LLANWERN EAST
WASTE
MANAGEMENT SITE
LANDFILL
CORUS WORKS
LLANWERN

APPENDIX 3
STABILITY RISK ASSESSMENT

Report Number 525.1/Appendix 2/0207

LLANWERN EAST WASTE MANAGEMENT SITE LANDFILL CORUS WORKS LLANWERN

STABILITY RISK ASSESSMENT

Report Number 525.1/Appendix 3/0207

Commissioned by

Corus (UK) Limited
Port Talbot Works
Margam
Port Talbot
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1 INTRODUCTION

1.1 Report Context

Corus (UK) Ltd. has commissioned Geotechnology to undertake a Stability Risk Assessment (SRA) of the Llanwern East Waste Management Site (LEWMS), Port Talbot. The assessment has been carried out as part of the requirements of the Landfill Regulations 2002 (as amended) and forms part of the information required for the Closure Notice. The site location is shown on Figure SRA1.

The stability assessment has been undertaken in accordance with the Environment Agency's guidance drafted in March 2003 "Stability of Landfill Lining Systems: Report No.2 Guidance"

The stability assessment includes a topographic survey, in-situ slope data acquisition and computer slope stability modelling. This report summarises the work carried out to examine the existing site and provides recommendations to monitor the long term stability of LEWMS.

1.1.1 Outline of the Installation

LEWMS lies at the eastern end of the Corus Steel Plant at Llanwern. It is centred on National Grid Reference ST 397 864. The site lies entirely within the boundary of the works.

LEWMS is a landraise and occupies an area of 197,835m^2 (19.78 Ha) which is fully occupied by deposited wastes. It comprises a steep sided plateau, with only 1m of relief across the top of the landraise. LEWMS measures approximately 830m long by 300m wide with the long axis oriented north to south. In the northern half of the site, the boundary tapers to point at its northern limit whilst the southern half of the site boundary is a uniform rectangle measuring 300m wide by 400m long. Figure SRA2 is a topographic plan of the site drawn in December 2003 and partially revised in February 2007 to reflect changes as a result of waste deposition since the earlier date.

The land surrounding LEWMS is flat lying, and forms part of the Gwent levels. This is an area of reclaimed coastal marshland that extends through several counties surrounding the Severn Estuary. Though the site is 3.5km from the current estuary boundary this is the case only because of extensive land drainage and sea flood defences maintenance since Roman times.

Current levels typically comprise low grade arable and grazing land in a system of fields separated by drainage ditches or reens. The reens form an inter-bedded network of drainage ditches with levels controlled by a series of sluices at the sea defence to the south of the site. Surface water discharges at low tide and at periods of high water the sluices are closed to prevent seawater incursion into the reen system. The nominal elevation of the ground surface surrounding the site is 5m AOD with a reen water level of 2.3m AOD.

It is proposed that following closure, progressive restoration of the deposited wastes at LEWMS will occur, and will entail the placement of a gas geo-composite, a HDPE capping membrane, and a drainage geo-composite overlain by clean soils. Specific details relating to the stability of various elements will be evaluated in this SRA.

2 SITE SETTING AND GROUND CONDITIONS

2.1 Available Information

The regional geological setting of the site has been established by an examination of the published 1:10560 geological plan that includes the LEWMS Area.

The ground conditions at the site have been established by a combination of ground investigations, a walkover survey and a survey of existing waste slopes. Intrusive investigations around the waste mass have comprised trial pits and cable tool and rotary boreholes, together with the installation of groundwater monitoring wells.

A number of investigatory holes have been undertaken in and around the site and are summarised in Table SRA 2-1.

Table SRA 2-1 Previous Ground Investigations

Date	Contractor / Engineer	Investigation Details
November 2003	Geotechnology	Trial Pits 1 to 13 inclusive, and Cable Tool Boreholes 1 to 6 and Rotary holes DR1,4, and 6 undertaken as part of the investigation to support PPC application

A total of 9 boreholes and 13 trial pits have been excavated in the vicinity of LEWMS. The logs of these investigatory holes are included in Appendix SRA 1.

Table SRA 2-2 Geological Site Sequence

Age	Formation	Description	Depth (m)
Recent	Wentlooge Formation	Estuarine Clays and Peat	0 – 15.0
Triassic	Mercia Mudstone	Mudstone and claystone sequences	Approx. >15.0m

2.2 Geological Model

LEWMS is underlain by superficial strata referred to as the Wentlooge Formation which typically comprise an upper clay, peat and lower clay. In turn the superficial deposits are underlain by strata of the Mercia Mudstone series, Triassic in Age.

The waste comprising LEWMS has been deposited into shallow excavations within the upper clay layer. The water body (leachate) in the waste was seen to be perched on the Upper Clay layer. Beneath the upper clay layer peat was encountered and is of relatively low permeability.

In every borehole drilled a second, lower clay layer was encountered beneath the peat horizon. The clay was subjected to simple classification tests to compare its physical composition to that of the upper clay layer. Geotechnical testing reveals that the two clay layers are almost identical in composition, grading and strength and therefore the likelihood is that the permeability of this layer will also be very similar to the upper clay.

Beneath the lower clay Mercia mudstone bedrock was encountered in each of the rotary boreholes. In each case it was overlain by a thin layer of surrounded gravels with localised clays and silts forming the matrix. The underlying bedrock was investigated by three deep boreholes (16m) drilled by rotary methods.

A conceptual geological model is included on Figure SRA 3.

2.3 Waste Infilling

LEWMS has been accepting wastes since the mid 1970's with slag and demolition wastes predominating the waste stream. The site was licensed to accept such wastes initially under a Control of Pollution Act Licence and later a Waste Management Licence. It is known that these wastes were deposited directly onto the upper marine clay. No artificial lining system therefore exits beneath the site.

The entire site area which equates to approximately 19 Ha has been formed by the deposition of waste in layers of approximately 2m thickness to the waste surface profiles observed today. On a large proportion of the site, vegetation has been encouraged to grow via the spreading of "sub-dredgings", which effectively comprise of materials excavated or dredged from the surface water collection ditches from around the site. Excavation and cleaning of the ditches is undertaken as part of the routine maintenance.

Upon final closure LEWMS will continue to be regulated by the Environment Agency under it's Waste Management Licence. Corus will continue to maintain operational control of the site in order to ensure that no significant detrimental effects to the environment, human health or amenity will occur.

2.4 Groundwater and Leachate

The wastes comprising LEWMS are predominantly highly permeable coarse angular gravel (>70%) and cobble sized fragments of steel slag and demolition rubble with the remainder comprising predominantly of other wastes. Consequently, the waste mass is highly permeable and free draining. Permeabilities in the waste were measured in five separate test locations with an average permeability of 3.1×10^{-4} ms^{-1}

LEWMS is underlain entirely by the upper estuarine clay with a measured permeability of between 3.9×10^{-10} and 9.2×10^{-10} ms. This indicates a very low permeability stratum beneath the waste mass. Groundwater levels around the site are all beneath the ground level, except in excavated ditches on the western edge of the site, which intercept and collect this upper artificial water body.

