PARRY'S QUARRY LANDFILL, ALLTAMI, FLINTSHIRE

Environmental Permit Application

Stability Risk Assessment

Prepared for: Mold Investments Limited

Ref: SRA/MIL/PQ/1.00/2020
Version No: 1
August 2020

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1.0 Introduction

White Rock Geo Environmental Ltd has been instructed by Mold Investments Limited (Mold) to prepare an Environmental Permit (EP) application for Parrys Quarry Inert Landfill Pinfold Lane, Alltami, Flintshire (the site).

As part of the permit application, WRGE has undertaken a geotechnical Stability Risk Assessment (SRA). This document describes the manner in which the assessment has been carried out and presents the overall findings of the work.

Relevant background information describing the site setting (including geological, hydrological, site monitoring data and development proposals) is detailed within the site's Environmental Setting and Site Design (ESSD)[1].

The methodology adopted for this WRGE generally follows the principles outlined in the Environment Agency R&D Technical Report P-385, volumes TR1 and TR2[2] (from here on referred to as the guidance). Where additional analytical techniques have been used, these are described within the text.

1.1 Conceptual Stability Site Model

The conceptual stability site model has been developed from information contained in the ESSD[1] and review of relevant publicly available and site specific data.

The site is situated within the existing Parry's Quarry in Alltami, Flintshire and bounded by the A494 to the south, A55 to the north and Pinfold Road to the west. The National Grid Reference (NGR) for the entrance to the site is SJ 27478 66278.

The remaining land use immediately surrounding the proposed site is predominately agricultural land, with scattered residential and commercial / industrial premises. Access to the site will be via Pinfold lane.

It is proposed that the site will accept inert, non-hazardous non-biodegradable and biodegradable waste for disposal. The site will also benefit from an associated WTS; however, this operation is not assessed further in the SRA.

The installation is a former brick clay quarry covering an area of approximately 17 hectares. The site is on the edge of a valley at an elevation of 105m -110mAOD with the base of the quarry ranging from 86m – 88mAOD.

An SRA[3] was completed in 2016 as part of a previous permit application.

A review of the available data and British Geological Survey (BGS) records[4] indicate the site was underlain by superficial deposits comprising Devensian Till - Diamicton formed in the Quaternary period. This has been removed during quarry operations but remains in the surrounding area.

[1] WRGW (2020). Parrys Quarry Landfill Environmental Permit Application Environmental Setting and Site Design Report Ref: ESSD/MIL/PQ/1.00/2020. Prepared on behalf of Mold Investments Limited.
[2] Environment Agency R&D Technical Report P1-385/ TR1 and TR2, 'Stability of Landfill Liner Systems', March 2003.
[3] TerraConsult (2016). Parry's Quarry Landfill Site Stability Risk Assessment. Report No 2434/R/10-SRA. Prepared on behalf of Mold Investments Limited.
[4] British Geological Survey – Geology of Britain Viewer. Available at: http://mapapps.bgs.ac.uk, accessed January 2018.

The bedrock comprises a downthrown block of Etruria Marl intersected to 32mAOD. The bedrock is described[5] as faulted blocks of sandstone, siltstone between mudstone. The wider area comprises Upper Carboniferous Westphalian Coal Measures.

The current extraction has resulted in the presence of a bund along the eastern edge of the quarry. Sections of the eastern facing external slope reach a gradient of approximately 1V:2H. The bund is constructed of site won material overlying in-situ strata and reaches a maximum height of 6m. The topographical survey indicates the bund is set back from the site boundary and the area nearest the boundary slopes upwards towards the perimeter fence. The stability of the bund was raised in comments from Natural Resources Wales. However, the bund is vegetated and has been in place long enough for the trees to reach mature height. The placement of waste will not impact the stability of the bund and it is considered to be stable in the current condition. Any minor surface cracking is shallow and attributed to the vegetation. Minor sloughing will be contained by the existing slope geometry.

Groundwater has been recorded in the base of the excavation at approximately 86.5mAOD in association with a siltstone horizon.

The quarry will be restored to a flat profile with a maximum elevation of 112mAOD falling to 110m AOD within the landfill footprint forming part of a development footprint for residential development.

The following sections provide further details of the principal components of the landfill development.

1.1.1 Basal Subgrade Model

The basal subgrade will be formed by the base of mineral extraction between approximately 92m – 90mAOD, sloping to the northwest in the deepest area of extraction. The basal subgrade slopes at a shallow gradient, following the base of the mineral horizon.

The current base is even as a result of advance mineral lining works for the now abandoned non hazardous landfill development at the site. The Phase 1 area is below the water table and the site is being developed on the basis of hydraulic containment with initial groundwater management to keep the water tasble below the landfill in the early stages of infill.

1.1.2 Side Slope Subgrade Model

The side slope subgrade will be formed by the cut extraction side slopes and fill comprising site won clay. Overburden comprising glacial till is observed as being up to 2m thick in some locations with underlying mudstone of the Etruria Marl.

Extraction has left the quarry with engineered slopes on the south and east and the west face cut with the same slope angle and the north face to the placed using opencast backfill. In the main extraction area, the depth of excavation currently reaches 20m below surrounding ground level. Prior to installation of the lining system site won clay will be placed against the in-situ side slopes at a maximum gradient of 1V:2.5H.

1.1.3 Basal Lining System Model

The site will benefit from full containment engineering; the lining system will comprise:

- Geological barrier a minimum of 0.5m thick constructed of clay with a permeability of $5x10^{-10}$m/s;

1.1.4 Side Slope Lining System Model

The side slope lining system will be composed of the same material as the basal lining system as outlined in Section 1.1.3 with a geogrid drainage layer in the lower 3metres of the southern slope to intercept groundwater.

1.1.5 Waste Mass Model

The site will accept inert e waste for disposal. Waste will be subject to waste acceptance procedures.

The site will be filled in one operational cell known as Phase 1.

1.1.6 Capping System Model

The site will not be capped as the site inert and will be left as a development platform for residential development..

The proposed restoration contours will result in a slightly domed profile with a maximum slope gradient of approximately 1V:150H.

2.0 STABILITY RISK ASSESSMENT

Each of the six principal components of the conceptual stability site model has been considered and the various elements of that component have been assessed with regard to stability.

The principal components considered are:

- The basal subgrade.
- The side slope subgrade.
- The basal lining system.
- The side slope lining system.
- The waste.
- The capping system.

2.1 Risk Screening

Issues relating to stability and integrity for each principal component of the proposed development have been subject to a preliminary review to determine the need to undertake further detailed geotechnical analyses. The following sections present the results of this screening exercise.

2.1.1 Basal Subgrade Screening

The base of the site will be formed in in-situ bedrock with placed clay to ensure the base remains above groundwater. Each aspect of the stability and deformability of the basal subgrade identified in the Guidance is discussed in Table 2-1 below.

Table 2-1
Stability Components for Basal Subgrade

Excessive Deformation	Compressible subgrade	The basal subgrade will be formed within the in-situ bedrock or engineered low permeability clay; this is considered to be effectively incompressible under the limited stresses imposed by the replacement of excavated material with inert waste. This component does not require further consideration.
	Basal heave	Groundwater seepage has been recorded in the base of the excavation at approximately 86mAOD. Prior to installation of the lining system suitable material will be placed to prevent groundwater seepage. This component therefore does not need to be considered further.
	Cavities in subgrade	It is not considered likely that cavities will exist within the bedrock subgrade; therefore, this issue is not considered further.
Filling on Waste	Compressible waste	Not applicable.
	Cavities in waste	Not applicable.

Given the foregoing, it is considered that the basal subgrade system does not require further assessment.

