CAULMERT LIMITED

Engineering, Environmental & Planning
Consultancy Services

Bryn Posteg Landfill Site

Sundorne Products (Llanidloes) Ltd

Stability Risk Assessment

Addendum No.5

Prepared by:

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Caulmert
Engineering, Environmental and Planning

APPROVAL RECORD

Site: Bryn Posteg Landfill Site

Client: Potters Waste Management

Project Title: Bryn Posteg Permit – Regulation 61(1) Notice Response

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Reviewer	Andy Stocks	**Date**	15/03/18
Approved	Jonathan Clark	**Date**	15/03/18

DISCLAIMER

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(*Located in text where referenced*)

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1. INTRODUCTION

1.1 The Site

1.1.1 Bryn Posteg Landfill Site in Llanidloes, Powys is operated by Sundorne Products (Llanidloes) Ltd Trading as Potters Waste Management (Potters) under Environmental Permit EPR/BU7766IC.

1.1.2 Bryn Posteg Landfill Site (the Site) is situated approximately 2.8km south-east of Llanidloes, Powys and is centred at National Grid Reference SN 971 822.

1.1.3 The Site has been developed in the surface void associated with an old lead mine. The Site was operated by Montgomery County Council, later Powys County Council, from 1982 until April 1997, when it was taken over by Evans Logistics, now Potters Waste Management.

1.1.4 The Site previously operated under a Waste Management Licence and was issued with a PPC permit in 2004 (now transferred to Environmental Permit). It is currently operating under Environmental Permit EPR/BU7766IC.

1.2 Report Context

1.2.1 On the 18th January 2018 Natural Resources Wales (NRW) issued a Regulation 61(1) Information Notice pertaining to the Site. Under Schedule 1 NRW requested that that the following information was presented to NRW by the 18th April 2018;

Submit to Natural Resources Wales a revised Stability Risk Assessment (SRA) that assess the risk(s) on the long-term stability of the land form because of the overtipping. This must also consider the impact of the period of non-compliance with permitted leachate head limits recorded between January 2016 and April 2017.

1.2.2 This Stability Risk Assessment (SRA Addendum No.5) presents details of the over-tipping, the current stability of the resultant landform and assesses the long-term stability of the landform. The impact of the period of non-compliance with permitted leachate head limits recorded between January 2016 and April 2017 is also considered herein.

1.3 Extent of the Over-tipping

1.3.1 The over-tipping assessed herein and as referenced by NRW in their Schedule 1 pertains to the difference in surface elevation between the following survey and drawing information.

- Survey; NRG dated 6th March 2017 as shown on Drawing No. 3428.CAU.XX.XX.DR.S.1801 P1
- Pre-settlement restoration profile; Drawing Reference DRWG9 as shown on Drawing No. 3428.CAU.XX.XX.DR.S.1802 P1

1.3.2 On the basis of the above survey and pre-settlement restoration profile an isopachyte representation of the difference in levels between the two profiles has been prepared and is presented as Drawing No. 3428.CAU.XX.XX.DR.S.1803 P1.

1.3.3 The areas where the levels exceed the pre-settlement profile are shown on Drawing No. 3428.CAU.XX.XX.DR.S.1803 P1.shaded in darker green, orange and brown. These areas typically occupy the central part of the site. An orange patch is present to the northern most extent of the site and four additional areas to the southern site boundary. These areas are anomalies from the modelling process and are outside of the landfilled area.

1.3.4 For ease of reference the area where the levels exceed the pre-settlement profile is shown as yellow on Drawing No. 3428.CAU.XX.XX.DR.S.1804 P1. The over-tip area is located in the central part of the Site and overlays parts of phases 3, 4, 5, 7 and 9.

1.3.5 The extent of the over-tip is shown on Drawing No. 3428.CAU.XX.XX.DR.S.1804 P1. The over-tip at its highest exceeds the pre-settlement profile of Drawing No. DRWG9 by circa 12.5m in the central part of the site.

1.3.6 The impact of the over-tip on the geometry of the landform to March 2017 has been to increase the maximum elevation of the landform to levels in excess of the pre-settlement profile and to form a single mound, whilst increasing the length and gradient of the external slopes to Phases 3 and 9 to the northern and eastern boundaries of the over-tip area.

1.4 Landform Stability

1.4.1 The landform resultant from landfilling and including the over-tip at March 2017 is shown on Drawing No. 3428.CAU.XX.XX.DR.S.1801 P1.

Internal, Short Term Waste Slopes

1.4.2 Internal, short term waste slopes are present in Phase 9 in the south and south western parts of the Site are typically at gradients in the order of 1 in 2.5 or shallower in accordance with the SRA Addendum 4.

