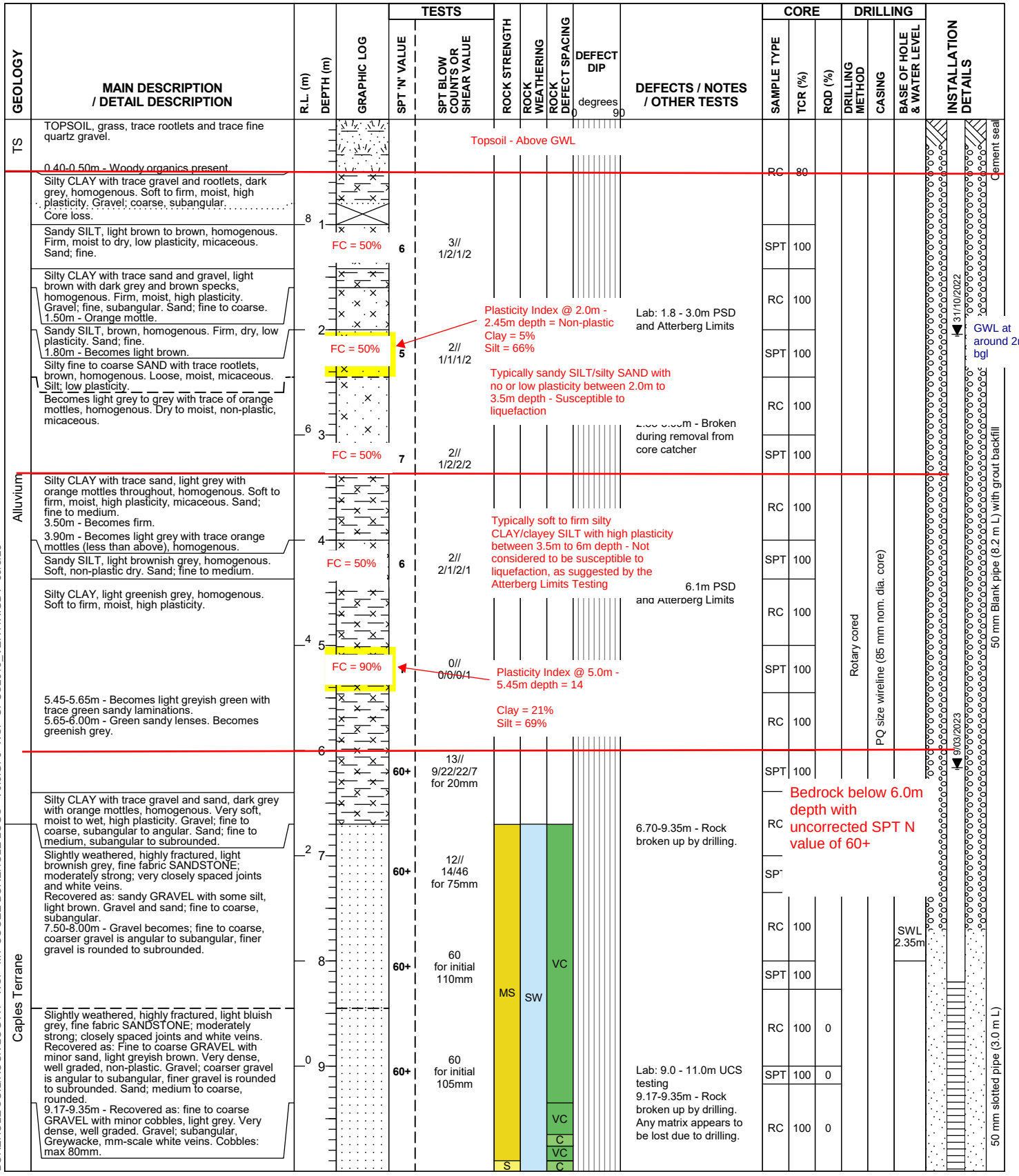
Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m

Inclination: Vertical



BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Slightly weathered, fractured, light grey, fine fabric SANDSTONE; strong; white veins smooth and tight aperture. Recovered as: COBBLES, with some gravel and sand. Well graded. Cobbles and gravel; angular to subangular. Sand; fine to medium.*(continued)* 10.11-11.00m - Thinly laminated veins throughout. Veins are mostly white, some are greenish white. Apertures extremely closely spaced, very narrow. 10.40-10.60m - Heavily veined. Minor sand. 10.80-11.00m - Angular GRAVEL and COBBLES.	-2 / 11		60+	60 for initial 105mm	S	SW	VC			SPT	100	0	Rotary cored			
								C			RC	100	0				
								VC									
				60+	60 for initial 95mm			C			SPT	100	0				
								VC			RC	100	0				
	END OF BOREHOLE AT 11.6m - Target Depth Reached	12															
		-4 / 13															
		14															
		-6 / 15															
		16															
		-8 / 17															
		18															
		-10 / 19															