Minor seepage is also included within the peat but the second principal water body beneath the site is encountered in the Mercia mudstone bedrock. Permeability tests revealed a stratum permeability ranging from 1.5×10^{-6} to 2.9×10^{-4}, with an average of 1.3×10^{-4} ms^{-1}. This must be attributable to fracture flow or secondary permeability rather than porosity, which is known to be low in the Mercia mudstone.

Water levels rose rapidly upon hitting the bedrock or the directly overlying gravels to an elevation of 2.9m AOD in Borehole 1 (north of the site) to 2.64m in Borehole 6 and 2.63m in Borehole 4 (south of the site).

3 CONCEPTUAL STABILITY SITE MODEL

3.1 Final Waste Model

LEWMS has accepted both hazardous and non-hazardous wastes comprising steel slag, sludges, timber, brick, concrete, plastics, steel and other ferrous metals, which have been deposited in a controlled manner. The landfill created comprises a large dome with a relatively flat plateau area, with final waste slopes of between 1 in 1.8 and 1 in 4. The waste has been built up to form a land raise rising to a level of approximately 15m A.O.D. above a surrounding ground elevation of 7m A.O.D.

3.2 Restoration Model

The plateau area and the flank on the western and southern sides of the landfill will be restored using a combination of geo-composites and geomembranes. The eastern flank comprises of the bund constructed as confinement to the waste along this edge. This flank is also heavily vegetated with many mature trees established on the side slopes. It is therefore proposed that as this surface area is relatively small and due to the presence of established vegetation, no capping is proposed.

The plateau cap currently has gradients varying from approximately 1 in 70 to 1 in 130. It is likely however that via a combination of re-grading of the existing waste, and placement of small amounts of new waste, gradients on the cap will increased to be no less than 1:50. This will allow more effective removal of surface and infiltrated precipitation. This surface water will be directed to the existing surface water collection system surrounding the site. It is proposed that restored flanks will have a gradient of no greater than 1 in 2.40 or 22.6 degrees.

The existing completed waste surface, which generally comprises slag covered by sub-dredgings will be prepared by a combination of vegetation stripping, scarifying, rolling and if necessary application of finer waste materials prior to the placement of a sequence of geo-composites and geomembranes. Finally a soil, which more than likely will be clay based, will be applied as a final restoration cover. The detailed sequence of the capping materials is described below.

The following top down sequence of soil, artificial geo-composites and geo-membranes is to be applied:

a) Clay or other approved soil, comprising a minimum 650mm layer covered by site won sub-dredgings to host a seeded vegetative cover.

b) Pozidrain 7S250D/NW8, which comprises a 7mm cuspated HDPE core with geotextile fused to both the upper and lower surface.

c) 1mm HDPE barrier membrane, comprising GSE 1mm DRS (Double Rough Sided) high density polyethylene acting as the main precipitation ingress and gas egress barrier.

d) Gas Collection and Membrane Protection Geotextile, comprising Pozidrain 7S250D/NW8, which comprises a 7mm cuspated HDPE core with geotextile fused to both the upper and lower surface.

e) Regulating Layer, comprising re-graded and rolled waste surface.

The restoration stability model examines the cover soil stability and the interface stability of these capping elements as well as the underlying waste mass stability.

4 STABILITY RISK ASSESSMENT

4.1 Risk Screening

4.1.1 Post Waste Settlement

The wastes within LEWMS comprise 76% slag and other granular non-degradable wastes and only 20% is "general rubbish", of which it is estimated that only 10% are biodegradable. The waste placement method has always been to encapsulate general wastes within steel slag by placing thin layers of general waste overlain by thick layers of slag. In the full 8m thickness of the land raise approximately 1.0m would be expected to be biodegradable. Using current industry expectations, this biodegradable function could volume reduce due to degradation by 25% - 35%. Thus, the waste mass would experience a total settlement of less than 0.25m. As the settlement of biodegradable wastes occurs by immediate elastic settlement and delayed decomposition settlement it can reasonably be expected that much of the 0.25m settlement has already occurred. It is therefore concluded that detailed post-waste settlement assessment is not required.

4.1.2 Waste Mass Stability

Only selected existing waste flanks will be re-graded, dependent on current slope angles. Restored slopes will be those in the north and west, with the eastern and southern flanks remaining in their current heavily vegetated condition. As the closure procedure requires evidence of long term stability (as a result of the influx of additional waste), the waste mass detailed assessment is required.

4.1.3 Restoration Slopes

Those flanks that are to be capped as part of the restoration scheme will be covered with a capping system that includes multiple interfaces. Accordingly, the restoration slopes will have to be subject to detailed assessment to demonstrate long term stability. Detailed assessment is therefore required.

4.1.4 Plateau Area

As the maximum post-restoration gradients on the plateau area are 1 in 50, detailed assessment is not required.

4.2 Geotechnical Data

4.2.1 Waste Mass Material Data

As stated in Geotechnology Report 360.1 of March 2005, Llanwern East Waste Management Site, Response to Information Request, the waste mass material data is based on the strength of the similar made ground encountered at the landfill edge. Shear strength data is based on Standard Penetration Test obtained from cable tool drilling (see Table SRA 4-1).

The use of shear strength data from made ground material outside the similar waste within the landfill is considered to be conservative as it has not been subjected to the same compaction and self weight loadings.

Table SRA 4-1 Standard Penetration Test Results in the Made Ground

Material Location	Made Ground SPT 'N' value
BH1	12, 6
BH2	37,10
BH3	19,6 and 4
BH4	>50 and 5
BH5	5
BH6	21

These values are converted to angles of shear strength using Figure 2.16 of Foundation Design and Construction (Tomlinson) after Peck, Hansen and Thorburn using the relationship graph of Standard Penetration N value versus angle of shearing resistance of granular soil.

A statistical analysis of the results shows that the 50th percentile provides an N value of 12, which equates to the angle of shearing resistance of 31 degrees used in the slope stability analysis.

The in-situ density of the wastes in LEWMS have not been measured, but an audit in the period 2001-2002 has revealed that well over 75% of the waste stream comprises slag, and other non-biodegradable materials and soils. This is reflected in a waste density of 1800 kg/m^3 being adopted in the analysis, and represents a density higher than that expected in a typical domestic refuse landfill.

4.2.2 Sub-grade

The geotechnical parameters of the sub-grade have been obtained from previous investigations undertaken by Geotechnology. The data is not extensive, but does provide an indication of in-situ shear strength of the underlying deposits. The underlying sub-grade deposits include the upper marine clay, the peat, the lower marine clay and basal deposits. With respect to the clays and basal deposits the shear strength (total stress) parameters are indicated in Table SRA 4-2.