1.4.3 On this basis and due to the current absence of reported signs of instability in the waste slopes they are therefore considered to be stable. It is noted that these slopes will need to be reduced by future infilling against them within the void that currently exists in Phase 9.

1.4.4 These internal short-term waste slopes are therefore not considered further in this report.

The Western Perimeter Slopes

1.4.5 The western perimeter slopes of the Site have been capped and restored. It is understood that this area which is outside the over-tip area, does not currently exhibit ant signs of instability. On this basis and due to the current absence of reported instability these slopes are therefore considered to be stable.

1.4.6 The western perimeter slopes are therefore not considered further in this report.

The Northern and Eastern Slopes

1.4.7 The northern and eastern slopes to phases 3 and 9 are shown on Drawing No. 3428.CAU.XX.XX.DR.S.1801 P1 with gradients ranging from approximately 1 in 3 to 1 in 4.5 over the majority of the area (with the exception of one area in the central part of the eastern boundary which is approximately 1 in 6) as shown on Figure 1 below.

1.4.8 Typically these slopes are steeper than the gradient for the waste profile detailed in the SRA Addendum 4 and are steeper than the 1 in 5 to 1 in 15 gradients of the pre-settlement profile of Drawing No. DRWG9.

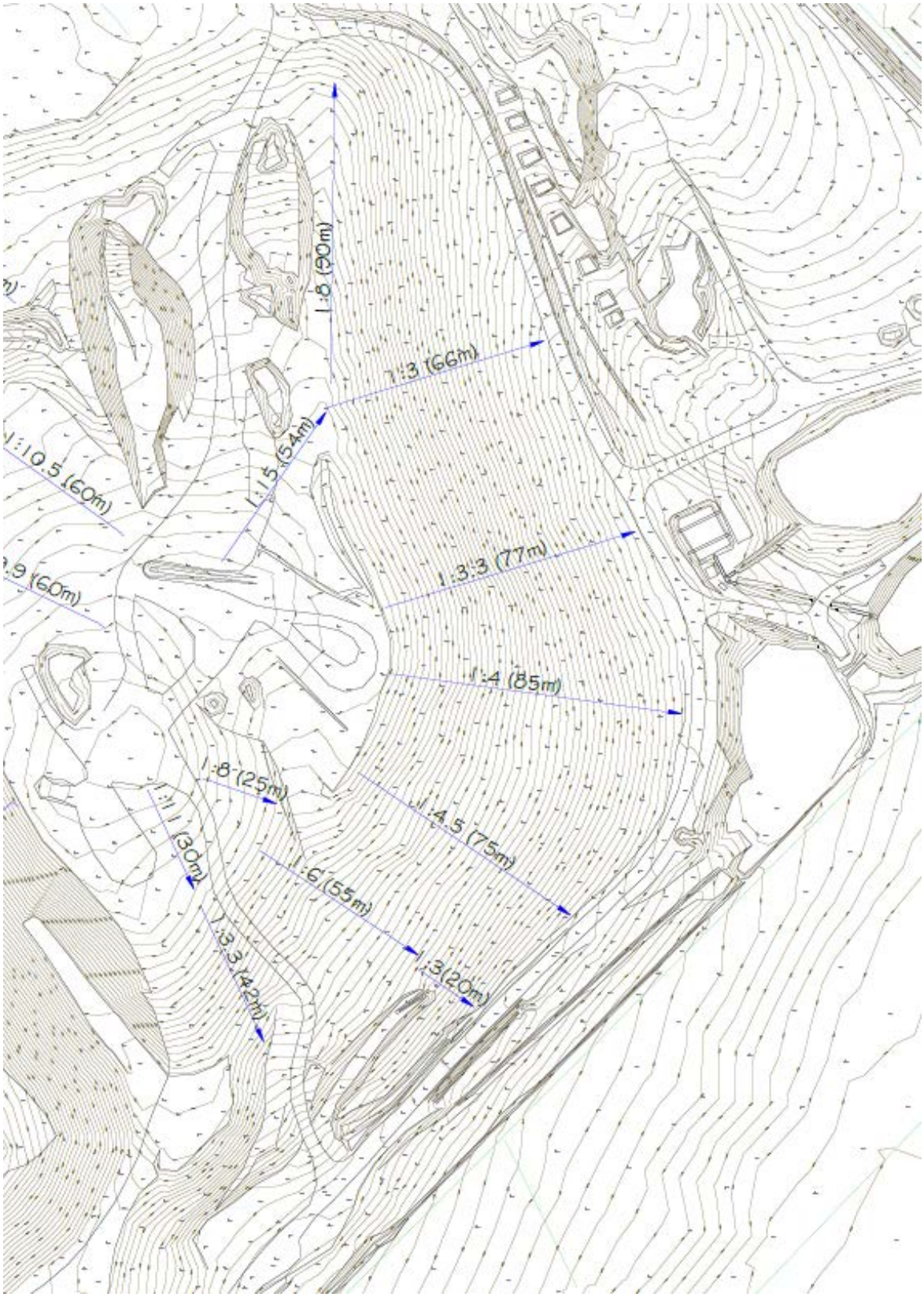

Figure 1; Slope Gradients (March 2017 Survey)