2.1.2 Side Slope Subgrade Screening

The controlling factors that will affect the stability and deformability of the side slope subgrade are detailed in Table 2-2 below.

Table 2-2
Stability/Integrity Components of Side Slope Subgrade

Cut slope	Rock	Stability	Not applicable
		Cavities in subgrade	Not applicable
		Deformability	Not applicable
	Cohesive soils	Stability	Not applicable
		Deformability	Not applicable
		Time dependent stability	Not applicable.
		Groundwater	Not applicable.
	Granular soils	Stability	Not applicable.
		Deformability	Not applicable.
		Groundwater	Not applicable.
Fill Slope	Cohesive soils	Stability	Clay fill will be used to raise the base of the excavation above ground level. It will also be placed on the excavation side slopes to form a maximum gradient of 1V:2.7H. Analysis of the stability of the unconfined side slope subgrade is required.
		Time dependent stability	The waste will be placed against the clay. This component does not require further consideration.
		Groundwater	Groundwater is recorded at the base of the excavation and will not influence the side slope as this will be pumped until
	Granular soils	Stability	Not applicable.
		Deformability	Not applicable.
		Groundwater	Not applicable.

Given the foregoing, it is considered that the side slope subgrade requires further assessment.

2.1.3 Basal Lining System Screening

The controlling factors that influence the stability and integrity of the basal lining system are given in

Table 2-3 below.

Table 2-3
Stability/Integrity Components of Basal Lining System

Mineral only	Stability and Integrity	Not applicable.
	Compressible subgrade	Not applicable.
	Cavities	Not applicable.
	Basal heave	Not applicable.
Clay geological barrier	Stability and Integrity	The basal lining system will comprise an engineered lining system placed at a shallow gradient. In terms of potential for movements along the basal lining system, the development of the landfill will result in the generation of temporary waste slopes. The presence of temporary slopes are unlikely to cause instability due to the inert nature of the waste and the maximum height of each lift which is subject to compaction this aspect of the stability review is covered under Section 2.1.5, Waste Mass Stability.
	Compressible subgrade	The basal subgrade will comprise in-situ bedrock or engineered low permeability clay which is considered to be effectively incompressible under the stresses imposed by the waste height proposed.
	Cavities	It is not considered likely that cavities will exist within the bedrock subgrade or basal lining system; therefore, this issue is not considered further.
	Basal heave	Groundwater seepage has been recorded in the base of the excavation at approximately 86mAOD. Prior to installation of the lining system suitable material will be placed to prevent groundwater seepage. This component therefore does not need to be considered further. Active groundwater management will take place

Given the foregoing, it is considered that the basal lining system does not require further assessment.

2.1.4 Side Slope Lining System Screening

The controlling factors that influence the stability and integrity of the side slope lining system are given in Table 2-4 below.

Table 2-4
Stability/Integrity Components of Side Slope Lining System

Unconfined	Mineral only	Stability	Not applicable.
		Integrity	Not applicable.
Confined	Mineral only	Stability	Not applicable.
		Integrity	Not applicable.

Given the foregoing, it is considered that the side slope lining system does not require further assessment.

2.1.5 Waste Mass Screening

The controlling factors that influence the stability of the waste mass are presented in Table 2-5 below.

Table 2-5
Stability Components of Waste Slopes

Failure wholly in waste	Stability		Waste will be placed in phases within the void. Temporary waste slopes may be generated through progressive filling. Temporary waste slopes will require further assessment.
Failure involving lining system	Mineral only	Stability	Not applicable
		Integrity	Not applicable

Given the foregoing, it is considered that the waste mass does not requires further assessment.

Leachate Collection System

No leachate collection system is required and is not considered further.

Gas Collection System

Due to the nature of the waste to be deposited at Parry's Quarry Landfill gas will not be generated. This is not considered further as part of this assessment.

2.1.6 Capping System Screening

The controlling factors that influence the stresses in the capping system are given not considered further as an inert landfill is not required to have an engineered cap.

2.2 Lifecycle Phases

This aspect of the assessment identifies the critical phases during the development of the landfill.

The landfill will be filled in one phase Waste filling is likely to result in development of temporary waste slopes within each phase. Temporary waste gradients will be limited by basal cell extent and daily waste input. Placement will result in the worst case with a waste slope formed from formation level up to the proposed restoration level.

To ensure the SRA fully addresses the key issues throughout the life of the landfill, the side slope lining system, temporary waste slope (short term) stability are considered.

2.3 Data Summary

The following data are required as input for the analyses undertaken for this Stability Risk Assessment

- Material unit weight.
- Drained and undrained shear strength of soils and waste
- Elastic and compressibility properties of soils and waste.
- Elastic properties of interfaces.
- Properties of structural elements, if used, to represent geosynthetics within the basal and lining system in finite difference analysis.

It should be noted that there is no laboratory test data relating to the shear strength of the materials available on the site or those proposed for import to site.

The geotechnical parameter values adopted are discussed in more detail in Section 2.6.

2.4 Selection of Appropriate Factors of Safety

The factor of safety is the numerical expression of the degree of confidence that exists, for a given set of conditions, against a particular failure mechanism occurring. It is commonly expressed as the ratio of the load or action which would cause failure against the actual load or actions likely to be applied during service. This is readily determined by limit equilibrium slope stability analyses.

However, greater consideration must be given to analyses which do not report factors of safety directly. For example, a stress deformation analysis of shear strains within a steep side slope lining system would not usually indicate overall 'failure' of the model even though the strains could be high enough to indicate a failure of the *integrity* of the lining system. In such cases, it is necessary to define an upper limit for shear strains and to express the factor of safety as the ratio of allowable strain to actual strain.

Prior to determining appropriate factors of safety for the various components of the model, it is necessary to identify key 'receptors' and evaluate the consequences in the event of a failure (relating to both stability and integrity). Consideration of the following receptors is required:

- Groundwater
- Property - relating to site infrastructure, third party property
- Human beings (i.e. direct risk)

The Factor of Safety adopted for each component of the model would be related to the consequences of a failure.

2.4.1 Factor of Safety for Basal Subgrade

Whilst further assessment of this component is presented in Section 2.8.1, no formal analysis is undertaken; therefore, the selection of an appropriate factor of safety is not required.

2.4.2 Factor of Safety for Side Slope Subgrade

A factor of safety of 1.3 is considered appropriate when using conservative peak shear strength parameters.

2.4.3 Factor of Safety for Basal Lining System

An assessment is not required on this component as it has been screened out in Section 2.1.3.

2.4.4 Factor of Safety for Side Slope Lining System

A factor of safety of 1.3 is considered appropriate when using conservative peak shear strength parameters.

Where reduced shear strength parameters are adopted (for example, for very long term conditions, involving the 'fully-softened' or residual shear strength of the side slope lining system or interface parameters), it is considered that the factor of safety could be reduced to a value greater than unity, in accordance with the advice given in the Guidance.

2.4.5 Factor of Safety for Waste Mass

An assessment is not required as the waste is inert and will be rolled in 300mm layers and compacted to 95% of optimum.

2.4.6 Factor of Safety for Capping System

Not considered further as part of this assessment.

2.5 Justification for Modelling Approach and Software

This stability risk assessment (SRA) has been carried out in accordance with the principles of EuroCode 7, which uses a partial factor method (on actions and strength), to determine the Over Design Factor (ODF).

EuroCode 7 is based on the principles of limit state design, whereby a design must ensure that no limit state is exceeded. With respect to the analyses presented in this report, the limit state of relevance is limit state GEO defined as "*failure or excessive deformation of the ground, in which the strength of soil or rock is significant in providing resistance*", e.g. global stability of the landfill, bearing capacity of foundation soils.

