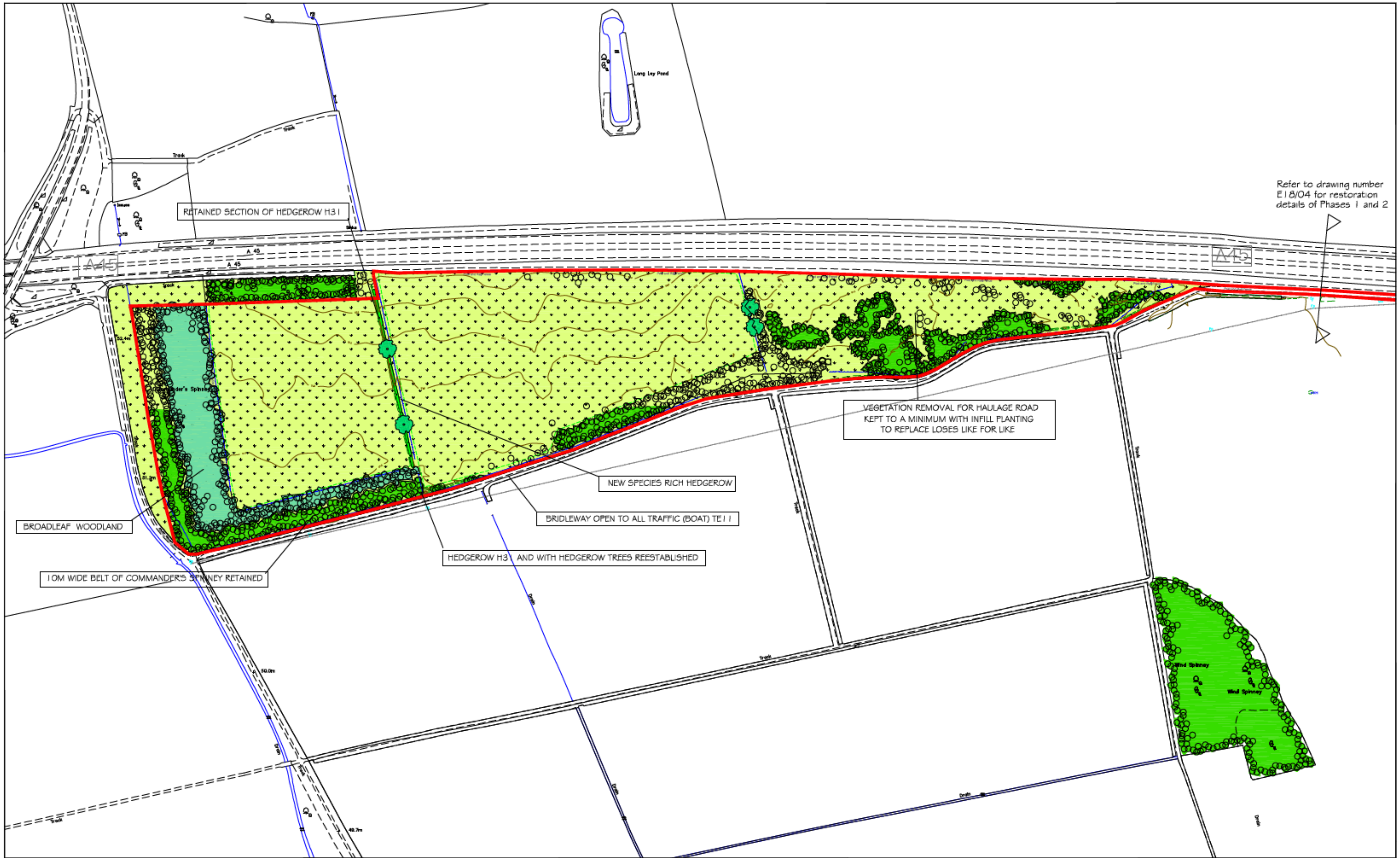
APPENDIX L

DRAWING REFERENCE E18 / 05 ENTITLED 'RESTORATION PROPOSALS: PHASE 3'



LEGEND

- APPLICATION BOUNDARY
- EXISTING WOODLAND AND SCRUB RETAINED
- HEDGEROW REINSTATED
- REINSTATED ARABLE LAND
- PROPOSED BROADLEAF WOODLAND
- FOOTPATHS AND BRIDLEWAYS

Note

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GRID NORTH

ENNSTONE JOHNSTON LIMITED

Location
Earls Barton Spinney Quarry

Title
Restoration Proposals: Phase 3

Drg.No.	Scale	Date
E18 / 05	1:2,500	09/07

APPENDIX D

HYDROGEOLOGICAL RISK ASSESSMENT (HRA) (REPORT REFERENCE BRE/EA/AW/5624/01/HRA)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT FOR THE PERMANENT DEPOSIT OF INERT WASTE AS A DISPOSAL OPERATION FOR THE RESTORATION OF EARLS BARTON SPINNEY QUARRY, GRENDON ROAD, EARLS BARTON, NORTHAMPTON TO AGRICULTURE AND NATURE CONSERVATION INTEREST

HYDROGEOLOGICAL RISK ASSESSMENT (HRA)

Report reference: BRE/EA/AW/5624/01/HRA
February 2022

Technical advisers on environmental issues

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APPENDICES

1. Introduction

1.1 MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare a Hydrogeological Risk Assessment (HRA) report to support an application for a bespoke Environmental Permit for the deposition of waste on land as a disposal activity, specifically as an inert waste landfill operation, in Phases 1 and 3 at Earls Barton Spinney Quarry (Earls Barton Quarry), Grendon Road, Earls Barton, Northampton. Throughout this report the areas in Phases 1 and 3 in which waste will be deposited and which it is anticipated will be the subject of an Environmental Permit are referred to as the site and, unless specified otherwise, references to Phase 1 and Phase 3 are to those areas of Phases 1 and 3 in which waste will be deposited. The site location and the Environmental Permit application boundary are shown in green on Figure ESSD 1 presented in the Environmental Setting and Site Design (ESSD) report reference BRE/EA/AW/5624/01/ESSD. The ESSD report is presented at Appendix C of the application report.

1.2 The HRA is based on the hydrogeological conceptual model presented in the ESSD report. Details of the environmental setting of the site, the geology and hydrogeology, the development design, the history of the site, potential contamination migration pathways and receptors are also described in the ESSD report. The acceptance at the site of inert waste materials only will be the subject of Waste Acceptance Procedures which are presented at Appendix K of the application report.

1.3 The structure of the HRA is based on a template which was produced by the Environment Agency (EA) in March 2010 for proposed landfill sites entitled “Hydrogeological Risk Assessment Report” Version 1 dated March 2010. Although now withdrawn by the EA the template still provides for the inclusion in an HRA of the necessary information. As the site will accept strictly inert waste materials only there are sections of the template which are not relevant to this HRA report although the general structure has been followed.

2. Hydrogeological risk assessment

2.1 The hydrogeological risk assessment is undertaken based on the relevant guidance presented on the GOV.UK website[1]. Information on the geology, hydrology and hydrogeology of the site is presented in the ESSD report. The information is used in the ESSD report to identify the relationships between the source, pathways and the identified potential receptors.

2.2 The works will include the deposit of materials including imported inert waste materials and on site soils and overburden in Phase 1 and Phase 3 at Earls Barton Quarry as shown on Figure ESSD 2 presented in the ESSD report. The infilling of Phase 1 and Phase 3 will necessitate the importation of approximately 250,000m^3 of inert waste materials.

2.3 The waste materials that will be deposited at the site will comprise imported inert waste materials and on site soils and overburden. Precipitation infiltrating the restoration materials in Phases 1 and 3 may migrate to groundwater in the in situ sand and gravels of the River Terrace Deposits and Ecton Member round the site, and following cessation of dewatering by the pumping of groundwater, the groundwater will be in contact with some of the materials placed in Phases 1 and 3. Groundwater in the River Terrace Deposits and Ecton Member is supported on the underlying Whitby Mudstone Formation. The Whitby Formation is underlain by the Marlstone Rock Formation which comprises mudstone. Given that the Whitby Mudstone Formation underlying the superficial deposits is designated as unproductive strata by the Environment Agency it is considered that there is no risk to groundwater quality beneath the superficial deposits. There are surface water bodies potentially in hydraulic continuity with the groundwater in the River Terrace Deposits and Ecton Member including Ecton Brook, Earls Barton Brook and the River Nene which are considered to be potential sensitive receptors.

2.4 Based on the definition specified in Council Directive 1999/31/EC (reference 1) inert waste comprises:

> *"…waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or*

[1] https://www.gov.uk/guidance/groundwater-risk-assessment-for-your-environmental-permit

chemically react, biodegradable or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to health."

2.5 The waste types that it is proposed will be accepted at the site are presented in Section 2 of the application report. The waste types listed in Table 1 of Section 2 to the application report are listed in the 'Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC' as waste types which may not need to be tested. The waste types listed in Table 2 of Section 2 to the application report are the waste types which may be accepted following testing. The waste types that will be accepted at the site comprise a limited range of inert waste types only. On this basis it is considered that the waste does not comprise a contaminant source with the potential to have a significant detrimental effect on groundwater quality.

2.6 Furthermore, Waste Acceptance Procedures will be in place to minimise the risk that unacceptable waste materials will be accepted at the site including procedures for the rejection of non-conforming loads. No wastes will be accepted from contaminated sites. Given that these robust Waste Acceptance Procedures will be implemented the uncertainty with regard to the presence of contaminants in the waste deposited will be low.

2.7 As the materials imported to the site will comprise inert waste only together with on site soils and overburden, the water that has percolated through the waste mass is highly unlikely to contain discernible concentrations of hazardous substances and on this basis the concentrations of hazardous substances in groundwater at a relevant compliance point located down hydraulic gradient of the site also will not be discernible. The inert waste and on site soils and overburden deposited at the site is highly unlikely to contain significant concentrations of non-hazardous substances which could give rise to pollution of groundwater. Based on the hydrogeological setting, the waste types that will be accepted and the Waste Acceptance Procedures it is concluded that there is a negligible risk of unacceptable impacts on groundwater or surface water quality.

2.8 The excavation of the site will comprise the removal of the superficial deposits only. A natural geological barrier at the site comprises the Whitby Mudstone Formation

which underlies the superficial sand and gravels deposits and will form the base of the void prior to the placement of inert waste. It is considered that the hydraulic conductivity of the natural geological barrier in the base of the void comprising the Whitby Mudstone Formation is less than 1 x 10^{-7}m/s and the thickness of the natural geological barrier is in excess of 1m, an additional artificial geological barrier (AGB) will not be necessary at base of void.

2.9 The side slopes of the excavation will comprise the in situ superficial deposits. In the southern areas of Phase 1B and Phase 1F, where the extent of quarrying operations extends beyond the Environmental Permit application boundary, the side slopes will be formed from backfilled site derived overburden material. As a result it will be necessary to construct a side slope AGB against both the in situ superficial deposits excavation side slopes and the backfilled side slopes constructed from placed site derived overburden material. The AGB constructed against the side slopes will comprise carefully selected suitable materials to provide a 1m thick barrier with a hydraulic conductivity no greater than 1.0 x 10^{-7}m/s. It is considered that the AGB that will be constructed against the side slopes satisfies the requirements of the Landfill Directive as implemented through the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016). The Landfill Directive specifies that for landfill sites accepting inert waste the geological barrier shall provide sufficient attenuation capacity to prevent a potential risk to soil and groundwater.

2.10 Based on the nature of the wastes which will be deposited at the site it is concluded that the placement of an AGB against the side slopes comprising carefully selected suitable materials will provide sufficient attenuation capacity to prevent a risk of contamination of soil and groundwater. It is considered that no further artificial enhancement or reinforcement of the geological barrier is necessary. It is considered that no artificial sealing liner or capping system including a water drainage layer is necessary.

2.11 Based on the information reviewed it is considered that there is no history of potentially contaminative activities at the site which at the time of deposition will have been used only for mineral extraction activities. A historical landfill site is located east of Phase 1G and will be located beneath the Plant Site. A historical landfill has not been identified by Breedon during the operation of the Plant Siter but mineral extraction operations have not been carried out in the Plant Site by Breedon. Based

on discussions with Breedon it is understood that historical landfill in the Plant Site may comprise material that was deposited during the construction of the A45. Given the location of the historical landfill and the assumed direction of groundwater flow it is considered that groundwater quality in the north and in the south and south east of Phase 1 could be affected by the historical landfill. Based on the available groundwater quality monitoring data reviewed in the ESSD report there are several groundwater monitoring boreholes in the vicinity of Phase 1 including boreholes GW4, GW5 and GW6 at which groundwater quality may be adversely affected by the historical landfill site.

2.12 Notwithstanding that it is concluded based on the proposed use of inert waste only that there will be no significant risks to human health or to the environment from the proposed development and that Waste Acceptance Procedures will be in place to minimise the risk that unacceptable waste materials are accepted, consideration has been given to the potential effect on groundwater quality of the possible acceptance of rogue loads and a quantitative rogue load risk assessment is presented in Section 3 of this report.

3. Quantitative hydrogeological rogue load risk assessment methodology

3.1 Notwithstanding that Waste Acceptance Procedures will be in place to minimise the risk that unacceptable waste materials will be accepted at the site and procedures will be in place for the rejection of non-conforming loads, it is considered reasonable that consideration should be given in the HRA to the possibility, however remote, that non-conforming loads will be accepted and that the potential for such non-conforming loads to affect groundwater quality is considered. It is considered that such an assessment provides useful context for considering the suitability and proportionality of the proposed Waste Acceptance Procedures and the procedures that will be in place for the rejection of non-conforming loads. It is in this context that consideration has been given to the potential effect on groundwater quality of the possible acceptance of rogue loads. A rogue load assessment provides an assessment of the magnitude of potential impacts on groundwater in the unlikely event that the procedures in place relating to the acceptance of waste are not adequate.

3.2 The methodology adopted in undertaking the quantitative hydrogeological rogue load risk assessment is explained in this section. Information on the input parameters used in the modelling is presented in Section 4. The results of the modelling and conclusions are presented in Section 5.

3.3 The quantitative hydrogeological rogue load assessment for the site has been undertaken using ConSim version 2.5 augmented by additional spreadsheet based calculation as necessary. ConSim is a quantitative groundwater modelling tool developed on behalf of the EA which uses the probabilistic Monte Carlo simulation technique to accommodate parameter uncertainty. The approach adopted to carry out the assessment is consistent generally with the EA Remedial Targets Methodology (reference 9). ConSim is used to calculate the concentrations of substances predicted at the edge of the imported materials and its associated AGB layer which are used as an input parameter in the spreadsheet model which calculates the predicted concentration of contaminants in the sand and gravel aquifer at the compliance point taking into account immediate dilution in the aquifer. It is considered that the use of ConSim version 2.5 augmented by additional spreadsheet based calculations is reasonable and appropriate in this context. Electronic copies of the ConSim models for Phase 1 and Phase 3 are presented at Appendix A.

3.4 For the purpose of the modelling it is assumed that non-conforming loads potentially could be accepted at the site notwithstanding the waste acceptance and other procedures that will be in place. It is assumed that each rogue load will have a volume of 30m^3 which is approximately two to three times the capacity of a typical road going tipper lorry. It is assumed that rogue loads are placed in the waste mass at a distance of 9m from the down hydraulic gradient edge of the imported material which is 10m from in situ aquifer taking into account the sidewall AGB. It is considered that this assumption is conservative as based on the dimensions of the site it is probable that if present the rogue loads would be likely to be placed a greater distance generally from the down hydraulic gradient edge of the imported material.

3.5 Following recovery of groundwater levels in the imported materials it is assumed that contaminants present in each rogue load will migrate through advection which is the migration of contaminants carried by groundwater flow and dispersion to the down hydraulic gradient edge of the imported materials, migrate through advection through the AGB and then enter the groundwater in the sand and gravel superficial aquifer. Attenuation in the flow path from the location of the rogue load to the down hydraulic gradient edge of the imported material and in the AGB is taken into account. The compliance point for hazardous substances is in groundwater at the down hydraulic gradient edge of the AGB following immediate dilution in the sand and gravel aquifer. Conservatively the same compliance point is assumed for non-hazardous pollutants.

3.6 Based on the available information on the groundwater flow regime at and in the vicinity of the Phases 1 and 3 it is considered that groundwater migrating through the deposited waste could migrate down hydraulic gradient and discharge to the Earls Barton Brook and the River Nene. As it is likely that the hydraulic conductivity of the deposited waste will be lower than the hydraulic conductivity of the sand and gravel horizons in the River Terrace Deposits and the Ecton Member, groundwater flowing through the deposited waste will be diluted by groundwater flowing round the deposited waste and incident rainfall which runs off the site and infiltrates the ground round Phases 1 and 3.

3.7 Other than immediate dilution no attenuation of hazardous substances or of non-hazardous pollutants in the sand and gravel aquifer is taken into consideration. Because attenuation processes will act to reduce the concentrations of non-hazardous pollutants along the groundwater flow path prior to the groundwater

reaching discrete receptors such as areas of groundwater discharge to surface watercourses or water features it is considered that this assumption is conservative. Dilution in the surface water features is also ignored.

3.8 Consistent with the deposition of the imported materials below the water table the source term in respect of the rogue loads has been modelled using simulation level 3a in ConSim which simulates direct groundwater contamination. A constant source term is assumed conservatively although over time physical and chemical processes will operate to reduce the concentrations of substances present in the rogue load. It is considered that this approach will result in a conservative assessment of the effects of acceptance of rogue loads on groundwater receptors.

3.9 The concentrations of substances predicted at the edge of the AGB calculated using the ConSim model are used as an input parameter in a spreadsheet based model which calculates the predicted concentration of contaminants in the sand and gravel aquifer at the compliance point taking into account immediate dilution in the aquifer. For each of the substances modelled environmental assessment limits (EALs) have been specified. To assess the magnitude of the potential impact on groundwater quality of the possible acceptance of rogue loads the predicted concentration of contaminants in the sand and gravel aquifer at the compliance point are compared with the EALs. The spreadsheet models are presented at Appendix C.

3.10 The predicted concentration of contaminants in the sand and gravel aquifer at the compliance point following immediate dilution is calculated as follows:

$$C_{aq} = \frac{C_{mat} \times Q_{mat} + C_{bg} \times Q_{aq}}{Q_{mat} + Q_{aq}}$$

where:

C_{aq} is the predicted concentration in the aquifer (mg/l)

C_{mat} is the concentration predicted at the edge of the AGB using the ConSim model output (mg/l)

Q_{mat} is the groundwater discharge from the imported materials (m^3/s) which is calculated based on the hydraulic conductivity of the imported materials multiplied by the assumed hydraulic gradient across the imported materials.

C_{bg} is the background concentration of the contaminant in the sand and gravel aquifer (mg/l)

Q_{aq} is the groundwater flow in the sand and gravel aquifer (m^3/s) down hydraulic gradient of the site which is calculated based on the assumed hydraulic conductivity of the sand and gravel multiplied by the assumed hydraulic gradient across the imported materials. Dilution is assumed to occur in the aquifer down hydraulic gradient of the rogue load only. The approach to calculating groundwater flow is consistent generally with the approach adopted to calculating the steady state dilution in the aquifer presented in the Environment Agency spreadsheet model "Contaminant Fluxes from Hydraulic Containment Landfills Worksheet Version 1.0".

4. Model input parameters

4.1 The model input parameters have been entered as necessary using probability density functions to accommodate variations in data or uncertainty in data and to facilitate use of the Monte Carlo simulation technique. Where possible the input parameters are based on site specific data or other relevant sources. Where no site specific data are available professional judgement has been used to select appropriate parameter values based on relevant scientific literature. The model input parameters are presented in Tables 1 to 4.

4.2 The materials imported to the site will comprise inert waste only and there is no expectation that the imported materials will contain discernible concentrations of hazardous substances or significant concentrations of non-hazardous pollutants. Nevertheless to carry out a quantitative assessment of the potential for rogue loads to affect groundwater quality it is necessary to establish a source term for the possible rogue loads. On this basis a representative set of substances was selected for the modelling of potential rogue loads based generally on the physical and chemical properties and behaviour in the environment of a wide range of substances and which has been agreed with the EA previously in respect of other sites.

4.3 It is considered that the hazardous substances mercury and toluene are representative of the general behaviour of substances in the categories heavy metals and light aromatic hydrocarbons respectively. Based on the available groundwater quality monitoring data mercury is typically recorded as below the analytical detection limit on which basis it is assumed that mercury is not present in groundwater at the site.

4.4 The selected non-hazardous pollutants comprise the metal zinc, together with sulphate, chloride and naphthalene (although previously classed as a hazardous substance naphthalene has been reclassified as a non-hazardous pollutant). Chloride is selected for its conservative behaviour in groundwater as it does not sorb readily to aquifer materials, does not undergo biodegradation and forms common mineral compounds which are very soluble in natural waters. Sulphate is a non-hazardous substance which is ubiquitous in geological materials and natural waters. Zinc was selected as it is a non-hazardous metal which may have the potential to be present in a rogue load in respect of the waste types which it is proposed will be

accepted at the site. Naphthalene is considered to be representative of the general behaviour of polycyclic aromatic hydrocarbons (PAHs). The substances which comprise the source term in respect of the modelled rogue load together with the source concentrations are presented in Table 1.

4.5 The use of inert Waste Acceptance Criteria (WAC) limits as a basis for specifying a source term in respect of an activity which involves placing of inert waste in the ground is a standard risk assessment approach adopted in a range of hydrogeological settings where site specific information is not available. Although as described above procedures will be in place including robust waste acceptance procedures during deposition of waste at the site so that the quality of the restoration materials meets the necessary minimum standards for use at the site it is assumed generally that the source term for the rogue load assessment will comprise material in which the concentrations of the substances that will be modelled exceed significantly inert WAC limits where such are specified.

4.6 For the purpose of the rogue load assessment it is assumed conservatively that non-conforming loads with the hazardous substance mercury and the non-hazardous pollutants chloride, sulphate and zinc potentially could be accepted at the site at concentrations which exceed significantly the liquid to solid ratio 10 l/kg leaching limit values expressed in mg/l and the maximum concentration comprises three times the liquid to solid ratio 10 l/kg leaching limit values C_0 concentration presented in the EU Commission document for inert WAC (reference 1) notwithstanding the waste acceptance and other procedures that will be in place. As the inert WAC limits for total organic substances are not converted readily to leachate concentrations for individual organic substances representative of the likely leachate concentrations generated by infiltration through the inert waste, leachate source concentrations for toluene and naphthalene are set based on literature values. The source concentrations in respect of the rogue loads for toluene and naphthalene are based conservatively on concentrations of these substances recorded in leachate at landfill sites accepting a range of non-hazardous and hazardous waste (reference 2). It is assumed conservatively that the concentrations of naphthalene and toluene in rogue loads will range between the respective maximum and three times the respective maximum leachate concentrations presented in reference 2. The input parameters

relevant to attenuation in the flow path from the location of a rogue load to the down hydraulic gradient edge of the AGB are presented in Table 2.

4.7 Consistent with Tables 3 and 4 it is assumed that the hydraulic conductivity of the imported materials will be approximately 1 x 10^{-7} m/s. The value is consistent with a typical literature value for an upper estimate of the hydraulic conductivity of clay. It is assumed that a rogue load is placed in the waste mass at a distance of 9m from the down hydraulic gradient edge of the waste mass or 10m from the in situ aquifer material taking into account the 1m thickness of the AGB. For the purpose of the ConSim modelling the AGB, which will have a hydraulic conductivity less than 1x10^{-7}m/s, comprises part of the pathway separating the rogue load from the in situ aquifer material. It is not necessary to model the attenuation as a separate pathway in ConSim as the assumed hydraulic conductivity of the waste mass and the imported waste is consistent. The hydraulic gradient assumed for the sand and gravel aquifer pathway in the vicinity of Phases 1 and 3 is based on the available groundwater level monitoring data. It is assumed conservatively that the hydraulic gradient across the deposited waste in Phases 1 and 3 will be double the hydraulic gradient assumed for the sand and gravel the aquifer. Infiltration to the waste mass is also taken into account in the ConSim models presented at Appendix A.

4.8 For each of the substances modelled Environmental Assessment Limits (EALs) are proposed. The EALs comprise the concentrations of substances above which it is considered there may be a discernible discharge of hazardous substances to groundwater or pollution of groundwater by non-hazardous pollutants. The EALs for hazardous substances are set at their respective minimum reporting values (MRVs). The EALs for non-hazardous pollutants are set based on background groundwater quality where available and relevant water quality standards. Background groundwater quality data used in the derivation of the EALs for chloride and sulphate is from the period January 2020 to October 2021 (31 datasets) and for zinc from the period of March 2020 to October 2021 (21 datasets) and the data is presented at Appendix ESSD I of the ESSD report. The background quality data for zinc between 7 January 2020 and 25 March 2020 has a few datasets where the concentrations recorded appear to be outliers. From 31 March 2021 there is less variation recorded in the concentration of the 21 datasets.