1.4.9 In accordance with the SRA Addendum 4, the design slopes pertaining to the external slopes should be;

- no steeper than 1 in 5 and capped using an LLDPE geomembrane overlain by a drainage geocomposite layer (GDL); or
- no steeper than 1 in 6.5 and capped using an LLDPE geomembrane overlain by a protection geotextile.

1.4.10 Most of the external slopes to phases 3 and 9 were capped a number of years ago (from 2009 onwards as referenced in the Site's Gas Risk Assessment), using an LLDPE geomembrane overlain by a drainage geocomposite and restoration soils, in accordance with the materials referenced in SRA Addendum 4, but on slopes steeper than the 1 in 5 detailed therein. These capped and restored areas are seen as green to the right side of the landform on the recent photograph (Figure 2) below.

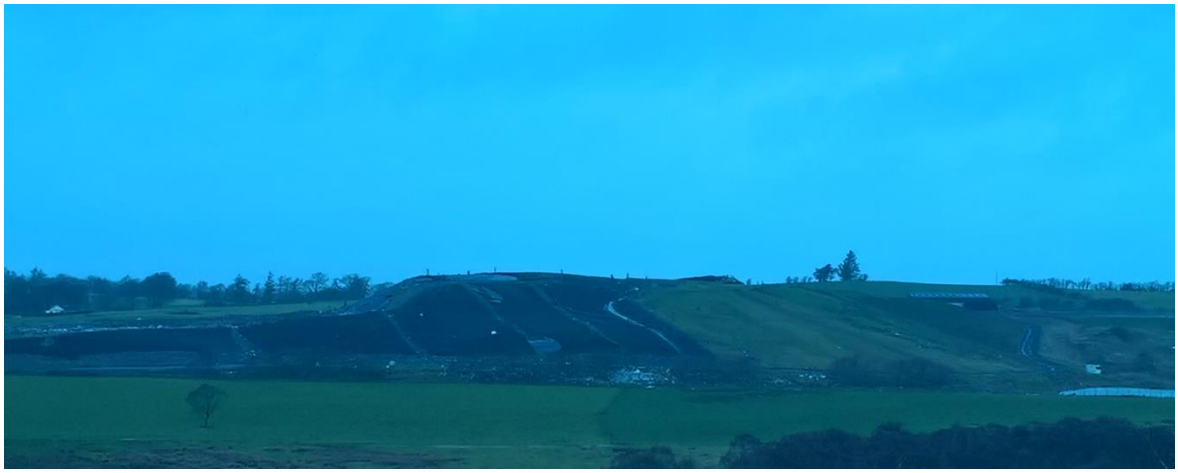

Figure 2: Recent Site Photopraph

1.4.11 During 2017, further capping works were carried out (part of which was in the over-tip area; these recently capped areas are shown as black on the above photograph (Figure 2). The extent of the 2017 capping works is shown on Figure 3 below.