Each limit state requires different partial factors to be used in the analysis. These are presented in the spreadsheet provided in Appendix B. It should be noted that the approach adopted in the UK for limit state GEO (Design Approach 1) requires two combinations of partial factors to be analysed as follows:

Combination 1	A1 + M1 + R1
Combination 2	A2 + M2 + R1

Where;
A = Partial factors on actions (applied forces and moments);
M = Partial factors on soil parameters; and
R = Partial factors on resistances.

The values of various sets of partial factors that are applied to characteristic actions (A1 and A2), characteristic material strengths (M1 and M2) and resistances (R1) vary depending upon whether they are favourable or unfavourable to the stability of the structure. Note: Only Combination 2 is considered in this assessment because any imposed loadings are negligible compared to the soil masses.

When considering a limit state of rupture or excessive deformation EuroCode 7 requires that $E_d \leq R_d$ where:
E_d = design value of effect of actions (forces) and
R_d = design value of the resistance to actions
The ratio R_d / E_d can be defined as the Over Design Factor and stability is demonstrated when the ODF ≥ 1.00. Hence, for each limit state considered, ODF's ≥ 1.00 are required for the construction to be considered stable (i.e. safe).

Computer Software

The analysis of global stability was undertaken using the computer programme *FLAC/Slope* (version 7), which utilises the finite difference method of analysis. *FLAC/Slope* offers many advantages over traditional limit equilibrium based programmes.

i. Limit equilibrium codes use an approximate scheme (typically based on the method of slices) in which a number of assumptions are made (eg the location and angle of the interslice forces). Several assumed failure surfaces are tested (often many hundreds), and the one giving the lowest factor of safety is chosen. Equilibrium is only satisfied on an idealised set of surfaces.

ii. In contrast, *FLAC/Slope* provides a full solution of the coupled stress/displacement, equilibrium and constitutive equations. Given a set of properties, the system is determined to be stable or unstable. By automatically performing a series of simulations while changing the strength properties (strength reduction technique), the factor of safety (= ODF in these analyses) can be found to correspond to the point of stability and the critical failure (slip) surface can be located. Hence:

1. Any failure mode develops naturally; there is no need to specify a range of trial surfaces in advance.
2. No artificial parameters (eg functions for interslice force angles) need to be given as input.
3. Multiple failure surfaces (or complex internal yielding) evolve naturally, if the conditions give rise to them.

The solution consists of mechanisms that are kinematically feasible whereas the limit equilibrium method considers only forces and not kinematics.

2.6 Justification of Geotechnical Parameters Selected for Analysis

The following sections present a justification for the various parameters used in the stability analyses based on the following criteria:

- An assessment of the suitability of non-site-specific data, where used.
- Methods for the derivation of the parameters adopted.

A summary of the geotechnical parameters used in the design and analysis of the development are presented in tabular form for each component of the landfill

The geotechnical parameters selected for the required analysis are presented below in Table 2-7 and the interface parameters in Table 2-8.

[6] Bishop, A.W., (1965), 'The use of the slip-circle in the stability analysis of slopes' Geotechnique
[7] Morgenstern, N.R and Price, V.E. (1965), 'The analysis of stability of general slip surfaces' Geotechnique.

Table 2-7.

The parameters used in the analysis have been:

- Adapted from similar work undertaken by SLR.
- Inferred from site specific data or other relevant published data.

It should be noted that the geotechnical parameters for limit equilibrium analysis include the shear strength and unit weight of each material within the model, plus pore water or gas pressure assumptions. Shear strength has been defined using total or undrained (s_u), and effective shear strength parameters of cohesion, (c'), and the angle of shearing resistance, (ø').

For integrity analysis additional properties required in the modelling include the elastic properties of the materials (Young's modulus, E and poisons ratio, v).

2.6.1 Parameters Selected for Basal Subgrade Analysis

Analysis of the basal subgrade is not necessary as it has been screened out in Section 2.1.1.

2.6.2 Parameters Selected for Side Slopes Subgrade Analysis

The parameters required for the analysis of the side slope subgrade stability are the angle of shearing resistance, cohesion and unit weight of the materials forming the side slope subgrade.

2.6.3 Parameters Selected for Basal Lining System Analysis

Analysis of the basal lining system is not necessary as it has been screened out in Section 2.1.3. It will be considered as part of the waste mass analysis.

2.6.4 Parameters Selected for Side Slope Lining System Analyses

Soil/Rock Shear Strength

Material properties used in the slope stability analysis (using FLAC/Slope computer software) and assessment are discussed in detail below and a summary of the characteristic densities and shear strength parameters for the material types is presented in Table 1.

Short term (ie undrained) and long term (i.e. effective) strength parameters have been considered in the analyses.

The parameters listed in Table 1 represent the characteristic values selected for the stability assessment.

In accordance with EuroCode 7 partial factors have then been applied to obtain the design values for Combination 2 used which are also presented in Table 1.

Note: Only Combination 2 is considered in this assessment of slope stability because any imposed loadings are negligible compared to the soil masses.

Inert Soils (CEDW)

The inert materials will be a mixture of demolition materials, construction excavation arisings etc and will sometimes be placed wet. Very conservative shear strength parameters have therefore been assumed for this material ie c_u = 30 kPa and c' = 0 and ?'= 25°.

Engineered Clay (Liners, Subgrades & bunds)

The Engineered Clay is understood to comprise reworked weathered mudstones ie sandy gravelly clays. Conservative characteristic shear strength parameters have been assumed for this material based on the Specification and TCL Experience ie c_u = 50 kPa and c' = 2.4 kPa and ϕ' = 24.55^o.

Weathered Mudstone

The Weathered Mudstone has been assigned very conservative characteristic shear strength parameters based on Cripps & Taylor and Bell ie c_u = 140 kPa and c' = 50 kPa and ϕ' = 26^o.

Table 2-7 below.

2.6.5 Parameters Selected for Waste Analyses

For inert waste strength, WRGE has adopted conservative values of effective shear strength parameters. These have been adopted based on assumptions made from WRGE's recent experience.

The geotechnical parameters selected for the required analysis are presented below in Table 2-7.

[8] Van Impe, W. F. and Bouazza, A., "Geotechnical properties of MSW", draft version of keynote lecture, Osaka, 1996.

[9] Kavanjia, E. Jr., Matasovic, N., Bonaparte, R and Schmertman, G.R. (1995),'Evaluation of MSW properties for seismic analysis', Proc. Geoenvironment 2000, ASCE Special Geotechnical Publication, pp1126-1141.

[10] Jotisankasa, A., "Evaluating the Parameters that Control the Stability of Municipal Solid Waste Landfills", Master of Science Dissertation, University of London, September 2001.

2.6.6 Parameters Selected for Capping Analyses

Not applicable.

Table 2-7

Material	EC7 Characteristic material parameters			EC7 Design Combination 2 material parameters			Unit weight (kN/m³)		Source
	Undrained	Effective stress		Undrained	Effective stress				
	$c_{u\,k}$ kPa	c'_k kPa	ϕ'_k deg	$c_{u\,des}$ kPa	c'_{des} kPa	ϕ'_{des} deg	Moist γ_d kPa	Sat'd γ_{sat} kPa	
Inert Waste (CEDW)	30	5	25	21.4	4	20.5	18	20	WRGE Experience
Engineered Clay (Liners, Subgrades & bunds)	50	2.4	24	35.7	2	20.0	17.5	19.5	Specification & WRGE Experience
Weathered Mudstone	14	50	26	100	40	21.3	22	23	Cripps & Taylor, Bell

2.7 Analyses

Details of the various Stability Risk Assessment analyses undertaken for the site are presented in the following sections.