Table SRA 4-2 Geotechnical Parameters of the Sub-Grade

Material Location	Upper Marine Clay Shear Strength kPa	Lower Marine Clay Shear Strength kPa	Basal Deposits Shear Strength kPa
TP1	44 and 30		
TP2	52		
TP4	53		
TP6	41,21 and 28		
TP13	44		
BH 2	29	28	
BH5	5 and 8	3 and 14	
BH6	28		82

A statistical analysis of the results for the upper marine clay show that values of un-drained shear strengths of 29.5 kPa are attained for the 50th percentile. Geotechnology consider that whilst considerably lower shear strength values do exist within the marine clays they are not representative of the whole mass. The very low values obtained of 3 and 5 kPa were acquired from the boreholes, and it is considered that these very low values are probably representative of sampling disturbance during the drilling, leading to a considerable loss in shear strength. Examination of the borehole logs show that the no. of blows of the U100 sampling tube is comparable to those in much higher strength clays.

Effective stress parameters for the marine alluvial clays obtained through consolidated drained triaxial tests indicate values of phi (Ø) of 29^0 and 33^0 degrees with cohesion of 11 and 10 kPa respectively were obtained. These results are included in Appendix SRA 2 of this submission.

No testing is available in the peat due to difficulties in obtaining a sample. During the drilling, on occasions, difficulty was observed in punching through the peat due to it's woody and fibrous nature. In the absence of in-situ samples for alternative documentary sources have been sourced to use as strength parameters for the peat.

The main source of shear strength data for the peat is from the Quarterly Journal of Engineering Geology. From this document a conservative value of 20 kPa has been adopted for the peat. With respect to the effective stress parameters, much lower values of Cu and phi (Ø) have been adopted being 2 kPa and 4^0 degrees respectively. With respect to this assessment it is the latter values that have been used as no large volumes of waste are anticipated to be placed.

The basal deposits were generally granular, though a stiff clay was encountered in BH 6 at a depth of 10.70m. An un-drained shear strength value of 82kPa was obtained from this material. Unfortunately no SPT values were undertaken in the gravels comprising the basal deposits. A conservative value of 30 degrees has been used in the stability analysis for the angle of shearing resistance.

4.2.3 Restoration Slopes

The geotechnical parameters of the waste mass comprising the restoration slopes have been established in Section 4.2.1. Additionally, the geotextile and geomembrane elements of the capping system have been assigned interface shear strength parameters based on published interface shear strength tests from manufacturers of the materials. These values lie within the range of values indicated by Environment Agency guidance.

Tensile strength parameters of the materials are included on the data sheets provided by the relevant manufacturer, and these are included in Appendix SRA3. Also included are shear box test results undertaken on similar materials as justification for the preliminary shear strength data used.

4.2.4 Leachate Levels

Leachate levels within the waste mass have not been monitored but values within the made ground which is in continuum with the wastes and located on the edge of the landfill indicates a level between 3.90m and 4.60m AOD. These levels were taken during the winter period and are therefore likely to reflect maximum leachate levels. For this reason a sensitivity analysis of this parameter has not been undertaken.

4.3 Selection of Appropriate Factors of Safety

4.3.1 Factors of Safety for Final Waste Slopes

Factors of safety in excess of 1.30 will be considered acceptable, in accordance with Agency guidance. Slopes indicated to have a factor of safety below this will subjected to remediation which would include re-grading and / or deposition of waste to shallow the existing slope angles to achieve the required factor of safety.

4.3.2 Factors of Safety for Restoration

A factor of safety of 1.30 has been considered as acceptable for the elements involved in the restoration process.

4.4 Modelling Approach and Software

4.4.1 Modelling Software

Waste mass stability modelling has been undertaken using Slide 3.1, a 2-D limit equilibrium slope stability program for evaluating the Factor of Safety of circular or non-circular failure surfaces in soil and rock. External loading onto the landfill wastes is supported as well as a multi-layer geometry. Slide analyses the stability of slip surfaces using numerous vertical slice methods, though the general limit equilibrium method has been chosen for this project, as it satisfies both force and moment equilibrium. Individual slip surfaces can be analysed, though search methods have been applied to these slopes to locate and analyse the critical slip surface.

The stability of capping system elements on the re-profiled slopes has been assessed by the finite slope length active/passive wedge method proposed by Dixon and Jones (1998) and advocated in Agency guidance.

4.4.2 Scenarios Evaluated

Stability assessments have been carried out for the following scenarios:

Final Waste Slopes – Analysis of 4 slopes around the landfill have been undertaken. This has allowed simulation of the steepest, longest and highest slopes. The fourth slope is a re-graded slope at an angle of 1 in 2.4.

Apart from small volumes of granular waste required to create an acceptable final landform no significant volumes of waste are anticipated to be incorporated into the landfill. Therefore no significant and rapid loading which could lead to increased pore water pressure increases will occur. No total stress analyses are therefore considered necessary, and stability assessments will address effective stress conditions only.

Restoration Slopes – The stability of the proposed restoration slopes will be evaluated, and these include the capping system with dry and partially saturated cover soils.

4.5 Parameters Selected for Waste Mass Stability Analyses

The material parameters used in the analysis of the waste mass are shown in Table SRA 4-3 and have been described in Section 4.2.1 and 4.2.2.

Table SRA 4-3 Parameters used in Waste Mass Stability Analyses

Material	Unit Weight (kN/m3)	Cohesion kPa	Friction Angle Ø (Deg)
Waste	18.00	0	31.0
Upper Marine Clay	18.40	11	29.0
Peat	12.00	2	4.0
Lower Marine Clay	18.40	11	29.0
Basal Deposit	19.50	0	30.0
Triassic Bedrock	22.00	60	45.0

The simulations have been run with leachate levels at their measured elevations, which are considered to be their maximum as they were recorded during winter.

4.5.1 Parameters Selected for Restoration Analyses

The material parameters used in the analysis of the capping elements are shown in Table SRA 4-4 and have been determined as described in Section 4.2.3.

Table SRA 4-4 Material parameters of the Capping Elements

Material Interface	Cohesion/Adhesion kPa	Friction Angle (Deg)
Restoration Soils (Internal Friction)	11	29
Restoration Soils / Pozidrain	2*	27*
Pozidrain / 1mm HDPE DRS	2*	25*
1mm HDPE DRS / Pozidrain	3*	26*
Pozidrain / Slag Waste	4*	27*

* -Assumed parameters – to be checked via appropriate laboratory testing

Cover soils for restoration are likely to be clay based, in order to reflect surrounding superficial geology, though soil for restoration cover will be dependent on the local sources available at the time. A submergence ratio of 0.75 (0.50m) has been analysed to examine the effect of saturation.

4.5.2 Stability Analyses

A total of 4 slope sections have been analysed as they are the steepest, longest and highest, and a re-graded slope in the steepest waste section areas. The position of these slopes is shown on Figure SRA 2.