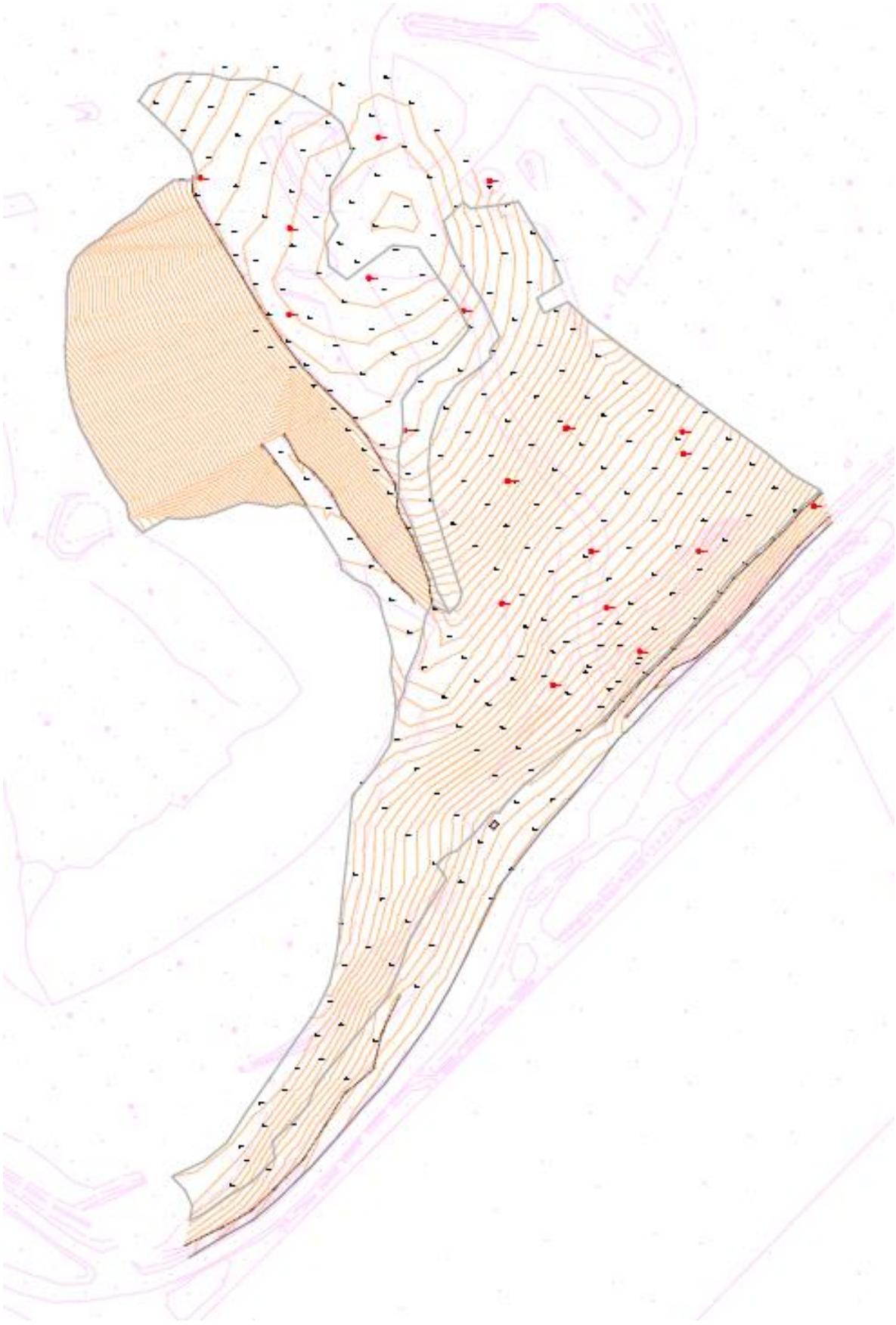

Figure 3: Extent of the 2017 Capping Works

1.4.12 The slope gradients associated with the 2017 capping works are broadly in the range of circa 1 in 3 to 1 in 6 and are the same gradient or shallower than the steepest capped and restored slopes of 1 in 3 associated with the over-tip area pertaining to Phase 3.

1.4.13 The long term stability of the northern and western slopes is therefore assessed in this Stability Risk Assessment report below.

1.4.14 Settlement of the waste slopes will occur over time resulting in gentler slope gradients as time progresses. It is therefore recognised that the Fs value for the slope will therefore increase over time as settlement occurs. In the longer term shallower, more stable slopes will exist.

1.5 The Impact of the Period of Non-Compliance With Permitted Leachate Head Limits

1.5.1 The period of non-compliance with permitted leachate head limits was recorded between January 2016 and April 2017.

1.5.2 The leachate heads associated with this period were contained at levels below the rim of the Site and therefore the below surrounding ground level. As such these increased leachate levels would not have come into contact and would not have impacted on the capped and restored perimeter waste slopes.

1.5.3 The impact of the non-compliant leachate head levels is therefore not considered further in this report in connection with the perimeter waste slopes.

1.5.4 Internal, short term waste slopes are present in Phase 9 in the south and south western parts of the Site and are typically at gradients in the order of 1 in 2.5 or shallower in accordance with the SRA Addendum 4. Increased, non-compliant leachate head levels would have had the potential to affect these short term waste slopes but no adverse effect on the stability of the slope was recorded either during or after this non-compliant period.

1.5.5 On this basis and due to the current absence of any reported signs of instability in these short-term waste slopes, it is considered that the non-compliant leachate head levels did not adversely impact on the stability of the short term slopes. These short-term slopes are therefore considered to be stable. It is noted that these slopes will need to be reduced by future infilling against them within the void that currently exists in Phase 9.

1.5.6 The impact of the non-compliant leachate head levels is therefore not considered further in this report in connection with the internal, short term waste slopes.