2.7.1 Basal Subgrade Analysis

Analysis of the basal subgrade is not necessary, as it has been screened out in Section 2.1.1.

2.7.2 Side Slope Subgrade Analysis

Side slopes are currently stable along the western wall and no further assessment is required as these have remained stable since cut in 2016

2.7.3 Basal Lining System Analysis

Analysis of the basal lining system is not necessary as it has been screened out in Section 2.1.3.

2.7.4 Side Slope Lining System Analysis

Unconfined Lining System Stability

The section analysed was Section A derived from Drawing SRA1 (Engineering) Sections for Stability Risk Assessment**);** Section A being the longest side slope. The Flac section analysed is shown below.
Water levels were set at 90 m OD-92mAOD and a surcharge of 10 kPa was applied to the crest.

SECTION A

Analyses - Global Stability (GEO Limit State)

The outputs/results of the analyses are presented in Appendix A. In Appendix A the following should be considered when looking at the graphical outputs:

a. The X axis represents the distance along the section in m x 10.
b. The Y axis represents the reduced level of the various points in m x 10 at each distance along the section.
c. Unfortunately the units of strain contours cannot be plotted to a common scale as they are fixed by the software depending upon the range of strains produced. What the plot is used to show is where the critical failure (sliding) surface would be ie where the highest strains are concentrated.

Table 2-8 - ODFs for Global Stability of Sidewall Subgrade and Liner Section A

Section Run	**Over Design Factor**	**"Old BS" Factor of Safety (approx.)**	**Comment on analysis result**
A 01	1.02	1.43	Short term (Undrained) analysis. Critical slip surface deep through sideslope subgrade **SAFE**
A 02	1.72	2.15	Long term (Effective) analysis. Critical slip surface through toe of sideslope **Very SAFE**

Notes:

The factor of safety quoted on the FLAC/Slope output sheets is the EC7 ODF in these analyses.
To obtain the approximate Factor of Safety in effective stress analyses with no surcharge loadings the ODF is multiplied by 1.25.

To obtain the approximate Factor of Safety in undrained analyses in clay with no surcharge loadings the ODF is multiplied by 1.40.

Assessment and Recommendations
The Over Design Factor (ODF) is greater than 1.00 even with very conservative parameters and considering the entire subgrade to be highly weathered. The design is considered, therefore, to be safe.

2.7.5 Waste Analysis

The inert waste is deposited in 300mm horizontal layers and compacted and therefore I there is no instability issues with the waste mass.

2.7.6 Capping Analysis

Not required as part of this assessment

Closed Form Construction Plant Analysis

Not required as part of this assessment

2.8 Assessment

2.8.1 Basal Subgrade Assessment

Assessment of this component is not required as it was eliminated from consideration by the screening process (Section 2.1.1).

2.8.2 Side Slope Subgrade Assessment

The analysis of the side slope subgrade indicated that the placed clay forming the lining system element of the side slope lining system required further investigation. The assessment considers the stability of designed 1V:2.5H gradient slopes. The slope is considered to have an acceptable factor of safety. Lifts should be placed to a maximum of 5m high.

2.8.3 Basal Lining System Assessment

Assessment of this component is not required as it was eliminated from consideration by the screening process (Section 2.1.3). Those components that have been assessed are considered under Section 2.8.5.

2.8.4 Side Slope Lining System Assessment

The analysis of the side slope lining system indicated that the placed clay forming the lining system element of the side slope lining system required further investigation. The assessment considers the stability of designed 1V:2.5H gradient slopes. The slope has been demonstrated to be stable on site and has not shown evidence of instability since placement occurred in October 2016.

The confining slope would be with inert waste against the side slope reducing the slope length and increasing the Factor of Safety

2.8.5 Waste Assessment

Waste Mass Stability

The inert waste is deposited in 300mm horizontal layers and compacted and therefore I there is no instability issues with the waste mass.

2.8.6 Capping Assessment

The assessment of the capping system is not required at an inert landfill.

3.0 MONITORING

3.1 The Risk Based Monitoring Scheme

Based upon the foregoing Stability Risk Assessment, a simple risk-based monitoring scheme is considered appropriate for the future development of the landfill. The monitoring is limited to ensuring compliance with the tipping rules and monitoring of groundwater levels.

3.2 Basal Subgrade Monitoring

No additional instrumentation is deemed as being required during construction or post closure.

3.3 Side Slope Subgrade Monitoring

No additional instrumentation is deemed as being required during construction or post closure.

3.4 Basal Lining System Monitoring

Monitoring during construction will comprise construction quality assurance to ensure compliance with the construction specification.

No additional instrumentation is deemed as being required during construction or post closure.

3.5 Side Slope Lining System Monitoring

Monitoring during construction will comprise construction quality assurance to ensure compliance with the construction specification.

No additional instrumentation is deemed as being required during construction or post closure.

3.6 Waste Mass Monitoring

Tip faces and surrounding areas should be inspected daily for signs of failure.

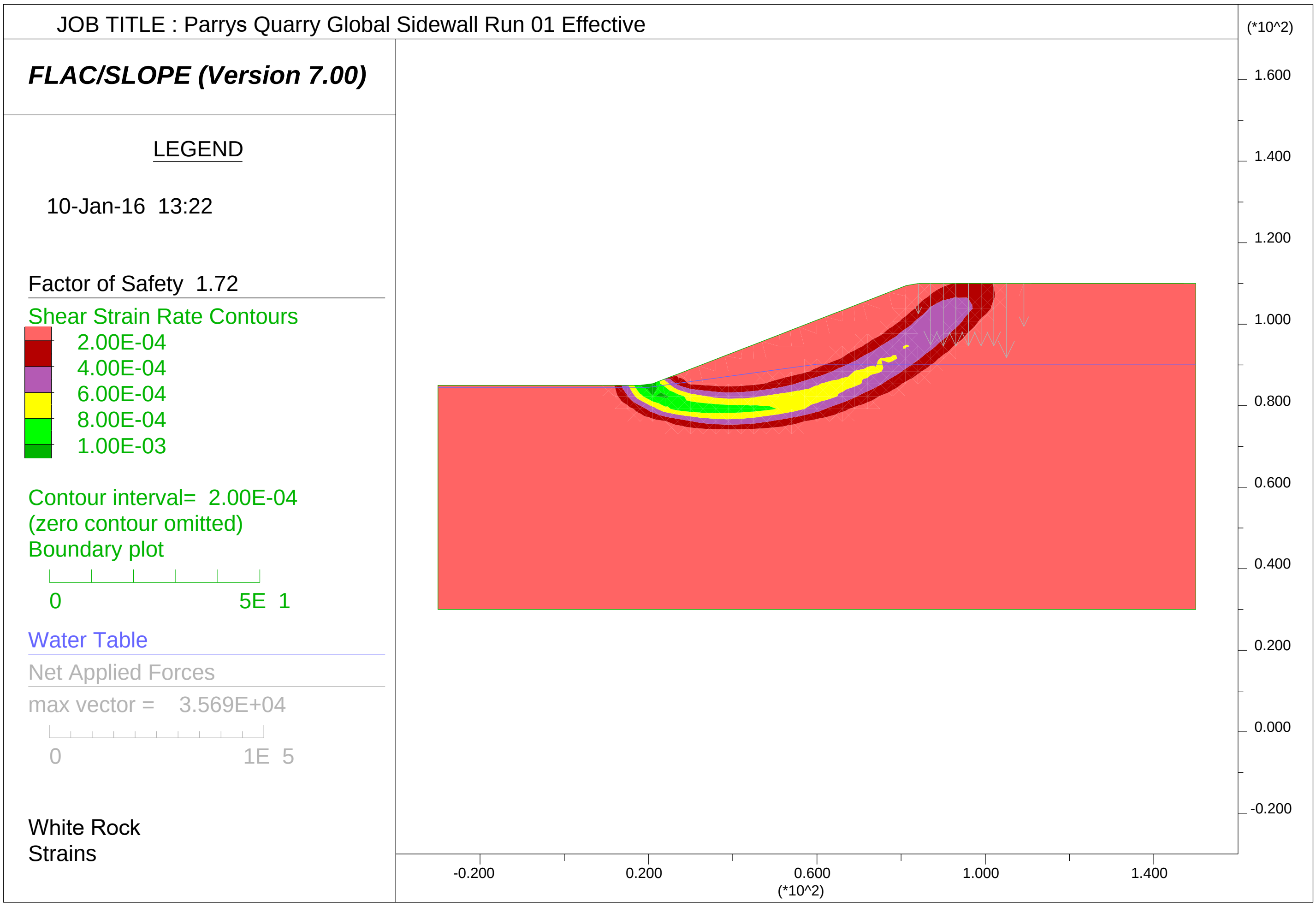
No other specific monitoring is required for the waste other than to record waste elevations across the site.