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 19/10/2022
Finished: 20/10/2022
Drilling Co.: McMillan Drilling
Drilling Rig: Hanjin D&B-8D - track
Logged by: C. Hall
Checked by: C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Updated Liquefaction Assessment Outputs - Base Case

WSP
Dunedin Office
197 Rattray St, Dunedin, 9016
New Zealand

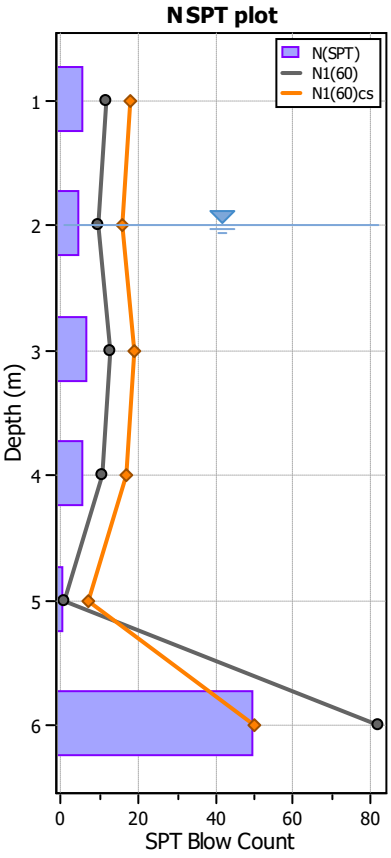
SPT BASED LIQUEFACTION ANALYSIS REPORT

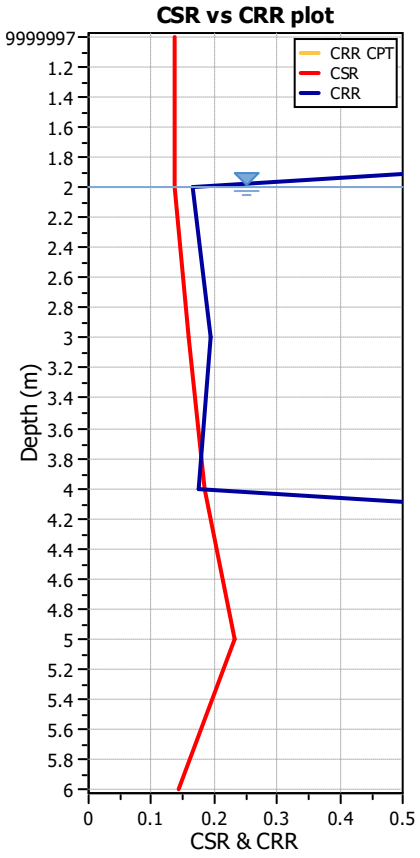
Project title : Mount Cooee Landfill Development **Location : Balclutha, Otago**

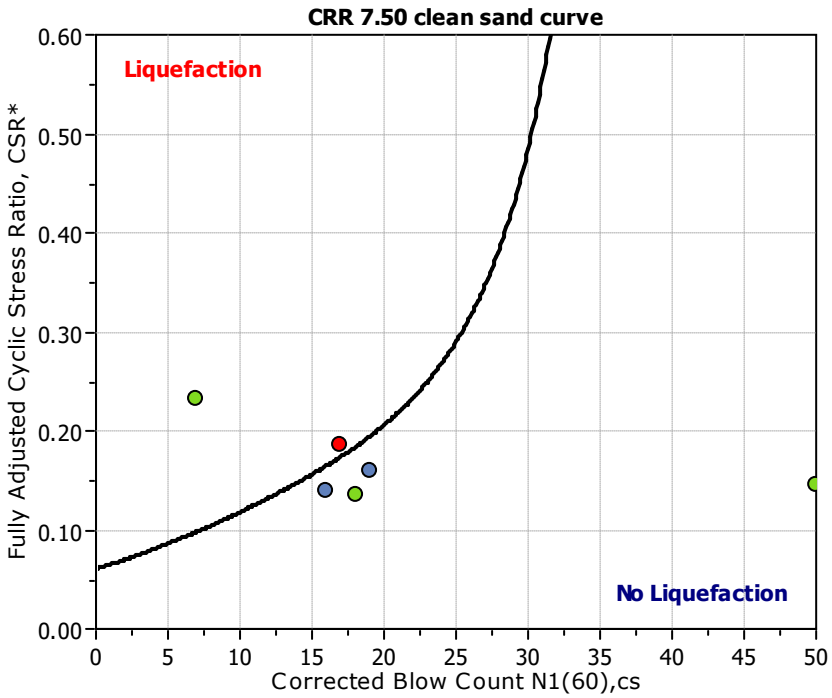
Borehole Name : BH1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.00	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.29		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	1.51				