2. STABILITY RISK ASSESSMENT

Context

The stability Risk Assessment included in the Permit Application for the Site allowed for two capping options. One option was a 1m thick clay liner covered by 1m of restoration soils and the other was a 1mm thick welded LLDPE geomembrane.

In April 2005 Sundorne Products (Llanidloes) Ltd, the Permit holder, appointed Egniol Ltd to re-assess the stability calculations for the LLDPE option and to assess the stability of the mineral option but with the clay replaced by a geosynthetic clay liner (GCL). This assessment was presented in their report titled, 'Stability Risk Assessment – Capping; Addendum 4'; hereafter referred to as 'SRA Addendum 4'.

Subsequent capping activities at the Site, and those specifically related to the over-tipped northern and eastern perimeter slopes, were carried out using the LLDPE option presented in SRA Addendum 4.

The capping and restoration works to the perimeter slopes of phases 3 and 9 were carried out from 2009; on slopes steeper than 1 in 5.

Over the past 9 years these perimeter slopes have remained stable. Taking into consideration the time that has now elapsed, these slopes could be considered to be long-term stable from a stability perspective.

Theoretically, if the on-site conditions and interface characteristics matched those used in the modelling to support the SRA Addendum 4 these existing capped and restored slopes (which are within the over-tip area) would have either failed or shown signs of significant instability. This has clearly not occurred on the Site.

The over-tip has created longer and steeper slopes to phases 3 and 9 than those assessed under SRA Addendum 4. Since the capped and restored, 1 in 3 to 1 in 5 slopes have remained stable for this significant long-term period, it is considered likely that the assumed interface characteristics and material parameters used in the modelling to support the SRA Addendum 4 were conservative.

The minimum long term Factor of Safety (Fs) required for designed slopes is 1.3, this being consistent with the approach used in SRA Addendum 4. On this basis it can be assumed that

the extended and steepened perimeter slopes to phases 3 and 9, which are present in their current geometry as a result of the over-tip; exhibit a stable Fs value of, or in excess of 1.3.

On the basis of the above information it is considered that the perimeter slopes to phases 3 and 9 are stable at gradients as steep as 1 in 3. Whilst the Fs value for these slopes has been reduced as a result of the over-tip, the Fs value has been reduced but not to a level where the slopes are unstable.

On the basis of the above information, a back analysis has been undertaken using the same methodology used in the SRA Addendum 4, to estimate the potential interface parameters present at the site and to provide estimated Fs values for the currently capped and restored slopes at the Site.

This report describes the derivation of the input parameters to the stability analyses, the method of analysis and discusses the results.

2.1 Risk Screening

2.1.6 Capping System Screening

The stability of the LLDPE capping option overlain by a drainage geocomposite layer (GDL) and restoration soils has been assessed via back analysis.

2.2 Lifecycle Phases

No change

2.3 Data Summary

To take into account the effects of the over-tip on slope gradient and slope length these were revised to reflect the steepest perimeter slope in phases 3 and 9. This slope was 1 in 3 for a vertical height of 22m.

2.4 Selection of Appropriate Factors of Safety

No change

2.5 Justification of Modelling Approach and Software

Model A was developed using the approach used in the SRA Addendum 4. To take into account the effects of the over-tip on slope gradient and slope length these were revised to reflect the steepest perimeter slope in phases 3 and 9. This slope was 1 in 3 for a vertical height of 22m.

No change

2.6 Justification of Geotechnical Parameters Selected for Analysis

2.6.6 Parameters Selected for Capping Analysis

The interface parameters pertaining to the formation / LLDPE geomembrane and the geotextile (GDL) / restoration soils, together with the soil cohesion values were assumed values in the SRA Addendum 4. For ease of analysis it was assumed that these values were consistent. Whilst a possible range of parameters was determined via the back analysis cohesion of 0 and phi of 25.5 was selected for the analysis.

The interface parameters incorporated in the SRA Addendum 4 and the Model A analysis are summarised in Table 1 below.

Table 1; Parameters and Results Pertaining to Model A and SRA Addendum 4.

Interface	**Source; SRA Addendum No.4**		**Back Analysis Parameters**	
	C	Phi	C	Phi
Clay / LLDPE (Textured)	0	20	*0**	*25.5**
	Assumed value		*Revised*	
LLDPE (Textured) / Non-woven Geotextile or GDL	6.3	15.3	6	13
	Measured Values		Unchanged	
Non-woven Geotextile or GDL / Restoration Soils	0	20	*0**	*25.5**
	Assumed Value		*Revised*	
Soil Cohesion	0	25	*0**	*25.5**
	Assumed Value		*Revised*	
Stability Model Details	**Source; SRA Addendum No.4**		**Back Analysis Parameters**	
Slope Gradient	1 in 5		*1 in 3**	
Slope Height (m; vert)	10m		*22m**	
Factor of Safety - Dry	1.95		*1.45**	
Factor of Safety - Saturated	1.04		*0.67**	
Factor of Safety – Under drained	1.35		*1.30**	
	SRA Addendum No.4		**Model A**	

* denotes details revised in Model A from those used in the SRA Addendum 4 analysis.