4.9 As the background concentrations for chloride, sulphate and zinc at both phases are typically significantly lower than relevant water quality standards the EALs for these substances are set at concentrations intermediate between the average background concentrations recorded in the receiving groundwater and the relevant water quality standard. The EALs derived are substantially lower than the relevant water quality standards which are relevant at the receptor. For zinc concentrations recorded at Phase 1 the mean background concentration is slightly higher than the freshwater environmental quality standard (EQS) and the EQS has been exceeded on a number of occasions based on the background groundwater quality data. For zinc the EAL has been set at the mean background concentration plus 1.5 times the standard deviation. The EALs for the substances modelled are presented in Tables 5 and 6.

5. Modelling results and conclusions

5.1 As stated above it is considered that there is no significant risk to groundwater quality from the deposition at the site of the waste types specified in the application. The purpose of the quantitative risk assessment is to assess the effects of the possible acceptance at the site of rogue loads. The results of the quantitative rogue load assessment carried out using ConSim are presented in Tables 5 and 6. Electronic copies of the risk assessment models and results are presented at Appendix C.

5.2 For Phase 1 and Phase 3 the results for the hazardous substance toluene and the results for the non-hazardous substance naphthalene in Phase 1 show that the modelling peak 50th percentile and 95th percentile concentrations at the down hydraulic gradient edge of the AGB are less than 1×10^{-10}mg/l. For Phase 3 the results for the non-hazardous substance naphthalene show that the modelling peak 50th percentile concentration at the down hydraulic gradient edge of the AGB is less than 1×10^{-10}mg/l. The modelling peak for the 95th percentile concentration at the down hydraulic gradient edge of the AGB is 4.3×10^{-10}mg/l and following dilution in the aquifer the concentration is less than 1×10^{-10}mg/l. The mercury concentrations for both phases show that the modelling peak 50th percentile and 95th percentile concentrations at the down hydraulic gradient edge of the AGB are less than 1×10^{-10}mg/l.

5.3 Based on the waste types that it is proposed will be accepted to the site it is considered highly unlikely that the organic hazardous substances toluene and non-hazardous substance naphthalene would be recorded in the imported waste and on this basis it is considered that there is a no reasonable basis for monitoring for and specifying compliance limits for toluene and naphthalene.

5.4 For Phases 1 and 3 the results for the non-hazardous pollutants chloride, sulphate and zinc show that the modelled peak 50th percentile and 95th percentile groundwater concentrations at the non-hazardous pollutant compliance point following immediate dilution in the sand and gravel aquifer do not increase the concentrations in groundwater when compared with the background concentrations. The concentrations calculated at the compliance point in the aquifer are lower than the relevant EALs.

5.5 It is considered that the assumptions on which the quantitative modelling is based are conservative. The receptor is groundwater in the sand and gravel aquifer external to the site. Whilst immediate dilution is taken into account at the down hydraulic gradient edge of the AGB no account is taken of natural attenuation in the aquifer which will occur prior to groundwater reaching discrete down hydraulic gradient receptors such as groundwater abstractions or areas of groundwater discharge to surface watercourses.

5.6 The ConSim modelling is based on the assumption that a single rogue load will be present in discrete flow paths through the imported material. Based on the way that the dilution calculations are constituted and the results of the modelling it is considered unlikely that the presence of more than one rogue load would affect significantly the results of the modelling

5.7 Based on the results of the assessment it is considered that there is no significant risk of discernible discharges of hazardous substances and that there will be no significant pollution by non-hazardous substances resulting from the acceptance of a rogue load at the site consistent with the modelled source term.

5.8 Based on the results of the risk assessment it is considered that the site will be compliant with The Environmental Permitting (England and Wales) Regulations 2016 with regard to the relevant provisions of the Directive 2006/118/EC of the European Parliament and of the Council on the protection of groundwater against pollution and deterioration (the 2006 Groundwater Directive).

6. Requisite surveillance

6.1 The scheme of operational groundwater quality monitoring is presented in Table ESSD 1 of the ESSD report. The groundwater monitoring locations are shown approximately on Figure ESSD 10. The proposed groundwater monitoring locations and determinands for which groundwater quality compliance and assessment limits should be set are presented in Table 7. Consistent with Table 7 groundwater quality compliance and assessment limits for groundwater at the down hydraulic gradient boreholes GW2, GW3, BHF, GW5 and GW6 have been calculated based on the available groundwater quality monitoring data.

6.2 No surface water monitoring is proposed as groundwater monitoring boreholes are located between the deposited waste and the surface water receptors. The groundwater monitoring boreholes down hydraulic gradient of each phase are considered the most appropriate locations at which to assess the environmental performance of the site given their proximity to the boundary of each phase. As there are potential influences on surface water in proximity to the site and surface water would dilute any contaminants entering the watercourse from groundwater migrating from the deposited waste it is considered that the surface water monitoring locations are not the appropriate monitoring locations to assess the environmental performance of the site.

7. Conclusions

7.1 The deposited materials will comprise site soils and overburden and imported inert waste. The waste acceptance procedures that will be in place will minimise the risk that unacceptable waste materials are accepted. The waste types that will be accepted at the site comprise a limited range of inert waste types only. Based on the assessment of the waste types water which percolates through the waste mass will not contain discernible concentrations of hazardous substances and the concentrations of hazardous substances in groundwater at a relevant compliance point located down hydraulic gradient of the site will not be discernible. Based on the waste types that will be accepted and the Waste Acceptance Procedures there is a negligible risk of unacceptable impacts on groundwater or surface water quality and based on the HRA presented in this report it is considered that there is no significant risk from the proposed deposition of inert waste to groundwater quality in the vicinity of the site. Based on the environmental setting and the inert nature of the waste materials that will be deposited, active long term site management will not be necessary in order to prevent long term groundwater pollution.

7.2 Waste Acceptance Procedures will be implemented to minimise the probability that non-inert wastes will be deposited at the site. It is considered that there will be no significant risk to groundwater beneath the site, surface water bodies in the vicinity of the site and groundwater and surface water abstractions in the vicinity of and down hydraulic gradient of the site.

8. References

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8. Scott Doherty Associates, Proposed Sand & Gravel Working on Land at Earls Barton Quarry Hydrological and Hydrogeological Assessment, September 2007

9. Environment Agency, 2006, Remedial Targets Methodology

TABLES

Table 1

Source term concentrations assumed in the ConSim rogue loads assessment model

Determinand	Environmental assessment limit (EAL) (mg/l)	EAL source [a]	Source term concentration (mg/l)	Probability density function
Hazardous substances				
Mercury	0.00001 [h]	MRV	0.001/0.003 [b]	Uniform
Toluene	0.004	MRV	1.287/3.861 [c]	Uniform
Non-hazardous pollutants				
Zinc	Phase 1 0.1045 Phase 3 0.01065 [e]	Midpoint between UK DWS and BGC	0.4/1.2 [b]	Uniform
Chloride	Phase 1 172.0 Phase 3 156.35 [f]	Midpoint between UK DWS and BGC	80/240 [b]	Uniform
Sulphate	Phase 1 174.5, Phase 3 172.7 [g]	Midpoint between UK DWS and BGC	100/300 [b]	Uniform
Naphthalene	0.00001 [d]	MRV	0.042/0.126 [c]	Uniform

Notes:

MRV Minimum reporting value;
EQS Environmental Quality Standard;
UK DWS UK Drinking Water Standard;
BGC Mean background groundwater concentration based on the available water quality monitoring data presented at Appendix D for the period January 2020 to October 2021 for chloride and sulphate and for zinc from the period of March 2020 to October 2021.

[a] The MRVs specified are consistent with MRVs specified at https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values unless stated otherwise.

[b] The minimum concentration comprises the liquid to solid ratio 10 l/kg leaching limit values expressed in mg/l and maximum concentration comprises three times the liquid to solid ratio 10 l/kg leaching limit values expressed in mg/l presented in the EU Commission document for inert WAC (reference 1)

[c] Concentrations are the maximum and three times the maximum concentrations respectively based on the maximum concentrations recorded in 63 leachate samples from a variety of waste types including municipal, mixed MSW and non-hazardous waste types and co-disposal sites (reference 2)

[d] Based on information provided by the Environment Agency National Laboratory Service that a typical MRV for naphthalene in clean groundwater is 0.01µg/l

[e] The EQS for zinc is 0.0109mg/l of bioavailable zinc plus the ambient background concentration of the River Nene of 0.004mg/l as specified by the Environment Agency in The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (a total of 0.0149mg/l). Conservatively it is assumed that all the zinc is bioavailable. The mean background groundwater concentration of zinc for Phase 1 (GW4) is 0.006mg/l. The EAL for Phase 3 is 0.0084mg/l calculated as the midpoint between the background concentration for Phase 3 (GW1) of 0.0064mg/l and the EQS of 0.0149mg/l.

[f] The EALs are calculated as the midpoint between the mean background groundwater concentrations of chloride for Phase 1 and Phase 3 of 172.0mg/l and 156.35mg/l respectively and the UK DWS for chloride 250mg/l.

[g] The EALs are calculated as the midpoint between the mean background groundwater concentrations of sulphate for Phase 1 and Phase 3 of 174.5mg/l and 172.7mg/l respectively and the UK DWS for sulphate of 250mg/l.

[h] The MRV in respect of mercury is 0.00001mg/l. It is assumed that mercury is not present in groundwater at the site.

Table 2

Input parameters used in the ConSim model relevant to attenuation in the flow path from the location of the rogue load to the down hydraulic gradient edge of the artificial geological barrier

Determinand	K_{oc} (ml/g) [1,2]			K_d (ml/g) [1]			Half-life (years) [1,3]	
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	Minimum	Maximum
Hazardous substances								
Mercury					3835.4			
Toluene	131		242				0.054	0.822
Non-hazardous pollutants								
Zinc					26			
Chloride					0			
Sulphate					0			
Naphthalene		1288					0.274	2.740

[1] Parameters derived from ConSim suggested input parameters. Conservatively a K_d of zero is used for sulphate even though sulphate frequently undergoes chemical reactions during migration in the subsurface.
[2] For organic substances K_{oc} values are used to calculate K_d.
[3] For substances which biodegrade.

Table 3

Physical input parameters used in the ConSim model for Phase 1

Parameter		Units	Minimum	Most likely	Maximum	Probability density function	Reference/Justification
Source parameters							
Size	Width	m		3.33		Single	Each individual rogue load is assumed to comprise a volume of 30m^3. Assuming that the thickness of the imported materials is approximately 2.71m the width and length of each individual rogue load is assumed as 3.33m.
	Length			3.33		Single	
Parameters relevant to contaminant migration in the waste mass							
Infiltration		mm/year		Mean: 62.4 Standard deviation: 6.24		Normal	Rainfall runoff and infiltration calculations have been undertaken consistent with a methodology developed by Thornthwaite and Mather (reference 3) and described in detail in Koerner and Daniel (reference 4) which take into account that the amount of runoff and infiltration will vary depending on the time of year. Runoff rates are calculated using a method published by the National Coal Board (reference 5) which takes into account slope gradient, vegetation type and soil type variations. Ground slope is a key determinant of runoff rate. The water balance approach is based on long term mean meteorological conditions published for the England South East and Central South area by the Met Office. The calculations are presented at Appendix B. It is assumed that the standard deviation is 10% of the infiltration.
Waste porosity		Fraction		0.3		Single	The porosity assumed for inert waste in Hjelmar et al, 2001 (reference 6)
Waste dry density		kg/l		1.4		Single	Calculated assuming a waste bulk density of 1.7kg/l. It is assumed that the waste is fully saturated with a porosity of 0.3.
Effective porosity		Fraction		0.3		Single	The porosity assumed for inert waste in Hjelmar et al, 2001 (reference 6). It is assumed that the waste is fully saturated.
Hydraulic conductivity		m/s		1×10^{-7}		Single	It is assumed that the hydraulic conductivity of the waste mass is 1×10^{-7} m/s based on the upper estimate of the hydraulic conductivity of clay reported by Kruseman and de Ridder 1994 (reference 7).
Longitudinal dispersivity		m		1		Single	The length of the pathway is 10m. Consistent with the comments in the ConSim manual it is assumed that the longitudinal dispersivity is 10% of the pathway length. It is assumed that the transverse dispersivity is 30% of the longitudinal dispersivity.
Transverse dispersivity		m		0.3		Single	
Fraction of organic carbon (f_{oc})		Fraction	0.01		0.1	Uniform	Based on the range of values presented for clay in the ConSim Help file.
Thickness of the imported materials		m		2.71		Single	Approximate based on Figure ESSD 11 (drawing reference BRE/EA/05-20/21774).
Hydraulic gradient				8.6×10^{-3}		Single	To account for the possibility that the hydraulic gradient in the waste mass will be greater than in the aquifer conservatively a hydraulic gradient of twice that in the aquifer has been used.
Travel distance to the edge of the imported materials (including the artificial geological barrier thickness)		m		10		Single	Conservatively it is assumed that rogue loads are placed in the waste mass at a distance of 10m only from the down hydraulic gradient edge of the imported material
Sand and gravel aquifer parameters							
Hydraulic gradient				4.3×10^{-3}		Single	The hydraulic gradient is calculated based on the indicative groundwater contours for 15 January 2020 shown on Figure ESSD 13 (drawing reference BRE/EA/04-20/21726).
Hydraulic conductivity		m/s		5.8×10^{-3}		Single	Range of values reported in reference 8 for the River Terrace Deposits in the vicinity of the site.

Table 4

Physical input parameters used in the ConSim model for Phase 3

Parameter		Units	Minimum	Most likely	Maximum	Probability density function	Reference/Justification
Source parameters							
Size	Width	m		2.77		Single	Each individual rogue load is assumed to comprise a volume of 30m^3. Assuming that the thickness of the imported materials is approximately 3.93m the width and length of each individual rogue load is assumed as 2.77m.
	Length			2.77		Single	
Parameters relevant to contaminant migration in the waste mass							
Infiltration		mm/year		Mean: 55.3 Standard deviation: 5.53		Normal	Rainfall runoff and infiltration calculations have been undertaken consistent with a methodology developed by Thornthwaite and Mather (reference 3) and described in detail in Koerner and Daniel (reference 4) which take into account that the amount of runoff and infiltration will vary depending on the time of year. Runoff rates are calculated using a method published by the National Coal Board (reference 5) which takes into account slope gradient, vegetation type and soil type variations. Ground slope is a key determinant of runoff rate. The water balance approach is based on long term mean meteorological conditions published for the England South East and Central South area by the Met Office. The calculations are presented at Appendix B. It is assumed that the standard deviation is 10% of the infiltration.
Waste porosity		Fraction		0.3		Single	The porosity assumed for inert waste in Hjelmar et al, 2001 (reference 6)
Waste dry density		kg/l		1.4		Single	Calculated assuming a waste bulk density of 1.7kg/l. It is assumed that the waste is fully saturated with a porosity of 0.3.
Effective porosity		Fraction		0.3		Single	The porosity assumed for inert waste in Hjelmar et al, 2001 (reference 6). It is assumed that the waste is fully saturated.
Hydraulic conductivity		m/s		1×10^{-7}		Single	It is assumed that the hydraulic conductivity of the waste mass is 1×10^{-7} m/s based on the upper estimate of the hydraulic conductivity of clay reported by Kruseman and de Ridder 1994 (reference 7).
Longitudinal dispersivity		m		1		Single	The length of the pathway is 10m. Consistent with the comments in the ConSim manual it is assumed that the longitudinal dispersivity is 10% of the pathway length. It is assumed that the transverse dispersivity is 30% of the longitudinal dispersivity.
Transverse dispersivity		m		0.3		Single	
Fraction of organic carbon (f_{oc})		Fraction	0.01		0.1	Uniform	Based on the range of values presented for clay in the ConSim Help file.
Thickness of the imported materials		m		3.93		Single	Approximate based on Figure ESSD 11 (drawing reference BRE/EA05-20/21774).
Hydraulic gradient				5.2×10^{-3}		Single	To account for the possibility that the hydraulic gradient in the waste mass will be greater than in the aquifer conservatively a hydraulic gradient of twice that in the aquifer has been used.
Travel distance to the edge of the imported materials		m		10		Single	Conservatively it is assumed that rogue loads are placed in the waste mass at a distance of 10m only from the down hydraulic gradient edge of the imported material
Sand and gravel aquifer parameters							
Hydraulic gradient				2.6×10^{-3}		Single	The hydraulic gradient is calculated based on the indicative groundwater contours for 15 January 2020 shown on Figure ESSD 13 (drawing reference BRE/EA/04-20/21726).
Hydraulic conductivity		m/s		5.8×10^{-3}		Single	Range of values reported in reference 8 for the River Terrace Deposits in the vicinity of the site.

Table 5
Results of the ConSim rogue loads assessment (Phase 1)

Determinand	Background concentration (mg/l)	Maximum concentration (mg/l)				Environmental assessment limit (EAL) (mg/l)
		Concentration predicted at the edge of the imported materials using the ConSim model output		Concentration predicted in the sand and gravel aquifer [1]		
		50th percentile	95th percentile	50th percentile	95th percentile	
Toluene	NA	-	-	-	-	0.004
Naphthalene	NA	-	-	-	-	0.00001
Mercury	NA	-	-	-	-	0.00001
Chloride	94.0	172.2	207.6	94.0	94.0	172.0
Zinc	0.006	0.40	0.57	0.006	0.006	0.01045
Sulphate	99.0	195.1	240.9	99.0	99.0	174.5

Notes:
Probabilistic results from the risk assessment model are given as the 50th percentile which presents a 'most likely' assessment and the 95th percentile which represents a 'realistic worst case' assessment.

- Maximum concentration does not exceed 1 x 10^{-10} mg/l.

[1] The calculated groundwater concentration immediately down hydraulic gradient of the imported materials after allowing for immediate dilution in the groundwater.

NA No background groundwater quality data available.

Table 6
Results of the ConSim rogue loads assessment (Phase 3)

Determinand	Background concentration (mg/l)	Maximum concentration (mg/l)				Environmental assessment limit (EAL) (mg/l)
		Concentration predicted at the edge of the imported materials using the ConSim model output		Concentration predicted in the sand and gravel aquifer [1]		
		50th percentile	95th percentile	50th percentile	95th percentile	
Toluene	NA	-	-	-	-	0.004
Naphthalene	NA	-	$4.3x10^{-10}$	-	-	0.00001
Mercury	NA	-	-	-	-	0.00001
Chloride	62.7	129.1	159.4	62.7	62.7	156.35
Zinc	0.0064	0.35	0.49	0.0064	0.0064	0.01065
Sulphate	95.4	177.1	217.2	95.4	95.4	172.7

Notes:
Probabilistic results from the risk assessment model are given as the 50th percentile which presents a 'most likely' assessment and the 95th percentile which represents a 'realistic worst case' assessment.

- Maximum concentration does not exceed 1 x 10^{-10} mg/l.

[1] The calculated groundwater concentration immediately down hydraulic gradient of the imported materials after allowing for immediate dilution in the groundwater.

NA No background groundwater quality data available

Table 7

Groundwater quality compliance and assessment limits

Criterion Objective To confirm that the deposition of inert waste at the site has no adverse effect on groundwater quality	
Measurement	Ammoniacal nitrogen, chloride, sulphate, lead and zinc
Frequency	Quarterly. To be reviewed annually.
Monitoring points	Groundwater monitoring borehole GW5 and GW6 down hydraulic gradient of Phase 1 and boreholes GW2, GW3 and BH F down hydraulic gradient of Phase 3.
Compliance limits[1] for down hydraulic gradient groundwater monitoring boreholes	**Phase 3** **GW2, GW3 and BH F** The concentration of ammoniacal nitrogen shall not exceed 0.38mg/l. The concentration of chloride shall not exceed 177mg/l. The concentration of sulphate shall not exceed 192mg/l. The concentration of lead shall not exceed 0.001mg/l. The concentration of zinc shall not exceed 0.043mg/l. **Phase 1** **GW5** The concentration of ammoniacal nitrogen shall not exceed 0.056mg/l. **GW6** The concentration of ammoniacal nitrogen shall not exceed 0.66mg/l. **GW5 and GW6** The concentration of chloride shall not exceed 229mg/l. The concentration of sulphate shall not exceed 192mg/l. The concentration of lead shall not exceed 0.001mg/l. The concentration of zinc shall not exceed 0.042mg/l.
Assessment limits[2] for down hydraulic gradient groundwater monitoring boreholes	**Phase 3** **GW2, GW3 and BH F** The concentration of ammoniacal nitrogen shall not exceed 0.27mg/l. The concentration of chloride shall not exceed 139mg/l. The concentration of sulphate shall not exceed 160mg/l. The concentration of lead shall not exceed 0.001mg/l. The concentration of zinc shall not exceed 0.03mg/l. **Phase 1** **GW5** The concentration of ammoniacal nitrogen shall not exceed 0.042mg/l. **GW6** The concentration of ammoniacal nitrogen shall not exceed 0.51mg/l.

	GW5 and GW6 The concentration of chloride shall not exceed 184mg/l. The concentration of sulphate shall not exceed 161mg/l. The concentration of lead shall not exceed 0.001mg/l. The concentration of zinc shall not exceed 0.03mg/l.
Assessment test	Concentrations exceed the assessment limit on three consecutive occasions.

Contingency action	**Response Time**
Advise the Environment Agency.	1 month
Increase the survey frequency to monthly.	1 month
Undertake investigation work to identify the source of the contaminants.	6 months
Report to the Environment Agency on the re-appraisal of risks and options for corrective measures.	12 months
If the risks are acceptable re-evaluate the assessment criteria. If the risks are unacceptable implement agreed corrective measures.	18 months 18 months

Notes:

[1] The compliance limits generally are set at the mean concentration recorded plus three standard deviations.

[2] The assessment levels generally are set at the mean concentration recorded plus two standard deviations.

Compliance and assessment limits for ammoniacal nitrogen, chloride, sulphate and zinc at boreholes GW2, GW3 and BHF are calculated based on concentrations recorded between January 2020 and October 2021 (except for zinc which is from the period of March 2020 to October 2021) from borehole GW1, GW2, GW3 and BHF.
Compliance and assessment limits for chloride, sulphate and zinc at boreholes GW5 and GW6 are calculated based on concentrations recorded between January 2020 and October 2021 (except for zinc which is from the period of March 2020 to October 2021) from boreholes GW4, GW5 and GW6.
Compliance and assessment limits for ammoniacal nitrogen at borehole GW5 are calculated based on concentrations recorded between January 2020 and October 2021 from boreholes GW4, and GW5. As the variation in ammoniacal nitrogen concentrations recorded in borehole GW6 between January 2020 and October 2021 generally are greater than in the other boreholes the assessment and compliance limits for ammoniacal nitrogen at borehole GW6 have been calculated based on the concentrations recorded in borehole GW6 only.
As lead is not recorded above the detection limit the assessment limit and compliance limits provisionally are set at the detection limit.

