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OPAL VALE LANDFILL

Technical Studies to Support Design

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REPORT

Report Number. 1417287-001-R-Rev0

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Golder Associates

Executive Summary

Opal Vale Pty Ltd (Opal Vale) has engaged Golder Associates Pty Ltd (Golder) to provide technical studies to support the design of a new Class II landfill site known as the Opal Vale Landfill, designed by IW Projects (IWP). The scope of this report is summarised as follows:

1) Outcomes of the visual subgrade assessment carried out on site
2) Stability assessment of the proposed liner systems and relevant geotechnical units, incorporating the findings from 1)
3) Liner integrity assessment to estimate the strains likely to be induced in the proposed geomembrane materials during the life of the facility
4) Geosynthetic Clay Liner (GCL) assessment to verify proposed product suitability for intended applications
5) Infiltration and seepage assessment for cap and basal liner systems, respectively
6) Leachate modelling and water balance.

The findings and results of the assessments are presented below:

Description	Conclusion	Recommendation
Subgrade settlement assessment	Tensile strains on the liner are likely limited if the saturated soft material present within the proposed landfill footprint is removed prior to subgrade placement and liner installation. The soft saturated material is potentially liquefiable. During cyclic loading, liquefaction of this material could cause foundation failure or settlement that could induce tensile strains on the liner beyond its allowable limit.	The saturated soft material should be removed prior to the installation of the liner system. The extent of the soft material should be verified and witnessed by a third party CQA inspector. PCPT could be undertaken during detail design to investigate the extent of the soft saturated material within the pit base. The extent of the uncompacted fill located at the eastern side of the proposed landfill footprint should be verified. A qualified third party CQA inspector should witness the extent of the uncompacted fill removal prior the placement of compacted fill material on the side slopes.
Stability assessment	The stability assessment undertaken for the base liner system has shown acceptable safety factors for the landfill. The stability of the final landform, under current conservative design assumptions, is marginally stable. We therefore recommend that additional analysis be carried out during detail design that incorporates actual site geometry and test results based on materials identified for construction.	Based on the stability assessment the minimum friction angle at the side slopes and base of the landfill should be no less than 10° and 15°, respectively. Large shear box interface shear tests should be carried out on the various liner interfaces (Refer Section 8.6) to confirm that the recommended minimum interface friction angle is achieved. The testing should be undertaken using the materials that will be adopted during construction. The waste slopes should not be steeper

Description	Conclusion	Recommendation
		than the slopes listed in Table 10. The liner system should be secured in an anchor trench at the top of the division wall between Cell 1 and Cell 3, and Cell 2 and Cell 4. The liner can be installed beneath the division wall between Cell 1 and Cell 2, and Cell 3 and Cell 4.
Liner integrity assessment	The liner system integrity assessment undertaken has shown that the risk of straining the proposed liner system is limited and the estimated tensile strains are deemed acceptable.	Large shear box tests should be carried out as recommended in Section 8.6. We recommend selecting materials such that the weakest interface is located between the protection geotextile and the geomembrane. This will further limit the risk of straining the containment system (HDPE and GCL).
GCL assessment	Should the proposed GCL meet the requirements as discussed in this section as well as the technical specification prepared by IWP, the material would be deemed suitable for the intended application at Opal Vale landfill site.	Hydraulic conductivity testing of GCL with leachate or synthetic leachate should be carried out. Cation exchange capacity of GCL and subgrade materials should be carried out to assess potential for cation exchange and increase and permeability over time. Refer Section 10.2
Leachate modelling and water balance	The leachate generation rate estimated for Opal Vale landfill is 1600 m^3/hectare/year (based on two consecutive wet years). Under the conditions modelled, the freeboard level of 0.5 m inside the leachate ponds will likely not be exceeded. Based on the water balance assessment the following pond construction sequencing is required: ■ 2 ponds required Year 0 to Year 4 ■ 3 ponds required Year 5 to Year 7 ■ 4 ponds required Year 8 to 11 The percentage of leachate required to be recirculated inside the landfill: ≥ 20% of inflows from year 1 to year 7 and ≥ 40% of inflows from year 8 to end of life of facility. Under the conditions modelled the BPEM requirements for the containment of stormwater inside the leachate pond of 1 in 20 storm event, 24 hours duration is met. The leachate ponds, based on the	The construction sequencing of the ponds should be aligned with the cell development. If the planned cell development should change, the construction sequencing of the ponds should be also be revised (including the water balance study). During the end of facility life, the amount of leachate that is required to be recirculated to limit the possibility of increasing the water level inside the leachate ponds will likely increase. This could be reduced by constructing an additional pond at approximately year 8. The leachate into and out of the ponds as well as the ponds' water level should be monitored during the facility life. This would allow calibration of the water balance model developed for the project which could then be used to forecast possible future scenarios to improve the water management at the landfill site.

Description	Conclusion	Recommendation
	above construction sequence, will likely meet the 1 in 100 storm event, 24 hours duration.	
Infiltration and seepage assessment	Based on the assumed parameters the basal leakage rate is within the acceptable limits outlined in the BPEM (10 L/ha/day, or 3650 L/ha/year). The seepage modelling indicates that no flux occurs through the cap liner system. This is consistent with a climate (typical of the site location) characterised by a negative water balance (evaporation exceeds the precipitation). The proposed cap meets the intended objectives of the BPEM guidelines under the conditions and assumptions detailed in this report.	Refer Section 10.2 in regards to assessment of potential cation exchange in regards to the basal liner.

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1.0 INTRODUCTION

1.1 Overview

Opal Vale Pty Ltd (Opal Vale) has engaged Golder Associates Pty Ltd (Golder) to provide technical studies to support the design of a new Class II landfill site known as the Opal Vale Landfill, designed by IW Projects (IWP). This report has been prepared in accordance with our Proposal No. P1417287-001-L-Rev0 dated 18 November 2014. The scope of this report is summarised as follows:

1) Outcomes of the visual subgrade assessment carried out on site;
2) Stability assessment of the proposed liner systems and relevant geotechnical units, incorporating the findings from 1);
3) Liner integrity assessment to estimate the strains likely to be induced in the proposed geomembrane materials during the life of the facility.
4) Geosynthetic Clay Liner (GCL) assessment to verify proposed product suitability for intended applications;
5) Infiltration and seepage assessment for cap and basal liner systems, respectively;
6) Leachate modelling and water balance.

The above scope items are presented in the following sections of this Report, with additional information attached in appendices where appropriate. Note that data received from various sources were used as is and not verified for correctness.

1.2 Project location

The proposed landfill is located within the Williamsons 'Clay Pit' on Lot 11, approximately 1.5 km east from Chitty Road, in the Shire of Toodyay. Figure 1 and Figure 2 show the project location and the layout view of the Williamsons 'Clay Pit'.

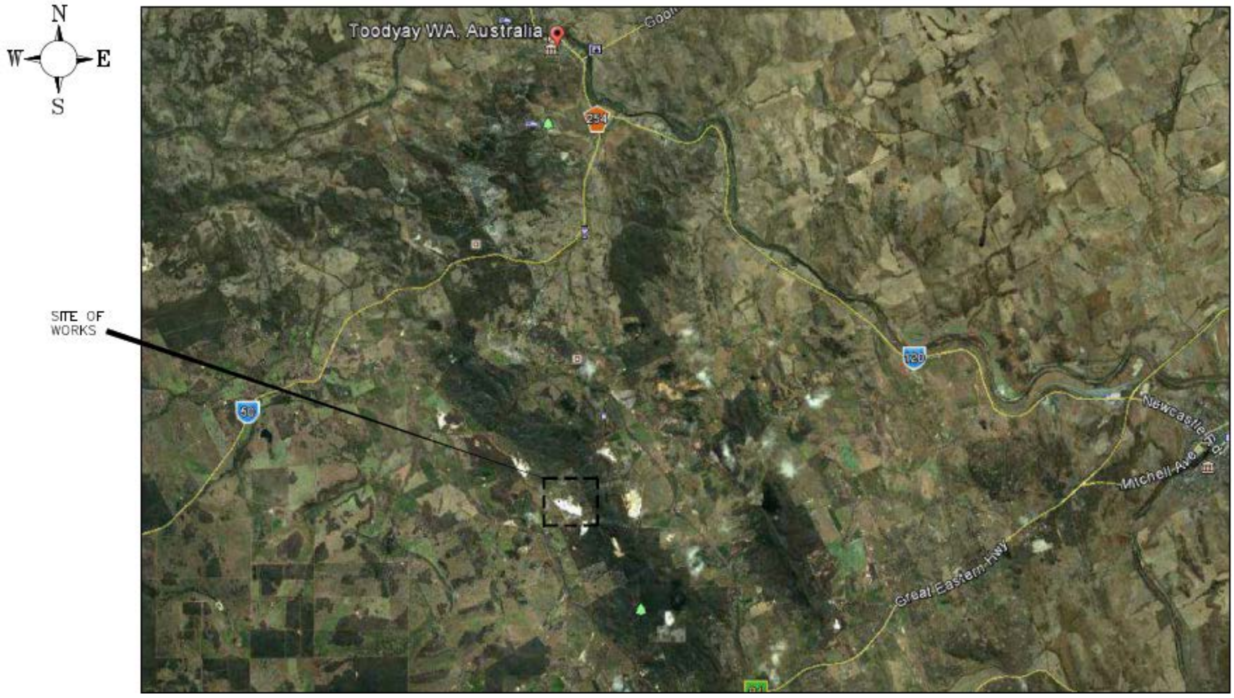


Figure 1: Project location.

Figure 2: Layout view of Williamson 'Clay Pit'.

2.0 INFORMATION PROVIDED

The following information was provided to Golder for the purposes of undertaking our scope of work:

- Drawings (OV-WA-21 to OV-WA-43)
- CAD Models corresponding to selected drawings from the above
- Opal Vale Salt Valley Road, Class II Landfill, Lot 11 Chitty Road, Toodyay, Works Approval Application Supporting, Documentation prepared by IW Projects – dated 26 July 2013
- Personal communication with Ian Watkins from IWP

Golder used the provided data as required for the various assessments and models. However the data, as received, was not verified and used as is. Should the base data used in our models be amended the assessments and models should be updated to reflect the relevant changes.

3.0 SITE DESCRIPTION

3.1 Climate

3.1.1 Overview

The site is located in an area with a typical Mediterranean climate with warm to hot dry summers and cool wet winters.

Climate data for the study were gathered from SILO (Queensland Government, 2014). SILO data are a synthetic dataset ('data drill') based on an interpolated grid derived from nearby Bureau of Meteorology (BoM) stations. The synthetic data were interpolated from recorded rainfall for the period between 1 January 1900 and 12 December 2014. For the current study SILO data were obtained for the coordinates 31.50° S latitude and 116.5° E longitude.

The records show an average annual rainfall of 482 mm and a distinct seasonal pattern with about 75% of the rainfall occurring from May to September. Average monthly evaporation exceeds average monthly rainfall throughout the entire year. The average annual A-Pan evaporation at the site is approximately 2 000 mm.

Figure 3 shows the monthly average rainfall and evaporation values of the study location.

The maximum and minimum monthly average temperatures are approximately 33°C in January and February, and approximately 6°C in July and August, respectively.

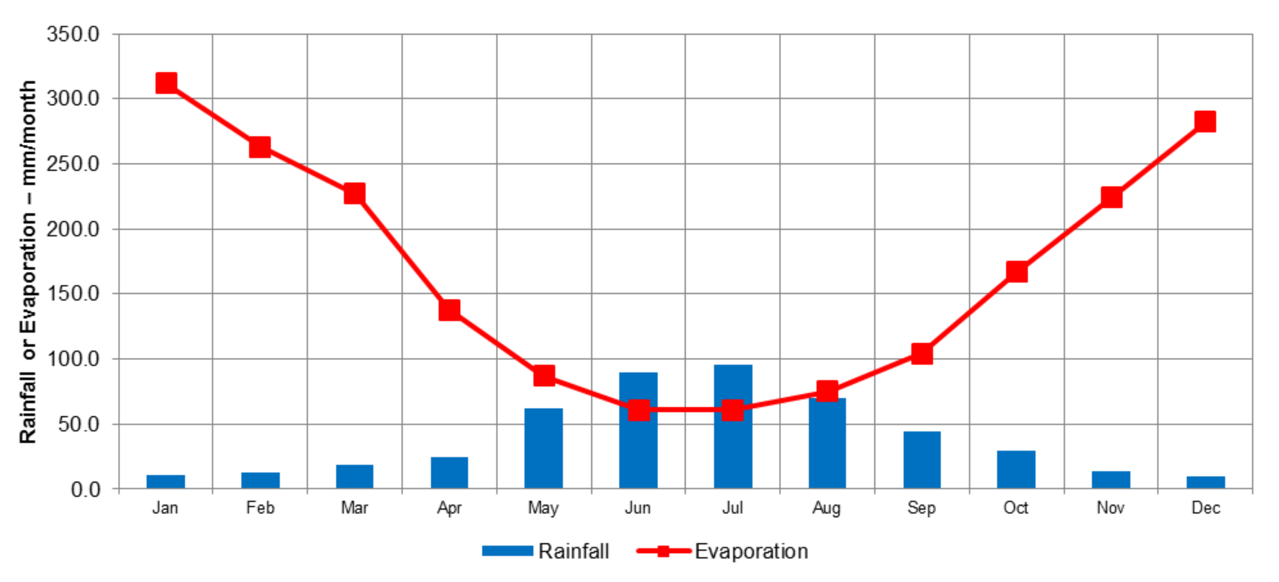


Figure 3: Average monthly rainfall and evaporation.

3.1.2 Rainfall

Table 1 presents the monthly SILO rainfall statistics.

Table 1: Monthly SILO rainfall statistics (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average	95.3	70.0	44.3	29.0	13.8	9.5	10.8	12.4	18.9	24.9	61.6	90.0	482.2
Maximum	250.8	190.3	131.3	77.8	75.9	66.6	156.0	152.2	230.5	98.3	151.3	308.6	812.4
90th Percentile	159.8	111.7	75.8	56.1	30.1	31.3	26.6	37.1	45.1	54.1	112.6	144.4	635.9
75th Percentile	117.3	84.2	54.5	38.1	21.8	9.8	11.8	16.4	24.9	40.6	82.4	116.3	546.1
Median	84.5	70.0	42.6	26.3	9.7	2.6	1.6	3.3	10.0	20.0	62.2	83.1	474.6
25th Percentile	63.2	50.0	26.7	17.2	3.7	0.2	0.0	0.1	1.0	6.5	33.5	56.6	394.9
10th Percentile	47.2	35.0	17.8	7.6	0.1	0.0	0.0	0.0	0.0	2.2	17.2	41.9	338.1
Minimum	12.1	1.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	8.9	215.4

Rainfall has shown a decreasing pattern from 1900 to 2014. This trend is shown on Figure 4.

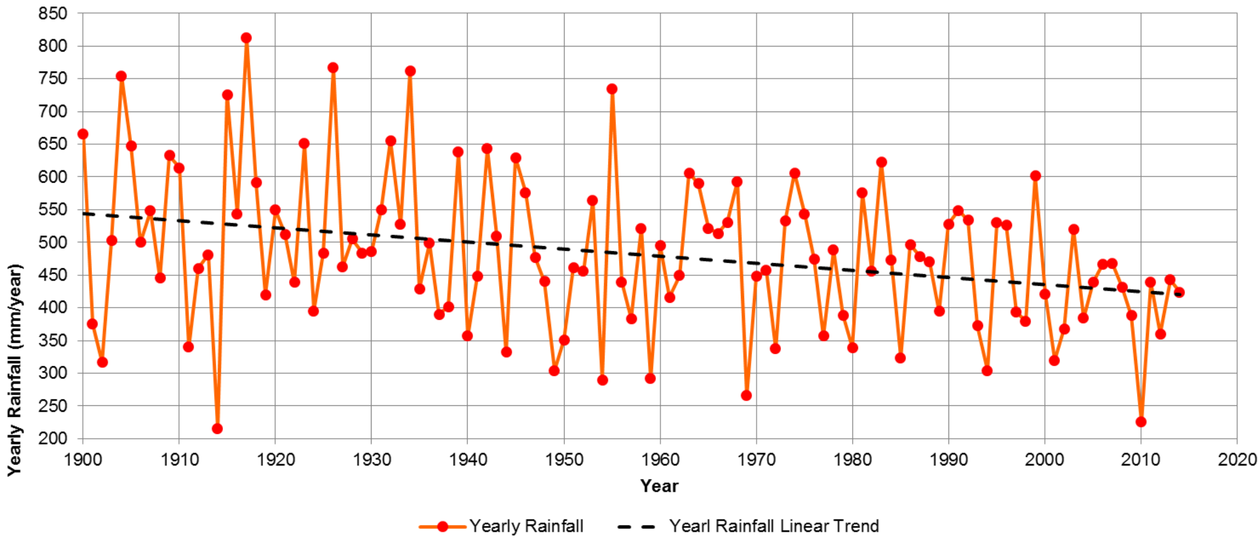


Figure 4: Rainfall trend from 1900 to 2014.

Precipitation appears to be decreasing at a rate of approximately 1.1 mm/year, which results in a reduction of annual precipitation of approximately 125 mm in 114 years. The maximum recorded precipitation has decreased significantly during the last 50 years. We have therefore adopted the last twenty years of rainfall data in our leachate assessment, and water balance study (from 1984 to 2014). The seepage study utilises the full data period as a worst case scenario as seepage from the landfill would be associated with a potential increase in environmental risk.

3.1.3 Evaporation

Table 2 presents the monthly SILO evaporation statistics.

Table 2: Monthly SILO evaporation statistics (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average	311.9	263.0	227.1	137.9	86.8	60.6	60.7	75.2	104.2	166.7	224.0	282.2	2000.3
Maximum	369.0	325.4	265.4	197.4	114.8	74.4	76.4	94.6	132.4	199.4	268.8	351.4	2223.0
90th Percentile	347.9	299.8	248.9	156.6	106.1	68.2	68.1	82.8	114.2	189.2	250.4	312.8	2127.4
75th Percentile	332.5	279.0	242.8	148.4	92.6	64.1	64.8	80.2	109.1	178.9	235.1	300.1	2070.4
Median	317.0	266.0	229.0	136.0	85.0	60.0	60.0	75.0	102.0	167.0	223.0	284.0	2005.0
25th Percentile	292.7	242.4	215.6	126.6	78.8	56.8	56.0	70.7	99.1	160.1	209.2	268.0	1933.2
10th Percentile	278.3	231.0	198.7	119.4	73.6	53.5	53.1	66.5	93.3	142.7	202.2	260.1	1864.8
Minimum	247.6	200.0	170.8	110.4	63.6	48.4	48.0	64.4	90.6	131.8	179.4	90.8	1664.0

3.1.4 Intensity-Frequency-Duration (IFD)

The rainfall intensity frequency duration (IFD) data for the site are presented for various event durations and average recurrence intervals (ARIs) in Table 3. The data were estimated using the online Rainfall IFD Data System developed by the Bureau of Meteorology.

Table 3: IFD rainfall data

Duration (min)	Rainfall Intensity (mm/h)						
	ARI = 1 year	ARI = 2 years	ARI = 5 years	ARI = 10 years	ARI = 20 years	ARI = 50 years	ARI = 100 years
10	35.400	40.200	57.000	70.200	83.400	102.600	118.800
20	28.400	32.400	46.400	56.400	67.200	82.800	96.000
30	18.800	21.400	30.400	36.800	43.800	53.800	62.000
60	12.200	13.700	19.200	23.200	27.500	33.700	38.900
120	7.750	8.750	12.050	14.650	17.400	21.450	24.950
180	5.967	6.700	9.267	11.267	13.467	16.767	19.600
360	3.833	4.300	5.983	7.333	8.867	11.217	13.317
720	2.450	2.750	3.867	4.783	5.833	7.483	8.975
1440	1.538	1.729	2.438	3.021	3.679	4.721	5.663
2880	0.942	1.058	1.471	1.798	2.160	2.710	3.192
4320	0.700	0.785	1.075	1.296	1.532	1.881	2.175

3.2 Site setting

The landfill site is proposed to be developed on the south-eastern portion of Lot 11 Chitty Road, within an existing clay extraction pit. Approximately 1 000 000 m^3 of clay and soil have been excavated from the pit. Based on the drawings received the proposed landfill will require some additional excavation and filling to achieve the required design levels. Further data on the site setting is provided in the Works Approval Application prepared by IWP.

3.3 Geological setting

The geological setting has been characterised by others and we have only carried out a preliminary geological characterisation of the site to understand its proximity to geological faults.

3.4 Proximity to Geological Faults

The landfill site is underlain by a range of Archaean granitic and gneissic rocks that form part of the Archaean Yilgarn Craton, an ancient, stable part of the earth crust that is characterised by the absence of more mobile crustal tectonic settings where seismic activity and/or faulting is relatively abundant. The Perth 1:250 000 Geological Sheet (SH 50-14 and part of SH 50-13, first edition 1978) and Total Magnetic Intensity (TMI) data imagery acquired from the Geological Survey indicate that no faults have been identified within 1 km of the site.

3.5 Seismicity

Information regarding the seismicity of the site location is based on the *Atlas of Seismic Hazard Maps of Australia* (Leonard M. et al., 2013). According to the 2013 Atlas hazard map publication, the peak ground acceleration (PGA), equivalent to the spectral period of zero seconds, in proximity of the site location for the 1 in 500-year return period is approximately 0.07g.

Figure 5 presents the earthquake hazard map for Australia for the 1 in 500-year return period.

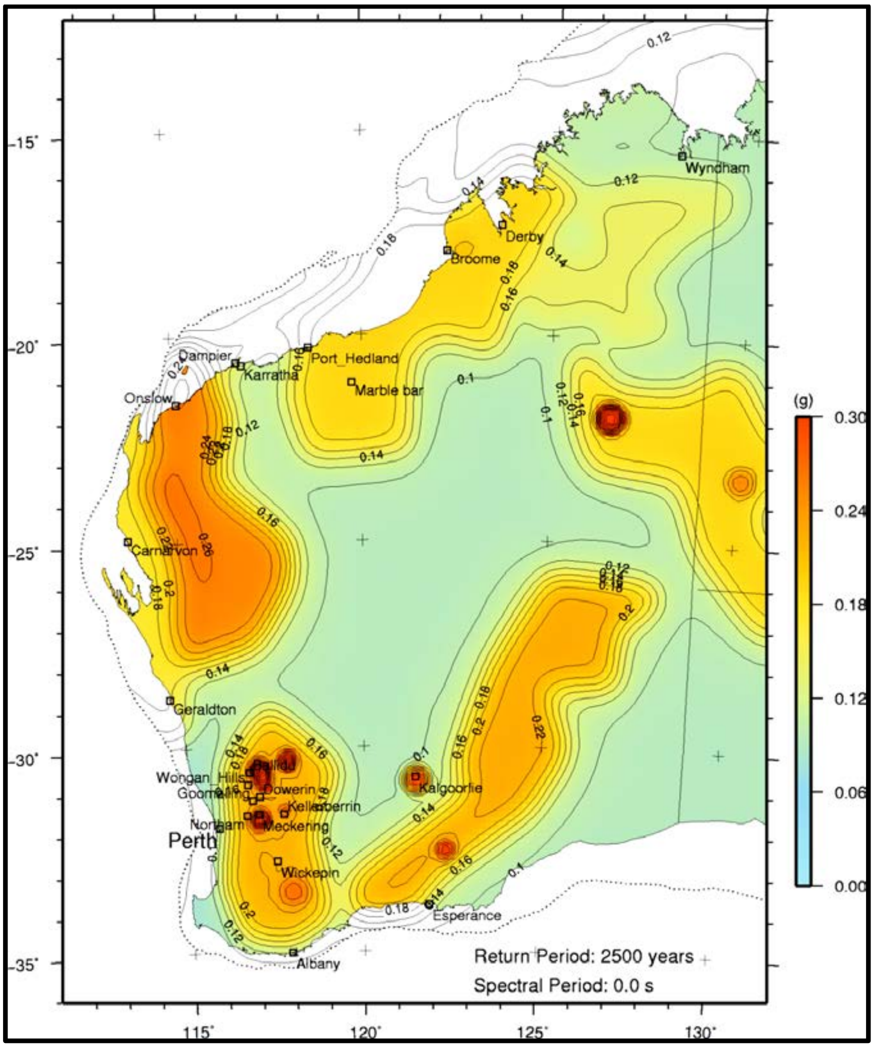


Figure 5: PGA in g units for a 1 in 500-year return period, zero seconds spectral period (Leonard M. et al., 2013).

3.6 Capping system

IWP drawing OV-WA-26 indicates the capping system will comprise the following (top to bottom):

i) Uncompacted vegetative soil 1 m to 2 m thick;

ii) Sand drainage layer 300 mm thick;

iii) Cushion Geotextile;

iv) Double textured LLDPE geomembrane (2.0 mm thick);

v) GCL

The above components are collectively referred to as ‘the cap’ or ‘the capping system’ throughout this report. The cap liner system is illustrated in Figure 6.

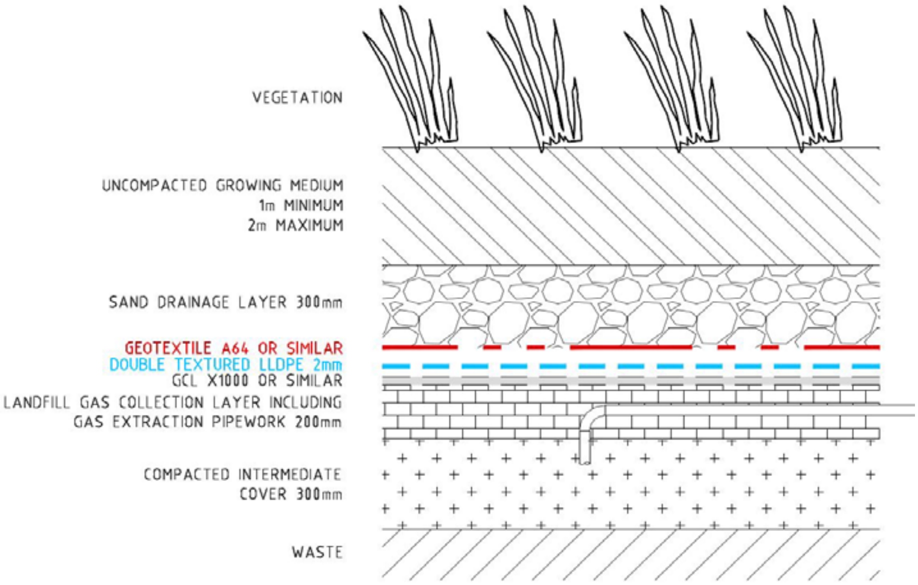


Figure 6: Cap liner system (extracted from IWP Drawing OV-WA-27)

3.7 Basal Liner System

IWP drawing OV-WA-26 indicates the basal system will comprise the following (top to bottom):

i) Separation geotextile;

ii) Drainage aggregate layer 300 mm thick;

iii) Cushion geotextile;

iv) HDPE geomembrane (2.0 mm thick):

  a) Side slopes – Mono-textured, textured side down

  b) Base – Double-textured

v) GCL

It is noted that on the side slopes of the basal system, a higher mass per unit area GCL is proposed. The liner system on the side slopes is otherwise identical to that of the facility floor. The basal liner system is illustrated in Figure 7

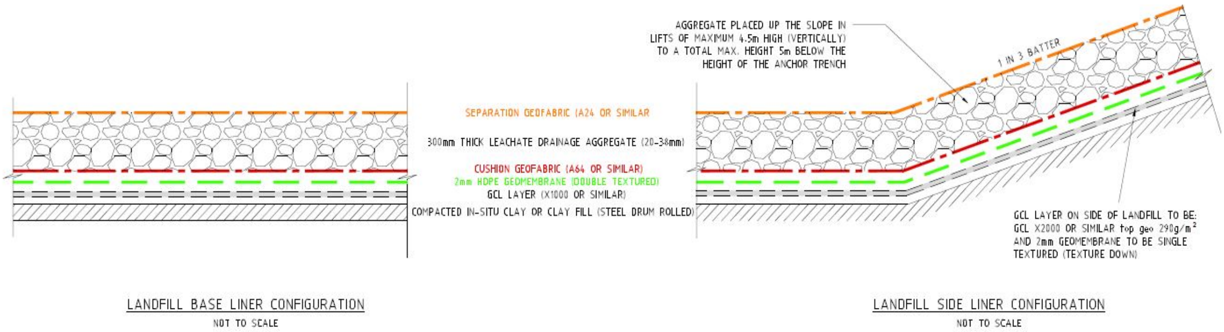


Figure 7: Basal Liner System Configuration Proposed by IWP (Extracted from IWP drawing OV-WA-26)

4.0 SITE VISIT

4.1 Purpose

The proposed landfill site was visited on 25 November 2014 with the purpose of carrying out a visual inspection of the site and the current subgrade conditions. During the site visit a sample was taken from one of the stockpiles in the quarry to obtain basic geotechnical parameters.

4.2 Observations

Based on visual assessment carried out during the site visit the materials appear to be generally competent and of a clayey silty nature. Areas of seepage was noticed in the dewatering pit which is consistent with rapid draw down caused by the dewatering of the quarry over a short period of time (approx. 5 days).

The areas of the pit where water has ponded in the past appeared to be characterised by soft saturated material. Material of soft consistency should be removed to a depth to be identified during the next phase of the design process or during construction prior to the placement of fill material or the liner being installed to avoid the occurrence of differential settlement on the subgrade. Differential settlement on the subgrade could stress the liner beyond its maximum allowable strain value. We recommend removing any saturated soft material from the areas where the liner will be installed and replacing this soft material with compacted fill sourced from an identified stockpile within the quarry. The material should be compacted in layers not greater than 150 mm thickness, after compaction, and tested to verify that the compaction has been achieved in accordance with the construction quality assurance (CQA) plan. We also recommend that a qualified third party CQA inspector be engaged to undertake the inspections during construction. The CQA inspector should assess the extent of the subgrade characterised by saturated soft material and review the CQA testing.

Typical examples of these soft saturated material zones are presented in Figure 8.

Figure 8: Dewatering pit (left) and typical saturated soft material inside the dewatering pit.

Extensive erosion was also noticed at the eastern side of the proposed landfill footprint. During the site visit IWP has advised Golder that the eastern side of the premises were rehabilitated in the past by placing uncontrolled fill to reshape the batter to a flatter slope. The presence of this uncompacted fill has resulted in the formation of deep gullies due to water erosion. Based on a review of the three dimensional model of the proposed landfill, the area characterised by these deep gullies will be cut and replaced with compacted fill. The extent of the uncompacted fill should however be identified during the next phase of the design process or during construction to avoid occurrence of significant settlement. This should be witnessed by a qualified third party CQA inspector. Compacted fill should be used as replacement for the uncontrolled fill. Figure 9 shows the deep gully located at the eastern side of the proposed landfill site.

Figure 9: Deep gully located at the eastern side of the proposed landfill site.

5.0 MATERIAL TESTING

Approximately 15 kg of material obtained from a stockpile on the site was sent to Trilab laboratories in Perth for characterisation and testing. The following tests were carried out:

- 1 × Atterberg Limits.
- 1 × Standard Maximum Dry Density (SMDD).
- 1 × Particle Size Distribution (PSD) by Sedigraph™.
- 3 × Isotropically consolidated undrained single-stage triaxial (CIU) tests at 95% SMDD at optimum moisture content (OMC) and at normal effective stresses of 150 kPa, 300 kPa, and 600 kPa.
- 1 ×Oedometer testing at 95% SMDD at OMC.

Laboratory certificates are provided in Appendix A. Table 4 summarises the results of testing performed on the *in situ* material retrieved from site. The result of the oedometer testing is pending.

Table 4: Summary of Laboratory Test Results on *In Situ* Material Samples (25 November 2014 site visit)

Test	Parameter	Value
Particle Size Distribution	Gravel (> 2.36 mm)	3%
	Sand (2.36 mm to 75 µm)	42%
	Fines (< 75 µm)	55%
	Clay size (< 2 µm)	15%
Atterberg Limits	Liquid Limit	31
	Plastic Limit	21
	Plastic Index	10
	Linear Shrinkage	4
USCS Classification	CL – Low plasticity clay/ML – Low plasticity silt	
Standard Compaction Test	Maximum Dry Density	1.74 t/m^3
	Optimum Moisture Content	14.5%
Particle Density	Particle Density	2.68 t/m^3
Triaxial shear	Drained friction angle	30
	Undrained shear strength ratio su/σ_v	0.58 (average of three tests)

The physical characterisation of the material, performed by Trilab, indicates that the material comprises a low-plasticity clay/silt material. Based on Figure 10, the material exhibits a drained friction angle of 30° and an undrained shear strength ratio that varies from 0.7 to 0.47, corresponding to initial vertical effective pressures of approximately 150 kPa and 600 kPa, respectively.

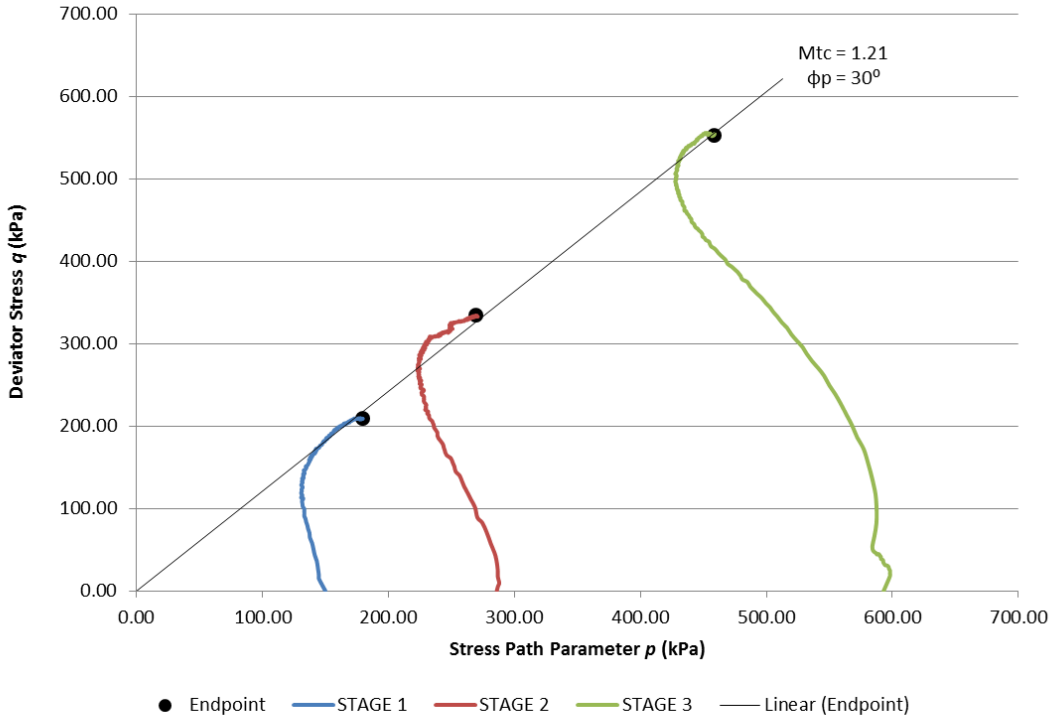


Figure 10: Cambridge p-q plot of the triaxial test results (Mtc = line gradient, φp = calculated peak friction angle)

As part of the works approval process, IWP undertook laboratory testing on six fill material samples sourced from stockpiles within the site. The testing was undertaken by SGS. The material appears to be generally consistent with the results of the laboratory testing undertaken on the sample of fill sourced during the 25 November 2014 site visit undertaken by Golder. The Atterberg limits and the results of the standard compaction test appear to be generally consistent with the Golder test results. A summary of the test results is presented in Table 5. Dispersivity (Emerson Crumb) and permeability testing were also undertaken by SGS. The results suggest that the material is not dispersive and has a permeability of approximately 1×10^{-8} m/s.

Table 5: Summary of Laboratory Test Results on *In Situ* Material Samples (SGS testing)

Test		Sample ID					
		Opal 1	**Opal 2**	**Opal 3**	**Opal 4**	**Opal 5**	**Opal 6**
Dispersivity	Emerson Crumb	6	6	6	6	6	6
Atterberg Limits	Liquid Limit	38	35	36	39	35	39
	Plastic Limit	24	22	23	24	24	23
	Plastic Index	14	13	13	15	11	16
	Linear Shrinkage	4	5.5	5	2.5	2.5	4.5
Standard Compaction Test	SMDD (t/m^3)	1.75	1.63	1.81	1.67	1.76	1.67
	OMC (%)	16	20	14.5	18.5	15	18.5
Permeability Test	Falling Head Permeability testing @ SMDD and OMC (m/s)	7.20×10^{-9}	3.90×10^{-9}	5.80×10^{-9}	6.80×10^{-8}	2.20×10^{-8}	9.10×10^{-9}

Figure 11 shows the plasticity chart for the testing undertaken by Golder and SGS. The chart shows that the fines in the material are geotechnically classified as low plasticity clay to intermediate plasticity clay, borderline with low plasticity silt material. This is consistent with the amount of fines of clay size that appears to be present in the sample (generally less than the silt size fraction) and the permeability of the material generally higher than 1×10^{-9} m/s (typical of material of higher plasticity).

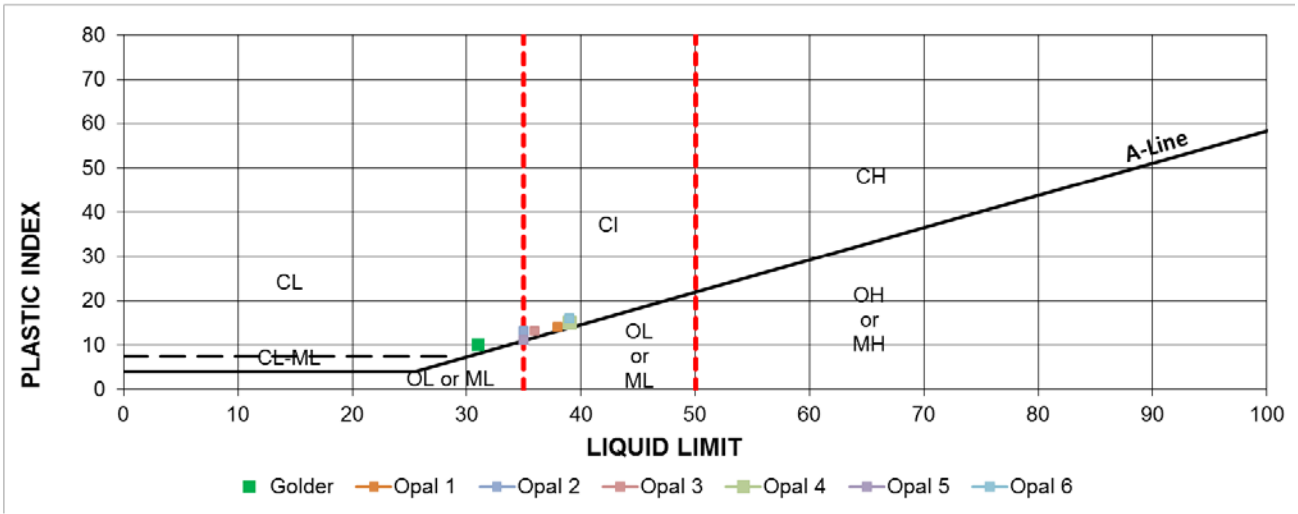


Figure 11: Plasticity chart comparison between Golder and SGS testing.

The results of the testing undertaken by Trilab and SGS are presented in Appendix A and Appendix B, respectively.

6.0 LIQUEFACTION ASSESSMENT

The results obtained from the laboratory testing undertaken by Golder and SGS have been used to assess the susceptibility of the material to liquefaction. The methods used are the Seed et al. (2003) and Bray & Sancio (2006) index property screening methods. These provide an indication as to the range of index properties indicative of soils that may be *capable* of undergoing liquefaction. For example, plastic clays are generally not susceptible to liquefaction.

The available data is plotted in the Seed et al. (2003) modified plasticity chart in Figure 12 and in the form suggested by Bray & Sancio (2006) in Figure 13.

The index property assessment indicates the following:

- Seismically-induced strength loss cannot be ruled out for this material on the basis of index properties (refer to Figure 12)
- The material will likely not liquefy if compacted to SMDD (refer to Figure 13). However, based on the PI range, if the density is such that the water content/liquid limit ratio is above 0.85, the material will likely be liquefiable. This corresponds to a dry density of lower than approximately 80% to 90% of its SMDD value.

The assessment highlights the importance of removing all soft saturated materials within the landfill footprint. This material, under an earthquake event may cyclically loose strength and cause foundation failure or settlement. The additional settlement could overstress the liner to exceed the allowable tensile strain value.

To investigate the depth of soft saturated material within the pit base, piezocone penetration testing (PCPT) could be undertaken during the detail design stage. This will assist in identifying zones of soft material prior to construction.

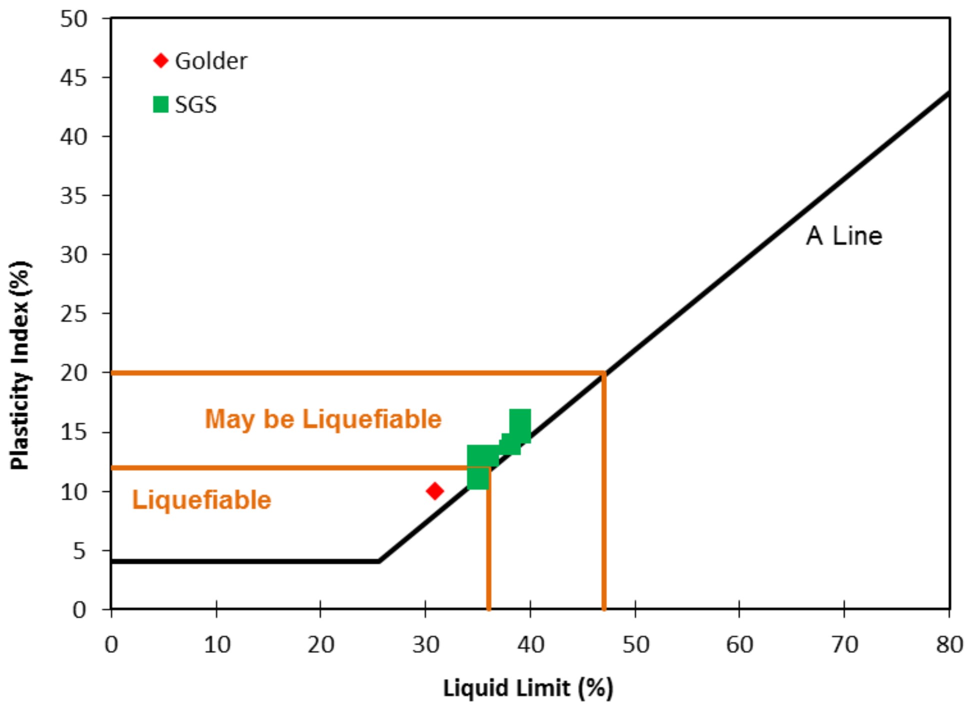


Figure 12: Modified Plasticity Chart (Seed et al., 2003) with Golder and SGS samples plotted

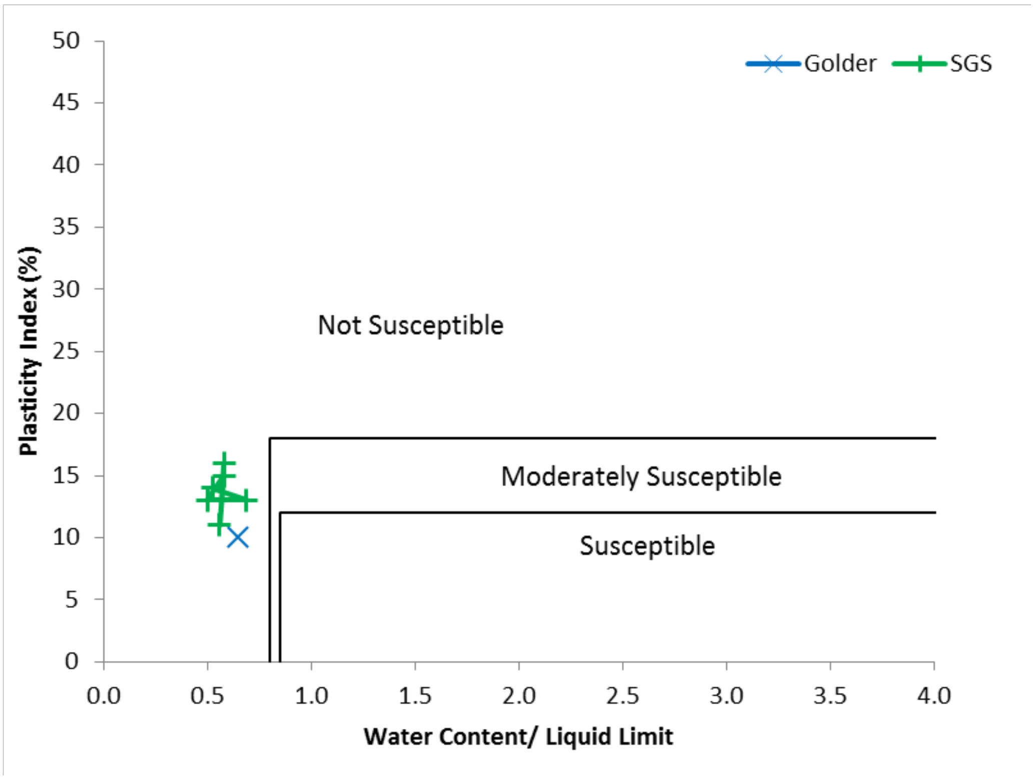


Figure 13: Bray & Sancio (2006) Chart, with Golder and SGS samples plotted (water content based on SMDD values)

7.0 SUBGRADE SETTLEMENT ASSESSMENT

7.1 Purpose

The purpose of the subgrade settlement assessment is to estimate the maximum differential settlement on the compacted fill induced by the waste once the landfill reaches its maximum height. This is then used to assess the maximum tensile strains on the liner system to assess whether this is within the acceptable limit. This assessment does not address the settlement induced on soft saturated material under static or dynamic (seismic) loading.

7.2 Allowable strains

The maximum allowable global design strain for geomembrane is discussed by Ian Peggs in 2003 in the paper '*Geomembrane liner durability: Contributing factors and the status quo*'. This paper is referenced in the BPEM (2014) guidelines as a minimum value to use for assessing the global strains stability of a geomembrane. The values reported in Table 6 are applicable to the analyses undertaken in this report.

The allowable strain for the GCL and protection geotextile is not usually reported as it does not represent the barrier for the release of leachate generated by the waste. We have therefore adopted our professional judgement and knowledge of this type of material to assess its state of serviceability under the strains estimated in the settlement assessment presented in this section and numerical model for the liner strains induced by the waste during deposition presented in Section 9.0.

Table 6: Maximum allowable strain for various geomembrane materials (BPEM, 2014; after Peggs, 2003)

Geomembrane type	Maximum allowable strain (%)
HDPE smooth	6
HDPE randomly textured	4
HDPE structured profile	6
LLDPE density <0.935 g/cm^3	12
LLDPE density >0.935 g/cm^3	10
LLDPE randomly textured	8
LLDPE structured profile	10

7.3 Soil modulus for settlement assessment

Assessments of the settlement of the compacted fill subgrade under the loading imposed by the waste when it reaches its final height (approximately 35 m) has been undertaken. Typically, this type of assessment are undertaken using the constrained modulus of the soil estimated from a consolidation testing (e.g. oedometer testing). An oedometer test is currently underway but the results are pending. Therefore, the assessment has been undertaken estimating the constrained modulus of the soil from the undrained young's modulus. The estimated settlement will be confirmed in the future once the result of the oedometer testing is available. The undrained young's modulus was estimated from the CIU test performed on a sample of fill material (refer Section 5.0). Based on the CIU test results, the confining modulus ranged from approximately 8 MPa to 13 MPa.