2.7 Analysis

2.7.6 Capping Analyses

Model A was developed using the methodology used in the SRA Addendum 4. To take into account the effects of the over-tip on slope gradient and slope length these were revised to reflect the steepest perimeter slope in phases 3 and 9. This slope was 1 in 3 for a vertical height of 22m**.**

The back analysis confirmed that the critical interface for slope instability was between the GDL and the overlying restoration soils. The Fs values for the under drained conditions (using a GDL) which were appropriate for the capped slopes present, were analysed and are summarised in the Table 3 below. Fs values for the I in 3 slopes under dry, saturated and drained conditions were also analysed and the results shown in Table 1.

The Model A analysis pertaining to the under drained conditions (using a GDL) is presented in Appendix 1**.**

For the purposes of the analysis the Fs value for the 1 in 3 slope analysed by Model A has been as assumed at 1.3 to reflect the minimum Fs value for a long term stable slope.

The back analysis has been carried out to ascertain the common values for the selected parameters would result in the stable Fs value of 1.3. For analysis purposes C = 0 and Phi = 25.5 were selected and used in the modelling.

A range of 'C' and 'Phi' interface strength values were identified which would also result in and Fs value of 1.3, for the under drained model analysed. The range of values pertaining to interface strength parameters which presented an Fs value of 1.3 is summarised below in Table 2.

Table 2; Alternative Soil Cohesion and Soil Interface Parameters

Alternative Soil Cohesion and Clay Soil Interface Parameters Providing an Fs Value of 1.3 or Greater		
C	**Phi**	**Fs**
0	25.5	1.30
0.5	24	1.30
1.00	23	1.33
1.25	22	1.32

Using Model A to reflect the under drained conditions present on Site, the Fs values pertaining to the relevant interfaces was determined for the typical, steepest perimeter slopes (in the over-tip area) ranging from 1 in 3 to 1 in 5. These ranged from the assumed 1.3 for the 1 in 3 slope to 2.16 for the 1 in 5 slope profile. A summary of the Fs values pertaining to these slope profiles is presented below in Table 3.

Table 3; Summary of Fs Values for Slopes with Under Drained Conditions

Fs Values Under Drained Conditions (Model A; with a GDL)			
Interface			Slope Gradient
formation / *geomembrane*	*geomembrane* / *geotextile*	*geotextile* / *soils*	
1.45	1.86	1.30	1 in 3
1.94	2.45	1.73	1 in 4
2.42	3.04	2.16	1 in 5

On the basis of the above information it is considered that the perimeter slopes to phases 3 and 9 are stable at gradients as steep as 1 in 3. Whilst the Fs value for these slopes has been reduced as a result of the over-tip, the Fs value has been reduced but not to a level where the slopes are unstable. The over-tip has therefore not resulted in an increased potential for the Site to pollute the environment on stability grounds.

On the basis of the above information it is considered that the perimeter slopes to Phase 9 which were capped in 2017 are stable at gradients as steep as 1 in 3. Whilst the Fs value for these slopes has been reduced as a result of the over-tip, the Fs value has been reduced but not to a level where the slopes are unstable. The over-tip has therefore not resulted in an increased potential for the Site to pollute the environment on stability grounds.

DRAWINGS

3428.CAU.XX.XX.DR.S.1801 P1 – Site Survey of 06/03/2017
3428.CAU.XX.XX.DR.S.1802 P1 – DRWG9
3428.CAU.XX.XX.DR.S.1803 P1 – Isopachyte Between March 2017 Survey and DRWG9
3428.CAU.XX.XX.DR.S.1804 P1 – Area of Overtip Between March 2017 and DRWG9

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REV	MODIFICATIONS	BY	RE	AP	DATE
P1	ISSUED FOR COMMENT	EJD	JC	JC	19.01.18

POTTERS WASTE MANAGEMENT

PROJECT:

BRYN POSTEG LANDFILL SITE

TITLE:

SITE SURVEY OF 06/03/2017

DRAWN BY	DATE	
EJD	19.01.2018	
REVIEWED BY: JC	SCALE @ A1: 1:1000	JOB REF: 3428
AUTHORISED BY: JC	ISSUE: S1	REVISION: P1

DRAWING NUMBER: 3428-CAU-XX-XX-DR-S-1801

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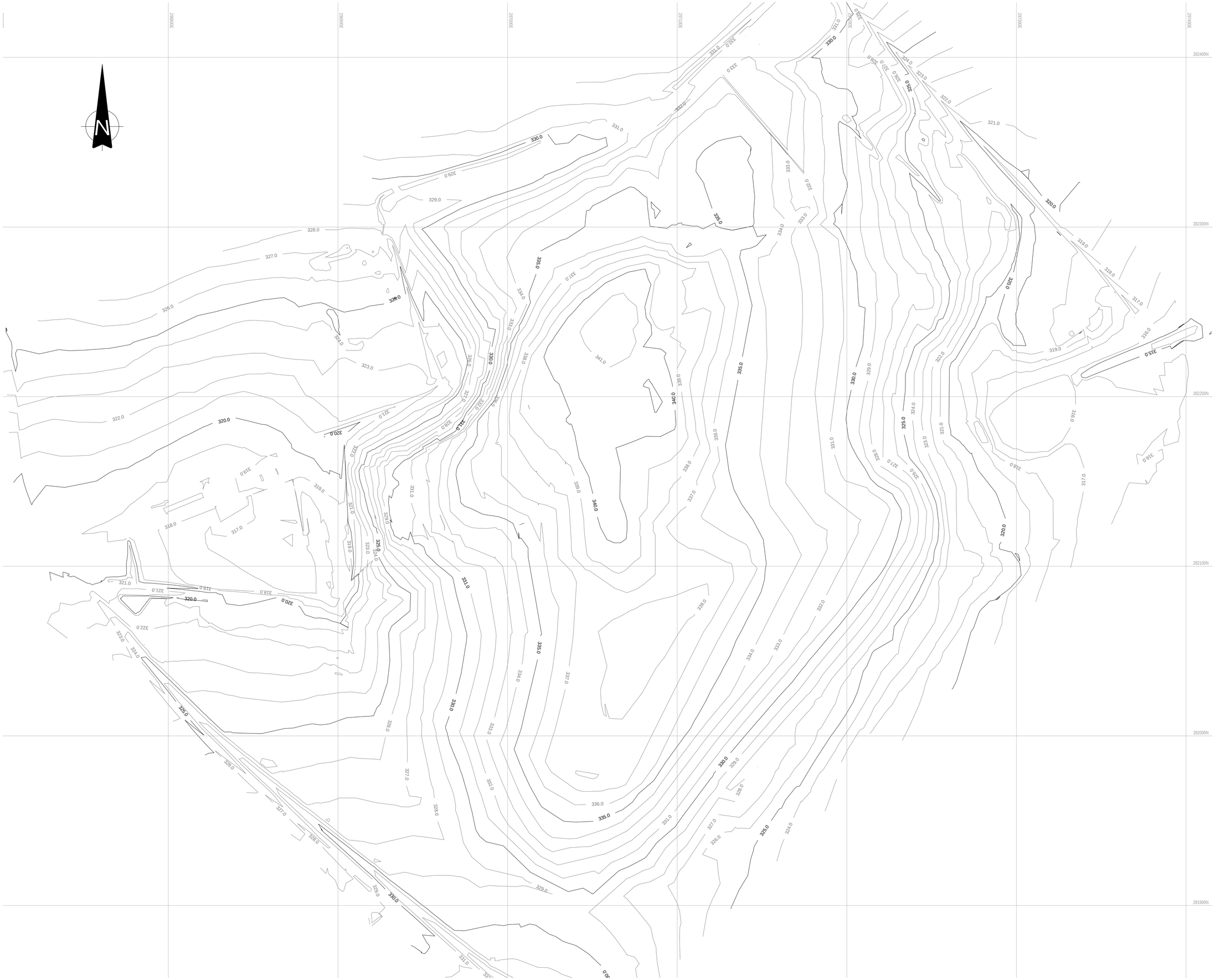

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REV	MODIFICATIONS	BY	RE	AP	DATE
P1	ISSUED FOR COMMENT	EJD	JC	JC	19.01.18

POTTERS WASTE MANAGEMENT

PROJECT:

BRYN POSTEG LANDFILL SITE

TITLE:

DRWG 9

DRAWN BY: EJD	DATE: 19.01.2018	
REVIEWED BY: JC	SCALE @ A1: 1:1000	JOB REF: 3428
AUTHORISED BY: JC	ISSUE: S1	REVISION: P1

DRAWING NUMBER: 3428-CAU-XX-XX-DR-S-1802

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HEIGHT RANGES

15.0	OVERFILL
12.5	
10.0	
7.5	
5.0	
2.5	
0.0	VOID TO FILL
-2.5	
-5.0	
-7.5	
-10.0	
-12.5	
-15.0	

REV	MODIFICATIONS	BY	RE	AP	DATE
P1	ISSUED FOR COMMENT	EJD	JC	JC	19.01.18

POTTERS WASTE MANAGEMENT

PROJECT:

BRYN POSTEG LANDFILL SITE

TITLE:

ISOPACHYTE BETWEEN MAR2017 SURVEY AND DRWG 9

DRAWN BY: EJD	DATE: 19.01.2018	
REVIEWED BY: JC	SCALE @ A1: 1:1000	JOB REF: 3428
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PHASE 3C
PHASE 1
PHASE 6
PHASE 5
PHASE 2
PHASE 3B
PHASE 3A
PHASE 4B
PHASE 7
PHASE 8
PHASE 4A
PHASE 9A
PHASE 9C
PHASE 9B
PHASE 9D
+
PHASE 9E

SUMP 1
SUMP 2
SUMP 3
SUMP 4
SUMP 5
SUMP 7
SUMP 9A
SUMP 9B
SUMP 9C
SUMP 9D
RLMP 9A NORTH
RLMP 9A SOUTH

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AREA OF OVERFILL TO DRWG 9

STOCKPILE 1

STOCKPILE 2

REV	MODIFICATIONS	BY	RE	AP	DATE
P1	ISSUED FOR COMMENT	EJD	JC	JC	19.01.18

POTTERS WASTE MANAGEMENT

PROJECT:

BRYN POSTEG LANDFILL SITE

TITLE:

AREA OF OVERTIP BETWEEN MAR2017 AND DRWG 9

DRAWN BY	DATE	
EJD	19.01.2018	
REVIEWED BY: JC	SCALE @ A1: 1:1000	JOB REF: 3428
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APPENDICES

Appendix 1 Back Analysis Model A

Capped Slopes at 1 in 3 with 1.0m of Soils

Calculates stability of veneer covered slope

Construction plant loading(after Koerner & Soong (1998) 6th Int Conf on Geosynthetics)

weight of equipment		Wb	200	kN	
length of track		w	3	m	
width of track		b	0.6	m	
influence factor		I	0		- 0 if no plant loading
track pressure		q	55.56	kN/m2	
equivalent equipment force on geomembrane		We	0.00	kN/m	- add to weight of upper wedge
acceleration ratio		(a/g)	0		- 0 if pushing up slope
dynamic force parallel to slope		Fe	0.00	kN/m	- apply as active thrust

Vertical component of inter-slice force neglected to simplify analysis

Data Input

Interface details:		*Lower material*			*formation*	*geomembrane*	*geotextile*
		Upper material			*geomembrane*	*geotextile*	*soils*
height of slope base *(actual)*		H	m		*22.00*	*22.00*	*22.00*
lining thickness		T1	m		*1.00*	*1.00*	*1.00*
slope of liner *(actual)*		Cot(alpha)			*3.00*	*3.00*	*3.00*
dry density		Gamdry-1	kN/m3		18.00	18.00	18.00
saturated density		Gamsat-1	kN/m3		20.00	20.00	20.00
saturated thickness interface		Tw	m		0.00	*0.20*	*0.20*
saturated thickness cover soil					*1.00*	*1.00*	*1.00*
interface cohesion		C1	kN/m2		0.00	6.30	0.00
interface friction angle		Phi-1	deg		25.50	15.30	25.50
soil cohesion		C2	kN/m2		0.00	0.00	0.00
soil friction angle		Phi-2	deg		25.50	25.50	25.50
active thrust at top of slope		Pa	kN		0.00	0.00	0.00
reinforcement		Tr	kN		0.00	0.00	0.00

Calculations

nett active force			kN		0.00	0.00	0.00
slope of liner		alpha	rads		0.32	0.32	0.32
length of interface		L1	m		69.57	69.57	69.57
length of soil		L2	m		3.16	3.16	3.16
weight of upper wedge		W1	kN		1252.26	1252.26	1252.26
weight of lower wedge		W2	kN		33.33	33.33	33.33
pwp on interface		U'	kN		0.00	129.49	129.49
pwp in cover soil		U''	kN		14.72	14.72	14.72
Disturbing force		D+Pa-Tr	kN		396.00	396.00	396.00
Resisting Forces		T1	kN		566.65	727.87	504.88
		Ts	kN		8.88	8.88	8.88
Factor of Safety		**Fs**			**1.45**	**1.86**	**1.30**
FoS greater than 1.3 reported in the SRA					*YES*	*YES*	*YES*
Ignore lower wedge		Fs = T1/D			1.43	1.84	1.27
		Lower material			*formation*	*geomembrane*	*geotextile*
		Upper material			*geomembrane*	*geotextile*	*soils*

Critical Interface