APPENDIX A

CONSIM MODELS FOR PHASE 1 AND PHASE 3 AT EARLS BARTON QUARRY

APPENDIX B

SPREADSHEET MODELS FOR INFILTRATION RATES FOR PHASE 1 AND PHASE 3 AT EARLS BARTON QUARRY

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Total	Comments/justification
Average monthly temperature [°C]	3.4	3.6	5.4	7.7	10.9	13.8	15.8	15.5	13.2	9.8	6.0	4.1		Mean monthly temperature for the Midlands (Met Office)
Monthly heat index [H_m]	0.6	0.6	1.1	1.9	3.3	4.7	5.7	5.5	4.3	2.8	1.3	0.8	32.55	Koerner and Daniel, 1997. Eqn 4.7.
Unadjusted daily potential evapotranspiration [UPET], mm	0.56	0.59	0.89	1.28	1.81	2.31	2.64	2.59	2.20	1.62	0.99	0.68		Koerner and Daniel, 1997. Eqn 4.8
Possible monthly duration of sunlight [N]	22.2	23.4	30.6	34.5	39.9	40.8	41.1	37.5	31.8	27.6	22.8	21.0		Koerner and Daniel, 1997. Table 4.3, NB: use 50deg poleward of 50deg
Potential evapotranspiration [PET], mm	12.3	13.7	27.4	44.1	72.3	94.2	108.4	97.0	69.9	44.7	22.6	14.2	620.97	PET= UPET **x N**
Precipitation [P], mm	74.3	56.2	55.6	53.6	59.4	57.9	65.6	72.1	64.0	74.4	78.0	78.6	789.70	Mean monthly rainfall for the Midlands (Met Office)
Runoff coefficient [C]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
Runoff [R], mm	39.4	29.8	29.5	28.4	31.5	30.7	34.7	38.2	33.9	39.5	41.3	41.7	418.54	R = P x C
Infiltration [IN], mm	34.9	26.4	26.1	25.2	27.9	27.2	30.8	33.9	30.1	35.0	36.6	36.9	371.16	IN = P - R
IN - PET, mm	22.6	12.7	-1.2	-18.9	-44.4	-67.0	-77.6	-63.1	-39.8	-9.8	14.0	22.7		
Accumulated water loss [WL], mm	0.0	0.0	-1.2	-20.1	-64.6	-131.5	-209.1	-272.2	-312.0	-321.8	-321.8	-321.8		WL = Sum of neg * IN - PETs
Water stored (WS), mm	75.0	75.0	73.7	57.6	40.3	29.4	25.4	31.1	43.0	65.4	75.0	75.0		
Change in water storage [CWS], mm	0.0	0.0	-1.3	-16.2	-17.3	-10.9	-4.1	5.7	12.0	22.4	9.6	0.0		
Actual evapotranspiration [AET], in	12.3	13.7	27.4	41.4	45.2	38.1	34.9	28.2	18.1	12.6	22.6	14.2	308.75	
Percolation [PERC], mm	22.6	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	22.7	62.41	
Check [CK], mm	74.3	56.2	55.6	53.6	59.4	57.9	65.6	72.1	64.0	74.4	78.0	78.6	789.70	
Percolation rate [FLUX], m/s	8.7E-09	4.9E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.7E-09	8.8E-09		

Runoff coefficient (NCB, 1982)	**0.53**	Ground slope:	**0.007**	Based on an approximate fall of 3m across the restored phase over a distance of approximately 415m.
		Vegetation type:	**Cultivated**	
		Soil type:	**Clay loam**	
Root zone depth, mm	200.0	Lowest maximum root zone depth specified in Koerner and Daniel, 1997 paragraph 4.4.1.12.		
Volumetric water content at field capacity (θ)	0.375	Clay loam (Koerner and Daniel, 1997 table 4.5)		
Maximum water storage capacity, mm	75.0	Start water storage calculation on a month where water stored is known or can be calculated (e.g. after winter when there is no soil moisture deficit)		

	Annual	Percentage of precipitation
Precipitation, mm	789.7	100.0
Runoff, mm	418.5	53.0
Actual evapotranspiration, mm	308.7	39.1
Percolation, mm	62.4	7.9
Ratio of runoff to percolation	6.7	

References

Koerner, R. M. and Daniel, D. E. 1997. Final covers for solid waste landfills and abandoned dumps. American Society of Civil Engineers, Virginia and Thomas Telford, London. (Reference 15)

National Coal Board (NCB) document entitled "Technical Management of Water in the Coal Mining Industry " dated 1982. (Reference 16)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Total	Comments/justification
Average monthly temperature [°C]	3.4	3.6	5.4	7.7	10.9	13.8	15.8	15.5	13.2	9.8	6.0	4.1		Mean monthly temperature for the Midlands (Met Office)
Monthly heat index [H_m]	0.6	0.6	1.1	1.9	3.3	4.7	5.7	5.5	4.3	2.8	1.3	0.8	32.55	Koerner and Daniel, 1997. Eqn 4.7.
Unadjusted daily potential evapotranspiration [UPET], mm	0.56	0.59	0.89	1.28	1.81	2.31	2.64	2.59	2.20	1.62	0.99	0.68		Koerner and Daniel, 1997. Eqn 4.8
Possible monthly duration of sunlight [N]	22.2	23.4	30.6	34.5	39.9	40.8	41.1	37.5	31.8	27.6	22.8	21.0		Koerner and Daniel, 1997. Table 4.3, NB: use 50deg poleward of 50deg
Potential evapotranspiration [PET], mm	12.3	13.7	27.4	44.1	72.3	94.2	108.4	97.0	69.9	44.7	22.6	14.2	620.97	PET= UPET x N
Precipitation [P], mm	74.3	56.2	55.6	53.6	59.4	57.9	65.6	72.1	64.0	74.4	78.0	78.6	789.70	Mean monthly rainfall for the Midlands (Met Office)
Runoff coefficient [C]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
Runoff [R], mm	40.9	30.9	30.6	29.5	32.7	31.8	36.1	39.7	35.2	40.9	42.9	43.2	434.34	R = P x C
Infiltration [IN], mm	33.4	25.3	25.0	24.1	26.7	26.0	29.5	32.5	28.8	33.5	35.1	35.4	355.37	IN = P - R
IN - PET, mm	21.1	11.6	-2.3	-20.0	-45.6	-68.1	-78.9	-64.5	-41.1	-11.2	12.5	21.1		
Accumulated water loss [WL], mm	0.0	0.0	-2.3	-22.3	-67.9	-136.1	-215.0	-279.5	-320.6	-331.8	-331.8	-331.8		WL = Sum of neg * IN - PETs
Water stored (WS), mm	75.0	75.0	72.6	56.7	39.7	29.0	24.9	30.4	42.3	64.1	75.0	75.0		
Change in water storage [CWS], mm	0.0	0.0	-2.4	-15.9	-17.1	-10.7	-4.0	5.5	11.8	21.8	10.9	0.0		
Actual evapotranspiration [AET], in	12.3	13.7	27.4	40.0	43.8	36.7	33.5	26.9	17.0	11.7	22.6	14.2	300.04	
Percolation [PERC], mm	21.1	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	21.1	55.32	
Check [CK], mm	74.3	56.2	55.6	53.6	59.4	57.9	65.6	72.1	64.0	74.4	78.0	78.6	789.70	
Percolation rate [FLUX], m/s	8.1E-09	4.5E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-10	8.1E-09		

Runoff coefficient (NCB, 1982)	**0.55**	Ground slope:	**0.011**	Based on an approximate fall of 1.5m across the restored phase over a distance of approximately 135m.
		Vegetation type:	**Cultivated**	
		Soil type:	**Clay loam**	
Root zone depth, mm	200.0	Lowest maximum root zone depth specified in Koerner and Daniel, 1997 paragraph 4.4.1.12.		
Volumetric water content at field capacity (θ)	0.375	Clay loam (Koerner and Daniel, 1997 table 4.5)		
Maximum water storage capacity, mm	75.0	Start water storage calculation on a month where water stored is known or can be calculated (e.g. after winter when there is no soil moisture deficit)		

	Annual	Percentage of precipitation
Precipitation, mm	789.7	100.0
Runoff, mm	434.3	55.0
Actual evapotranspiration, mm	300.0	38.0
Percolation, mm	55.3	7.0
Ratio of runoff to percolation	7.9	

References

Koerner, R. M. and Daniel, D. E. 1997. Final covers for solid waste landfills and abandoned dumps. American Society of Civil Engineers, Virginia and Thomas Telford, London.

National Coal Board (NCB) document entitled "Technical Management of Water in the Coal Mining Industry " dated 1982

APPENDIX C

SPREADSHEET MODELS FOR PHASE 1 AND PHASE 3 TO CALCULATE THE PREDICTED CONCENTRATIONS AT THE COMPLIANCE POINT IN THE AQUIFER

Determinand	Maximum concentration (mg/l)				Environmental assessment limit (EAL) (mg/l)	Assumed background concentrations (mg/l)	EQS/DWS
	Concentration predicted at the edge of the imported materials using the ConSim model output		Concentration predicted in the compliance point in the aquifer				
	50th percentile	95th percentile	50th percentile	95th percentile			
Toluene	-	-	-	-	4.0×10^{-3}	0	
Naphthalene	-	-	-	-	1.0×10^{-5}	0	
Mercury	-	-	-	-	1.0×10^{-5}	0	
Chloride	172.2	207.6	94.00269646	94.00391711	172.00	94	250
Zinc	4.00E-01	0.57	0.006013586	0.006019448	0.01045	0.006	0.0149
Sulphate	195.1	240.9	99.00331368	99.00489293	174.5	99	250

$$C_{aq} = \frac{C_{mat} \times Q_{mat} + C_{bg} \times Q_{aq}}{Q_{mat} + Q_{aq}}$$

Where C_aq is the concentration in the aquifer (mg/l)
Where Qmat = Kmat x i_mat x (w_rogue x thickness_waste)
Where Qaq = K_aq x i_aq x (width_waste x thickness_waste)

K_mat is the hydraulic conductivity of the imported materials (m/s)	materials K	1.00E-07 m/s
K_aq is the hydraulic conductivity of the sand and gravel aquifer (m/s)	aquifer K	5.80E-03 m/s
i_aq is the hydraulic gradient within the sand and gravel aquifer (m/m)	aquifer i	4.30E-03
i mat is the hydraulic gradient within the imported materials (m/m)	materials i	8.60E-03
w rogue is the width of the rogue load (m)		3.33
w waste is the width of the waste (m)		3.33
thickness waste is the thickness of the waste (m)		2.71

C_bg is the background concentration in the sand and gravel aquifer (mg/l)
C_mat is the concentration predicted at the edge of the imported materials using the ConSim model output.

Determinand	Maximum concentration (mg/l)				Environmental assessment limit (EAL) (mg/l)	Assumed background concentrations (mg/l)	EQS/DWS
	Concentration predicted at the edge of the imported materials using the ConSim model output		Concentration predicted in the compliance point in the aquifer				
	50th percentile	95th percentile	50th percentile	95th percentile			
Toluene	-	-	-	-	4.0×10^{-3}	0	
Naphthalene	-	4.3E-010	-	1.48271E-14	1.0×10^{-5}	0	
Mercury	-	-	-	-	1.0×10^{-5}	0	
Chloride	129.1	159.4	62.70228958	6.27E+01	156.35	62.7	250
Zinc	3.50E-01	0.49	0.006411848	0.006416675	0.01065	0.0064	0.0149
Sulphate	177.1	217.2	95.40281714	95.40419986	172.7	95.4	250

$$C_{aq} = \frac{C_{mat} \times Q_{mat} + C_{bg} \times Q_{aq}}{Q_{mat} + Q_{aq}}$$

Where C_aq is the concentration in the aquifer (mg/l)
Where Qmat = Kmat x i mat x (w rogue x thickness waste)
Where Qaq = K_aq x i_aq x (width_waste x thickness_waste)

K_mat is the hydraulic conductivity of the imported materials (m/s)	materials K	1.00E-07	m/s
K_aq is the hydraulic conductivity of the sand and gravel aquifer (m/s)	aquifer K	5.80E-03	m/s
i aq is the hydraulic gradient within the sand and gravel aquifer (m/m)	aquifer i	2.60E-03	
i mat is the hydraulic gradient within the imported materials (m/m)	materials i	5.20E-03	
w_rogue is the width of the rogue load (m)		2.77	
w waste is the width of the waste (m)		2.77	
thickness_waste is the thickness of the waste (m)		3.93	

C bg is the background concentration in the sand and gravel aquifer (mg/l)
C_mat is the concentration predicted at the edge of the imported materials using the ConSim model output.

APPENDIX D

CALCULATED COMPLIANCE AND ASSESSMENT LIMITS FOR PHASE 1 AND PHASE 3 AT EARLS BARTON QUARRY

Date	GW1	GW2	GW3	GW4	GW5	GW6	BHF
07/01/2020	0.01	0.01	0.01	0.01	0.01	0.05	0.01
15/01/2020	0.01	0.01	0.03	0.01	0.04	0.4	0.01
28/01/2020	0.01	0.01	0.03	0.03	0.08	0.2	0.02
04/02/2020	0.01	0.01	0.03	0.01	0.02	0.16	0.01
13/02/2020	0.01	0.01	0.02	0.01	0.01	0.07	0.01
25/02/2020	0.01	0.01	0.01	0.01	0.01	0.08	0.01
05/03/2020	0.01	0.01	0.01	0.01	0.01	0.02	0.01
12/03/2020	0.01	0.01	0.01	0.01	0.01	0.05	0.01
18/03/2020	0.01	0.01	0.02	0.02	0.01	0.2	0.04
25/03/2020	0.01	0.01	0.01	0.01	0.01	0.19	0.01
31/03/2020	0.01	0.01	0.01	0.01	0.01	0.11	0.01
14/04/2020	0.01	0.01	0.02	0.01	0.01	0.16	0.01
28/04/2020	0.01	0.01	0.05	0.03	0.01	0.2	0.02
14/05/2020	0.01	0.01	0.01	0.01	0.03	0.05	0.08
09/06/2020	0.02	0.01	0.04	0.01	0.01	0.19	0.02
08/07/2020	0.02	0.02	0.13		0.03	0.2	0.03
06/08/2020	0.02	0 9	0.3		0.02	0.5	0.3
08/09/2020	0.01	0.01	0.06		0.01	0.4	0.2
07/10/2020	0.05	0.01	0.01		0.01	0.2	0.04
10/11/2020	0.6	0.49	0.03	0.02	0.03	0.2	0.04
08/12/2020	0.02	0.01	0.01	0.01	0.01	0.2	0.02
07/01/2021	0.01	0.01	0.01	0.01	0.01	0.5	0.01
18/02/2021	0.01	0.01	0.01	0.01	0.01	0.4	0.01
12/03/2021	0.01	0.01	0.01	0.01	0.01	0.5	0.01
14/04/2021	0.01	0.01	0.01	0.01	0.01	0.02	0.01
21/05/2021	0.02	0.02	0.02	0.06	0.04	0.07	0.01
17/06/2021	0.01	0.02	0.01	0.03	0.01	0.2	0.01
06/07/2021	0.005	0.13	0.01	0.01	0.01	0.12	0.01
11/08/2021	0.16	0.02	0.12	0.01	0.01	0.2	0.02
16/09/2021	0.01	0.04	0.09	0.01	0.01	0.2	0.01
15/10/2021	0.11	0.03	0.05	0.01	0.01	0.5	0.03

								GW1, GW2, GW3 and BHF	GW4 and GW5
Minimum	0.005	0.01	0.01	0.01	0.01	0.02	0.01	0.005	0.01
Maximum	0.6	0 9	0.3	0.06	0.08	0.5	0.3	0.9	0.08
Mean	0.039839	0.060968	0.038387	0.014815	0.016774	0.210968	0.033548	0.043185484	0.015862069
Standard deviation (STDEV)	0.1088	0.178706	0.057914	0.011222	0.014919	0.149963	0.061076	0.111874884	0.01324989
Mean + 1*STDEV	0.148639	0.239673	0.096301	0.026036	0.031693	0.360931	0.094625	0.155060368	0.029111959
Mean + 1.5*STDEV	0.203039	0.329026	0.125257	0.031647	0.039153	0.435913	0.125163	0 21099781	0.035736904
Mean + 2*STDEV	0.257439	0.418379	0.154214	0.037258	0.046612	0.510895	0.155701	0.266935252	0.042361849
Mean + 3*STDEV	0.366239	0.597085	0.212128	0.04848	0.061532	0.660858	0.216777	0.378810136	0.055611739

Notes

Concentrations recorded below the analytical detection limit are set at the detection limit.

Value considered a possible outlier or the detection limit is elevated hence excluded.

Analytical result reported as below the analytical detection limit.

Proposed interim assessment limit

Proposed interim compliance limit

Date	GW1	GW2	GW3	GW4	GW5	GW6	BHF
07/01/2020	13	120	106	216	71	130	167
15/01/2020	14	124	104	208	81	91	83
28/01/2020	12	113	83	191	74	93	141
04/02/2020	11	107	81	185	54	90	68
13/02/2020	12	104	86	181	49	88	40
25/02/2020	10	98	78	165	63	90	144
05/03/2020	10	91	75	156	50	90	113
12/03/2020	9	85	74	151	51	90	111
18/03/2020	10	81	72	156	54	88	70
25/03/2020	11	81	76	150	56	89	53
31/03/2020	10	77	82	151	56	88	47
14/04/2020	11	75	89	145	57	88	35
28/04/2020	11	74	86	147	58	89	33
14/05/2020	11	72	79	154	59	90	33
09/06/2020	12	76	84	149	64	80	33
08/07/2020	14	77	84		72	70	35
06/08/2020	12	82	85		74	71	37
08/09/2020	13	86	74		66	77	42
07/10/2020	7	93	70		55	78	43
10/11/2020	16	107	68	87	56	69	44
08/12/2020	15	125	70	94	37	71	42
07/01/2021	15	102	59	119	28	77	128
18/02/2021	14	73	68	154	28	76	102
12/03/2021	13	70	78	168	33	75	70
14/04/2021	10	67	80	136	40	65	35
21/05/2021	10	71	77	116	37	58	37
17/06/2021	10	75	88	151	54	68	41
06/07/2021	10	81	104	158	65	74	45
11/08/2021	13	86	120	167	57	73	48
16/09/2021	13	94	122	151	58	73	49
15/10/2021	12	104	119	129	55	71	46
							Phase 3	Phase 1
							GW1, GW2, GW3 and BHF	**GW4, GW5 and GW6**
Minimum	7	67	59	87	28	58	33	7	28
Maximum	16	125	122	216	81	93	167	167	216
Mean	11.7419355	89.3871	84.54839	153.1481	55.22581	79.66667	65	62.66935484	94.01123596
Standard deviation (STDEV)	1.99946229	16.84177	15.79417	29.23605	13.2255	9.68231	38.66954	38.09609625	45.06497692
Mean + 1*STDEV	13.7413978	106.2289	100.3426	182.3842	68.45131	89.34898	103.6695	100.7654511	139.0762129
Mean + 1.5*STDEV	14.7411289	114.6497	108.2396	197.0022	75.06406	94.19013	123.0043	119.8134992	161.6087013
Mean + 2*STDEV	15.7408601	123.0706	116.1367	211.6202	81.67682	99.03129	142.3391	138.8615473	184.1411898
Mean + 3*STDEV	17.7403224	139.9124	131.9309	240.8563	94.90232	108.7136	181.0086	176.9576436	229.2061667

Notes

Concentrations recorded below the analytical detection limit are set at the detection limit.

Value considered a possible outlier or the detection limit is elevated hence excluded.

Analytical result reported as below the analytical detection limit.

Proposed interim assessment limit

Proposed interim compliance limit

Date	GW1	GW2	GW3	GW4	GW5	GW6	BHF
07/01/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
15/01/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
28/01/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
04/02/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
13/02/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
25/02/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
05/03/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
12/03/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
18/03/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
25/03/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
31/03/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
14/04/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
28/04/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
14/05/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
09/06/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
08/07/2020	0.001	0.001	0.001		0.001	0.001	0.001
06/08/2020	0.001	0.001	0.001		0.001	0.001	0.001
08/09/2020	0.001	0.001	0.001		0.001	0.001	0.001
07/10/2020	0.001	0.001	0.001		0.001	0.001	0.001
10/11/2020	0.001	0.001	0.001	0.001	0.001	0.001	0.001
08/12/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
07/01/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
18/02/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
12/03/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
14/04/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
21/05/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
17/06/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
06/07/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
11/08/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
16/09/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001
15/10/2021	0.001	0.001	0.001	0.001	0.001	0.001	0.001

								GW2, GW3 and BHF	GW5 and GW6
Minimum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Standard deviation (STDEV)	6.61E-19	6.61274E-19	6.61274E-19	6.62913E-19	6.61274E-19	6 61274E-19	6.61274E-19	6.52054E-19	6.54207E-19
Mean + 1*STDEV	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean + 1.5*STDEV	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean + 2*STDEV	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean + 3*STDEV	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Notes

Concentrations recorded below the analytical detection limit are set at the detection limit.

Value considered a possible outlier or the detection limit is elevated hence excluded.

Analytical result reported as below the analytical detection limit.

Proposed interim assessment limit

Proposed interim compliance limit

Date	GW1	GW2	GW3	GW4	GW5	GW6	BH F
07/01/2020	52	96	162	68	167	161	125
15/01/2020	50	91	157	66	133	102	97
28/01/2020	50	94	139	70	129	102	112
04/02/2020	51	94	141	70	114	103	109
13/02/2020	51	95	142	68	117	102	94
25/02/2020	49	94	135	65	110	103	102
05/03/2020	48	91	127	62	139	104	88
12/03/2020	52	97	128	64	117	99	102
18/03/2020	53	102	129	66	123	100	103
25/03/2020	51	96	137	67	129	92	95
31/03/2020	55	95	145	61	120	96	93
14/04/2020	54	96	156	57	139	97	86
28/04/2020	55	95	142	60	140	100	90
14/05/2020	57	93	118	58	137	99	86
09/06/2020	56	101	129	63	151	100	84
08/07/2020	54	81	124		143	88	82
06/08/2020	55	103	123		148	98	86
08/09/2020	58	98	147		142	99	83
07/10/2020	58	104	200		157	107	84
10/11/2020	60	99	151	62	169	96	87
08/12/2020	61	89	164	57	89	106	88
07/01/2021	54	96	135	66	56	106	112
18/02/2021	49	94	128	71	72	102	103
12/03/2021	52	94	126	65	88	110	97
14/04/2021	55	88	138	59	103	127	80
21/05/2021	62	95	144	61	105	116	88
17/06/2021	59	83	134	54	132	98	79
06/07/2021	60	98	138	55	142	107	85
11/08/2021	67	87	130	52	129	103	75
16/09/2021	58	99	142	57	137	110	83
15/10/2021	56	87	138	53	126	103	81

								Phase 3	Phase 1
								GW1, GW2, GW3 and BH F	**GW4, GW5 and GW6**
Minimum	48	81	118	52	56	88	75	48	52
Maximum	67	104	200	71	169	161	125	200	169
Mean	54.90323	94.35484	140.2903	62.11111	125.9032	104.3871	92.22581	95.44354839	99 05617978
Standard deviation (STDEV)	4.399658	5.382369	15.87281	5.46551	25.49164	12.6588	11.58939	32.093943	31.10771592
Mean + 1*STDEV	59.30288	99.73721	156.1631	67.57662	151.3949	117.0459	103.8152	127.5374914	130.1638957
Mean + 1.5*STDEV	61.50271	102.4284	164 0995	70.30938	164.1407	123.3753	109.6099	143.5844629	145.7177537
Mean + 2*STDEV	63.70254	105.1196	172.036	73.04213	176.8865	129.7047	115.4046	159.6314344	161.2716116
Mean + 3*STDEV	68.1022	110 5019	187.9088	78.50764	202.3781	142.3635	126 994	191.7253774	192.3793275

Notes

Concentrations recorded below the analytical detection limit are set at the detection limit.

Value considered a possible outlier or the detection limit is elevated hence excluded.

Analytical result reported as below the analytical detection limit.

Proposed interim assessment limit

Proposed interim compliance limit

Date	GW1	GW2	GW3	GW4	GW5	GW6	BH F
07/01/2020	0.002	0.004	0.002	0.002	0.002	0.004	0.005
15/01/2020	0.004	0.003	0.004	0.002	0.003	0.015	0.011
28/01/2020	0.002	0.002	0.002	0.002	0.002	0.003	0.005
04/02/2020	0.002	0.003	0.002	0.002	0.002	0.004	0.003
13/02/2020	0.009	0.006	0.003	0.003	0.003	0.004	0.005
25/02/2020	0.002	2.083	0.002	0.035	0.002	0.002	0.002
05/03/2020	0.002	0.002	0.002	0.002	0.126	0.19	0.009
12/03/2020	0.002	0.003	0.002	0.002	0.002	0.006	0.003
18/03/2020	0.002	0.002	0.002	0.002	0.002	0.002	0.002
25/03/2020	0.002	0.002	0.216	0.233	0.187	0.002	0.003
31/03/2020	0.003	0.002	0.003	0.002	0.004	0.002	0.003
14/04/2020	0.002	0.002	0.086	0.003	0.017	0.066	0.002
28/04/2020	0.003	0.002	0.002	0.006	0.002	0.004	0.004
14/05/2020	0.002	0.002	0.002	0.002	0.02	0.067	0.004
09/06/2020	0.002	0.002	0.002	0.002	0.002	0.004	0.002
08/07/2020	0.003	0.006	0.002		0.002	0.004	0.015
06/08/2020	0.002	0.002	0.002		0.002	0.003	0.005
08/09/2020	0.002	0.002	0.007		0.012	0.009	0.011
07/10/2020	0.002	0.002	0.002		0.002	0.008	0.007
10/11/2020	0.004	0.002	0.002	0.002	0.002	0.007	0.003
08/12/2020	0.008	0.004	0.004	0.006	0.005	0.008	0.005
07/01/2021	0.003	0.003	0.006	0.005	0.002	0.007	0.004
18/02/2021	0.002	0.003	0.017	0.002	0.002	0.006	0.003
12/03/2021	0.012	0.002	0.002	0.002	0.003	0.004	0.006
14/04/2021	0.002	0.002	0.002	0.002	0.003	0.004	0.003
21/05/2021	0.004	0.002	0.002	0.002	0.003	0.003	0.007
17/06/2021	0.005	0.004	0.002	0.002	0.002	0.002	0.004
06/07/2021	0.002	0.002	0.002	0.002	0.002	0.003	0.004
11/08/2021	0.085	0.003	0.002	0.002	0.003	0.004	0.003
16/09/2021	0.003	0.006	0.003	0.005	0.003	0.006	0.003
15/10/2021	0.002	0.004	0.003	0.006	0.004	0.008	0.005

								Phase 3	Phase 1
								GW1, GW2, GW3 and BH F	**GW4, GW5 and GW6**
Minimum	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Maximum	0.085	0.006	0.086	0.006	0.02	0.067	0.015	0.086	0.067
Mean	0.0072857	0.00281	0.007381	0.003118	0.004619	0.010905	0.004905	0.005937063	0.006423729
Standard deviation (STDEV)	0.0179726	0.001289	0.018332	0.001691	0.005133	0.018604	0.003097	0.012418873	0.011868828
Mean + 1*STDEV	0.0252583	0.004099	0.025713	0.004809	0.009752	0.029508	0.008002	0.018355936	0.018292557
Mean + 1.5*STDEV	0.0342446	0.004743	0.034878	0.005655	0.012319	0.03881	0.00955	0.024565372	0.024226971
Mean + 2*STDEV	0.0432309	0.005388	0.044044	0.0065	0.014885	0.048112	0.011098	0.030774809	0.030161385
Mean + 3*STDEV	0.0612035	0.006677	0.062376	0.008191	0.020018	0.066715	0.014195	0.043193682	0.042030213

Notes

Concentrations recorded below the analytical detection limit are set at the detection limit.