4.5.3 Final Waste Slope Analyses

The results of the analyses of the slope sections are summarised in Table SRA 4-5.

Table SRA 4-5 Results of Slide Analyses

Slope Reference	Description	Justification for Analysis	Factor of Safety
LEWMS1	Located at the NE corner of landfill immediately adjacent to railway siding.	Steepest identified final waste slope	0.83
LEWMS2	Located at the SE corner of landfill.	Longest identified final waste slope	2.139
LEWMS3	Located at Western edge of Landfill	Highest identified final waste slope	2.144
LEWMS4	Located at the NE corner of landfill immediately adjacent to railway siding.	Re-graded (assumed) slope at the location ofLEWMS1	1.354

The location of each section analysed is shown on Figure SRA 2. The results of each slope analysed are graphically shown on Figures SRA 4 to 7 inclusive for analyses LEWMS1 to LEWMS4 respectively.

4.5.4 Restoration Analyses

A summary of the factors of safety calculated for the capping system are presented in Table SRA 4-6 and the calculation sheets are included in Appendix SRA 4. The results are split into the design restoration slope gradient, which is no less than 1 in 2.4 and equivalent to a slope angle of 22.6 degrees.

Table SRA 4-6 Capping Factors of Safety

Description	Analysis No.	Interface Friction - Factor of Safety	Tensile Failure of Material
Existing Slopes 1 in 1.89(steepest measured slope) – Zero Submergence ratio	1	1.40	None
Existing Slopes 1 in 1.89(steepest measured slope) – 0.5m Submergence ratio	2	1.07	None
Existing Slopes 1 in 3 (measured slope) – Zero Submergence ratio	3	2.43	None
Existing Slopes 1 in 3 (measured slope) – 0.5m Submergence ratio	4	1.80	None
Restoration Slopes 1 in 2.4 (maximum allowable) – Zero Submergence ratio	5	1.92	None
Restoration Slopes 1 in 2.4 (maximum allowable) – 0.5m Submergence ratio	6	1.42	None

4.6 Assessment

4.6.1 Final Waste Slopes Assessment

The analysis of the steepest (LEWMS1) longest (LEWMS2) and highest (LEWMS3) waste slopes has revealed factors of safety of below 1.3 for the steepest slope but above 1.3 for the longest and highest. In fact, the steepest slope (LEWMS1) showed a factor of safety of 0.83. However, this is an existing slope which has been stable for some years and must therefore have a factor of safety of ≥1. This means that the parameters chosen for the analysis, as suspected, are overly conservative.

Analysis LEWMS4 mimics a re-graded slope at the location of LEWMS1 and shows that using the same parameters, slope gradients of less than 1 in 2.4 will be stable in this material. Figure SRA 8 identifies the locations of the current waste surfaces that exhibit gradients greater than 1 in 2.4 or 22.6 degrees as shown. These slopes are considered to be over-steep and would in turn result in factors of safety below 1.30 using the current analysis.

The slopes with the lowest factors of safety are located in the northern portion of the site. However, slopes in their current configuration have been stable for over 5 years. Many of the slopes are now heavily vegetated, especially on the eastern flanks; this contributes to near surface stability. Riling, caused by surface water flow is not evident. Based on the results of this stability assessment however these slopes will require re-grading through a combination of re-profiling and granular waste placement to a gradient less than 1 in 2.4.

4.6.2 Restoration Assessment

The analysis of capping stability on the restoration slopes indicates that Factors of Safety will be in excess of 1.30, so long as slope gradients of less than 1 in 2.4 are maintained. This is based on the frictional properties of the capping elements involved. It is important however that prior to completion of any design, these values are confirmed via a series laboratory

tests, including the proposed cover soils. Indeed it would be pertinent to undertake the shear box tests prior to any slope re-grading exercise, as the results may well indicate further re-profiling than that proposed.

Due to the nature of the wastes, gas pressures and waste settlements are expected to be negligible, and are not anticipated to affect the stability of the restoration cap.

5 SUMMARY AND RECOMMENDATIONS

The SRA undertaken has identified that in order to maintain long term stability and achieve a stable landform which presents no future problems with respect to slope failure at LEWMS, remediation works are required in certain parts of the existing waste surface. This can be undertaken via a combination of further waste placement, especially on the western steep flanks next to the internal site access road, though due to the presence of the railway siding in the North Eastern corner of the site, a re-profiling exercise is likely to be required at this location.

The steepness of these slopes not only raises waste mass stability issues, but also in their current profile they will not be suitable to accept the capping elements proposed.

5.1 Settlement Monitoring

Due to the highly granular nature of the wastes, and the age of wastes placed, no settlement monitoring is proposed at LEWMS.

5.2 Stability Monitoring

5.2.1 Final Waste Slopes Monitoring

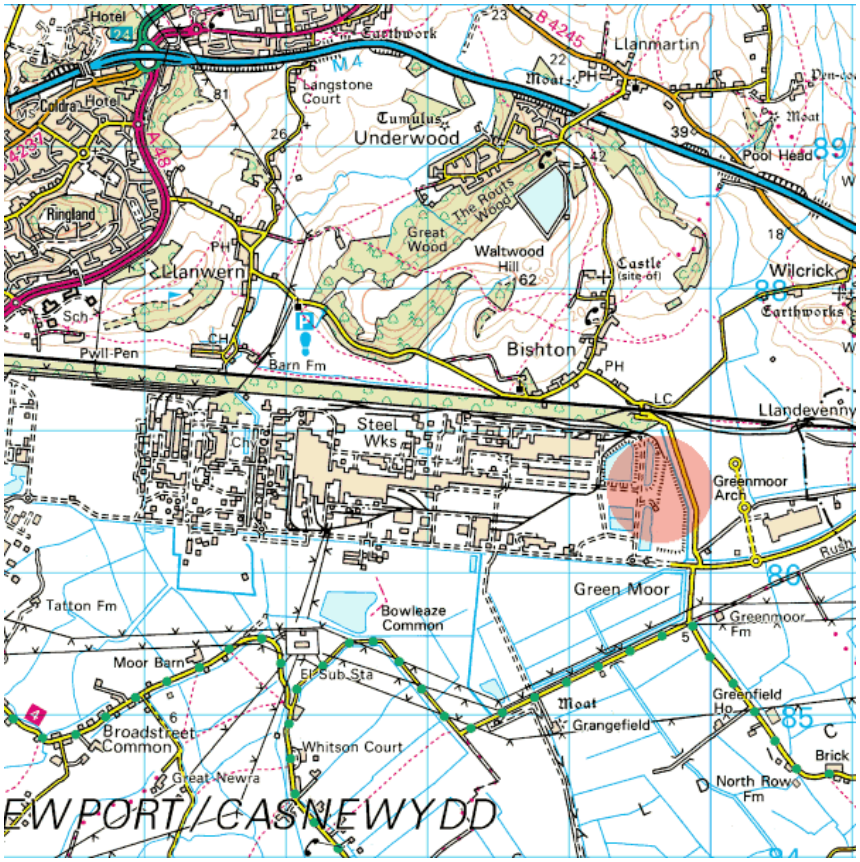
It is recommended that the waste slopes are visually inspected as part of the closed landfill aftercare monitoring which would be implemented after the final wastes have been placed.