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m³)	u_o (kPa)	σ_v (kPa)	Ext. Load (kPa)	σ'_v (kPa)	r_d	CSR	K_σ	MSF_{max}	MSF	CSR^*
1	1.00	17.00	0.00	17.00	0.00	17.00	0.99	0.187	1.10	1.42	1.48	2.000
2	2.00	17.00	0.00	34.00	0.00	34.00	0.98	0.184	1.10	1.35	1.48	0.138
3	3.00	17.00	9.81	51.00	0.00	41.19	0.96	0.224	1.10	1.45	1.48	0.160
4	4.00	17.00	19.62	68.00	0.00	48.38	0.94	0.249	1.09	1.38	1.48	0.186
5	5.00	17.00	29.43	85.00	0.00	55.57	0.92	0.265	1.05	1.14	1.48	2.000
6	6.00	17.00	39.24	102.00	0.00	62.76	0.90	0.274	1.10	2.20	1.48	2.000

Abbreviations

Depth: Depth from free surface where SPT was performed (m) during eq.
u_0: Water pressure at test point (kPa) during eq.
σ_v: Total overburden pressure at test point (kPa) during eq.
σ_v': Effective overburden pressure based on GWT during earthquake (kPa) during eq.
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (m)	Fines %	u_o (kPa)	σ_v (kPa)	σ'_v (kPa)	N_{SPT}	C_N	C_R	C_B	C_S	C_E	$N_{1(60)}$	$\Delta(N_1)_{60}$	$N_{1(60),cs}$	$CRR_{7.5}$	F.S.
1	1.00	50.00	0.00	17.00	17.00	6	1.70	0.75	1.00	1.00	1.51	12	5.61	18	4.000	2.00
2	2.00	50.00	0.00	34.00	34.00	5	1.68	0.80	1.00	1.00	1.51	10	5.61	16	0.165	1.19
3	3.00	50.00	9.81	51.00	41.19	7	1.50	0.85	1.00	1.00	1.51	13	5.61	19	0.194	1.22
4	4.00	50.00	19.62	68.00	48.38	6	1.41	0.85	1.00	1.00	1.51	11	5.61	17	0.174	0.93
5	5.00	90.00	29.43	85.00	55.57	1	1.42	0.95	1.00	1.00	1.51	1	5.51	7	4.000	2.00
6	6.00	50.00	39.24	102.00	62.76	50	1.13	0.95	1.00	1.00	1.51	82	5.61	50	4.000	2.00

Liquefiable layer between 4.0m and 4.5m bgl based on SPT data and borehole logs

Abbreviations

Depth: Depth from free surface where SPT was performed (m)
Weight: Soil unit weight from previous test point to current (kN/m³)
u_0: Water pressure at test point (kPa)
σ_v: Total overburden pressure at test point (kPa)
σ_v': Effective overburden pressure based on in situ GWT (kPa)
N_{SPT}: Number of blows count in the field (blows/30 cm)
C_N: Overburden pressure factor
C_E: Energy ratio factor
C_B: Borehole diameter factor
C_R: Rod length factor
C_S: Sampling method factor
$N_{1(60)}$: Number of blows corrected for 60% energy
$\Delta N_{1(60),cs}$ Fines correction
$N_{1(60),cs}$: Number of blows corrected for 60% energy and fines
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