Value considered a possible outlier or the detection limit is elevated hence excluded.

Analytical result reported as below the analytical detection limit.

Proposed interim assessment limit

Proposed interim compliance limit

APPENDIX E

STABILITY RISK ASSESSMENT (SRA) (REPORT REFERENCE BRE/EA/AW/5624/01/SRA)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT FOR THE PERMANENT DEPOSIT OF INERT WASTE AS A DISPOSAL OPERATION FOR THE RESTORATION OF EARLS BARTON SPINNEY QUARRY, GRENDON ROAD, EARLS BARTON, NORTHAMPTON TO AGRICULTURE AND NATURE CONSERVATION INTEREST

STABILITY RISK ASSESSMENT (SRA)

Report reference: BRE/EA/AW/5624/01/SRA
February 2022

Technical advisers on environmental issues

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APPENDICES

1 INTRODUCTION

1.1. Report Context

i) MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare a Stability Risk Assessment (SRA) as part of an application for a bespoke Environmental Permit for the deposition of waste on land as a disposal activity, specifically as an inert waste landfill operation, in Phases 1 and 3 at Earls Barton Spinney Quarry (Earls Barton Quarry), Grendon Road, Earls Barton, Northampton. Throughout this report the areas in Phases 1 and 3 in which waste will be deposited and which it is anticipated will be the subject of an Environmental Permit are referred to as the site and, unless specified otherwise, references to Phase 1 and Phase 3 are to those areas of Phases 1 and 3 in which waste will be deposited. Phases 1 and 3 of the site will be restored to agriculture by the importation of inert waste materials and on-site soils and overburden. No waste materials will be deposited in Phase 2 of the site.

ii) The structure of this SRA is based on a template which was produced by the Environment Agency (EA) in March 2010 for proposed landfill sites entitled “Stability Risk Assessment Report Version 1” (Reference 1). Although now withdrawn by the EA the template still provides for the inclusion in an SRA of the necessary information. The SRA presents relevant aspects of the site setting and the proposed landfill design. A risk screening stage identifies which potential stability risks need further assessment. The further assessment methodology is explained and the geotechnical parameters and target factors of safety used are described. From the stability assessment it is concluded that the side slope Artificial Geological Barrier (AGB) achieves an acceptable factor of safety.

Site Description

iii) The SRA is based on the conceptual model presented in the Environmental Setting and Site Design (ESSD) report which is provided at Appendix C to the application report. Details presented in the ESSD include:

- the site location,
- the environmental setting of the site,
- the site geology and hydrogeology,
- the history of the site,

- the landfill design,
- the potential contamination migration pathways and receptors, and
- the waste acceptance procedures to verify that inert waste materials permitted under the site permit only are accepted at the site.

Site location

iv) The area of Earls Barton Quarry which is the subject of the Environmental Permit application (the site) is located approximately 350m south-south east of Earls Barton, approximately 550m south of Ecton and approximately 1km east of Great Billing which comprises the eastern outskirts of Northampton as shown on Figure SRA 1. There are three main phases of mineral extraction at Earls Barton Quarry as shown on drawing reference EB 1 presented at Appendix ESSD C to the ESSD report and the phases are sub divided. As explained above, the site which is the area the subject of the Environmental Permit application is limited to those areas in Phases 1 and 3 in which waste will be deposited. No waste will be deposited in the southern half of Phase 1 or in Phase 2. The area in which waste will be deposited in Phase 1 (referred to as Phase 1) is centred approximately on National Grid Reference (NGR) SP 847 623 between the River Nene to the south and the A45 to the north. The areas in which waste will be deposited in Phase 3 (referred to as Phase 3) is centred approximately on NGR SP 831 624 adjacent to and south of the A45. The River Nene is approximately 300m south of Phase 1 and approximately 0.8km south of Phase 3. The area the subject of the Environmental Permit application is approximately 24 hectares.

Topography

v) Topography survey data for the site and the immediate surrounds provided by Breedon is presented on Figure SRA2. Extraction of the sand and gravel deposits has commenced in Phase 1 of the site. Prior to the extraction of sand and gravel ground levels in Phase 1 were generally level ranging in elevation from approximately 51m Above Ordnance Datum (AOD) to 48mAOD and falling generally from north-west to south-east at an average slope gradient of approximately 1v:300h. Ground levels in Phase 3 are generally level ranging in elevation from approximately 53m Above Ordnance Datum (AOD) to 51mAOD and falling generally from north to south at an approximate slope gradient of 1v:100h

Geology

vi) A detailed description of the geology at the site is presented in the ESSD report. In summary, the geology of the site comprises superficial sand and gravel deposits as well as localised clay and silt with peat deposits overlying Whitby Mudstone.

vii) Based on the British Geological Survey geological mapping the superficial deposits across the site comprise river terrace deposits and alluvium of the Nene Valley Formation. Boreholes drilled in the Phase 1 of the site encountered superficial deposits comprising between 0.85m and 1.4m of clay overlying a unit of predominantly sand and gravel between 1.0m and 6.5m in thickness and containing clay layers of variable thickness. In the Phase 3 of the site a clay layer was encountered of between 0.9m and 4.0m thickness overlying a unit of predominantly sand and gravel of between 0.5m and approximately 5.05m thickness and containing clay layers up to 0.5m in thickness.

viii) The superficial deposits are underlain by the mudstone and siltstone of the Whitby Mudstone Formation. Information published by the British Geological Survey describes the Whitby Mudstone in the vicinity of the site as having a thickness of 20m to 65m.

Hydrogeology

ix) A detailed description of the hydrogeology is provided in the ESSD report.

x) The superficial deposits at the site are water bearing and are classified as a Secondary A aquifer containing permeable layers capable of supporting water supplies at a local rather than strategic level. The Whitby Mudstone Formation is designated as unproductive strata. Based on information provided by the Environment Agency the site is not located within 5km of a groundwater Source Protection Zone (SPZ).

General Site Design

xi) The extracted areas of Phase 1 that will be infilled with inert waste comprise three areas:

- Phase 1A and 1B which are separated by an internal phase boundary,
- Phase 1F and 1G which are also separated by an internal phase boundary and
- The Plant Site area

xii) The extracted areas of Phase 3 that will be infilled with inert waste comprise two areas:

- Phases 3A and
- Phase 3B.

xiii) The design of the quarry slopes, the proposed construction of the AGB and subsequent infilling operations at the site are consistent generally with the operations undertaken at other Breedon inert material landfill sites. Extraction of sand and gravel deposits has commenced at the site and the proposed extracted profile is shown on Figure SRA3.

Quarry Base Design

xiv) The proposed base of the mineral excavations at the site will be generally flat with the elevation of the base of Phase 1A and 1B ranges between approximately 42.9mAOD and 45.6mAOD, the base of Phase 1F and 1G ranges between approximately 45.6mAOD and 49.7mAOD, the base of Phase 3A ranges between approximately 46.5mAOD and 49.0mAOD and the base of Phase 3B ranges between approximately 45.7mAOD and 47.5mAOD.

xv) The base of the extractions will comprise the Whitby Mudstone Formation. The low permeability clay of the Whitby Mudstone Formation is considered to constitute a natural geological barrier with a hydraulic conductivity of less than 1.0×10^{-7} m/s. Based on borehole logs drilled in the vicinity of the site and information from the British Geological Survey the Whitby Mudstone Formation is estimated to have a thickness of 20m to 65m.

xvi) Groundwater in the vicinity of the site is recorded in the sand and gravel deposits overlying the Whitby Mudstone and will be dewatered as necessary to facilitate the excavation and infilling operations. Dewatering will continue from the mineral extraction operations such that the waste and restoration materials will not be deposited directly into water.

Quarry Side Slope Design

xvii) As shown on the extracted profile drawing (Figure SRA3) the final quarry excavated slopes will be between 3m and 6m high with slope gradients of up to approximately 1v:1.5h. Where the extent of quarrying operations extends beyond the Environmental

Permit application boundary, this area will be backfilled with site derived overburden material as part of the quarrying operation, and this backfilling will be undertaken in accordance with the Quarry Regulations 1999. As a result the side slopes will comprise either the in situ clayey overburden and silty sand and gravels superficial deposits or backfilled site derived overburden material. The excavations of quarry slopes and the backfilling of overburden will be the subject of a separate ongoing geotechnical assessment as required by the Quarries Regulation 1999.

Artificial Geological Barrier (AGB) Design

xviii) The Environment Agency guidance on environmental permitting requirements for landfills for inert waste[1] specifies that where a natural geological barrier equivalent to 1m of in situ material with a hydraulic conductivity no greater than 1 x 10^{-7} m/s is not present it is necessary to construct an equivalent artificial geological barrier (AGB).

xix) As the base of the excavations comprise Whitby Mudstone consisting of low permeability clay deposits, it is considered that a natural geological barrier equivalent to 1m of in situ material with a hydraulic conductivity no greater than 1 x 10^{-7} m/s is present and it is not necessary to construct a basal AGB.

xx) The side slopes of the excavations will comprise in situ clayey overburden and silty sand and gravels superficial deposits . In the southern areas of Phase 1B and Phase 1F, where the extent of quarrying operations extends beyond the Environmental Permit application boundary, the side slopes will be formed from backfilled site derived overburden material. As both the in situ clayey overburden and silty sand and gravels superficial deposits and the backfill overburden are assumed to have a hydraulic conductivity greater than 1 x 10^{-7} m/s, it will be necessary to construct an AGB equivalent to a natural geological barrier 1m thick with a hydraulic conductivity of no greater than 1 x 10^{-7} m/s against the side slopes.

xxi) The procedures for the selection, placement, and compaction of the materials used to form the AGB will be agreed with the Environment Agency through the preparation and approval of a Construction Quality Assurance (CQA) Plan in accordance with

[1] https://www.gov.uk/guidance/landfill-operators-environmental-permits/landfills-for-inert-waste

Environment Agency guidance[2] to achieve a hydraulic conductivity of no greater than 1 x 10^{-7} m/s and a shear strength of no less than 40kPa.

xxii) The side slope AGB will be constructed to a height of up to 6m and to a minimum thickness of 1m perpendicular to the face of the slope. Slopes will be constructed to achieve a maximum gradient no steeper than 1v:3h. A schematic diagram showing the construction design for the side slope AGB is presented on Figure SRA 4.

xxiii) The construction of the AGB will be the subject of Construction Quality Assurance (CQA) as specified in the Environment Agency guidance[2].

xxiv) Filling against the side slope AGB will commence shortly after the construction of each lift of the side slope AGB. Dewatering will continue during the construction of the AGB and during waste placement as necessary.

Restored Slope Design

xxv) A total of approximately 250,000m^3 of inert waste material will be placed in Phases 1 and 3 of the excavated void. The proposed restoration profiles will return the land generally to the original ground levels with slope gradients no steeper than approximately 1v:30h. The proposed restoration schemes are shown on the drawing at Appendix SRA A.

1.2. Conceptual Stability Site Model (CSSM)

i) The principles of the site design as presented above have been used to define the individual slopes and materials which comprise each of the elements considered in the stability risk assessment.

1.2.1 Basal Sub-Grade Model

i) The base of the excavations will be generally flat at an elevation of approximately 42.9mAOD to 49.7mAOD and comprise in situ low permeability Whitby Mudstone which has a thickness of 20m to 65m. Groundwater is not present within the Whitby Mudstone.

[2] https://www.gov.uk/guidance/landfill-operators-environmental-permits/construction-quality-assurance-cqa

1.2.2 Side Slope Sub-Grade Model

i) The side slopes will either comprise in situ overburden and sand and gravel deposits or in the southern extent of Phase 1B and 1F backfilled site derived overburden material. The side slopes will be formed at gradients of up to 1v:1.5h and to a maximum depth of approximately 6m below ground level. For the purpose of developing a worse case side slope sub grade model it is assumed that the side slope sub grade will consist of slope with a height of 6m and a gradient of 1v:1.5h and will be formed from material which achieves a factor of safety when at a slope with these dimensions. Groundwater is present within the sand and gravel deposits and the deposits will be dewatered to facilitate mineral extraction and infilling. Current and proposed site excavations and slopes are subject to ongoing geotechnical assessment as required by the Quarries Regulations 1999.

1.2.3 Basal Lining System Model

i) No artificially constructed basal lining system is necessary as the Whitby Mudstone of the basal sub-grade is considered to provide a suitable natural basal geological barrier.

1.2.4 Side Slope Lining System Model

i) A side slope AGB will be constructed progressively with the deposition of inert waste materials. Dewatering will continue during the construction of the AGB to maintain groundwater levels below the base of the construction works. The side slope AGB will be constructed in lifts not exceeding 3m high of up to a total of 6m in height with internal slope gradients no steeper than 1v:3h and to a minimum thickness of 1m perpendicular to the side slopes of the excavation.

ii) The AGB will be constructed using carefully selected imported inert waste materials or suitable site derived materials. The materials will be selected, placed and compacted to achieve a minimum undrained shear strength of 40kPa and a hydraulic conductivity of no greater than 1×10^{-7} m/s.

1.2.5 Waste Mass Model

i) The inert waste materials will be placed generally in horizontal layers so that no significant internal waste slopes are formed during the infilling operations. The upper

surface of the waste mass will consist of placed suitable imported inert materials and on site soils and overburden to form the restored landform.

ii) Dewatering of the site will continue throughout the infilling operations to maintain groundwater levels below the base of the waste materials until the level of material placement is above natural groundwater level.

1.2.6 Capping System and Restoration Model

i) No capping system is proposed. The final restoration will consist of placed suitable imported inert restoration materials and on site soils and overburden to form a restored landform with slope gradients no steeper than approximately 1v:30h.

2 STABILITY RISK ASSESSMENT

2.1 Risk Screening

i) A risk screening of the CSSM is presented in this section of the SRA. The risk screening considers each element of the CSSM and assesses whether the component of each element needs further detailed assessment.

2.1.1 Basal Sub-Grade Screening

i) The basal sub-grade is formed in the natural in situ Whitby Mudstone. The basal profile will be generally flat. Groundwater is not present within the Whitby Mudstone. The excavations at the site are the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate quantitative assessments of the basal sub-grade.

2.1.2 Side Slope Sub-Grade Screening

i) The side slopes will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate quantitative assessments of the side slope sub-grade.

2.1.3 Basal Lining System Screening

i) No artificially constructed basal lining system is proposed.

2.1.4 Side Slope Lining System Screening

i) As each lift of the side slope AGB will be constructed to a slope gradient of up to 1v:3h and up to a height of 3m it is appropriate to undertake a quantitative analysis of the short term stability of the side slope AGB to verify that a suitable factor of safety against slope failure is achieved.

ii) As in the long term the side slope AGB will be supported by waste materials placed against it, it is unnecessary to assess further the long term stability of the side slope AGB.

2.1.5 Waste Mass Screening

i) As the internal temporary waste slopes formed during the waste placement will be generally horizontal with no significant slopes constructed and as dewatering will continue during the restoration to maintain groundwater levels at a depth sufficient to pose no significant risk it is unnecessary to undertake quantitative assessments of the waste mass.

2.1.6 Capping System and Restoration Screening

i) No capping system is proposed.

ii) As the restored landform will have slope gradients no greater than approximately 1v:30h it is considered unnecessary to undertake quantitative slope stability assessments of the site restoration.

2.2 Life Cycle Phases

i) The site will be excavated and infilled progressively. The critical phase in relation to stability will be during the construction of the lifts of the side slope AGB and the placement of supporting inert waste materials against the side slope AGB, during which the areas of excavation and infilling will need to be dewatered until the waste level has reached a level above the natural groundwater level.

2.3 Data Summary

i) The data used in the stability analysis and the data sources are presented in Table SRA 1.

2.4 Justification for Modelling Approach and Software

i) Based on the results of the risk screening a quantitative SRA has been undertaken to assess the short term stability of the side slope AGB. All other elements have been assessed qualitatively in the risk screening as not needing further assessment.

ii) The stability risk assessment analyses have been undertaken in general accordance with conventional British Standard methodologies using global factors of safety rather than incorporating partial factors into the individual parameters describing the slopes, strengths and forces.

iii) Analysis of stability against rotational failure of the AGB is undertaken using the two dimensional limit equilibrium programme SLOPE/W. Slopes are analysed using the Spencer method. The Spencer method has been selected as it is one of the more mathematically robust limit equilibrium methods and considers the shear and the normal inter-slice forces together with moment and force equilibrium (Reference 2). It is considered that this method is more appropriate than simpler methods such as Bishop's Simplified Method or Janbu's Simplified Method.

2.5 Justification for Geotechnical Parameters Selected for Analysis

2.5.1 Parameters Selected for Basal Sub-Grade Analysis

i) No quantitative assessment of the basal sub-grade is necessary.

2.5.2 Parameters Selected for Side Slope Sub-Grade Analysis

i) No quantitative assessment of the side slope sub-grade is necessary.

2.5.3 Parameters Selected for Basal Liner Analysis

i) No basal lining system is proposed as detailed in Section 1.2.3.

2.5.4 Parameters Selected for Side Slope Liner Analysis

ii) The model represents the construction of the initial lift of the side slope AGB against the side slope gradient up to 3m from the base shown on the worked out model such that:

a. The basal sub-grade is a horizontal surface formed of Whitby Mudstone.

b. The side slope sub-grade has a slope gradient of 1v:1.5h, a height of 6m and is formed of superficial side deposits consisting of clayey overburden and silty sands and gravels.

c. The side slope AGB has a slope gradient of 1v:3h with a height of 3m and a minimum horizontal thicknesses of 1.8m (which is the minimum horizontal thickness necessary to maintain a minimum 1m perpendicular thickness on a side slope subgrade gradient of 1v:1.5h).

d. Elevated groundwater levels and pressures are not included as dewatering will continue during the construction of the AGB and during infilling until the level of the waste materials is above the natural groundwater level.

ii) The values for the geotechnical parameters used are based on specified values, site specific information and parameters published in Hoek and Bray (Reference 3).

a. As the AGB will be constructed from selected imported inert waste material or site derived material that will be placed and compacted to achieve a minimum undrained shear strength of 40kPa, a shear strength of 40kPa is used to represent the AGB in the model. A unit weight of 17 kN/m^3 is used in the modelling based on the lowest values provided for stiff glacial clay by Hoek and Bray.

b. The superficial sand and gravel deposits and site derived material of the side slope sub-grade are modelled as having an angle of friction of 33.7°, an apparent cohesion of 0kPa and a unit weight of 19kN/m^3. These values for the strength parameters are equivalent to the minimum needed for a drained material with no cohesion which has an angle of repose of 1v:1.5h. As stated in the description of the conceptual model the side slopes at the site which will form the sub-grade are either the clayey overburden and silty sand and gravel deposits or backfilled site derived material. The unit weight is based on values provided for sand and gravel of mixed grain size by Hoek and Bray (Reference 3).

c. The Whitby Mudstone bedrock underlying the superficial deposits is modelled as impenetrable bedrock.

2.5.5 Parameters Selected for Waste Mass Analysis

i) No quantitative assessment of the waste mass is necessary.

2.5.6 Parameters Selected for Capping System and Restoration Analysis

i) No capping system is proposed as detailed in Section 1.2.6.

ii) No quantitative assessment of the site restoration is necessary.

2.6 Selection of Appropriate Factors of Safety

2.6.1 Factor of Safety for Basal Sub-Grade

i) Analysis of the stability of the basal sub grade is not necessary as detailed in Section 2.1.1.

2.6.2 Factor of Safety for Side Slope Sub-Grade

i) Analysis of the stability of the side slope sub grade is not necessary as detailed in Section 2.1.2.

2.6.3 Factor of Safety for Basal Lining System

i) Analysis of the stability of the basal lining system is not necessary as detailed in Section 2.1.3.

2.6.4 Factor of Safety for Side Slope Lining System

i) A factor of safety of 1.3 has been selected for the assessment of the side slope AGB as during a failure event of the side slope AGB the failure will be contained within the site boundary, can be monitored and remediated, and would not extend outwards towards nearby buildings and infrastructure. This is consistent with Environment Agency guidance (Reference 4) and British Standards BS6031:2009 (Reference 5).

2.6.5 Factor of Safety for Waste Mass

i) Analysis of the waste mass is not necessary as detailed in Section 2.1.5.

2.6.6 Factor of Safety for Capping System and Restoration

i) Analysis of the capping system and restoration is not necessary is detailed in Section 2.1.6.

2.7 Analysis

i) This sub-section provides the results of the quantitative analysis, where identified as being needed as part of the risk screening.

2.7.1 Basal Sub-Grade Analysis

i) No analysis has been conducted on the basal sub-grade.

2.7.2 Side Slope Sub-Grade Analysis

i) No analysis has been conducted on the side slope sub-grade.

2.7.3 Basal Lining System Analysis

i) No analysis has been conducted on the basal lining system.

2.7.4 Side Slope Lining System Analysis

i) The stability analysis of the initial 3m high lift of the side slope AGB with a horizontal thickness of 1.8m with a slope gradient of 1v:3h onto the underlying Whitby Mudstone Formation yields a factor of safety of 4.954 which is above the target factor of safety of 1.3 and is therefore considered stable. The SLOPE/W plot of the assessment is presented at Appendix SRA B.

ii) Given the conservative selection of parameters, low risk due to slope failure and high factors of safety determined in the analysis of the construction scenario no further sensitivity analysis has been undertaken.

2.7.5 Waste Mass Analysis

i) No analysis has been conducted on the waste mass.

2.7.6 Capping System and Restoration Analysis

i) No analysis has been conducted on the capping system and restoration.

2.8 Assessment

2.8.1 Basal Sub-Grade Assessment

i) Due to the almost flat basal area, thickness of basal Whitby Mudstone and lack of groundwater within the Whitby Mudstone it is considered that the basal sub-grade is stable and that there is no potential for basal heave at the site.

2.8.2 Side Slope Sub-Grade Assessment

i) The side slopes excavations at the site will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate assessments of the side slope sub-grade.

2.8.3 Basal Lining System Assessment

i) No basal lining system is proposed.

2.8.4 Side Slope Lining System Assessment

i) The stability of the side slope AGB has been analysed in the short term and the resulting lowest factor of safety assessed is 4.954 which is above the target factor of safety of 1.3 and is therefore considered stable.

ii) In the long term the side slope AGB will be supported by waste materials placed against it and therefore is considered stable.

2.8.5 Waste Mass Assessment

i) As the internal temporary and final waste slopes will be generally horizontal and dewatering will continue during infilling operations to maintain groundwater levels below the level of waste, the waste mass is considered stable.

2.8.6 Capping System and Restoration Assessment

i) No capping system is proposed.

ii) As the restored landform will have slope gradients no greater than approximately 1v:30h it is considered that the restoration will be stable.

3 MONITORING

3.1 The risk based monitoring scheme

i) The results of the SRA show that all elements of the proposed site design, where assessed, are stable and where analysed achieve appropriate factors of safety.

ii) An annual topographical survey which facilitates the identification of areas of settlement or instability and weekly visual inspection of the exposed sub-grade, AGB and the waste mass for signs of settlement or instability is appropriate for monitoring at the site. The results of the weekly inspections will be recorded in the site diary during the operation of the site. In the unlikely event that areas of concern are identified from the topographical survey or the weekly inspection further assessment and remediation will be carried out as necessary.

iii) It will be necessary to monitor and control groundwater at the site during the extraction and filling works so that groundwater is dewatered in the sand and gravel deposits overlying the base of the excavations until waste placement has reached a level above the natural groundwater level. A programme of groundwater monitoring is presented in the ESSD.