3.7 Capping Monitoring

No additional instrumentation is deemed as being required during construction or post closure.

APPENDIX A:

Global Stabilty/FLAC Outputs


JOB TITLE : Parrys Quarry Global Sidewall Run 01 Effective
FLAC/SLOPE (Version 7.00)
LEGEND
10-Jan-16 13:22
Factor of Safety 1.72
Shear Strain Rate Contours
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
Contour interval= 2.00E-04
(zero contour omitted)
Boundary plot
0
5E 1
Water Table
Net Applied Forces
max vector = 3.569E+04
0
1E 5
White Rock
Strains
(*10^2)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
-0.200
0.200
0.600
1.000
1.400
(*10^2)

JOB TITLE : Parrys Quarry Global Sidewall Run 01 Effective

FLAC/SLOPE (Version 7.00)

LEGEND

10-Jan-16 13:23

Factor of Safety 1.72

User-defined Groups

'Weathered Rock:Weath Mudst

Boundary plot

0 5E 1

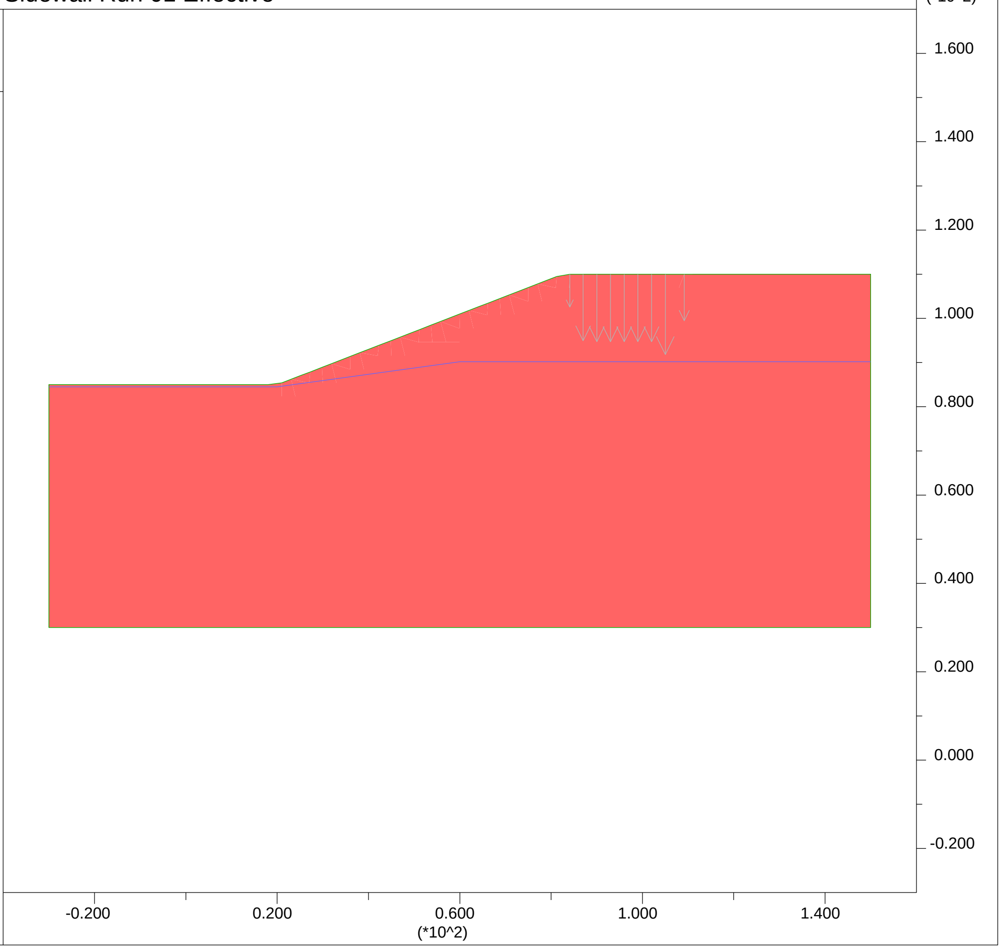
Water Table

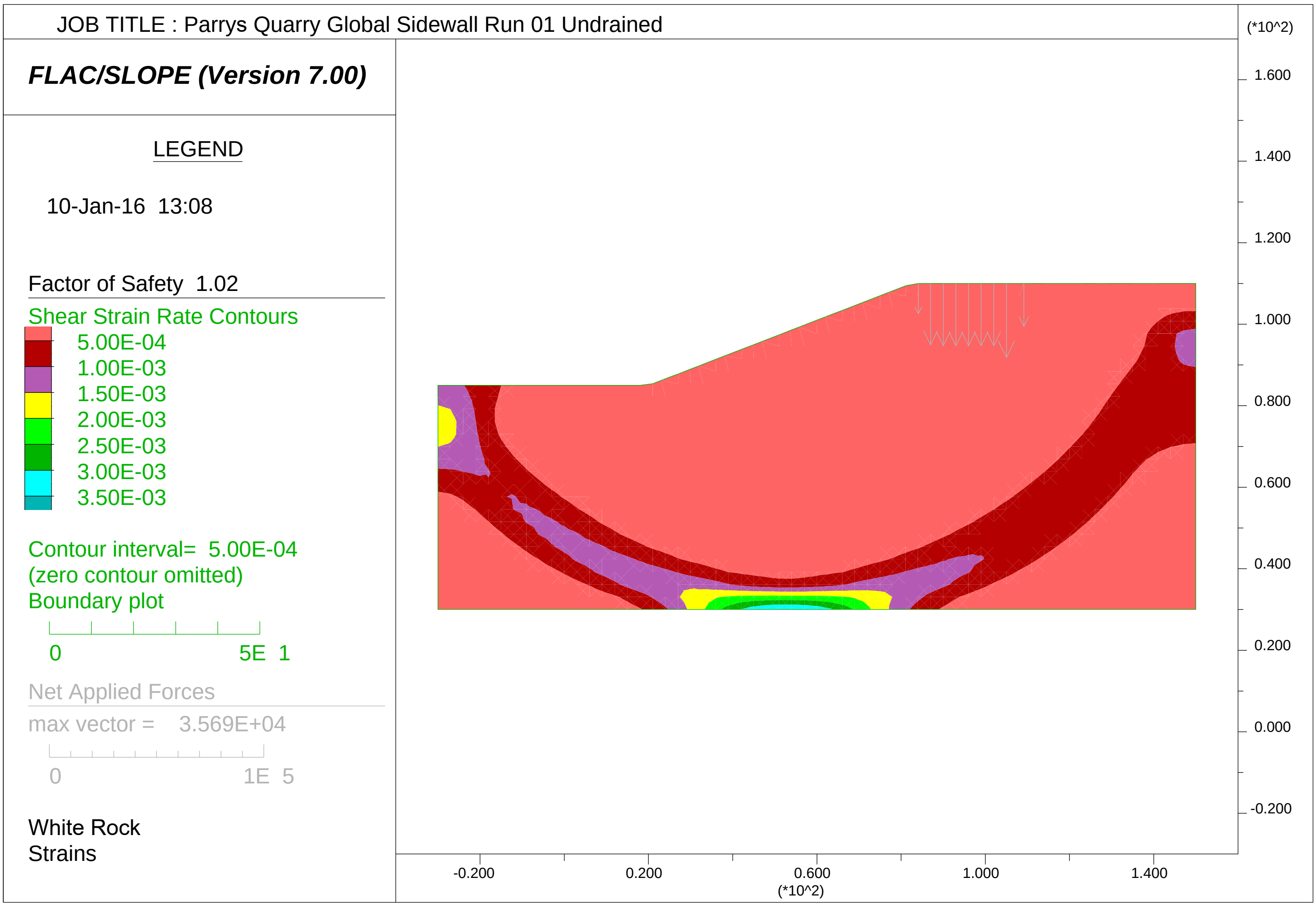
Net Applied Forces

max vector = 3.569E+04

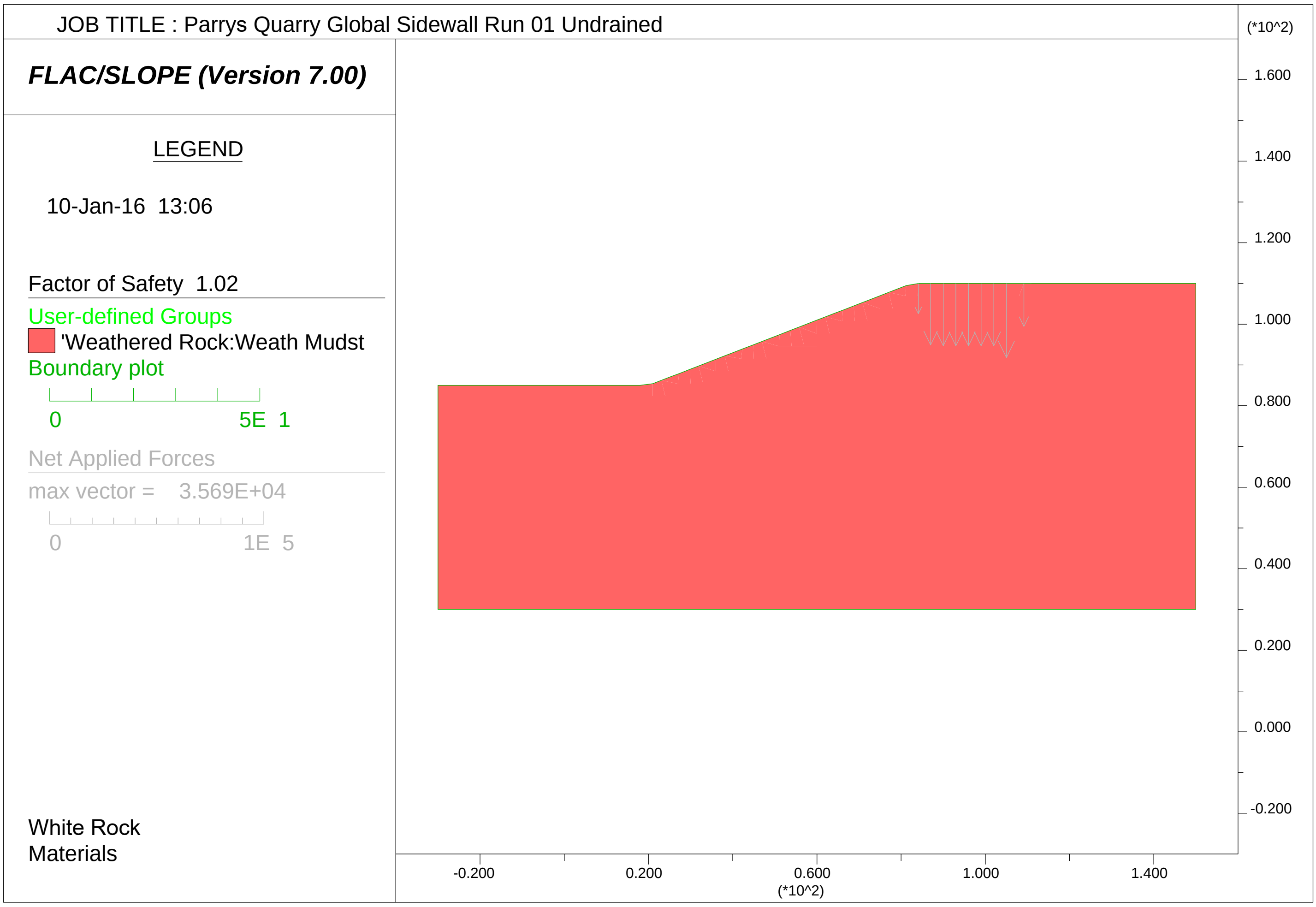
0 1E 5

White Rock
Materials

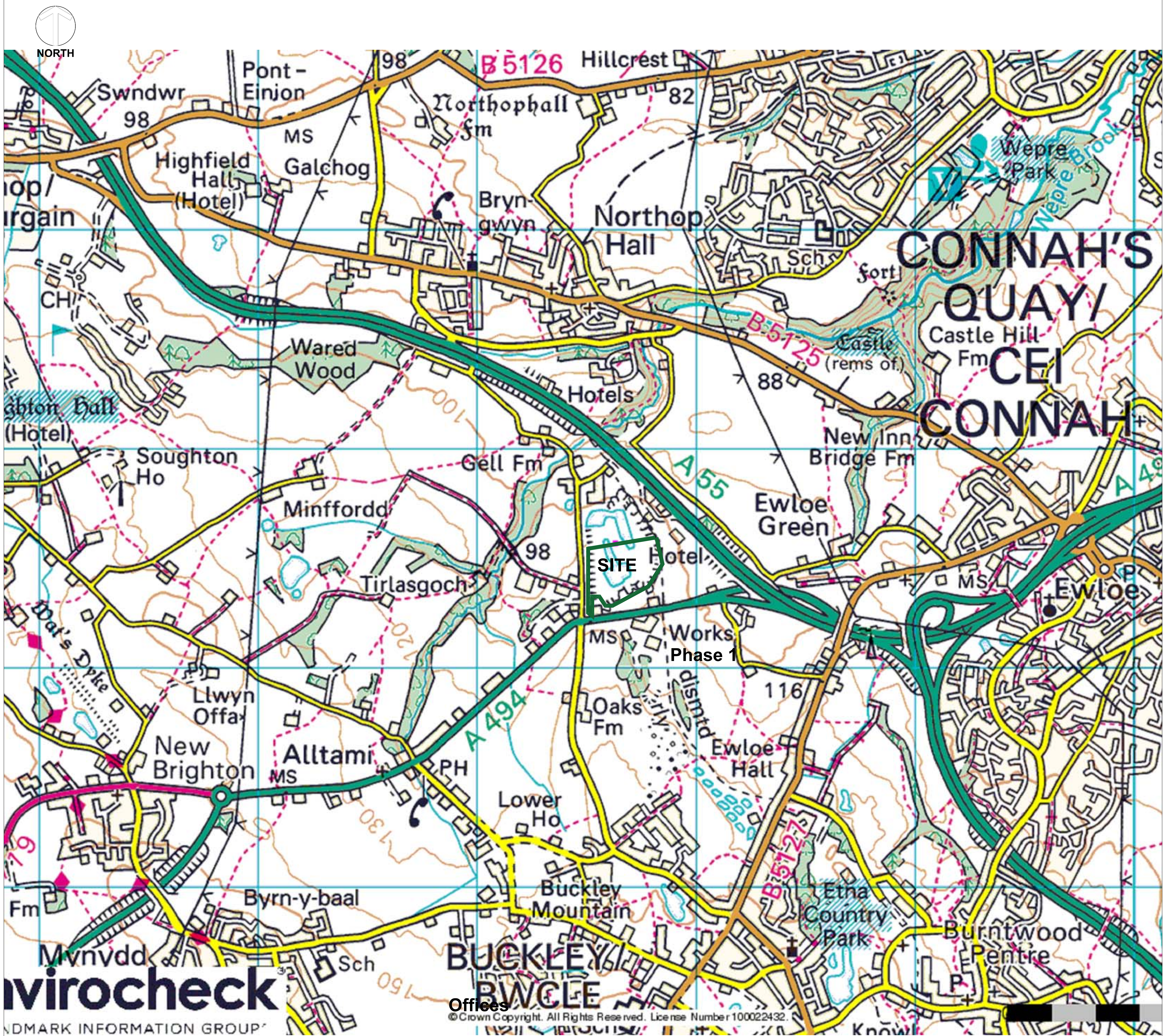




JOB TITLE : Parrys Quarry Global Sidewall Run 01 Undrained
FLAC/SLOPE (Version 7.00)
LEGEND
10-Jan-16 13:08
Factor of Safety 1.02
Shear Strain Rate Contours
5.00E-04
1.00E-03
1.50E-03
2.00E-03
2.50E-03
3.00E-03
3.50E-03
Contour interval= 5.00E-04
(zero contour omitted)
Boundary plot
0 5E 1
Net Applied Forces
max vector = 3.569E+04
0 1E 5
White Rock
Strains
(*10^2)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
-0.200
0.200
0.600
1.000
1.400
(*10^2)