Updated Liquefaction Assessment Outputs - Fines Content SensitivityCase

WSP
Dunedin Office
197 Rattray St, Dunedin, 9016
New Zealand

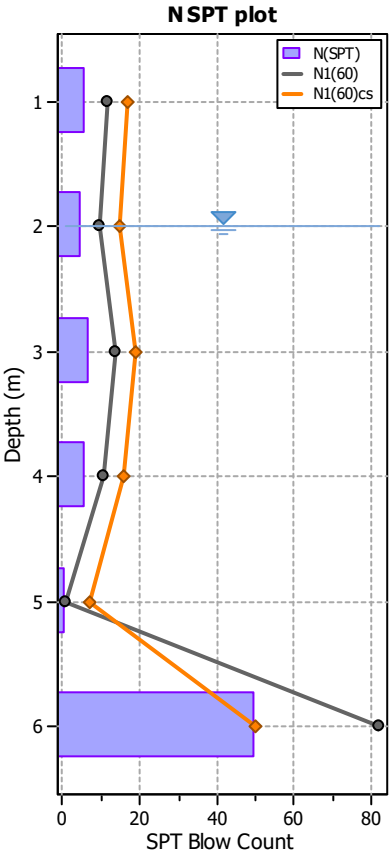
SPT BASED LIQUEFACTION ANALYSIS REPORT

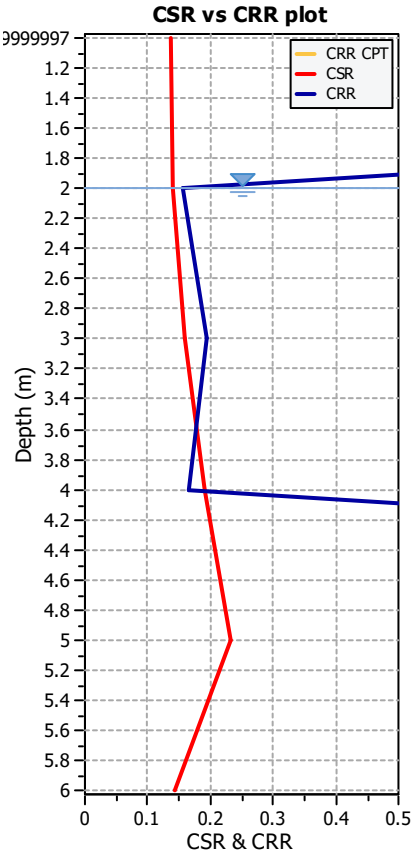
Project title : Mt Cooee Landfill Development **Location : Balclutha, Otago**

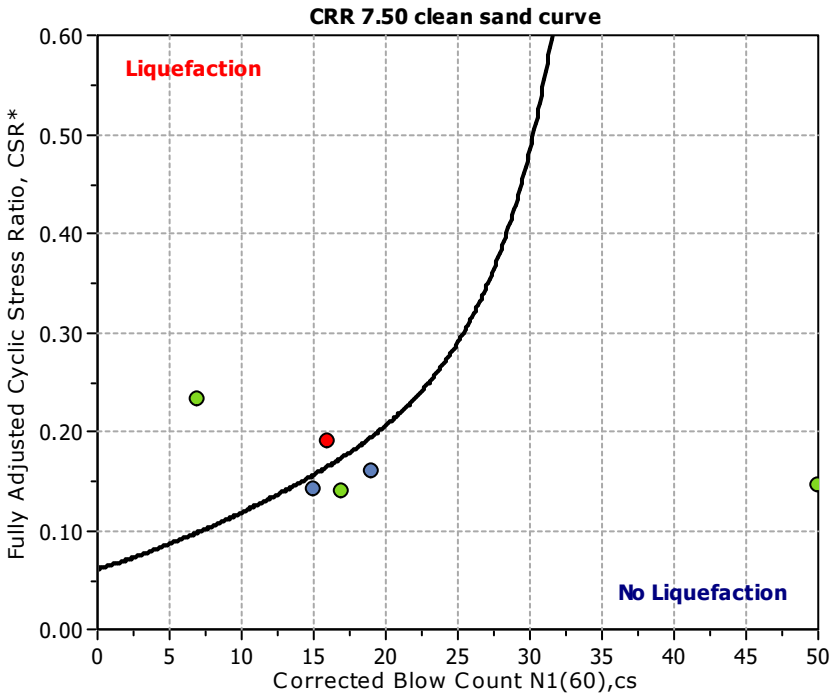
Borehole Name : BH1

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.00	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.29		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	1.51				







:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::

No	Depth (m)	Weight (kN/m³)	u_o (kPa)	σ_v (kPa)	Ext. Load (kPa)	σ'_v (kPa)	r_d	CSR	K_σ	MSF_{max}	MSF	CSR^*
1	1.00	17.00	0.00	17.00	0.00	17.00	0.99	0.187	1.10	1.38	1.48	2.000
2	2.00	17.00	0.00	34.00	0.00	34.00	0.98	0.184	1.10	1.32	1.48	0.141
3	3.00	17.00	9.81	51.00	0.00	41.19	0.96	0.224	1.10	1.45	1.48	0.160
4	4.00	17.00	19.62	68.00	0.00	48.38	0.94	0.249	1.08	1.35	1.48	0.190
5	5.00	17.00	29.43	85.00	0.00	55.57	0.92	0.265	1.05	1.14	1.48	2.000
6	6.00	17.00	39.24	102.00	0.00	62.76	0.90	0.274	1.10	2.20	1.48	2.000

Abbreviations

Depth: Depth from free surface where SPT was performed (m) during eq.
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σ_v: Total overburden pressure at test point (kPa) during eq.
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r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Effective overburden stress factor
K_σ: Magnitude Scaling Factor
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1	1.00	30.00	0.00	17.00	17.00	6	1.70	0.75	1.00	1.00	1.51	12	5.36	17	4.000	2.00
2	2.00	30.00	0.00	34.00	34.00	5	1.70	0.80	1.00	1.00	1.51	10	5.36	15	0.156	1.11
3	3.00	30.00	9.81	51.00	41.19	7	1.51	0.85	1.00	1.00	1.51	14	5.36	19	0.194	1.22
4	4.00	30.00	19.62	68.00	48.38	6	1.42	0.85	1.00	1.00	1.51	11	5.36	16	0.165	0.87
5	5.00	70.00	29.43	85.00	55.57	1	1.42	0.95	1.00	1.00	1.51	1	5.57	7	4.000	2.00
6	6.00	30.00	39.24	102.00	62.76	50	1.13	0.95	1.00	1.00	1.51	82	5.36	50	4.000	2.00