3.1.1 Basal Sub-Grade Monitoring

i) The basal sub-grade will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999.

3.1.2 Side Slopes Sub-Grade Monitoring

i) The side slopes at the site will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999.

3.1.3 Basal Lining System Monitoring

i) No basal lining system is necessary.

3.1.4 Side Slope Lining System Monitoring

i) The construction of the AGB will be the subject of CQA to verify that it is constructed with maximum slope gradients of 1v:3h and to a minimum perpendicular thickness of

1m and from materials which achieve a hydraulic conductivity of no greater than 1 x 10^{-7} m/s and a shear strength of no less than 40kPa. Prior to the construction of the AGB a CQA Plan shall be prepared and agreed in accordance with Environment Agency guidance[2].

ii) Placement of inert waste materials will commence shortly after construction of each lift of the side slope AGB to provide support to the side slope AGB.

iii) The side slope lining system will be monitored for signs of instability by weekly visual inspections as detailed above.

3.1.5 Waste Mass Monitoring

i) The waste mass will be monitored for signs of settlement or instability by annual topographical surveys and weekly visual inspections as detailed above.

3.1.6 Capping System and Restoration Monitoring

i) No capping system is necessary.

ii) The restoration will be monitored for signs of settlement or instability by annual topographical surveys.

REFERENCES

1. Environmental Permitting (England and Wales) Regulations. 'Information in support of an application for a landfill permit – Stability Risk Assessment Report', Environment Agency, 2010.

2. Slope Stability Modelling with Slope/W 2007 Version. An Engineering Methodology. Fourth Edition, February 2010. GEO-SLOPE International Ltd.

3. Hoek and Bray "Rock Slope Engineering: Third Edition" 1981.

4. Environment Agency "Stability of Landfill Lining Systems: Report No. 2 Guidance" R&D Technical Report P1-385/TR2.

5. British Standard BS6031 – 2009, Code of practice for Earthworks.

TABLES

Table SRA 1

Geotechnical parameters used in the stability modelling

Material	Unit weight	Undrained parameters (short term)	Drained parameters (long term)
Artificial Geological Barrier (AGB)	γ = 17 kN/m^3 (1)	C_u = 40 kPa (2)	Not required
Side slope subgrade material	γ = 19 kN/m^3 (1)	Not required	Ø' = 33.7° (3) c' = 0 kPa (3)
Whitby Mudstone	Modelled as impenetrable bedrock		

Notes: γ Unit weight
Ø' Friction angle
c' Apparent cohesion
C_u Undrained shear strength

(1) Value based on conservative estimates taken from Hoek and Bray, "Rock Slope Engineering", 1981.

(2) Value based on minimum specified undrained shear strength.

(3) Value is conservatively based on minimum friction angle with no cohesion needed to achieve a 1v:1.5h slope.

FIGURES

Key / Notes

Approximate boundary of the site the subject of the Environmental Permit application

Rev	Status	Drn	App	Chk	Date
	Final	JCR	JCR	GT	22/02/22

Site: EARLS BARTON QUARRY

Client: BREEDON

Title: Site location

Figure SRA 1 | Scale 1:50,000@A4

Drawing Ref: BRE/EA/12-20/22135

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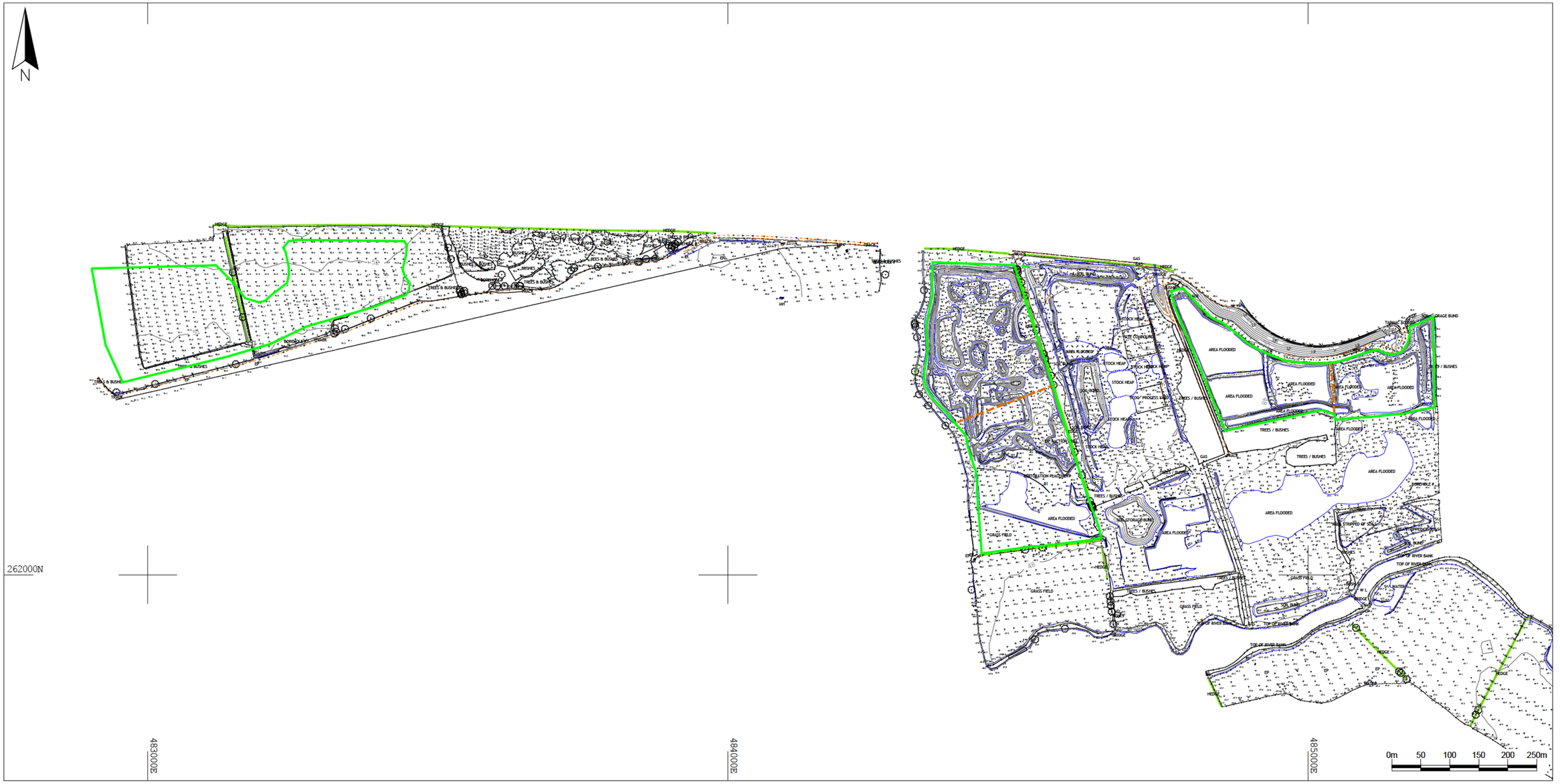

Key / Notes

- Approximate boundary of the site the subject of the Environmental Permit application
- Internal phase boundary
- Bottom of bank
- Building
- Contours (mAOD)
- Fence
- Hedge
- Kerb
- Levels (mAOD) (18.75)
- Top of bank
- Track
- Water

Based on survey reference "EB 2020-11-16.LSS" provided by Breedon on 18 January 2021

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Rev	Status	Dm	App	Chk	Date
	Final	JCR	JCR	GT	22/02/22

Site: EARLS BARTON QUARRY

Client: BREEDON

Title: Topographical survey of the site

Figure SRA 2 | Scale 1:5,000@A2

Drawing Ref: BRE/EA/12-20/22136

Key / Notes

- Approximate boundary of the site the subject of the Environmental Permit application
- Internal phase boundary
- Bottom of bank
- Building
- Contours (mAOD)
- Fence
- Hedge
- Kerb
- Survey points
- Top of bank
- Track
- Water

Based on survey reference "EARLS BARTON FQD V3.LSS" provided by Breedon on 8 January 2020

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Rev	Status	Dm	App	Chk	Date
	Draft	JCR	JCR	GT	22/02/22

Site: EARLS BARTON QUARRY

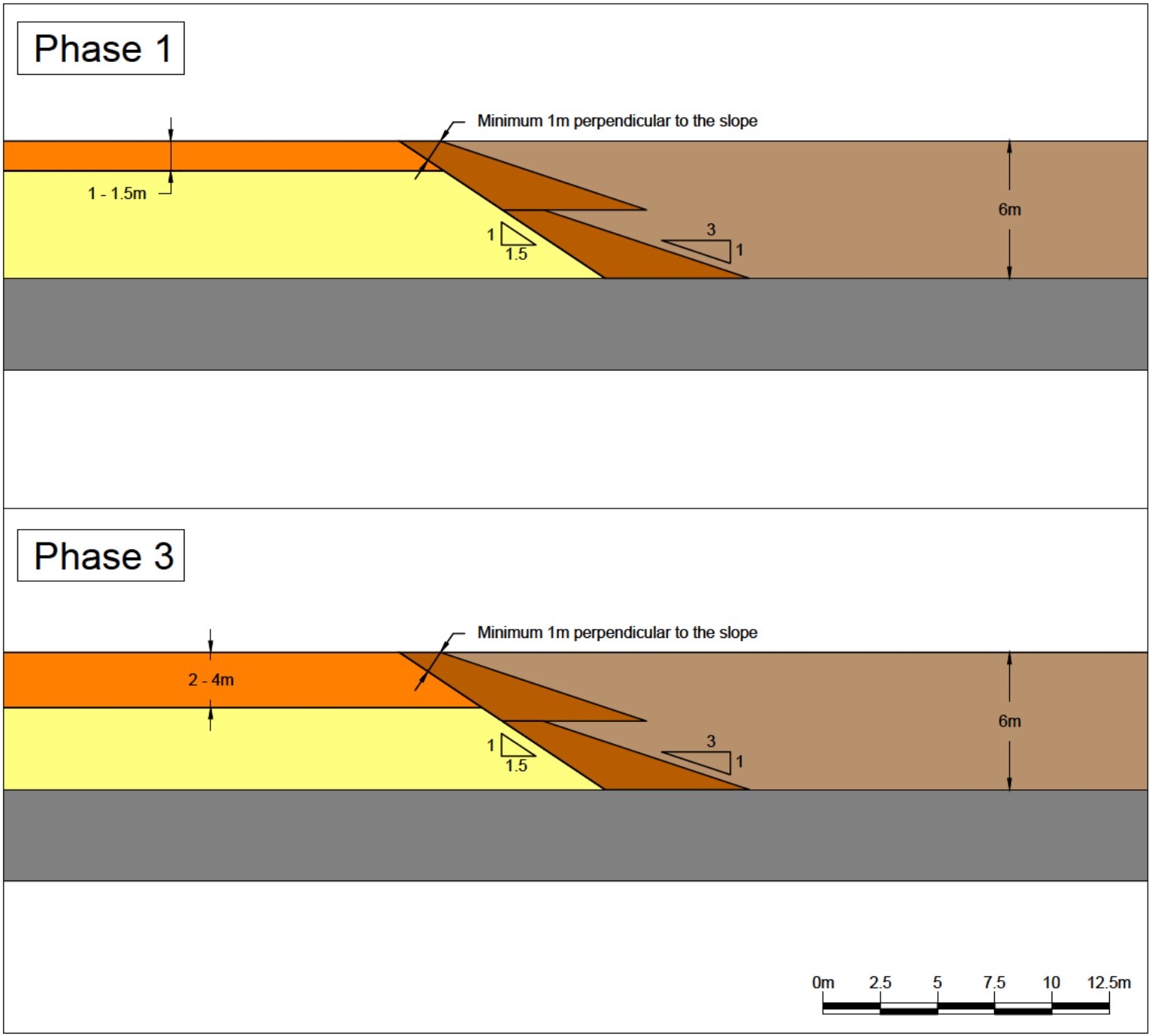
Client: BREEDON

Title: Proposed extracted profile

DRAFT

Figure SRA 3 | Scale 1:5,000@A2

Drawing Ref BRE/EA/12-20/22137



Key / Notes

- Alluvial clay
- Sand and gravel
- Whitby Mudstone
- Artificial Geological Barrier
- Inert recovery materials

Rev	Status	Drn	App	Chk	Date
	Final	JCR	JCR	GT	22/02/22

Site: WILLINGTON LOCK

Client: BREEDON

Title: Schematic drawing of the construction of the side slope AGB

Figure SRA 4

Scale: 1:250@A4

Drawing Ref: BRE/EA/12-20/22138

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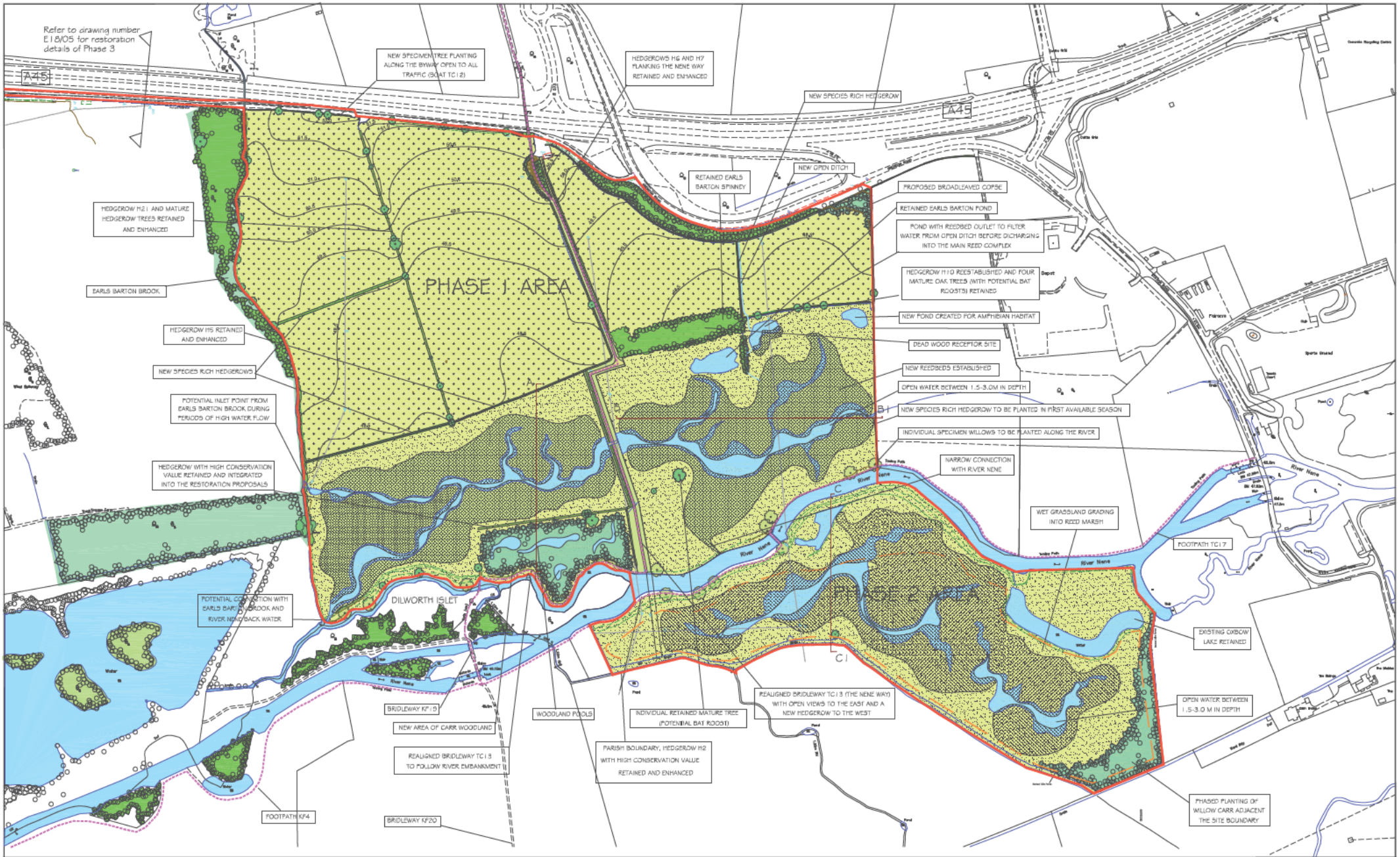
APPENDICES

APPENDIX A

DRAWINGS SHOWING THE RESTORATION SCHEMES FOR PHASE 1 & 2 AND PHASE 3



LEGEND

- REINSTATED ARABLE LAND
- HEDGEROW REINSTATED
- PROPOSED SPECIES RICH HEDGEROW
- PROPOSED BROADLEAF WOODLAND
- EXISTING WOODLAND AND SCRUB RETAINED
- EXISTING WOODLAND AND SCRUB RETAINED
- APPLICATION BOUNDARY
- FOOTPATHS AND BRIDLEWAYS
- REINSTATED CONTOUR (AOD)
- PROPOSED REEDBED
- PROPOSED WET GRASSLAND

Note

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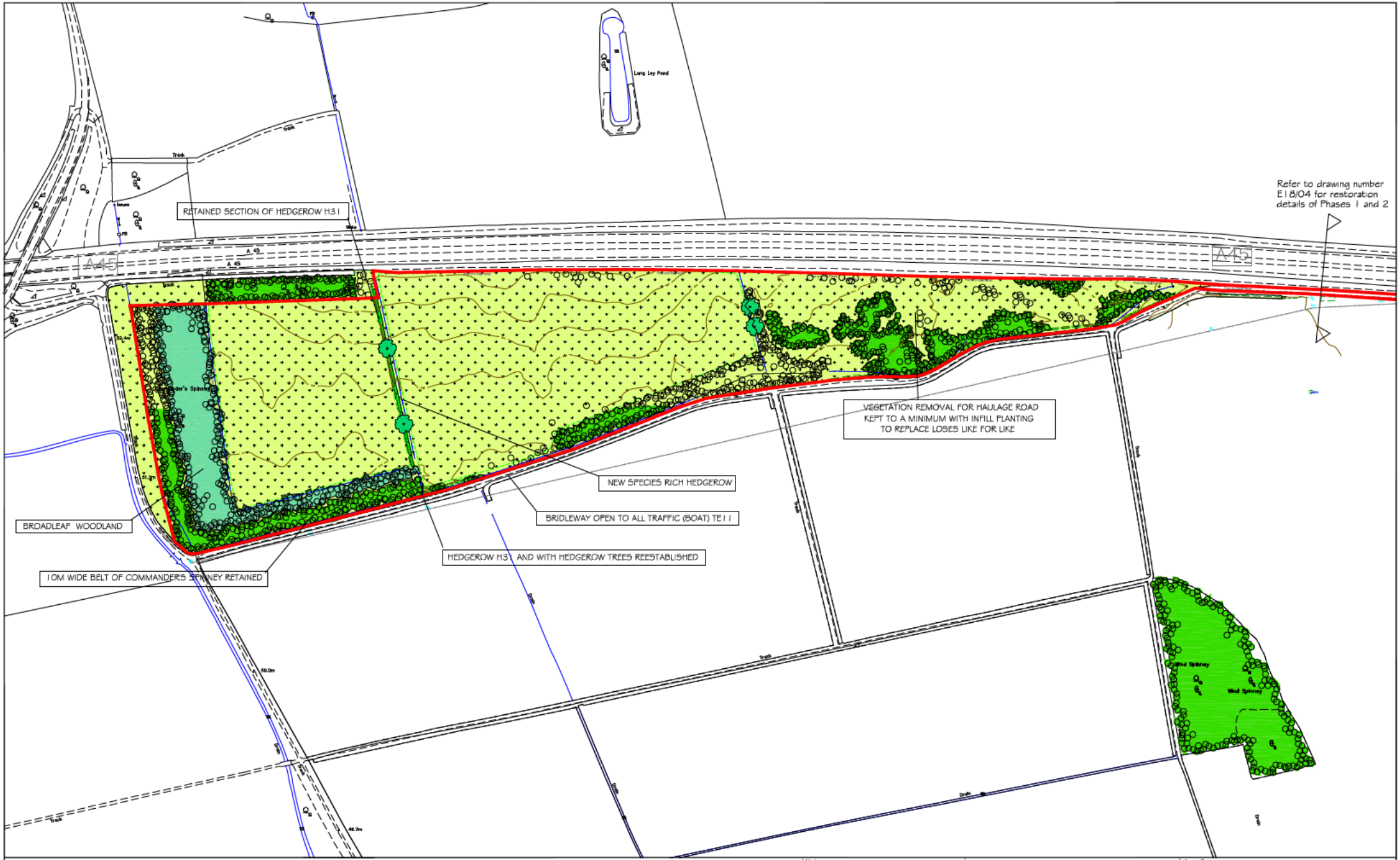
ENNSTONE JOHNSTON LIMITED

Location: Earls Barton Spinney Quarry

Title: Restoration Proposals Phases 1 and 2

Drg.No.	Scale	Date
E18 / 04	1:2,500	09/07



LEGEND

- APPLICATION BOUNDARY
- EXISTING WOODLAND AND SCRUB RETAINED
- HEDGEROW REINSTATED
- REINSTATED ARABLE LAND
- PROPOSED BROADLEAF WOODLAND
- FOOTPATHS AND BRIDLEWAYS

Note

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ENNSTONE JOHNSTON LIMITED

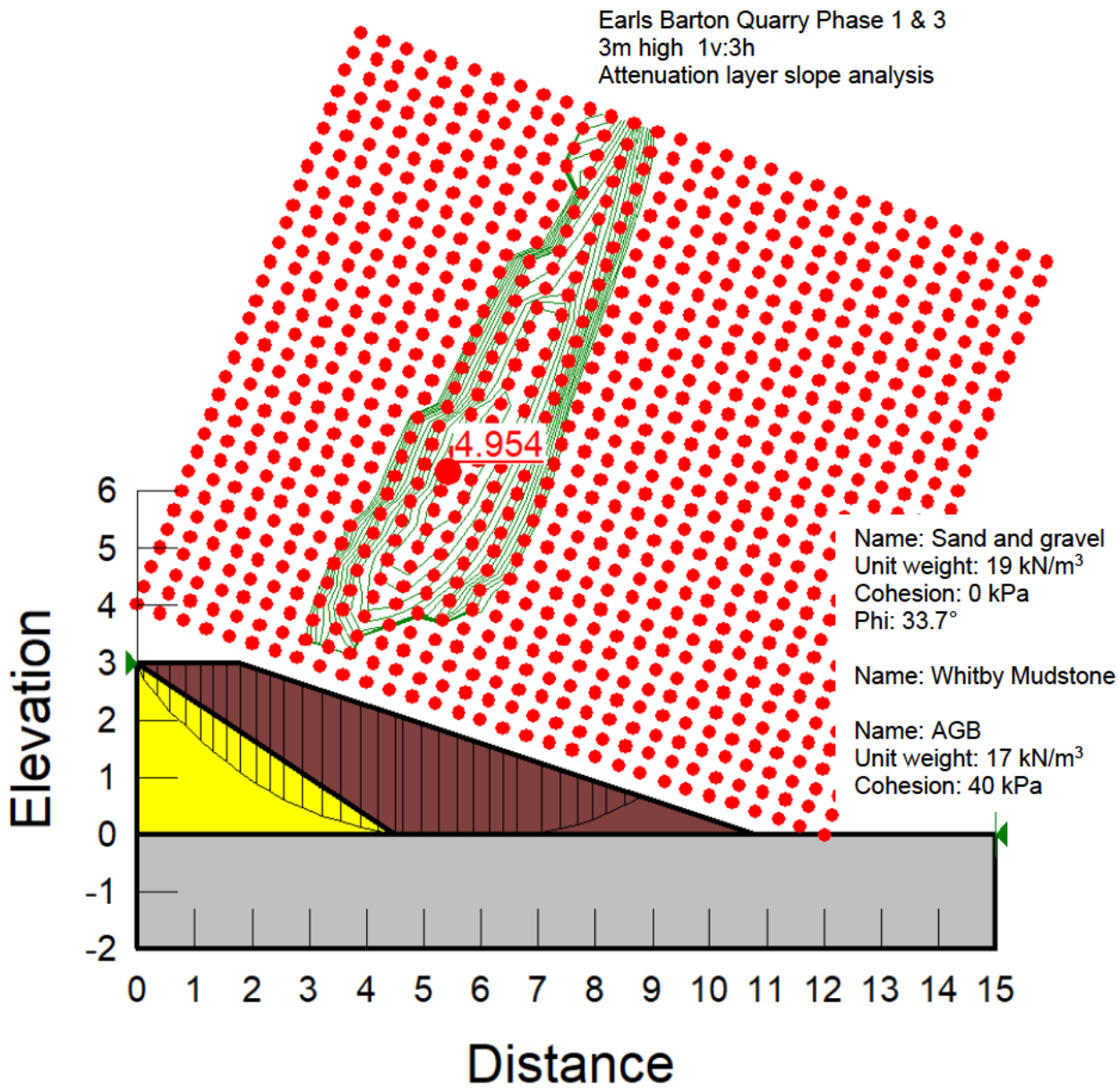
Location: Earls Barton Spinney Quarry

Title: Restoration Proposals: Phase 3

Drg.No.	Scale	Date
E18 / 05	1:2,500	09/07

APPENDIX B

RESULTS OF THE STABILITY MODELLING


Earls Barton Quarry Phase 1 & 3
3m high 1v:3h
Attenuation layer slope analysis
4.954
Name: Sand and gravel
Unit weight: 19 kN/m3
Cohesion: 0 kPa
Phi: 33.7°
Name: Whitby Mudstone
Name: AGB
Unit weight: 17 kN/m3
Cohesion: 40 kPa
Elevation
Distance
6
5
4
3
2
1
0
-1
-2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

APPENDIX F

ENVIRONMENTAL RISK ASSESSMENT (ERA) (REPORT REFERENCE BRE/EA/AW/5624/01/ERA)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT FOR THE PERMANENT DEPOSIT OF INERT WASTE AS A DISPOSAL OPERATION FOR THE RESTORATION OF EARLS BARTON SPINNEY QUARRY, GRENDON ROAD, EARLS BARTON, NORTHAMPTON TO AGRICULTURE AND NATURE CONSERVATION INTEREST

ENVIRONMENTAL RISK ASSESSMENT FOR NUISANCE AND AMENITY (ERA)

Report reference: BRE/EA/AW/5624/01/ERA
February 2022

Technical advisers on environmental issues

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CONTENTS

TABLES

1. Introduction

1.1 MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare an application for a bespoke Environmental Permit for the deposition of waste on land as a disposal activity, specifically as an inert waste landfill operation, in Phases 1 and 3 at Earls Barton Spinney Quarry (Earls Barton Quarry), Grendon Road, Earls Barton, Northampton. Throughout this report the areas in Phases 1 and 3 in which waste will be deposited and which it is anticipated will be the subject of an Environmental Permit are referred to as the site and, unless specified otherwise, references to Phase 1 and Phase 3 are to those areas of Phases 1 and 3 in which waste will be deposited. Phases 1 and 3 of the site will be restored to agriculture by the importation of inert waste materials and on-site soils and overburden. No waste materials will be deposited in Phase 2 of the site. This document comprises a nuisance and amenity environmental risk assessment (ERA) prepared to support the application based on the risk screening matrix provided in Table ERA 1 and the assessment presented in Table ERA 2.