JOB TITLE : Parrys Quarry Global Sidewall Run 01 Undrained
FLAC/SLOPE (Version 7.00)
LEGEND
10-Jan-16 13:06
Factor of Safety 1.02
User-defined Groups
'Weathered Rock:Weath Mudst
Boundary plot
0
5E 1
Net Applied Forces
max vector = 3.569E+04
0
1E 5
White Rock
Materials
(*10^2)
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
-0.200
0.200
0.600
1.000
1.400
(*10^2)

Drawings



Legend

Proposed Permit Boundary

Based upon the Ordnance Survey maps with the permission of the controller of Her Majesty's Stationery Office, © Crown Copyright reserved. Licence number AR100019096.

Client: **Mold Investments Ltd**

Project: **Parrys Quarry**

Title: Site Location

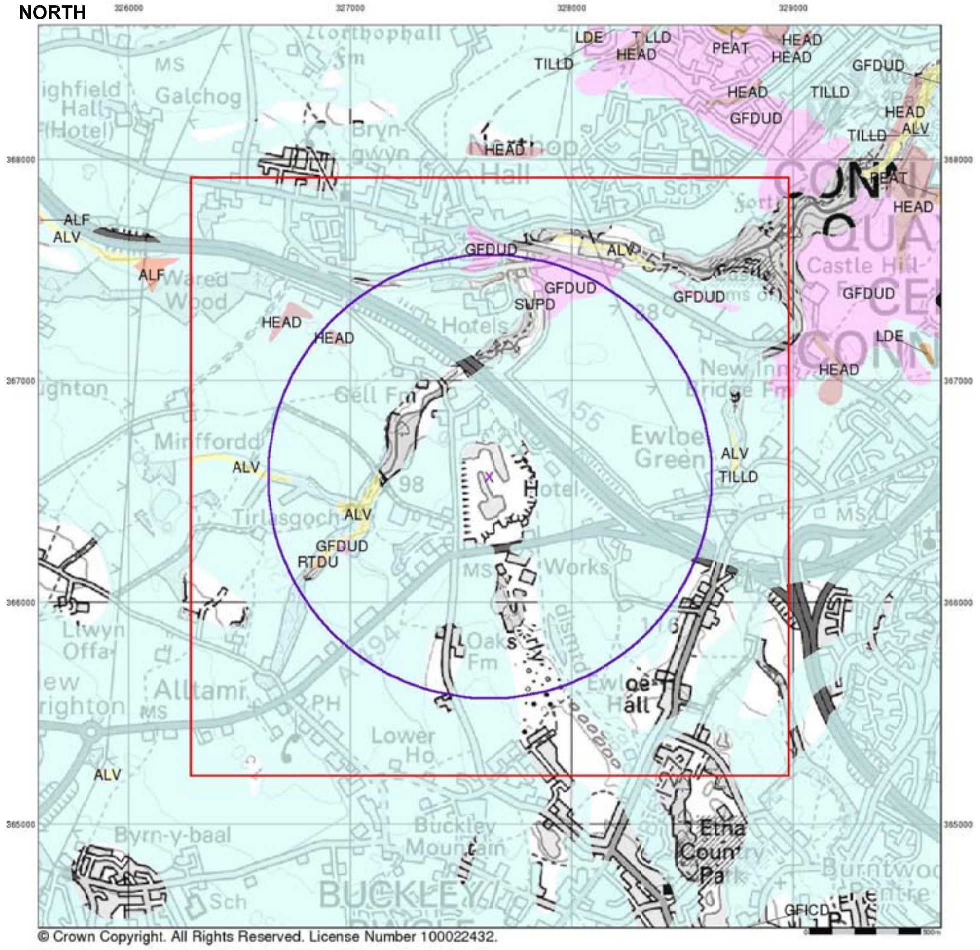
CAD Ref:	Version:	Drawn by:	Scale:	Date:
EL/MQBH/1	1	ARM		August 2020