7.4 Settlement estimation and liner strain assessment

As the maximum depth of waste is 35 m, the maximum pressure inferred by the waste to the sub-grade will be approximately 350 kPa, if the bulk density of the waste is assumed to be 10 kN/m^3.

The maximum fill depth is located approximately at the middle of the landfill. At this location, approximately 6.5 m of compacted fill will be placed to shape the floor of the landfill to its final elevation. Figure 14 presents the estimated settlement when the landfill reaches 35 m in depth based on the confining modulus estimated for the material.

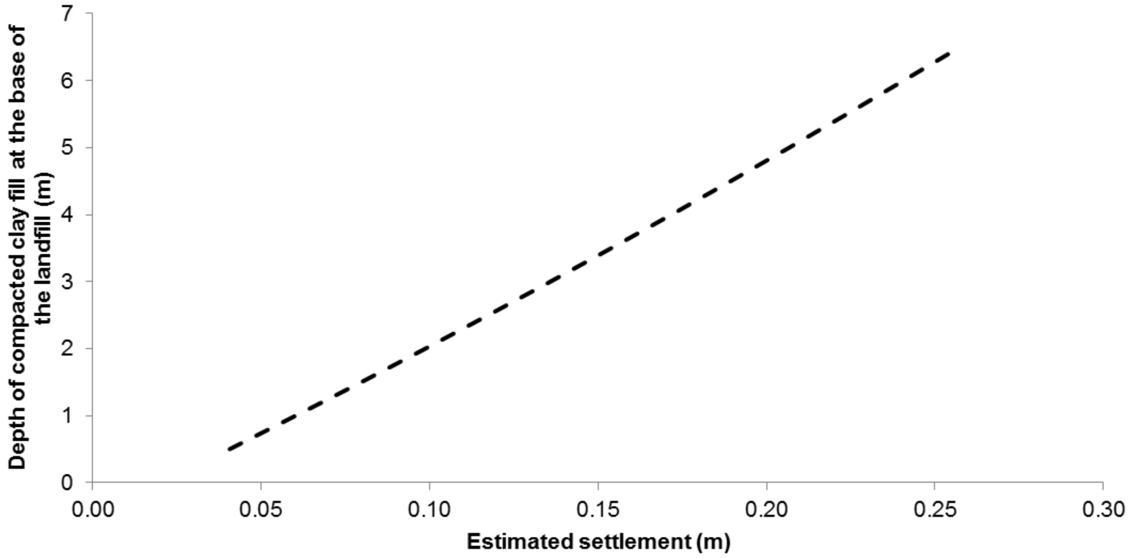
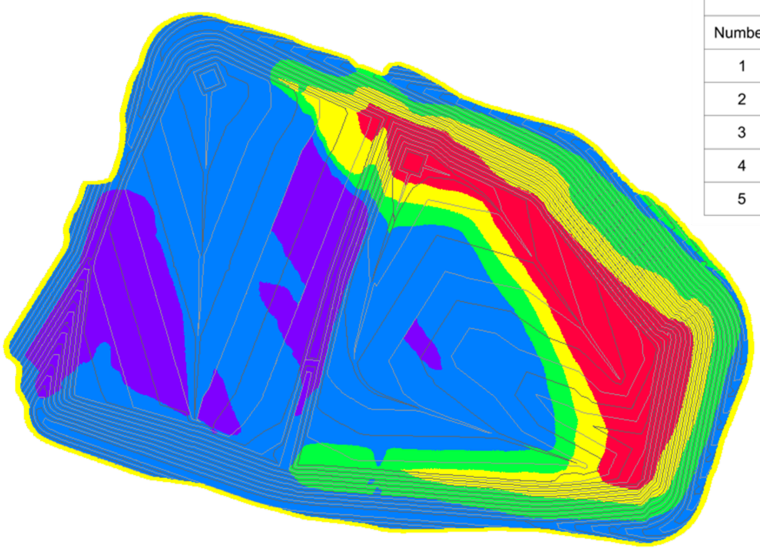


Figure 14: Estimated compacted fill material settlement against its depth.

A cut and fill three-dimensional model has been created to assess the differential settlement and the possible tensile strain on the liner system. Figure 15 presents the layout view of the cut and fill proposed to be undertaken to shape the landfill to the design elevations. Based on the proposed cut and fill plan, the maximum cut depth will be approximately 12 m, while a maximum of approximately 10 m of fill will be placed within the landfill footprint.



CUT and FILL CONTOURS			
Number	Minimum Elevation	Maximum Elevation	Color
1	-12.10	-6.00	red
2	-6.00	-3.00	yellow
3	-3.00	0.00	green
4	0.00	4.50	blue
5	4.50	9.71	purple

Figure 15: Layout view of estimated settlement contours.

Based on the estimated settlement presented in the Figure 14 above and the cut and fill plan shown on Figure 15, an assessment of the differential settlement and liner tensile strains has been undertaken at different locations within the areas of the landfill floor where the waste will reach its maximum height (coinciding in the highest pressure on sub-grade). The maximum differential settlement has been identified at the location of the existing dewatering pit. The estimation accounts for the removal of a maximum of 3.0 m of saturated soft material. Based on the assessment, the maximum differential settlement has been estimated to be approximately 0.2 m along a length of approximately 40 m. This could generate a tensile strain on the liner of approximately 0.5%. Therefore, under the conditions assessed, the estimated liner tensile strain is deemed acceptable for the proposed liner system. However, the removal of saturated soft material to deeper extent could generate additional strains. This should be verified in the future and the liner tensile strain assessment reassessed.

8.0 STABILITY ASSESSMENT

8.1 Overview

The study approach was divided into two main portions:

1) Geotechnical stability of the pit shell and overall landform (including basal liner system) at various stages of development

2) Veneer stability of basal drainage layer and cap liner system

Stability of the landfill relies, to a large extent, on the liner interface shear strength. IWP has advised Golder that no project-specific liner interface shear testing has been undertaken to support the proposed design. Golder recommends that this testing be undertaken prior to construction to verify the assumptions made in this assessment.

Veneer stability refers to the tendency of soil materials placed as part of a thin layer to slide along a liner interface. The aim of the basal veneer stability assessment was to identify the maximum height to which drainage aggregate could be placed up the pit slope. The aim of the cap veneer assessment was to identify the interface shear strength parameters required to achieve the minimum acceptable factor of safety (FoS).

8.2 Pit Wall Stability Assessment

8.2.1 Overview

The approach taken was to first assess the stability of the re-profiled pit slopes simulating the short-term condition prior to installation of geosynthetic materials and placement of waste. Following this, the critical sections of the landform were identified and the stability assessed of each section once the liner system has been installed and waste has been placed. The assessment was carried out under static and earthquake conditions using the limit equilibrium software package *Slide* (v6.0 distributed by Rocscience Inc.).

8.2.2 Design Seismic Events

Design seismic events for the project were selected using the *Atlas of Seismic Hazard Maps of Australia*.

Figure 16 presents the ground accelerations for the Toodyay area for a range of earthquake return periods.

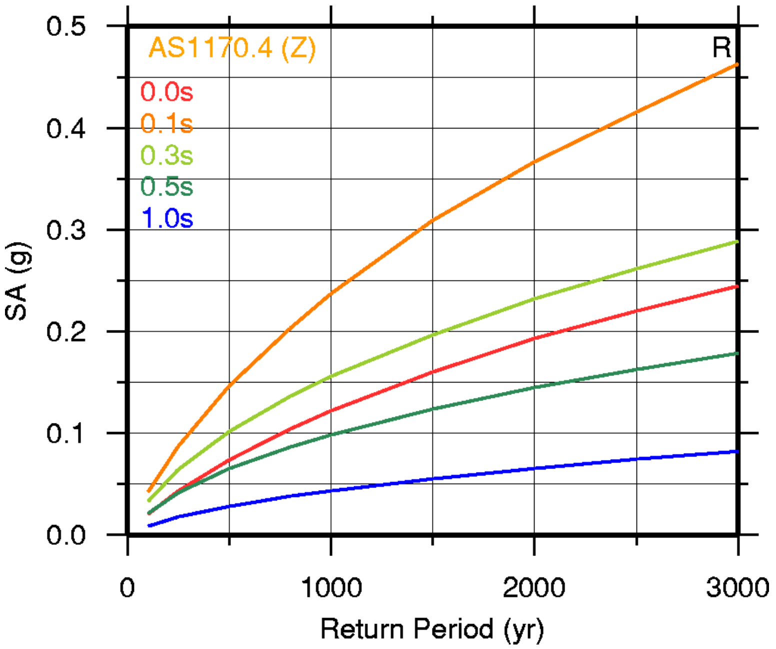


Figure 16: Ground Acceleration vs. Earthquake Return Period for Various Spectral Periods (Geoscience Australia, 2013)

The peak ground acceleration, equivalent to the spectral period of zero seconds, adopted for the analyses are as follows:

- Operating Basis Earthquake (OBE): 500 year return period, Peak Ground Acceleration (PGA) 0.07g
- Maximum Design Earthquake (MDE): 2500 year return period, PGA 0.22g

The OBE event was applied to the landform during operational stages, and the MDE was applied to the final landform.

8.2.3 *In Situ* Material Strength

8.2.3.1 Background

The proposed landfill is to be constructed within the pit void formed by a former quarry. The existing walls of the pit shell are described as a weathered schist mass (SAT, 2013). Site visits undertaken by Golder personnel showed the existing walls as inclined at approximately 70° to horizontal, with the exposed pit walls exhibiting significant foliation, weathering and signs of slumping.

In the first instance the existing walls will be re-shaped to 1V:3H to facilitate construction of the landfill. It is noted that no detailed information has been provided to Golder regarding the properties of the discontinuity sets observed in the walls. However, it is clear that the stability of the pit slopes will benefit from this re-shaping

8.2.3.2 Approach

The approach taken was to estimate the Geological Strength Index (GSI) of the weathered schist based on the qualitative assessment of weathering and foliation described in SAT (2013). The equivalent Mohr-Coulomb friction angle of the *in situ* material was then estimated based on GSI and used in a limit equilibrium model of the reshaped 1V:3H slope.

8.2.3.3 Material strength characterisation

Using the charts provided in Hoek et al. (1998) the structure of the pit walls was classified as "*Blocky/disturbed – folded and/or faulted with angular blocks formed by many intersecting discontinuity sets*" and the surface quality classified as "*Poor – Slickensided or highly weathered surfaces or compact coatings with fillings of angular fragments*". Based on these two classifications the GSI was estimated to be between 25 and 35.

Published values of the material constant m_i, presented in Hoek et al. (1998), propose values for schist of 12±3, i.e. 9 to 15. This range is superimposed onto the range of estimated GSI values on Figure 17.

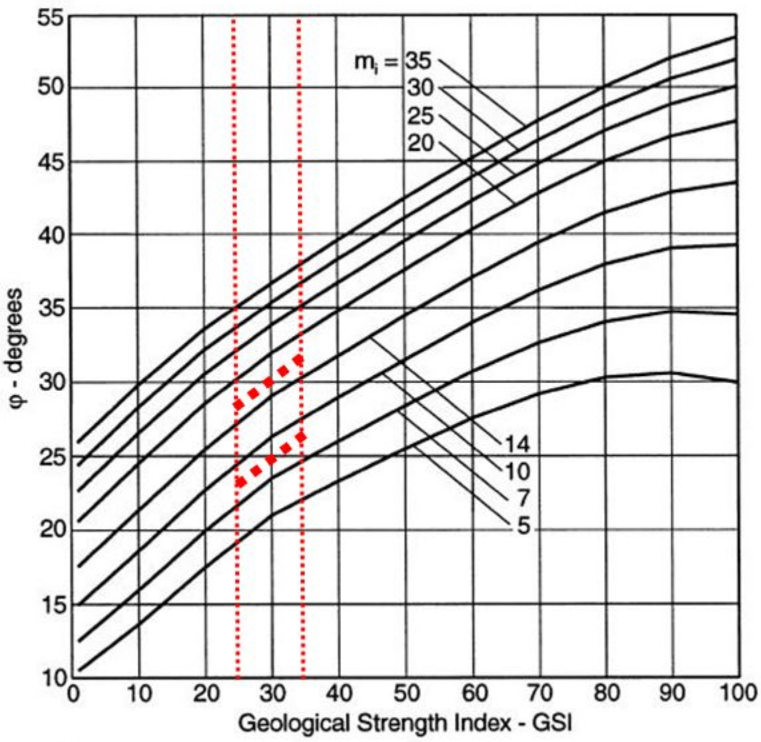


Figure 17: Friction Angle vs. GSI for Ranges of Material Constant mi (after Hoek et al., 1998)

Figure 17 indicates that a friction angle in the range of approximately 24° to 31° is appropriate for the weathered schist. A friction angle of 24° and a cohesion of 0 kPa has been adopted for the weathered schist.

8.2.3.4 Stability of re-profiled pit slope

A limit equilibrium model was prepared for the pit slope with the following inputs:

- Slope: 1V:3H to maximum height 15 m above pit floor;
- Weathered schist: friction angle = 24°, cohesion = 0 kPa;
- Seismic analysis: Peak Ground Acceleration = 0.07g (500 year return period)

Target FoS values have been adopted cognisant of the temporary nature of the exposed pit slopes (i.e. prior to placement of geosynthetic materials and prior to being buttressed by waste). The results of the pit slope stability analyses are summarised in Table 7.

Table 7: Results of Stability Analyses for Re-profiled Pit Slope

Condition	Factor of Safety (FoS)	Target FoS
Static	1.4	1.3
Seismic (OBE)	1.1	1.1

The critical failure surfaces from the assessment (corresponding to the reported FoS values above) represent shallow block sliding mechanisms. The FoS was found to be satisfactory for both static and seismic cases considered.

8.3 Stability of Waste Landform

8.3.1 Model Sections and Scenarios

The key consideration for this aspect of the stability analysis is the deposition planning of waste into each cell. The critical scenario occurs when the active waste slope is not buttressed – either by a competent bund (i.e. the ‘major bund’ labelled on the design drawings) or by waste in an adjacent cell. The following sections have been modelled:

- Section A: NE-SW through Cells 1 and 3
- Section B: NW-SE though Cells 6, 3 and 4
- Section C: NW-SE through Cells 5, 1, and 2

Four scenarios were considered as part of the stability assessment, representing different conditions throughout the life of the landform. A minimum acceptable factor of safety was adopted for each scenario. The following critical scenarios have been modelled and compared to their respective minimum factors of safety:

Table 8: Scenarios and Target Factors of Safety

	Scenario	Minimum Acceptable FoS	Applicable Sections
1	Operational landform, Static	1.3	A
			B
			C
2	Operational landform, Static, Elevated Phreatic Surface	1.3	A
			B
			C
3	Operational landform, Earthquake (OBE)	1.1	A
			B
			C
4	Final Landform, Earthquake (MDE)	1.0	A
			B

Long term static analysis of the final landform and waste was assessed qualitatively and found not to be critical to the stability of the landfill. The sections used in the stability modelling are shown superimposed onto the corresponding waste landform in Figure 18 to Figure 21.

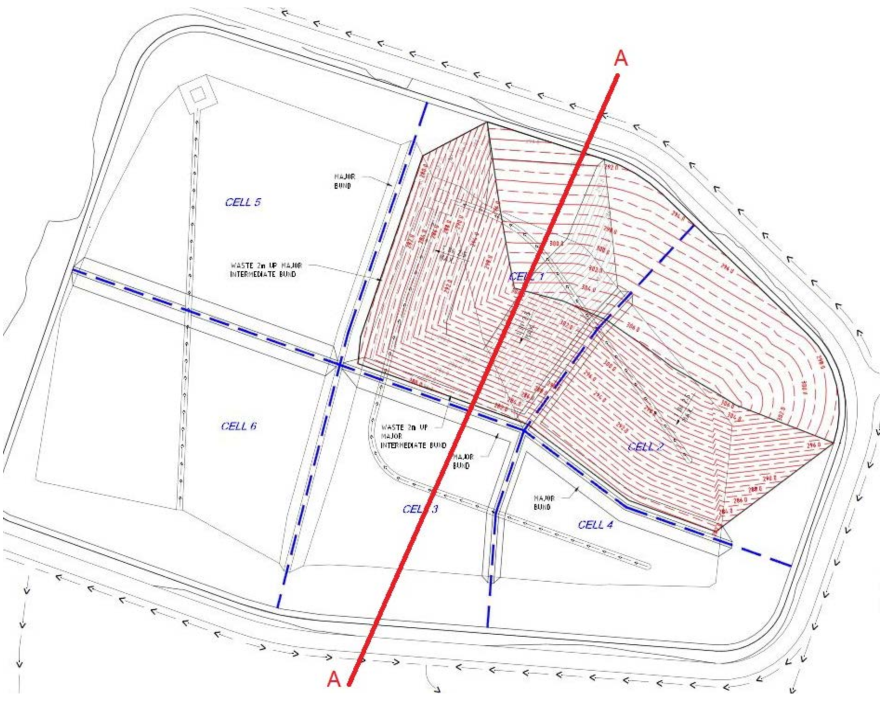


Figure 18: Section A – Operational landform (Scenarios 1-3)

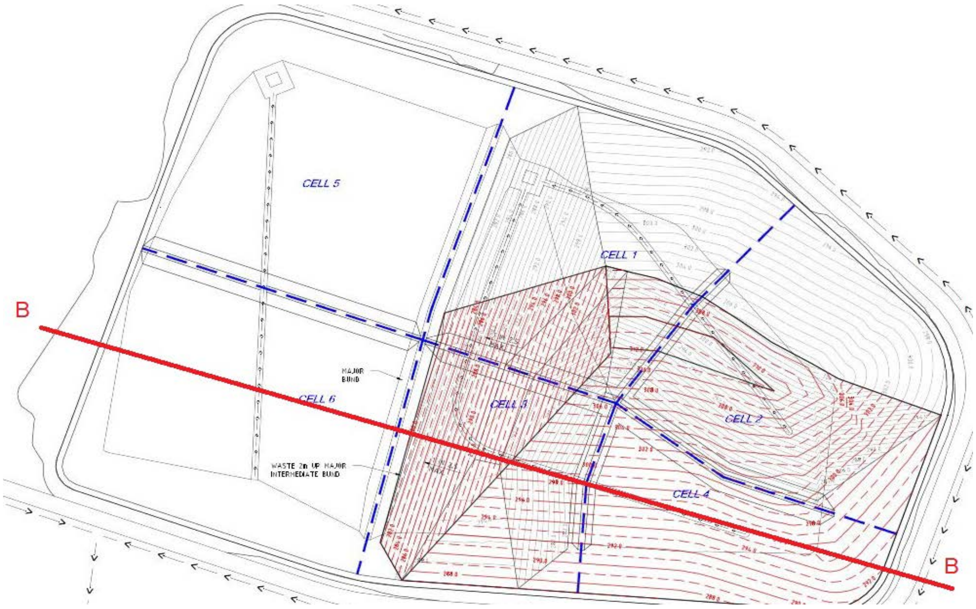


Figure 19: Section B – Operational landform (Scenarios 1-3)

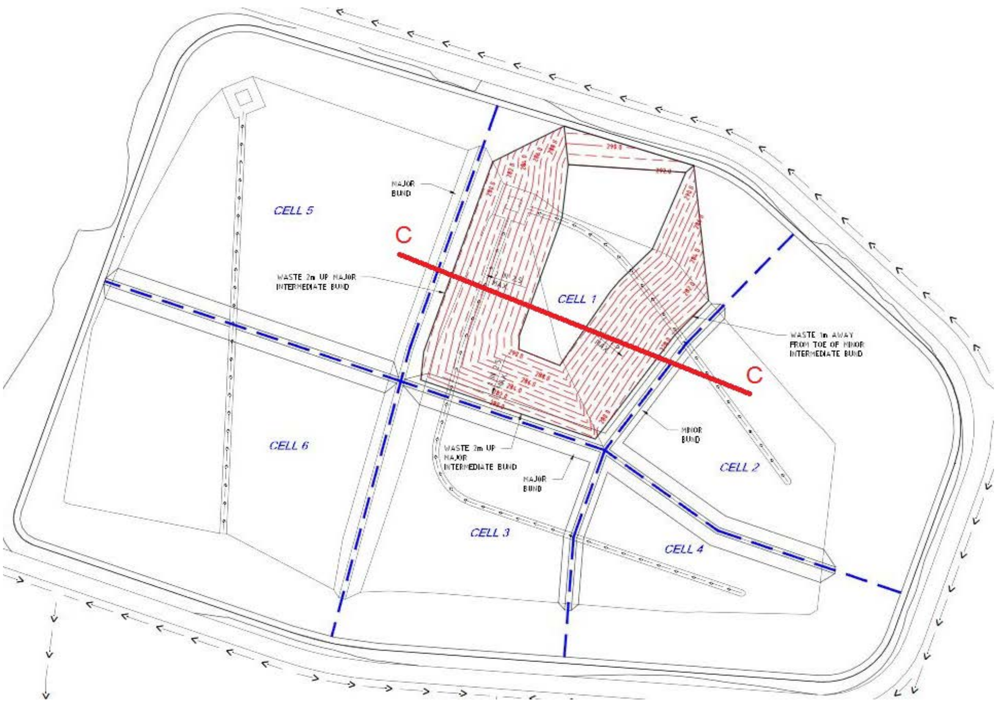


Figure 20: Section C – Operational landform (Scenarios 1-3)

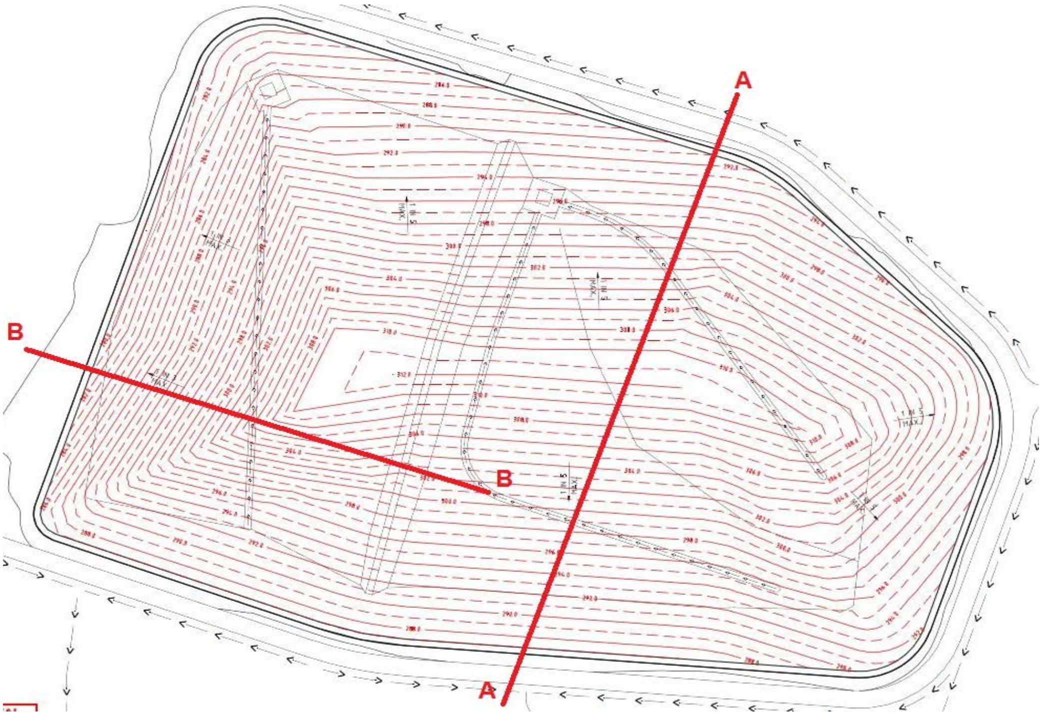


Figure 21: Sections A and B – Final Landform (Scenario 4)

8.3.1.1 Material Parameters

The material parameters used in the stability assessment are summarised in Table 9.

Table 9: Summary of Material Parameters for Geotechnical Stability Assessment

Parameter	Material			
	Waste[1]	**Engineered Fill[2]**	**Liner System[3]**	**Weathered Schist[4]**
Unit Weight (kN/m^3)	10	20	10	20
Cohesion (kPa)	5	0	0	0
Friction Angle (deg)	25	30	15 (base) 10 (side slopes)	24

Notes: [1]Waste parameters taken from published values (Dixon, 2005)

[2]Engineered Fill parameters interpreted based on results of laboratory testing (see Section 5.0)

[3]Assumed minimum values adopted based on previous experience with similar materials

[4]Adopted values consistent with Section 8.2.3.3

8.3.1.2 Phreatic Surface in Waste

For the stability assessment of the operational landform, two phreatic surface (water level in waste) scenarios were simulated:

- No phreatic surface
- Elevated phreatic surface up to crest of division bund (i.e. 3 m above floor level at toe of division bund, representing temporary inundation due to stormwater inflows)

For the assessment of the final landform, a separate phreatic surface was applied to each cell simulating a head of approximately 0.3 m above the liner at the internal toe of the embankments (increasing toward the centre of the cell), representing a hypothetical 'steady-state' condition.

8.3.2 Results

Table 10 presents the results of the stability analysis. FoS values have been rounded up to one decimal place.

Table 10: Results of Stability Modelling

Scenario		Section	FoS*	Waste Slope (max)	Outcome
1	Operational, Static	A	1.3	1 V : 2.5 H	Satisfactory
		B	1.3	1 V : 2.5 H	Satisfactory
		C	1.3	1 V : 3.0 H	Satisfactory
2	Operational, Static, Elevated Phreatic Surface	A	1.3	1 V : 2.5 H	Satisfactory
		B	1.3	1 V : 2.5 H	Satisfactory
		C	1.3**	1 V : 3.0 H	Satisfactory
3	Operational, Earthquake (OBE)	A	1.1	1 V : 2.5 H	Satisfactory
		B	1.1	1 V : 2.5 H	Satisfactory
		C	1.1	1 V : 3.0 H	Satisfactory
4	Final Landform, Earthquake (MDE)	A	1.6	1 V : 5.0 H	Satisfactory
		B	1.5	1 V : 3.0 H	Satisfactory

Notes: *The interim or final waste slopes and liner parameters were adjusted by IWP during the analysis period to achieve the minimum FoS values required, based on discussion between Golder and IWP

**Small failure surfaces with FoS≈1.0 were found corresponding to hydraulic instability at the submerged waste toe. These failure surfaces are not relevant to overall stability of the landform and were therefore discarded from the results.

Table 10 shows that the stability of each scenario and model section is satisfactory. It is noted that the final landform (refer to Figure 21) results in a higher FoS under seismic conditions than the operational landform due to the flatter slopes.

Figures with the outcomes of the stability analysis are presented in Appendix C.

8.4 Veneer Stability Assessment – Final Cap Liner System

8.4.1 Approach

The veneer stability of the final cap liner system was analysed using the methods proposed by Koerner and Soong (1998). Based on professional judgement and experience with similar projects it is Golder's view that the critical shear interface from a veneer stability perspective will be the geotextile vs. LLDPE. This interface is likely to exhibit the lowest friction angle (φ) and adhesion (*c*) when tested in direct shear.

Whilst the abovementioned methods (which are based on sliding-block mechanics) are applicable to cover soil vs. geomembrane interfaces, the presence of the separation geotextile (red dashed line in Figure 6) was accounted for by adopting a zero adhesion value for that interface.

8.4.2 Assumptions

For the intents and purposes of the veneer stability assessment the following assumptions have been made:

- Stability of the temporary 1V:3H western slope was not considered, as it will not be capped as part of the current works
- No pore pressures develop at the shear interface
- No slippage occurs at the sand drainage layer relative to the geotextile

- The landfill gas collection layer will remain functional and thus no pressures will act on the liner system from below due to the accumulation of landfill gas
- A minimum acceptable FoS of 1.5 has been adopted for this assessment.

8.4.3 Input parameters

The input parameters used in the veneer stability assessment are summarised in Table 11.

Table 11: Summary of input parameters for veneer stability assessment

Design Aspect	Parameter	Value
Cover soil	Unit weight	15 kN/m^3
	Thickness	Both 1 m and 2 m
	Internal friction angle	25°
	Internal cohesion	1 kPa
Interface	Adhesion	0 kPa
	Friction angle*	Variable (5 to 25 deg)
Slope Geometry	Slope gradient	1V:5H
	Slope height	25 m (assuming continuous slope) 12.5 m (assuming intermediate anchoring)

Notes: *Friction angle is treated as the independent variable in this assessment for the purposes of identifying the minimum acceptable values.

8.4.4 Results

A graph of the liner interface friction angle vs FoS for the range of scenarios in Table 11 is presented in Figure 22. The graph shows the minimum friction angles required at the geotextile-LLDPE interface to obtain the minimum acceptable FoS against veneer instability.

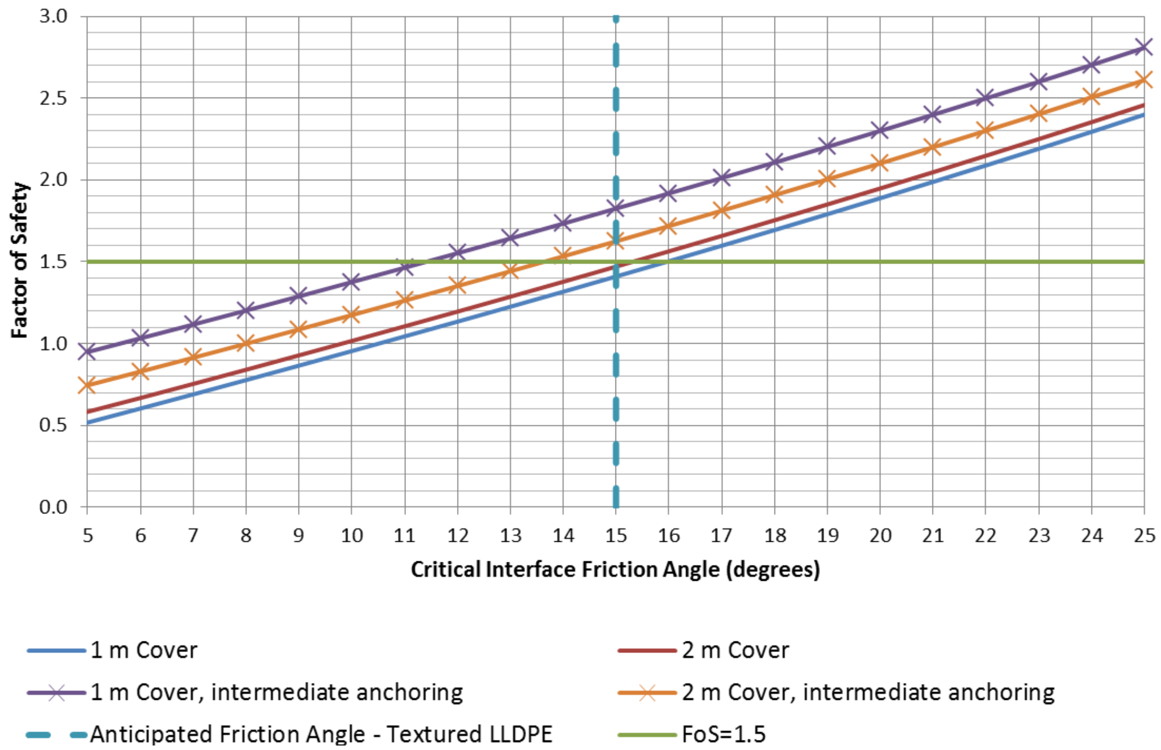


Figure 22: Comparison of interface friction requirements for different cover soil thicknesses and anchoring

Figure 22 shows that for the slopes assuming no intermediate panel anchoring, the critical interface friction angle required to achieve FoS = 1.5 is ≈16° for a 1 m cover and ≈15° for a 2 m cover, without intermediate anchoring. Whilst these friction angles may be achievable for these materials, they are near the upper-bound based on our experience. If geosynthetic panels are installed with intermediate anchoring at 12.5 m height intervals (i.e. at approximately half maximum height above pit crest) the required friction angles are significantly reduced, to 12° and 14° for cover thicknesses of 1 m and 2 m, respectively.

Once the final landform has been completed, a detailed design should be carried out based on the landfill geometry and geosynthetic materials available at that time. Should intermediate anchoring be incorporated, and based on current knowledge of materials, we would consider the veneer stability acceptable.

8.5 Veneer Stability Assessment – Leachate Drainage Aggregate

8.5.1 Purpose

The design provided to Golder includes a 300 mm thick layer of leachate drainage aggregate placed above the cushion geotextile (see drawing OV-WA-26). The layer is placed up the inside slope of the lined pit shell throughout the facility. Golder has assessed the stability of the drainage layer and liner system to identify and reduce the risk of veneer failure during construction.

8.5.2 Approach

The approach taken was to perform a limit equilibrium analysis using *Slide* as per Section 8.2, using a pit shell slope of 1V:3H, consistent with the design. The components of the stability model are as follows:

- Leachate drainage aggregate
- Liner interface on side slopes (smooth HDPE facing up, interface friction angle 10°)
- Liner interface on base (double-textured HDPE, interface friction angle 15°)
- Pit shell (weathered schist)

The key design parameter is the maximum height that the aggregate may be placed up the slope before the minimum acceptable FoS is reached. The height of aggregate was therefore iterated until the acceptable FoS was met. For this assessment a minimum acceptable FoS of 1.2 was adopted, cognisant of the temporary nature of the exposed aggregate against the pit shell slope.

8.5.3 Aggregate Material Properties

The material properties used for the aggregate were as follows:

- Unit weight: 18 kN/m^3
- Friction angle: 35°
- Apparent cohesion: 15 kPa

The material properties used for the liner system and pit shell were identical to those outlined in Section 8.3.1.1 for the geotechnical assessment.

The adopted friction angle was estimated using the simplified methods proposed by Dhawan and the correction methods by Brinch-Hansen. The value of 35° reflects the assumptions of angular aggregate particles, poor gradation, and a relative density corresponding to loose placement (end-tipped).

8.5.4 Outcome – Maximum Drainage Aggregate Height

The results of the stability model of the leachate drainage aggregate indicate that a FoS of 1.2 can be achieved for aggregate heights up to 4.5 m from the base of the pit.

8.6 Discussion

To support the stability assessment the following is recommended:

Waste landform

- Material-specific direct shear testing in accordance with ASTM D5321[1] should be undertaken on each interface in the proposed liner system to support detailed design. This testing should identify the interface friction angle (φ) and cohesion (*c*) for comparison with the suggested minimum values. The results of the testing should be interpreted by a qualified and experienced engineer, and the stability assessment revised with the laboratory-derived parameters.
- The following interfaces should be tested:
  - Drainage layer vs protection geotextile
  - Protection geotextile vs smooth side HDPE
  - Protection geotextile vs textured side HDPE
  - GCL vs Textured HDPE
  - GCL vs compacted fill.
- The abovementioned laboratory testing should be performed at normal loads relevant to the application (i.e. representing overburden stresses up to maximum waste height).

Veneer stability

- The stability of the final landform, under current conservative design assumptions, is marginally stable. We therefore strongly recommend that additional analysis be carried out during detail design that incorporates actual site geometry and test results based on materials identified for construction.
- Material-specific direct shear testing in accordance with ASTM D5321[2] should be undertaken on each interface in the proposed liner system to support detailed design. This testing should identify the interface friction angle (φ) and adhesion (*a*) for comparison with the suggested minimum values. The results of the testing should be interpreted by a qualified and experienced engineer, and the stability assessment revised with the laboratory-derived parameters.
- The abovementioned laboratory testing should be performed at normal loads relevant to the application (i.e. representing overburden stresses of up to 50 kPa), or as close as possible given the practical difficulties of testing at these low stresses. Given the difficulty of achieving these conditions in direct shear, specialist guidance should be sought prior to testing.
- The slope lengths of the final landform (up to approximately 127 m) may exceed the length of geosynthetic panels. Should the as-constructed landform have steeper slopes than assumed in the veneer stability analysis, consideration should be given to anchoring at an intermediate location on the cap slopes. This will also improve veneer stability.
- Adopting a 2 m capping soil thickness (in preference to 1 m) will tend to improve veneer stability, all else being equal.
- Consideration should be given to positioning the interface of lowest shear strength above the containment liners (LLDPE and GCL). Therefore the designer should select materials such that the friction angle between the LLDPE-GCL is greater than that between the LLDPE-geotextile.

1 Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic- Geosynthetic Interfaces by Direct Shear

2 Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic- Geosynthetic Interfaces by Direct Shear

9.0 LINER INTEGRITY ASSESSMENT

9.1 Introduction

The assessment of stresses in the lining system is one of the key design aspects that govern the selection of appropriate geosynthetic materials. Stresses on the liner are generally assessed pre-waste placement and during operation (up to final waste level deposition). Prior to waste placement, the only stresses acting on the lining system components are self-weight of the lining system components. During operation, the stresses on the liner are due to the placement of waste, resulting in mobilising forces on the liner and drag forces induced by the settlement and degradation of the waste.

Stresses developed during the placement of the waste have to be managed by designing a lining system capable of resisting the development of tensile stresses beyond the capacity of the liner to accept. This can be achieved by selecting the geosynthetic materials with interface shear strengths that minimise the stresses on the liner and maximise the transference of the stresses from the waste mass to the sub-base.

This section of the report investigates the serviceability of the liner system prior to placement of waste, and during operations.

9.2 Pre-waste placement

To assess the integrity of the side slope liner system pre-waste placement, the self-weight of each liner component is compared with the tensile strength of the material to establish whether any layer of geosynthetic is over-stressed. The slope identified to undertake the assessment is located at the north-eastern corner of the facility, where Cell 2 is proposed (refer to Figure 23). This represents the longest slope in the proposed landfill design.

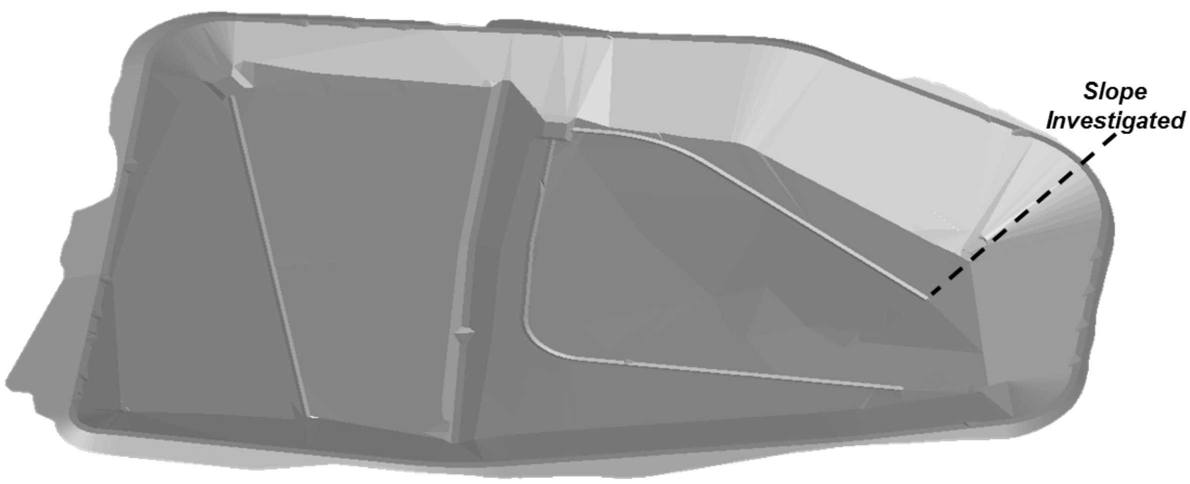


Figure 23: Three dimensional view of landfill showing the slope investigated pre-waste placement

Table 12 presents the assumption and outcomes of the assessment. The results of the assessment indicate that the integrity of the proposed lining system is not compromised prior to waste placement.

Table 12: Side Slope pre-waste placement liner system integrity assessment

Property	Unit	Geosynthetic Material		
		GCL	HDPE Geomembrane	Protection Geotextile**
Thickness	mm	6.0	2.0	10.0
Density	kg/m^3	Not required	940	Not required
Mass per unit area	g/m^2	2 000	1 880	1 200
Tensile Strength	kN/m	10	29(*)	50
Height	m	20	20	20
Slope angle	degrees	18	18	18
Length	m	63	63	63
Tensile Force	kN/m	0.12	0.12	0.07
Assumed interface friction between geosynthetic and underlying material	degrees	17	17	10
Friction Force	kN/m	0.11	0.11	0.04
Tensile Stress	kN/m	0.01	0.01	0.04
Elongation	%	0.10	0.03	0.07
Factor of Safety (Tensile Strength/Tensile Stress)	**-**	**1000**	**2900**	**1250**

Notes: *Yield tensile strength of 2.0 mm HDPE based on GRI-GM13

**The protection geotextile was not assessed for puncturing, only for deformation relative to waste settlement

9.3 During operation

9.3.1 Software and model development

The explicit finite difference modelling software, FLAC, has been used to undertake the liner integrity assessment during waste deposition due to its capability to model large deformation associated with the waste settlement whilst avoiding numerical calculation difficulties associated with large strain continuum modelling. Additionally, FLAC allows simulating a geosynthetic material by introducing a beam element with a moment of inertia set to zero to represent a flexible sheet, which is unable to support any bending moment. Different beams can be included in the model to simulate each of the geosynthetic layers. The model developed for the project was simplified by introducing only one beam element, representing the geosynthetic material under investigation. The beam was fixed at the first and last node to simulate its anchoring. Linear elastic-perfect plastic models with Mohr-Coulomb failure envelopes were adopted for the interfaces and materials.

Generally, the location with greatest potential to strain the liner due to waste settlement is at the longest or steepest slope. Other locations that require careful investigation are locations that have limited buttressing in place. Based on this consideration, a typical section through Cell 2 and Cell 4 (within the proposed Stage 1 landfilling strategy) was selected for the assessment. This represents one of the locations within the landfill with the longest slope and additionally contains the division berm between the north and south landfill cells, which has been identified as a location of potential liner strain. At this location (prior to waste being placed in Cell 3 and Cell 4) the waste will be against the division wall that separates the northern from the southern cell. Here the liner, which is temporarily secured in an anchor trench, could be strained as waste is progressively and vertically placed in layers. Therefore, an assessment is required to investigate its integrity. The selected section is presented in layout and section view in Figure 24 and Figure 25, respectively. The proposed side slopes of the landfill are constant: 1V:3H (vertical:horizontal).

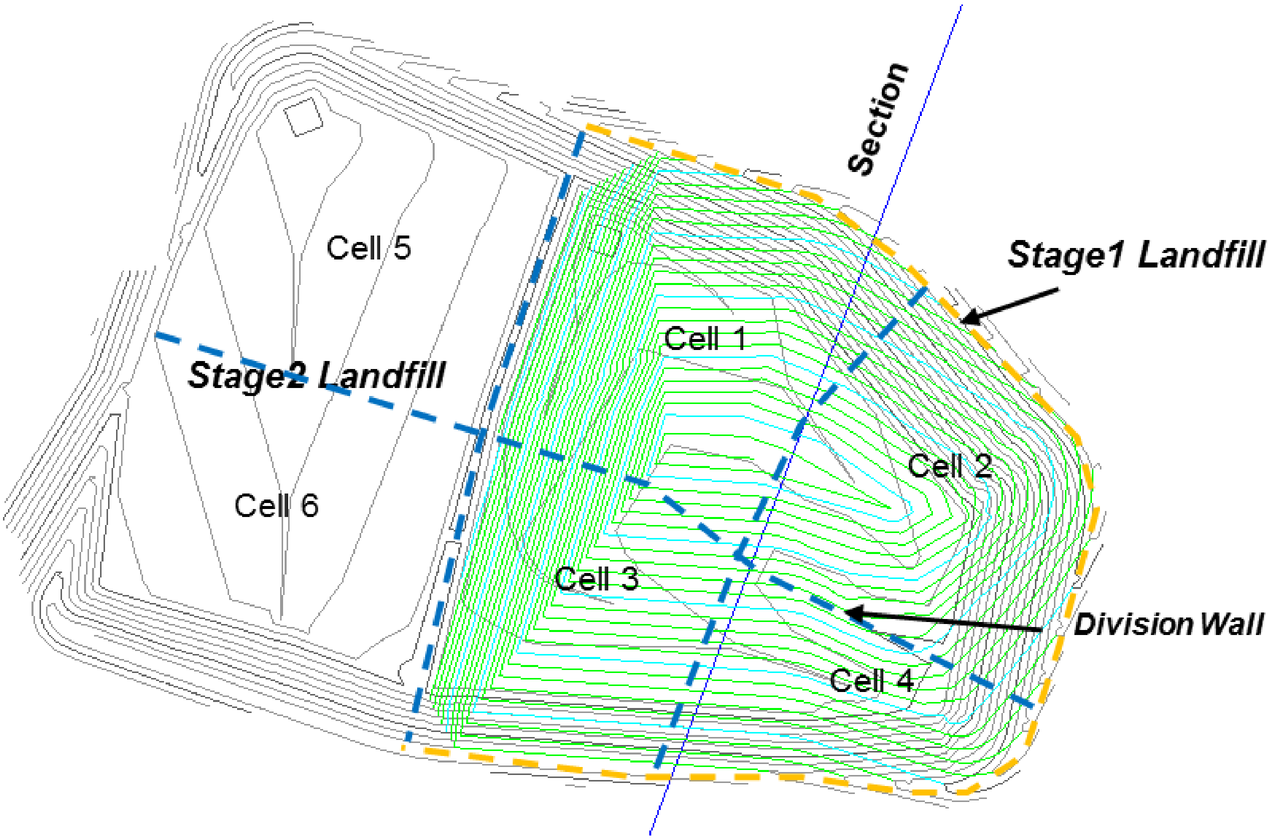


Figure 24: Layout view of the landfill showing selected section for numerical assessment.

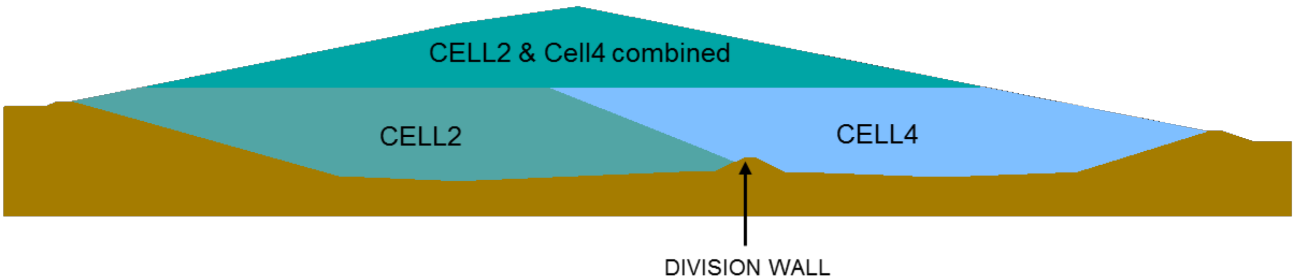


Figure 25: Section view selected for the liner integrity assessment

A staged modelling sequence was adopted to track the stresses on the liner as waste is deposited and to model the progressive settlement of the waste during operation. The lift sequencing used in the numerical model is presented in Table 13. The majority of the waste layers were placed in 3.0 m lifts, with higher lifts at the commencement and end of operations to simulate the higher rate of rise of waste placement caused by the limited availability of space (or area) during these periods of time.