5.2.2 Restoration Slopes Monitoring and Recommendations

In order to confirm the conservative parameters used in the stability analyses, interface shear strength testing is to be undertaken on the elements that make up the cap. Shear box testing information will be incorporated into a revised SRA should the tests reveal a lower than anticipated strength profile. This information will be forwarded, as and when received.

As with the final waste slopes, regular visual inspection of the restored slopes will be undertaken as part of the aftercare closed landfill monitoring scheme, when waste acceptance has finished.

Figure SRA1 Site Location Plan



Reproduced from the Ordnance Survey Land Ranger Map
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Figure SRA2 Topographic Plan

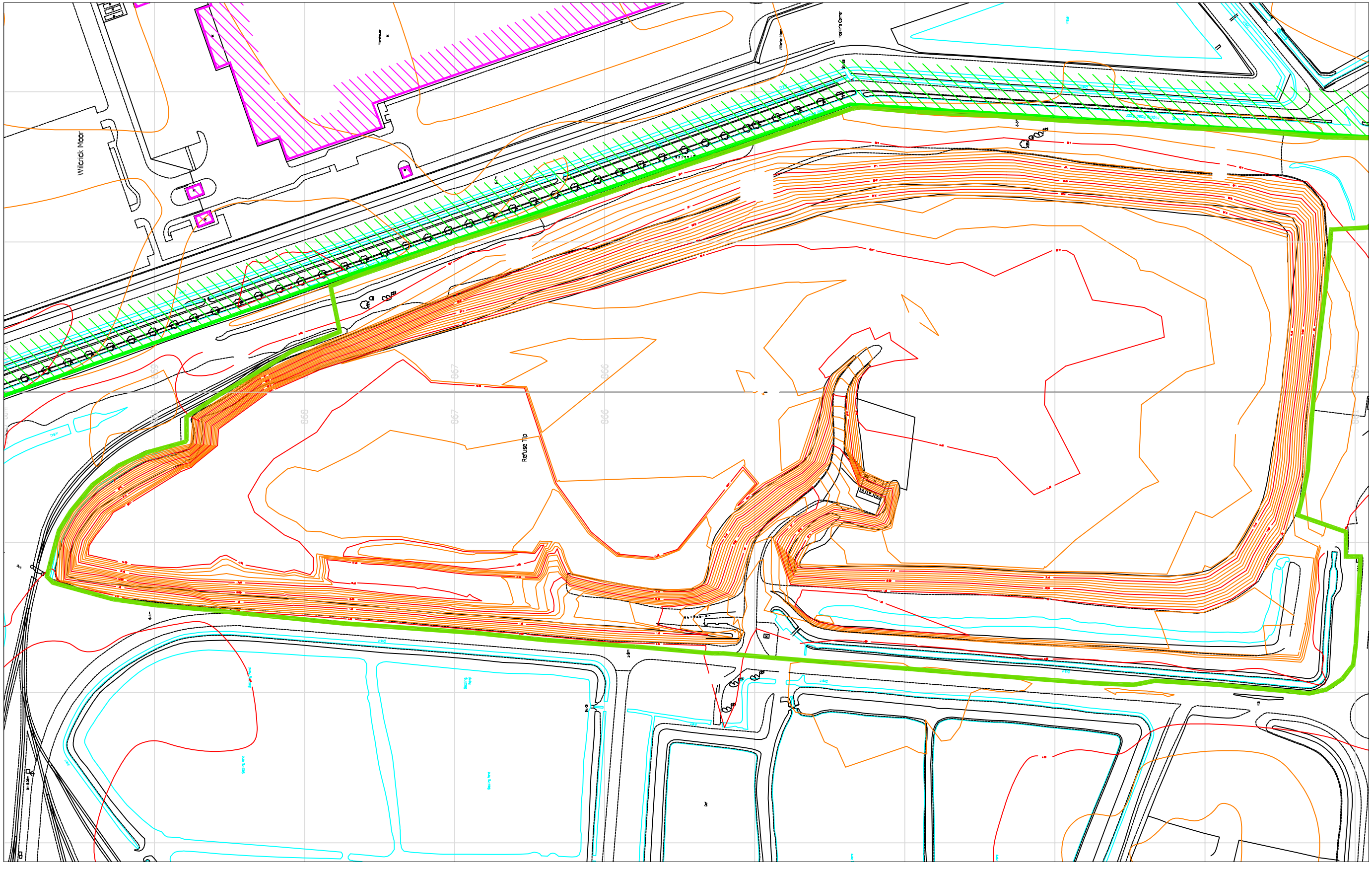


Figure SRA3 Conceptual Geological Model Made Ground

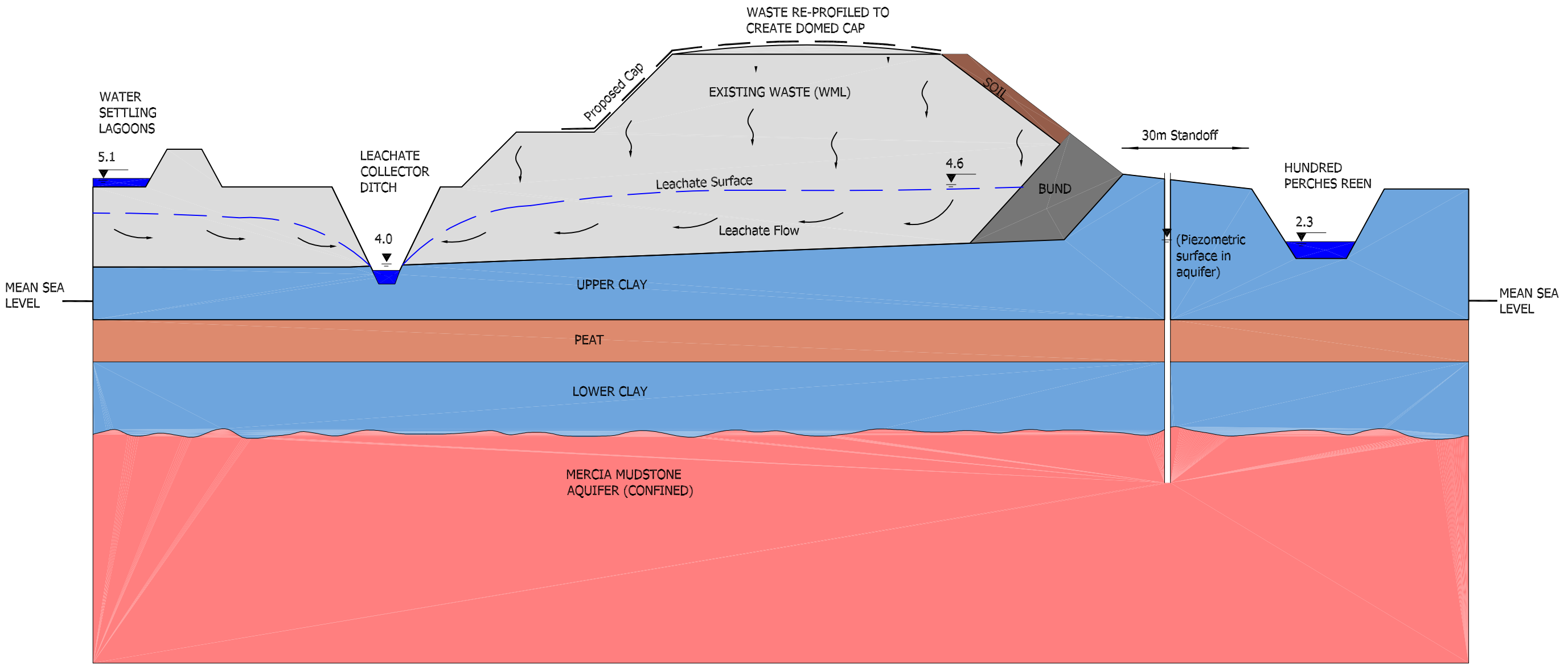


Figure SRA4 Steepest Slope Model (LEWMS1)

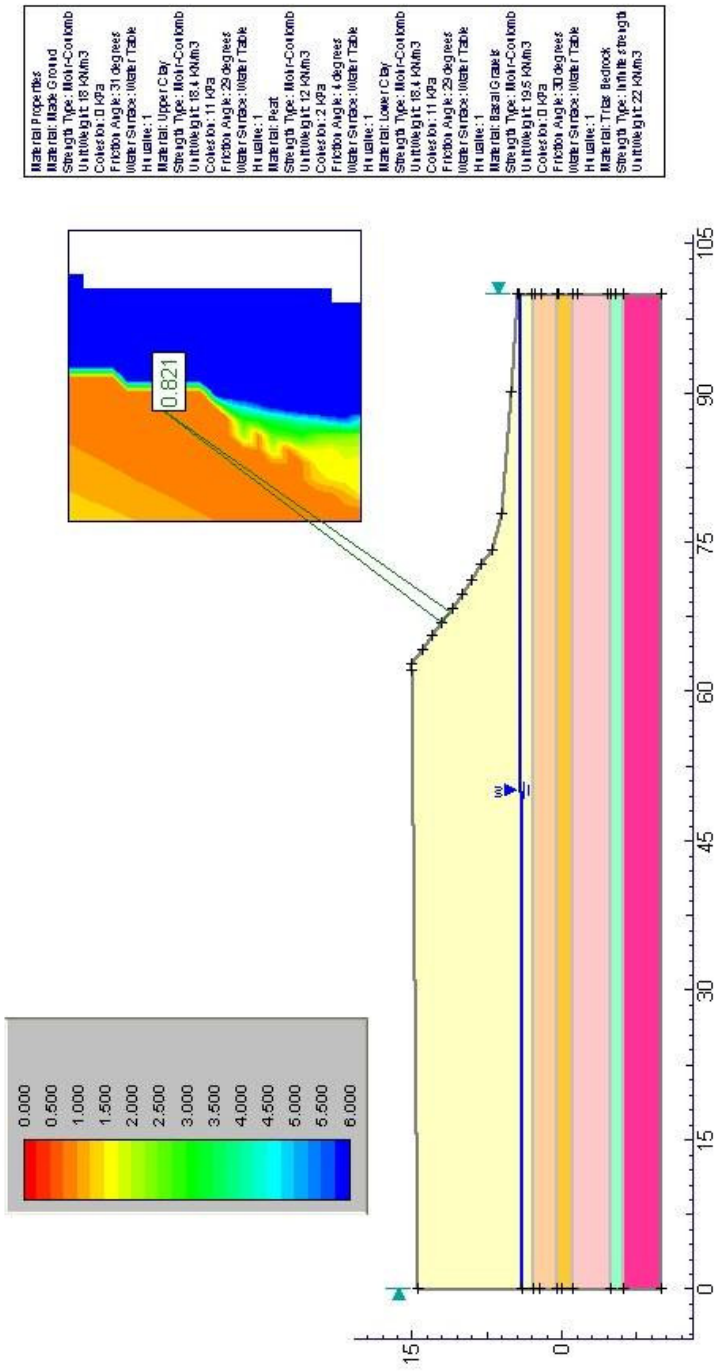


Figure SRA5 Longest Slope Model (LEWMS2)

