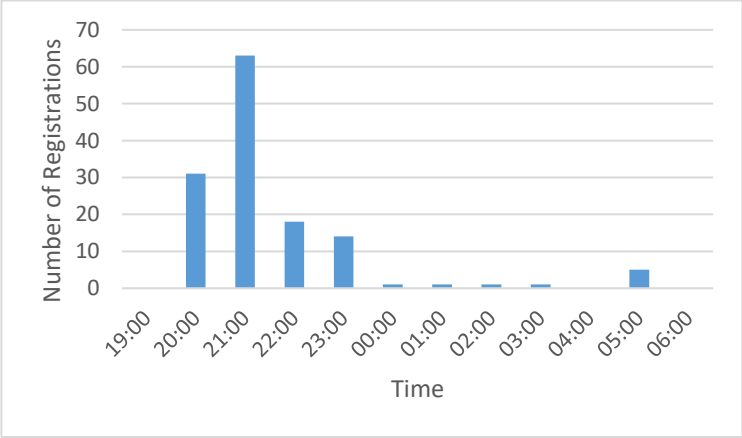


Figure 3b

Total number of bat registrations logged for each hour of the monitoring period.

Results continued

24. Slightly higher levels of activity have been recorded at the eastern boundary, with a similar species mix, in very similar proportions.

25. The number of registrations is more consistent throughout the night in this location suggesting more continuous foraging activity. This could be due to the presence of better habitat (canal) being present offsite.

26. As with at the sites centre, overall the number of registrations is low, and does not indicate that the Site is of any significant importance to any local bat populations.

Table 3 Total number of registrations logged for each bat species at the eastern boundary

Species	24th	25th	26th	27th	28th	29th	30th
C. pipistrelle	125	12	12	4	17	27	16
S. pipistrelle	0	1	0	0	0	0	0
Noctule	2	1	1	0	1	0	0
Brandt's/ Whiskered	1	1	0	1	0	4	1

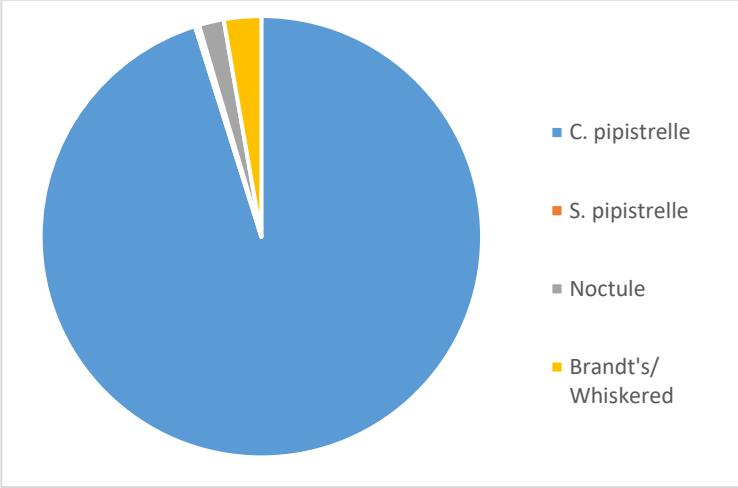


Figure 4a

Proportion of bat activity attributed to each bat species.

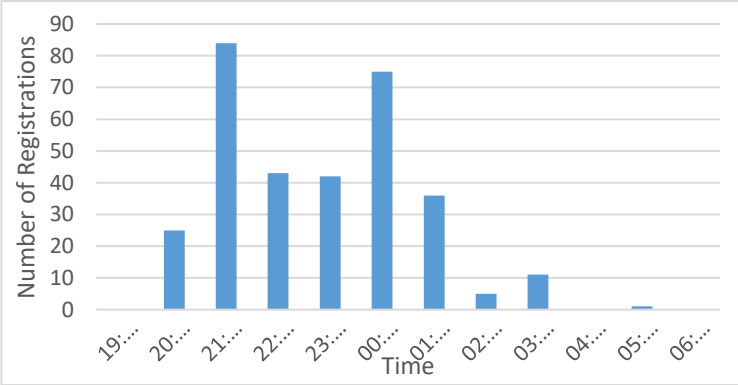


Figure 4b

Total number of bat registrations logged for each hour of the monitoring period.

Conclusions & Recommendations

27. A dedicated bat activity survey, encompassing a walked transect and period of remote monitoring, has found that the Site attracts only very low-levels of bat activity.

28. Only a small number of common bat species are recorded making use of the Site, with common pipistrelle being the most abundant and consistent.

29. There was considerable variation in the number of registrations logged each night throughout the monitoring period, suggesting that low numbers of bats forage over the Site, in low numbers and on an *ad hoc* basis.

30. The data collected does not indicate that the Site is of any significant importance to any particular local bat populations and the proposals are therefore unlikely to impact significantly on any local bat populations.

31. To minimise any impacts upon this group, the following mitigation is recommended.

    - A sensitive lighting plan should be designed to show how light spill will be minimised/ avoided across the site and into adjacent off site areas
    - Bat boxes should be installed in suitable locations on suitable trees around the site, particularly along the eastern boundary.