Table 13: Staged waste deposition used in the FLAC model

Deposition Stage	Relative Elevation (m)	Lift Thickness (m)	Cumulative Lift Thickness (m)
Cell 2	277-281	4	4
	281-284	3	7
	284-287	3	10
	287-290	3	13
	290-293	3	16
	293-296	3	19
Cell 4	278-284	6	6
	284-287	3	9
	287-290	3	12
	290-293	3	15
	293-296	3	18
Cell 2 + Cell 4	296-302	6	25
	302-312	10	35

9.3.2 Scenarios

The following two scenarios were investigated in the liner integrity assessment:

- ***Scenario 1***. Integrity of the protection geotextile
- ***Scenario 2***. Integrity of the HDPE geomembrane.

It is important to maintain the integrity of the protection geotextile (Scenario 1) during the operation of the facility, as this layer will protect the containment system (HDPE and GCL) from damaging due to puncturing caused by the gravel particles that are part of the drainage layer. Additionally, if the weakest interface is between the protection geotextile and the geomembrane, tensile strains of the geomembrane and the GCL will be minimised. In our assessment, we have assumed that this interface represents the weakest interface.

The integrity of the HDPE is investigated in Scenario 2 to estimate the possible tensile stresses developed on the HDPE during the placement of the waste. To simplify the numerical model, the GCL has been excluded from the assessment. However, if the HDPE integrity is maintained, the GCL layer will not be impacted.

9.3.3 Geotechnical Properties

Specific materials (i.e. from specific manufacturers) to be adopted for the lining system have not being identified yet and therefore testing has not been performed. The interfaces shear strength between the materials has therefore been assumed based on our experience and the outcomes of the slope stability assessment (presented in Section 8.0).

The interface strength parameters adopted in the model are presented in Table 14.

Table 14: Interface Strength Parameters

Interface	Friction Angle (°)	Cohesion Intercept (kPa)
Gravel drainage layer/Separation geotextile	35	0
Separation Geotextile/Textured HDPE (landfill base)	15	0
Separation Geotextile/Smooth HDPE (landfill side slopes)	10	0
Smooth or Texture HDPE/Layers below geomembrane	17	0

Interfaces were introduced at two locations: above and below the protection geotextile and HDPE. Table 15 presents the interface properties used in the FLAC model.

Table 15: Interface properties used in the FLAC model

Interface	Friction (°)	Cohesion Intercept (kPa)	Normal Stiffness (kPa/m)	Shear Stiffness (Pa/m)
Scenario 1				
Upper Protection Geotextile	35	0	1×10^{13}	1×10^{12}
Lower Protection Geotextile (Side Slopes)	10	0		
Lower Protection Geotextile (Base)	15	0		
Scenario 2				
Upper HDPE Interface (Side Slopes)	10	0	1×10^{9}	1×10^{8}
Upper HDPE Interface (Base)	15	0		
Lower HDPE Interface	17	0		

The normal and shear stiffness adopted in the model were selected to stabilise the model and avoid interpenetration of the beam element into the grid that could have caused unreasonable values of tension and compression in the beam element.

Table 16 presents the mechanical parameters used to simulate the protection geotextile and the HDPE geomembrane in FLAC.

Table 16: LLDPE Geomembrane properties used in the FLAC model

Beam Element	Young's Modulus (Pa) Secant at Yield	Thickness (mm)	Reference
Protection Geotextile	1×10^{7}	10	Assumed
HDPE Geomembrane	1×10^{8}	2	Internal database from multi-axial tensile testing

The Young's Modulus adopted in the model for the geosynthetic is the secant at yield (assumed 50% of strain for the geotextile and 20% of strain for the HDPE). This is considered a simplified and conservative assumption used to model systems that could exceed a tensile strain greater than 2% (Fowmes, 2007).

The material properties used for the numerical analyses are presented in Table 17. The properties assigned to the clay-schist are based on typical geotechnical properties found in the literature for this type of rock formation (Read, 2009). The general fill (clayey material) has not been included in the model, as the focus of this assessment is to investigate the serviceability of the liner during the settlement of the waste. The implications that the settlement of general fill may have with the serviceability of the liner is discussed in detail in Section 7.0 ('Subgrade Assessment').

The waste stiffness values adopted in the analyses have been based on Jones and Dixon (2005), who adopted waste stiffness parameter in their numerical modelling between 2 MPa (high stiffness) to 0.5 MPa (low stiffness). A low stiffness waste parameter has been conservatively adopted in our assessment as this will induce more settlement and, consequently, a greater propensity to strain the liner.

Table 17: Material properties used in the FLAC model

Material	Model	Density (kg/m^3)	Friction (°)	Cohesion Intercept (kPa)	Young's Modulus (MPa)	Poisson's Ratio (-)
Clay Schist (*in situ* material)	Mohr-Coulomb	2700	24	0	15 000	0.3
Waste		1000	25	5	0.5	0.3

9.3.4 Results and Discussion

Table 18 presents the outcome of the liner integrity assessment. The outcomes of the numerical modelling are illustrated in the figures presented in Appendix D.

Table 18: Integrity liner assessment FLAC model outcomes

Scenario	Maximum Tensile Strain (%)	Maximum Tensile Stress (kN/m)
1 – Protection geotextile	0.90	0.9
2 – HDPE geomembrane	0.05	0.1

Based on the outcomes of the modelling, the estimated maximum strain on the geomembrane during waste placement is well below its maximum acceptable value (refer to Table 6 presented in Section 7.2). The strain of approximately 1% estimated by the numerical model for the protection geotextile during waste deposition is also considered acceptable.

The assessment indicates that, under the conditions and scenarios investigated, the integrity of the lining system during waste placement is satisfactory.

To support the preceding liner integrity assessment, laboratory analysis, as described in Section 8.6, should be carried out.

10.0 GCL ASSESSMENT

10.1 Basis of Assessment

The purpose of this assessment is to provide high level comment on whether the proposed geosynthetic clay liner (GCL) would meet the requirements as set out in the BPEM produced by the Victorian Environmental Protection Authority (EPA)[3].

The GCL material proposed for the Opal Vale landfill is shown in Figure 26.

[3] *Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills.* Publication 788.2, October 2014.

Table 1: GCL Material Specifications

Property	Test	Frequency	Value	Value
			Base and Cap	Side Slopes
Free Swell (bentonite)	ASTM D5890	50 tonnes	≥ 24 mL/2g	≥ 24 mL/2g
Moisture Content (bentonite) (*1*)	ASTM D5993	4,000 m^2	≤ 25% at Manufacture ≤ 35% Site Samples	≤ 25% at Manufacture ≤ 35% Site Samples
Fluid Loss (bentonite) (*1*)	ASTM D5891	50 tonnes	18 ml max.	18 ml max.
Top Geotextile Mass (*2*)	ASTM D5261	20,000 m^2	≥ 270 g/m^2	≥ 290 g/m^2
Mass of GCL (*3*)	ASTM D5993	4,000 m^2	≥ 4,380 g/m^2	≥ 4,700 g/m^2
Mass of Bentonite (*3*)	ASTM D5993	4,000 m^2	≥ 4,000 g/m^2	≥ 4,000 g/m^2
Bottom Geotextile Mass	ASTM D5261	20,000 m^2	≥ 110 g/m^2	≥ 410 g/m^2
Composite layer Thickness (Dry)	ASTM D1777	4,000 m^2	≥ 6 mm	≥ 6 mm
Elongation	ASTM D4632	20,000 m^2	≥ 10%	≥ 10%
Tensile Strength	ASTM D6768	20,000 m^2	≥ 8 kN/m	≥ 12 kN/m
Peel Strength	ASTM D6496	4,000 m^2	360 N/m	360 N/m
Permeability (*1*)	ASTM D5887	25,000 m^2	≤ 5 x 10^{-11} m/s	≤ 5 x 10^{-11} m/s

(1) These values are maximum (all others are minimum).

(2) For both cap and carrier fabrics for non-woven reinforced GCL's; one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability. This only applies to GM/GCL composites, which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.

(3) Mass of the GCL and bentonite is measured after oven drying per the stated test method.

Figure 26: Excerpt from Opal Vale Class II Landfill (GCL Requirements) – Specification produced by IWP

2.7.2.2 MINIMUM REQUIREMENTS FOR GCL

The GCL shall be a reinforced, multi-layered system comprising two layers of geotextiles encapsulating a layer of dry bentonite.

As a minimum, the bentonite shall meet the Specifications indicated below:

- Montmorillonite content > 70 wt%;
- Carbonate content*, 1-2 wt%;
- Bentonite form – Natural Na-bentonite or >80 wt% Sodium as activated bentonite;
- Particle size - Powdered (e.g. 80% passing 75 micron sieve) or Granulated (e.g. < 1% passing 75 micron);
- Cation exchange capacity ≥ 70 meq/100 g (or cmol/kg); and,
- Free swell index ≥ 24 cm^3/2g.

* Carbonate here implies calcite, calcium carbonate or other soluble or partially soluble carbonate minerals.

Figure 27: Excerpt from Opal Vale Class II Landfill (Bentonite Requirements) – Specification produced by IWP

No laboratory test work was carried out on the proposed GCL materials. The current assessment is therefore a qualitative assessment only and material properties should be confirmed through laboratory testing prior to use in construction on the site.

10.2 Hydraulic Conductivity

The saturated hydraulic conductivity of the proposed material (≤ 5×10^{-11} m/s) will be sufficient to meet the maximum leakage rate as stated by the BPEM. (Refer Section 12.4.2.1.) Allowance should however be made for potential cation exchange over time and hence it is prudent to increase the permeability 5×10^{-10} m/s, when estimating the potential seepage rate from the basal liner.

If the permeability of the GCL were to increase to 5×10^{-10} m/s due to cation exchange over time, the seepage rates can increase to approximately 5.6 L/ha/day to 30.6 L/ha/day. Even though the high confining pressure under which the base liner is placed will result in less of an impact on permeability, the cation exchange capacity of the subgrade materials and the proposed bentonite should be confirmed prior to finalisation of the specification, such that the initial permeability requirement can be amended should it be required.

In addition a hydraulic conductivity test should be carried out on the GCL prior to construction. The permeating liquid should ideally be leachate from the landfill, but as the landfill will not have been constructed use of an artificial leachate, representative of other sites with similar waste streams, should be considered for use in the test.

The estimated seepage rate through the cap was calculated and is presented in Section 12.4.4. A key component to achieving this seepage rate is to place the cover soils as soon as possible after placement of the GCL and to allow for sufficient overburden on the liner to achieve the required permeability.

To obtain good hydraulic behaviour from a GCL it is good practice to hydrate the GCL after placement with potable water. To achieve this the for the basal liner and cap liner the GCL should be placed on subgrade that has been compacted at or wet of optimum moisture content and then covered with geomembrane on the same day. Placement of leachate aggregate or cover soils should take place as soon as possible after that. Best practice is to place it on the same day or shortly thereafter, however, for practical reasons this generally not possible. A period of maximum one to two weeks is generally practical and acceptable. In the case of Opal Vale, if the liner system is installed correctly, it would be expected that saturation of the basal GCL could be achieved.

10.3 Gas Permeability

As the GCL in the basal liner and the cap are both used in conjunction with a geomembrane as a composite system, gas permeability is not considered a critical aspect.

10.4 Chemical Compatibility

The GCL will need to be chemically compatible with the subgrade soils and any moisture that may come into contact with it. Such moisture sources potentially include leachate, groundwater, seepage though the soil layers on top of the cap system and gas condensate from below the cap.

The base of the landfill is approximately 3 m above the groundwater table and hence the GCL is not likely to come into contact with groundwater. No leachate analysis is available at this time; hence it is not possible to assess the chemical compatibility of the GCL relative to the leachate from this site.

However, based on the expected waste types, (Class I and II – Commercial & Industrial, Construction & Demolition and Municipal Waste) that will be disposed at the landfill, it can be expected that the leachate will be relatively neutral. There in regards to pH values the specified GCL will meet the requirements of the BPEM. As discussed in the previous sections (10.2 and 10.3) various tests can be carried out to assess the behaviour of the GCL prior to ordering materials and commencing construction. We recommend that these test be carried out at that time.

10.5 Diffusion properties

Diffusion is generally only an issue of concern in cases on long lasting hydraulic head or high volatile organic content (VOC). Neither of these scenarios are expected at the Opal Vale landfill, based on the leachate management strategy and waste type allowed on the site. (Refer Works Approval Application prepared by IWP). For this reason diffusion is not considered a critical issue, whereas estimated seepage would be expected to have a higher relative environmental impact.

10.6 Discussion

Should the proposed GCL meet the requirements as discussed in this section as well as the technical specification prepared by IWP, the material would be deemed suitable for the intended application at Opal Vale landfill site.

11.0 LEACHATE MODELLING AND WATER BALANCE

11.1 General Approach

Simulations of leachate generated from rainfall on the landfill were carried out using the Hydrogeological Evaluation of Landfill Performance (HELP) computer program. A layered system of waste, barriers and drainage layers were considered in the analysis. The program evaluates movement of water through the layered landfill system.

The model has been prepared to reflect current EPA Publication 788.2 *'Best Practice Environmental Management Siting, Design, Operation and Rehabilitation of* Landfills', dated October 2014 criteria by assessing the volume of leachate generated from a 'worst case' scenario whereby two consecutive wet years have been modelled for the open landfill case followed by average rainfall conditions. The modelled scenarios consider the staging of the landfill with 2 years of open landfill.

For the Opal Vale landfill, daily records of rainfall were obtained from the Silo located at 31 30' S and 116 30'E. Solar radiation, temperature, wind speed and humidity monthly records were obtained from Northam weather station in Western Australia (Station No. 010111). The HELP simulation for the wet year was undertaken using Visual HELP whereby synthetic weather data is generated based on the wettest rainfall year (1990) for weather records between 1984 and 2014. The rainfall records prior to 1984 were excluded as the data did not represent current climate in the region. Refer Section 3.1.2 and 3.1.3.

11.2 Leachate Model

11.2.1 Assumptions

The liner system presented in Section 3.7 was modelled in the HELP simulation.

The HELP model was utilised to simulate the amount of leachate generated from two years of operation of an open landfill with approximate waste thickness of 28 m.

To undertake leachate generation modelling for the above scenario the following assumptions were made:

- A landfill floor slope of 3% with leachate drains at 20 m spacing.
- The hydraulic conductivity of waste was assumed to be 10^{-5} m/s.
- The waste entering the landfill was assumed to be at Field Capacity[4].
- The interim cover soil overlying the waste was considered as bare ground.
- An evaporative zone depth of 250 mm was assumed for the bare ground surface.

[4] Field capacity is defined as the water content reached if a sample of the waste is initially saturated and then subjected to prolonged free drainage.

- A surface slope on the interim cap of 4% over 20 m length with a runoff permitted from the interim cover soils of 100% of the landfill cell area.
- For the High Density Polyethylene (HDPE) liner the following were assumed:
  - Placement quality of 3 – Good
  - Pinhole Density of 2 holes/Ha
  - Installation Defects of 2 holes/Ha.

The hydraulic conductivity of GCL as manufactured is typically 3×10^{-11} m/s. Field observations of the performance of GCL based composite liners suggest the permeability of these liners may increase by approximately an order of magnitude due to cation exchange processes that may occur following installation. The hydraulic conductivity of GCL adopted for the simulation was adjusted to 3×10^{-10} m/s for potential cation exchange effects.

11.2.2 Results and Discussion

The results of the HELP simulation (Refer Appendix E) indicate that a high proportion of the rainfall during the first two years of cell filling will be lost in evapotranspiration (70% on average) while approximately 26% of rainfall infiltrates in to the waste and is collected in the base leachate collection system. Water absorption by the waste is considered to be negligible. Runoff from the waste surface in this scenario is considered to contribute to leachate and was small at 2.6% of rainfall.

In a peak wet years scenario the amount of leachate that could be collected is approximately 160 mm/year (30% of rainfall). This wet year scenario would result in a volume of leachate generated of approximately 1600 m^3/hectare/year.

The greatest potential for leachate generation in an open landfill cell occurs when the first loads of waste have been placed on the liner system and waste does not cover the entire floor area. It would be prudent in early stages of operation to use a low temporary bund within the cell to create a temporary sub-cell until there is sufficient waste present to have absorption capacity.

11.3 Water Balance

11.3.1 Introduction

During the life of the facility leachate will be pumped from the landfill cells to a series of leachate ponds. The number of leachate ponds are planned to progressively increase as more landfill cells are developed. This section of the report aims to assess if the proposed size of the leachate ponds will be sufficient to contain leachate that may be generated during the life of the facility. The number of leachate ponds required to be constructed during the life of the facility is also investigated in this study.

The BPEM Victoria 2014 guideline requires that storage ponds be designed to contain and control rainfall run-off for a 1 in 20 year storm event for a putrescible landfill maintaining a freeboard of at least 0.5 m. The BPEM Victoria 2014 guideline also recommends giving consideration to a storm event up to the 1 in 100 year recurrence intervals to limit the risk of a catastrophic failure such as flooding of the leachate storage ponds. An additional assessment has been undertaken to investigate this scenario as per the BPEM Victoria guideline.

11.3.2 Modelling approach

A dynamic/probabilistic water balance was developed for the Opal Vale landfill to investigate the possibility of water overtopping the proposed leachate ponds as result of the inflows that are expected to be received by these storage facilities.

The water balance was developed using the GoldSim software (Version 11). GoldSim is a Monte Carlo simulation software package for a dynamic complex logic network, such as water balances. In a Monte Carlo simulation, the entire water balance is simulated for a large number of events. Each simulation is referred to as a realisation of the system. For each realisation a probabilistic distribution is developed and the probability that a particular event occurs is estimated. The water balance for the Opal Vale landfill was performed using a total of 100 realisations. Climate records from the Silo Data were used to simulate precipitation and evaporation. GoldSim chooses, at random, a set of 11 different years (as per approximately the expected total life of the facility) of climate data and performs an analysis for each set.

The model was run for a time of operation of 11 years (from January 2016 to January 2027) assuming a leachate generation rate of 1600 m^3/hectare/year (based on the result of the Visual Help Model). This leachate generation represents the estimated leachate generated during two consecutive wet year (refer to Section 11.2). In the water balance model, we have applied this leachate generation rate for the entire 11 years of facility life as this maximum leachate generation could occur anytime during the life of the facility.

The water balance model was based on the following balance equation:

$$\Delta S = (P+L_{IN}) - (E+L_R+S)$$

Where:

ΔS = change in storage water volume in the pond

P = Precipitation

L_{IN} = Leachate in to the pond from landfill (including allowance for recirculation)

E = Evaporation

L_R = Leachate recirculated to the landfill as percentage of total inflows ($P+L_{IN}$)

S = Seepage from the pond

The inflow into the pond due to leachate (L_{IN}) has been increased to include the volume of leachate being recirculated. This assumption is conservative as some of the recirculated leachate will be lost through evaporation/evapotranspiration from the waste mass. The seepage from the pond is assumed to be negligible as the facility will be lined.

11.3.3 Input parameters

The storage capacity of the leachate ponds (depth, areas and storage volume – shown in Figure 28) has been taken from the three-dimensional model provided by IWP. The maximum depth of the ponds is 4.2 m Based on the three-dimensional model for the leachate ponds, to maintain a freeboard of 0.5 m inside the ponds, the maximum water depth should not be greater than 3.7 m.

Information of the cells' development during the life of the facility has been provided by IWP (refer to Table 19).

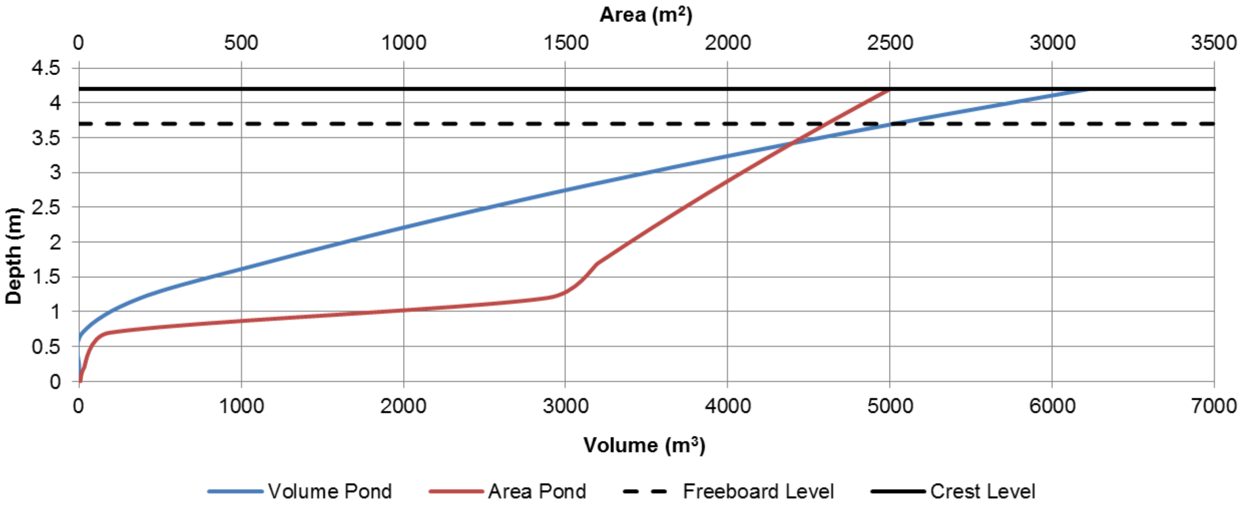


Figure 28: Storage capacity curves for a single leachate pond.

Table 19: Cells' development over time and area of cells

Cells	Time	Cumulative Time	Area	Cumulative Area
	Year		m²	
Cell 1	1.8	1.8	12 500	12 500
Cell 2	2.2	4	15 500	28 000
Cell 3	1	5	10 000	38 000
Cell 4	1.9	6.9	12 000	50 000
Cell 5	1.3	8.2	19 000	69 000
Cell 6	2.5	10.7	19 000	88 000
Total	10.7		88 000	

11.3.4 Climate data

The study has been undertaken using the last twenty year of climate data (1984 – 2014). A-pan evaporation data was corrected using a pan coefficient of 0.75 to convert the A-Pan data to lake evaporation.

11.3.5 GoldSim model results

The construction sequencing of the number of the ponds and the leachate recirculation percentage was assessed by changing them until a freeboard of at least 0.5 m was maintained inside each of the leachate ponds. The leachate ponds were modelled assuming that an equal amount of leachate is distributed inside each of the ponds.

The construction sequencing of the number of the ponds was aligned with the expected growth of the landfill. If the filling rate of the cells were to increase or decrease, the timing for the construction of the leachate ponds will have to be modified.

The number of the ponds constructed during the life of the facility is shown on Table 20.

Table 20: Number of ponds required during the facility life

Time (year)	Number of Ponds	Cell Development
1.8	2	Cell 1
4	2	Cell 1 + Cell 2
5	3	Cell 1 + Cell 2 + Cell 3
6.9	3	Cell 1 + Cell 2 + Cell 3 + Cell 4
8.2	4	
11	4	

Table 21: Generated and recirculated leachate during the facility life

Time (year)	Generated Leachate (m^3/year)	Leachate Recirculated (% of generated leachate)
1.8	2 000	20
4	4 480	20
5	6 080	20
6.9	8 000	20
8.2	11 040	40
11	14 080	40

The level of water inside each of the leachate ponds is shown in Figure 29. As shown in Figure 29 under the conditions modelled, the water level inside the leachate ponds will not exceed an operational depth and maximum level of 3.7 m, while still allowing for 0.5 m of freeboard. During the end of the facility life, the estimated amount of leachate to be recirculated in to the landfill will likely increase. The amount of recirculated leachate could be reduced if an additional pond were to be constructed at approximately year 8.

The leachate into and out of the ponds as well as the ponds' water level should be monitored during the facility life. This would allow calibration of the water balance model developed for the project which could then be used to forecast possible future scenarios to improve the water management at the landfill site.

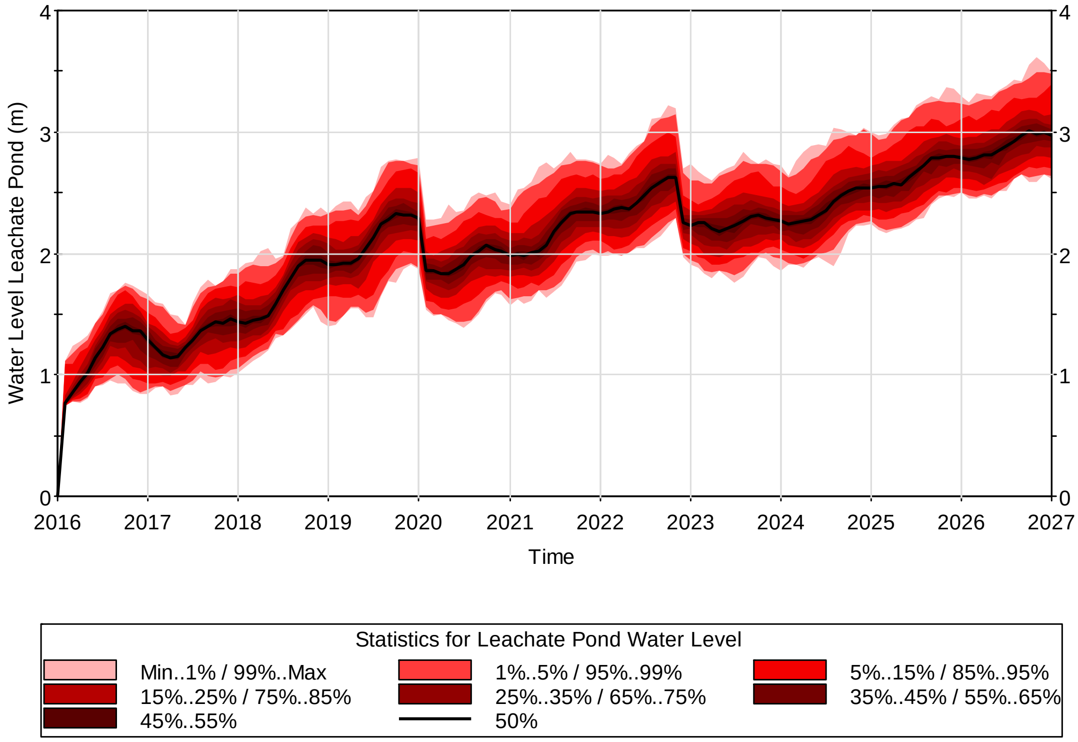


Figure 29: Estimated water level inside each of the ponds during the facility life.

11.3.6 BPEM Victoria 2014 Guideline Leachate Pond Storage Assessment

Figure 30 presents the number of ponds required in order to not exceed the 1 in 20 year (88 mm) and 1 in 100 year (136 mm) storm event 24 hours duration.

The assessment has been conservatively undertaken assuming a coefficient of runoff of 1 for all surfaces (waste and unlined areas) and that all runoff is diverted from the landfill cells to the leachate ponds immediately after the occurrence of the storm event. This is a conservative assumption, as once waste is deposited into the landfill the coefficient of runoff will likely be less than 1 (for those cells where waste has already been deposited).

As shown on Figure 30, under the conditions assessed the number of ponds expected to be constructed during the life of the facility are sufficient to contain the design storm events.

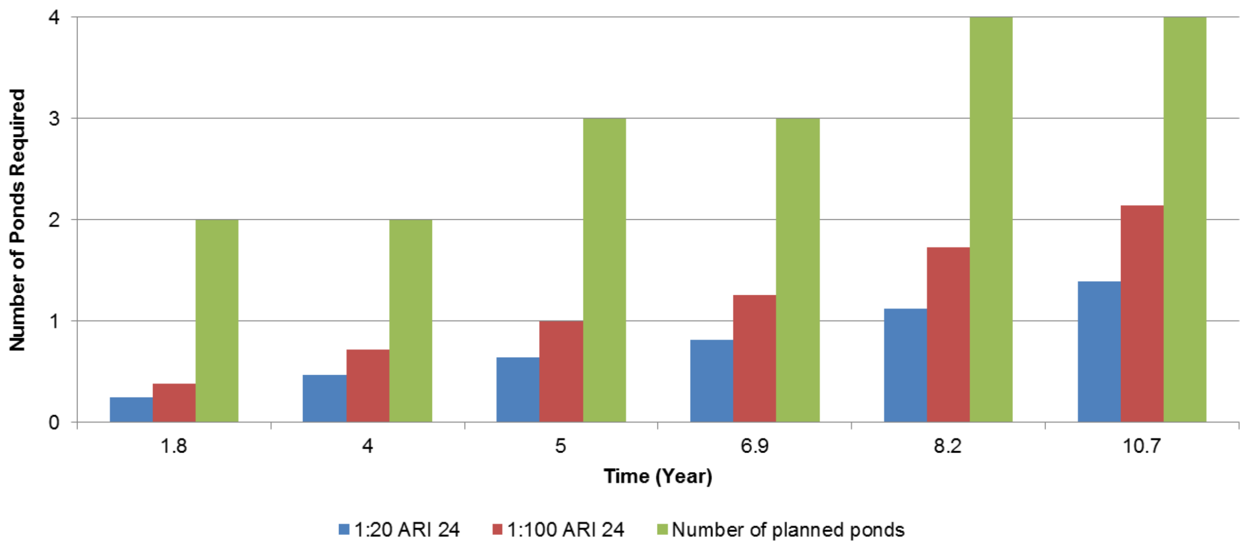


Figure 30: Number of ponds required during the facility life.

12.0 INFILTRATION AND SEEPAGE ASSESSMENT

12.1 Introduction

The aspects of the design that Golder has been engaged to assess are the proposed cap and basal geosynthetic liner systems. The function of these systems is to limit fluid migration into and out of the stored waste, respectively. Current best-practice guidelines (see Section 12.2) provide objectives for the design of cap and basal liner systems to fulfil these functions. This report presents the infiltration and seepage assessment for the proposed landfill cognisant of the best-practice guidelines.

12.2 Relevant Guidelines

Guidelines on current best-practice environmental management (BPEM) produced by the Victorian Environmental Protection Authority (EPA)[5] provide the following performance standards relevant to infiltration and seepage:

- Seepage rate through basal liner not exceeding 10 L/ha/day (annualised to 3650 L/ha/yr and equivalent to 0.365 L/m^2/yr)
- Leakage through the cap shall not exceed 75% of the seepage rate (i.e. infiltration into waste shall be less than or equal to 2740 L/ha/yr, equivalent to 0.274 L/m^2/yr).

12.3 Information Provided

12.3.1 Liner systems

Drawings prepared by IWP of the cap and basal liner systems are provided in Figure 6 and Figure 7 respectively. The components of the liner systems being modelled are the geomembrane and GCL in combination (i.e. the containment barriers), and the overlying soil layers. For the intents and purposes of the current assessment any fluid migrating through the GCL is classified as leakage, and therefore the materials below the GCL are omitted from the model.

Whilst the vegetative soil layer incorporated into the cap system design is expected to improve water removal via evapotranspiration, IWP has informed Golder that the long-term functionality of the cap is to be maintained by the liner system, and thus the system is not a ‘phytocap’ in terms of the BPEM.

[5] *Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills.* Publication 788.2, October 2014.

12.4 Assessment

12.4.1 Assumptions

12.4.1.1 General

The following general assumptions have been made for the purposes of the infiltration and seepage assessment:

- Thickness of vegetative soil – 1 m (lower-bound value indicated on drawing OV-WA-27 – conservative assumption)
- Where no material-specific test results are available, the proposed materials will have hydraulic properties similar to typical values from relevant literature.
- Geotextile materials (separation and cushion and layers in the cap and base) were not assigned individual material parameters.
- A one-dimensional model was developed, which inherently assumes that the there is no slope on the sand drain.
- A constant head of 0.3 m is assumed to be acting on the basal liner (i.e. the basal drainage aggregate layer remains saturated).

12.4.1.2 Liner system

The liner system comprises the geomembrane and underlying GCL. The following assumptions have been made with regard to the liner system:

- GCL permeability = 5×10^{-11} m/s (does not allow for cation exchange – refer Section 10.2 for potential impact)
- Geomembrane defect diameter = 2 mm
- Defect distribution density ≈ 24/ha (Based on installation quality: “Fair”, Giroud et al. 1989)

The above assumptions were applied to both the cap and basal liner systems, under the reasonable expectation that the construction quality will be similar across both systems, and to facilitate comparison within the framework of the BPEM guidelines summarised in Section 12.2.

12.4.2 Approach

12.4.2.1 Estimation of Anticipated Leakage Rate Through Base

The first step taken was to estimate the anticipated leakage rate through the basal liner system in order to establish the relevant limiting value for the cap. Leakage flux Q_{GM} (equivalent to Q in Darcy’s law) through defects was estimated using the methods described in Giroud et al. (1989), considering “poor contact” and “good contact” conditions between the geomembrane and underlying GCL and assuming ‘fair’ installation as outlined above.

$$Q_{GM} = Ca^{0.1}h^{0.9}{k_{GCL}}^{0.74}n$$

Where Q_{GM} is the flux through the geomembrane, *C* is the coefficient of contact between geomembrane and underlying GCL (1.15 for “poor” and 0.21 for “good”), *a* is the area of geomembrane defect, *h* is the head of water, k_{GCL} is the permeability of the underlying GCL, and *n* is the density of defects (assumed 24/ha).

For the basal liner system where a 0.3 m head is assumed to exist above the liner system (as per Section 12.4.1.2), an anticipated leakage rates poor and good contact of approximately 5.6 L/ha/day (2036 L/ha/year) and 1.0 L/ha/day (372 L/ha/year), respectively, was estimated. Based on the assumed parameters this leakage rate is within the acceptable limits outlined in the BPEM (10 L/ha/day, or 3650 L/ha/year).

12.4.2.2 Relevant Flux Limits Through Cap Liner

Based on the BPEM guideline, leakage through the cap should be limited to 75% of the basal leakage rate. The flux limits allowable through the cap is therefore 4.2 L/ha/day (1 527 L/ha/year).

12.4.2.3 Modelling of Cap Liner System

A seepage model was developed for flow through the proposed cap system (vegetative soil, sand drain and composite liner system). The finite element seepage software *SVFlux* (©2008 SoilVision Systems Ltd) was used to prepare the 1-dimensional seepage model. The resulting flux through the cap liner system was modelled and compared to the basal leakage rate. The setup of the seepage model is outlined in Section 12.4.3.

12.4.3 Model setup

12.4.3.1 Climate

Climate data used for this analysis is provided in Section 3.1. The set included data for precipitation, evaporation, temperature, and humidity. Transpiration due to plant establishment was not considered as part of the model. The raw daily data were processed to obtain a representative average year and input into the SVFlux climate manager as a climate boundary condition acting on the vegetative topsoil.

The precipitation data used in the model represents a total annual rainfall of 488 mm. For comparison, the total annual potential evaporation for the site is approximately 1 500 mm (adjusted lake evaporation; 2000 mm × 0.75), indicating a strongly evaporation-dominant climate data set.

12.4.3.2 Initial conditions

The initial conditions applied to the materials are outlined in Table 22. The initial conditions were selected to simulate water contents drier than field capacity, assuming that some drain-down of the materials had occurred after placement. The basal drainage aggregate was also assumed to be saturated.

Table 22: Summary of Initial Conditions

Material	Initial Pore Water Pressure	Corresponding Water Content
Vegetative topsoil	- 80 kPa	0.113 m^3/m^3
Drainage sand	- 100 kPa	0.042 m^3/m^3

12.4.3.3 Boundary conditions

The climate boundary condition was applied to the column surface (RL 31.3 m) and a head constant of 0 m was applied below the liner system (RL 29.9).

12.4.3.4 Liner equivalent permeability

The liner system was modelled as a 100 mm thick layer representing the equivalent permeability of the geomembrane and GCL in combination. The equivalent permeability *K* of the liner system was estimated from Darcy's law, $K = Q/i$ (where *Q* is the flux and *i* is the hydraulic gradient). For the "good contact" condition and equivalent permeability of 2.2×10^{-13} m/s was used; for the "poor contact" condition the value was increased to 1.3×10^{-12} m/s.

12.4.3.5 Saturated Material Parameters

The properties of saturated materials were defined in terms of hydraulic conductivity K_{sat} and volumetric water content VWC_{sat}. The saturated material parameters adopted in the model are listed in Table 23. IWP has informed Golder that the vegetative topsoil will comprise natural soils available on site (clay schist). Absent any detailed information about the hydraulic properties of the material when placed in the cap, Golder has assumed parameters for the vegetative soil based on an uncompacted silty clay.

Table 23: Saturated Material Parameters Used

Material	Ksat (m/s)	VWCsat (m^3/m^3)	Source	
			Ksat	VWCsat
Vegetative topsoil	1.0×10^{-6}	0.35	Assumption	Assumption
Over-liner Sand	2.2×10^{-5}	0.44	Qian et al., 2002	Qian et al., 2002
Liner system ("good contact")	2.2×10^{-13}	0.35	Calculated (Section 12.4.3.4)	Assumption‡
Liner system ("poor contact")	1.3×10^{-12}	0.35	Calculated (Section 12.4.3.4)	Assumption‡
Aggregate drainage layer	3.0×10^{-3}	0.40	Qian et al., 2002	Qian et al., 2002

Notes: ‡Based on typical value for clay (bentonite component of GCL)
*Based on average value from 6 laboratory permeability results provided by IWP

12.4.3.6 Unsaturated Material Parameters

The properties of unsaturated materials were defined in terms of K_{sat}, VWC and a soil-water characteristic curve (SWCC). The SWCC describes the relationship between water content and suction for a given porous material. For sand, the SWCC was estimated using the methods described in Perera & Zapata (2007) based on the PSDs provided. For the vegetative topsoil, the SWCC was estimated using the Fredlund 2-point method included in SVFlux, based on the relevant parameters suggested in literature (Qian et al., 2002). The unsaturated hydraulic conductivity functions for the topsoil and sand were estimated in SVFlux using the relevant SWCC and saturated permeability values.

12.4.4 Seepage Model Results

The seepage modelling indicates that no flux occurs through the cap liner system. Figure 31 shows that the sand drainage layer above the liner system experiences a net inflow (from the vegetative soil) of 1 300 m^3/ha and a net outflow due to evaporation of 1 315 m^3/ha. For the initial moisture content in the sand of 0.035 m^3/m^3 this represents a removal of 46% of the initial moisture content.

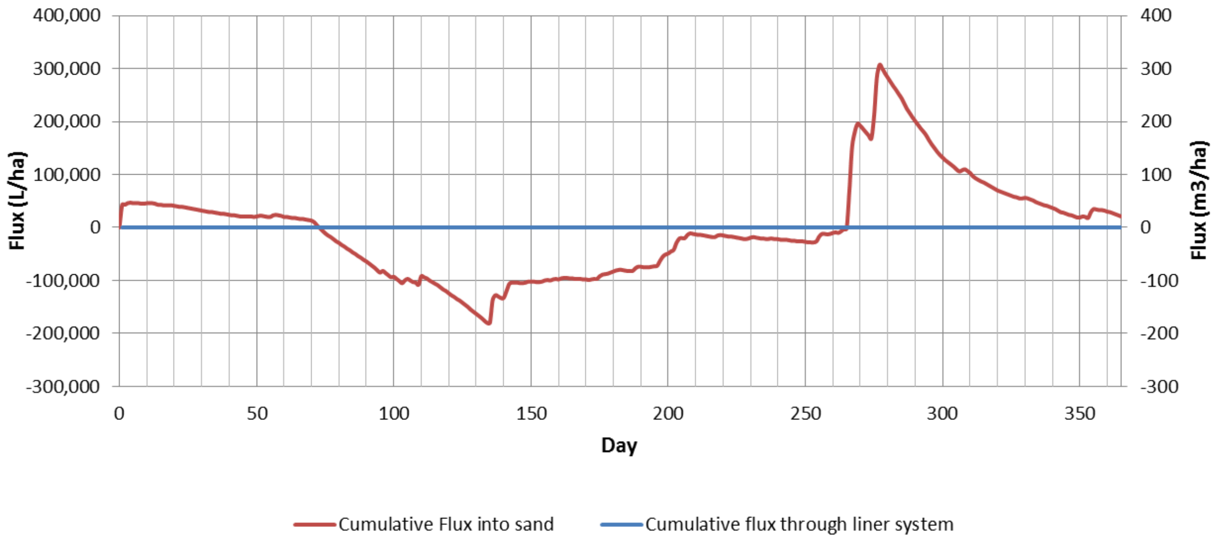


Figure 31: Cumulative flux through sand drainage layer and liner system – Positive flux: infiltration, Negative flux: evaporation

The proposed cap meets the intended objectives of the BPEM guidelines under the conditions and assumptions detailed in this report.

13.0 CONCLUSIONS AND RECOMMENDATIONS

A summary of our conclusions and recommendations are provided in Table 24.

Table 24: Summary of Conclusions and Recommendations

Description	Conclusion	Recommendation
Subgrade settlement assessment	Tensile strains on the liner are likely limited if the saturated soft material present within the proposed landfill footprint is removed prior to subgrade placement and liner installation. The soft saturated material is potentially liquefiable. During cyclic loading, liquefaction of this material could cause foundation failure or settlement that could induce tensile strains on the liner beyond its allowable limit.	The saturated soft material should be removed prior to the installation of the liner system. The extent of the soft material should be verified and witnessed by a third party CQA inspector. PCPT could be undertaken during detail design to investigate the extent of the soft saturated material within the pit base. The extent of the uncompacted fill located at the eastern side of the proposed landfill footprint should be verified. A qualified third party CQA inspector should witness the extent of the uncompacted fill removal prior the placement of compacted fill material on the side slopes.
Stability assessment	The stability assessment undertaken for the base liner system has shown acceptable safety factors for the landfill. The stability of the final landform, under current conservative design assumptions, is marginally stable. We therefore recommend that additional analysis be carried out during detail design that incorporates actual site geometry and test results based on materials identified for construction.	Based on the stability assessment the minimum friction angle at the side slopes and base of the landfill should be no less than 10° and 15°, respectively. Large shear box interface shear tests should be carried out on the various liner interfaces (Refer Section 8.6) to confirm that the recommended minimum interface friction angle is achieved. The testing should be undertaken using the materials that will be adopted during construction. The waste slopes should not be steeper than the slopes listed in Table 10. The liner system should be secured in an anchor trench at the top of the division wall between Cell 1 and Cell 3, and Cell 2 and Cell 4. The liner can be installed beneath the division wall between Cell 1 and Cell 2, and Cell 3 and Cell 4.
Liner integrity assessment	The liner system integrity assessment undertaken has shown that the risk of straining the proposed liner system is limited and the estimated tensile strains are deemed acceptable.	Large shear box tests should be carried out as recommended in Section 8.6. We recommend selecting materials such that the weakest interface is located between the protection geotextile and the geomembrane. This will further limit the risk of straining the containment system (HDPE and GCL).
GCL assessment	Should the proposed GCL meet the	Hydraulic conductivity testing of GCL with

Description	Conclusion	Recommendation
	requirements as discussed in this section as well as the technical specification prepared by IWP, the material would be deemed suitable for the intended application at Opal Vale landfill site.	leachate or synthetic leachate should be carried out. Cation exchange capacity of GCL and subgrade materials should be carried out to assess potential for cation exchange and increase and permeability over time. Refer Section 10.2.
Leachate modelling and water balance	The leachate generation rate estimated for Opal Vale landfill is 1600 m^3/hectare/year (based on two consecutive wet years). Under the conditions modelled, the freeboard level of 0.5 m inside the leachate ponds will likely not be exceeded. Based on the water balance assessment the following pond construction sequencing is required: ■ 2 ponds required Year 0 to Year 4 ■ 3 ponds required Year 5 to Year 7 ■ 4 ponds required Year 8 to 11 The percentage of leachate required to be recirculated inside the landfill: ≥ 20% of inflows from year 1 to year 7 and ≥ 40% of inflows from year 8 to end of life of facility. Under the conditions modelled the BPEM requirements for the containment of stormwater inside the leachate pond of 1 in 20 storm event, 24 hours duration is met. The leachate ponds, based on the above construction sequence, will likely meet the 1 in 100 storm event, 24 hours duration.	The construction sequencing of the ponds should be aligned with the cell development. If the planned cell development should change, the construction sequencing of the ponds should be also be revised (including the water balance study). During the end of facility life, the amount of leachate that is required to be recirculated to limit the possibility of increasing the water level inside the leachate ponds will likely increase. This could be reduced by constructing an additional pond at approximately year 8. The leachate into and out of the ponds as well as the ponds' water level should be monitored during the facility life. This would allow calibration of the water balance model developed for the project which could then be used to forecast possible future scenarios to improve the water management at the landfill site.
Infiltration and seepage assessment	Based on the assumed parameters the basal leakage rate is within the acceptable limits outlined in the BPEM (10 L/ha/day, or 3650 L/ha/year). The seepage modelling indicates that no flux occurs through the cap liner system. This is consistent with a climate (typical of the site location) characterised by a negative water balance (evaporation exceeds the precipitation). The proposed cap meets the intended objectives of the BPEM guidelines under the conditions and assumptions detailed in this report.	Refer Section 10.2 in regards to assessment of potential cation exchange in regards to the basal liner.

14.0 LIMITATIONS

Your attention is drawn to the document "Limitations", which is included in Appendix F to this report. This document is intended to assist you in ensuring that your expectations of this report are realistic, and that you understand the inherent limitation of a report of this nature. If you are uncertain as to whether this report is appropriate for any particular purpose please discuss this issue with us.