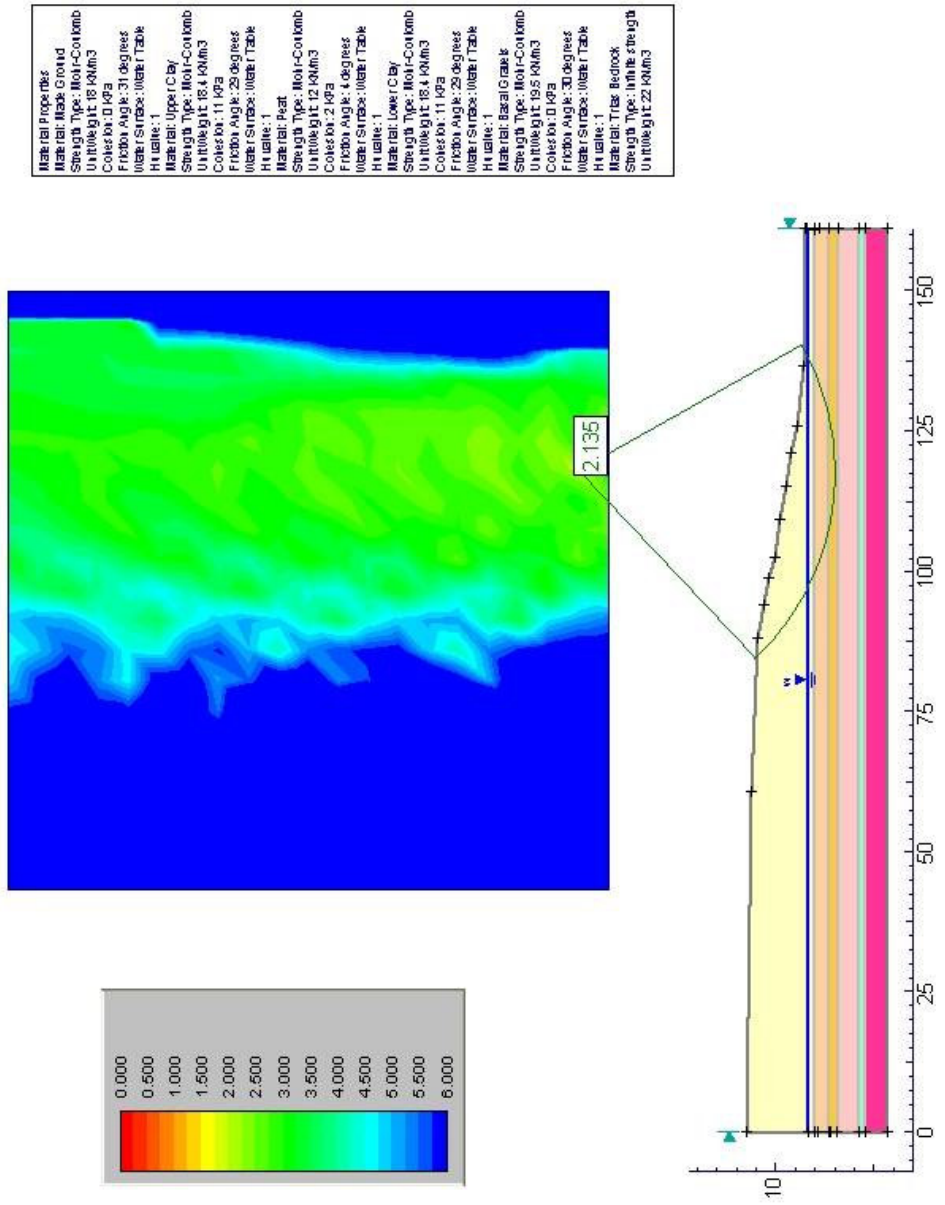


Figure SRA6 Highest Slope Model (LEWMS3)

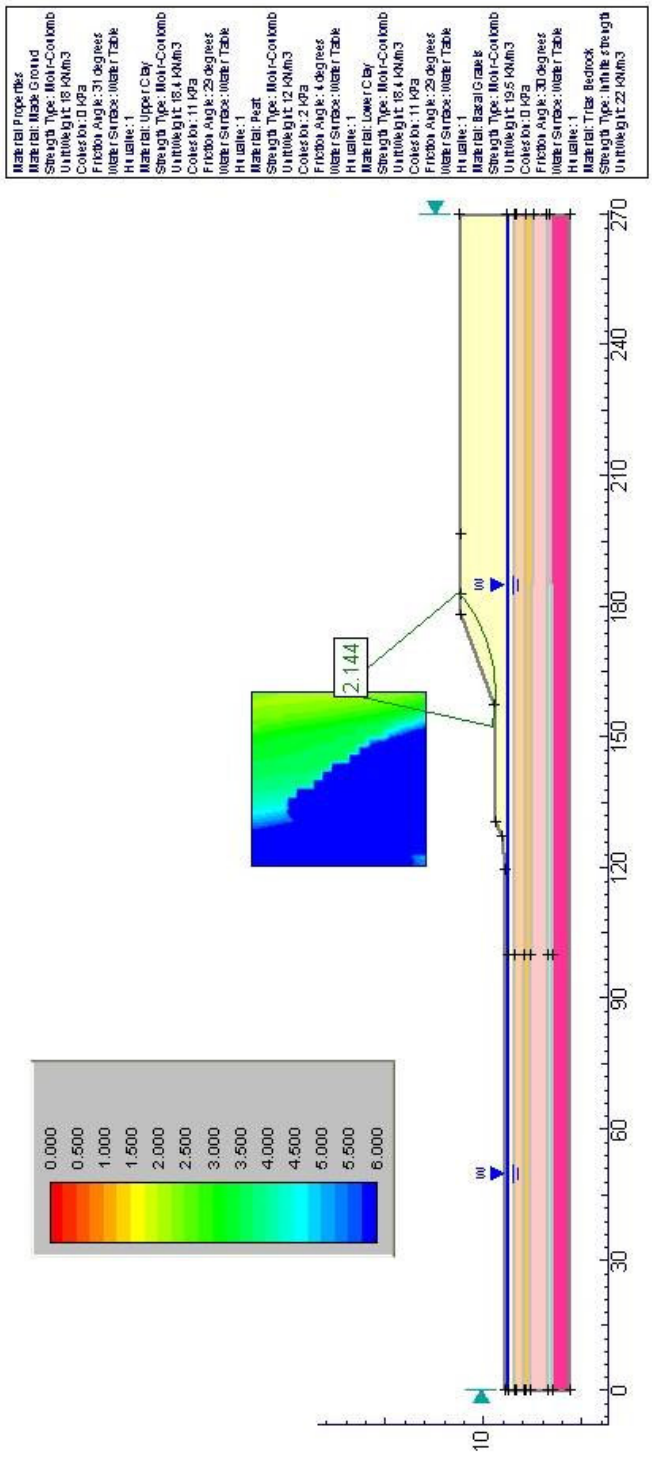


Figure SRA7 Re-Graded Slope Model (LEWMS4)