References

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APPENDIX A: Lancashire County Council Screening Opinion

LANCASHIRE COUNTY COUNCIL'S SCREENING OPINION ON:

THE EXTRACTION OF SAND AND GRAVEL AND RESTORATION WITH IMPORTED INERT WASTE ON LAND TO THE NORTH EAST SIDE OF JUNCTION 8 OF THE M61, GALE MOSS, CHORLEY

Applicant's Proposal

A screening opinion is requested for the extraction of sand and gravel and restoration with imported inert waste at a site with an area of 7.85 hectares. The applicant estimates that approximately 300,000 tonnes of sand and gravel would be extracted to a depth of around 4m, with a similar tonnage of infill.

The extraction rate is anticipated to be 75,000 to 150,000 tonnes per year over the course of 2-4 years. Restoration would be at the same rate, but that would follow on after extraction has been completed. The applicant anticipates that the development would be completed within approximately 6-8 years.

Observations on Selection Criteria for Screening Schedule 2 Developments

The proposed development would relate to a type set out in Schedule 2 of The Town and Country Planning (Environmental Impact Assessment) Regulations 2017. Schedule 2, Paragraph 2(a) refers to *Extractive Industry,* and Paragraph 11 (b) refers to *'Installations for the disposal of waste'* for a site over 0.5 ha or within 100m of controlled waters.

Planning guidance set out in the *Planning Practice Guidance* (PPG) to accompany the *National Planning Policy Framework* includes indicative criteria and screening thresholds and states that quarries covering more than 15ha or involving the extraction of more than 30,000 tonnes of mineral per year are more likely to require Environmental Impact Assessment. It advises that the likelihood of significant effects will tend to depend on the scale and duration of the works, and the likely consequent impact of noise, dust, discharges to water and visual intrusion. In respect of the disposal of waste the PPG states that in relation to installations for the disposal of non-hazardous waste, sites seeking only to accept inert wastes are unlikely to require EIA. The key issues to consider could be the scale of the development and the nature of the potential impact in terms of discharges, emissions or odour.

Characteristics of the development

a) Size and design of development

See 'applicant's proposal' above.

b) Cumulative impact with other development

The nature of the proposal would mean that significant environmental effects through cumulative impacts would be unlikely. There are no other mineral extraction or waste disposal developments taking place in the vicinity of the site.

c) Use of natural resources

The application would involve the extraction of natural resources.

d) Production of waste

Any extracted mineral waste would be utilised within the site as part of the overall restoration.

e) Pollution and nuisance

Elements of the proposed development would have the potential to generate noise and dust impacts through the operation of plant and machinery within the quarry, and the movement of HGV's to and from the site. Consideration of these impacts must take into account the proximity of sensitive receptors. However, the site is located next to the M61 Motorway and the A674 where existing noise levels are significant.

Water pollution could be caused through the leakage and spillage of fuel and lubricant from mobile plant and haulage vehicles, contaminated waste materials, and from sediment laden surface water discharges. The hydrogeological environment would need to be fully understood as watercourses/drains run through the site and the site is adjacent to the Leeds-Liverpool Canal. It is likely that a hydrogeological assessment would be needed to establish fluctuations in groundwater levels through the year. There may also be Environmental Permitting issues associated with the importation of waste materials.

f) Risk of major accidents and/or disasters

The potential risk is considered to be low.

g) Risks to human health

The proposed development would be unlikely to pose a risk to human health so long as adequate pollution control measures would be employed.

Location of the development

a) Existing and approved land use

The site is known as Gale Moss, which is currently agricultural land occasionally used as the location for weekend car boot sales. The land is allocated in the Chorley Local Plan as Employment Land and it also falls within a mineral safeguarding area. Fields to the north are in Green Belt but would not form part of the proposal. The site has outline planning permission for employment use (Use Classes B2 and B8) with associated highways, landscaping provision and ancillary development. All matters are reserved except for access, which is proposed off the existing A674 roundabout (ref. 17/00713/OUTMAJ – Chorley Council).

b) Quality and regenerative capacity of natural resources in the area

Appropriate and acceptable restoration of the quarry could provide habitat opportunities and/or reinstated reusable pasture land. However, the longer term end use of the site could be determined by the approval of planning permission details

associated with employment land development, and subsequent implementation of that permission.

c) The absorption capacity of the natural environment

The development would be unlikely to have any significant impact on designated wetlands, coastal zones, mountain and forest areas, nature reserves and parks or landscapes of historical, cultural or archaeological significance.

Characteristics of the potential impact

a) The magnitude and spatial extent of the impact

The extent of the potential impacts would generally be limited to the site and the immediate surroundings.

b) The nature of the impact

Visual Impact

The operational development would be unlikely to generate visual impact to an extent that would warrant environmental impact assessment (EIA). The site is not located within an area that is covered by any higher tier landscape designations and the proposal would be to return the land largely to its previous condition. Following that the site may be developed for employment uses.

Habitat

The site is not subject to any European or national level ecological designations. There is unlikely to be any major areas of ecological potential on the site although a baseline survey would be required as a minimum. There could be some ecological value in the ditches through the site.