GOLDER ASSOCIATES PTY LTD

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https://aupws.golder.com/sites/1417287opalvaledesignsupport/correspondence out/1417287-001/1417287-001-r-rev0 technical studies report.docx

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State Administrative Tribunal (SAT, 2013) *Witness Statement of Francis Raymond Gordon*, DR 292 of 2012 Dated 21 January 2013, Civic Legal Ref. MTM:102747

APPENDIX A

Laboratory Test Certificates – Golder Associates

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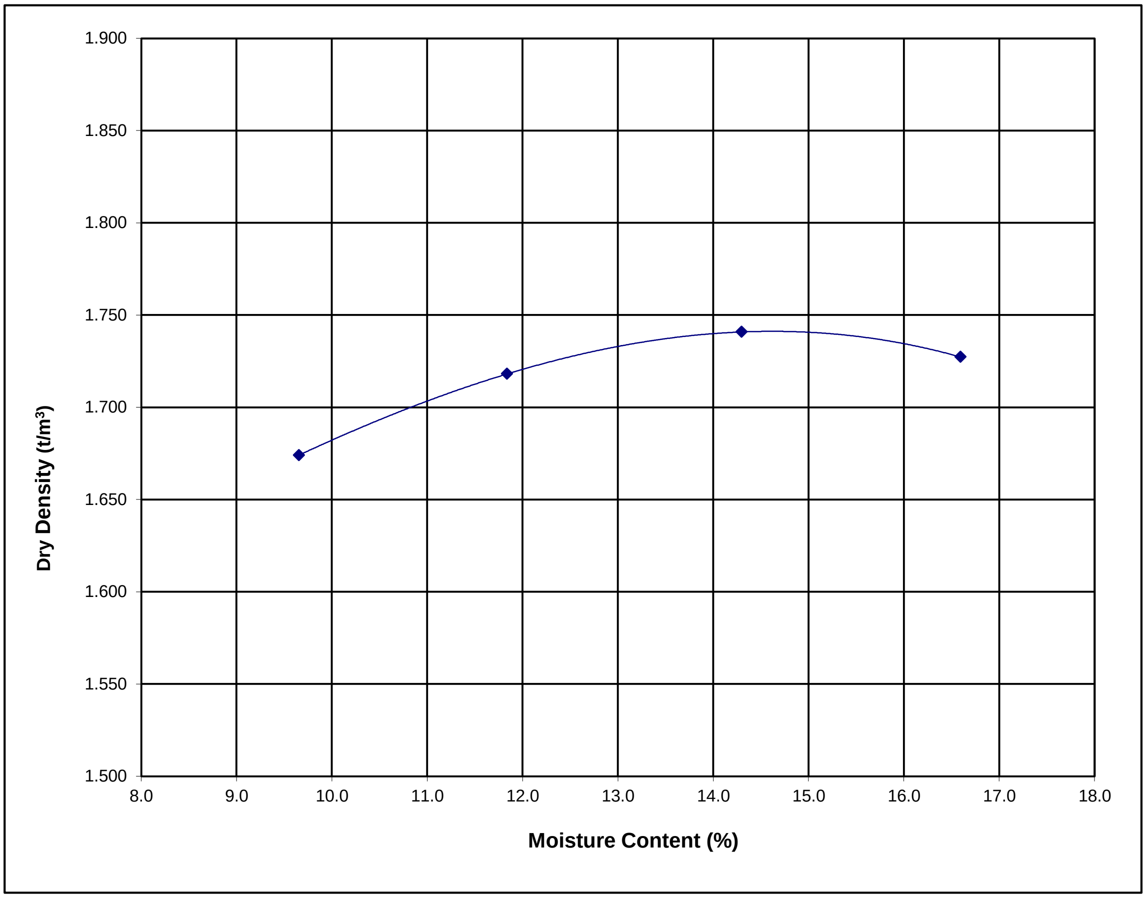
MOISTURE/DENSITY RELATIONSHIP TEST REPORT

Test Method: AS1289 5.1.1

Client	Golder Associates Pty Ltd	**Report No.**	14120001-MDD
Project	1417287-Opal Vale. Lot 11 Chitty Road Toodyay	**Test Date**	4/12/2014
		Report Date	5/12/2014
Client ID	Bag 1,2 & 3 sourced from stockpile combined	**Depth (m)**	-
Description	SILT- pale yellow		



Maximum Dry Density (t/m^3)	1.74	**Optimum Moisture Content (%)**	14.5
Moisture Content (%)	10.2	**Percentage of Oversize/Sieve Size (mm)**	0/19

NOTES/REMARKS: This is a computer generated plot so estimates may show some minor variations from the results summarised.

Sample/s supplied by the client

Tested at Trilab Perth Laboratory

Authorised Signatory

G. Creely

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TRIAXIAL TEST REPORT

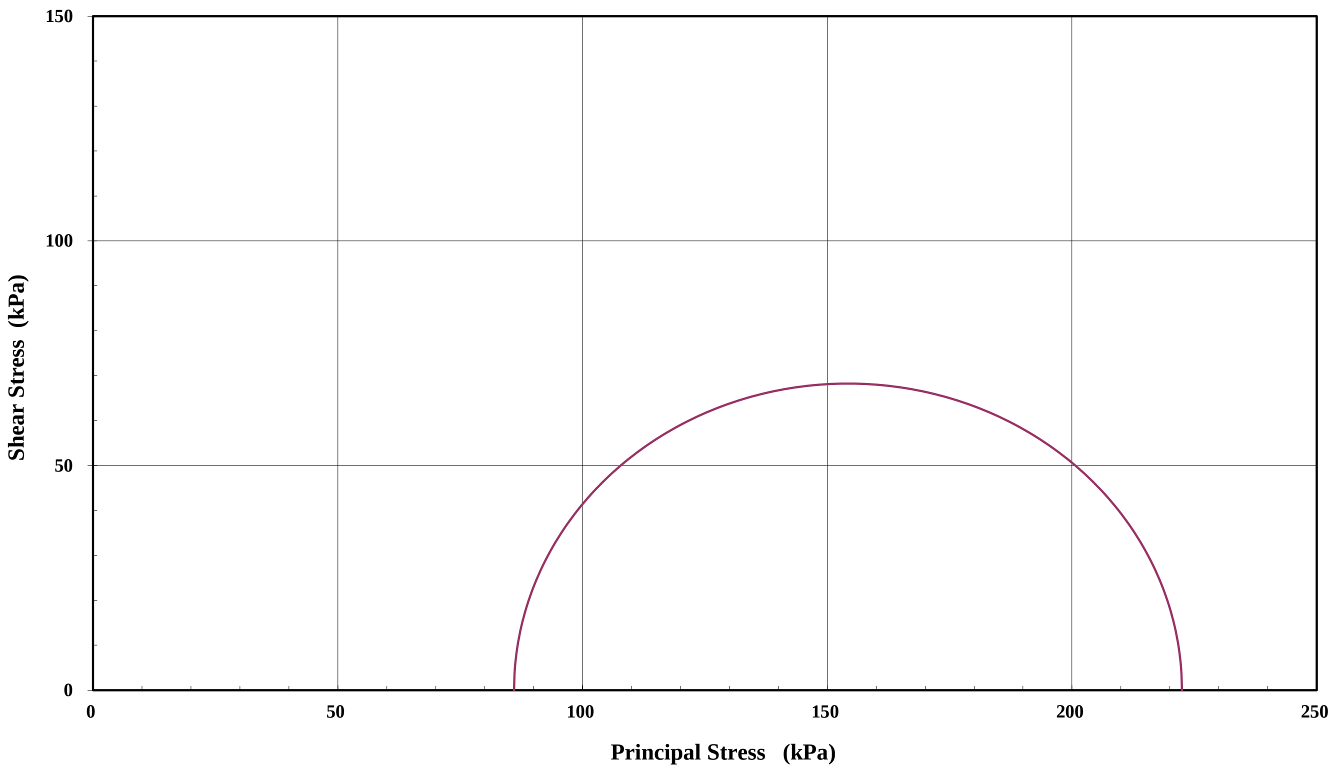
Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

SAMPLE & TEST DETAILS

Initial Height:	128.9	mm	Initial Moisture Content:	14.1	%	Rate of Strain:	0.006	%/min
Initial Diameter:	63.0	mm	Final Moisture Content:	22.4	%	B Response:	97	%
L/D Ratio:	2.0 : 1		Wet Density:	1.89	t/m^3			
			Dry Density:	1.66	t/m^3			

Mohr Circle Diagram



Interpretation between stages :

Cohesion C' (kPa) :

Angle of Shear Resistance Φ' (Degrees) :

Failure Criteria: Peak Principal Stress Ratio

Sample Type:	Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content
Sample/s supplied by the client	Note: Graph not to scale

REP03001

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory Number 9926

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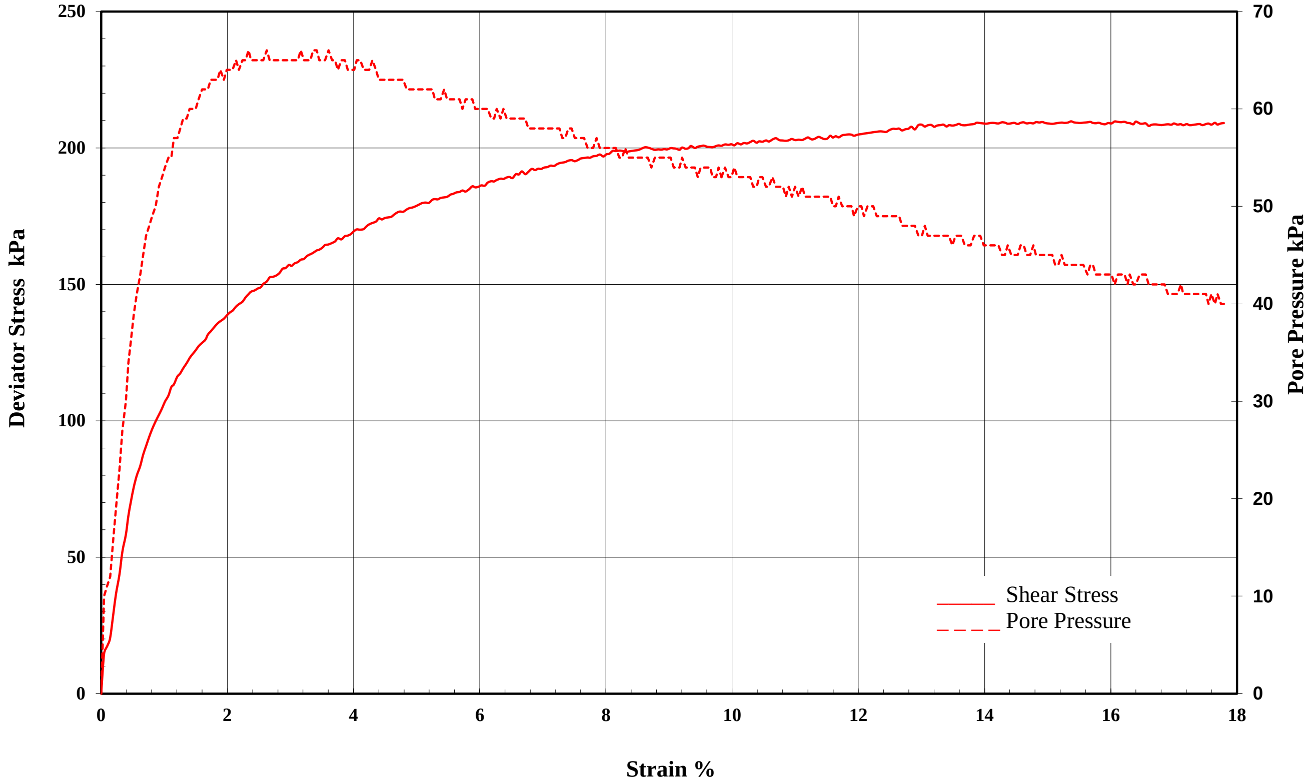
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Stress/Strain & Pore Pressure/Strain Diagram



FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
150 kPa	647 kPa	497 kPa	497 kPa	561 kPa	222 kPa	86 kPa	2.587	136 kPa	1.89 %

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale — **Page 2**

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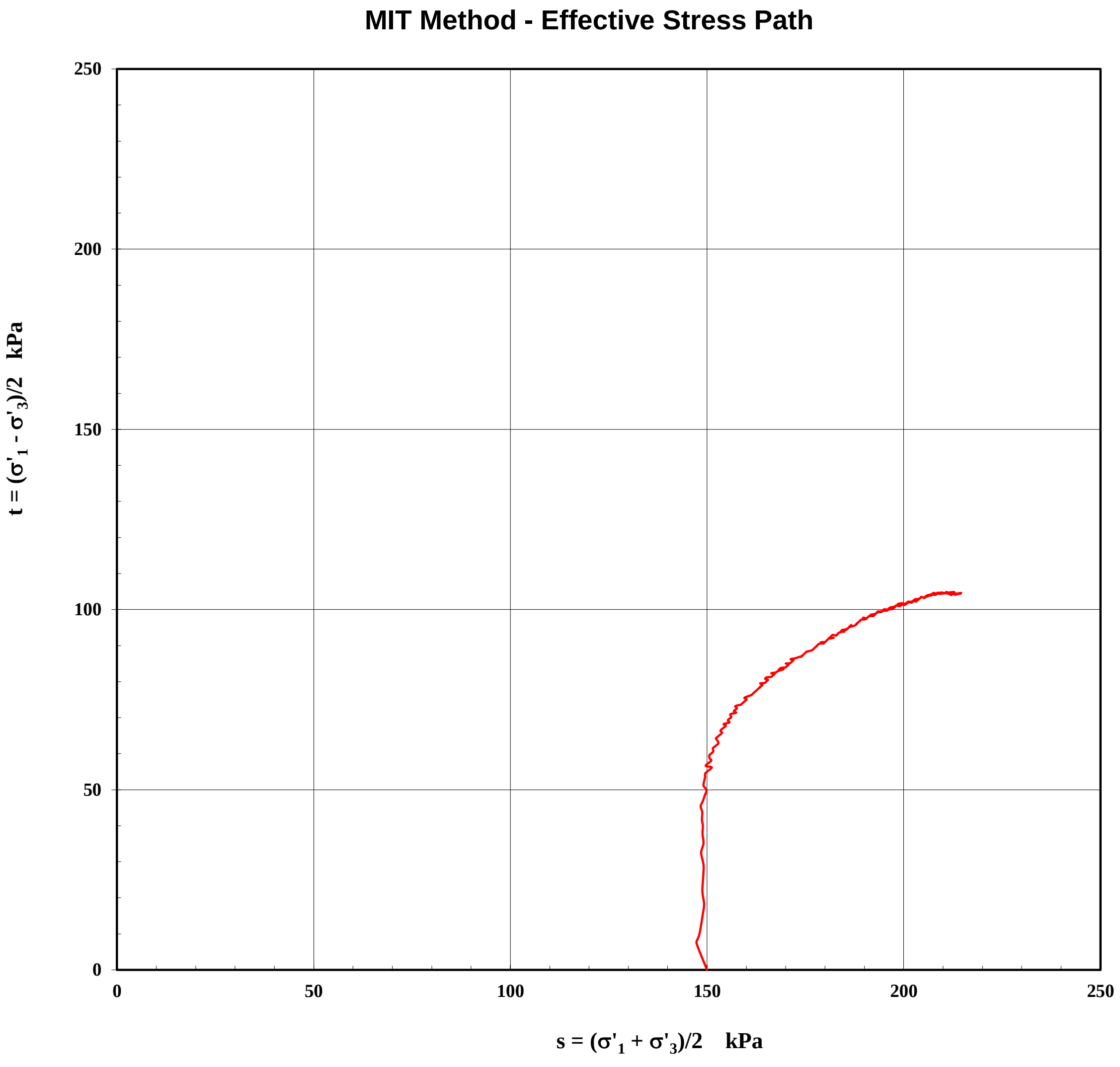
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		



Note: Graph not to scale.

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

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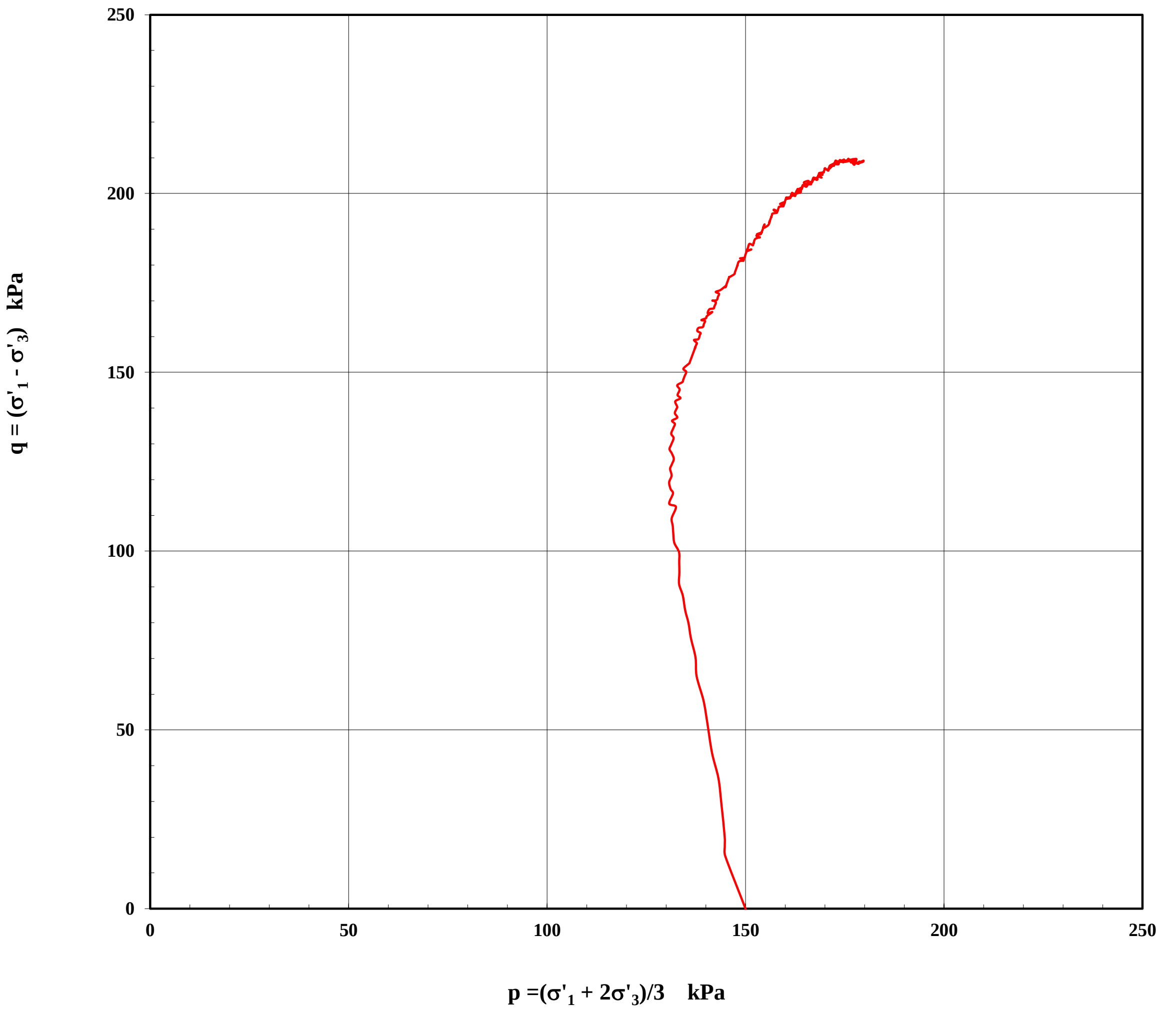
Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Cambridge Method - Effective Stress Path



Note: Graph not to scale.

Sample Type:	Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale — **Page 4**

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client | Note: Graph not to scale | **Page 5**

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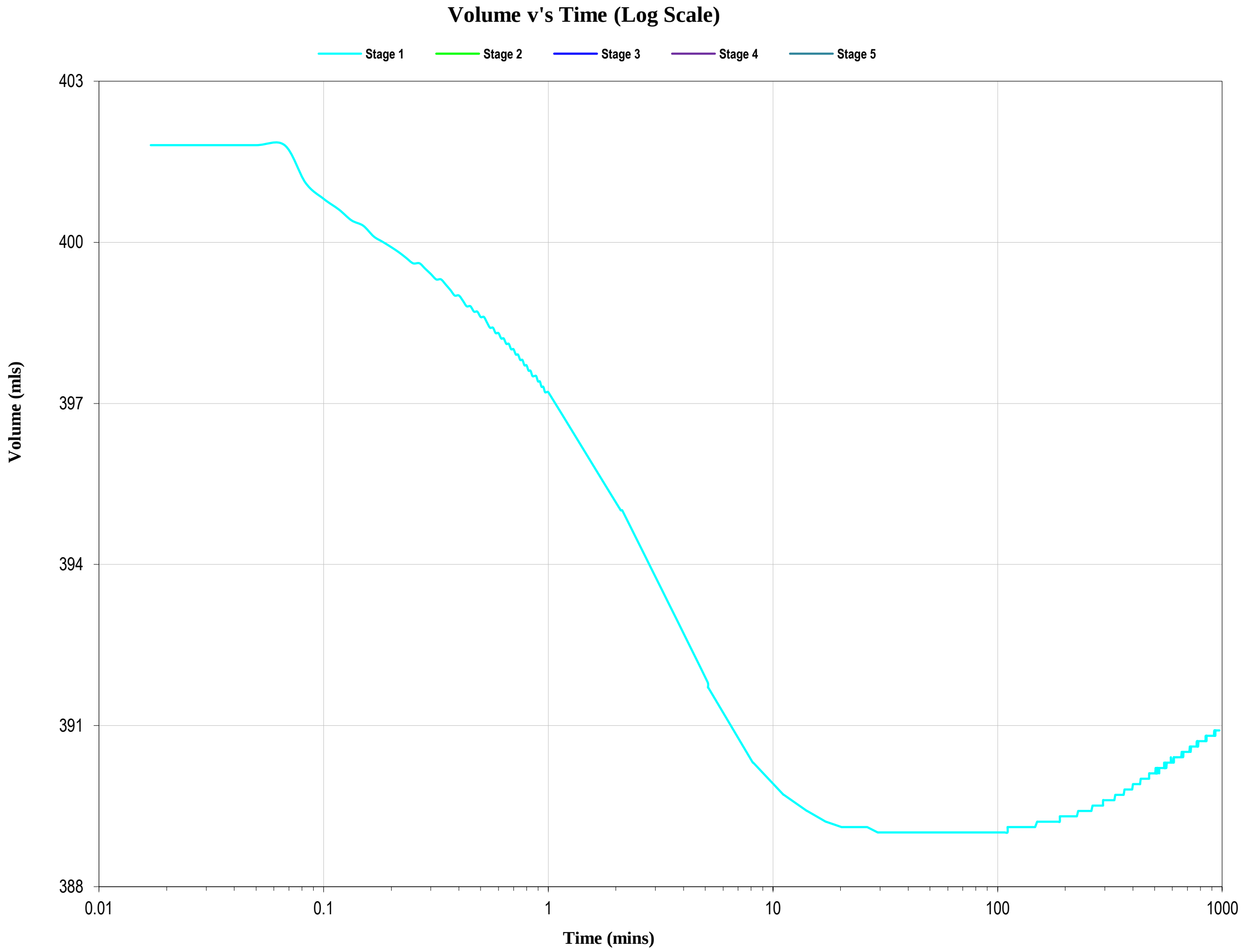
Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120164 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		



	Stage 1
Cv (m^2/year) **:**	8.27
Mv (m^2/MN) **:**	0.209
k (m/s) **:**	5.36E-10

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client Note: Graph not to scale

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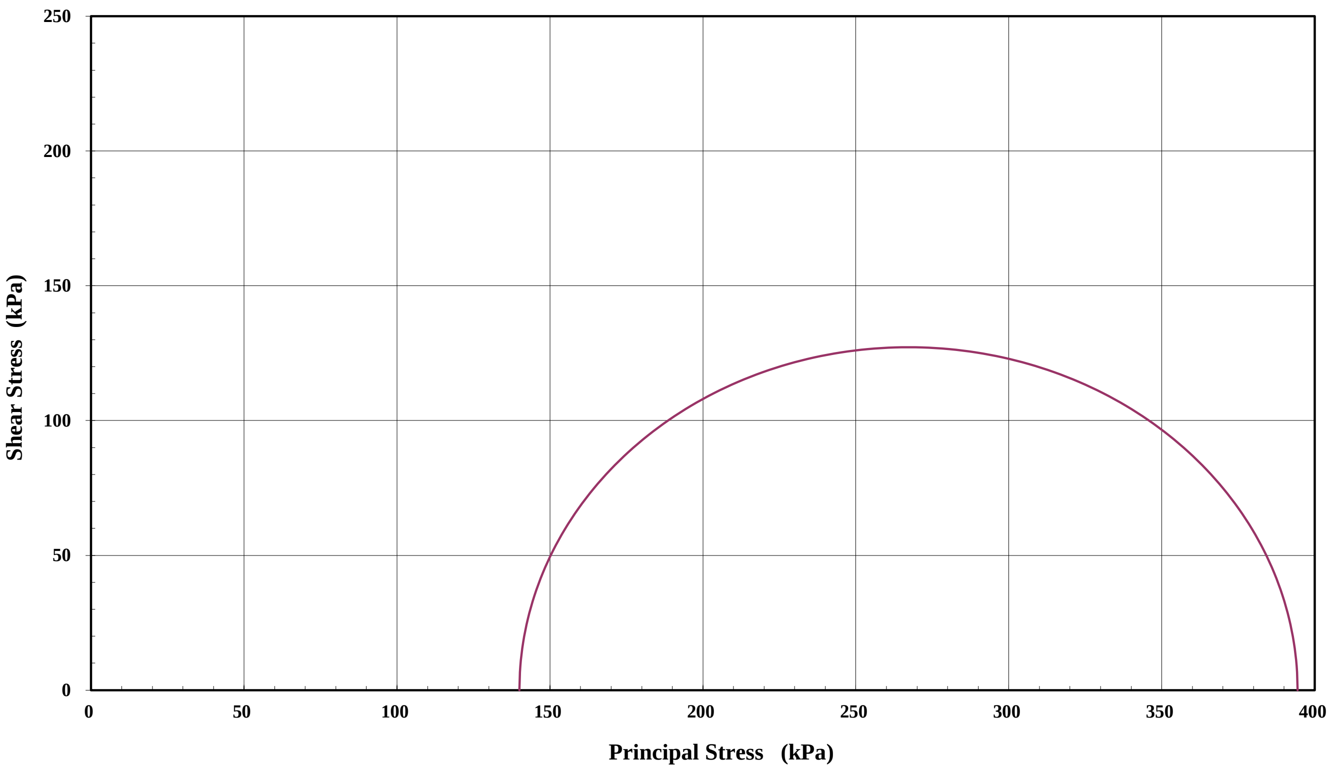
Client:	Golder Associates Pty Ltd	**Report No.:**	14120165 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

SAMPLE & TEST DETAILS

Initial Height:	129.0	mm	Initial Moisture Content:	14.1	%	Rate of Strain:	0.006	%/min
Initial Diameter:	63.0	mm	Final Moisture Content:	21.8	%	B Response:	97	%
L/D Ratio:	2.0 : 1		Wet Density:	1.89	t/m^3			
			Dry Density:	1.66	t/m^3			

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Principal Stress Ratio

Sample Type: Single Individual Specimen remouded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client

Note: Graph not to scale

REP03001

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory
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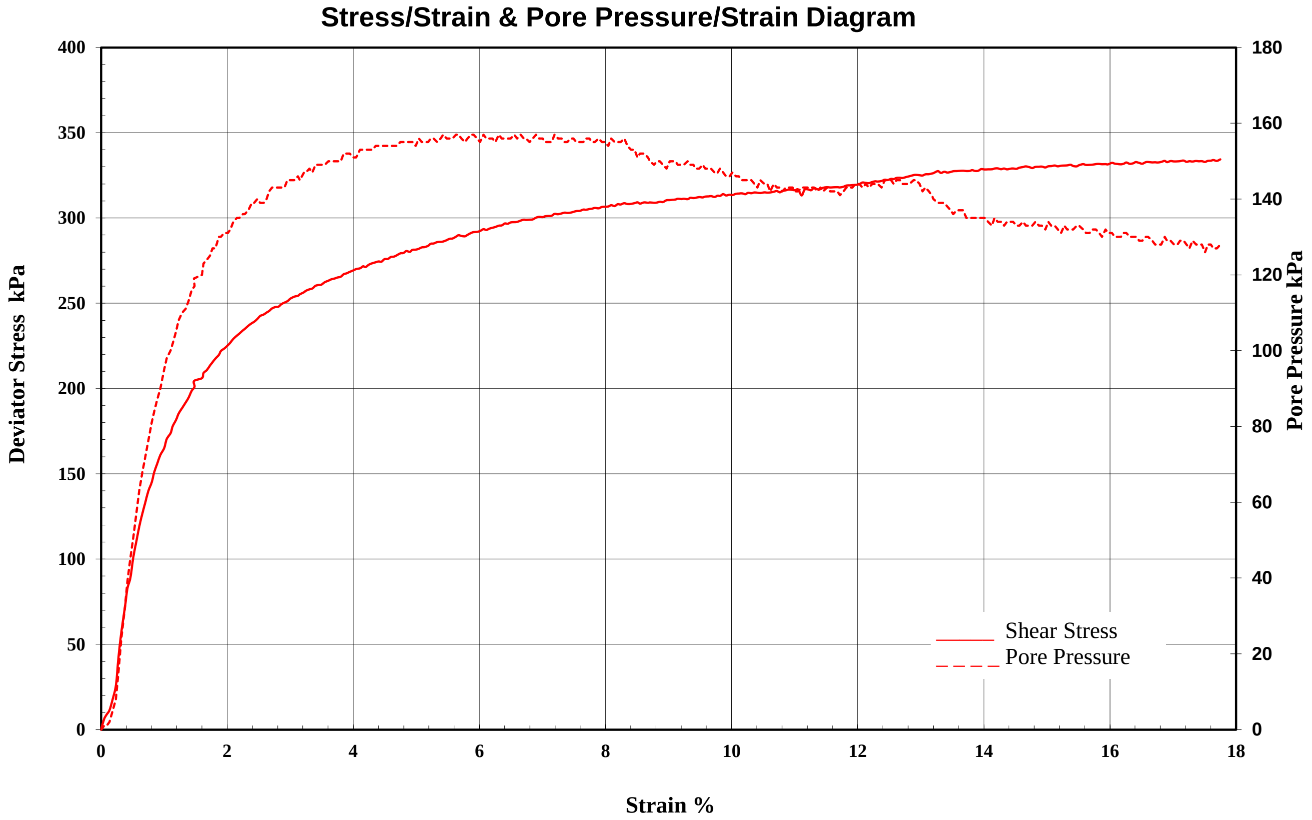
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120165 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		



FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
286 kPa	799 kPa	513 kPa	513 kPa	659 kPa	394 kPa	140 kPa	2.817	254 kPa	3.12 %

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client | Note: Graph not to scale | **Page 2**

REP03001

Accredited for compliance with ISO/IEC 17025.
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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory Number
9926

Trilab
Soil Rock Calibration

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346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

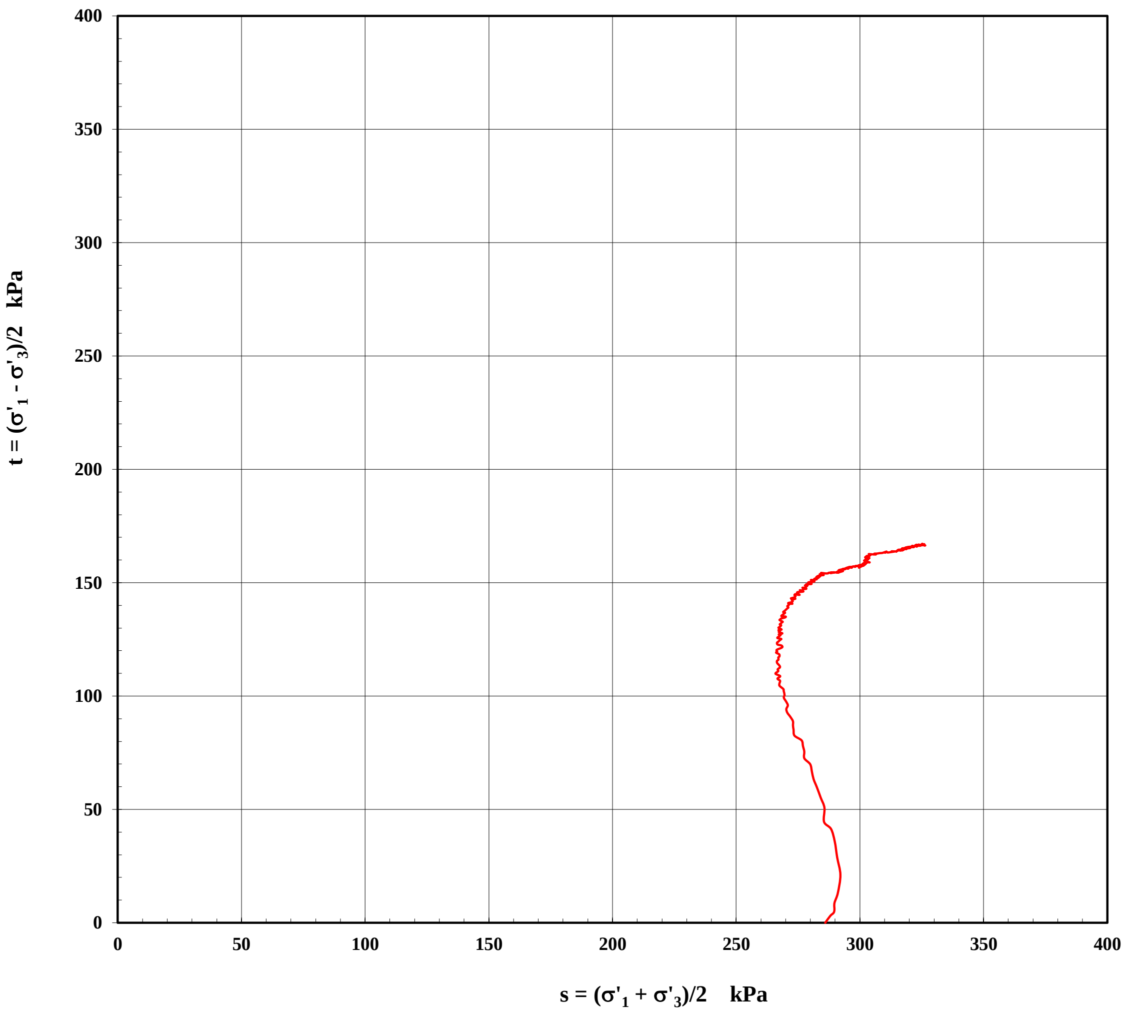
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120165 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

MIT Method - Effective Stress Path



Note: Graph not to scale.

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Sample/s supplied by the client

Note: Graph not to scale

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Test Method: AS1289.6.4.2

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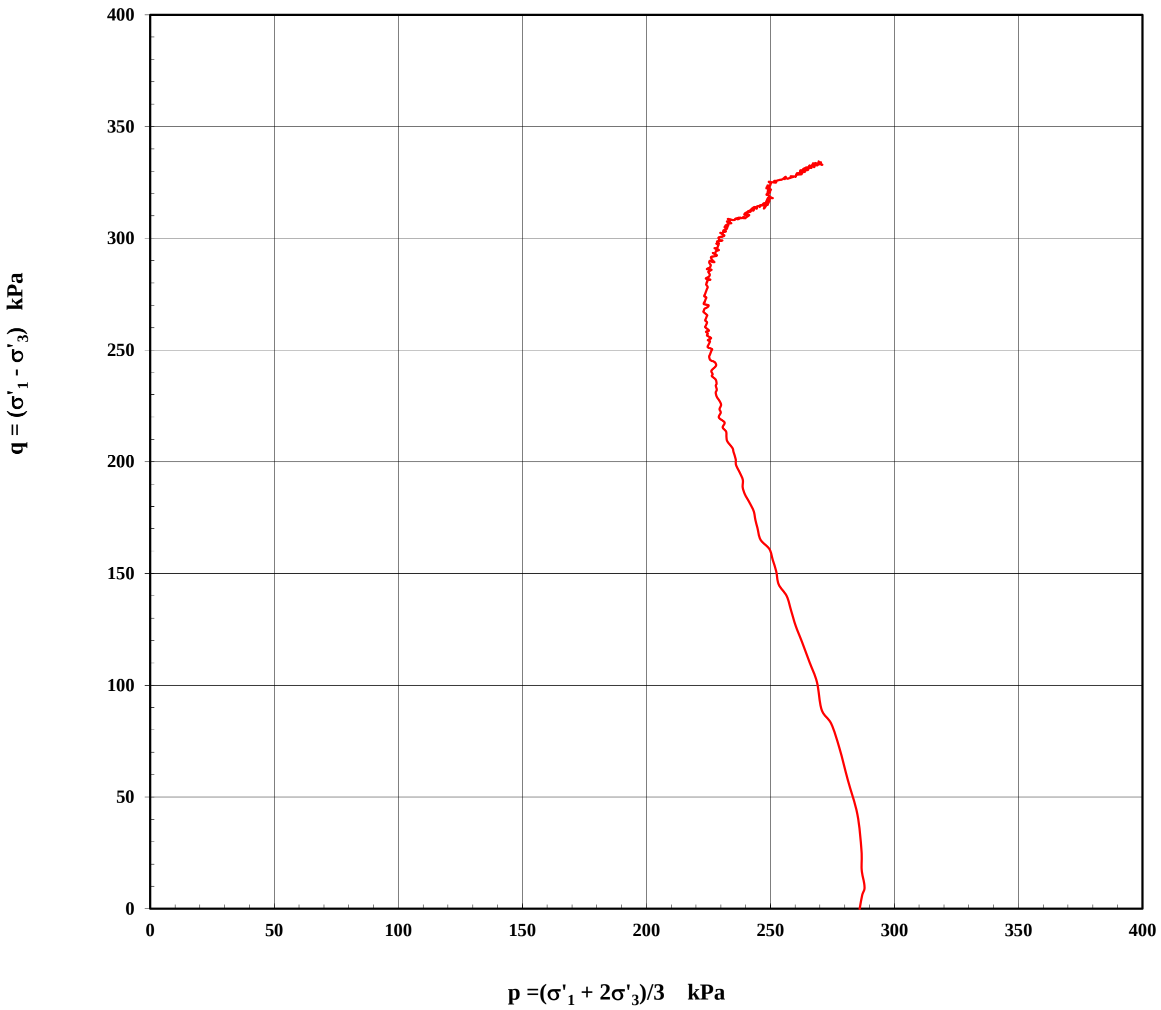
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Cambridge Method - Effective Stress Path



Note: Graph not to scale.

Sample Type:	Single Individual Specimen remoluded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale —

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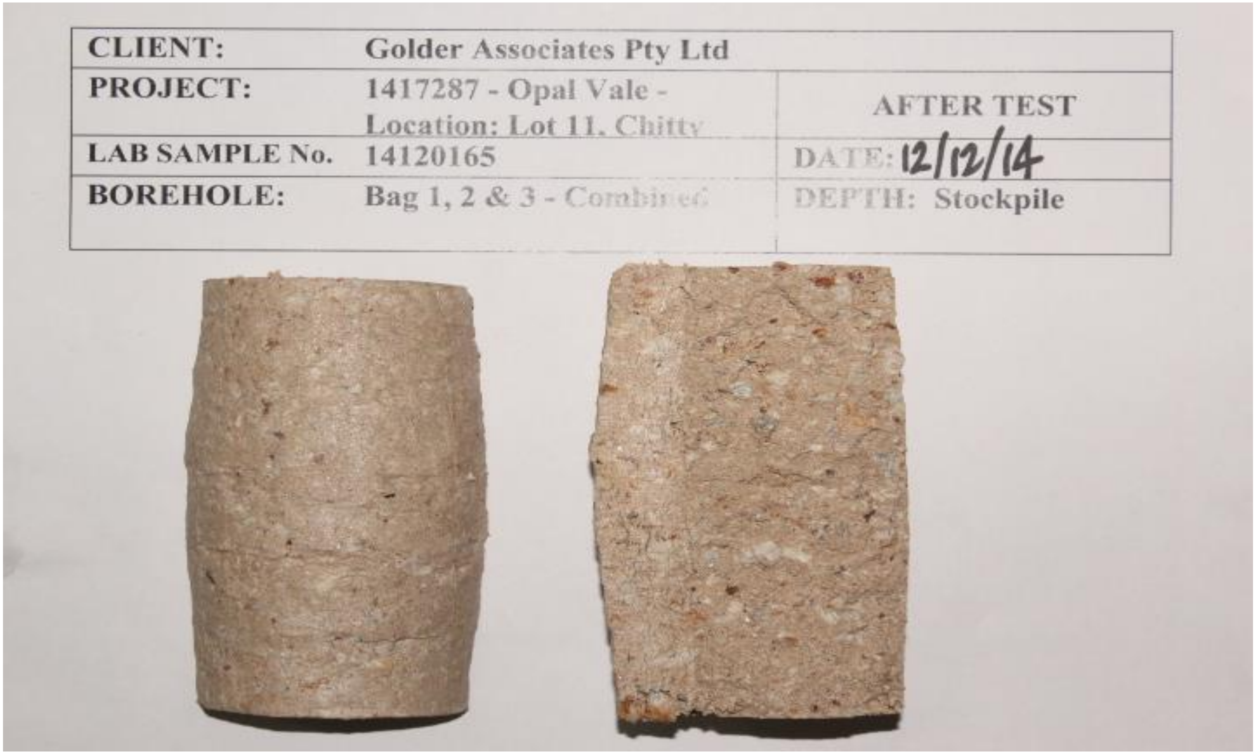
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120165 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		



Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale — **Page 5**

REP03001

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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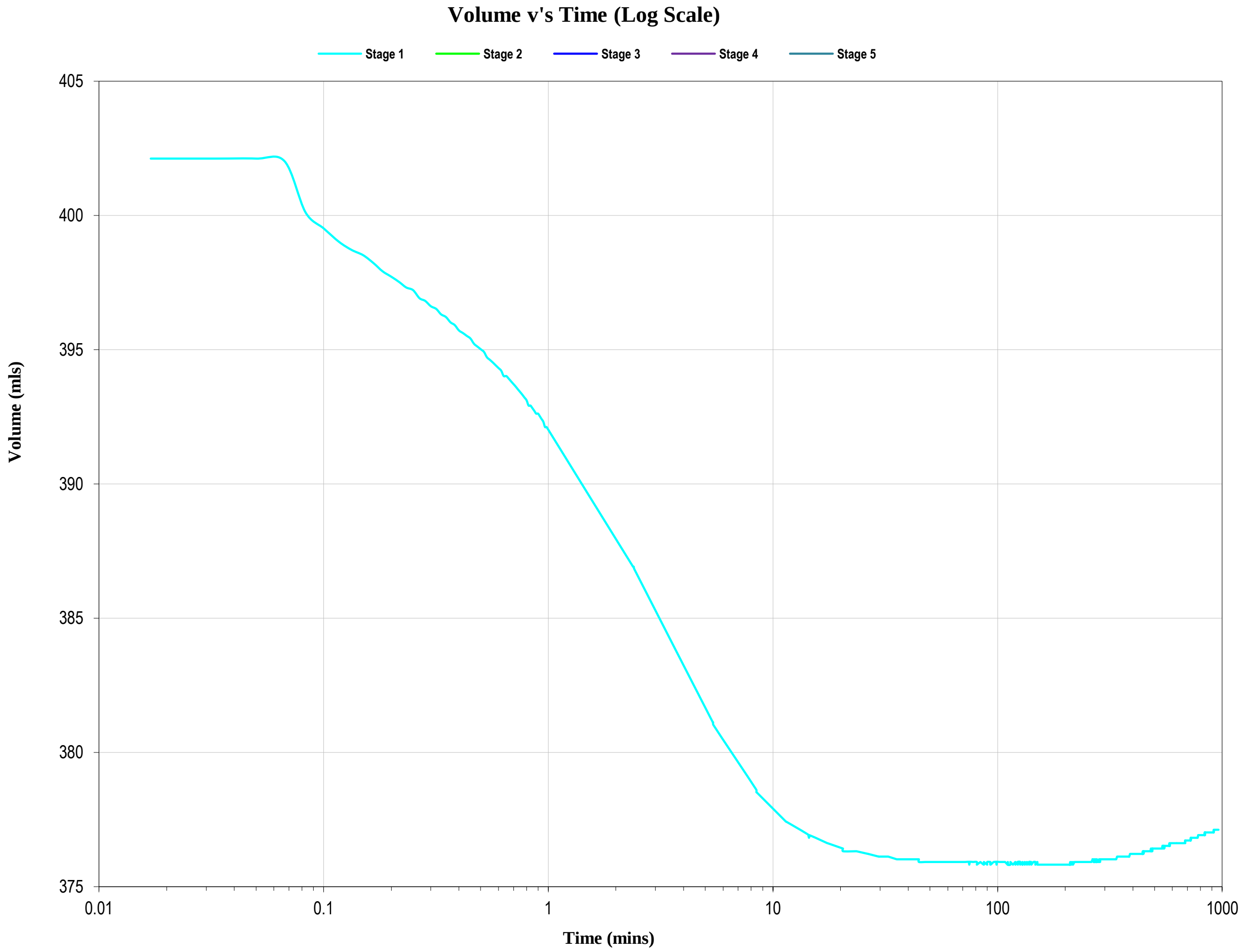
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120165 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile

Description: SILT-pale brown



	Stage 1
Cv (m^2/year) **:**	**8.63**
Mv (m^2/MN) **:**	**0.219**
k (m/s) **:**	**5.86E-10**

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale —

REP03001

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Authorised Signatory

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TRIAXIAL TEST REPORT

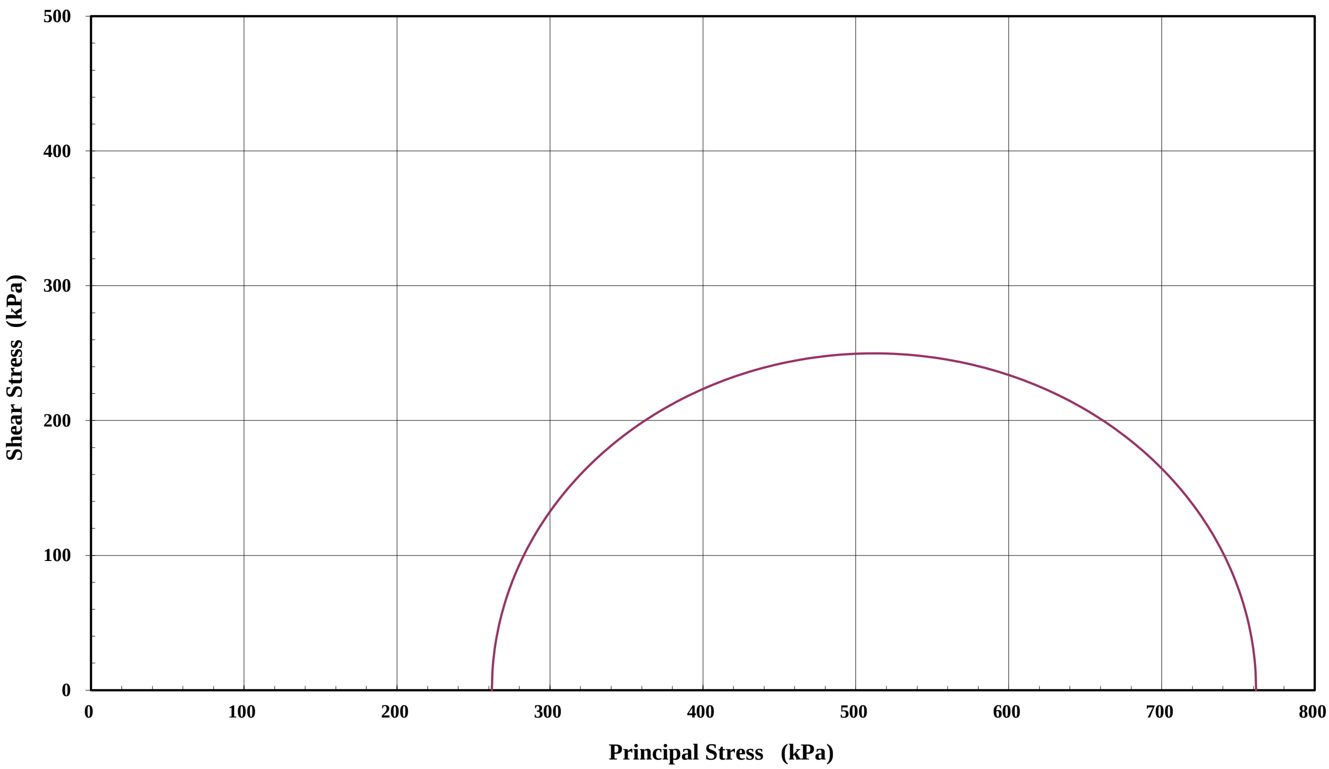
Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	14120166 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