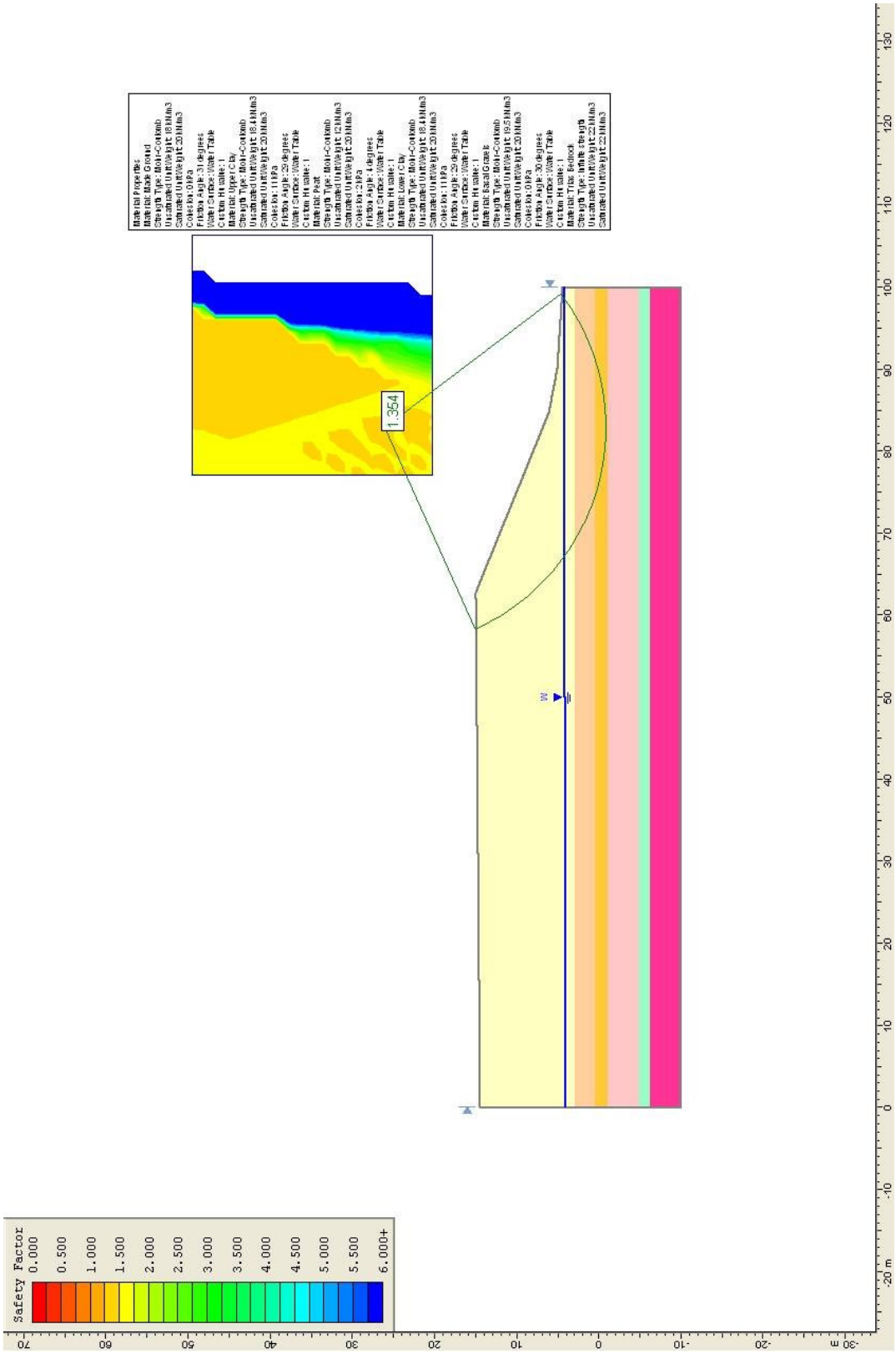
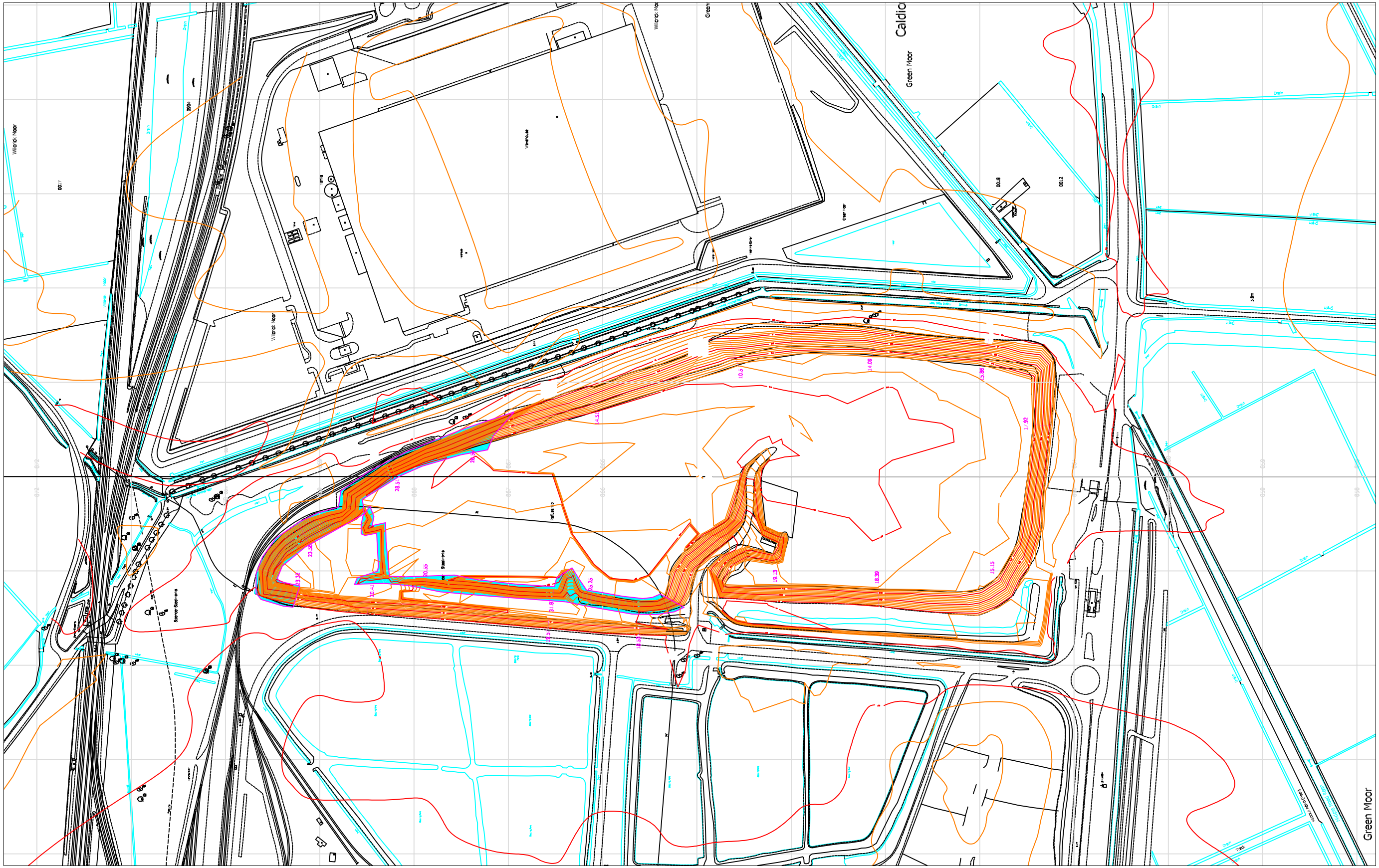


Figure SRA8 Existing Waste Slope Angles



LLANWERN EAST
WASTE MANAGEMENT
SITE
LANDFILL
CORUS WORKS
LLANWERN

APPENDIX SRA1
TRIAL PIT AND
BOREHOLE LOGS
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LLANWERN EAST
WASTE MANAGEMENT
SITE
LANDFILL
CORUS WORKS
LLANWERN

APPENDIX SRA2
GEOTECHNICAL DATA
ON MARINE CLAYS
Report Number 525.1/Appendix 3/0207

LLANWERN EAST
WASTE MANAGEMENT
SITE
LANDFILL
CORUS WORKS
LLANWERN

APPENDIX SRA3
MANUFACTURERS DATA SHEETS
Report Number 525.1/Appendix 3/0207

LLANWERN EAST
WASTE MANAGEMENT
SITE
LANDFILL
CORUS WORKS
LLANWERN

APPENDIX SRA4
CALCULATION SHEETS
FOR CAPPING FACTOR
OF SAFETY
Report Number 525.1/Appendix 3/0207