WHITE ROCK GEO-ENVIRONMENTAL LIMITED

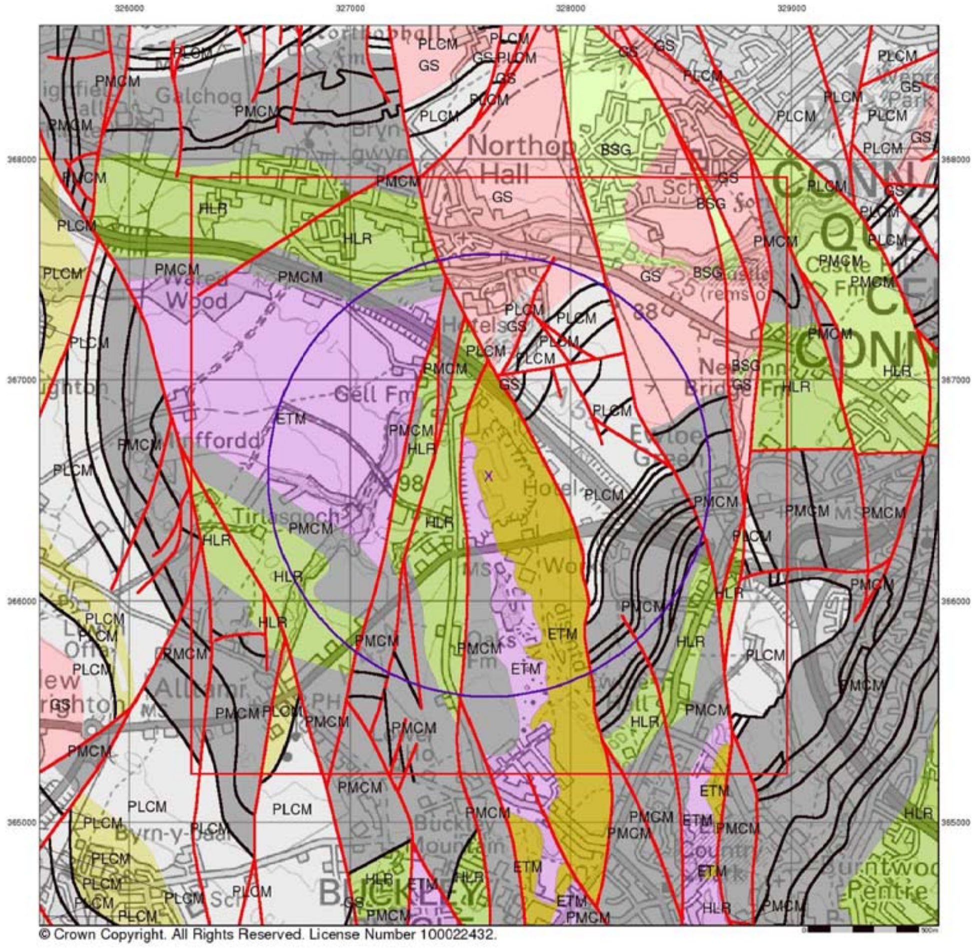
Drawing: **ESSD1**

NORTH

Superficial Geology



Bedrock Geology



Rock Type	LEX	Rock Name	Age	Rock Type	LEX	Rock Name	Age
Sand and Gravel	GFDUD	Glaciofluvial Deposits, Undifferentiated, Devensian	Devensian - Devansian	Clay, Silt, Sand and Gravel	GFDUD	Head (Undifferentiated)	Quaternary - Quaternary
Diamicton	TILLD	Till, Devensian	Devansian - Devanisan	Sand and Gravel	TILLD	River Terrace Deposits (Undifferentiated)	Quaternary - Quaternary
Clay, Silt, Sand and Gravel	ALV	Alluvium	Quaternary - Quaternary	Unknown Lithology	ALV	Superficial Deposits (Undifferentiated)	Quaternary - Quaternary

Rock Type	LEX	Rock Name	Age	Rock Type	LEX	Rock Name	Age
Mudstone, Siltstone and Sandstone	PLCM	Pennine Lower Coal Measures Formation	Langsettian - Langsettian	Mudstone, Siltstone and Sandstone	PMCM	Head (Undifferentiated)	Bolsovian - Durkmantian
Mudstone, Sandstone and Conglomerate	ETM	Etruria Formation	Westphalian - Westphalian	Sandstone	ETM	River Terrace Deposits (Undifferentiated)	Westphalian - Westphalian
Sandstone and [Subequal/subordinate] Argillaceous Rocks, Interbedded	GS	Gwespyr Sandstone	Langsettian - Yeadonian	Sandstone	HLR	Superficial Deposits (Undifferentiated)	Bolsovian - Bolsovian

Legend

Client: **Mold Investments Ltd**

Project: **Parrys Quarry**

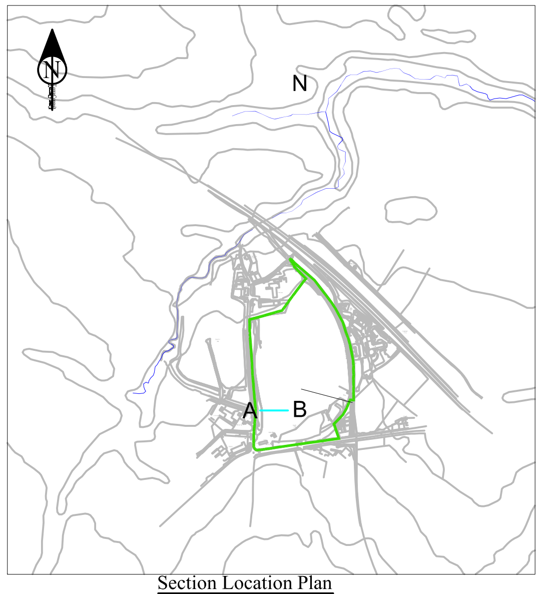
Title: Regional Geology

CAD Ref:	Version:	Drawn by:	Scale:	Date:
EL/MQBH/1	1	ARM		June 2020

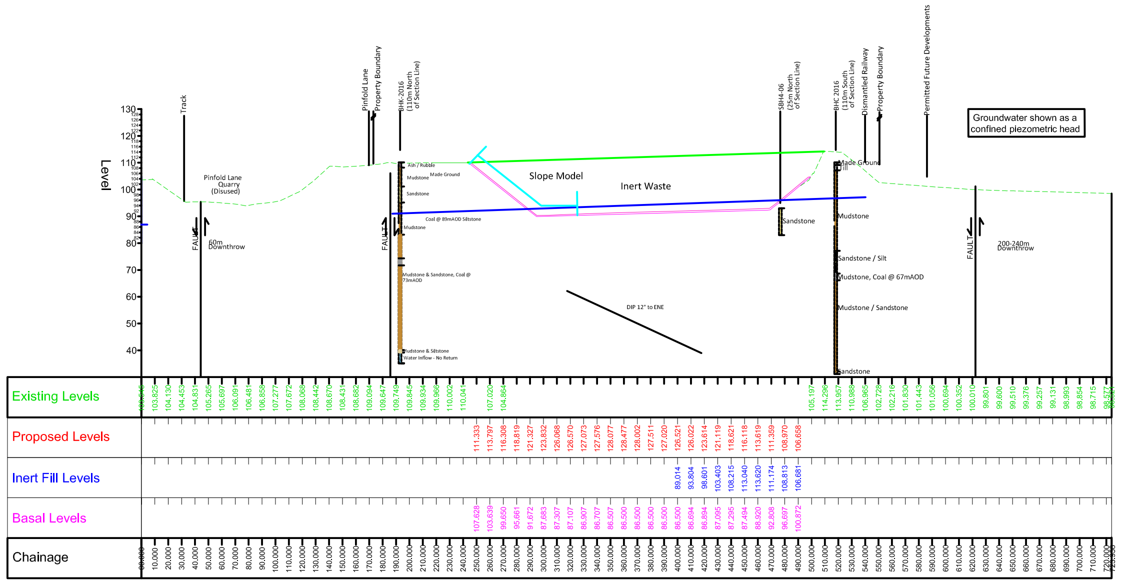
WHITE ROCK GEO-ENVIRONMENTAL LIMITED

Drawing: **ESSD8**

NORTH



Section Location Plan
Scale 1:10,000



West-East Section
Scale 1:2,000 Hz/1:1,000 Vt

Legend

Client: **Mold Investments Ltd**

Project: **Parrys Quarry**

Title: Stability Risk Assessment Cross Section

CAD Ref:	Version:	Drawn by:	Scale:	Date:
EL/QQSRA/1	1	ARM		June 2020

WHITE ROCK GEO-ENVIRONMENTAL LIMITED

Drawing: **SRA 1**