SAMPLE & TEST DETAILS

Initial Height:	129.1	mm	Initial Moisture Content:	14.1	%	Rate of Strain:	0.006	%/min
Initial Diameter:	63.5	mm	Final Moisture Content:	20.8	%	B Response:	97	%
L/D Ratio:	2.0 : 1		Wet Density:	1.86	t/m^3			
			Dry Density:	1.63	t/m^3			

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Principal Stress Ratio

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client | Note: Graph not to scale | **Page 1**

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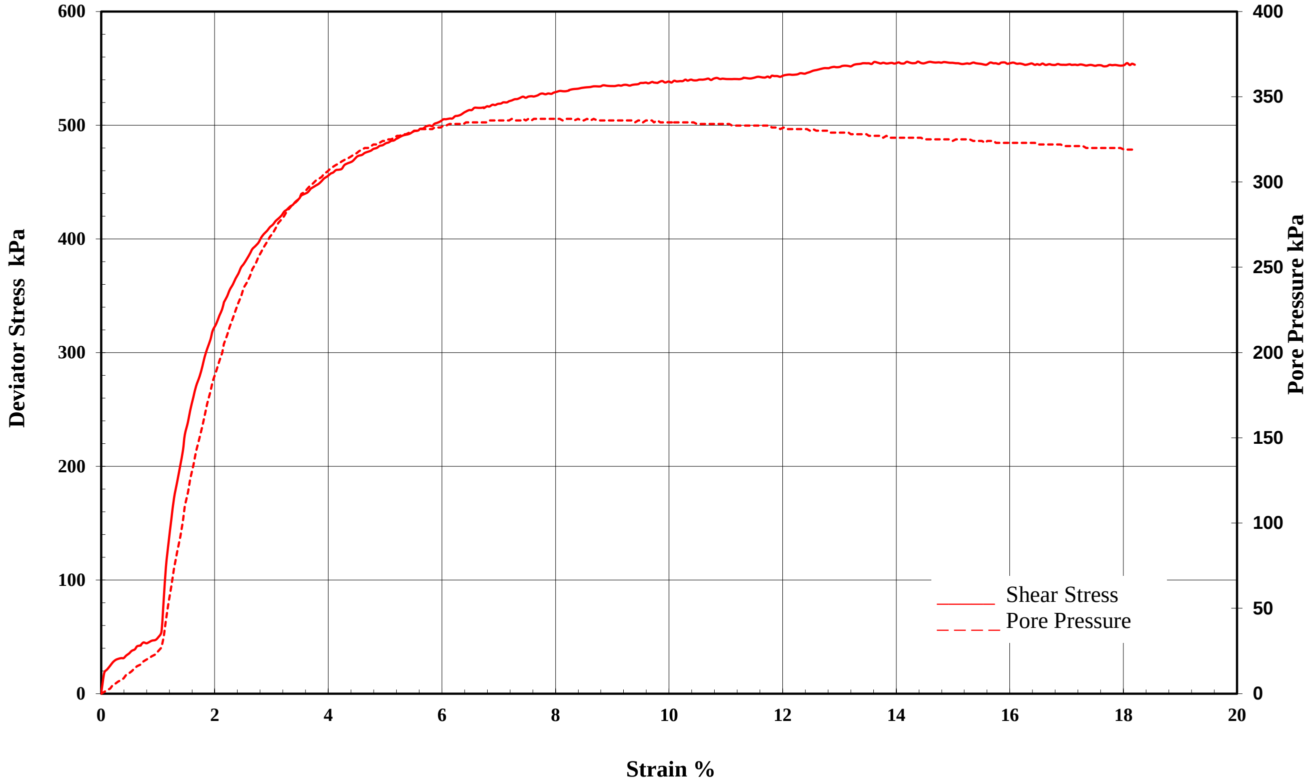
Client:	Golder Associates Pty Ltd	**Report No.:**	14120166 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Stress/Strain & Pore Pressure/Strain Diagram



FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
593 kPa	1090 kPa	497 kPa	497 kPa	828 kPa	762 kPa	262 kPa	2.907	500 kPa	5.78 %

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale — **Page 2**

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

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Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
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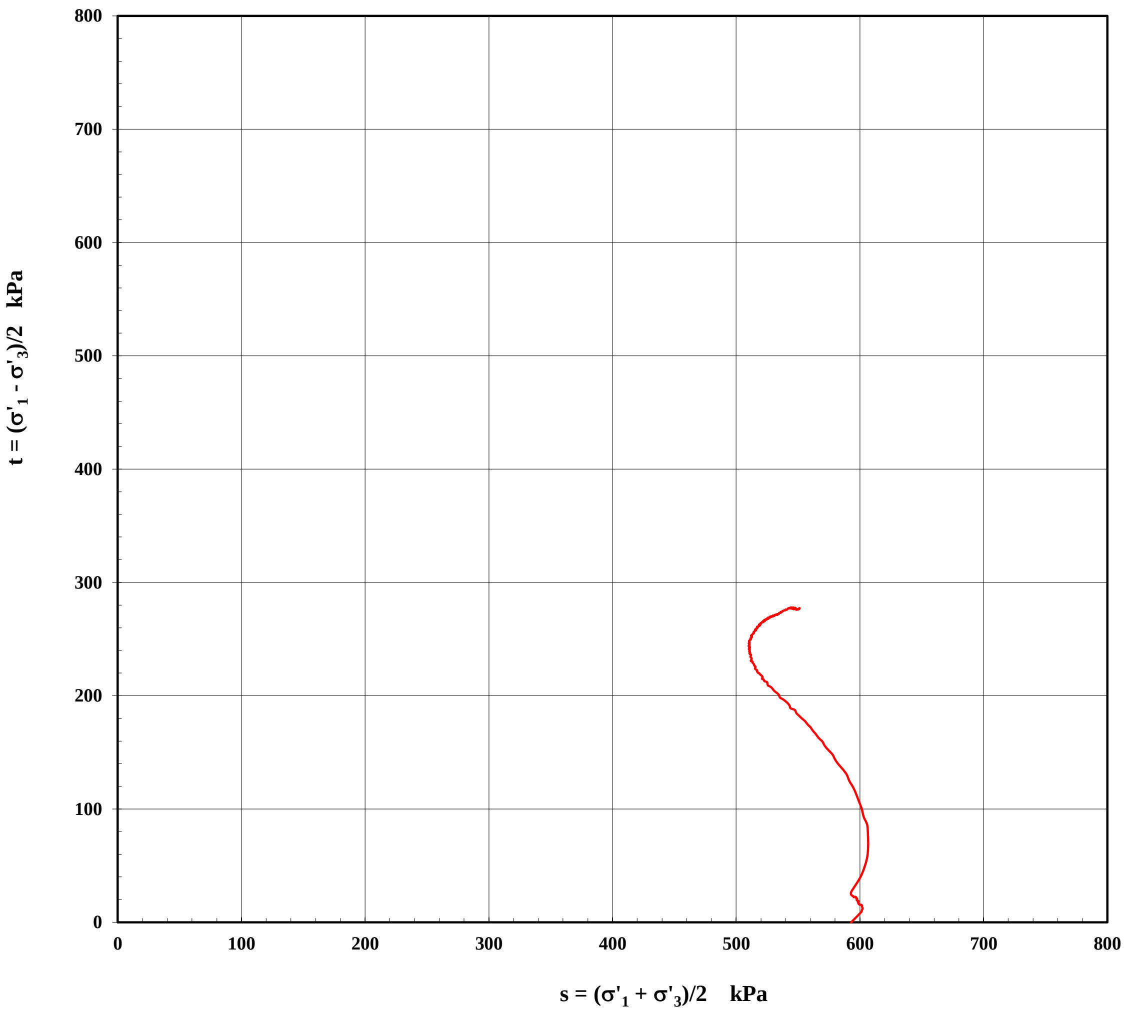
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

MIT Method - Effective Stress Path



Note: Graph not to scale.

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client Note: Graph not to scale **Page 3**

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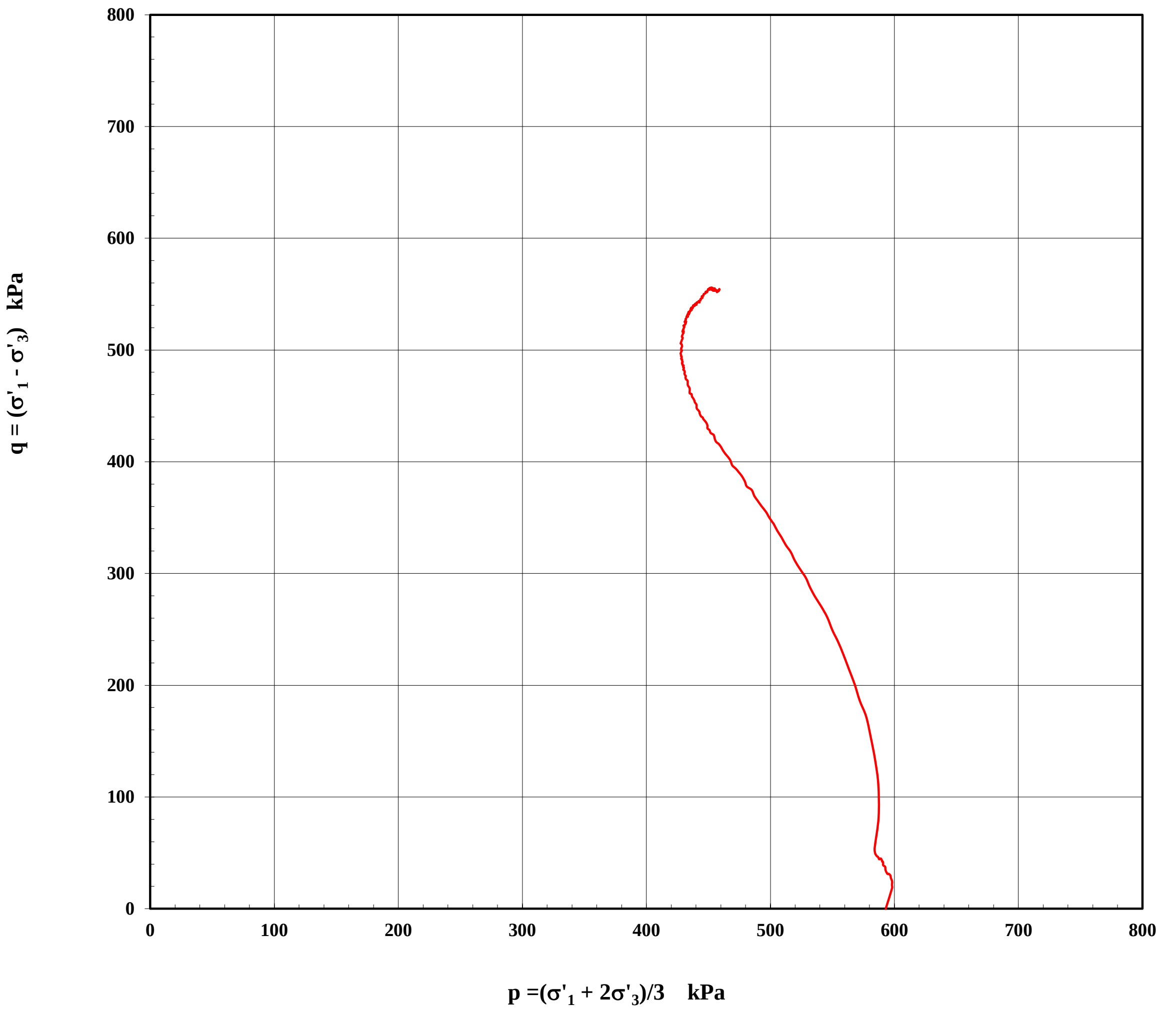
Client:	Golder Associates Pty Ltd	**Report No.:**	14120166 - CU
Project:	1417287 - Opal Vale - Location: Lot 11, Chitty Road, Toodyay	**Test Date:**	9/12/2014
		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		

Cambridge Method - Effective Stress Path



Note: Graph not to scale.

Sample Type:	Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale —

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		Report Date:	12/12/2014
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile

Description: SILT-pale brown

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client | Note: Graph not to scale | **Page 5**

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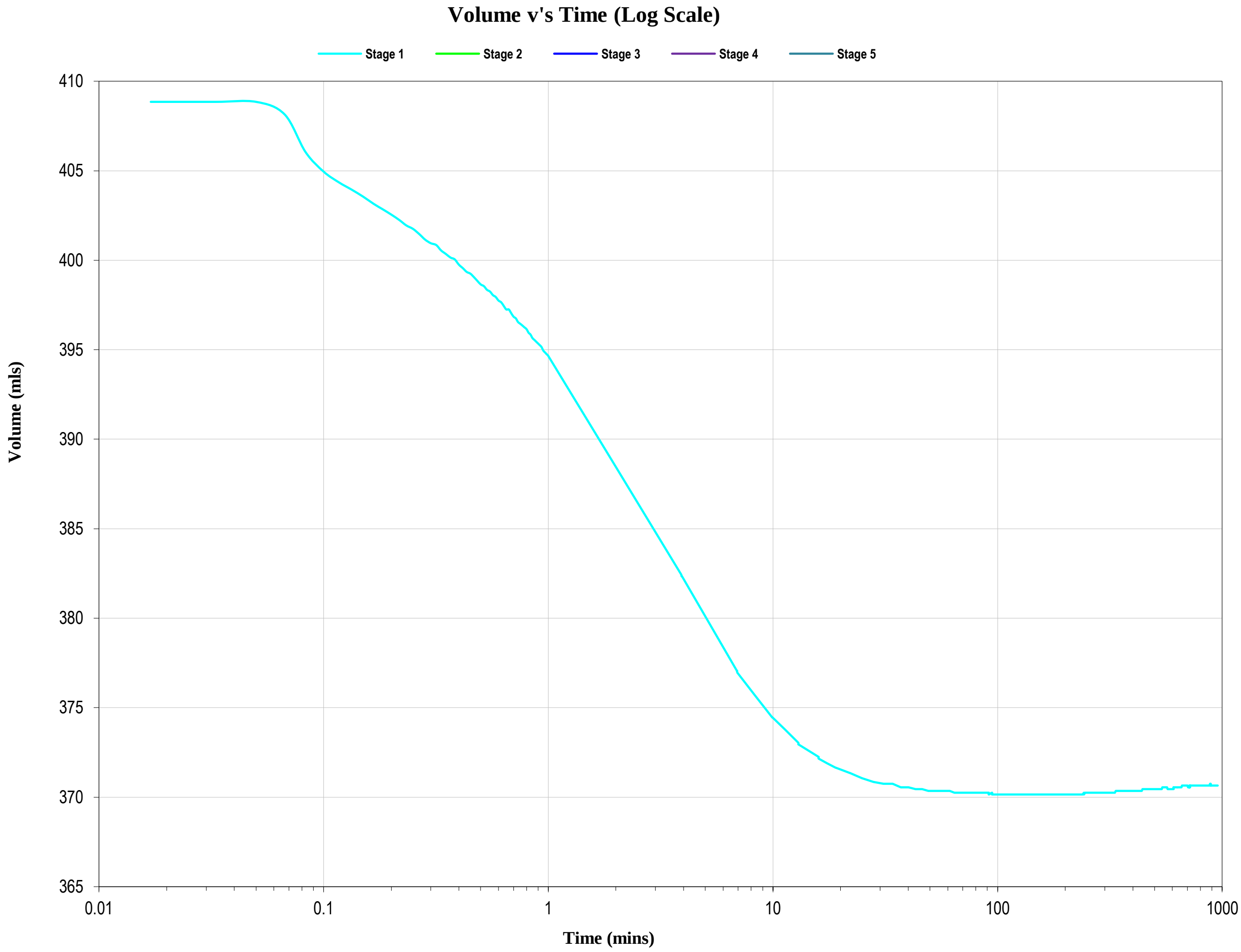
Client Id.:	Bag 1, 2 & 3 - Combined	**Depth (m):**	Stockpile
Description:	SILT-pale brown		



	Stage 1
Cv (m^2/year) **:**	**7.57**
Mv (m^2/MN) **:**	**0.152**
k (m/s) **:**	**3.57E-10**

Sample Type: Single Individual Specimen remoulded (-9.5mm material tested) to a target of 95% of Standard Maximum Dry Density at Optimum Moisture Content

Sample/s supplied by the client — Note: Graph not to scale

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ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	Golder Associates Pty Ltd	**Report No.**	P 14120001-AL
Project	1417287-Opal Vale. Lot 11 Chitty Road Toodyay	**Test Date**	04/12/2014
		Report Date	05/12/2014

Sample No.	14120001					
Client ID	Bag 1,2 & 3 sourced from stockpile combined					
Depth (m)	-					
Liquid Limit (%)	31					
Plastic Limit (%)	21					
Plasticity Index (%)	10					
Linear Shrinkage (%)	4.0					
Field Moisture Content (%)	10.2					

NOTES/REMARKS: The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Crumbling occurred + Curling occurred

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Tested at Trilab Perth Laboratory

Authorised Signatory
G. Creely

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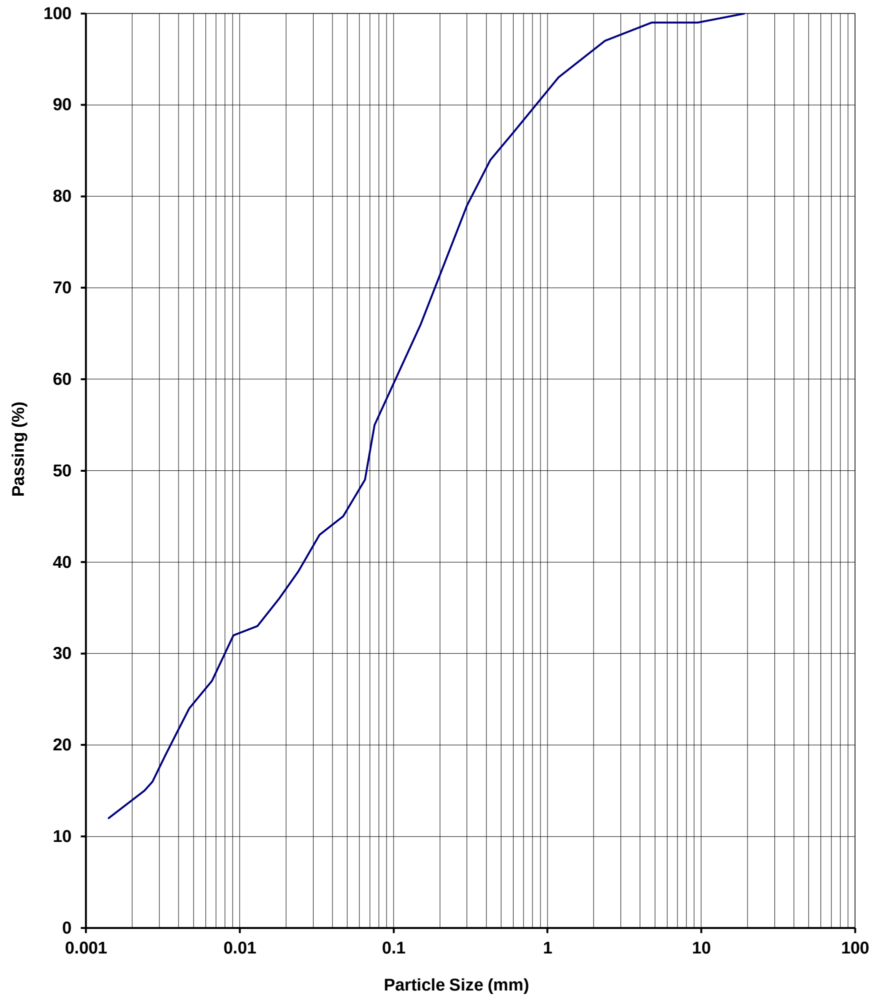
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1

Client	Golder Associates Pty Ltd	**Report No.**	P 14120001-G
Project	1417287-Opal Vale. Lot 11 Chitty Road Toodyay	**Test Date**	02/12/2014-08/12/2014
		Report Date	08/12/2014
Client ID	Bag 1,2 & 3 sourced from stockpile combined	**Depth (m)**	-

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	100
9.5	99
4.75	99
2.36	97
1.18	93
0.600	87
0.425	84
0.300	79
0.150	66
0.075	55
0.065	49
0.047	45
0.033	43
0.024	39
0.018	36
0.013	33
0.009	32
0.007	27
0.005	24
0.004	21
0.003	19
0.003	16
0.002	15
0.001	12



NOTES/REMARKS:

Moisture Content 10.2%

-2.36mm Soil Particle Density(t/m^3) 2.68

Sample/s supplied by the client

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Tested at Trilab Perth Laboratory

Authorised Signatory

G. Creely

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Laboratory No. 9926

APPENDIX B

Laboratory Test Certificates – Provided By IWP

Soil Test Results - SGS

SGS

ABN 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16259
Lab:	Welshpool	Sample ID:	Opal 1

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	Off white silty clay
EMERSON CLASS NUMBER:	**6**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16259-S318

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16259
Lab:	Welshpool	Sample ID:	Opal 1

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2	
Liquid Limit (%)	38
AS 1289.3.2.1	
Plastic Limit (%)	24
AS 1289.3.3.2	
Plasticity Index (%)	14
AS 1289.3.4.1	
Linear Shrinkage (%)	4.0
History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	125

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16259-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09
Client Address: 25 Heather Road Roleystone WA 6111

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

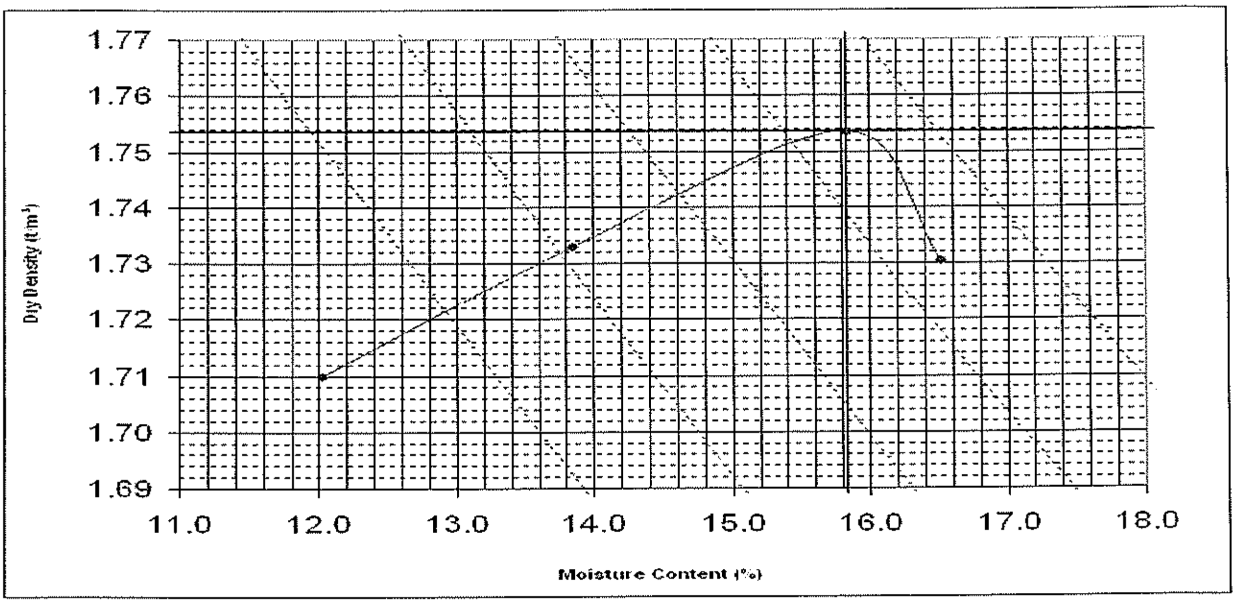
TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	15/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16259
Lab:	Welshpool	Sample ID:	Opal 1

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort	
Maximum Dry Density (t/m^3):	**1.75**
Optimum Moisture Content (%)	**16.0**
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.47

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

NATA

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Site No.: 2411
Cert No.: 10-MT-16259-S400

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009
Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	20/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16259
Lab:	Welshpool	Sample ID:	Opal 1

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m^3):
Max. Dry Density :	1.75 t/m^3
Optimum Moisture Content	15.8 %
Dry Density	1.71 t/m^3
Dry Density Ratio :	97.7 %
Moisture Content:	15.9 %
Moisture Ratio:	100.5 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,610 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	2
COEFFICIENT OF PERMEABILITY	
m/sec at 20 ° C	**7.2E-09**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010
Site No.: 2411
Cert No.: 10-MT-16259-S800

Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010
Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16260
Lab:	Welshpool	Sample ID:	Opal 2

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	Grey white clay
EMERSON CLASS NUMBER:	**6**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16260-S318

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009
Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN. 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	22/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16260
Lab:	Welshpool	Sample ID:	Opal 2

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2	
Liquid Limit (%)	35
AS 1289.3.2.1	
Plastic Limit (%)	22
AS 1289.3.3.2	
Plasticity Index (%)	13
AS 1289.3.4.1	
Linear Shrinkage (%)	5.5
History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	126

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16260-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09
Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

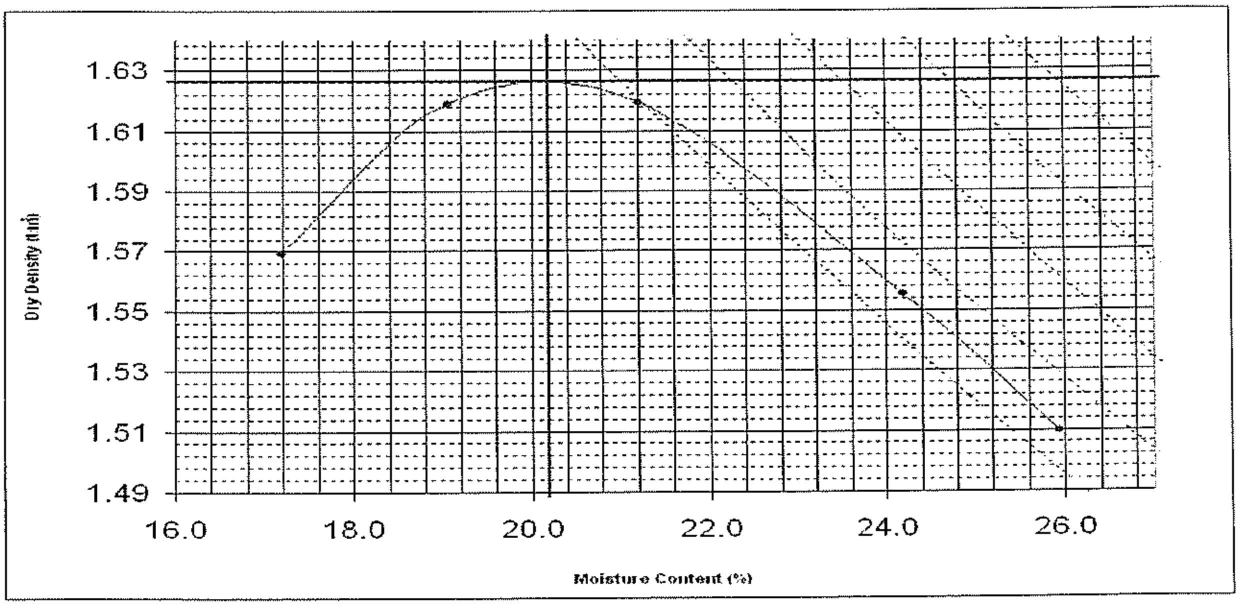
TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	18/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16260
Lab:	Welshpool	Sample ID:	Opal 2

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m^3):	**1.63**
Optimum Moisture Content (%)	**20.0**
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.81

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16260-S400

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009
Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16260
Lab:	Welshpool	Sample ID:	Opal 2

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m³):
Max. Dry Density :	1.63 t/m³
Optimum Moisture Content	20.2 %
Dry Density	1.60 t/m³
Dry Density Ratio :	98.4 %
Moisture Content:	19.9 %
Moisture Ratio:	98.5 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,606 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	0

COEFFICIENT OF PERMEABILITY

m/sec at 20 ° C **3.9E-09**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010

Site No.: 2411
Cert No.: 10-MT-16260-S800

Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010
Client Address: 25 Heather Road Roleystone WA 6111

TEST CERTIFICATE

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16261
Lab:	Welshpool	Sample ID:	Opal 3

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	Off white silty clay
EMERSON CLASS NUMBER:	**6**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

This document is issued in accordance with NATA's accreditation requirements

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009

Site No.: 2411
Cert No.: 10-MT-16261-S318

Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

ABN. 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	22/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16261
Lab:	Welshpool	Sample ID:	Opal 3

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2	
Liquid Limit (%)	36
AS 1289.3.2.1	
Plastic Limit (%)	23
AS 1289.3.3.2	
Plasticity Index (%)	13
AS 1289.3.4.1	
Linear Shrinkage (%)	5.0
History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	125

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16261-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09

Client Address: 25 Heather Road Roleystone WA 6111

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

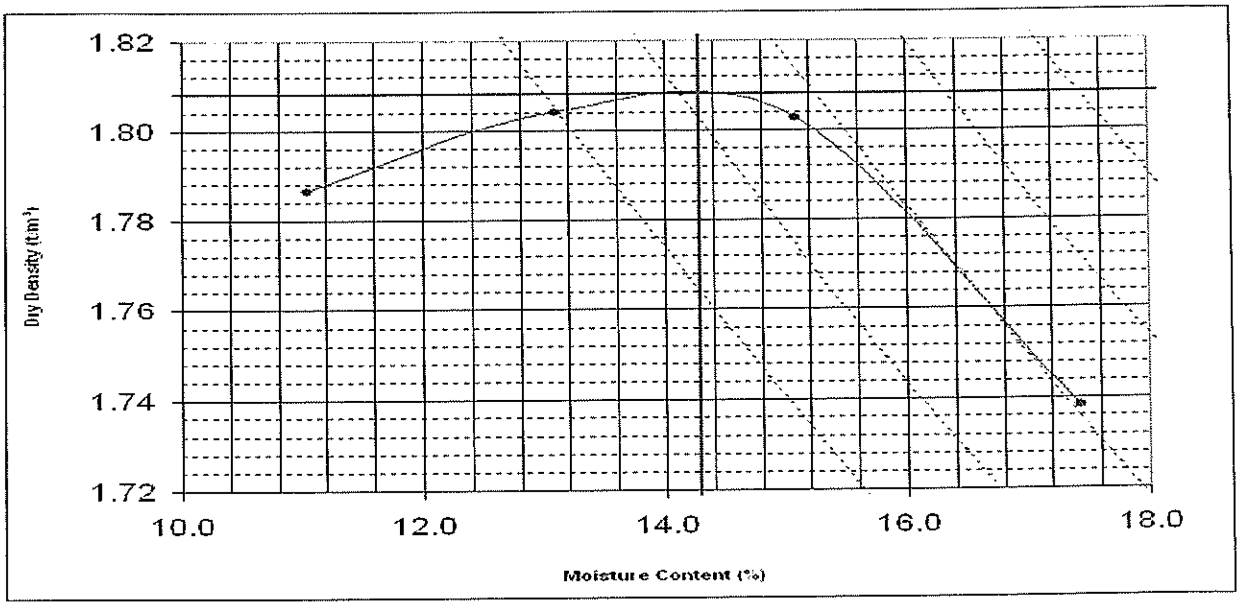
TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	15/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16261
Lab:	Welshpool	Sample ID:	Opal 3

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m^3):	1.81
Optimum Moisture Content (%)	14.5
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.64

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16261-S400

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph. 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	20/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16261
Lab:	Welshpool	Sample ID:	Opal 3

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m³):
Max. Dry Density :	1.81 t/m³
Optimum Moisture Content	14.3 %
Dry Density	1.76 t/m³
Dry Density Ratio :	97.4 %
Moisture Content:	14.1 %
Moisture Ratio:	99.0 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,598 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	1

COEFFICIENT OF PERMEABILITY

m/sec at 20 ° C **5.8E-09**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010
Site No.: 2411
Cert No.: 10-MT-16261-S800

Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx' (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16262
Lab:	Welshpool	Sample ID:	Opal 4

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	Grey white clay
EMERSON CLASS NUMBER:	6

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16262-S318
Page: 1

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16262
Lab:	Welshpool	Sample ID:	Opal 4

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2	
Liquid Limit (%)	39
AS 1289.3.2.1	
Plastic Limit (%)	24
AS 1289.3.3.2	
Plasticity Index (%)	15
AS 1289.3.4.1	
Linear Shrinkage (%)	2.5
History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	125

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16262-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

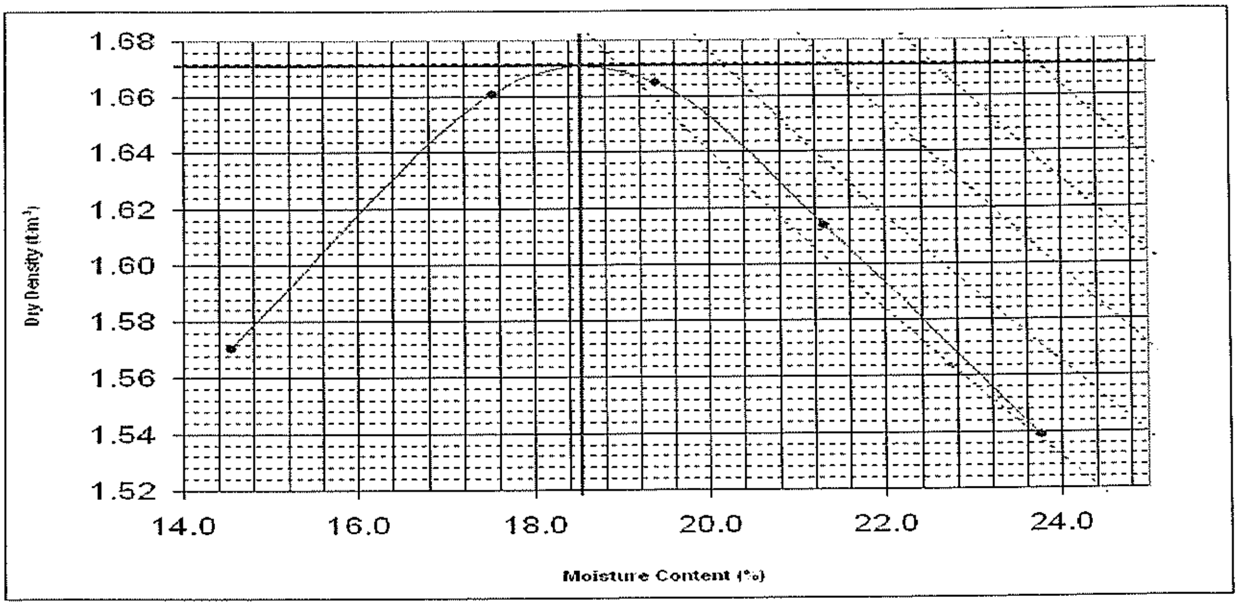
TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16262
Lab:	Welshpool	Sample ID:	Opal 4

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m^3):	1.67
Optimum Moisture Content (%)	18.5
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.77

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

Site No.: 2411
Cert No.: 10-MT-16262-S400

ABN. 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16262
Lab:	Welshpool	Sample ID:	Opal 4

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m^3):
Max. Dry Density :	1.67 t/m^3
Optimum Moisture Content	18.5 %
Dry Density	1.64 t/m^3
Dry Density Ratio :	98.1 %
Moisture Content:	18.2 %
Moisture Ratio:	98.0 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,597 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	2

COEFFICIENT OF PERMEABILITY

m/sec at 20 ° C **6.8E-08**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010

Site No.: 2411
Cert No.: 10-MT-16262-S800

Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16263
Lab:	Welshpool	Sample ID:	Opal 5

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	white silty clay
EMERSON CLASS NUMBER:	6

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16263-S318

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	22/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16263
Lab:	Welshpool	Sample ID:	Opal 5

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2	
Liquid Limit (%)	35
AS 1289.3.2.1	
Plastic Limit (%)	24
AS 1289.3.3.2	
Plasticity Index (%)	11
AS 1289.3.4.1	
Linear Shrinkage (%)	2.5
History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	125

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16263-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

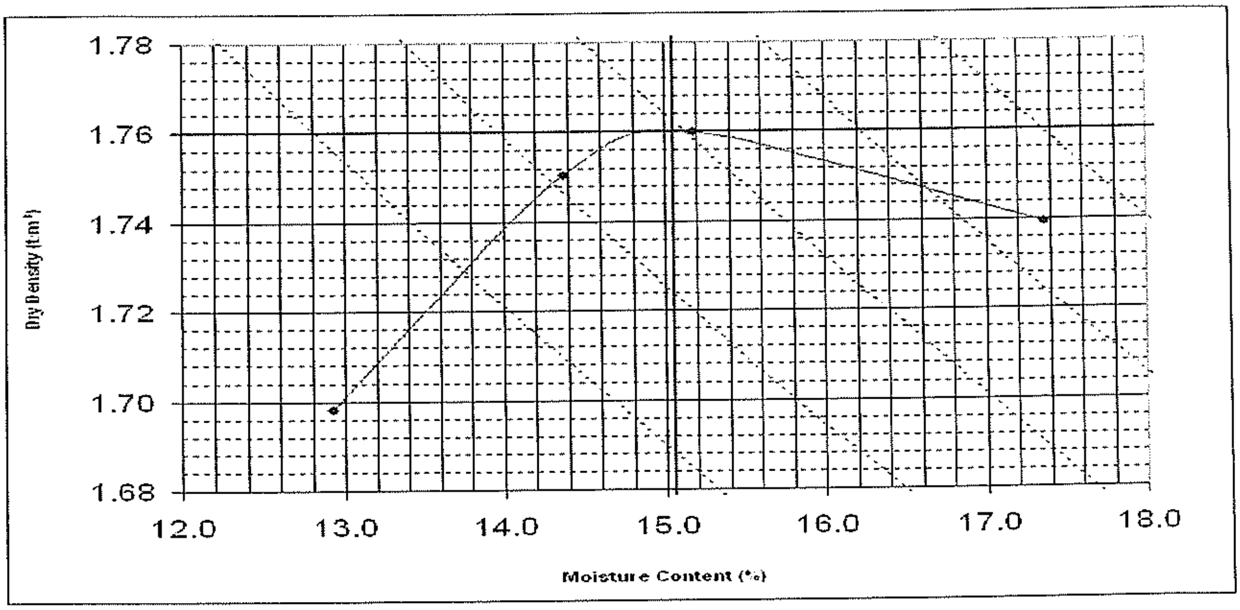
TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	16/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16263
Lab:	Welshpool	Sample ID:	Opal 5

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m^3):	**1.76**
Optimum Moisture Content (%)	**15.0**
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.53

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

This document is issued in accordance with NATA's accreditation requirements

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

Site No.: 2411
Cert No.: 10-MT-16263-S400

SGS

TEST CERTIFICATE

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16263
Lab:	Welshpool	Sample ID:	Opal 5

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m³):
Max. Dry Density :	1.76 t/m³
Optimum Moisture Content	15.1 %
Dry Density	1.72 t/m³
Dry Density Ratio :	98.0 %
Moisture Content:	15.1 %
Moisture Ratio:	100.0 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,592 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	9
COEFFICIENT OF PERMEABILITY	
m/sec at 20 ° C	**2.2E-08**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010
Site No.: 2411
Cert No.: 10-MT-16263-S800

Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010

Client Address: 25 Heather Road Roleystone WA 6111

SGS

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	17/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16264
Lab:	Welshpool	Sample ID:	Opal 6

DETERMINATION OF EMERSON CLASS NUMBER OF A SOIL

AS1289.3.8.1

Soil Description	White silty clay
EMERSON CLASS NUMBER:	6

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16264-S318

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S318.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16264
Lab:	Welshpool	Sample ID:	Opal 6

PLASTICITY INDEX

AS 1289.3.9.2(Single Point Cone Method), 3.2.1(Plastic Limit), 3.3.2(Plasticity Index), 3.4.1(Linear Shrinkage)

AS 1289.3.9.2
Liquid Limit (%) 39

AS 1289.3.2.1
Plastic Limit (%) 23

AS 1289.3.3.2
Plasticity Index (%) 16

AS 1289.3.4.1
Linear Shrinkage (%) 4.5

History of Sample	Oven Dried at <50°C
Method of preparation	Dry Sieved
Nature of Shrinkage	Flat
Length of mould (mm)	125

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews) Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16264-S324

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S324.LCER/D/02.09.09

Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

This document is issued by the Company subject to its General Conditions of Service (www.sgs.com/terms_and_conditions.htm). Attention is drawn to the limitations of liability, indemnification and jurisdictional issues established therein.

This document is to be treated as an original within the meaning of UCP 600. Any holder of this document is to be advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorised alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

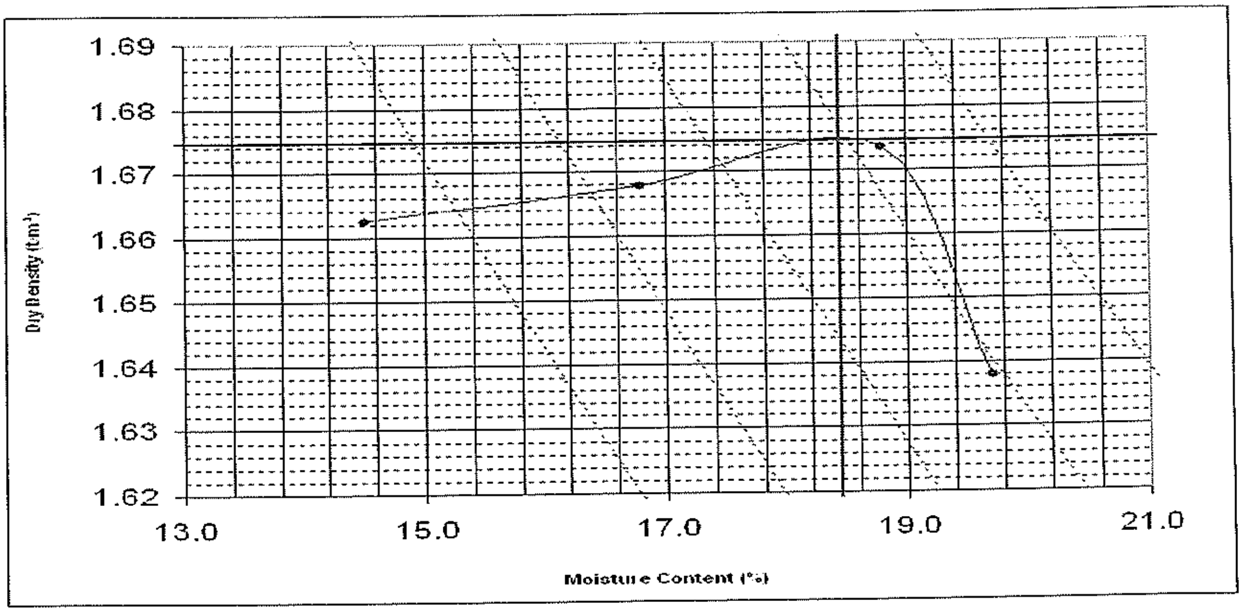
ABN: 44 000 964 278
ph: 1300 781 744
fx: (08) 9458 3700

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	16/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16264
Lab:	Welshpool	Sample ID:	Opal 6

DRY DENSITY/MOISTURE CONTENT RELATIONSHIP OF A SOIL

AS 1289.5.1.1 (Standard Compactive Effort)



Standard Effort

Maximum Dry Density (t/m^3):	1.67
Optimum Moisture Content (%)	18.5
% Retained 37.5 mm	0
% Retained 19.0mm	0

Air Voids: Voids %: 0 - 2 - 4 - 6 - 8 at SPD: 2.50

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Site No.: 2411
Cert No.: 10-MT-16264-S400

Accreditation No.: 2418 Form No.PF-(AU)-[IND(MTE)]-TE-S400.LCER/A/01.01.2009

Client Address: 25 Heather Road Roleystone WA 6111

SGS

TEST CERTIFICATE

SGS Australia Pty Ltd
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

ABN: 44 000 964 278
ph. 1300 781 744
fx (08) 9458 3700

Client:	Landform Research	Client Job No:	
Order No:		Project:	Opal Vale
Tested Date:	21/12/2010	Location:	Toodyay Pit
SGS Job Number:	10-01-3080	Sample No:	10-MT-16264
Lab:	Welshpool	Sample ID:	Opal 6

PERMEABILITY: FALLING HEAD

AS1289.6.7.2 Remoulded sample

MDD:	Std.Max Dry Density (t/m³):
Max. Dry Density :	1.67 t/m³
Optimum Moisture Content	18.4 %
Dry Density	1.64 t/m³
Dry Density Ratio :	98.2 %
Moisture Content:	18.3 %
Moisture Ratio:	99.5 %
Surcharge (kPa):	0.0
Hydraulic Head:	1,598 mm
Hydraulic Gradient:	16
Sieve Size (mm):	4.75
Percentage Retained:	2

COEFFICIENT OF PERMEABILITY

m/sec at 20 ° C **9.1E-09**

Note: Sample supplied by client.