Liquefiable layer between 4.0m and 4.5m bgl based on SPT data and borehole logs

Abbreviations

Depth: Depth from free surface where SPT was performed (m)
Weight: Soil unit weight from previous test point to current (kN/m³)
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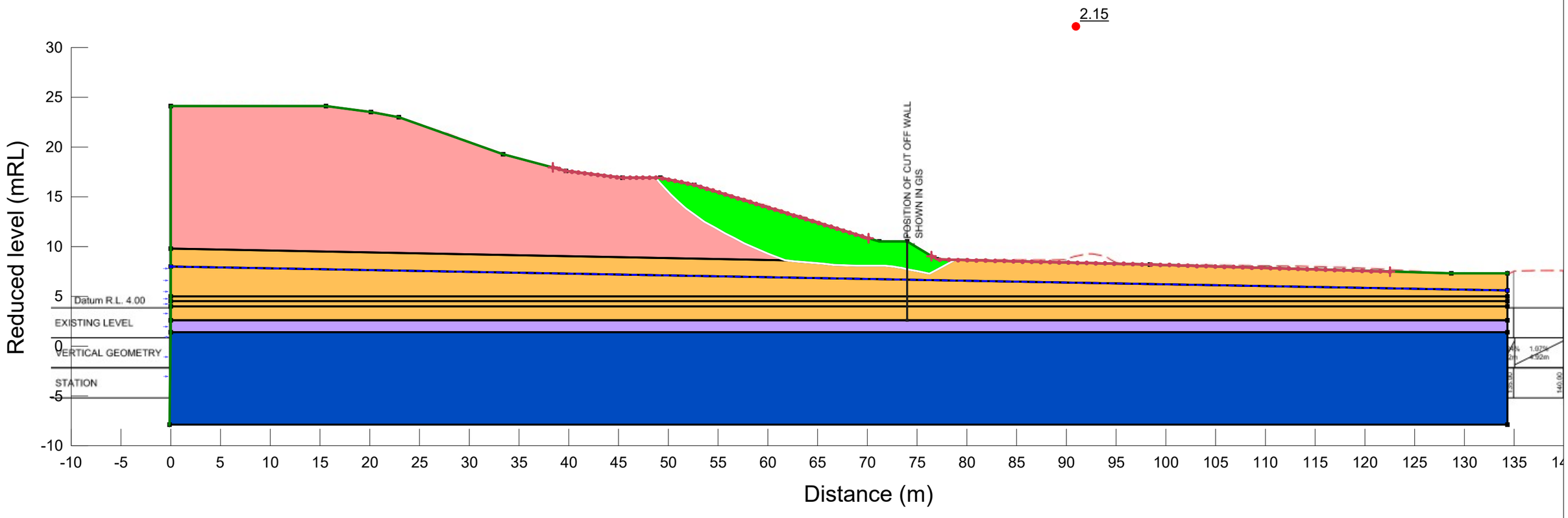
C_E: Energy ratio factor
C_B: Borehole diameter factor
C_R: Rod length factor
C_S: Sampling method factor
$N_{1(60)}$: Number of blows corrected for 60% energy
$\Delta N_{1(60),cs}$ Fines correction
$N_{1(60),cs}$: Number of blows corrected for 60% energy and fines
$CRR_{7.5}$: Cyclic Resistance Ratio for M_w 7.50
F.S.: Factor of safety against liquefaction

Horz Seismic Coef.:

Method: Morgenstern-Price

Updated Stability Assessment Outputs

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18	3	28	0	1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25	0	1
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	24	0	1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44	0	1



wsp	Mt Cooee Landfill Development Plan	1.1 Static - Long term	6-CO082.00	Date: 07/09/2023
			Scale: 1:400	By: NT