1.2 The ERA considers potential receptors and pathways for impacts based on the understanding of the environment surrounding the site that is presented in the Environmental Setting and Site Design (ESSD) Report presented at Appendix C of the application report. The assessment of the risks associated with the restoration of the site is based on the information on the design and operation of the inert landfill described in the ESSD report and the general principles of Environment Agency guidance “Risk assessments for your environmental permit” published on the GOV.UK website on 1 February 2016 and last updated on 25 March 2021.

1.3 The selection of potential receptors has been informed by information presented on the Defra MAGIC website and the Environmental Statement (ES) prepared in support of the application for planning permission reference 15/00091/MINVOC & WP/15/00791/CRA (as amended). This risk assessment takes into consideration receptors within 500m of the site with the exception of statutorily designated nature conservation sites for which the relevant distance is up to 2km.

1.4 Based on information reviewed on the Defra MAGIC website the Upper Nene Valley Gravel Pits SSSI is located approximately 600m to the east - south east of the site and the Upper Nene Valley Gravel Pits Ramsar Site is located approximately 1.0km to the east south east of the site. The Upper Nene Valley Gravel Pits Ramsar Site

has additionally been scheduled as a Special Protection Area (SPA). There are no Special Areas of Conservation (SACs), Local Nature Reserves (LNRs) or National Nature Reserves (NNRs) located within 2km of the site.

2. Conclusions

2.1 The ERA presented in Table ERA 2 that has been completed to support the application demonstrates that the operation of the facility has a low or very low risk of adverse impact on the surrounding environment including sites of heritage or nature conservation interest.

TABLES

Table ERA 1 - Risk screening matrix (inert landfill)

RISK TYPE	ODOUR		NOISE AND VIBRATION		FUGITIVE EMISSIONS								
					PARTICULATE MATTER				LITTER		BIRDS, VERMIN AND INSECTS		MUD ON THE ROAD
GENERIC HAZARDS / GENERIC RECEPTORS[1]	Waste storage and handling	Waste delivery	Waste delivery	Waste storage and handling	Waste delivery	Waste storage and handling	Restored surfaces	Access routes	Waste delivery	Waste storage and handling	Waste delivery	Waste deposition	Vehicle Movements
DOMESTIC DWELLING			x	x	x	x	x	x					
SCHOOLS AND COLLEGES													
HOSPITALS													
OFFICES / COMMERCIAL PREMISES			x	x	x	x	x	x					
INDUSTRIAL PREMISES			x	x	x	x	x	x					
PUBLIC FOOTPATH OR BRIDLEWAY			x	x	x	x	x	x					
HIGHWAYS OR ROADS					x	x	x	x					x
PARKS AND PUBLIC OPEN SPACES			x	x	x	x	x	x					
FARMLAND WITH LIVESTOCK					x	x	x	x					
FARMLAND ARABLE					x	x	x	x					
PRIORITY HABITAT					x	x	x	x					
NATURE SITE OF LOCAL IMPORTANCE (e.g. LNR, CWS)													

Table ERA 1 - Risk screening matrix (inert landfill)

RISK TYPE	ODOUR		NOISE AND VIBRATION		FUGITIVE EMISSIONS								
					PARTICULATE MATTER				LITTER		BIRDS, VERMIN AND INSECTS		MUD ON THE ROAD
GENERIC HAZARDS / GENERIC RECEPTORS[1]	Waste storage and handling	Waste delivery	Waste delivery	Waste storage and handling	Waste delivery	Waste storage and handling	Restored surfaces	Access routes	Waste delivery	Waste storage and handling	Waste delivery	Waste deposition	Vehicle Movements
SITE OF SPECIAL SCIENTIFIC INTEREST (within 2km)					x	x	x	x					
SPECIAL AREA OF CONSERVATION (within 2km)													
SPECIAL PROTECTION AREA OR OTHER RELEVANT SSSI (within 2km)					x	x	x	x					
LISTED BUILDINGS (within 500m)													
SCHEDULED MONUMENT (within 500m)													
AIRPORT													
RAILWAY													
SURFACE WATER					x	x	x	x					

x = generic receptor type present and generic hazard considered as part of this assessment set out in Table ERA 2.

[1] All generic receptors within 500m have been identified unless an alternative distance has been identified.

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
Odour							
There are no potential sources of odour at the site.						The wastes will be inert wastes. Acceptance procedures will be in place.	Negligible
Noise							
Mobile plant and vehicles (e.g. waste deposition and delivery)	Local human population/properties	Air	Medium to low	Nuisance from noise	Medium to low	Conditions 25, 26 and 27 of planning permission reference 15/00091/MINVOC & WP/15/00791/CRA (as amended) specify noise management and monitoring measures and include noise limits at identified receptors. A noise assessment is presented at Appendix M of the application report which includes measures for the management of noise at the site.	Low
Vibration							
Mobile plant and vehicles (e.g. waste deposition and delivery)	Local human population	Vibration through the ground	Very low	Nuisance from vibration	Low	Potential sources of vibration are limited to site-based activities only. It is considered that these are more likely to be associated with ground borne vibration rather than transmissions of vibration through the air. Based on the nature and location of the proposed activities it is considered unlikely that ground borne vibration will have a	Very low

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
						significant effect on potential receptors within the vicinity of the site. In the unlikely event that vibration becomes an issue in respect of the permitted operations at the site a vibration management plan will be prepared and implemented.	
Fugitive emissions							
Particulates from access routes, waste delivery, waste storage and waste deposition	Local human population / properties / public footpath or bridleway / farmland / public highways / priority habitats / water bodies	Air	Medium to low	Deposition of particulate matter	Medium to low	Condition 28 of planning permission reference 15/00091/MINVOC & WP/15/00791/CRA (as amended) specifies the submission of a dust management scheme and the implementation of the approved dust management measures. A Dust and Emissions Management Plan (DEMP) is presented at Appendix L of the application report which includes measures for the minimisation of dust at the site.	Low to very low
Mud and debris deposited on the public highway	Public highway	Vehicle movements	Low	Mud on the public highway	Low	A wheel wash facility will be provided and used as necessary by HGVs leaving the site. . The engineered haul road will be maintained for cleanliness by sweeping/washing. Unsurfaced roads will be watered as well as paved roads to reduce the transport of mud and debris offsite. All site roads and the	Low

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
						wheel wash will be inspected daily and maintained in a condition consistent with minimising the risk of the accumulation of mud and debris on the highway. A mobile road sweeper will be used as necessary.	
Windblown litter						The site will only accept inert wastes which have a low potential to generate litter. Waste acceptance procedures will be in place.	Negligible
Scavenging animals and birds						The waste types to be accepted at the site have a very low potential to attract scavenging animals and scavenging birds. Waste acceptance procedures will be in place.	Negligible
Pests (e.g. flies)						The waste types to be accepted at the site have a very low potential to attract pests such as flies. Waste acceptance procedures will be in place.	Negligible
Accidents							

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
Waste stored and deposited on site	Local human population gaining unauthorised access to the waste operation	Direct physical contact	Low	Bodily injury	Low	The inert waste types to be accepted at the site should not cause harm to human health by virtue of their composition. Security measures which are implemented currently as part of the mineral extraction operations comprising the use of fencing, safety signs and regular inspections will continue to be implemented to minimise the potential for unauthorised entry to the site	Very low
Vehicle movements on site	Local human population gaining unauthorised access to the site	Direct physical contact	Low	Bodily injury	Medium	Security measures are implemented in respect of the existing mineral extraction operations and will continue to be implemented to minimise the potential for unauthorised entry to the site. Vehicles will employ suitable non-tonal reversing alarms.	Low
Accidental release of fuel, spillage of liquids and leakages	Water resources / Priority habitats	Run off or infiltration	Low	Contamination of water resources	Medium	Company operational, maintenance, inspection and accident management procedures are in place and will continue to be implemented. Spillage kits are available and site personnel are trained in their use.	Low

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
Flooding	Local human population / roads / buildings / local environment / natural habitats downstream	Flood waters	Medium	Contamination of surrounding receptors including roads, buildings, habitats and agricultural uses.	Medium	The inert waste types that will be accepted at the site should not result in contamination by virtue of their composition. Following restoration ground levels in the proposed inert fill areas will generally be similar to pre-extraction ground levels, therefore minimising the risk of increased surface water run-off. As the imported inert materials generally will be similar to site won restoration materials there will be no significant change in the rate of transfer of run-off from the site to the surface water system as a result of the proposed use of imported restoration materials. As the wastes that will be stored and deposited at the site will be in areas which generally are below the surrounding ground level it is unlikely that materials will be washed off site.	Low
Fire	Atmospheric emissions	Air	Very low	Nuisance from smoke and odour / Contamination of water resources	Very low	As the materials deposited at the site will be non-flammable and non-combustible the risk of landfill fires occurring is negligible. As a result, associated risks from fire-fighting water being discharged to controlled waters are negligible.	Very low
Nature and heritage conservation sites							

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
Waste operations may cause harm to and deterioration of nature conservation sites.	Protected statutory designated conservation sites (European sites or SSSIs)	Air	Low	Deterioration of protected statutory designated conservation sites	Low	As stated in Section 1 the Upper Nene Valley Gravel Pits SSSI is approximately 600m to the east-south east of the site. In the Environmental Statement (ES) in respect of the application for planning permission reference 15/00091/MINVOC & WP/15/00791/CRA it is stated that *'the phased nature of the development and the separation distance should ensure that there will be no impact on the SSSI.'*	Very low
Waste operations may cause harm to and deterioration of nature conservation sites	Priority habitats	Air	Low	Deterioration of non-statutory designated conservation sites	Low	The site will only accept inert wastes which should not cause harm to priority habitats by virtue of their composition. The measures in place to minimise risks associated with fugitive emissions from the site will further minimise the risk of any potential impacts on priority habitats.	Very low
Waste operations may cause harm to and deterioration of heritage	Designated heritage sites					There are no World Heritage Sites within 2km of the site nor are there any Listed Buildings or Scheduled Monuments within 500m of the site.	Negligible

Table ERA 2 - Environmental Risk Assessment of nuisance and amenity risks associated with the extension to the inert waste landfill at Earls Barton Quarry

Sources of the risk			Assessing the risk			Managing the risk	
Hazard	Receptor (ESID)	Pathway	Probability of exposure	Consequence	What is the overall risk?	Risk management	What is the residual risk?
What has the potential to cause harm?	What is at risk? What do I wish to protect?	How can the hazard reach the receptor?	How likely is this contact?	What is the harm that can be caused?	What is the risk? The balance of probability and consequence	What measures will you take to reduce the risk? If it occurs – who is responsible for what?	What is the risk that still remains?
conservation sites							

APPENDIX G

LANDFILL GAS RISK ASSESSMENT (LFGRA) (REPORT REFERENCE BRE/EA/AW/5624/01/LFGRA)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT FOR THE PERMANENT DEPOSIT OF INERT WASTE AS A DISPOSAL OPERATION FOR THE RESTORATION OF EARLS BARTON SPINNEY QUARRY, GRENDON ROAD, EARLS BARTON, NORTHAMPTON TO AGRICULTURE AND NATURE CONSERVATION INTEREST

LANDFILL GAS RISK ASSESSMENT (LFGRA)

Report reference: BRE/WL/AW/5624/01/LFGRA
February 2022

Technical advisers on environmental issues

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CONTENTS

TABLES

1. Introduction

1.1 MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare a Landfill Gas Risk Assessment (LFGRA) for an application for a bespoke Environmental Permit for the deposition of waste on land as a disposal activity, specifically as an inert waste landfill operation, in Phases 1 and 3 at Earls Barton Spinney Quarry, Grendon Road, Earls Barton, Northampton. Throughout this application the areas in Phases 1 and 3 in which waste will be deposited and which it is anticipated will be the subject of an Environmental Permit are referred to as the site and, unless specified otherwise, references to Phase 1 and Phase 3 are to those areas of Phases 1 and 3 in which waste will be deposited. Phases 1 and 3 of the site will be restored to agriculture by the importation of inert waste materials and on-site soils and overburden. No waste materials will be deposited in Phase 2 of the site. The LFGRA is based on the conceptual model presented in the Environmental Setting and Site Design (ESSD) report reference BRE/EA/AW/5624/01/ESSD.

1.2 The structure of the LFGRA is based on a template which was produced by the Environment Agency (EA) in March 2010 entitled “Landfill Gas Risk Assessment Report Version 1” dated March 2010. Although now withdrawn by the EA the template still provides for the inclusion in an LFGRA of the necessary information. As the site will accept inert waste materials only there are sections of the template which are not relevant although the general structure has been followed.

2. Landfill gas risk assessment

2.1 Since the gas generating potential of the waste to be deposited at the site is negligible a simple qualitative landfill gas risk assessment methodology is used. The assessment of risk is based on the source-pathway-receptor methodology. There will be a risk only if there is a source of contamination, a pathway for migration and a receptor. Details of the environmental setting of the site, the geology, the hydrogeology, the landfill design, the history of the site, potential contaminant migration pathways and receptors are presented in the ESSD report.

2.2 The materials that will be deposited at the site will be imported inert wastes. The materials that will be used to restore the site will comprise a combination of soils and overburden from the site and imported inert waste. Waste acceptance procedures will be in place to minimise the risk that unacceptable waste materials will be accepted at the site including procedures for the rejection of non-conforming loads.

2.3 As no biodegradable waste materials will be deposited at the site which can degrade to generate landfill gas, a source of gaseous contamination will not be present hence there is no exposure pathway and no significant risk from landfill gas. As the gas generating potential of the waste will be negligible there will be no gas collection or gas treatment systems.

3. Requisite surveillance

3.1 The programme of gas monitoring is presented in Table 1 of the ESSD report. The Landfill Gas Action Plan is presented in Table LFGRA 1.

3.2 The purpose of in waste gas monitoring is to provide supporting evidence that confirms that the deposited waste is inert by demonstrating that landfill gas is not being generated at the site. The results of the groundwater quality monitoring, the records in respect of waste deposited at the site during the operational period and the results of the in-waste gas monitoring will provide several strands of evidence which together confirm that the inert waste landfill presents no significant risk to human health or to the environment. The several strands of evidence taken together will provide the confidence necessary to confirm that the site is being operated as an inert waste landfill.

3.3 Recommendations for in waste gas monitoring are presented in EA guidance entitled Landfill operators: environmental permits[1] (the monitoring and reporting guidance). The monitoring and reporting guidance states in Section 14 entitled *"monitor landfill gas"* that *"you can rely on searcher bar (also called spike test) monitoring where the total depth of waste is less than 4 meters or before each cell or area is complete.*" As explained in Section 4 of the ESSD report it is proposed, in line with monitoring and reporting guidance, that searcher bar monitoring is used to monitor gas from the inert waste materials during the operational period.

3.4 Although the maximum waste thickness may be up to 6m, it is anticipated that over a significant majority of the site the waste depth will not exceed 4m hence in accordance with the monitoring and reporting guidance it may not be necessary to install post closure in waste gas monitoring boreholes at the site. It is proposed that the need for post closure in waste gas monitoring boreholes will be determined based on the actual extracted profile and the restored profile and the need to install post closure in waste gas monitoring boreholes will be agreed with the EA with reference to the latest guidance. Landfill gas monitoring infrastructure external to the site is not necessary.

[1] Environment Agency. Landfill operators: environmental permits. Monitor and report your performance. Dated 30 January 2020. Updated 21 April 2021. Available at https://www.gov.uk/guidance/landfill-operators-environmental-permits/monitor-and-report-your-performance

3.5 As it is anticipated that over a significant majority of the site the waste depth will not exceed 4m it is proposed, in line with EA guidance, that searcher bar monitoring is used to monitor gas from the inert waste materials during the post closure period. The number and locations of post closure searcher bar locations will be agreed with the EA with reference to the latest guidance.

4. Conclusions

4.1 Based on the results of the risk assessment it is concluded that there is no significant risk to human health or to the environment from exposure to landfill gas generated in the site. Based on the wastes which will be deposited at the site it is concluded that there is no need to take measures to collect, treat or use landfill gas at the site. It is concluded that the proposed landfill is compliant with the Environmental Permitting (England and Wales) Regulations 2016.

TABLES

Table LFGRA 1

Gas Action Plan

Parameter	**Action limit [1] (% by volume)**
Methane	1% volume/volume (v/v)
Carbon dioxide	1.5% v/v
Frequency	Six-monthly
Assessment test Exceedance of the action limit on any one occasion.	
Contingency action	**Response time**
Repeat the monitoring at and in the vicinity of the affected location	Before the end of the working day
If the exceedance is sustained repeat the monitoring at and in the vicinity of the affected location	5 working days
Advise the Environment Agency	Within 48 hours of the repeat monitoring
If the exceedance is sustained assess the risks associated with the presence of the elevated gas concentrations.	Within one week
Advise the Environment Agency	Within two working days of the assessment
If the risks are acceptable re-evaluate the assessment test	12 months
If the risks are unacceptable implement corrective measures and or additional monitoring which may include the installation of in-waste gas monitoring wells.	Agree timetable with the Environment Agency based on the results of the revised risk assessment

Notes:

[1] Based on the trigger levels specified in Environment Agency LFTGN03 Guidance on the management of landfill gas the action limits comprise 20% of the lower explosive limit for methane and 20% of the 8-hour UK Occupational Exposure Standard for carbon dioxide.

APPENDIX I

SUMMARY OF THE ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

VERSION HISTORY				
DATE	PAGE No.	ISSUE No.	DESCRIPTION	APPROVED
February 2018	All	1.2	First Issue	AS

INTEGRATED MANAGEMENT SYSTEM TABULAR MANUAL ISO 14001: 2015, ISO 9001: 2015 and OHAS 18001: 2007

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
4.0	**Context of the Organisation**					
4.1	**Understanding the organization & its context**		HSE Manager Technical Director HSEQ Manager	Context and Scope of Organisation	Org Chart, Scoping flowchart	Annual; upon significant change
4.2	**Understanding the needs & expectations of interested parties**		HSE Manager Technical Director HSEQ Manager	Communication (IMS03)	Stakeholder assessment within Context spreadsheet	Annual; upon significant change
4.3	**Determining scope of the management system**		HSE Manager Technical Director HSEQ Manager	Context and Scope of Certification	Org Chart, Scoping flowchart BSI Certificates	Annual
4.4	**Management systems**		HSE Manager Technical Director HSEQ Manager	All	FPC; Objectives and Targets; Management Review Roles and Responsibilities	Annual
5	**Leadership**					
5.1	**Leadership and commitment** **Customer Focus (Q)** (5.1.2)		CEO; Directors & Senior management HSE Manager Technical Director	Management Review (IMS06); Communication (IMS03)	Policy Minutes Objectives and Targets Management programmes Newsletters /	Annual

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
			HSEQ Manager		communications Customer feedback	
5.2	**Policy**	4.2	CEO; Directors & Senior management	Management Review (IMS06)	Policy Risks & Opportunities Assessments Objectives and Targets Legal Register	Annual
5.3	**Roles, responsibility and authority**	4.4.1	CEO; Directors & Senior management Line management HR	Duties and Responsibilities (BS01 – Breedon Southern)		Annual
6	**Planning**					
6.1	**Actions to address risks & opportunities** **Compliance obligations (6.1.3)** **Planning Action (6.1.4)**	4.3.1 4.3.2 4.5.2	HSE Manager Technical Director HSEQ Manager Operational Management	Assessment of Risk (IMS01)	Risk Assessments; Aspects & Impacts Assessments & EIAs Associated action plans Legal Register	Annual; after incident; after changes in legal & other requirements
6.2	**Objectives & planning to achieve them**	4.3.3	CEO; Directors & Senior management HSE Manager, Technical Director, HSEQ Manager	Objectives (IMS02)	Objectives and Targets spreadsheet Management programmes Management Review	Quarterly

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
			Line management			
6.3 - Q	**Planning of changes**		Technical Director, HSEQ Manager, General Manager		Management Review Audit outputs	As required
7	**Support**					
7.1	**Resources (including People, Infrastructure, Environment)**	4.4.1	HSE Manager, Technical Director, HSEQ Manager; HR; Line / Operational management	Communication (IMS03) Duties and Responsibilities (BS01 – Breedon Southern)	Management Review Structural Survey Audit outputs Capex / Projects	Annual; upon significant change
7.1.5 - Q	**Monitoring & measuring resources**		Technical Director; Operational Management	Regional Quality Procedures	Certificates of Conformity; Statutory inspections records; Calibration records	
7.1.6 - Q	**Organisational knowledge**		Technical Director; HR; Operational Management	Duties and Responsibilities (BS01 – Breedon Southern)	Training records & documentation, including training needs assessments, matrices Legal Register	Annual, upon change, for new staff
7.2	**Competence**	4.4.2	HSE Manager, Technical Director, HSEQ Manager; HR; Line / Operational management	Duties and Responsibilities (BS01 – Breedon Southern)	Training records & documentation, including training needs assessments Appraisals	Annual, upon change, for new staff
7.3	**Awareness**		HSE Manager,	Communication	Policy, Objectives & Targets,	As required

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
			Technical Director, HSEQ Manager; Line / Operational management	(IMS03)	HSEQ Alerts Noticeboards Induction / TBT awareness tests	
7.4	**Communication** (Internal & External)	4.4.3	CEO; Directors & Senior management HSE Manager, Technical Director, HSEQ Manager Line management	Communication (IMS03)	Policy, Objectives & Targets, HSEQ Alerts Noticeboards Register of Legislation; TBT & Briefings; Liaison Committees, Website	As required
7.5	**Documented Information** (Creating & Controlling)	4.4.4 4.4.5 4.5.4	HSE Manager, Technical Director, HSEQ Manager	Document Control (IMS07)	All documents	
8	**Operation**					
8.1	**Operational planning and control**	4.4.6	HSE Manager, Technical Director, HSEQ Manager Operational management	Objectives (IMS02) Regional Quality procedures	Daily / weekly checksheets / log books Risk Assessments, Aspects & Impacts Assessments, EIAs FPC Environmental Permits & Licenses (inc Water)	
8.2 - Q	**Requirements for products & services**					
8.2.1-Q	**Customer Communication**		HSE Manager, Technical Director,	Communications (IMS03)	Contracts & specifications Electronic sales / dispatch	Periodic by agreement; new