Approved Signatory: (Mark .Matthews)

Date: 24/12/2010
Site No.: 2411
Cert No.: 10-MT-16264-S800

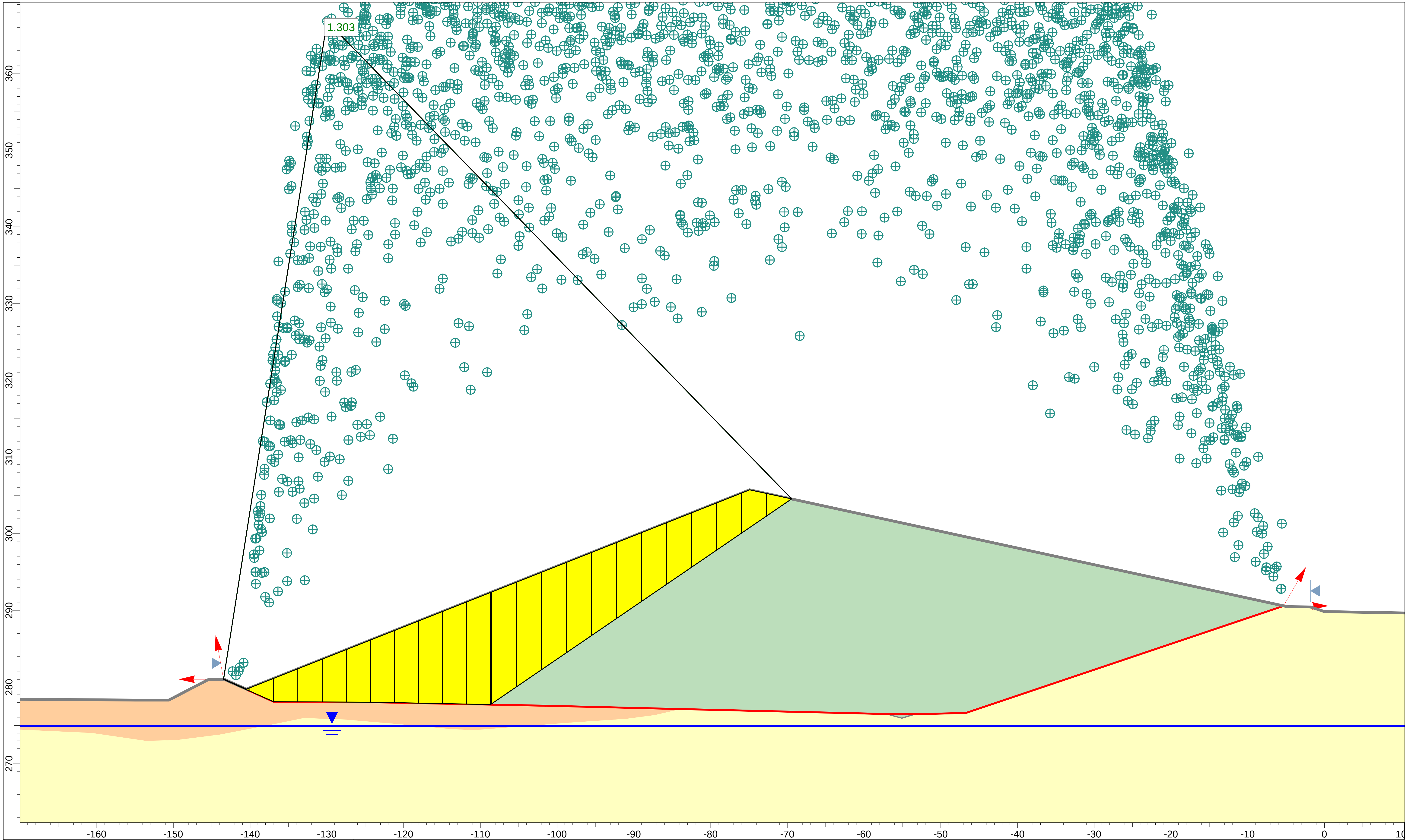
Form No.PF-(AU)-[IND(MTE)]-TE-S800.LCER/B/01.04.2010

Client Address: 25 Heather Road Roleystone WA 6111


OPAL VALE - TOODYAY LANDFILL
LOCATION OF PERMEABILITY SAMPLES
1
2
3
4
5
6
Showing 6 Jan 2010
50 m
200 ft
Terms of use

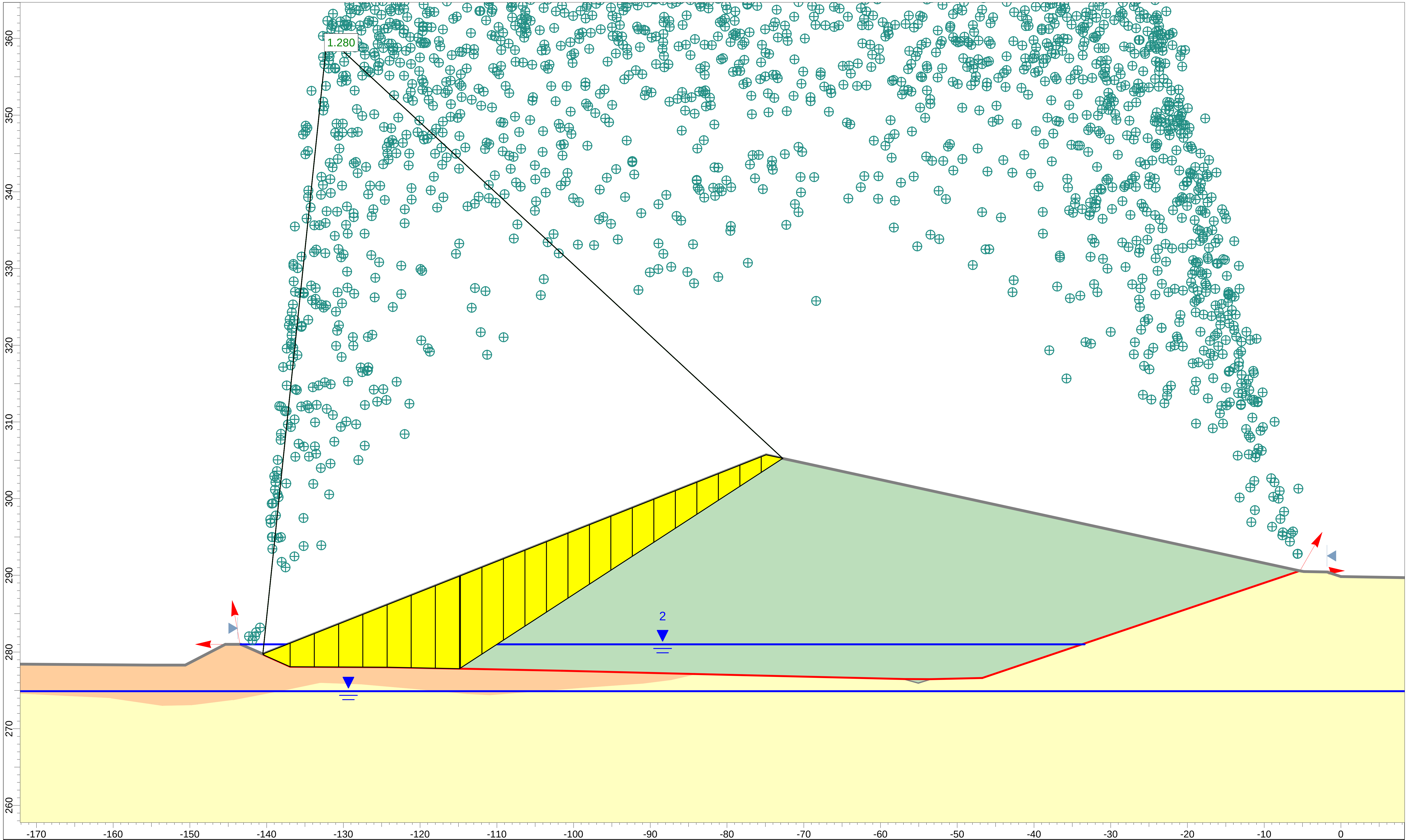
APPENDIX C

Stability Assessment

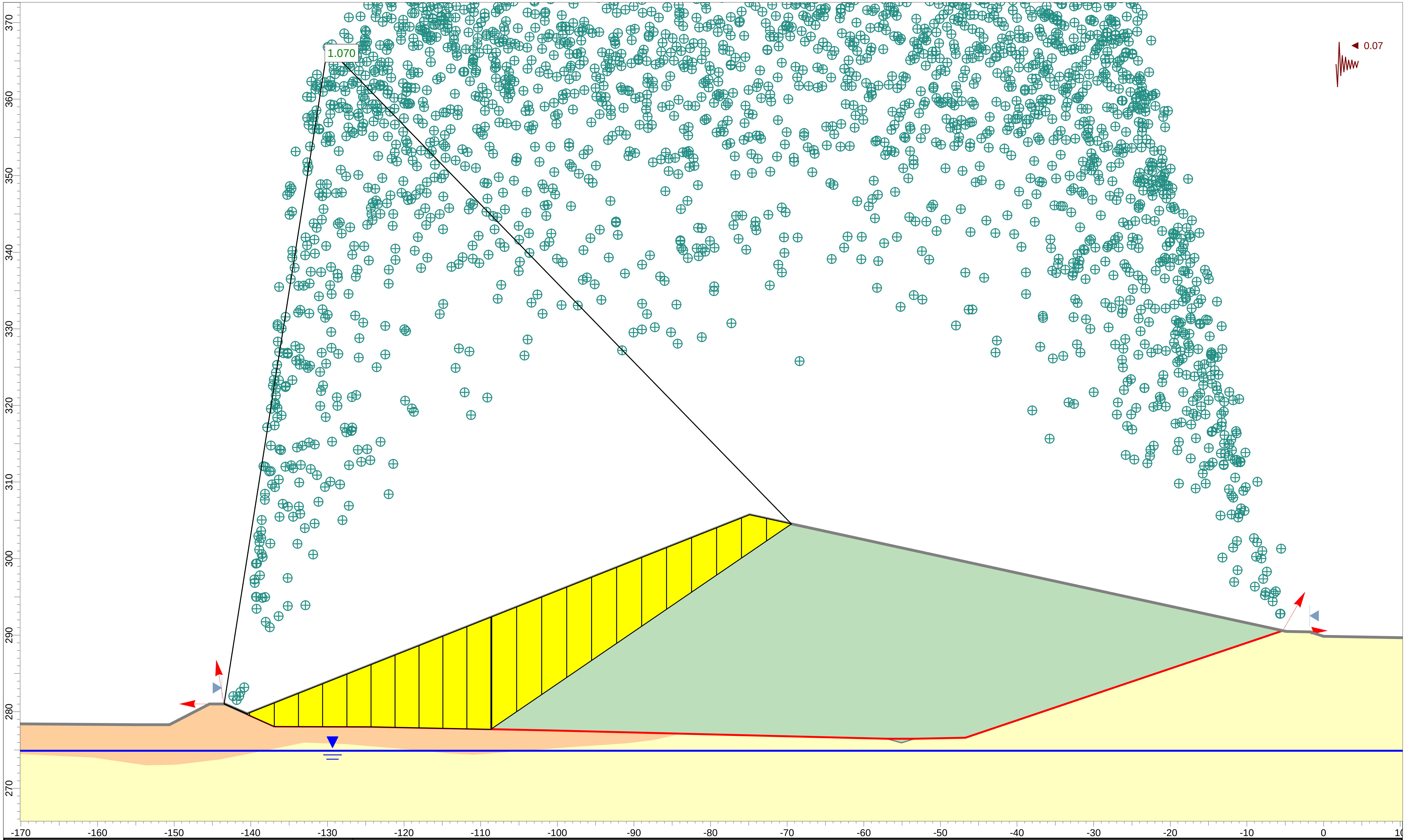


Golder Associates

Project	Opal Vale Stability Assessment		
Analysis Description	Section A - Static		
Drawn By: MK	Scale: 1:457	Company	Golder Associates Pty Ltd
Date: 02/12/2014, 9:36:14 AM		File Name	Case A4.slim

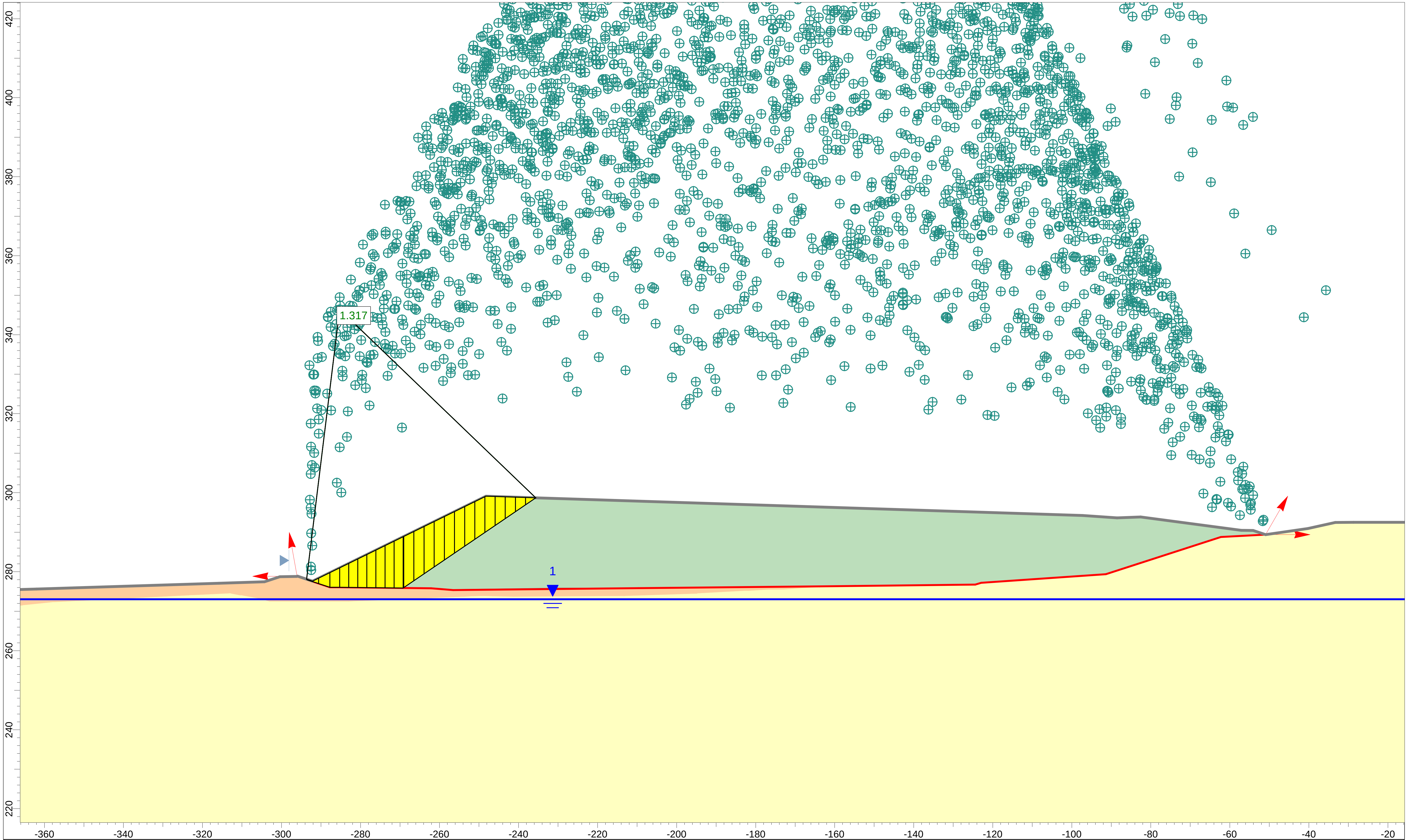


Project	Opal Vale Stability Assessment		
Analysis Description	Section A - Static, Elevated Phreatic Surface		
Drawn By: MK	Scale: 1:457	Company	Golder Associates Pty Ltd
Date: 02/12/2014, 9:36:14 AM		File Name	Case A4-Phreatic.slim



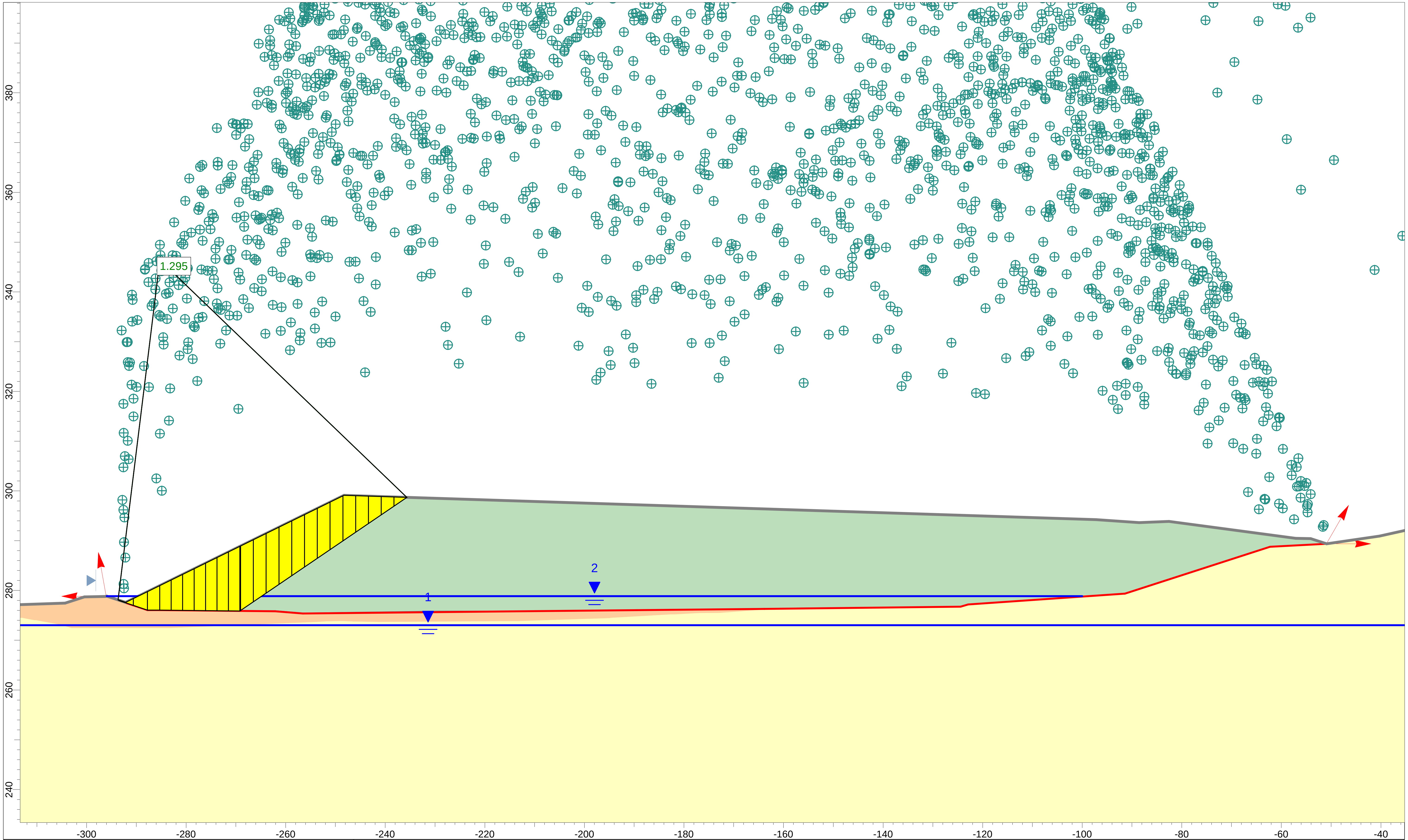
Golder Associates

Project	Opal Vale Stability Assessment
Analysis Description	Section A - Seismic Loading 0.07 g
Drawn By	MK
Scale	1:457
Company	Golder Associates Pty Ltd
Date	02/12/2014, 9:36:14 AM
File Name	Case A4 Seismic.slim



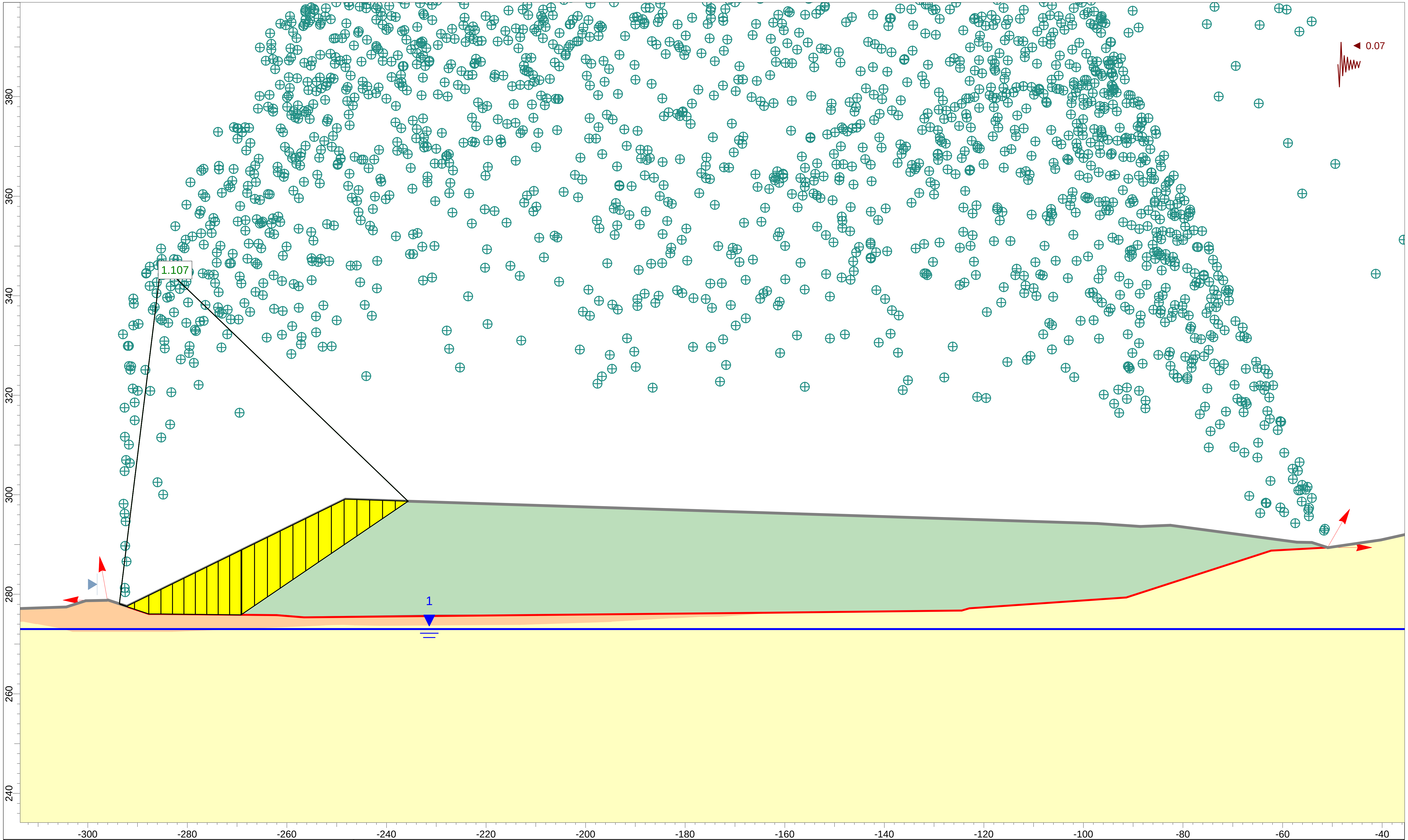
Golder Associates

Project	Opal Vale Stability Assessment		
Analysis Description	Section B - Static		
Drawn By MK	*Scale* 1:887	*Company*	Golder Associates Pty Ltd
Date 02/12/2014, 10:18:39 AM		*File Name*	Case B2.slim



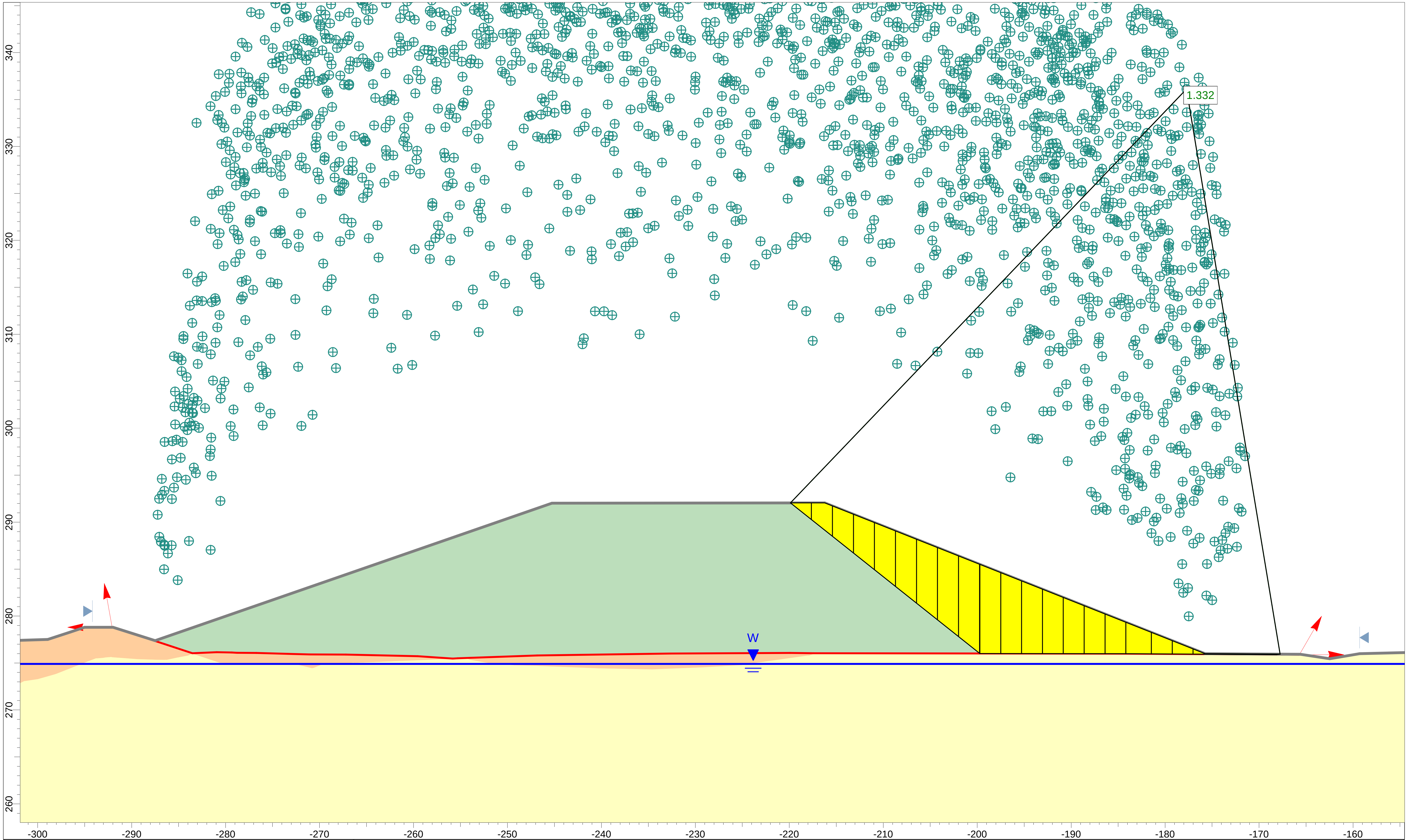
Golder Associates

Project	Opal Vale Stability Assessment		
Analysis Description	Section B - Static, Elevated Phreatic Surface		
Drawn By	MK	Scale	1:704
Company	Golder Associates Pty Ltd		
Date	02/12/2014, 10:18:39 AM	File Name	Case B2 - Phreatic.slim

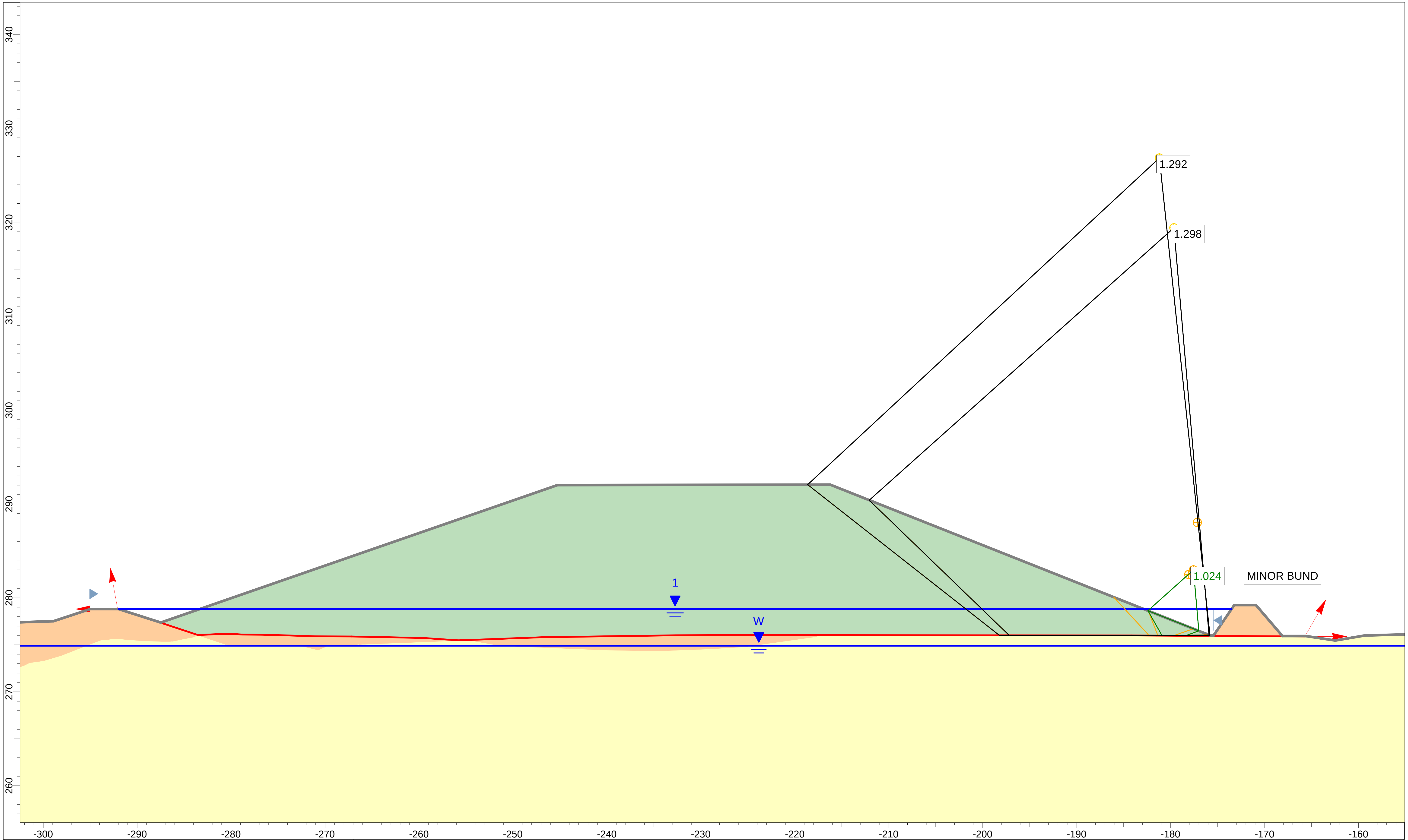


Golder Associates

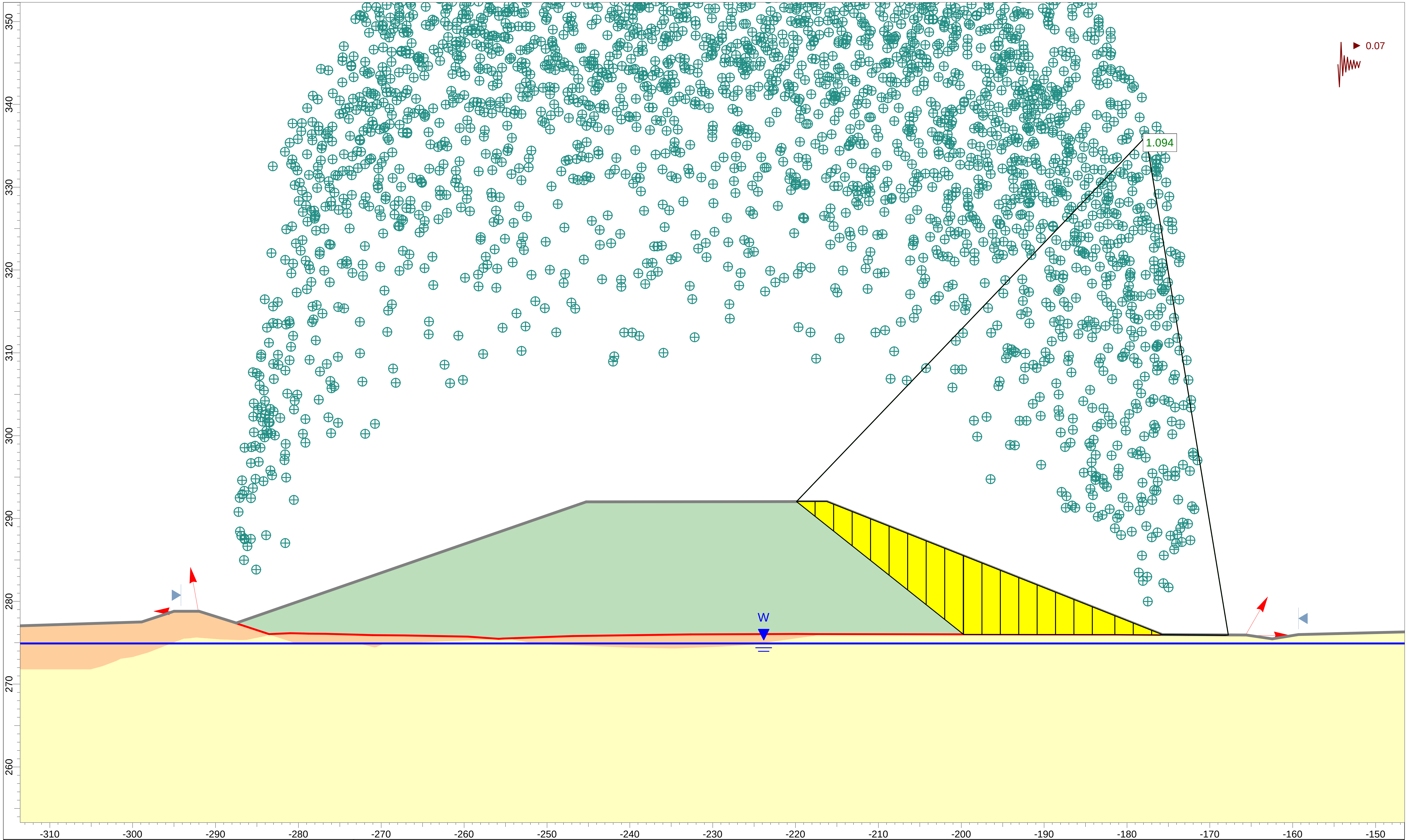
Project	Opal Vale Stability Assessment		
Analysis Description	Section B - Seismic Loading 0.07 g		
Drawn By	MK	Scale	1:704
Company	Golder Associates Pty Ltd		
Date	02/12/2014, 10:18:39 AM	File Name	Case B2 - seismic.slim



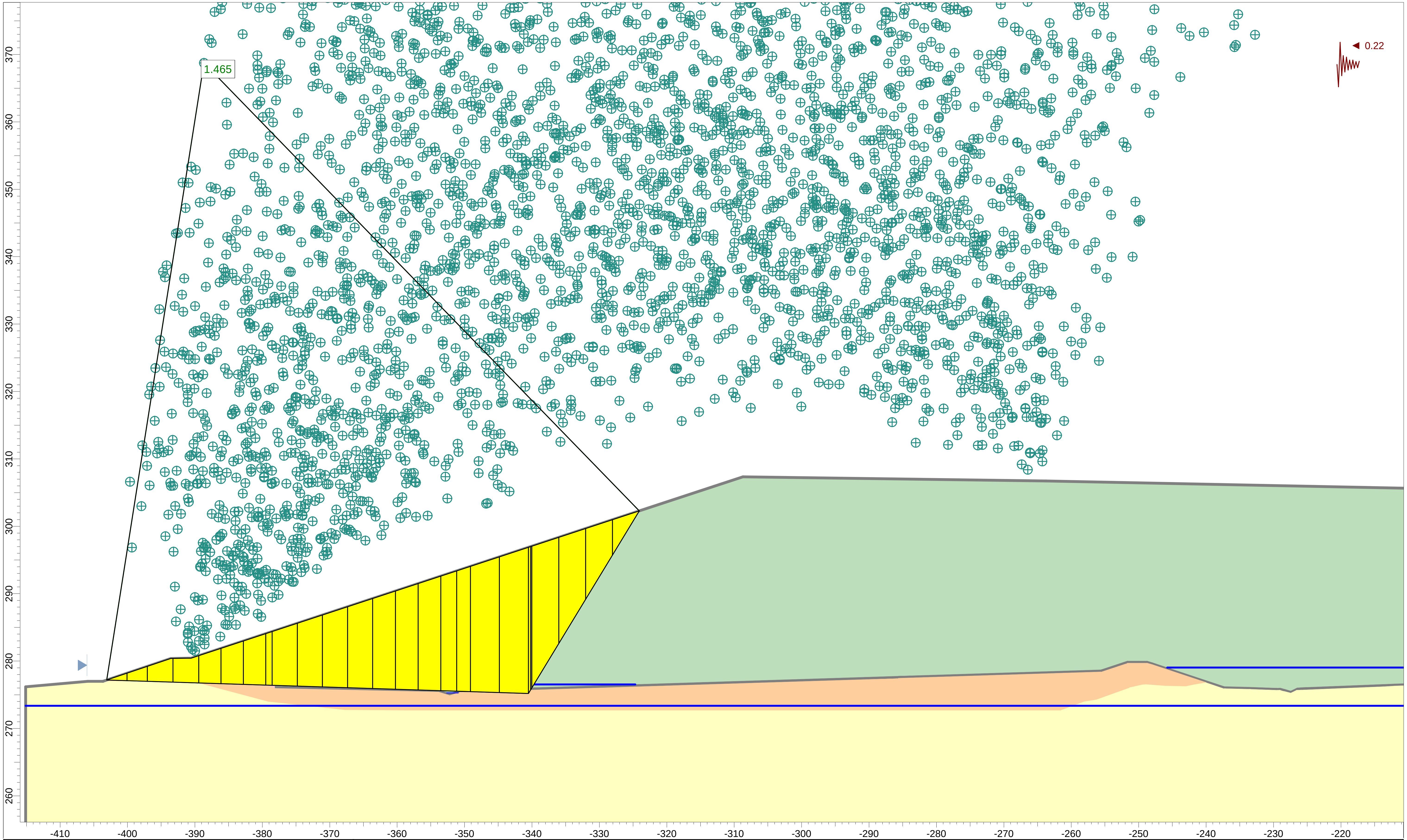
Project	Opal Vale		
Analysis Description	Section C - Static		
Drawn By	MK	Scale	1:373
Company	Golder Associates Pty Ltd		
Date	10/12/2014, 3:54:47 PM	File Name	Case C2.slim



Project	Opal Vale		
Analysis Description	Section C - Static, Elevated Phreatic Surface		
Drawn By	MK	Scale	1:373
Company	Golder Associates Pty Ltd		
Date	10/12/2014, 3:54:47 PM	File Name	Case C2 phreatic.slim

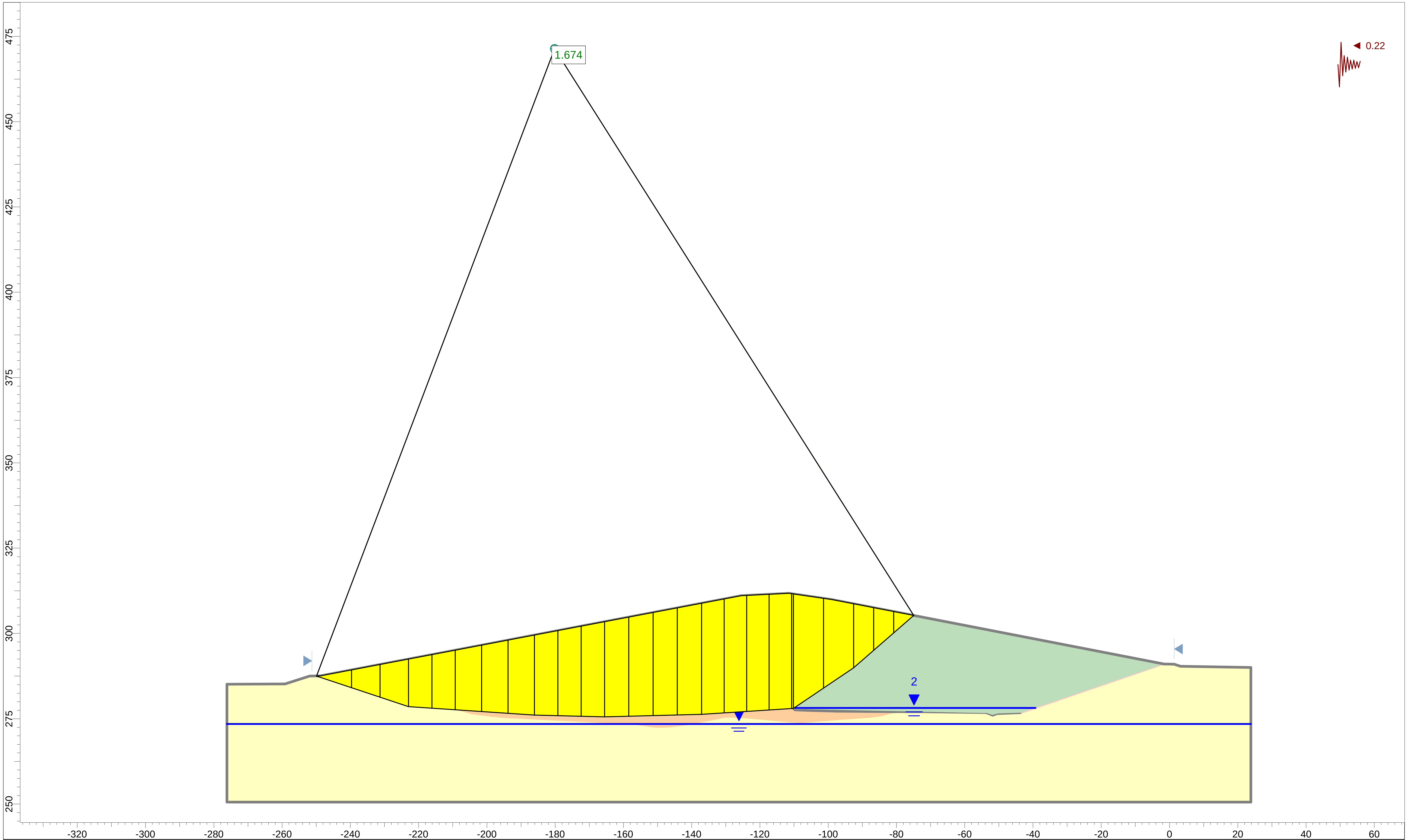


Golder Associates	Project	Opal Vale Stability Assessment		
	Analysis Description	Section C - Earthquake Loading 0.07 g		
	Drawn By	MK	Scale	1:423
	Company	Golder Associates Pty Ltd		
	Date	10/12/2014, 3:54:47 PM	File Name	Case C2 seismic.slim



Golder Associates

Project	Opal Vale Stability Assessment		
Analysis Description	Section B - Final Landform, Seismic Loading 0.22 g		
Drawn By: MK	Scale: 1:519	Company	Golder Associates Pty Ltd
Date: 02/12/2014, 10:18:39 AM		File Name	Section B.slim



Golder Associates

Project	Opal Vale Stability Assessment
Analysis Description	Section A - Final Landform, Earthquake Loading 0.22 g
Drawn By	MK
Scale	1:1027
Company	Golder Associates Pty Ltd
Date	02/12/2014, 9:36:14 AM
File Name	Section A.slim

APPENDIX D

Liner System Integrity Assessment

Material distribution and grid

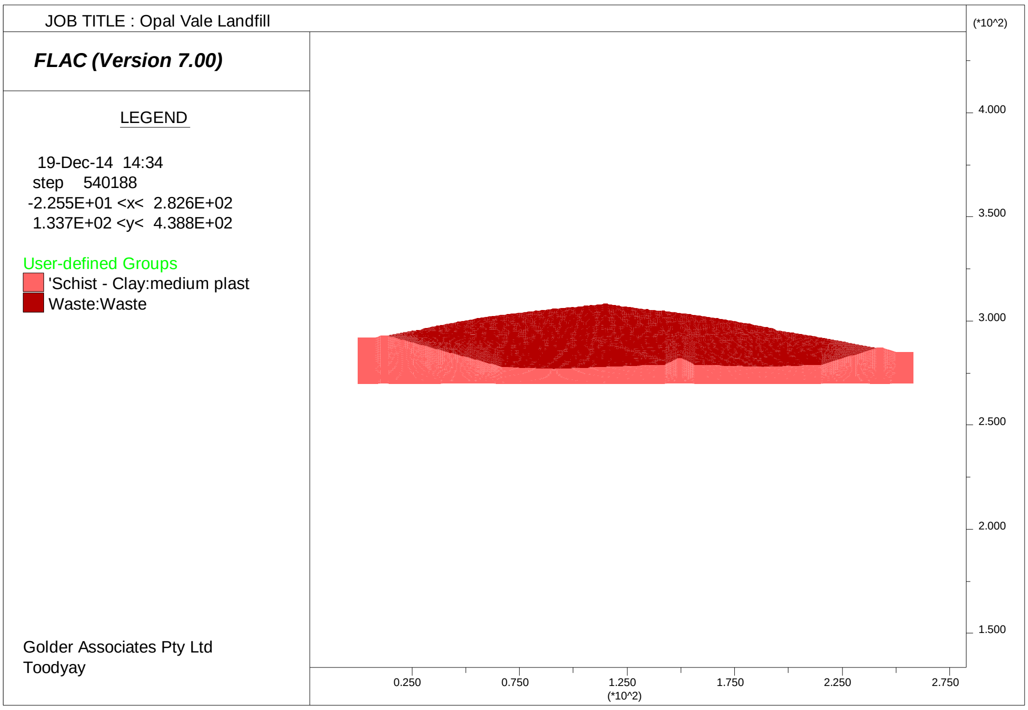


Figure 1D: Finite difference modelling material distribution for Scenario 1 to Scenario 8.

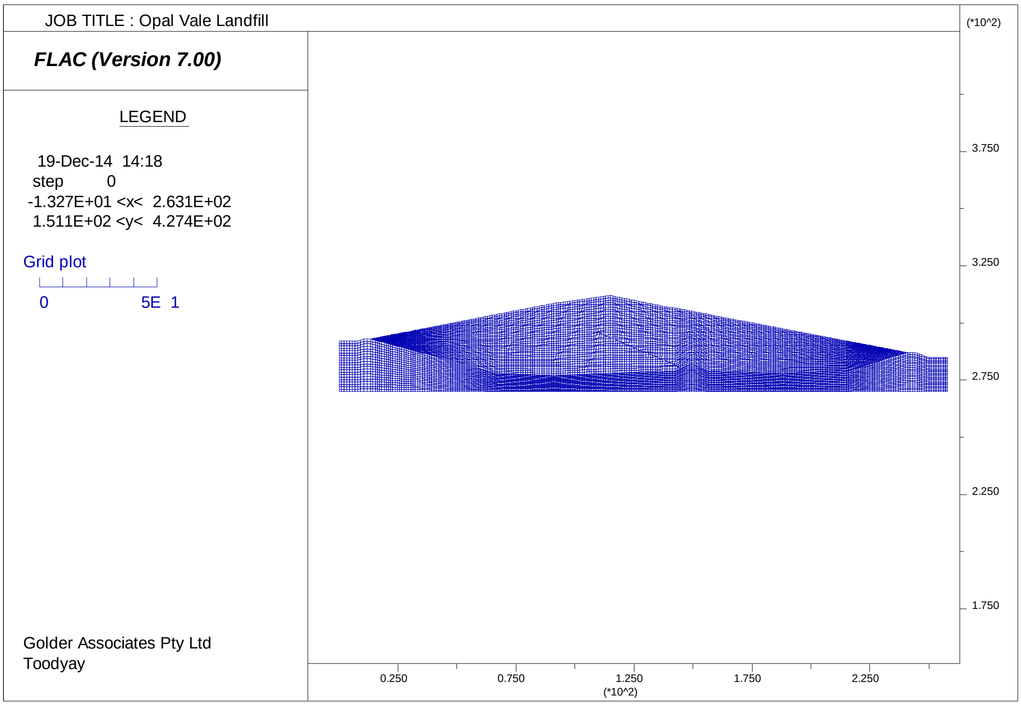


Figure 2D: Finite difference modelling grid for Scenario 1 to Scenario 8.

Scenarios investigated

Table 1D: Scenarios.