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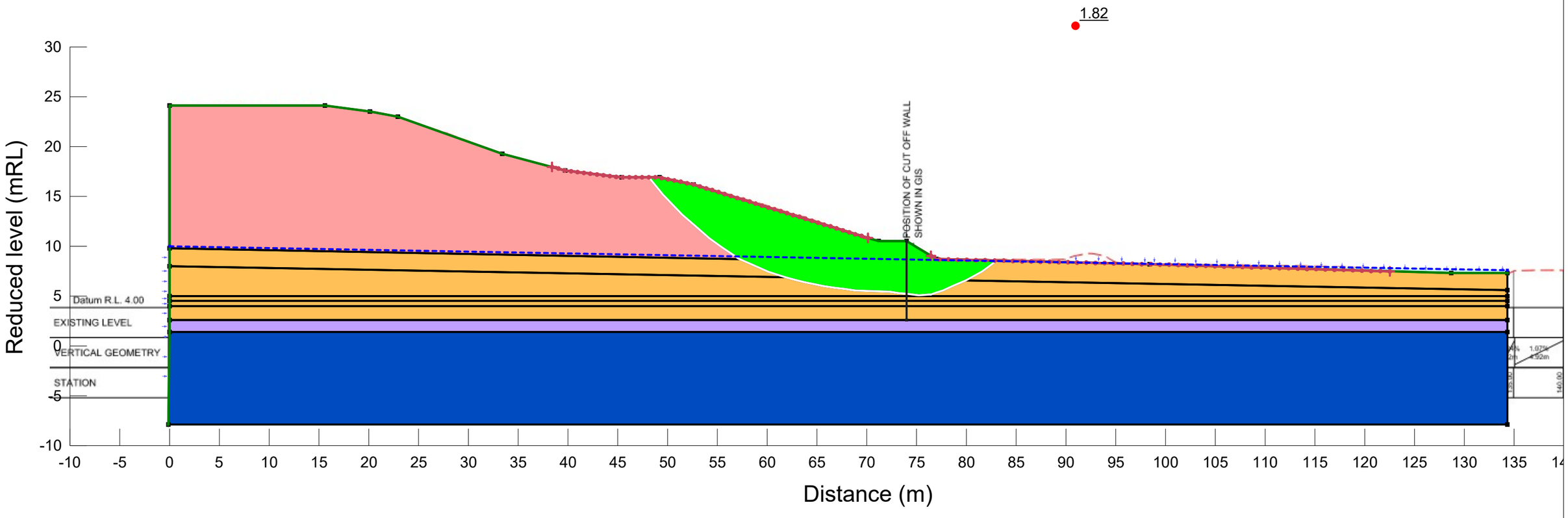
DO NOT SCALE

Version: 11.4.0.18

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18	3	28	0	1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25	0	1
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	24	0	1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44	0	1

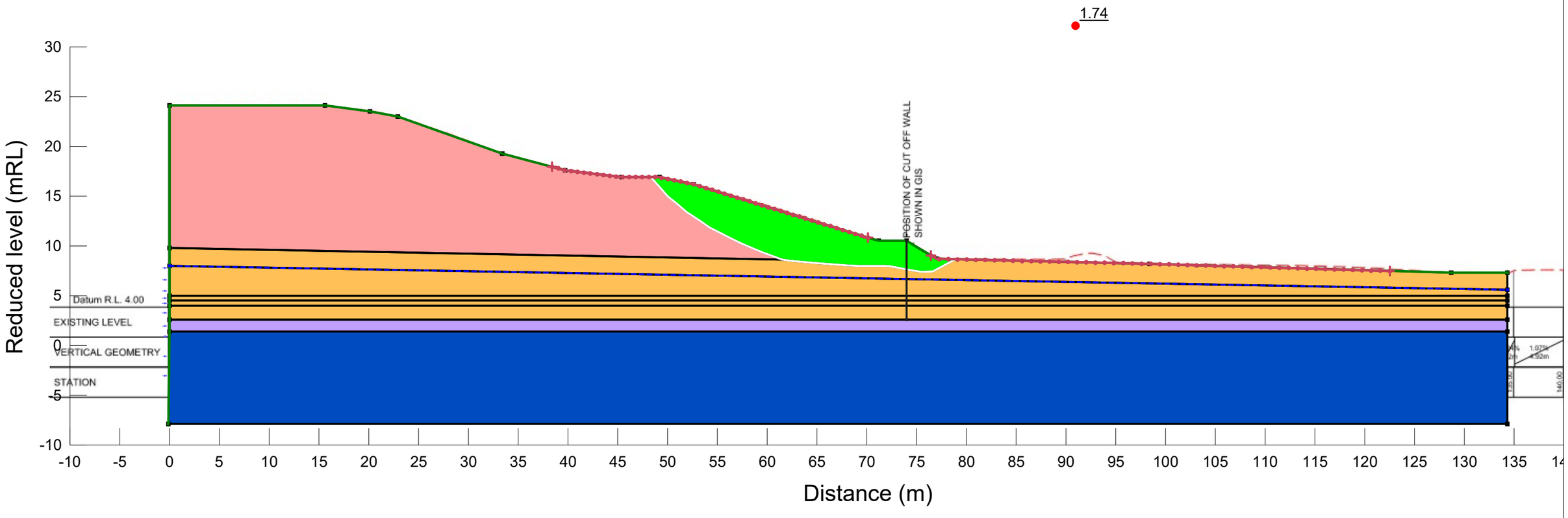


wsp	Mt Cooee Landfill Development Plan	1.2 Static - Short Term (High GWL)	6-CO082.00	Date: 07/09/2023
			Scale: 1:400	By: NT

Horz Seismic Coef.: 0.06

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18	3	28	0	1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25	0	1
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	24	0	1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44	0	1

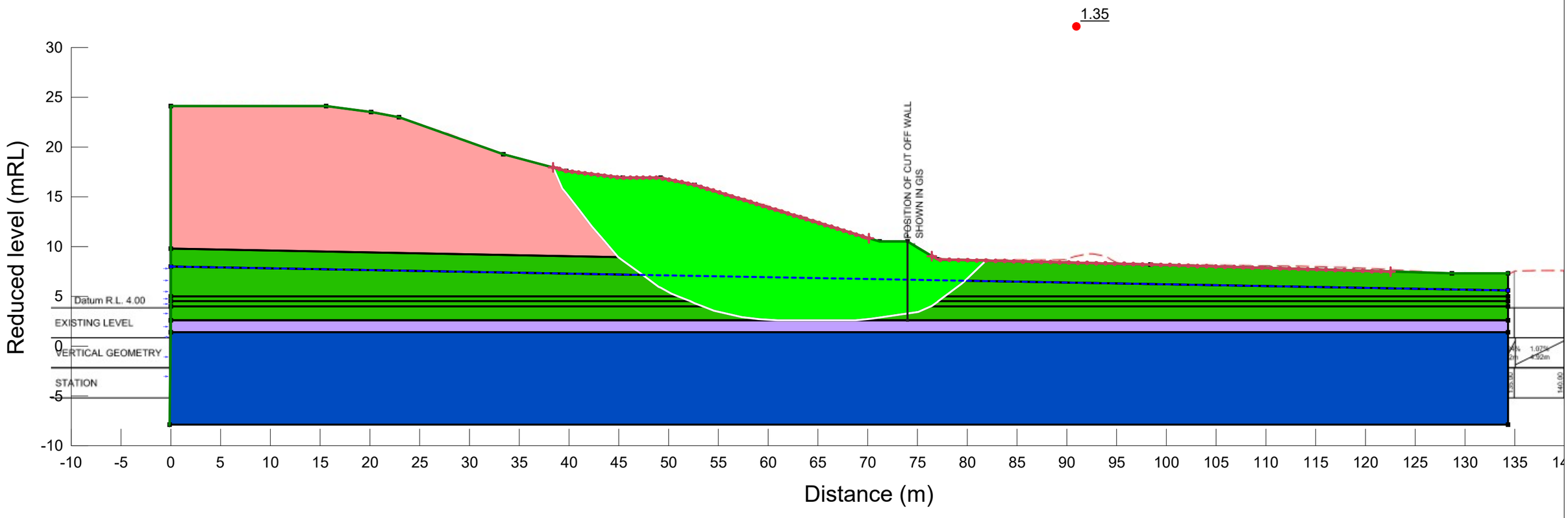


wsp	Mt Cooee Landfill Development Plan	1.3 Seismic - SLS	6-CO082.00	Date: 07/09/2023
			Scale: 1:400	By: NT

Horz Seismic Coef.: 0.06

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18		3	28	0	1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13		5	25	0	1
	Unit 2 - Alluvial Deposits (Undrained)	Undrained (Phi=0)	17	30				1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21		20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23		30	44	0	1

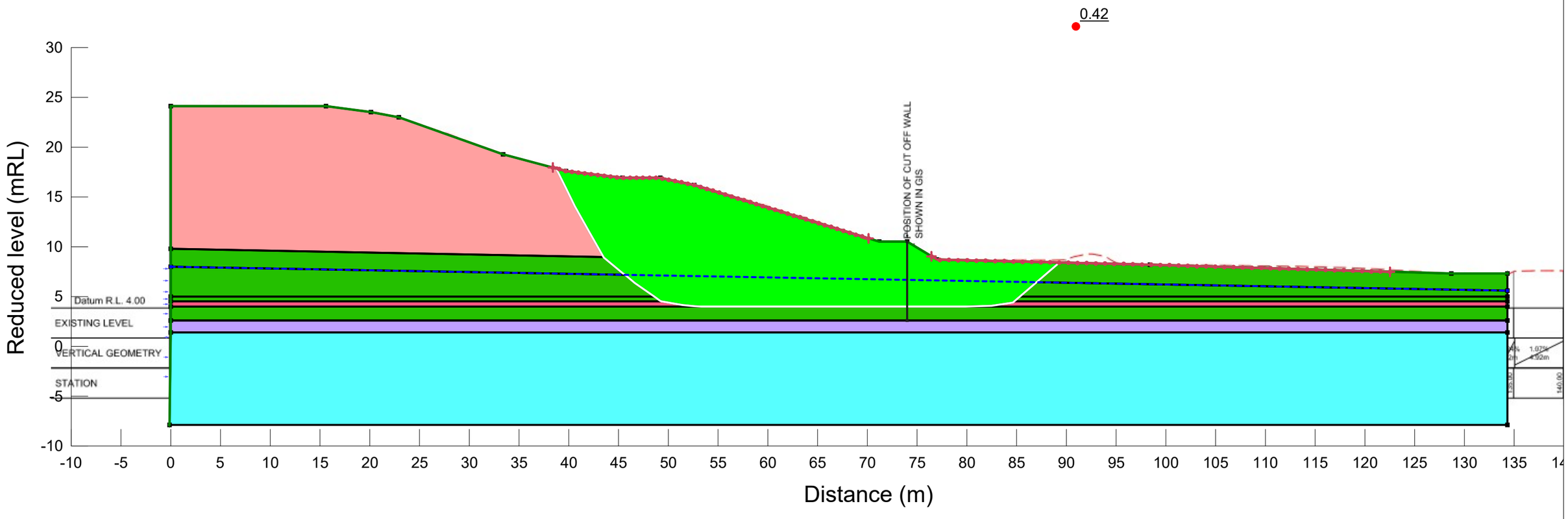


wsp	Mt Cooee Landfill Development Plan	1.3 Seismic - SLS (Undrained)	6-CO082.00	Date: 07/09/2023
			Scale: 1:400	By: NT

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18				3	28	0	1
	Liquefiable Unit 2 Alluvium (T/Sigma = 0.1)	SHANSEP	17		0	0.1				1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13				5	25	0	1
	Unit 2 - Alluvial Deposits (Undrained)	Undrained (Phi=0)	17	30						1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21				20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Undrained)	Undrained (Phi=0)	23	750						1

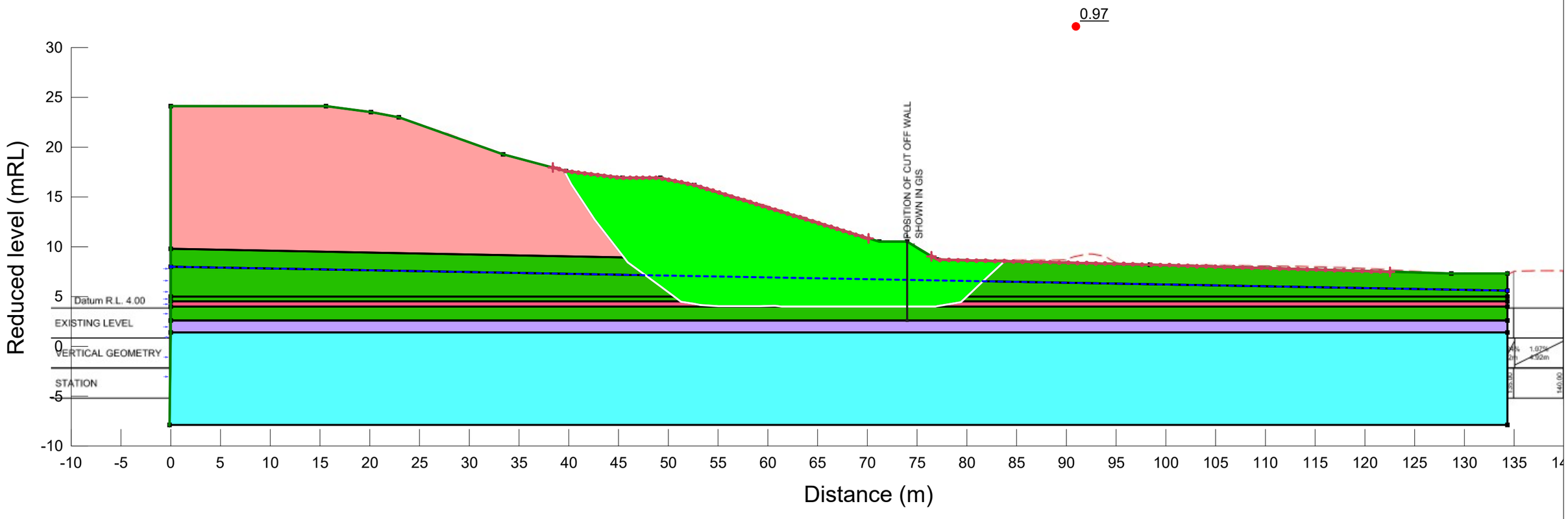


wsp	Mt Cooee Landfill Development Plan	1.4 Seismic - DCLS (Undrained + Liquefiable Alluvium)	6-CO082.00 Scale: 1:400	Date: 07/09/2023 By: NT

Horz Seismic Coef.: 0.05

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Surface
	Existing Clay Bund (Drained)	Mohr-Coulomb	18				3	28	0	1
	Liquefiable Unit 2 Alluvium (T/Sigma = 0.1)	SHANSEP	17		0	0.1				1
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13				5	25	0	1
	Unit 2 - Alluvial Deposits (Undrained)	Undrained (Phi=0)	17	30						1
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21				20	40	0	1
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Undrained)	Undrained (Phi=0)	23	750						1



wsp	Mt Cooee Landfill Development Plan	1.5 Seismic - Yield Acceleration - No sheet pile pinning	6-CO082.00	Date: 07/09/2023
			Scale: 1:400	By: NT