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
			HSEQ Manager Commercial		records	contract
8.2.2 - Q	**Determining requirements for products & services**		Technical Director, HSEQ Manager Commercial		Contracts & specifications, customer requirements	Periodic by agreement; new contract
8.2.3 - Q	**Review of requirements for products & services**		Technical Director, HSEQ Manager Commercial		Contracts & specifications, customer requirements	Periodic by agreement; new contract
8.2.4 - Q	**Changes to requirements for products & services**		Technical Director, HSEQ Manager Commercial		Contracts & specifications, customer requirements	Periodic by agreement; new contract
8.2 - E	**Emergency preparedness and response**	4.4.7	HSE Manager, HSEQ Manager Operational management	Emergency Arrangements Fire safety First aid Incident Reporting (Assure)	All risk assessments, EIAs Emergency drill forms (eg spill drills) Accident book Delivery tickets (In / out) Weekly check sheets Conformity declarations Complaints	
8.3 - Q	**Design and development** (To include planning, inputs, controls, outputs & changes)		Technical Manager		Batch designs / mix card	

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
8.4 - Q	**Control of externally provided products and services**		Site Managers	Haulier Management Induction and Training Contractor Safety Regional Quality procedures	Daily / Weekly check sheets	As required
8.5 - Q	**Production and service provision** (To include controls, identification & traceability, customer property)		Technical Director, HSEQ Manager	Regional Quality Procedures	Delivery tickets Customer feedback forms	As required
8.6 - Q	**Release of products and services**		Technical Director, HSEQ Manager Operational Management		DOPs Technical spreadsheets	As required
8.7 - Q	**Control of nonconforming outputs**		Technical Director, HSEQ Manager Operational Management	Non-conformance and corrective action (IMS05) Regional Quality procedures	Cat C failure notifications CAR reports Non-conformance database	As necessary
9	**Performance evaluation**					
9.1	**Monitoring, measurement,**	4.5.1	HSE Manager; Technical Director,	Internal Audit (IMS04) Regional Quality	Daily / weekly checksheets Calibration records	As required

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
	analysis and evaluation		HSEQ Manager Operational Management	Procedures	Customer feedback Audit outputs	
9.1.2 - Q	**Customer Satisfaction**		Technical Director, HSEQ Manager	Communications (IMS03)	Customer feedback (surveys etc)	As required
9.1.3 - Q	**Analysis & Evaluation**		Technical Director, HSEQ Manager	Management Review (IMS06)	Management Review	Annual
9.2	**Internal Audit** (Including Internal audit programme)	4..5.5	HSE Manager; Technical Director, HSEQ Manager	Internal Audit (IMS04)	Audit schedule (Internal & External) Audit reports (Internal & External) CARs Corrective Action Plan Minutes	Annual; as required with change or incident etc
9.3	**Management Review**	4.6	CEO; Directors & Senior management HSE Manager, Technical Director, HSEQ Manager Operational management	Management Review (IMS06)	Agenda & Minutes Annual Reports Objectives and targets	Annual
10	**Improvement**					
10.1	**Improvement – General**		CEO; Directors & Senior management HSE Manager, Technical Director, HSEQ Manager	Management Review (IMS06)	Minutes Objectives & targets Management programmes	Annual

Ref	Clause ISO 9001:2015 & ISO 14001:2015	Clause OHSAS 18001	Relevant Individual / Responsibility	Procedure (s)	Related Documents / Records	Review Frequency
			Operational management			
10.2	**Nonconformity and corrective action**	4.5.3	HSE Manager, Technical Director, HSEQ Manager Operational management	Nonconformance & corrective actions (IMS05)	Audit outputs CARs Minutes Alerts Incident reports	As required
10.3	**Continual improvement**		HSE Manager, Technical Director, HSEQ Manager Operational management	Management Review (IMS06)	Minutes Objectives & targets Management programmes	Quarterly

APPENDIX J

TECHNICAL COMPETENCE INFORMATION

CIWM

Continuing Competence Certificate

This certificate confirms that

Simon Bryant

Has met the relevant requirements of the Continuing Competence scheme for the following award(s) which will remain current for two years from 07/01/2022

LIN Landfill - Inert Waste

Expiry Date: 07/01/2024

Verification date: 10/12/2021

Authorised:

Professional Services Director

Learner ID: 12737

Certificate No.: 5190465

Date of Issue: 07/01/2022

CIWM Chief Executive Officer

The Chartered Institution of Wastes Management

Scan code on reverse to authenticate that this is a genuine paper

Credit certificate

This certificate determines credit awarded to:

Simon Thomas Bryant

Units gained:

		Credit Value	Credit Level
Y6015875	Monitor procedures to safely control work operations	4	3
M6009712	Manage the environmental impact of work activities	5	4
R6021609	Manage the reception of non hazardous waste	7	4
A6021670	Manage the movement, sorting and storage of waste	7	3
F6021671	Manage site operations for the treatment of non hazardous waste	14	4
L6021429	Manage the transfer of outputs and disposal of residues from non hazardous waste treatment and recovery operations	13	4

Awarded: 05/02/2015

Serial No.: 12737/HSS3/1

Authorised

Ray Burberry
Qualifications Manager, WAMITAB

Regulated by Ofqual

For more information see http://register.ofqual.gov.uk

Llywodraeth Cymru
Welsh Government

The qualifications regulators logos on this certificate indicate that the qualification is accredited only for England, Wales and Northern Ireland.

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APPENDIX K

WASTE ACCEPTANCE PROCEDURES

BREEDON	Ref No:		Issued:	**February 2022**	Version:	**1.0**
	Site:	**Earls Barton Landfill**				

Procedure Title: Waste Acceptance & Handling

1. PURPOSE & SCOPE

1.1	This procedure is to ensure compliance with site environmental permit conditions, duty of care and regulatory requirements.
1.2	Following this procedure will also assist customers of the landfill site in complying with their legal obligations relating to the correct categorisation and deposit of waste.

2. RESPONSIBILITIES

2.1	It is the responsibility of the Competent Person(s) to ensure this procedure is implemented on site.
2.2	Compliance with the customer's legal obligations (and compliance by the customer's driver or haulier) is the sole responsibility of the customer and its contractors.

3. DEFINITIONS & GLOSSARY

3.1	WAC – Waste Acceptance Criteria - covers the minimum testing requirements that need to be met for the disposal of waste at the inert landfill.
3.2	SI – Site Investigation report – details all relevant information and data regarding the waste excavation site, including (but not limited to) site location, scale & size, previous uses, details of investigations completed, location of boreholes, services, drains etc, potential for contamination, soil description & analysis.
3.3	Greenfield Site – undeveloped land in a city or rural area either used for agriculture or landscape design, or left to evolve naturally.
3.4	Technically Competent Person (TCP) – person holding the appropriate qualification / certification (WAMITAB) confirming the knowledge and skills to operate / manage the waste recovery operation.
3.5	List of Permitted Wastes – provides details (Waste Codes & Descriptions) of the wastes permitted by the Environmental Permit. The wastes are listed in Appendix 1. No other wastes may be accepted into the landfill site.

4. Procedural Content

4.1.	**Enquiry & Initial Approval**
4.1.1	Customer enquiry received by site personnel – providing full details of the waste materials, source site, quantities. A Site Investigation (SI) report, which includes the WAC analysis is forwarded if necessary. Waste listed in Appendix 1, Table 1 may be accepted

	without testing provided that the waste is from a well-characterised source or greenfield development. If there is suspicion of the presence of contamination or if there is doubt that the waste meets the definition of inert as specified in the Environmental Permitting Regulations (England and Wales) 2016 [EPR 2016]. The TCP will confirm if testing is necessary following review of the information presented and a site visit if needed.
4.1.2	The enquiry detail will be reviewed by the Technically Competent Person (TCP), who will decide if the material is acceptable. The TCP will communicate the decision to the customer.
4.1.3	All accepted & rejected enquires are entered into the Accepted & Rejected Materials Log – details include the date, customer details, site details, volume, reason for rejection if applicable.
4.1.4	If the material is acceptable, the customer must complete a pre-acceptance form. This form will be signed by the customer & the TCP prior to any material being accepted.
4.2	**Waste Acceptance (see Appendix 3 – flowchart)**
4.2.1	On arrival the customer will provide a waste transfer note which is to be checked against the Materials log. Loads not complying will be rejected and entered into the rejection.
4.2.2	A visual inspection of the waste is carried out. If contamination (organic material, topsoil, asphalt, wood, plastic etc) is seen, the load will be rejected. Details of the rejection will be entered onto the Site Rejection Log.
4.2.3	The waste will be directed to the tipping area as appropriate.
4.2.4	The waste material will be inspected during and after tipping to ensure no contamination is present. If contamination is seen (and cannot easily be removed), the load may be rejected. It will be reloaded and removed from site by the customer, and at the customer's expense. A record of this rejection & removal will be maintained on the site rejection log. If the contamination can easily be removed, site operative will remove it and place in a site skip provided.
4.2.5	The site dozer driver will push the material out into the operational phase.
4.2.6	All hauliers will adhere to the site traffic management rules / signage when entering & exiting the site and MUST use the wheel wash when exiting the quarry site.

Section 5 – Documents, records or other information

Earls Barton Landfill Permit – EPR/XXXXXXX
Earls Barton Accepted & Rejected Materials Log
Earls Barton Site Rejected Loads Log
Earls Barton Pre-Acceptance Form

Section 6 – Related information

Appendix 1 – List of Permitted Wastes (taken from Envionmental Permit)

Appendix 2 – Limits of the constituents of leachate produced from a waste

Appendix 3 – Waste Acceptance Flow Chart limit values for the total content of organic parameters in inert wastes

Written and issued by:	**Simon Bryant**

REVISION NOTES – What's new in this version?

Section	Version	Detail & reason for change	Date
All	1.0	This is a new document and should be read in full	2022

END OF PROCEDURE

Appendix 1 – Waste Types

Table 1

Waste types that may be accepted without testing

LoW Code	Description	Restrictions	Waste types to be accepted
10 11 03	Waste glass based fibrous materials	Only without organic binders	Glass fibres
15 01 07	Glass packaging		Glass
17 01 01	Concrete	Selected C&D waste only[(a)]	Reinforced concrete, concrete blocks, breeze blocks and aircrete blocks
17 01 02	Bricks	Selected C&D waste only[(a)]	Bricks
17 01 03	Tiles and ceramics	Selected C&D waste only[(a)]	Bricks, bricks and mortar, tiles, clayware, pottery, china, and refractories
17 01 07	Mixtures of concrete, bricks, tiles and ceramics	Selected C&D waste only[(a)]	Reinforced concrete, concrete blocks, breeze blocks and aircrete blocks, bricks, bricks and mortar, tiles, clayware, pottery, china and refractories
17 02 02	Glass		Glass
17 05 04	Soil and stones	Excluding topsoil, peat; excluding soil and stones from contaminated sites	Clay, sand, gravel sandstone, limestone, crushed stone, construction stone, stone from demolition
19 12 05	Glass		Glass
20 01 02	Glass	Separately collected glass only	Glass
20 02 02	Soil and stones	Only from garden and parks waste; excluding top soil, peat	Clay, sand, gravel, sandstone, limestone, crushed stone, construction stone, stone from demolition

[(a)] Selected construction and demolition waste (C & D waste): with low contents of other types of materials (l ke metals, plastic, organics, wood, rubber, etc). The origin of the waste must be known.

No C & D waste from constructions, polluted with inorganic or organic dangerous substances, e.g. because of production processes in the construction, soil pollution, storage and usage of pesticides or other dangerous substances, etc., unless it is made clear that the demolished construction was not significantly polluted.

No C & D waste from constructions, treated, covered or painted with materials, containing dangerous substances in significant amounts.

Table 2

Waste types that may be accepted following testing

LoW Code	Description	Waste types to be accepted
01 01 02	Wastes from mineral non-metalliferous excavation	Clay, sand, gravel, sandstone, limestone, crushed stone
01 04 08	Waste gravel and crushed rocks other than those mentioned in 01 04 07	Clay, sand, gravel, sandstone, limestone, crushed stone, construction stone, stone from demolition
01 04 09	Waste sand and clays	Sand and clay
01 04 12	Tailings and other wastes from washing and cleaning of minerals other than those mentioned in 01 04 07	Clay, sand, gravel, sandstone, limestone, crushed stone, construction stone, stone from demolition
10 11 12	Waste glass other than those mentioned in 10 11 11	Glass
10 12 01	Waste preparation mixture before thermal processing	Bricks, bricks and mortar, tiles, clayware, pottery, china, refractories
10 12 03	Particulates and dust	Bricks, bricks and mortar, tiles, clayware, pottery, china, refractories
10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)	Bricks, bricks and mortar, tiles, clayware, pottery, china, refractories
16 01 20	Glass	Glass
17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	Clay, sand, gravel, sandstone, limestone, crushed stone, construction stone, stone from demolition, sub-soil, bricks, bricks and mortar, tiles, clayware
19 12 09	Minerals (for example sand, stones)	Clay, sand, gravel, sandstone, limestone, crushed stone, construction stone, stone from demolition, sub-soil, bricks, bricks and mortar, tiles, clayware

Appendix 2 – Limits of the constituents of leachate produced from a waste

Table 1

Limits of the constituents of leachate produced from a waste using the BS EN 12457:2002 test for wastes that may be accepted at an inert site

Component	Symbol	L/S = 10 l/kg mg/kg dry substance
Arsenic	As	0.5
Barium	Ba	20
Cadmium	Cd	0.04
Total Chromium	Cr_{total}	0.5
Copper	Cu	2
Mercury	Hg	0.01
Molybdenum	Mo	0.5
Nickel	Ni	0.4
Lead	Pb	0.5
Antimony	Sb	0.06
Selenium	Se	0.1
Zinc	Zn	4
Chloride	Cl^-	800
Fluoride	F^-	10
Sulphate[a]	SO_4^{2-}	1,000
Phenol index	PI	1
Dissolved organic carbon[b]	DOC	500
Total dissolved solids[c]	TDS	4,000

A This limit value for sulphate may be increased to 6,000mg/kg, provided that the value of C· (the first elute of a percolation test at L/S = 01. l/kg) does not exceed 1,500 mg/l. It will be necessary to use a percolation test to determine the limit value at L/S = 01. l/kg under initial equilibrium conditions.

B If the waste does not meet this value for Dissolved Organic Carbon (DOC) at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7.5 and 8.0. The waste may be considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/kg.

C The value for Total Dissolved Solids can be used alternatively to the values for sulphate and chloride.

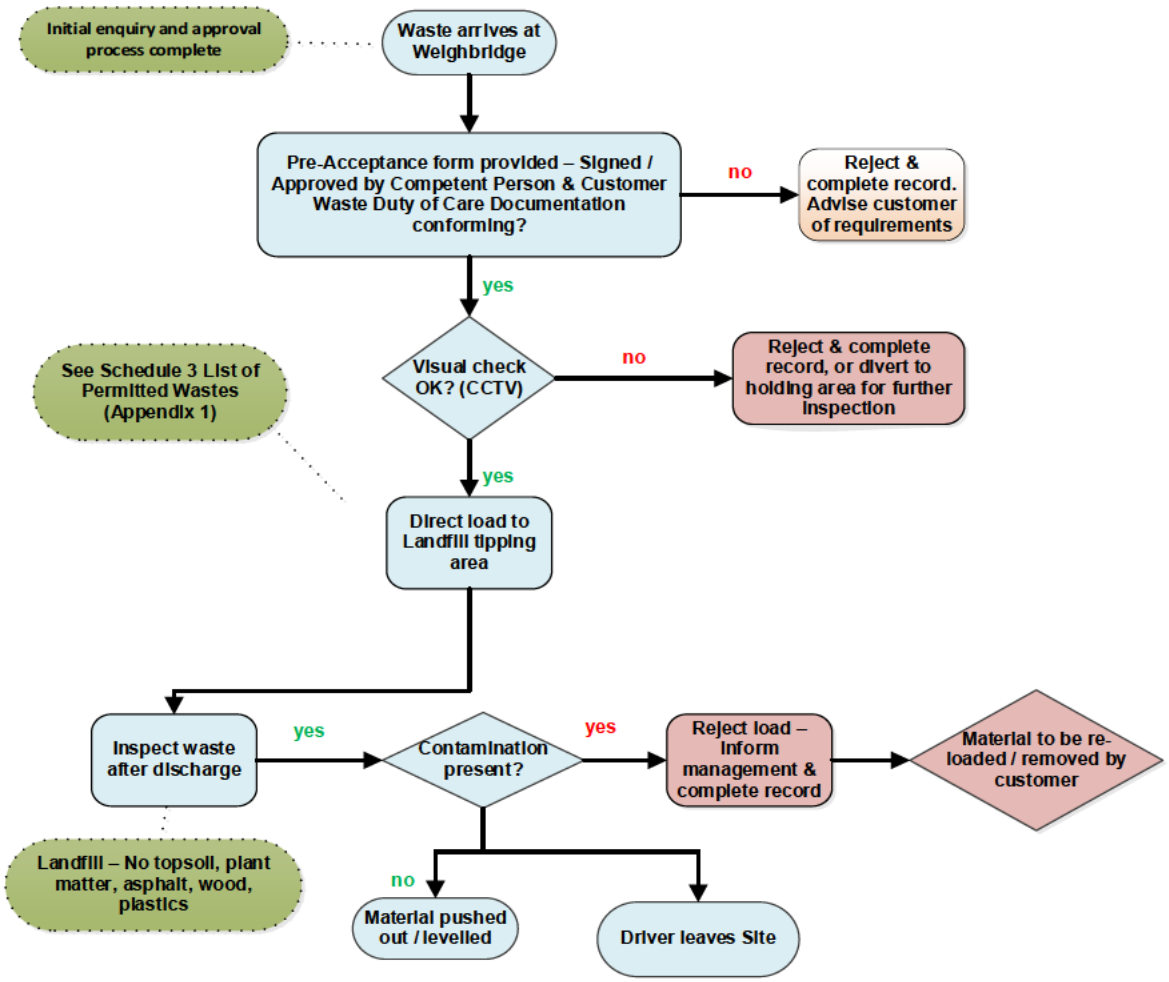
Table 2 –

Limit values for the total content of organic parameters in inert wastes

Component	**Value (mg/kg)**
Total organic carbon (TOC)[a]	30,000
BTEX compounds (benzene, toluene, ethyl benzene and xylenes)	6
Polychlorinated biphenyls (PCBs) (7 congeners)	1
PAHs (Polycyclic aromatic hydrocarbons) (total of 17)	100
Mineral oil (C10 to C40)	500

[a] In the case of soils, a higher limit value may be permitted by the Environment Agency provided a Dissolved Organic Carbon value of 500mg/kg is achieved at L/S 10 l/kg at the pH of the soil or at a pH value of between 7.5 and 8.0.

Appendix 3 – Waste Acceptance Flow Chart



APPENDIX L

DUST AND EMISSIONS MANAGEMENT PLAN (DEMP) (REPORT REFERENCE BRE/EA/AW/5624/01/DEMP)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT FOR THE PERMANENT DEPOSIT OF INERT WASTE AS A DISPOSAL OPERATION FOR THE RESTORATION OF EARLS BARTON SPINNEY QUARRY, GRENDON ROAD, EARLS BARTON, NORTHAMPTON TO AGRICULTURE AND NATURE CONSERVATION INTEREST

DUST AND EMISSIONS MANAGEMENT PLAN (DEMP)
V1.0

Report reference: BRE/EA/AW/5624/01/DEMP
February 2022

Technical advisers on environmental issues

Baddesley Colliery Offices, Main Road, Baxterley, Atherstone, Warwickshire, CV9 2LE
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CONTENTS

FIGURES

APPENDICES

1. Introduction

1.1 MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare an application for a bespoke Environmental Permit for the deposition of waste on land as a disposal activity, specifically as an inert waste landfill operation, in Phases 1 and 3 at Earls Barton Spinney Quarry (Earls Barton Quarry), Grendon Road, Earls Barton Northampton. Throughout this report the areas in Phases 1 and 3 in which waste will be deposited and which it is anticipated will be the subject of an Environmental Permit are referred to as the site and, unless specified otherwise, references to Phase 1 and Phase 3 are to those areas of Phases 1 and 3 in which waste will be deposited. This document comprises a Dust and Emissions Management Plan (DEMP) prepared to support the application.

1.2 This DEMP has been prepared based on Environment Agency guidance Control and monitor emissions for your environmental permit[1] with reference to the section of the guidance entitled "What to include in your dust management plan".

1.3 This document presents the management techniques that will be used at the site to minimise the potential for particulate matter emissions from the site, the monitoring proposed to confirm the effectiveness of the management techniques and an action plan which will be implemented in the unlikely event that there is a significant emission of particulate matter from the site.

1.4 An assessment of the likelihood of particulate matter nuisance associated with the operation of the site is presented in the nuisance and amenity Environmental Risk Assessment (ERA) which is presented at Appendix F of the Environmental Permit application. In the ERA it is concluded that the residual risk in respect of fugitive emissions of particulate matter is '*Low to very low'*.

1.5 The management and monitoring proposals in this document are based on a review of the ERA. The DEMP will be reviewed annually. The review will include consideration of the results of particulate matter monitoring and progress with any

[1] https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit Published 1 February 2016. Last Updated 19 October 2020.

improvements identified. A review of the effectiveness of dust monitoring techniques will be undertaken and changes made to monitoring techniques as necessary.

2. Site details and description of site operations

2.1 With the exception of the A45, Earls Barton Quarry is located in a generally rural setting. The area of Earls Barton Quarry which is the subject of the Environmental Permit application (the site) is located approximately 350m south-south east of Earls Barton, approximately 550m south of Ecton and approximately 1km east of Great Billing which comprises the eastern outskirts of Northampton as shown on Figure DEMP 1. There are three main phases of mineral extraction at Earls Barton Quarry as shown on drawing reference EB 1 presented at Appendix ESSD C of the ESSD report[2] and the phases are sub divided. As explained above, the site which is the area the subject of the Environmental Permit application is limited to those areas in Phases 1 and 3 in which waste will be deposited (Figure DEMP 2). No waste will be deposited in the southern half of Phases 1B and 1F, in Phases 1C to 1E, in the Plant Area or in Phase 2 where the extent of quarrying operations extends beyond the Environmental Permit application boundary. It is understood that these areas will be backfilled with site derived overburden material as part of the quarrying operation. The area in which waste will be deposited in Phase 1 (referred to as Phase 1) is centred approximately on National Grid Reference (NGR) SP 850 623 (Phases 1A and 1B) and NGR SP 844 623 (Phases 1F and 1G) between the River Nene to the south and the A45 to the north. The areas in which waste will be deposited in Phase 3 (referred to as Phase 3) is centred approximately on NGR SP 831 624 adjacent to and south of the A45. The River Nene is approximately 250m south of Phase 1 and approximately 0.8km south of Phase 3. The area the subject of the Environmental Permit application is approximately 21 hectares. The site is accessed from Grendon Road through a private access point which connects to the A45 to the north of Phase 1 (Figure DEMP 2).

2.2 The closest residential receptors to Phase 1 comprises a caravan park approximately 180m to the east. The caravan park is set amongst and generally to the north of a transport services depot. White Mills Marina is located approximately 400m east-south east of Phase 1. There is a residential property approximately 390m north of Phase 1 beyond the A45. The residential property is located adjacent to and north

[2] An application for an Environmental Permit for the permanent deposit of inert waste as a disposal operation for the restoration of Earls Barton Spinney Quarry, Grendon Road, Earls Barton, Northampton to agriculture and nature conservation interest. Environmental Setting and Site Design Report (ESSD). Report reference: BRE/EA/AW/5624/01/ESSD. February 2022.

of Whites Nursery which is located approximately 240m north of Phase 1. There are no residential receptors within 500m of Phase 3. The closest properties to Phase 3 comprise the service stations on the A45 with the northern service station location approximately 350m to the west – north west.