Scenario	Scenario
1	Integrity of the protection geotextile
2	Integrity of the HDPE geomembrane

Scenario 1

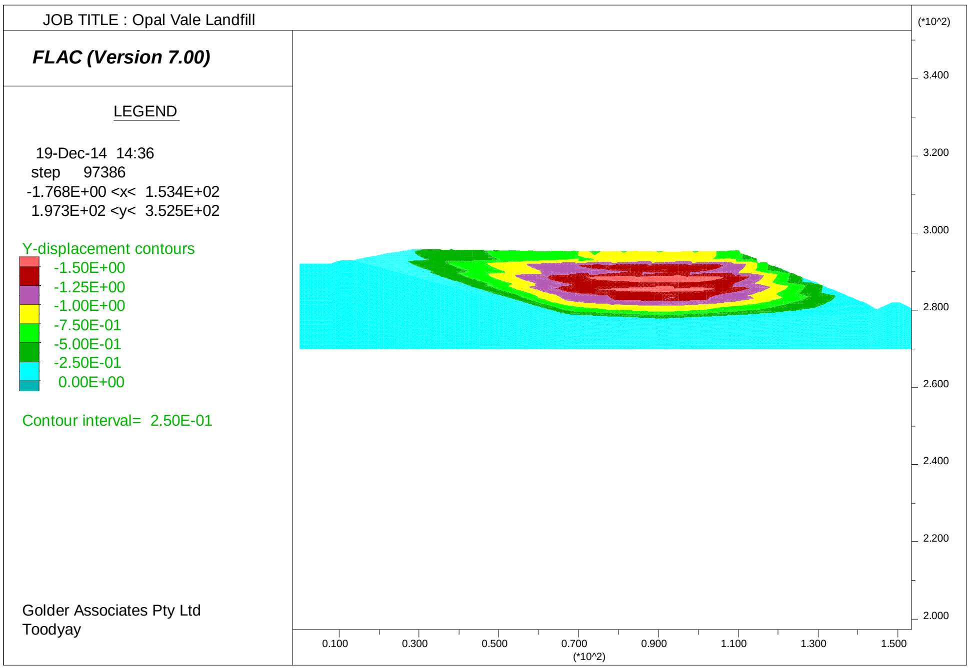


Figure 3D: Vertical displacement distribution for Scenario 2 – Cell2 Filled.

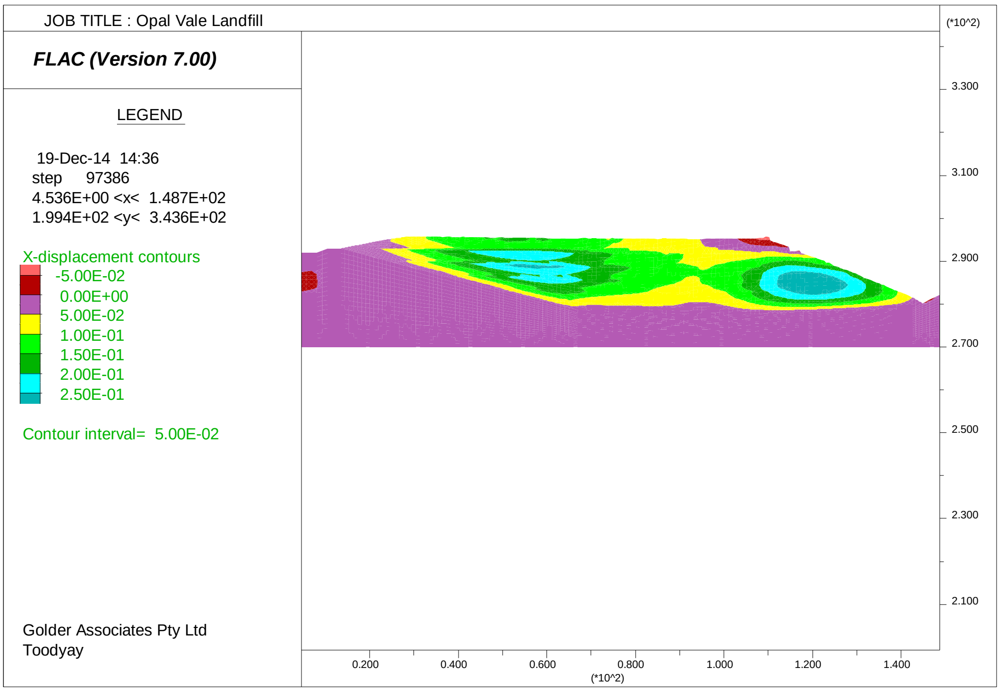


Figure 4D: Horizontal displacement distribution for Scenario 2 – Cell 2 Filled.

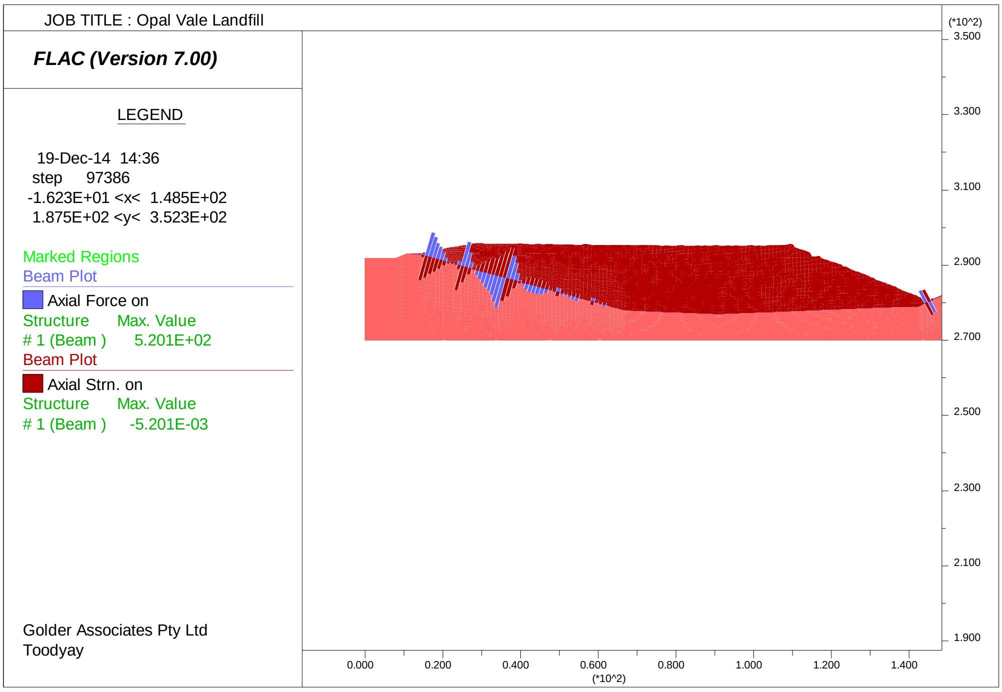


Figure 5D: Tensile and compressive strains and axial forces on HDPE geomembrane for Scenario 2 – Cell2 Filled.

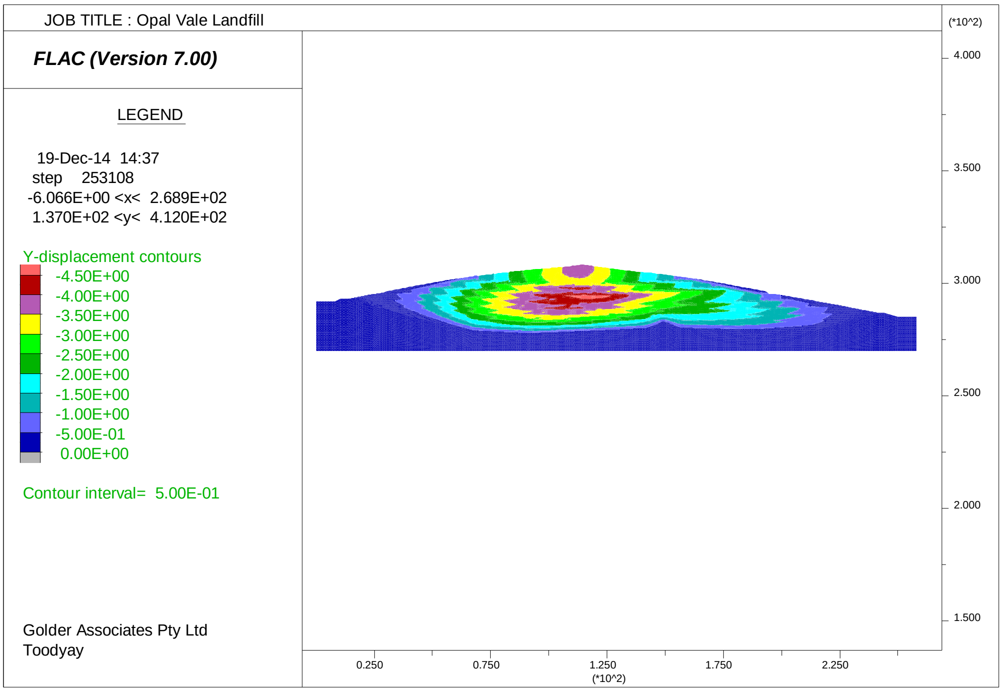


Figure 6D: Vertical displacement distribution for Scenario 2 – Cell2 + Cell4 Filled.

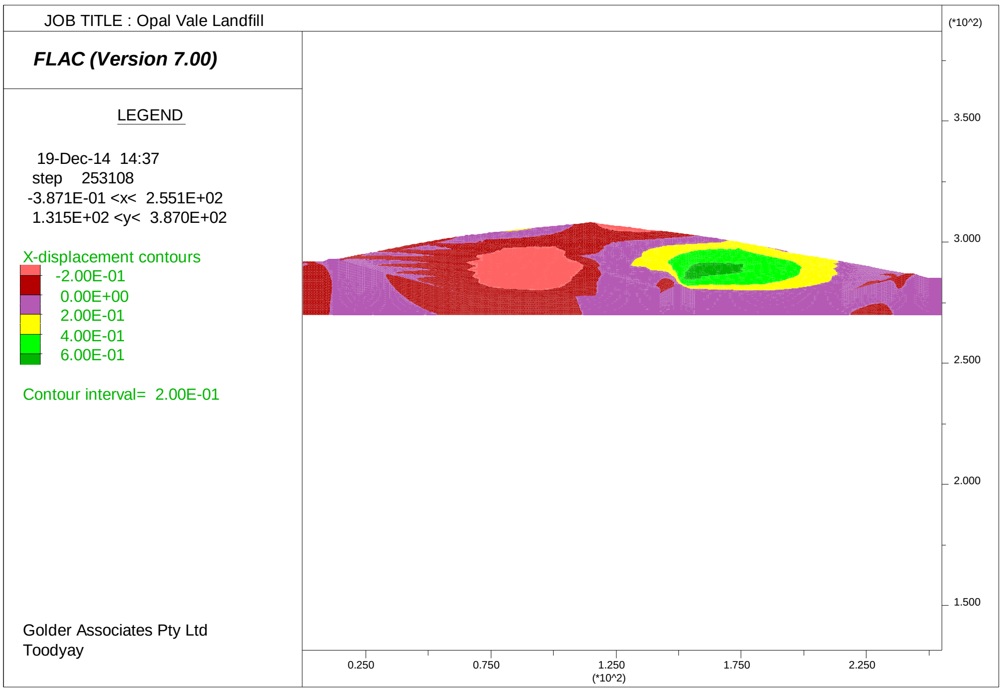


Figure 7D: Horizontal displacement distribution for Scenario 2 – Cell 2 + Cell4 Filled.

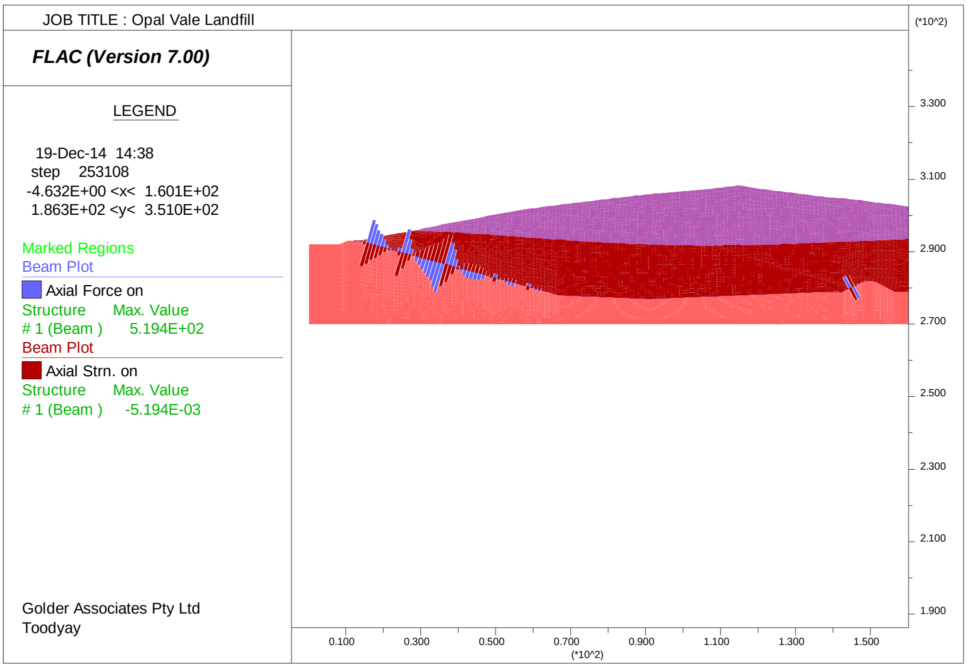


Figure 8D: Tensile and compressive strains and axial forces on HDPE geomembrane in Cell2 for Scenario 2 – Cell2 + Cell4 Filled.

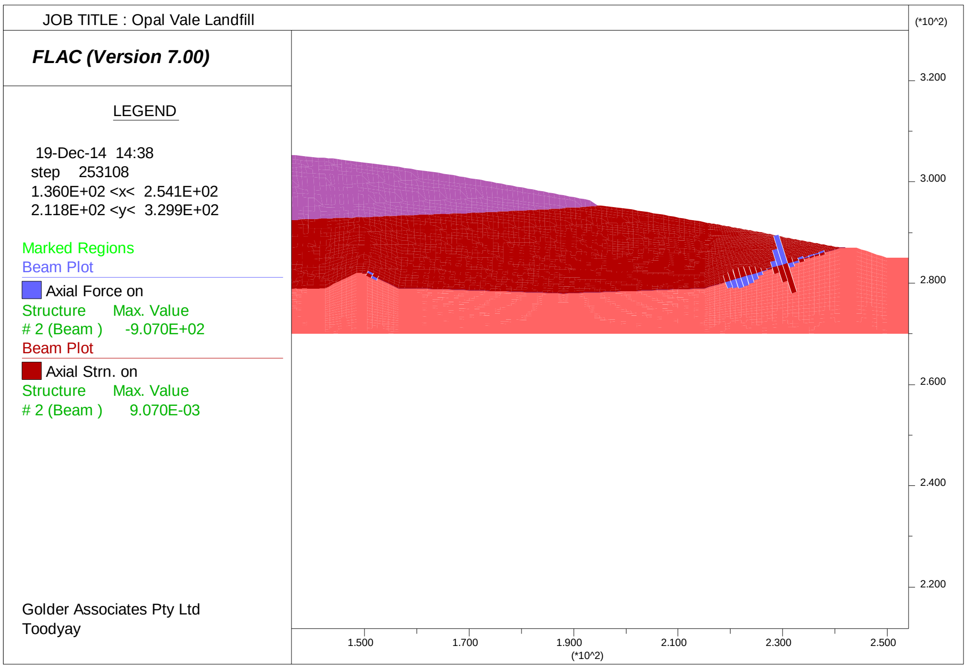


Figure 9D: Tensile and compressive strains and axial forces on HDPE geomembrane in Cell4 for Scenario 2 – Cell2 + Cell4 Filled.

Scenario 2

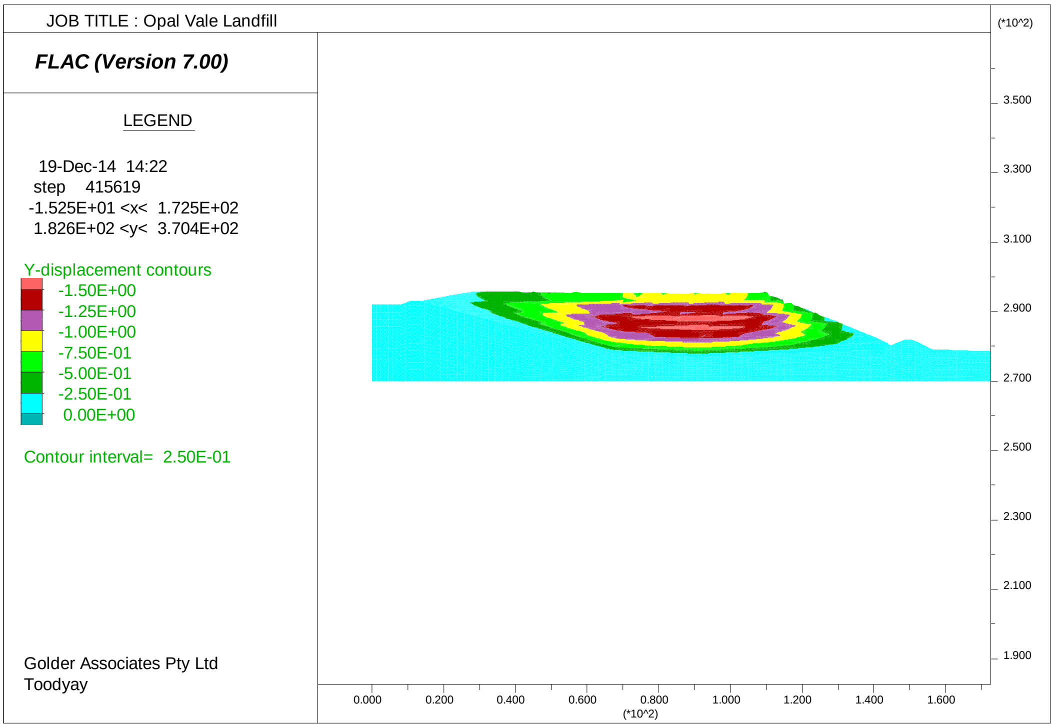


Figure 10D: Vertical displacement distribution for Scenario 2 – Cell2 Filled.

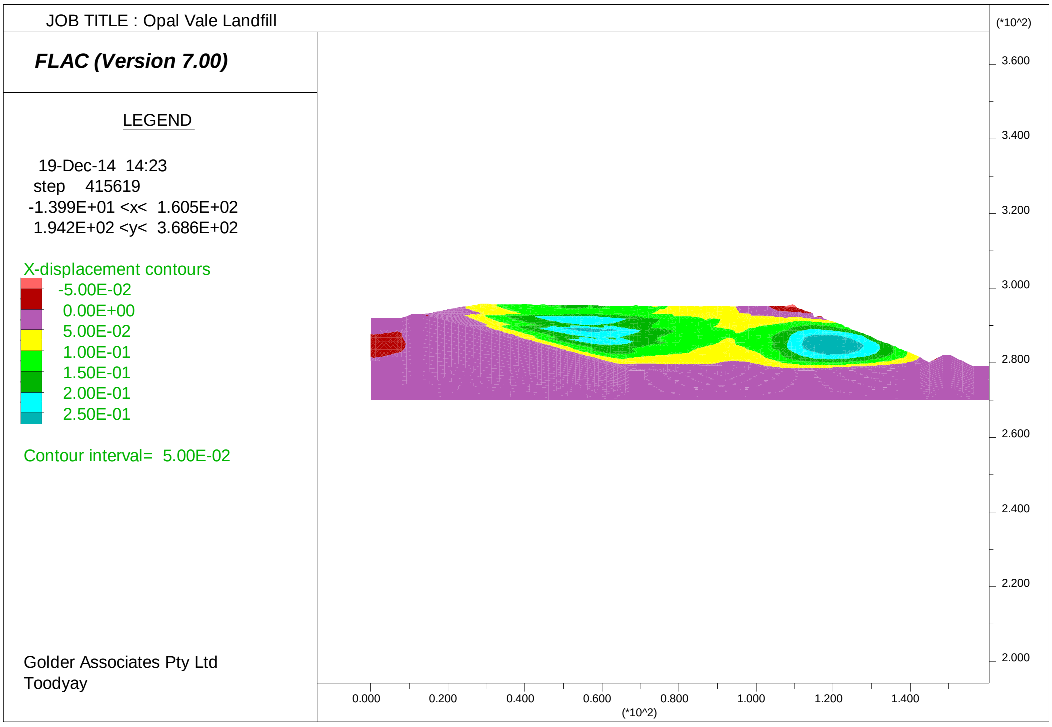


Figure 11D: Horizontal displacement distribution for Scenario 2 – Cell 2 Filled.

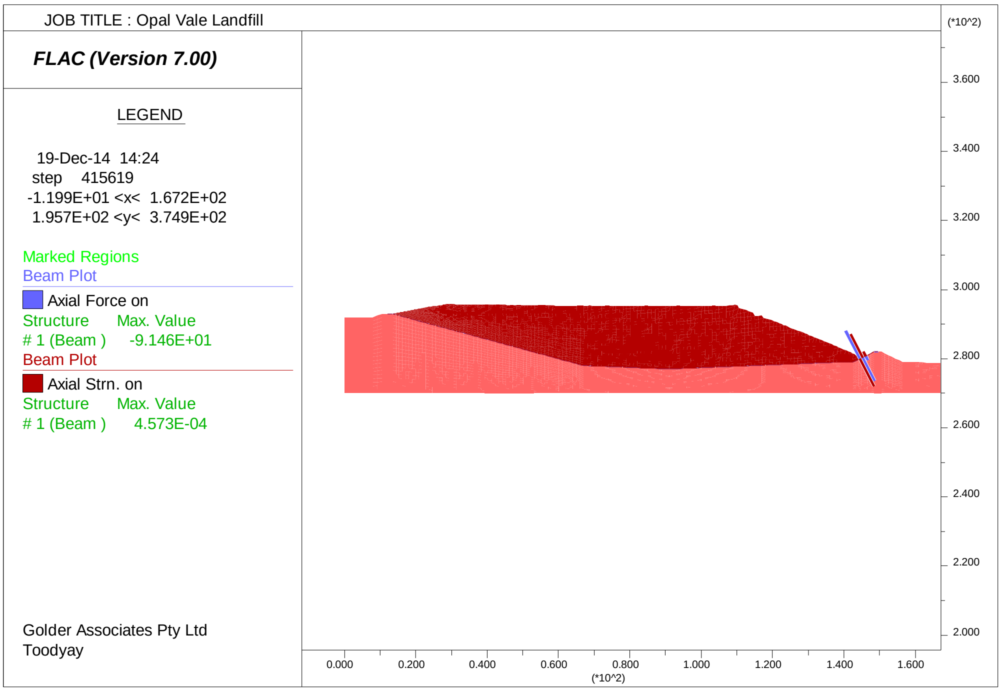


Figure 12D: Tensile and compressive strains and axial forces on HDPE geomembrane for Scenario 2 – Cell2 Filled.

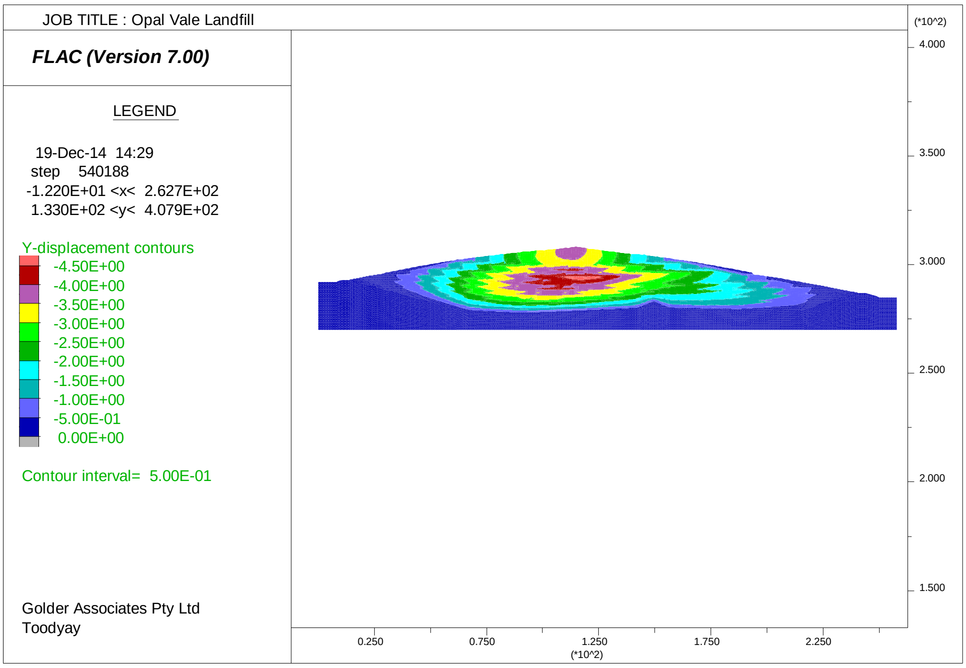


Figure 13D: Vertical displacement distribution for Scenario 2 – Cell2 + Cell4 Filled.

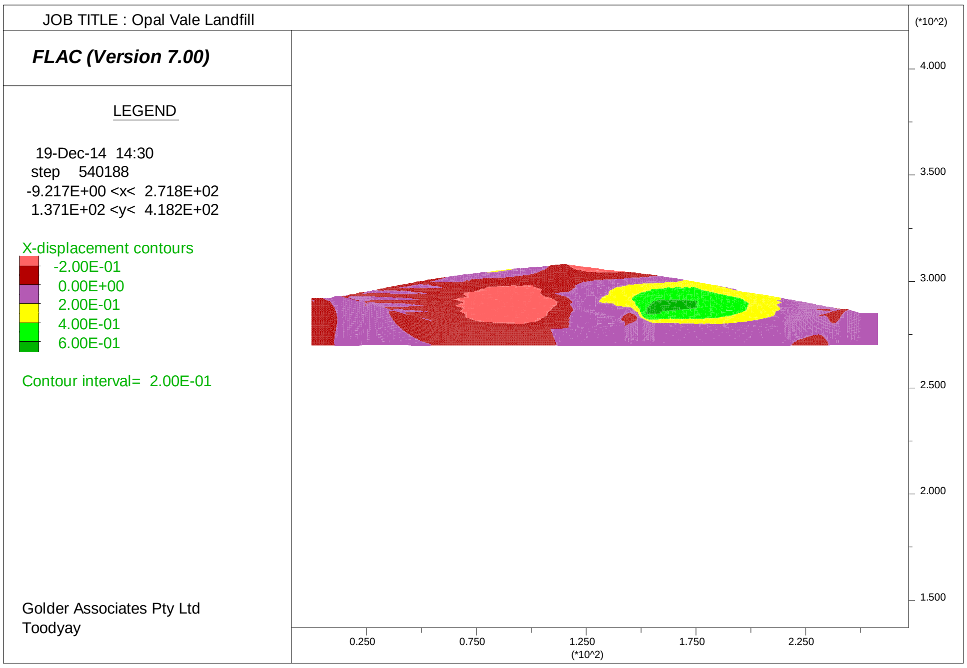


Figure 14D: Horizontal displacement distribution for Scenario 2 – Cell 2 + Cell4 Filled.

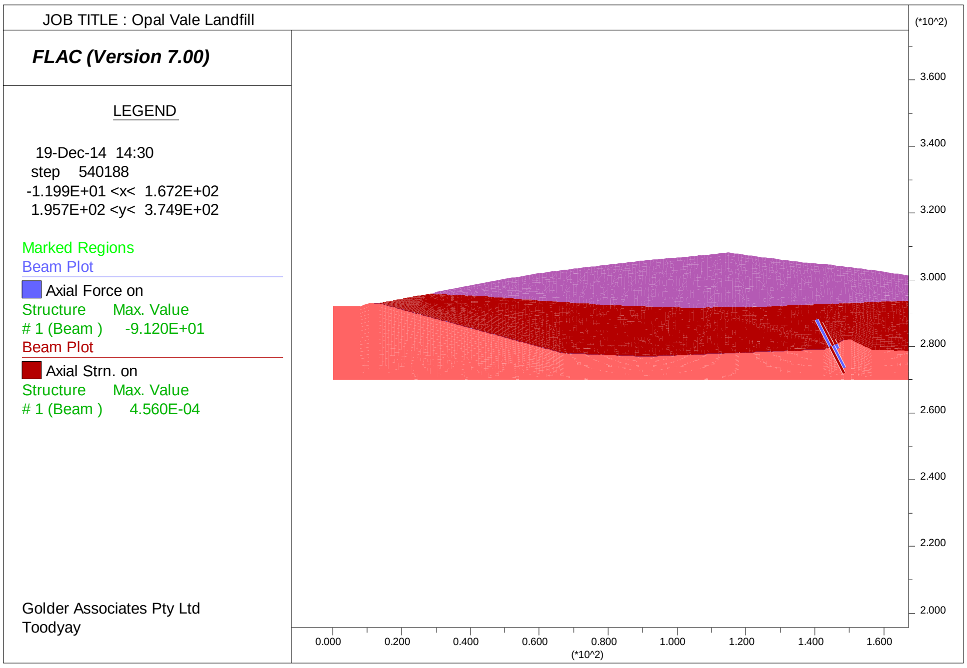


Figure 15D: Tensile and compressive strains and axial forces on HDPE geomembrane in Cell2 for Scenario 2 – Cell2 + Cell4 Filled.

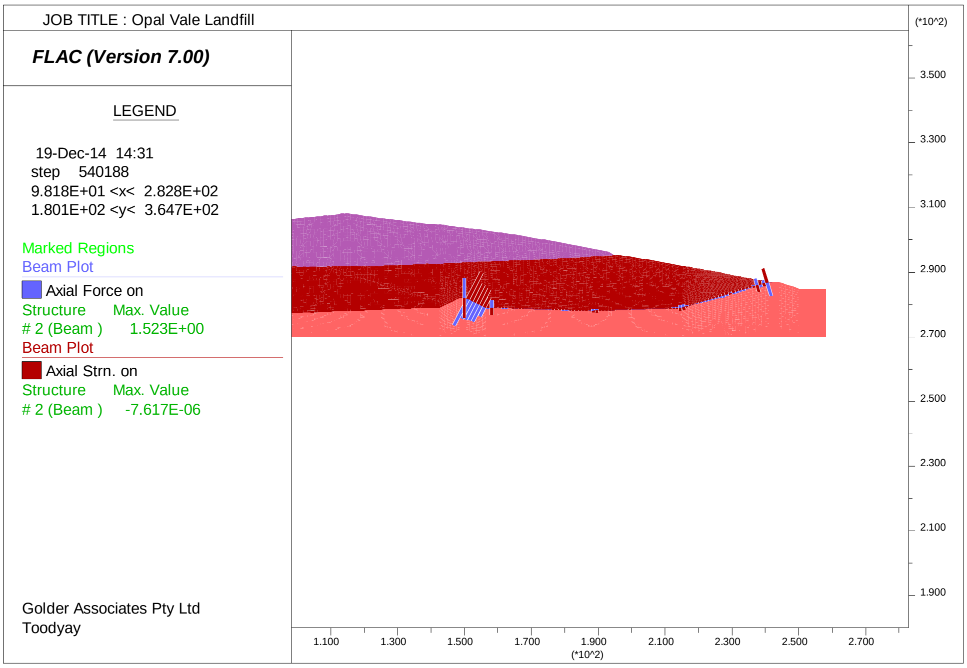


Figure 16D: Tensile and compressive strains and axial forces on HDPE geomembrane in Cell4 for Scenario 2 – Cell2 + Cell4 Filled.

APPENDIX E

Leachate Generation Assessment

```
_
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07 (1 November 1997)                    **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P20530.VHP\_weather1.dat
TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P20530.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P20530.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P20530.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P20530.VHP\I_0.inp
OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P20530.VHP\O_0.prt


TIME:  18:15     DATE:  12/18/2014


******************************************************************************

   TITLE:  Opal Vale Landfill

******************************************************************************


   NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                            LAYER  1
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  18
        THICKNESS                  =  2800.00   CM
        POROSITY                   =     0.6710 VOL/VOL
        FIELD CAPACITY             =     0.2920 VOL/VOL
        WILTING POINT              =     0.0770 VOL/VOL
        INITIAL SOIL WATER CONTENT =     0.2901 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC


                            LAYER  2
                            --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                   MATERIAL TEXTURE NUMBER  21
        THICKNESS                  =    30.00   CM
        POROSITY                   =     0.3970 VOL/VOL
        FIELD CAPACITY             =     0.0320 VOL/VOL
        WILTING POINT              =     0.0130 VOL/VOL
        INITIAL SOIL WATER CONTENT =     0.0320 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  = 0.300000000000     CM/SEC
        SLOPE                      =     3.00   PERCENT
        DRAINAGE LENGTH            =    20.0    METERS
```

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17
THICKNESS = 0.60 CM
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000000000E-07 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #18 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 4.% AND
A SLOPE LENGTH OF 20. METERS.

SCS RUNOFF CURVE NUMBER = 81.91
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 1.0000 HECTARES
EVAPORATIVE ZONE DEPTH = 25.0 CM
INITIAL WATER IN EVAPORATIVE ZONE = 1.925 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 16.775 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.925 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 813.635 CM
TOTAL INITIAL WATER = 813.635 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
TOODYAY AUST

STATION LATITUDE = -31.67 DEGREES
MAXIMUM LEAF AREA INDEX = 0.00
START OF GROWING SEASON (JULIAN DATE) = 181
END OF GROWING SEASON (JULIAN DATE) = 151
EVAPORATIVE ZONE DEPTH = 25.0 CM
AVERAGE ANNUAL WIND SPEED = 10.64 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 46.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 73.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 48.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TOODYAY WA, AUST

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
103.9	23.6	29.0	29.5	17.3	42.9
137.4	58.7	32.0	50.0	1.5	2.3

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TOODYAY WA, AUST

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.7	25.5	23.1	19.1	14.8	12.2
11.1	11.8	13.7	16.5	20.5	23.7

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TOODYAY WA, AUST
AND STATION LATITUDE = -31.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4

****

DAILY OUTPUT FOR YEAR 1

DAY	S A I R	O I L	RAIN MM	RUNOFF MM	ET MM	E. ZONE WATER CM/CM	HEAD #1 CM	DRAIN #1 MM	LEAK #1 MM
1			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
2			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
3			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
4			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
5			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
6			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
7			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
8			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
9			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
10			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
11			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
12			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
13			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
14			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
15			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
16			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
17			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
18			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
19			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
20			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
21			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
22			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
23			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
24			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
25			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000

26	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
27	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
28	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
29	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
30	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
31	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
32	5.2	0.00	0.14	0.0972	0.0000	0.000	0.000
33	1.6	0.00	0.14	0.1031	0.0000	0.000	0.000
34	9.2	0.00	0.20	0.1390	0.0000	.8782E-06	.1296E-06
35	0.0	0.00	0.19	0.1383	0.0000	.1832E-06	.8395E-07
36	0.0	0.00	0.17	0.1376	0.0000	0.000	0.000
37	0.0	0.00	0.20	0.1368	0.0000	0.000	0.000
38	0.0	0.00	0.20	0.1360	0.0000	0.000	0.000
39	0.0	0.00	0.20	0.1353	0.0000	0.000	0.000
40	0.0	0.00	0.19	0.1345	0.0000	0.000	0.000
41	0.0	0.00	0.19	0.1337	0.0000	0.000	0.000
42	0.0	0.00	0.19	0.1329	0.0000	0.000	0.000
43	0.0	0.00	0.19	0.1322	0.0000	0.000	0.000
44	0.0	0.00	0.19	0.1314	0.0000	0.000	0.000
45	0.0	0.00	0.19	0.1306	0.0000	0.000	0.000
46	0.0	0.00	0.19	0.1299	0.0000	0.000	0.000
47	0.0	0.00	0.19	0.1291	0.0000	0.000	0.000
48	0.0	0.00	0.19	0.1284	0.0000	0.000	0.000
49	0.0	0.00	0.19	0.1276	0.0000	0.000	0.000
50	0.0	0.00	0.19	0.1269	0.0000	0.000	0.000
51	0.0	0.00	0.19	0.1261	0.0000	0.000	0.000
52	0.0	0.00	0.19	0.1254	0.0000	0.000	0.000
53	0.0	0.00	0.18	0.1246	0.0000	0.000	0.000
54	0.0	0.00	0.18	0.1239	0.0000	0.000	0.000
55	0.0	0.00	0.18	0.1232	0.0000	0.000	0.000
56	0.0	0.00	0.18	0.1224	0.0000	0.000	0.000
57	0.0	0.00	0.18	0.1217	0.0000	0.000	0.000
58	0.0	0.00	0.18	0.1210	0.0000	0.000	0.000
59	0.0	0.00	0.18	0.1202	0.0000	0.000	0.000
60	0.0	0.00	0.19	0.1195	0.0000	0.000	0.000
61	0.0	0.00	0.19	0.1187	0.0000	0.000	0.000
62	0.0	0.00	0.19	0.1180	0.0000	0.000	0.000
63	0.0	0.00	0.19	0.1172	0.0000	0.000	0.000
64	0.0	0.00	0.20	0.1164	0.0000	0.000	0.000
65	0.0	0.00	0.20	0.1156	0.0000	0.000	0.000
66	1.5	0.00	0.24	0.1206	0.0000	0.000	0.000
67	0.0	0.00	0.18	0.1199	0.0000	0.000	0.000
68	0.0	0.00	0.19	0.1191	0.0000	0.000	0.000
69	0.0	0.00	0.19	0.1184	0.0000	0.000	0.000
70	0.0	0.00	0.20	0.1175	0.0000	0.000	0.000
71	0.0	0.00	0.20	0.1167	0.0000	0.000	0.000
72	0.0	0.00	0.19	0.1160	0.0000	.1530E-23	.3525E-15
73	0.0	0.00	0.19	0.1152	0.0000	0.000	0.000
74	0.0	0.00	0.19	0.1144	0.0000	0.000	0.000
75	0.0	0.00	0.19	0.1137	0.0000	0.000	0.000
76	0.0	0.00	0.19	0.1129	0.0000	0.000	0.000
77	0.0	0.00	0.19	0.1122	0.0000	0.000	0.000
78	0.0	0.00	0.19	0.1114	0.0000	0.000	0.000
79	0.0	0.00	0.19	0.1107	0.0000	0.000	0.000
80	0.0	0.00	0.19	0.1099	0.0000	0.000	0.000
81	0.0	0.00	0.19	0.1092	0.0000	0.000	0.000
82	0.0	0.00	0.19	0.1085	0.0000	0.000	0.000
83	0.0	0.00	0.18	0.1077	0.0000	0.000	0.000
84	0.0	0.00	0.18	0.1070	0.0000	0.000	0.000
85	0.0	0.00	0.19	0.1062	0.0000	0.000	0.000
86	0.2	0.00	0.24	0.1060	0.0000	0.000	0.000
87	0.0	0.00	0.18	0.1053	0.0000	0.000	0.000
88	0.0	0.00	0.18	0.1046	0.0000	0.000	0.000
89	0.0	0.00	0.19	0.1038	0.0000	0.000	0.000
90	0.0	0.00	0.19	0.1030	0.0000	0.000	0.000
91	0.0	0.00	0.19	0.1023	0.0000	0.000	0.000
92	1.0	0.00	0.25	0.1053	0.0000	0.000	0.000
93	11.9	0.00	0.24	0.1519	0.0000	0.000	0.000
94	0.5	0.00	0.24	0.1530	0.0000	0.000	0.000
95	6.3	0.00	0.24	0.1772	0.0000	0.000	0.000
96	0.0	0.00	0.19	0.1765	0.0000	0.000	0.000
97	6.1	0.00	0.25	0.1999	0.0000	0.000	0.000
98	0.0	0.00	0.19	0.1991	0.0000	0.000	0.000
99	0.3	0.00	0.24	0.1994	0.0000	0.000	0.000
100	0.0	0.00	0.18	0.1987	0.0000	0.000	0.000

101	0.0	0.00	0.17	0.1980	0.0000	0.000	0.000
102	0.0	0.00	0.19	0.1972	0.0000	0.000	0.000
103	0.0	0.00	0.19	0.1965	0.0000	0.000	0.000
104	0.0	0.00	0.18	0.1957	0.0000	0.000	0.000
105	0.0	0.00	0.18	0.1950	0.0000	0.000	0.000
106	0.5	0.00	0.24	0.1960	0.0000	0.000	0.000
107	0.0	0.00	0.18	0.1953	0.0000	0.000	0.000
108	0.0	0.00	0.18	0.1946	0.0000	0.000	0.000
109	0.0	0.00	0.18	0.1938	0.0000	0.000	0.000
110	0.0	0.00	0.18	0.1931	0.0000	0.000	0.000
111	0.0	0.00	0.18	0.1924	0.0000	0.000	0.000
112	0.0	0.00	0.18	0.1917	0.0000	0.000	0.000
113	0.0	0.00	0.18	0.1910	0.0000	0.000	0.000
114	0.0	0.00	0.18	0.1902	0.0000	0.000	0.000
115	0.0	0.00	0.18	0.1895	0.0000	0.000	0.000
116	0.0	0.00	0.18	0.1888	0.0000	0.000	0.000
117	0.0	0.00	0.18	0.1881	0.0000	0.000	0.000
118	0.0	0.00	0.18	0.1874	0.0000	0.000	0.000
119	18.1	0.00	0.24	0.2588	0.0000	0.000	0.000
120	0.0	0.00	0.18	0.2581	0.0000	0.000	0.000
121	0.0	0.00	0.18	0.2574	0.0000	0.000	0.000
122	0.0	0.00	0.18	0.2567	0.0000	0.000	0.000
123	0.0	0.00	0.18	0.2559	0.0000	0.000	0.000
124	0.0	0.00	0.18	0.2552	0.0000	0.000	0.000
125	4.7	0.00	0.25	0.2730	0.0000	0.000	0.000
126	9.1	0.00	0.25	0.3083	0.0041	.3220E-01	.1527E-06
127	0.3	0.00	1.89	0.3019	0.0005	.3499E-02	.1760E-06
128	0.0	0.00	2.15	0.2819	0.0244	.1893	.2888E-06
129	0.0	0.00	2.58	0.2679	0.0039	.3052E-01	.1952E-06
130	0.0	0.00	2.22	0.2590	0.0042	.3278E-01	.1961E-06
131	0.0	0.00	1.98	0.2511	0.0434	.3374	.3735E-06
132	0.0	0.00	1.62	0.2446	0.2581	2.005	.1489E-05
133	0.0	0.00	1.37	0.2391	0.1466	1.139	.9024E-06
134	0.0	0.00	1.20	0.2343	0.0070	.5460E-01	.2107E-06
135	0.0	0.00	1.09	0.2300	0.0003	.2617E-02	.1753E-06
136	0.0	0.00	1.00	0.2260	0.0000	.1253E-03	.1730E-06
137	0.0	0.00	0.93	0.2222	0.0000	.5841E-05	.1728E-06
138	0.0	0.00	0.87	0.2187	0.0000	.1437E-06	.7786E-07
139	0.0	0.00	0.83	0.2154	0.0000	0.000	0.000
140	0.0	0.00	0.79	0.2123	0.0000	0.000	0.000
141	0.0	0.00	0.75	0.2093	0.0000	0.000	0.000
142	0.0	0.00	0.72	0.2064	0.0000	0.000	0.000
143	0.0	0.00	0.69	0.2036	0.0000	0.000	0.000
144	0.0	0.00	0.67	0.2009	0.0000	0.000	0.000
145	0.0	0.00	0.65	0.1984	0.0000	0.000	0.000
146	0.0	0.00	0.63	0.1958	0.0000	0.000	0.000
147	0.0	0.00	0.61	0.1934	0.0000	0.000	0.000
148	0.0	0.00	0.59	0.1910	0.0000	0.000	0.000
149	0.0	0.00	0.58	0.1887	0.0000	0.000	0.000
150	0.0	0.00	0.56	0.1865	0.0000	0.000	0.000
151	0.0	0.00	0.55	0.1843	0.0000	0.000	0.000
152	2.7	0.00	0.61	0.1926	0.0000	0.000	0.000
153	3.0	0.00	0.57	0.2024	0.0000	0.000	0.000
154	0.0	0.00	0.51	0.2003	0.0000	0.000	0.000
155	0.0	0.00	0.50	0.1983	0.0000	0.000	0.000
156	0.0	0.00	0.50	0.1963	0.0000	0.000	0.000
157	0.1	0.00	0.53	0.1946	0.0000	0.000	0.000
158	6.6	0.00	0.52	0.2189	0.0000	0.000	0.000
159	0.0	0.00	0.47	0.2170	0.0000	0.000	0.000
160	0.0	0.00	0.46	0.2152	0.0000	0.000	0.000
161	0.0	0.00	0.45	0.2133	0.0000	0.000	0.000
162	0.0	0.00	0.45	0.2116	0.0000	0.000	0.000
163	0.0	0.00	0.44	0.2098	0.0000	0.000	0.000
164	0.0	0.00	0.43	0.2081	0.0000	0.000	0.000
165	3.1	0.00	0.47	0.2186	0.0000	0.000	0.000
166	1.0	0.00	0.47	0.2207	0.0000	0.000	0.000
167	7.0	0.00	0.46	0.2469	0.0000	0.000	0.000
168	9.1	0.00	0.45	0.2814	0.0000	0.000	0.000
169	0.8	0.00	1.78	0.2775	0.0000	0.000	0.000
170	8.2	0.00	1.55	0.3034	0.0130	.1013	.1029E-06
171	2.1	0.00	1.61	0.3048	0.0242	.1879	.2906E-06
172	0.0	0.00	1.89	0.2920	0.0176	.1370	.2612E-06
173	0.0	0.00	2.00	0.2729	0.0192	.1492	.2676E-06
174	0.0	0.00	1.76	0.2572	0.1054	.8190	.6486E-06
175	0.0	0.00	1.92	0.2429	0.0826	.6417	.5382E-06

176	0.0	0.00	1.84	0.2305	0.0425	.3304	.3709E-06
177	1.1	0.00	1.66	0.2283	0.0166	.1289	.2552E-06
178	0.1	0.00	1.55	0.2225	0.0347	.2693	.3337E-06
179	2.7	0.00	1.50	0.2273	0.0657	.5105	.4668E-06
180	5.5	0.00	1.41	0.2437	0.1257	.9761	.7510E-06
181	0.0	0.00	1.82	0.2364	0.3264	2.536	.1870E-05
182	0.0	0.00	1.68	0.2297	0.3120	2.424	.1790E-05
183	0.0	0.00	1.50	0.2237	0.0337	.2614	.3294E-06
184	0.0	0.00	1.36	0.2150	0.0612	.4751	.4433E-06
185	0.0	0.00	1.42	0.2065	0.0961	.7462	.5901E-06
186	0.0	0.00	1.37	0.1989	0.0780	.6061	.5174E-06
187	3.6	0.00	1.24	0.2083	0.0299	.2321	.3133E-06
188	0.0	0.00	1.09	0.2022	0.0343	.2662	.3326E-06
189	0.0	0.00	1.00	0.1969	0.0474	.3681	.3914E-06
190	0.0	0.00	0.93	0.1920	0.0388	.3017	.3553E-06
191	0.0	0.00	0.87	0.1874	0.0376	.2924	.3502E-06
192	0.0	0.00	0.83	0.1841	0.0159	.1234	.2520E-06
193	0.0	0.00	0.79	0.1809	0.0008	.5916E-02	.1779E-06
194	1.3	0.00	0.79	0.1829	0.0000	.2834E-03	.1731E-06
195	0.0	0.00	0.72	0.1801	0.0000	.1342E-04	.1728E-06
196	7.4	0.00	0.73	0.2067	0.0000	.4797E-06	.1236E-06
197	4.7	0.00	0.71	0.2227	0.0000	0.000	0.000
198	0.0	0.00	1.80	0.2153	0.0000	0.000	0.000
199	0.0	0.00	0.65	0.2127	0.0060	.4698E-01	.2059E-06
200	15.9	0.00	0.67	0.2737	0.0003	.2252E-02	.1749E-06
201	3.5	0.00	1.59	0.2813	0.0000	.1078E-03	.1729E-06
202	0.9	0.00	1.56	0.2787	0.0000	.5002E-05	.1728E-06
203	14.1	0.00	1.60	0.3287	0.0000	.1090E-06	.7032E-07
204	0.0	0.00	1.84	0.3055	0.0000	0.000	0.000
205	0.0	0.00	1.73	0.2808	0.0498	.3869	.3995E-06
206	0.0	0.00	1.89	0.2733	0.0040	.3108E-01	.1956E-06
207	0.0	0.00	1.76	0.2662	0.0193	.1498	.2587E-06
208	0.0	0.00	1.46	0.2604	0.0442	.3433	.3779E-06
209	5.6	0.00	1.28	0.2764	0.0930	.7222	.5844E-06
210	27.6	0.12	1.25	0.3801	0.1739	1.351	.1022E-05
211	0.0	0.00	1.40	0.3004	0.2661	2.068	.1535E-05
212	0.0	0.00	1.65	0.2820	0.3780	2.937	.2156E-05
213	0.0	0.00	1.71	0.2646	0.1243	.9655	.7836E-06
214	0.0	0.00	1.65	0.2504	0.0060	.4628E-01	.2055E-06
215	0.0	0.00	1.58	0.2383	0.0003	.2218E-02	.1749E-06
216	0.0	0.00	1.50	0.2278	0.0000	.1062E-03	.1729E-06
217	11.2	0.00	1.23	0.2677	0.0000	.4925E-05	.1728E-06
218	14.5	0.00	1.34	0.3204	0.0180	.1395	.2358E-06
219	8.6	0.00	1.46	0.3336	0.0429	.3331	.3716E-06
220	8.4	0.00	1.51	0.3418	0.1642	1.275	.9774E-06
221	10.0	0.00	1.56	0.3450	0.2201	1.710	.1279E-05
222	3.4	0.00	1.68	0.3237	0.2100	1.632	.1223E-05
223	0.0	0.00	1.71	0.2975	0.2231	1.733	.1296E-05
224	0.0	0.00	1.88	0.2809	0.0275	.2140	.3033E-06
225	1.8	0.00	1.45	0.2809	0.0013	.1026E-01	.1812E-06
226	1.0	0.00	1.34	0.2757	0.0001	.4915E-03	.1733E-06
227	2.5	0.00	1.34	0.2762	0.0153	.1191	.2456E-06
228	0.2	0.00	1.25	0.2698	0.0523	.4066	.4101E-06
229	1.6	0.00	1.43	0.2682	0.0372	.2893	.3447E-06
230	0.0	0.00	2.43	0.2551	0.0939	.7295	.5957E-06
231	0.0	0.00	2.02	0.2443	0.1165	.9052	.6996E-06
232	2.3	0.00	1.34	0.2482	0.0983	.7636	.6107E-06
233	0.0	0.00	2.21	0.2371	0.1484	1.153	.8785E-06
234	1.9	0.00	1.57	0.2377	0.1886	1.465	.1104E-05
235	3.3	0.00	1.79	0.2438	0.2090	1.623	.1218E-05
236	2.4	0.00	1.64	0.2468	0.2263	1.758	.1315E-05
237	1.3	0.00	1.65	0.2447	0.2583	2.007	.1493E-05
238	3.1	0.00	1.79	0.2494	0.3035	2.357	.1743E-05
239	0.5	0.00	1.72	0.2441	0.2884	2.241	.1659E-05
240	3.8	0.00	1.53	0.2532	0.2868	2.228	.1650E-05
241	5.4	0.00	1.67	0.2677	0.3030	2.354	.1740E-05
242	0.4	0.00	1.77	0.2615	0.3166	2.460	.1816E-05
243	0.2	0.00	1.59	0.2555	0.3051	2.370	.1752E-05
244	1.9	0.00	1.46	0.2572	0.3101	2.409	.1779E-05
245	0.0	0.00	2.29	0.2480	0.3028	2.352	.1739E-05
246	0.6	0.00	1.69	0.2418	0.3326	2.584	.1904E-05
247	0.0	0.00	2.64	0.2299	0.3202	2.487	.1835E-05
248	0.3	0.00	1.70	0.2243	0.2898	2.251	.1667E-05
249	16.4	0.00	1.64	0.2834	0.2808	2.182	.1617E-05
250	1.9	0.00	1.62	0.2842	0.2977	2.312	.1711E-05

251	1.7	0.00	1.50	0.2846	0.3059	2.376	.1756E-05
252	0.0	0.00	2.09	0.2745	0.3277	2.546	.1877E-05
253	0.0	0.00	2.32	0.2630	0.3366	2.615	.1927E-05
254	0.0	0.00	2.30	0.2538	0.2594	2.015	.1498E-05
255	0.0	0.00	2.43	0.2440	0.2793	2.170	.1609E-05
256	0.0	0.00	2.33	0.2347	0.4543	3.529	.2580E-05
257	4.5	0.00	1.56	0.2465	0.3714	2.885	.2120E-05
258	7.3	0.00	2.47	0.2658	0.0660	.5126	.4833E-06
259	2.8	0.00	1.81	0.2698	0.0032	.2457E-01	.1912E-06
260	0.0	0.00	2.17	0.2605	0.0002	.1178E-02	.1740E-06
261	0.0	0.00	2.88	0.2480	0.0420	.3265	.3670E-06
262	0.1	0.00	2.19	0.2370	0.0552	.4292	.4220E-06
263	7.3	0.00	1.96	0.2567	0.0767	.5961	.5121E-06
264	2.4	0.00	2.45	0.2562	0.0195	.1519	.2696E-06
265	1.1	0.00	2.49	0.2506	0.0079	.6160E-01	.2155E-06
266	1.8	0.00	2.27	0.2484	0.0050	.3919E-01	.1991E-06
267	0.7	0.00	2.20	0.2406	0.0347	.2692	.3354E-06
268	0.0	0.00	3.59	0.2253	0.0411	.3196	.3647E-06
269	0.0	0.00	3.84	0.2089	0.0348	.2701	.3378E-06
270	0.6	0.00	3.20	0.1985	0.0141	.1094	.2439E-06
271	3.4	0.00	2.54	0.2019	0.0007	.5246E-02	.1774E-06
272	0.0	0.00	3.87	0.1865	0.0000	.2513E-03	.1731E-06
273	0.0	0.00	2.99	0.1741	0.0108	.8418E-01	.2285E-06
274	0.0	0.00	2.49	0.1641	0.0020	.1520E-01	.1848E-06
275	0.0	0.00	3.96	0.1483	0.0001	.7287E-03	.1736E-06
276	0.0	0.00	3.79	0.1331	0.0000	.3476E-04	.1729E-06
277	0.0	0.00	4.63	0.1146	0.0000	.1502E-05	.1728E-06
278	0.0	0.00	2.11	0.1062	0.0000	.1159E-09	.3011E-08
279	0.0	0.00	1.62	0.0997	0.0000	0.000	0.000
280	0.0	0.00	1.37	0.0942	0.0000	0.000	0.000
281	27.7	0.00	1.24	0.2001	0.0000	0.000	0.000
282	0.0	0.00	5.11	0.1797	0.0000	0.000	0.000
283	0.0	0.00	4.43	0.1619	0.0000	0.000	0.000
284	0.0	0.00	4.22	0.1451	0.0000	0.000	0.000
285	0.0	0.00	4.79	0.1259	0.0000	0.000	0.000
286	0.0	0.00	2.11	0.1175	0.0000	0.000	0.000
287	15.1	0.00	1.66	0.1712	0.0000	0.000	0.000
288	0.0	0.00	5.04	0.1511	0.0000	0.000	0.000
289	0.0	0.00	4.38	0.1336	0.0000	0.000	0.000
290	0.0	0.00	4.11	0.1171	0.0000	0.000	0.000
291	0.0	0.00	2.11	0.1087	0.0000	0.000	0.000
292	0.0	0.00	1.62	0.1022	0.0000	0.000	0.000
293	0.0	0.00	1.25	0.0972	0.0000	0.000	0.000
294	0.0	0.00	1.10	0.0928	0.0000	0.000	0.000
295	0.0	0.00	0.99	0.0888	0.0000	0.000	0.000
296	0.0	0.00	0.91	0.0852	0.0000	0.000	0.000
297	0.0	0.00	0.90	0.0816	0.0000	0.000	0.000
298	0.0	0.00	0.81	0.0783	0.0000	0.000	0.000
299	1.2	0.00	0.37	0.0817	0.0000	0.000	0.000
300	2.4	0.00	0.19	0.0905	0.0000	0.000	0.000
301	0.0	0.00	0.31	0.0893	0.0000	0.000	0.000
302	0.0	0.00	0.32	0.0880	0.0000	0.000	0.000
303	0.0	0.00	0.42	0.0863	0.0000	0.000	0.000
304	0.0	0.00	0.44	0.0845	0.0000	0.000	0.000
305	0.0	0.00	0.43	0.0828	0.0000	0.000	0.000
306	0.0	0.00	0.42	0.0811	0.0000	0.000	0.000
307	0.0	0.00	0.41	0.0795	0.0000	0.000	0.000
308	0.0	0.00	0.40	0.0779	0.0000	0.000	0.000
309	0.2	0.00	0.24	0.0777	0.0000	.3584E-05	.4321E-07
310	0.0	0.00	0.08	0.0774	0.0000	.2864E-05	.1728E-06
311	0.0	0.00	0.07	0.0771	0.0000	.3098E-04	.1245E-06
312	0.0	0.00	0.01	0.0770	0.0000	.8995E-05	.1728E-06
313	0.9	0.00	0.09	0.0802	0.0000	.2780E-06	.1024E-06
314	0.0	0.00	0.04	0.0801	0.0000	0.000	0.000
315	0.0	0.00	0.13	0.0795	0.0000	0.000	0.000
316	0.0	0.00	0.10	0.0791	0.0000	0.000	0.000
317	0.0	0.00	0.10	0.0788	0.0000	0.000	0.000
318	0.1	0.00	0.12	0.0787	0.0000	0.000	0.000
319	0.5	0.00	0.09	0.0803	0.0000	.2097E-05	.4320E-07
320	0.0	0.00	0.04	0.0801	0.0000	.2474E-04	.1728E-06
321	0.0	0.00	0.13	0.0796	0.0000	.6955E-05	.1728E-06
322	0.0	0.00	0.09	0.0793	0.0000	.1926E-06	.8514E-07
323	0.0	0.00	0.09	0.0789	0.0000	0.000	0.000
324	0.0	0.00	0.08	0.0786	0.0000	0.000	0.000
325	0.4	0.00	0.11	0.0797	0.0000	0.000	0.000

326	0.3	0.00	0.09	0.0806	0.0000	.3294E-04	.4324E-07
327	0.0	0.00	0.04	0.0804	0.0000	.2744E-04	.1728E-06
328	0.3	0.00	0.16	0.0810	0.0000	.2205E-04	.1728E-06
329	0.0	0.00	0.06	0.0807	0.0000	.6341E-05	.1728E-06
330	0.0	0.00	0.17	0.0800	0.0000	.1653E-06	.8143E-07
331	0.0	0.00	0.11	0.0796	0.0000	0.000	0.000
332	0.0	0.00	0.10	0.0792	0.0000	0.000	0.000
333	0.0	0.00	0.08	0.0789	0.0000	.6806E-04	.4328E-07
334	0.1	0.00	0.10	0.0789	0.0000	.5685E-04	.1729E-06
335	0.0	0.00	0.04	0.0787	0.0000	.6260E-04	.1729E-06
336	0.0	0.00	0.07	0.0785	0.0000	.5022E-04	.1729E-06
337	0.0	0.00	0.06	0.0782	0.0000	.2369E-04	.1728E-06
338	0.0	0.00	0.06	0.0779	0.0000	.1790E-04	.1728E-06
339	0.0	0.00	0.06	0.0777	0.0000	.1225E-04	.1728E-06
340	0.0	0.00	0.06	0.0775	0.0000	.9546E-05	.1728E-06
341	0.0	0.00	0.06	0.0772	0.0000	.4701E-05	.1728E-06
342	0.0	0.00	0.04	0.0770	0.0000	.3540E-05	.1728E-06
343	0.0	0.00	0.01	0.0770	0.0000	.1693E-05	.9222E-07
344	0.0	0.00	0.00	0.0770	0.0000	.1228E-05	.1672E-06
345	0.0	0.00	0.00	0.0770	0.0000	.2027E-05	.8640E-07
346	0.0	0.00	0.00	0.0770	0.0000	.1992E-05	.1728E-06
347	0.0	0.00	0.00	0.0770	0.0000	.7084E-08	.2070E-07
348	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
349	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
350	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
351	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
352	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
353	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
354	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
355	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
356	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
357	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
358	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
359	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
360	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
361	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
362	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
363	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
364	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
365	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000

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MONTHLY TOTALS (MM) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.0	16.0	1.7	44.7	14.1	53.1
	84.6	87.8	54.8	46.4	2.8	0.0
RUNOFF	0.00	0.00	0.00	0.00	0.00	0.00
	0.12	0.00	0.00	0.00	0.00	0.00
EVAPOTRANSPIRATION	0.00	5.19	6.00	5.93	28.73	30.58
	39.14	50.36	70.49	68.79	4.21	0.47
LATERAL DRAINAGE COLLECTED	0.000	0.000	0.000	0.000	3.827	6.787
FROM LAYER 2	14.141	33.291	37.915	0.016	0.000	0.000
LATERAL DRAINAGE RECIRCULATED	0.000	0.000	0.000	0.000	0.000	0.000
FROM LAYER 2	0.000	0.000	0.000	0.000	0.000	0.000
PERCOLATION/LEAKAGE THROUGH	0.000	0.000	0.000	0.000	0.000	0.000
LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

MONTHLY SUMMARIES FOR DAILY HEADS (CM)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.016	0.029
TOP OF LAYER 3	0.059	0.138	0.163	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.053	0.065
HEAD ON TOP OF LAYER 3	0.096	0.115	0.153	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	MM	CU. METERS	PERCENT
PRECIPITATION	406.00	4060.000	100.00
RUNOFF	0.124	1.240	0.03
EVAPOTRANSPIRATION	309.898	3098.983	76.33
DRAINAGE COLLECTED FROM LAYER 2	95.9776	959.776	23.64
RECIRCULATION FROM LAYER 2	0.000000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000086	0.001	0.00
AVG. HEAD ON TOP OF LAYER 3	0.3373		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	8136.349	81363.485	
SOIL WATER AT END OF YEAR	8136.349	81363.485	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 4

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DAILY OUTPUT FOR YEAR 2

DAY	S A I R	O I L	RAIN MM	RUNOFF MM	ET MM	E. ZONE WATER CM/CM	HEAD #1 CM	DRAIN #1 MM	LEAK #1 MM
1			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
2			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
3			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
4			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
5			0.0	0.00	0.00	0.0770	0.0000	0.000	0.000

6	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
7	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
8	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
9	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
10	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
11	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
12	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
13	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
14	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
15	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
16	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
17	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
18	93.5	19.48	0.27	0.3720	0.0000	0.000	0.000
19	0.0	0.00	6.33	0.3006	0.0000	.1231E-05	.1728E-06
20	0.0	0.00	6.54	0.2596	0.0000	.8349E-08	.2219E-07
21	0.0	0.00	6.81	0.2324	0.0000	0.000	0.000
22	0.0	0.00	6.43	0.2067	0.0000	0.000	0.000
23	0.0	0.00	6.40	0.1811	0.0000	0.000	0.000
24	0.0	0.00	5.10	0.1607	0.0491	.3811	.3976E-06
25	0.0	0.00	2.11	0.1523	0.0763	.5924	.5098E-06
26	0.0	0.00	1.62	0.1458	0.1368	1.063	.8142E-06
27	0.0	0.00	1.37	0.1403	0.1878	1.459	.1100E-05
28	0.0	0.00	1.20	0.1355	0.2267	1.761	.1317E-05
29	0.0	0.00	1.09	0.1311	0.2550	1.981	.1474E-05
30	0.0	0.00	1.00	0.1271	0.3958	3.074	.2255E-05
31	34.5	0.19	0.98	0.2605	0.4203	3.265	.2391E-05
32	0.1	0.00	5.10	0.2405	0.1995	1.550	.1179E-05
33	5.7	0.00	4.49	0.2453	0.0119	.9267E-01	.2339E-06
34	0.0	0.00	5.69	0.2219	0.0172	.1336	.2552E-06
35	5.6	0.00	5.78	0.2204	0.0045	.3469E-01	.1980E-06
36	7.0	0.00	4.87	0.2289	0.0227	.1763	.2823E-06
37	10.9	0.00	4.59	0.2537	0.0139	.1078	.2414E-06
38	7.9	0.00	5.68	0.2622	0.0125	.9745E-01	.2371E-06
39	7.6	0.00	6.06	0.2683	0.0026	.2011E-01	.1882E-06
40	0.0	0.00	7.01	0.2403	0.0001	.9639E-03	.1738E-06
41	0.0	0.00	5.88	0.2168	0.0000	.4604E-04	.1729E-06
42	0.0	0.00	5.20	0.1957	0.0065	.5056E-01	.2065E-06
43	0.0	0.00	5.10	0.1749	0.0075	.5844E-01	.2135E-06
44	0.0	0.00	2.11	0.1664	0.0098	.7597E-01	.2246E-06
45	0.0	0.00	1.62	0.1599	0.0008	.6425E-02	.1783E-06
46	0.0	0.00	1.37	0.1544	0.0000	.3078E-03	.1732E-06
47	0.0	0.00	1.20	0.1496	0.0000	.1459E-04	.1728E-06
48	8.9	0.00	1.14	0.1807	0.0000	.5351E-06	.1271E-06
49	6.3	0.00	1.05	0.2017	0.0000	0.000	0.000
50	0.0	0.00	5.63	0.1791	0.0000	0.000	0.000
51	5.9	0.00	0.98	0.1988	0.0000	0.000	0.000
52	25.2	0.00	5.19	0.2788	0.0000	0.000	0.000
53	0.5	0.00	5.00	0.2608	0.0000	0.000	0.000
54	0.0	0.00	6.19	0.2360	0.0000	0.000	0.000
55	0.0	0.00	5.55	0.2137	0.0000	0.000	0.000
56	0.0	0.00	5.20	0.1929	0.0046	.3564E-01	.1989E-06
57	0.0	0.00	5.10	0.1722	0.0087	.6722E-01	.2184E-06
58	0.0	0.00	2.11	0.1638	0.0009	.7007E-02	.1788E-06
59	0.0	0.00	1.62	0.1568	0.0126	.9752E-01	.2364E-06
60	16.9	0.00	1.42	0.2187	0.0020	.1519E-01	.1848E-06
61	0.0	0.00	5.02	0.1987	0.0001	.7280E-03	.1736E-06
62	0.0	0.00	4.34	0.1810	0.0079	.6130E-01	.2142E-06
63	0.0	0.00	4.83	0.1617	0.0009	.6659E-02	.1785E-06
64	0.0	0.00	2.11	0.1532	0.0000	.3190E-03	.1732E-06
65	0.0	0.00	1.62	0.1468	0.0000	.1513E-04	.1728E-06
66	0.0	0.00	1.37	0.1413	0.0000	.5606E-06	.1285E-06
67	0.0	0.00	1.20	0.1365	0.0000	0.000	0.000
68	0.0	0.00	1.09	0.1321	0.0000	0.000	0.000
69	0.0	0.00	1.00	0.1281	0.0000	0.000	0.000
70	0.0	0.00	0.93	0.1244	0.0000	0.000	0.000
71	0.0	0.00	0.87	0.1209	0.0000	0.000	0.000
72	3.9	0.00	0.89	0.1330	0.0000	0.000	0.000
73	0.0	0.00	0.79	0.1298	0.0000	0.000	0.000
74	0.0	0.00	0.75	0.1268	0.0000	0.000	0.000
75	0.0	0.00	0.72	0.1239	0.0000	0.000	0.000
76	0.0	0.00	0.69	0.1212	0.0000	0.000	0.000
77	0.0	0.00	0.67	0.1185	0.0000	0.000	0.000
78	0.0	0.00	0.65	0.1159	0.0000	0.000	0.000
79	0.0	0.00	0.63	0.1134	0.0000	0.000	0.000
80	0.0	0.00	0.61	0.1109	0.0000	0.000	0.000

81	0.0	0.00	0.51	0.1089	0.0000	0.000	0.000
82	0.0	0.00	0.56	0.1067	0.0000	0.000	0.000
83	0.0	0.00	0.56	0.1044	0.0000	0.000	0.000
84	0.0	0.00	0.55	0.1022	0.0000	0.000	0.000
85	0.5	0.00	0.60	0.1018	0.0000	0.000	0.000
86	1.2	0.00	0.59	0.1043	0.0000	0.000	0.000
87	10.6	0.00	0.58	0.1444	0.0000	0.000	0.000
88	0.0	0.00	0.50	0.1423	0.0000	0.000	0.000
89	0.0	0.00	0.50	0.1404	0.0000	0.000	0.000
90	0.0	0.00	0.49	0.1384	0.0000	0.000	0.000
91	0.0	0.00	0.48	0.1365	0.0000	0.000	0.000
92	0.0	0.00	0.47	0.1346	0.0000	0.000	0.000
93	0.0	0.00	0.46	0.1328	0.0000	0.000	0.000
94	0.0	0.00	0.45	0.1310	0.0000	0.000	0.000
95	0.0	0.00	0.45	0.1292	0.0000	0.000	0.000
96	0.0	0.00	0.44	0.1274	0.0000	0.000	0.000
97	0.0	0.00	0.43	0.1257	0.0000	0.000	0.000
98	0.9	0.00	0.49	0.1273	0.0000	0.000	0.000
99	14.0	0.00	0.49	0.1814	0.0000	0.000	0.000
100	0.6	0.00	0.47	0.1819	0.0000	0.000	0.000
101	1.9	0.00	0.48	0.1875	0.0000	0.000	0.000
102	0.0	0.00	0.41	0.1859	0.0023	.1809E-01	.1868E-06
103	0.0	0.00	0.40	0.1843	0.0001	.8668E-03	.1737E-06
104	0.0	0.00	0.40	0.1827	0.0000	.4139E-04	.1729E-06
105	0.0	0.00	0.39	0.1811	0.0000	.1819E-05	.1728E-06
106	0.0	0.00	0.39	0.1796	0.0000	.3640E-08	.1547E-07
107	0.0	0.00	0.38	0.1780	0.0000	0.000	0.000
108	0.0	0.00	0.38	0.1765	0.0000	0.000	0.000
109	0.0	0.00	0.37	0.1750	0.0000	0.000	0.000
110	0.0	0.00	0.37	0.1736	0.0000	0.000	0.000
111	0.0	0.00	0.37	0.1721	0.0000	0.000	0.000
112	0.0	0.00	0.36	0.1706	0.0000	0.000	0.000
113	0.0	0.00	0.36	0.1692	0.0000	0.000	0.000
114	0.0	0.00	0.36	0.1678	0.0000	0.000	0.000
115	0.0	0.00	0.35	0.1664	0.0000	0.000	0.000
116	0.0	0.00	0.35	0.1650	0.0000	0.000	0.000
117	0.0	0.00	0.35	0.1636	0.0000	0.000	0.000
118	0.0	0.00	0.34	0.1622	0.0000	0.000	0.000
119	6.7	0.00	0.41	0.1874	0.0000	0.000	0.000
120	0.0	0.00	0.34	0.1861	0.0000	0.000	0.000
121	0.0	0.00	0.33	0.1847	0.0000	0.000	0.000
122	0.0	0.00	0.33	0.1834	0.0000	0.000	0.000
123	0.0	0.00	0.33	0.1821	0.0000	0.000	0.000
124	0.0	0.00	0.32	0.1808	0.0000	0.000	0.000
125	0.0	0.00	0.32	0.1795	0.0000	0.000	0.000
126	0.0	0.00	0.32	0.1782	0.0000	0.000	0.000
127	0.0	0.00	0.32	0.1770	0.0000	0.000	0.000
128	0.0	0.00	0.31	0.1757	0.0000	0.000	0.000
129	0.0	0.00	0.31	0.1745	0.0000	0.000	0.000
130	1.1	0.00	0.38	0.1773	0.0000	0.000	0.000
131	2.5	0.00	0.38	0.1858	0.0000	0.000	0.000
132	0.8	0.00	0.38	0.1875	0.0000	0.000	0.000
133	0.0	0.00	0.30	0.1863	0.0000	0.000	0.000
134	0.0	0.00	0.30	0.1851	0.0000	0.000	0.000
135	0.0	0.00	0.30	0.1839	0.0000	0.000	0.000
136	1.0	0.00	0.37	0.1864	0.0000	0.000	0.000
137	0.0	0.00	0.30	0.1852	0.0000	0.000	0.000
138	0.0	0.00	0.29	0.1840	0.0000	0.000	0.000
139	0.0	0.00	0.29	0.1829	0.0000	0.000	0.000
140	0.0	0.00	0.29	0.1817	0.0000	0.000	0.000
141	0.0	0.00	0.29	0.1806	0.0000	0.000	0.000
142	0.0	0.00	0.29	0.1794	0.0000	0.000	0.000
143	0.0	0.00	0.28	0.1783	0.0000	0.000	0.000
144	0.0	0.00	0.28	0.1771	0.0000	0.000	0.000
145	0.0	0.00	0.28	0.1760	0.0000	0.000	0.000
146	0.0	0.00	0.28	0.1749	0.0000	0.000	0.000
147	0.0	0.00	0.28	0.1738	0.0000	0.000	0.000
148	0.0	0.00	0.28	0.1727	0.0000	0.000	0.000
149	0.0	0.00	0.27	0.1716	0.0000	0.000	0.000
150	0.0	0.00	0.27	0.1705	0.0000	0.000	0.000
151	0.0	0.00	0.27	0.1694	0.0000	0.000	0.000
152	0.0	0.00	0.27	0.1684	0.0000	0.000	0.000
153	0.0	0.00	0.27	0.1673	0.0000	0.000	0.000
154	1.6	0.00	0.32	0.1724	0.0000	0.000	0.000
155	0.0	0.00	0.26	0.1714	0.0000	0.000	0.000

156	0.0	0.00	0.26	0.1703	0.0000	0.000	0.000
157	0.7	0.00	0.31	0.1719	0.0000	0.000	0.000
158	3.4	0.00	0.31	0.1842	0.0000	0.000	0.000
159	3.3	0.00	0.31	0.1962	0.0002	.1373E-02	.4443E-07
160	2.4	0.00	0.31	0.2045	0.0004	.2869E-02	.1755E-06
161	3.8	0.00	1.71	0.2129	0.0001	.5138E-03	.1734E-06
162	11.9	0.00	1.66	0.2539	0.0000	.2446E-04	.1728E-06
163	0.6	0.00	1.65	0.2497	0.0000	.1000E-05	.1589E-06
164	2.4	0.00	1.55	0.2531	0.0000	0.000	0.000
165	3.9	0.00	1.50	0.2626	0.0000	0.000	0.000
166	0.0	0.00	1.63	0.2561	0.0000	0.000	0.000
167	0.0	0.00	1.51	0.2501	0.0000	0.000	0.000
168	0.0	0.00	1.33	0.2448	0.0000	0.000	0.000
169	0.0	0.00	1.40	0.2392	0.0000	0.000	0.000
170	0.0	0.00	1.59	0.2328	0.0000	0.000	0.000
171	2.6	0.00	1.53	0.2364	0.0082	.6394E-01	.1725E-06
172	0.0	0.00	1.66	0.2297	0.0137	.1064	.2421E-06
173	0.0	0.00	1.80	0.2216	0.0147	.1143	.2463E-06
174	0.0	0.00	1.83	0.2133	0.0352	.2736	.3398E-06
175	0.0	0.00	1.68	0.2058	0.0278	.2162	.3076E-06
176	0.0	0.00	1.62	0.1988	0.0203	.1576	.2741E-06
177	0.0	0.00	1.44	0.1925	0.0190	.1479	.2685E-06
178	0.0	0.00	1.43	0.1868	0.0039	.3057E-01	.1953E-06
179	0.0	0.00	1.65	0.1802	0.0002	.1465E-02	.1743E-06
180	0.0	0.00	1.62	0.1737	0.0000	.7007E-04	.1729E-06
181	0.0	0.00	1.37	0.1682	0.0000	.3194E-05	.1728E-06
182	0.0	0.00	1.20	0.1634	0.0000	.4604E-07	.4231E-07
183	0.0	0.00	1.09	0.1591	0.0000	0.000	0.000
184	21.1	0.00	1.04	0.2393	0.0000	0.000	0.000
185	9.9	0.00	1.38	0.2734	0.0000	0.000	0.000
186	0.0	0.00	1.88	0.2658	0.0000	0.000	0.000
187	0.0	0.00	1.75	0.2588	0.0024	.1885E-01	.1873E-06
188	8.1	0.00	1.38	0.2855	0.0001	.9033E-03	.1737E-06
189	3.5	0.00	1.46	0.2936	0.0049	.3836E-01	.2004E-06
190	18.4	0.00	1.49	0.3613	0.0002	.1839E-02	.1746E-06
191	1.1	0.00	1.52	0.3071	0.0000	.8798E-04	.1729E-06
192	2.8	0.00	1.60	0.2977	0.0925	.7184	.6108E-06
193	0.9	0.00	1.50	0.2851	0.0133	.1035	.2404E-06
194	26.3	0.05	1.54	0.3773	0.0006	.4962E-02	.1772E-06
195	2.7	0.00	1.38	0.3093	0.0137	.1065	.2408E-06
196	0.0	0.00	1.54	0.2914	0.2191	1.702	.1292E-05
197	0.6	0.00	1.36	0.2795	0.0802	.6232	.5542E-06
198	9.5	0.00	1.30	0.3056	0.0038	.2987E-01	.1948E-06
199	0.0	0.00	1.65	0.2978	0.0002	.1432E-02	.1742E-06
200	49.2	4.98	1.35	0.4199	0.0001	.1054E-02	.1738E-06
201	28.3	1.93	1.29	0.3950	0.0757	.5881	.5496E-06
202	4.8	0.00	1.32	0.3188	0.2289	1.778	.1328E-05
203	2.4	0.00	1.37	0.3101	0.0205	.1589	.2724E-06
204	0.0	0.00	1.89	0.2928	0.0010	.7616E-02	.1792E-06
205	43.3	2.87	1.45	0.4126	0.0000	.3649E-03	.1732E-06
206	0.8	0.00	1.52	0.3095	0.1122	.8716	.7385E-06
207	4.2	0.00	1.50	0.3021	0.0589	.4576	.4477E-06
208	2.0	0.00	1.49	0.2936	0.0028	.2193E-01	.1895E-06
209	0.0	0.00	1.71	0.2819	0.0001	.1051E-02	.1739E-06
210	0.0	0.00	1.86	0.2700	0.0000	.5023E-04	.1729E-06
211	0.0	0.00	1.91	0.2563	0.0019	.1468E-01	.1832E-06
212	0.4	0.00	1.43	0.2518	0.0086	.6716E-01	.2185E-06
213	0.0	0.00	1.82	0.2392	0.0834	.6482	.5530E-06
214	0.0	0.00	1.95	0.2267	0.1469	1.141	.8712E-06
215	0.0	0.00	1.69	0.2170	0.1395	1.084	.8296E-06
216	0.0	0.00	1.89	0.2095	0.0495	.3848	.3976E-06
217	0.0	0.00	2.21	0.2006	0.0441	.3426	.3759E-06
218	0.0	0.00	2.10	0.1922	0.1249	.9706	.7492E-06
219	0.0	0.00	1.65	0.1856	0.1977	1.536	.1155E-05
220	0.0	0.00	2.02	0.1776	0.2530	1.965	.1463E-05
221	0.0	0.00	2.09	0.1692	0.2919	2.267	.1678E-05
222	0.0	0.00	2.09	0.1609	0.3178	2.469	.1822E-05
223	4.9	0.00	1.46	0.1746	0.3345	2.598	.1915E-05
224	12.8	0.00	1.54	0.2197	0.3448	2.678	.1972E-05
225	0.0	0.00	1.59	0.2133	0.3509	2.726	.2006E-05
226	10.3	0.00	1.61	0.2480	0.3544	2.753	.2025E-05
227	0.0	0.00	2.00	0.2400	0.3562	2.767	.2035E-05
228	5.9	0.00	1.50	0.2576	0.3570	2.773	.2039E-05
229	6.2	0.00	1.45	0.2766	0.3571	2.774	.2040E-05
230	8.6	0.00	1.57	0.3047	0.3567	2.771	.2038E-05

231	0.0	0.00	1.85	0.2974	0.3562	2.767	.2035E-05
232	1.6	0.00	1.56	0.2915	0.3554	2.761	.2031E-05
233	0.0	0.00	1.91	0.2737	0.3683	2.861	.2102E-05
234	0.0	0.00	2.19	0.2625	0.4893	3.801	.2775E-05
235	8.2	0.00	1.68	0.2886	0.4153	3.226	.2363E-05
236	1.5	0.00	1.77	0.2865	0.1520	1.180	.8990E-06
237	0.0	0.00	2.26	0.2760	0.1801	1.399	.1057E-05
238	0.0	0.00	2.32	0.2631	0.2551	1.982	.1475E-05
239	0.0	0.00	2.13	0.2519	0.2893	2.247	.1664E-05
240	0.0	0.00	2.76	0.2409	0.1958	1.521	.1144E-05
241	1.0	0.00	1.60	0.2376	0.2234	1.735	.1298E-05
242	0.0	0.00	2.39	0.2262	0.2968	2.305	.1706E-05
243	0.0	0.00	3.10	0.2123	0.3070	2.385	.1762E-05
244	7.2	0.00	2.23	0.2322	0.2621	2.036	.1514E-05
245	10.0	0.00	2.08	0.2630	0.2787	2.165	.1605E-05
246	1.5	0.00	1.89	0.2615	0.3141	2.440	.1802E-05
247	0.0	0.00	3.40	0.2479	0.3038	2.360	.1744E-05
248	2.9	0.00	2.29	0.2503	0.3171	2.463	.1818E-05
249	3.0	0.00	2.20	0.2525	0.3453	2.682	.1974E-05
250	3.7	0.00	1.77	0.2596	0.3184	2.473	.1825E-05
251	0.3	0.00	2.02	0.2527	0.3319	2.579	.1900E-05
252	2.6	0.00	1.96	0.2547	0.3229	2.508	.1850E-05
253	1.0	0.00	1.83	0.2509	0.3268	2.539	.1872E-05
254	0.6	0.00	1.97	0.2443	0.3445	2.676	.1970E-05
255	0.0	0.00	3.13	0.2305	0.3321	2.580	.1902E-05
256	0.0	0.00	3.11	0.2169	0.3234	2.512	.1853E-05
257	0.0	0.00	3.21	0.2034	0.3033	2.356	.1742E-05
258	0.0	0.00	2.25	0.1942	0.2912	2.262	.1675E-05
259	0.5	0.00	1.75	0.1885	0.3113	2.418	.1786E-05
260	0.0	0.00	2.27	0.1794	0.3084	2.396	.1770E-05
261	0.0	0.00	2.75	0.1684	0.3069	2.384	.1762E-05
262	0.0	0.00	2.79	0.1572	0.3155	2.451	.1810E-05
263	0.0	0.00	2.95	0.1455	0.3214	2.497	.1842E-05
264	0.0	0.00	3.03	0.1333	0.3249	2.524	.1862E-05
265	0.0	0.00	2.72	0.1225	0.3269	2.539	.1872E-05
266	0.0	0.00	2.11	0.1140	0.3278	2.547	.1878E-05
267	0.0	0.00	1.62	0.1076	0.3282	2.549	.1880E-05
268	0.0	0.00	1.37	0.1021	0.3281	2.549	.1879E-05
269	0.0	0.00	1.20	0.0973	0.3277	2.546	.1877E-05
270	0.0	0.00	1.09	0.0918	0.3481	2.705	.1990E-05
271	0.0	0.00	1.00	0.0878	0.3093	2.403	.1775E-05
272	0.0	0.00	0.93	0.0841	0.3116	2.421	.1788E-05
273	0.0	0.00	0.87	0.0806	0.3157	2.453	.1811E-05
274	0.0	0.00	0.83	0.0772	0.3183	2.472	.1825E-05
275	10.8	0.00	0.43	0.1187	0.3196	2.483	.1832E-05
276	7.3	0.00	0.36	0.1465	0.3202	2.488	.1836E-05
277	7.9	0.00	2.34	0.1687	0.3203	2.488	.1836E-05
278	6.0	0.00	3.23	0.1798	0.3201	2.487	.1835E-05
279	0.0	0.00	3.59	0.1654	0.3197	2.484	.1833E-05
280	0.0	0.00	3.61	0.1510	0.3191	2.479	.1830E-05
281	0.0	0.00	3.55	0.1368	0.3185	2.474	.1826E-05
282	0.0	0.00	1.93	0.1291	0.3178	2.469	.1822E-05
283	0.0	0.00	1.48	0.1232	0.4680	3.636	.2656E-05
284	0.0	0.00	1.25	0.1182	0.4228	3.285	.2405E-05
285	0.0	0.00	1.10	0.1138	0.1936	1.504	.1147E-05
286	13.8	0.00	1.04	0.1649	0.0113	.8792E-01	.2311E-06
287	0.0	0.00	4.91	0.1452	0.0005	.4214E-02	.1766E-06
288	0.0	0.00	0.97	0.1413	0.0000	.2018E-03	.1730E-06
289	0.0	0.00	0.92	0.1377	0.0000	.9510E-05	.1728E-06
290	0.0	0.00	0.85	0.1343	0.0000	.3005E-06	.1058E-06
291	0.9	0.00	0.85	0.1345	0.0000	0.000	0.000
292	0.0	0.00	0.76	0.1314	0.0000	0.000	0.000
293	0.0	0.00	0.74	0.1285	0.0000	0.000	0.000
294	0.0	0.00	0.72	0.1256	0.0000	0.000	0.000
295	0.0	0.00	0.69	0.1228	0.0000	0.000	0.000
296	0.0	0.00	0.67	0.1201	0.0000	0.000	0.000
297	0.0	0.00	0.65	0.1176	0.0000	0.000	0.000
298	0.4	0.00	0.68	0.1164	0.0000	0.000	0.000
299	0.0	0.00	0.61	0.1140	0.0000	.1813E-03	.1298E-06
300	0.0	0.00	0.59	0.1117	0.0000	.1954E-04	.1728E-06
301	0.0	0.00	0.58	0.1093	0.0000	.7655E-06	.1460E-06
302	0.0	0.00	0.52	0.1073	0.0000	0.000	0.000
303	0.0	0.00	0.50	0.1053	0.0000	0.000	0.000
304	0.0	0.00	0.49	0.1033	0.0000	0.000	0.000
305	0.0	0.00	0.49	0.1013	0.0000	0.000	0.000

306	0.0	0.00	0.50	0.0994	0.0000	0.000	0.000
307	0.1	0.00	0.55	0.0976	0.0000	0.000	0.000
308	0.0	0.00	0.45	0.0958	0.0000	0.000	0.000
309	0.0	0.00	0.44	0.0940	0.0000	.1530E-23	.3525E-15
310	0.0	0.00	0.44	0.0922	0.0000	0.000	0.000
311	0.0	0.00	0.43	0.0905	0.0000	0.000	0.000
312	0.0	0.00	0.42	0.0888	0.0000	0.000	0.000
313	0.0	0.00	0.41	0.0872	0.0000	0.000	0.000
314	0.0	0.00	0.41	0.0856	0.0000	0.000	0.000
315	0.0	0.00	0.40	0.0839	0.0000	0.000	0.000
316	0.0	0.00	0.40	0.0824	0.0000	0.000	0.000
317	0.0	0.00	0.41	0.0807	0.0000	0.000	0.000
318	0.0	0.00	0.41	0.0791	0.0000	0.000	0.000
319	0.0	0.00	0.40	0.0775	0.0000	0.000	0.000
320	0.0	0.00	0.12	0.0770	0.0000	0.000	0.000
321	0.0	0.00	0.00	0.0770	0.0000	.1530E-23	.3525E-15
322	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
323	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
324	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
325	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
326	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
327	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
328	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
329	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
330	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
331	0.3	0.00	0.09	0.0778	0.0000	0.000	0.000
332	0.0	0.00	0.03	0.0777	0.0000	0.000	0.000
333	0.0	0.00	0.06	0.0775	0.0000	0.000	0.000
334	0.0	0.00	0.06	0.0772	0.0000	0.000	0.000
335	0.0	0.00	0.05	0.0770	0.0000	0.000	0.000
336	0.0	0.00	0.01	0.0770	0.0000	0.000	0.000
337	0.0	0.00	0.00	0.0770	0.0000	.2464E-05	.8641E-07
338	0.0	0.00	0.00	0.0770	0.0000	.9963E-06	.1587E-06
339	0.2	0.00	0.09	0.0774	0.0000	0.000	0.000
340	0.4	0.00	0.09	0.0787	0.0000	0.000	0.000
341	0.0	0.00	0.03	0.0786	0.0000	0.000	0.000
342	0.0	0.00	0.06	0.0783	0.0000	0.000	0.000
343	0.0	0.00	0.06	0.0781	0.0000	0.000	0.000
344	0.0	0.00	0.06	0.0779	0.0000	0.000	0.000
345	0.0	0.00	0.05	0.0777	0.0000	0.000	0.000
346	0.0	0.00	0.05	0.0775	0.0000	0.000	0.000
347	0.0	0.00	0.05	0.0773	0.0000	.2518E-05	.4320E-07
348	0.0	0.00	0.05	0.0771	0.0000	.1972E-05	.1728E-06
349	0.0	0.00	0.01	0.0770	0.0000	.1185E-05	.6334E-07
350	0.2	0.00	0.09	0.0775	0.0000	.1472E-05	.1728E-06
351	0.0	0.00	0.03	0.0774	0.0000	.1444E-05	.1312E-06
352	0.0	0.00	0.05	0.0771	0.0000	.1671E-05	.1728E-06
353	0.0	0.00	0.03	0.0770	0.0000	.1457E-08	.1017E-07
354	0.0	0.00	0.01	0.0770	0.0000	0.000	0.000
355	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
356	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
357	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
358	0.0	0.00	0.00	0.0770	0.0000	0.000	0.000
359	1.5	0.00	0.09	0.0827	0.0000	0.000	0.000
360	0.1	0.00	0.07	0.0828	0.0000	0.000	0.000
361	0.4	0.00	0.18	0.0836	0.0000	0.000	0.000
362	0.0	0.00	0.15	0.0830	0.0000	0.000	0.000
363	0.0	0.00	0.13	0.0825	0.0000	0.000	0.000
364	0.0	0.00	0.13	0.0820	0.0000	0.000	0.000
365	1.4	0.00	0.22	0.0868	0.0000	0.000	0.000

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MONTHLY TOTALS (MM) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	128.0	91.6	33.1	24.1	5.4	36.6
	240.3	61.0	33.3	47.1	0.4	4.2
RUNOFF	19.67	0.00	0.00	0.00	0.00	0.00
	9.84	0.00	0.00	0.00	0.00	0.00
EVAPOTRANSPIRATION	47.24	116.53	37.63	12.17	9.56	35.78
	46.17	59.75	63.76	41.41	6.92	1.82
LATERAL DRAINAGE COLLECTED	13.576	2.613	0.084	0.019	0.000	1.117
FROM LAYER 2	7.318	64.824	74.013	30.841	0.000	0.000
LATERAL DRAINAGE RECIRCULATED	0.000	0.000	0.000	0.000	0.000	0.000
FROM LAYER 2	0.000	0.000	0.000	0.000	0.000	0.000
PERCOLATION/LEAKAGE THROUGH	0.000	0.000	0.000	0.000	0.000	0.000
LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

MONTHLY SUMMARIES FOR DAILY HEADS (CM)

AVERAGE DAILY HEAD ON	0.056	0.012	0.000	0.000	0.000	0.005
TOP OF LAYER 3	0.030	0.269	0.318	0.128	0.000	0.000
STD. DEVIATION OF DAILY	0.117	0.037	0.001	0.000	0.000	0.009
HEAD ON TOP OF LAYER 3	0.060	0.112	0.018	0.168	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	MM	CU. METERS	PERCENT
PRECIPITATION	705.10	7051.000	100.00
RUNOFF	29.510	295.097	4.19
EVAPOTRANSPIRATION	478.744	4787.439	67.90
DRAINAGE COLLECTED FROM LAYER 2	194.4046	1944.046	27.57
RECIRCULATION FROM LAYER 2	0.000000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000158	0.002	0.00
AVG. HEAD ON TOP OF LAYER 3	0.6823		
CHANGE IN WATER STORAGE	2.442	24.417	0.35
SOIL WATER AT START OF YEAR	8136.349	81363.485	
SOIL WATER AT END OF YEAR	8138.790	81387.902	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	64.00	53.80	17.40	34.40	9.75	44.85
	162.45	74.40	44.05	46.75	1.60	2.10
STD. DEVIATIONS	90.51	53.46	22.20	14.57	6.15	11.67
	110.10	18.95	15.20	0.49	1.70	2.97
RUNOFF						
TOTALS	9.834	0.000	0.000	0.000	0.000	0.000
	4.983	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	13.908	0.000	0.000	0.000	0.000	0.000
	6.871	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	23.620	60.860	21.815	9.051	19.146	33.181
	42.655	55.054	67.128	55.100	5.566	1.145
STD. DEVIATIONS	33.404	78.729	22.367	4.412	13.558	3.675
	4.977	6.638	4.757	19.363	1.917	0.950
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	6.7882	1.3063	0.0421	0.0095	1.9133	3.9519
	10.7296	49.0574	55.9642	15.4282	0.0001	0.0001
STD. DEVIATIONS	9.6000	1.8473	0.0595	0.0134	2.7059	4.0095
	4.8246	22.2970	25.5250	21.7962	0.0002	0.0001
LATERAL DRAINAGE RECIRCULATED FROM LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0282	0.0060	0.0002	0.0000	0.0079	0.0170
	0.0446	0.2037	0.2401	0.0641	0.0000	0.0000
STD. DEVIATIONS	0.0399	0.0085	0.0002	0.0001	0.0112	0.0172
	0.0200	0.0926	0.1095	0.0905	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 2

	MM		CU. METERS	PERCENT
PRECIPITATION	555.55	(211.496)	5555.5	100.00
RUNOFF	14.817	(20.7788)	148.17	2.667
EVAPOTRANSPIRATION	394.321	(119.3919)	3943.21	70.979
LATERAL DRAINAGE COLLECTED FROM LAYER 2	145.19108	(69.59836)	1451.911	26.13466
DRAINAGE RECIRCULATED FROM LAYER 2	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00012	(0.00005)	0.001	0.00002
AVERAGE HEAD ON TOP OF LAYER 3	0.510	(0.244)		
CHANGE IN WATER STORAGE	1.221	(0.0680)	12.21	0.220

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 2 and their dates (DDDYYYY)

	(MM)	(CU. METERS)	
PRECIPITATION	93.50	935.00000	180002
RUNOFF	19.482	194.82344	180002
DRAINAGE COLLECTED FROM LAYER 2	3.80131	38.01314	2340002
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.00003	2340002
AVERAGE HEAD ON TOP OF LAYER 3	4.893		
MAXIMUM HEAD ON TOP OF LAYER 3	9.279		
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	1.0 METERS		
SNOW WATER	0.00	0.0000	0
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4199		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0770		

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2

LAYER	(CM)	(VOL/VOL)
1	812.4690	0.2902
2	0.9600	0.0320
3	0.0000	0.0000
4	0.4500	0.7500

SNOW WATER 0.000

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APPENDIX F

Limitations

LIMITATIONS

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