Transport

The development would involve traffic movements associated with the export of sand and gravel and the importation of waste materials. However, access would be to an A-road via an existing roundabout and close to a motorway junction. A traffic assessment would be required but impacts are unlikely to be environmentally significant.

Cultural Heritage

Impacts on features of cultural significance are unlikely.

c) The transboundary nature of the impact

There is no likely potential for impacts of a transboundary nature.

d) The intensity and complexity of the impact

The proposed development would not be of a significant intensity or complexity.

e) The probability of the impact

The probability of a likely significant adverse environmental effect is low.

f) The expected onset, duration, frequency and reversibility of the impact

Although minerals would be removed from the site, the impact of the proposal on the landscape has the potential to be reversed through the implementation of a restoration scheme to return the land to a similar condition to existing. The proposed operations would be anticipated to take 6-8 years.

g) The cumulation of the impact with the impact of other existing and/or approved development

No significant impacts are anticipated.

h) The possibility of effectively reducing the impact.

No significant impacts are anticipated. However, appropriate controls on the depth of working and pollution control measures could be applied.

Conclusion

Overall, it is considered that in view of the scale, location and characteristics of the proposed development and the criteria set out in Schedule 3 of the Regulations it would not be likely to have significant effects on the environment and does not constitute Environmental Impact Assessment (EIA) development. Any potential impacts of the development would be likely to be of local importance; the development would not result in significant effects on environmentally sensitive or vulnerable locations, and would not be likely to have unusually complex or potentially hazardous effects. Any potential impacts could be addressed through the normal planning and Environmental Permitting process.

Screening Opinion

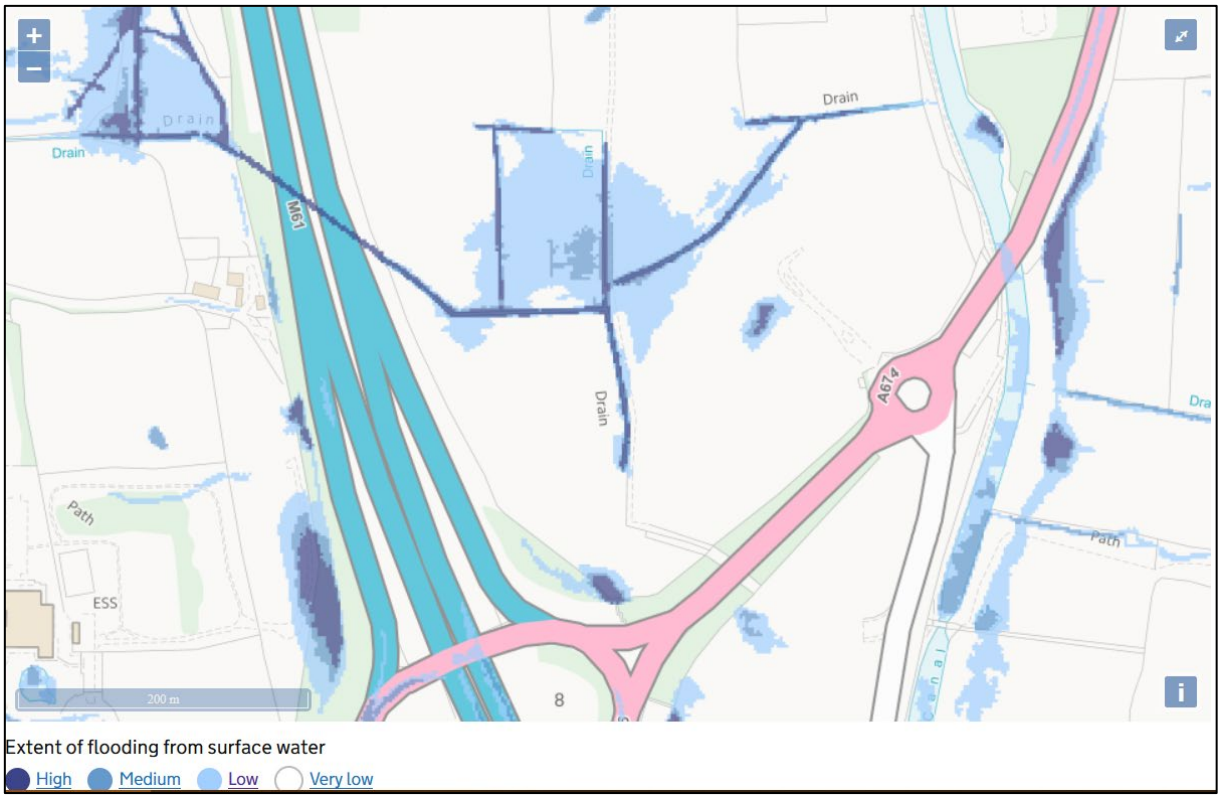
That the proposed development is not EIA Development for the purposes of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017.

A Mullaney

Andrew Mullaney
Head of Service for Planning and Environment

Date 6 October 2020

APPENDIX B: Surface Water Flood Risk Map


Drain
Drain
Drain
Drain
M61
A674
Path
ESS
Path
8
200 m
Extent of flooding from surface water
High
Medium
Low
Very low