2.3 There are several public rights of way in the vicinity of the site as shown on Figure DEMP 2. Footpath TC17 runs in a generally south westerly direction along the River Nene approximately 250m south of Phase 1 to a location approximately 390m south of Phase 1 where it joins Bridleway KF19 from the north, Bridleway KF20 from the south and Footpath KF4 from the south west. Bridleway KF19 joins Bridleway TC13 approximately 170m to the north. Prior to mineral extraction Bridleway TC13 ran in a generally north east direction through the southern part of Phase 1 of Earls Barton Quarry to the south of the site. It is understood that Bridleway TC13 has been diverted round the southern boundary of Phase 1D before running northerly between Phase 1C and Phases 1D and 1E. There is a byway which runs in a generally westerly direction from the north western corner of Phase 1 to the south western corner of Phase 3. The eastern end of the byway is number TC12 and the mid and western sections of the byway is number TE11. It is understood that the eastern end of Byway TC12 and the northern end of the diverted route of Bridleway TC13 are joined by a generally north south running track adjacent to and to the east of Phase 1A and between Phase 1A and the Plant Area. Adjacent to the south western corner of Phase 3 Byway TE11 joins Byway TE10 which runs in a generally north south direction to the east of Phase 3 and south of Phase 3.

Source

2.4 The activities with the potential to generate and/or release particulate matter include the movement of particulate matter on vehicle bodies, the resuspension of particulate matter on haul roads by vehicles, the wind scouring of waste surfaces and the action of the wind on waste materials while they are being handled. Temporary haul roads comprising hardstanding will be created to provide a surface suitable for HGV movements.

Pathway

2.5 Particulate matter is dispersed from the source to potential receptors by the wind. The location of sources of particulate matter in the site will vary depending on the location of waste deposit activities and temporary haul roads. Based on the prevailing wind direction which is from the south west, as shown on the wind roses for the Environment Agency Anglian Region presented at Appendix A, areas to the north east of the site are down prevailing wind of the site.

Receptors

2.6 As explained above Earls Barton Quarry is in a predominantly rural area with the majority of the surrounding land in agricultural use. The location of receptors is summarised above in Paragraphs 2.1 to 2.3.

2.7 The site is not located within an Air Quality Management Area (AQMA).

3. Particulate matter management techniques

3.1 The control of particulate matter at the site will be achieved by a combination of controls on waste delivery and receipt at the site and operational techniques employed at the site. The techniques selected for use at the site are based on well-established techniques to control the emissions of particulate matter. Collectively the techniques amount to good housekeeping. Reference has been made where relevant to the Environment Agency Technical Guidance Document (Monitoring) M17 entitled 'Monitoring of particulate matter in ambient air around waste facilities' (M17) and appropriate measures for control of dust and mud presented in Environment Agency Guidance Control and monitor emissions for your environmental permit. A variety of techniques will be used at the site based on site specific circumstances. The techniques are described below.

Responsibility for implementation of this plan

3.2 The Technically Competent Site Manager (TCM) shall be responsible for the management of particulate matter and site staff will be trained appropriately. The TCM will appoint a suitably trained deputy to oversee the management of particulate matter at the site during operational periods when the TCM is not present at the site. The TCM will provide the training for the deputy. The training will include refresher training where appropriate however during the course of routine operation of the site the experience of the site staff, including the deputy, will comprise on the job training which will complement the refresher training as necessary. It is the responsibility of the TCM to ensure that the DEMP is being followed and to ensure that appropriate training is given.

Operational controls

3.3 The operational controls employed currently at the existing quarry site will continue to be employed for the waste deposit area including the following.

3.4 All vehicles using the site will be instructed to sheet or otherwise contain their loads prior to arrival at the site to minimise the risk of particulate emissions. Loads will be sheeted or contained until such time as they are inspected and/or deposited. Following completion of the visual waste acceptance checks in the site reception

area, HGV drivers delivering waste to the site will be instructed to tip waste in the currently active phase of the site.

3.5 Waste received at the site is subject to pre-acceptance checks and acceptance screening comprising, where appropriate, visual inspection to confirm that the load is consistent with the waste types permitted for acceptance at the site. In the event that unsuitable materials are delivered to the site, including wastes comprising solely or mainly dusts, powders or loose fibres, the load will be rejected.

3.6 In order to minimise the deposition of mud that may subsequently dry and generate particulate matter if disturbed, such as when tracked over by vehicles, all vehicles delivering waste to the site will use the wheel cleaning facilities as necessary before leaving the site. The wheel cleaning facilities will be maintained in full working order throughout the life of the site. The site access road will be maintained and swept with a road sweeper as necessary.

3.7 The movement of mobile plant and site traffic will be restricted to defined haul routes which are maintained. Vehicle speed limits will continue to be imposed for safety reasons and to reduce the potential for significant particulate matter to be resuspended. Insofar as it is practicable all site vehicle exhausts will be upward pointing to prevent the disturbance of particulate matter from the road surfaces. Mobile plant equipment used at the site will be maintained in accordance with the manufacturer's recommendations to optimise performance and minimise vehicle emissions. A no idling policy will be implemented at the site for vehicles and plant.

3.8 During dry weather conditions a bowser will be used to spray water onto the haul roads and access roads together with areas of waste deposition as necessary to minimise the potential for particulate matter to be generated and become airborne. The bowser will have an adequate operational capacity. The use of a water bowser is a proven effective dust management technique at numerous other deposit for recovery sites and inert landfill sites operated by Breedon.

3.9 Operations which may have the potential to generate particulate matter will cease if weather conditions and ground conditions preclude effective dust control. This decision will be made at the discretion of the TCM based on the site conditions (dry, damp, wet) giving consideration to the weather conditions (windy, calm, etc) and the

type, quantity and particle size of the waste on site. Additional dust suppression will be employed as necessary to dampen waste materials during high winds particularly when the prevailing wind direction is towards potentially sensitive receptors in the vicinity of the site.

3.10 In the event that particulate matter control measures fail to the extent that effective dust management cannot be provided then waste related operations at the site will be suspended until such time as the control measures can be reinstated.

3.11 All relevant site personnel including contractors will be trained in working practices and mitigation measures to minimise the generation and release of particulate matter.

3.12 Drop heights will be minimised during the unloading of waste. The mobile water bowser will be employed if necessary to provide dust suppression to minimise the release of particulate matter during the unloading of waste at the site.

3.13 Visual monitoring for emissions of particulate matter will be undertaken by site personnel. Further details are provided in Section 4 of this document.

Action Plan

3.14 A particulate matter management and monitoring action plan is presented in Section 6. The particulate matter management and monitoring action plan will be implemented in the event that:

i. there is an unacceptable visual emission of particulate matter from the site, or

ii. a complaint is received.

4. Particulate matter monitoring programme

4.1 In TGN M17 it is stated that despite the subjective nature of the visual assessment of dust emissions:

> *'this simple, cheap and easy to implement assessment approach has the significant advantage of providing instantaneous information on problems (e.g. it may be possible to directly observe the source of the dust emission, such as a particular stockpile) allowing rapid actions to be taken to deal with the problem.'*

4.2 During all site operations visual monitoring for emissions of particulate matter will be undertaken by suitably trained site personnel. Visual monitoring by suitably trained site personnel is the most effective method of detecting as quickly as possible emissions of particulate matter throughout the working day thereby facilitating promptly the assessment of such emissions allowing the selection and implementation as quickly as practicable of control measures as necessary. The effectiveness of the measures taken in controlling emissions will be assessed during inspections undertaken at the site following implementation of the control measures. Any problem that is observed will be reported to the site manager who will be responsible for investigating the cause and implementing any necessary remedial action. The results of inspections and remedial measures taken will be recorded in the site diary.

4.3 As part of the daily housekeeping practices, a final site inspection will be completed at the end of each working day to check that the site is in a condition that has a low potential to release dust outside of normal operational hours. Publicly available weather forecasts will be consulted by site staff to identify forecasts of extreme weather events or storms which may have the potential to increase the risk of the release of particulate matter from the site outside operational hours and additional control measures such as dampening of the working face prior to the end of the working day will be implemented as necessary. The findings of the visual assessments will be recorded in the site diary. Any problem that is observed is reported to the TCM who will be responsible for investigating the cause and implementing any remedial action as necessary. Incidents and remedial measures taken will be recorded in the site diary.

4.4 The site manager will use the Meteorological Office (www.met-office.gov.uk) weather forecast or other forecast to predict weather conditions such as prolonged dry spells which may give rise to particulate matter emissions and will implement the appropriate precautionary and or management measures. A qualitative assessment of the on-site conditions will be undertaken as necessary and measures taken to control aerial emissions of particulate matter within the site boundary.

4.5 The records of the visual particulate matter monitoring will be reviewed periodically to facilitate the review and assessment of operational activities as necessary. The review will be carried out in conjunction with a review of meteorological data that are available and the site operations that took place during the monitoring period together with any complaints regarding particulate matter emissions that have been received.

4.6 In the event that based on the visual site observations there is an unacceptable particulate matter emission from the site the particulate matter management and monitoring action plan will be implemented. The particulate matter management and monitoring action plan is presented in Section 6.

4.7 As the activities undertaken at the site are limited to the deposit of inert waste and as the site is not located within an AQMA declared for Particulate Matter PM_{10} it is unnecessary to undertake quantitative dust monitoring at the site.

5. Engagement with the community

5.1 Breedon are conscious of the potential impact on the environment of its activities and strive to manage and minimise those impacts. Breedon recognises the importance of community engagement and strives to build a positive working relationship with local residents and businesses across all of its sites. Contact details for the site shall be displayed on the signage at the site entrance.

Reporting of complaints and management responsibilities

5.2 Any complaints about the site operations and/or their impact on the environment made by third parties (including any complaints identified by the Environment Agency or Local Authority) will be brought to the attention of the TCM in the first instance who will identify and implement the measures needed to resolve the matter as set out in Section 6. They shall then make a note of the complaint and the actions taken to resolve it. A register of complaints will be maintained onsite in the site diary. Complaints will be escalated to senior management if necessary, based on the number and type of complaints. The need to escalate complaints will be decided by the TCM. Should complaints be escalated the details will be recorded in the site diary.

5.3 The particulate matter management and monitoring action plan which is implemented in the event that a complaint is received is presented in Section 6.

6. Particulate matter management and monitoring action plan

Context

6.1 The overriding management principle of the site with respect to the control of particulate matter shall be to operate the site in a manner which prevents or minimises the release of dust as set out in the DEMP. If it is considered that the waste received, handled and deposited at the site, or the site surfacing itself is in a condition that has the potential to release a significant quantity of dust such that there is a potential for off site dust emissions, additional dust suppression measures will be employed in a manner proportionate to the risk. These actions will be undertaken as part of the routine operation of the site. The action plan in this section of the report sets out the additional actions that will be taken in the event that conditions are identified whereby the routine measures need to be supplemented or improved.

Introduction

6.2 The action plan will be implemented in the event that:-

i) there is an unacceptable visual emission of particulate matter from the site or
ii) a complaint is received

6.3 An unacceptable visual emission of particulate matter from the site comprises a visual observation of dust or particulate matter crossing the site boundary. The initial observation will be made by the site operative who has identified the emission and will be verified by the TCM.

6.4 The timescale for implementation of the action plan will vary depending on the circumstances under which it is implemented. If an unacceptable visual emission is observed by site operatives there will be no delay in implementing the action plan, whereas a complaint may be received by the operator a number of hours or even days after the activity that may have contributed to the complaint has ceased. In the latter case investigation of the complaint will be based on a review of the data and observations recorded at the site corresponding to the time at which the complainant observed the event.

Action plan

6.5 In the event that an unacceptable visual emission of particulate matter from the site is observed by site personnel or in the event of a complaint associated with particulate matter emitted from the site the event will be investigated immediately by the TCM to determine the source as follows:

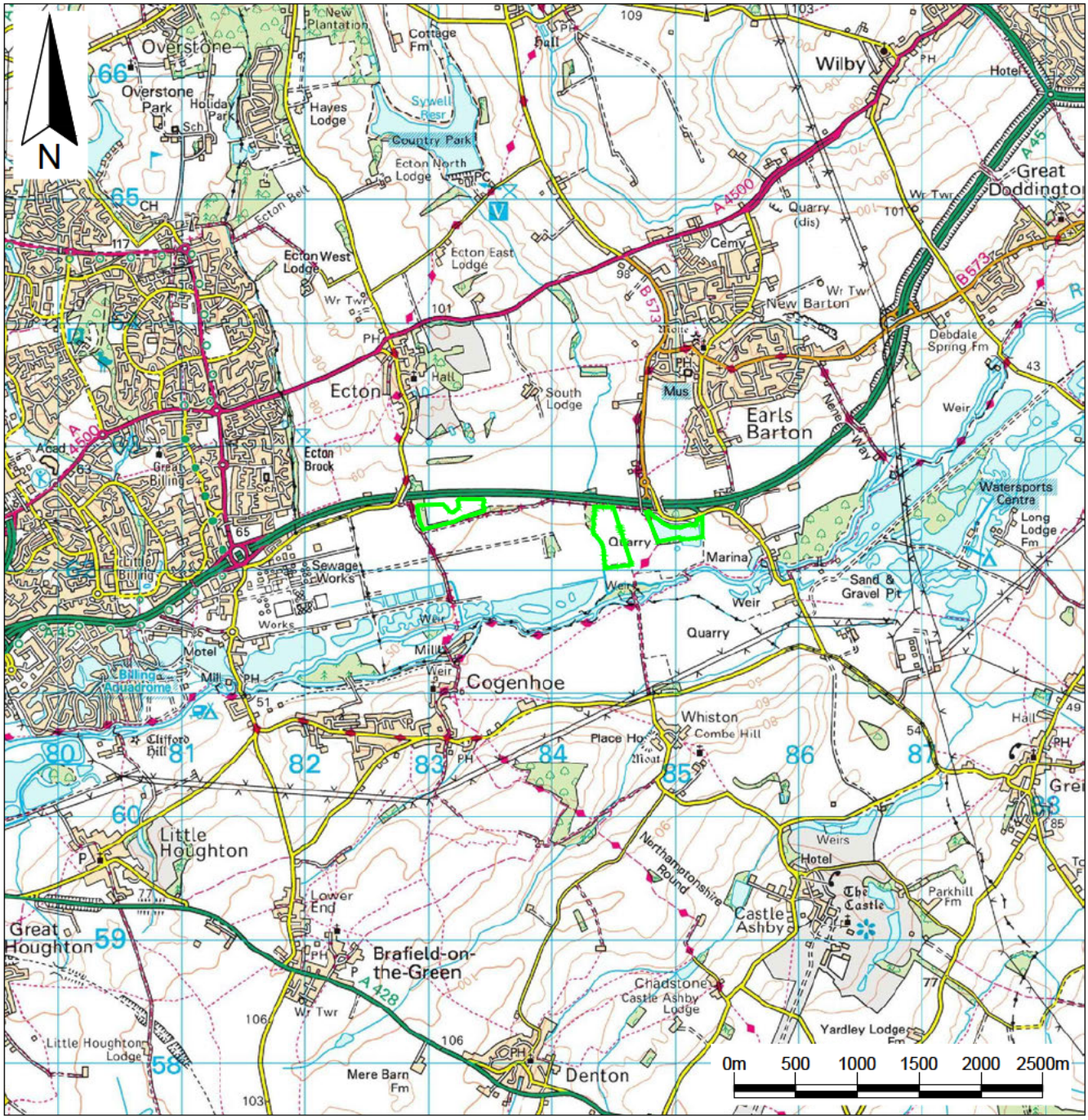
If it is established that the emissions are attributable to activities being undertaken at the Breedon site action will be taken to control the emissions including where relevant:

- Establish the cause of the emissions and take immediate action to control the emissions
- If emissions are attributable to unloading or depositing of waste dust suppression will be applied to control the particulate matter emission from the activity being undertaken. If necessary, the unloading and depositing of waste will temporarily cease.
- Organise additional road sweeping and mobilise the bowser to spray the affected area if necessary.
- Take action to ensure that vehicles are obeying the speed limits.
- Identify whether there are any other activities being undertaken at locations other than the Breedon site and estimate the extent to which other activities may contribute to the visual emissions observed on the site including circumstances where windblown dust may be transported across and/or over the site from the external sources.
- In the unlikely event that the routine control measures employed at the site are not sufficient to control particulate matter emissions then consideration will be given to further measures to minimise and control emissions including consideration of erecting static water sprays in strategic locations.

6.6 Appropriate action will be taken which will include the cessation of the activity if necessary. In the case of a complaint action taken will be communicated to the

complainant. The nature of the complaint, the findings of the investigation and the action taken will be recorded using the form presented at Appendix B. Consideration will be given to the wind speed and direction, the site operations and observations. As necessary the relevant operational procedures will be reviewed and improvements implemented.

FIGURES



Key / Notes

Approximate boundary of the site the subject of the Environmental Permit application

Rev	Status	Drn	App	Chk	Date
	Final	KR	GT	GT	22/02/22

Site: EARLS BARTON QUARRY

Client: BREEDON

Title: The site location

Figure DEMP 1

Scale: 1:50,000@A4

Drawing Ref: BRE/EA/02-22/23010

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Technical advisers on environmental issues
Baddesley Colliery Offices,
Main Road, Baxterley, Atherstone,
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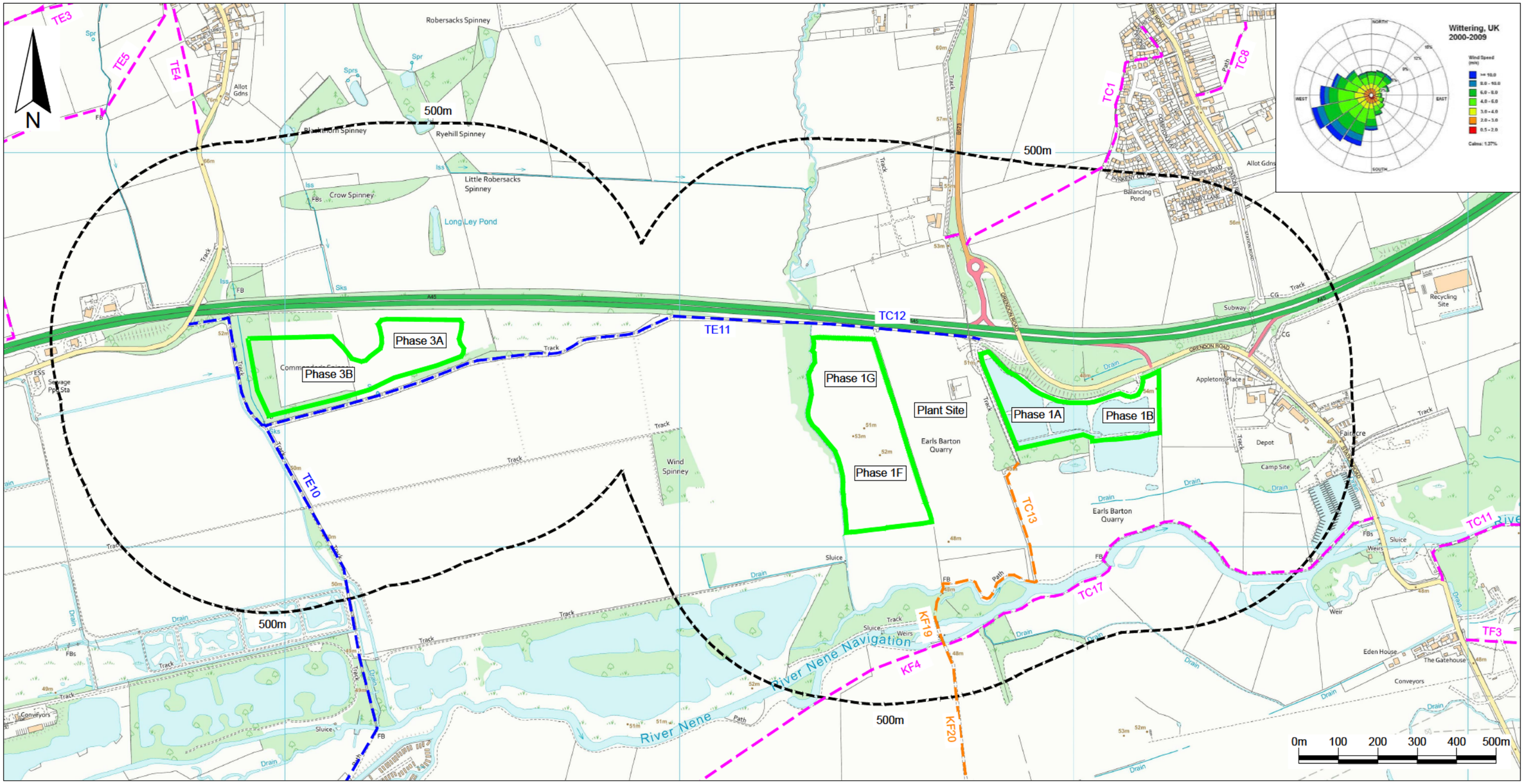
Fax : 01827 718507



Key / Notes

- Approximate boundary of the site the subject of the Environmental Permit application
- 500m distance from the site
- Footpath
- Bridleway
- Byway

Note:
The approximate site boundary is based on SLR drawing reference EB1 entitled "Working Phasing Scheme" dated August 2015 and discussions with Breedon

Rev	Status	Drn	App	Chk	Date
	Final	KR	GT	GT	22/02/22

Site: EARLS BARTON QUARRY

Client: BREEDON

Title: Plan showing receptors within the vicinity of the site

Figure DEMP 2 | Scale: 1:10,000@A3

Drawing Ref: BRE/EA/02-22/23011

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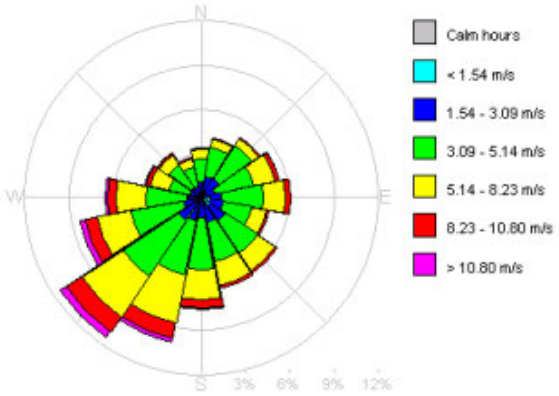
APPENDIX A

WIND ROSES FOR ANGLIAN REGION: CENTRAL, EASTERN AND NORTHERN

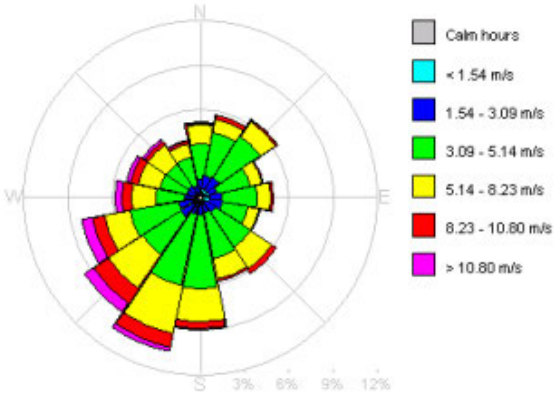
Anglian Region: Central

Windrose



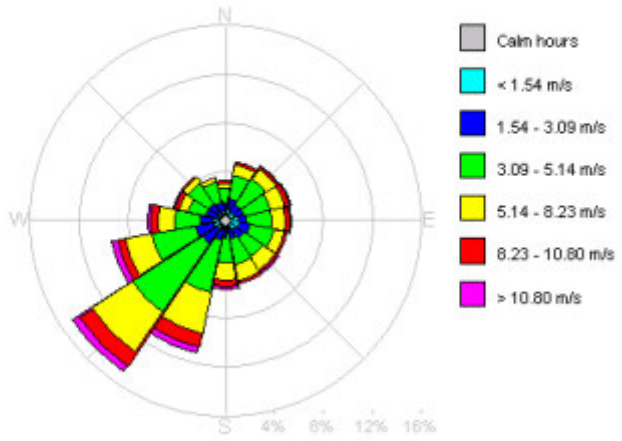
Anglian Region: Eastern

Windrose



Anglian Region: Northern

Windrose



APPENDIX B

PARTICULATE MATTER MONITORING AND MANAGEMENT ACTION PLAN RECORD FORM

Particulate matter monitoring and management action plan record form

Particulate Matter Complaint Report Form		Sheet No
Date:	Site to which complaint relates	Grid Reference:
Name and address of complainant:		
Tel no. of complainant:		
Time and date of complaint:		
Date, time and duration of particulate matter emission:		
Location of particulate matter emission, if not at above address:		
Weather conditions (i.e., dry, rain, fog, snow):		
Cloud cover (0-8):		
Cloud height (low, high, very high):		
Wind strength - (light, steady, strong, gusting)	Or use Beaufort scale:	
Wind direction:		
Complainant's description of particulate matter emission :		
Has complainant any other comments about the particulate matter emission?		
Are there any other complaints relating to the site, or to that location? (either previously or relating to the same exposure)		
Any other relevant information:		
On-site activities at time the particulate matter emission occurred:		
Form completed by	Signed	

Particulate matter monitoring and management action plan record form

Actions taken (and outcome):	
Completed by:	Date: