BOREHOLE CORE PHOTOGRAPHS: MH02-21

Client: Build Rich Limited
Project: Silverdale South Stage 3+4
Location: Silverdale
Project No: AKL2020-0125
Date: 5 August 2021

Logged by: LSW	Position: 1749102mE, 5945118mN	Hole Diameter: 63mm	Plant: Tractor-Mounted Drill Rig
Checked by:	Elevation: 30.3m	Angle from Horizontal: 90°	Contractor: ProDrill

MH02-21: 8.00m to 9.50m

Appendix C: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2016

MACHINE BOREHOLE - BH01-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 06/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
Northland Allochthon			0		OL: TOPSOIL											
					CL: CLAY: orange and brown. Very stiff to hard, dry to moist, low plasticity.		Vst to H		100			V-UTP				
					...becoming with fine to medium, angular, dark orange and light brown gravel.				80							
			1		*...becoming light golden orange with dark orange, grey and brown sub-horizontal, thinly laminated, wavy bands.*				100			V-UTP				
					...fine to medium gravel begins again.											
					CL: Silty CLAY with minor completely weathered SILTSTONE clasts: light grey with limonite staining. Hard, dry to moist, low plasticity.	D to M			0			V-UTP	(18,42,8/15mm) N* = R			
			2				H		20							
					Moderately weathered, light grey, with sub-vertical to sub-vertical orange banding SILTSTONE. Very weak.											
					...fractured to fine gravel, hard, CLAY with limonite on faces.				100							
			3		CH: Silty CLAY with some fine to medium siltstone gravel: light grey. Very stiff, moist, high plasticity.											
						M	VSt						(10,22,28/135mm) Nc = R			
			4						100	100						
					Highly weathered, light grey SILTSTONE. Extremely weak to very weak.											
			5										(24,50/140 mm) Nc = R		RC	
									100	60						5.5-5.9m:1 Crushed zone, 0°, crushed to fine to course gravel.
			6													
													(50,) Nc = R			6.7-7.5m:1 Crushed zone, 0°, crushed to very stiff to hard clay.
			7						100	100						
																7.6m:1 Joint, 0°, moderately wide, dark grey clay infill.
			8										(50,) Nc = R			
									100	100						
			9													
													(50/130mm) Nc = R			
			10		Continued on next sheet											

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 4.8m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH01-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 06/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
			11		*...becoming completely weathered to highly weathered. Weathered to very stiff, light grey Silty CLAY with fine to course gravel SILTSTONE clasts.*				100	90			(32,50,) Nc = R			10.2-10.3m:1 Crushed zone, 45°, crushed to dark grey medium gravel. 10.7m:1 Joint, 10°, dark grey clay infill.
			12						70	90						12.1-12.2m:2 Crushed zones, 25°, crushed to medium gravel. 12.3m:1 Joint, 25°, undulating rough, infill washed away.
			13						100	100			(50/140m m) Nc = R			
			14						100	50			(50/95mm) Nc = R			14.6-4.6m:1 Crushed Zone, 10°, crushed to fine gravel. 15.0-15.5m:6 Joints, 40°, very closely spaced, undulating rough.
			15													
					Borehole terminated at 15.5 m								(50/85mm) Nc = R			
			16													
			17													
			18													
			19													
			20													

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 4.8m

MACHINE BOREHOLE - BH02-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 05/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	RQD	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Drilling Method/ Support	Comments/Defect Description
Top soil		OL: TOPSOIL								
		CH: CLAY: orange with minor sub-horizontal thinly laminated wave brown banding. Very stiff to hard, moist, high plasticity. Minor rootlets.	M		80		V-UTP			
		...becoming light brown.			100					
		...sub-vertical shrink swell fissures with rootlets and orange staining on fissure faces.								
	1	*...becoming with sub-horizontal thinly laminated wavy orange and light grey banding. Minor very closely spaced cracking along banding becoming closely spaced at 0.9m.*		Vst to H	100		V-UTP			
		...becoming hard and friable, dry to moist, low plasticity. Sub-horizontal thinly laminated micro fractures with limonite and dark grey staining on faces. Fractures to fine to medium gravel sized clasts. Rootlets becoming rare.	D to M		0		V-UTP	(8,12,18) N* = 30		
	2	CL: Silty CLAY with traces of highly weathered, extremely weak fine to medium gravel siltstone clasts.: light grey and orange limonite staining. Hard, dry to moist, low plasticity.			100	100				2.2m:1 Joint, 45°, planar rough, limonite and rootlets on face.
		...fractures end.								2.6m:1 Joint, 45°, stepped smooth, limonite infill.
		Completely weathered to highly weathered, light grey SILTSTONE. Extremely weak to weak. Thinly laminated micro fractures throughout.:			100	100				
	3	*...becoming blueish dark grey.*								
		Highly weathered to moderately weathered, grey SANDSTONE. Very weak to weak. Minor thinly laminated, closely spaced micro fractures. Bedding contact is stepped at with 45°.			100	100		(10,17,25) Nc = 42		3.4m:1 Joint, 45°, planar rough, firm grey CLAY infill.
	4	:								
		Alternating highly weathered, grey SILTSTONE, very weak to weak, and highly weathered, grey SANDSTONE, very weak to weak. Bedding is moderately thick to moderately thin. Bedding boundaries are steeply inclined with 2mm thick hard grey CLAY infill.:			100	100				4.5m:1 Joint, 5°, planar rough, very narrow, firm grey CLAY infill.
	5							(16,23,27/ 140mm) Nc = R	RC	
					100	100				5.6m:1 Joint, 45°, undulating rough, moderately narrow, stiff grey CLAY infill.
	6	*...SANDSTONE ends.*								
		...becoming with thinly laminated dark grey sub-horizontal to steeply inclined banding.						(13,20,30) Nc = 50		
	7	*...thinly laminated micro fractures begin.*			100	100				7.2m:1 Drilling induced, 45°, planar slickensided, no infill.
	8							(13,25,25/ 100mm) Nc = R		
					100	100				
	9									
								(23,25,25/ 120mm) Nc = R		
Northland Allochthon	10	Continued on next sheet								

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 2.6m

MACHINE BOREHOLE - BH02-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 05/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering: RS	CW	HW	MW	SW	DW	Recovery	RQD	Estimated Strength: EW	VW	W	MS	S	VS	ES	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm): <20	20-60	60-200	200-600	600-2000	>2000	Drilling Method/ Support	Comments/Defect Description
			11											100	100										(24,44,6/15mm) Nc = R								10.6m:1 Drilling induced, 45°, undulating rough, no infill. 11.1m:1 Joint, 45°, stepped rough, moderately wide, stiff dark grey CLAY infill. 11.2m:1 Drilling induced, 10°, stepped smooth, no infill.
			12											100	100																	12.2m:1 Crushed zone, 0°, moderately narrow, crushed to fine to medium gravel.
			13											100	92										(24,50,) Nc = R							
			14											100	100										(31,45,5/10mm) Nc = R							13.7m:2 Joints, 30° intersecting at 120°, stepped slickensided, no infill.
			15		...thin sub-horizontal band of stiff dark grey CLAY.																											
					Borehole terminated at 15.5 m																				(17,27,23/110mm) Nc = R							
			16																													
			17																													
			18																													
			19																													
			20																													

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 2.6m

MACHINE BOREHOLE - BH03-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 04/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
Topsoil					OL: TOPSOIL											
Northland Allochthon			1		CH: CLAY: orange with minor sub-horizontal, thinly laminated brown banding. Very stiff to hard, moist, high plasticity. Minor rootlets throughout. *...banding ends. Vertical fissures with minor organic staining and rootlets running along fissure faces.* *...banding begins again. Fissures end.* *...fissures begin again. Banding ends.* *...becoming grey with orange mottle. Fissures end. Rootlets remain.*	M	Vst to H		80 100 100 100			V-UTP 89(41) V-UTP	(3,3,6) N* = 9			
			2		*...band of heavy limonite staining.* *...2 10mm thick sub-horizontal heavy limonite stained bands.* *...becoming dark grey with darker grey mottle and occasional limonite mottle.*											
			3									V-UTP	(6,8,10) N* = 18			
			4		CL: Silty CLAY with minor fine to medium siltstone gravel: grey with dark grey clasts. Hard, dry to moist, low plasticity. *...extremely closely spaced, laminated, sub-horizontal, wavy dark grey bans*	D to M	H		100							
			5		*...30mm thick crushed zone, crushed to angular siltstone clasts.*				50			V-UTP	(8,10,13) N* = 23		RC	
			6		Alternating completely weathered, dark grey SILTSTONE, extremely weak with darker grey micro-fractures throughout and highly weathered, light grey SILTSTONE, extremely weak to very weak with occasional micro-fracture.				100	100						
			7						100	100			(10,14,36/ 140mm) Nc = R			7.3m:1 Joint, 85°, undulating smooth, dark grey clay infill. 7.6m:1 Crushed zone, 5°, moderately thin, crushed to fine angular gravel.
			8						100	100						
			9						100	100			(19,32,18/ 90mm) Nc = R			9.1m:1 Drilling induced, 20°, stepped rough, no infill.
			10		Alternating highly weathered, grey SILTSTONE, extremely weak to weak and moderately weathered,				100	100						9.5-9.6m:1 Crushed zone, 45°, crushed to medium, angular, weak to very weak gravel in a grey, stiff clay.
					(16,25,25/ 140mm) Nc = R											
					Continued on next sheet											

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 1.4m

MACHINE BOREHOLE - BH03-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 04/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
			11		grey SILTSTONE, very weak to weak. Thin to moderately thin bedding.				50	100			(11,16,32) Nc = 48			
			12		*...band of slightly weathered, grey SANDSTONE, moderately strong. Minor sub-vertical, laminated quartz veins.*				90	50						11.5-11.5m:1 Drilling induced, 5°.
			13		*...1 sub-horizontal quartz vein with stepped rough boundaries.*				100	100			(10,19,21) Nc = 40			
			14		Borehole terminated at 14.0 m								(10,23,27/ 115mm) Nc = R			13.7-13.7m:1 Crushed zone, 45°, crushed to fine gravel.
			15													
			16													
			17													
			18													
			19													
			20													

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 1.4m

TEST PIT - TP11-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 20°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Top soil			0		OL: TOPSOIL	D			
Northland Allochthon					CH: Silty CLAY: Light orange with limonite staining. Very stiff, moist, high plasticity. Vertical and horizontal fissures from shrink/swell. Rootlets and limonite staining is fissures.		MS	V-107(52)	
					...fissures end.				
			1		*...becoming creamy white with limonite staining.*		MS	V-110(34)	
						M	MS	V-83(34)	
			2		*...band of heavy limonite staining above boundary.*		IS	V-62(41)	
					CH: Silty CLAY with some highly weathered fine to medium siltstone gravel: dark grey and light grey. Stiff to very stiff, moist, high plasticity.				
			3		Completely weathered to highly weathered, dark grey SILTSTONE. Extremely weak to very weak. Fractures to stepped smooth polished surfaces.				
					Test Pit excavated to 3.1 m				
			4						
			5						
			6						
			7						
			8						

Termination reason: Target depth reached

Remarks: Standing groundwater not encountered

TEST PIT - TP12-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 320°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil			0		OL: Topsoil	D			
Northland Allochthon					CL: Silty CLAY: dark orange with limonite staining and grey mottle. Stiff to very stiff, dry to moist, low plasticity. Vertical and horizontal fissures from shrink/swell. Limonite and rootlets on fissures.		S	V-89(21)	
			1				MS	V-62(28)	
					CH: Silty CLAY: light grey with orange mottle and limonite staining increasing with depth. Very stiff, dry to moist, high plasticity.				
			2				MS	V-103(44)	
					...limonite staining becoming major.			V-UTP	
					CL: Silty CLAY with trace extremely weathered fine to medium siltstone gravel: light grey/off white with orange mottle. Hard, dry to moist, low plasticity.	D to M			
			3						
					...orange end. Becoming blueish light grey. Becoming with some gravel.				
			4						
					...becoming blueish dark grey.				
			5		Extremely weathered to highly weathered, dark grey with black banding SILTSTONE. Extremely weak. Clasts of weak siltstone. Fractures to smooth stepped polished surfaces.				
					Test Pit excavated to 5.2 m				
			6						
			7						
			8						

Termination reason: Target depth reached
Remarks: Standing groundwater not encountered

TEST PIT - TP13-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 40°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Top soil			0		OL: TOPSOIL	D			
Northland Allochthon			1		CH: Silty CLAY: light grey and orange. Stiff to very stiff, dry to moist, high plasticity. Horizontal and vertical fissures from shrink/swell. Rootlets and very minor limonite and organic staining in fissures. *...fissured end. Becoming more orange.* *...becoming light grey and creamy white with orange mottle. Rootlets end.*	M	MS MS MS	V-165(48) V-76(21) V-83(34)	
			2		CH: Silty CLAY with trace fine to medium completely weathered siltstone gravel. : light blueish grey. Very stiff to hard, moist, high plasticity. Heavy limonite staining in top 200mm.		MS	V-165(55)	
			3		Completely weathered, dark grey SILTSTONE. Extremely weak. *... becoming dark grey and blocky in structure. Fractures on right angles to smooth stepped surfaces.* *...thin lenses of slightly sandier SILTSTONE. Becoming moderately weathered and weak. Fractures decreasing.*				
			4		Moderately weathered, light blueish grey SILTSTONE. Very weak to weak. Fractures to angular fine to medium gravel sized clasts. Test Pit excavated to 3.8 m				
			5						
			6						
			7						
			8						

Termination reason: Target depth reached

Remarks: Standing groundwater not encountered.

TEST PIT - TP14-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil			0		OL: TOPSOIL	D			
Tauranga Group			1		CH: Silty CLAY: light grey with orange mottle. Stiff to very stiff, dry to moist, high plasticity. Minor rootlets.	D to M	MS	V-138(58)	
							MS	V-179(50)	
					ML: SILT with trace fine sand: white. Hard, dry to moist, low plasticity. Pumiceous. Abrupt top boundary. Dipping at 10° at bearing 180°			V-UTP	
			2		CH: Silty CLAY: light grey with light brown organic staining. Firm, moist to wet, high plasticity.	M to W	IS	V-41(21)	
Northland Allochthon			3						
			4		CH: Silty CLAY with minor fine to medium completely weathered siltstone gravel: light blueish grey. Very stiff to hard, moist, high plasticity.	M			
					...becoming darker blueish grey.				
			5		Test Pit excavated to 5.0 m				
			6						
			7						
			8						

Termination reason: Target depth reached

Remarks: Groundwater seepage encountered at 2.0m

TEST PIT - TP15-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Chapman Morton Woodward

Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 20°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil					OL: TOPSOIL	M			
Tauranga Group	▼		1		ML: Clayey SILT: light grey and light brown. Soft to firm, moist to wet, high plasticity. Exhibiting dilatant behaviour. Rootlets throughout.	M…	MS	V-34(11)	
					...becoming with minor orange mottle. Becoming wet. Groundwater seepage. Side of pit failing in rectangular slabs.		MS	V-34(14)	
			2				S	V-83(14)	
						W	MS	V-55(25)	
							MS	V-55(28)	
Northland Allochthon			3		CH: Silty CLAY trace fine to medium highly weathered siltstone gravel: light grey with dark grey and black banding. Firm to stiff, moist to wet, high plasticity.	D to M			
					Highly weathered, light grey SILTSTONE. Extremely to very weak. Fractures to irregular stepped faces.				
			4		Test Pit excavated to 3.5 m				
			5						
			6						
			7						
			8						

Termination reason: Unable to penetrate further
Remarks: Seeping groundwater encountered at 0.5m

HAND AUGER BOREHOLE - HA06-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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Chapman Morton Woodward

1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ

Position:
Survey Source: Estimated onsite

Elevation:
Datum:

Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon			0		OL: Topsoil.					
					CH: CLAY: orange, mixed light grey. Hard, dry, high plasticity.	D		V-193+		
								V-162(66)		
			1		CL: Silty CLAY: orange, mixed, light grey. Very stiff, moist, low plasticity.	M		V-107(45)		
					CH: CLAY: orange, mixed light grey. Very stiff, moist, high plasticity. With sheared texture.					
					CL: Silty CLAY: grey, streaked orange. Hard, dry, low plasticity. With some limonite stained relict defects.	D		V-193+		
			2		MH: Clayey SILT: light grey, streaked orange, Hard, dry, high plasticity. With crushed and sheared texture.			V-UTP		
					CH: CLAY, with some fine to medium sand and seams of saturated orange clay: light grey streaked orange. Stiff, wet, high plasticity. Sand consists of residually weathered, hard siltstone, with crushed and sheared texture.	W		V-72(21)		
					ML: SILT, with trace fine sand and clay: grey. Hard, dry, low plasticity. With chaotic fracturing (residually weathered very fine sandstone).	D		V-UTP V-UTP		
			3							
			4		Borehole terminated at 4.0m					
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not encountered at end of borehole

HAND AUGER BOREHOLE - HA07-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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Chapman Morton Woodward

1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ

Position:
Survey Source: Estimated onsite

Elevation:
Datum:

Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon			0		OL: Topsoil.					
					CL: Silty CLAY: light brownish orange. Very stiff, dry, low plasticity.	D		V-197+		
					...becoming moist			V-197+		
			1		...becoming light grey and orange	M		V-197+		
					...becoming dry to moist and hard	D to M		V-UTP		
					...with some limonite staining					
			2		...becoming moist	M		V-UTP		
					...becoming light grey, with up to medium gravel sized angular clasts of extremely weathered siltstone			V-UTP		
					...becoming light grey mottled orange and dry with friable blocky texture and some extremely weathered siltstone clasts			V-UTP		
			3		...becoming greenish grey and hard, with some brownish red mottles, with sheared texture			V-UTP		
								V-UTP		
			4		Borehole terminated at 4.0m			V-UTP		
								V-UTP		
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not encountered at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA09-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ

Position:
Survey Source: Estimated onsite

Elevation:
Datum:

Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Alluvium			0		OL: Topsoil.					
					...with clay inclusions					
					MH: Clayey SILT mixed with topsoil: orange, mixed brown and black. Stiff, moist, low plasticity.		MS	V-49(14)		
					OH: Organic CLAY: dark brownish black. Stiff, moist, high plasticity.		MS	V-76(31)		
					...slight groundwater seepage					
			1			M	S	V-87(21)		
					ML: SILT mixed with CH: CLAY. SILT is orange and low plasticity, CLAY is light grey and high plasticity. Both are stiff and moist.		MS	V-75(27)		
					CL: Sandy CLAY: brown. Very stiff, moist, low plasticity.					
	▼		2		*...with some hard orange silty clay inclusions and trace organic mottles*		MS	V-99(44)		
Northland Allochthon					CL: Silty CLAY: greenish grey. Hard, dry, low plasticity. With sheared texture.	D		V-UTP		
					Borehole terminated at 2.8m			V-UTP		
			3							
			4							
			5							

Termination reason: Unable to penetrate further

Remarks: Groundwater at 2.0 meters at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA10-15

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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1:25 Sheet 1 of 1

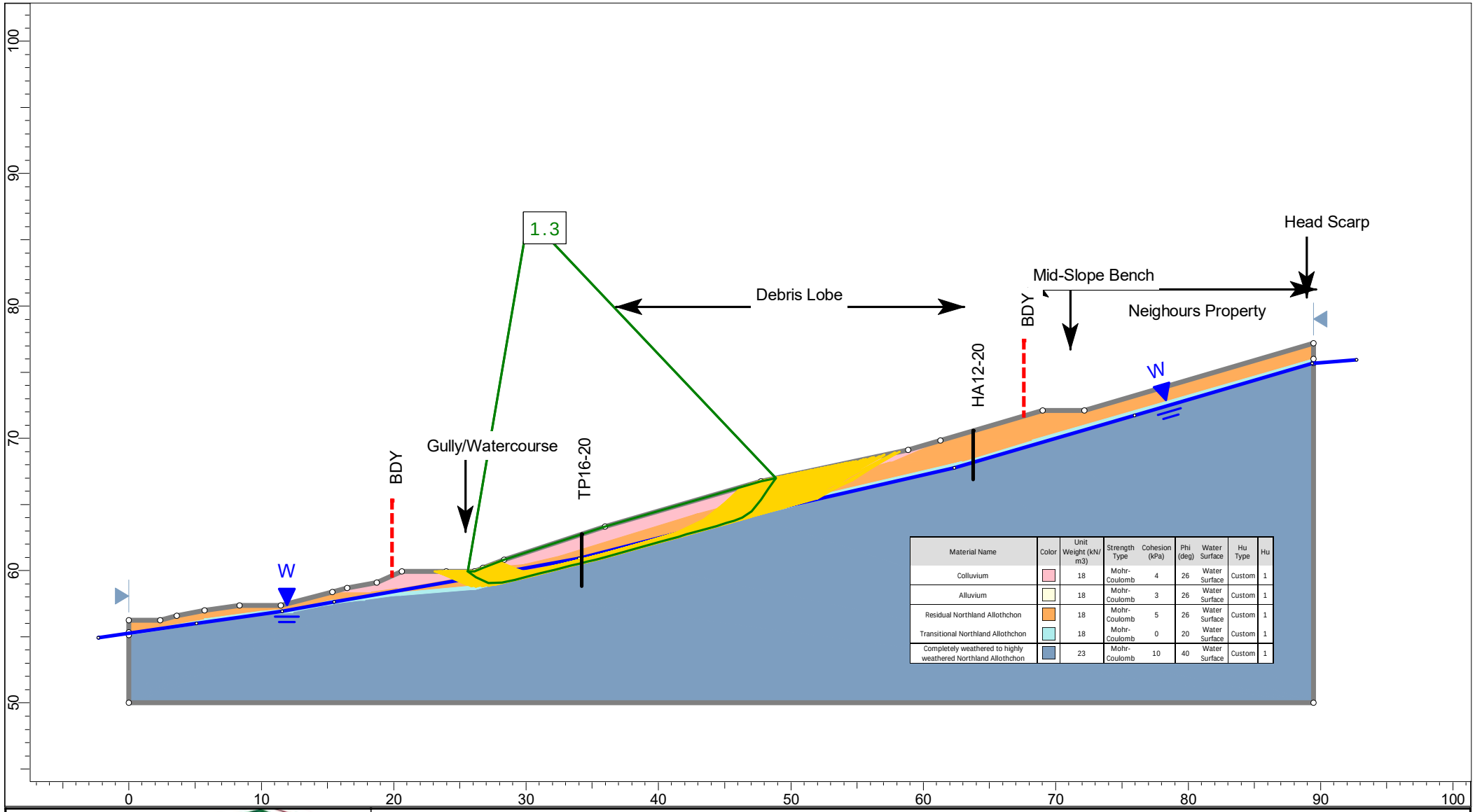
Logged by: MP
Checked by: JMJ
Position:
Survey Source: Estimated onsite
Elevation:
Datum:
Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon					OL: Topsoil.					
					CH: CLAY: reddish orange. Very stiff, moist, high plasticity. *...becoming light greyish orange*		S	V-162(39)		
							MS	V-142(39)		
			1		CL: Silty CLAY: light grey, streaked orange. Very stiff, moist, high plasticity. With pockets of clayey silt.	M				
					CH: CLAY, with minor silt: reddish brown, mixed light grey and orange. Hard, moist, high plasticity.		MS	V-186(66)		
								V-193+		
			2		MH: Clayey SILT: reddish brown. Hard, dry, low plasticity. With sheared and crushed texture.	D		V-UTP		
								V-UTP		
					CH: CLAY: dark reddish grey. Hard, moist, high plasticity. With sheared texture.	M		V-UTP		
			3		ML: SILT: light grey. Hard, dry, low plasticity.	D		V-UTP		
					CH: CLAY, with some silt: dark grey, mottled red. Hard, moist, high plasticity. With sheared texture.					
					CH: CLAY, with trace fine to medium sand: dark red. Hard, moist, high plasticity. Sand consists of completely weathered, extremely weak siltstone.	M		V-UTP		
			4		CL: Silty CLAY: greenish grey, mixed dark red. Hard, dry, low plasticity. With some pockets of SILT and with sheared and crushed textures.	D		V-UTP		
					Borehole terminated at 4.2m					
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not present at end of borehole

Appendix D: Stability Analysis



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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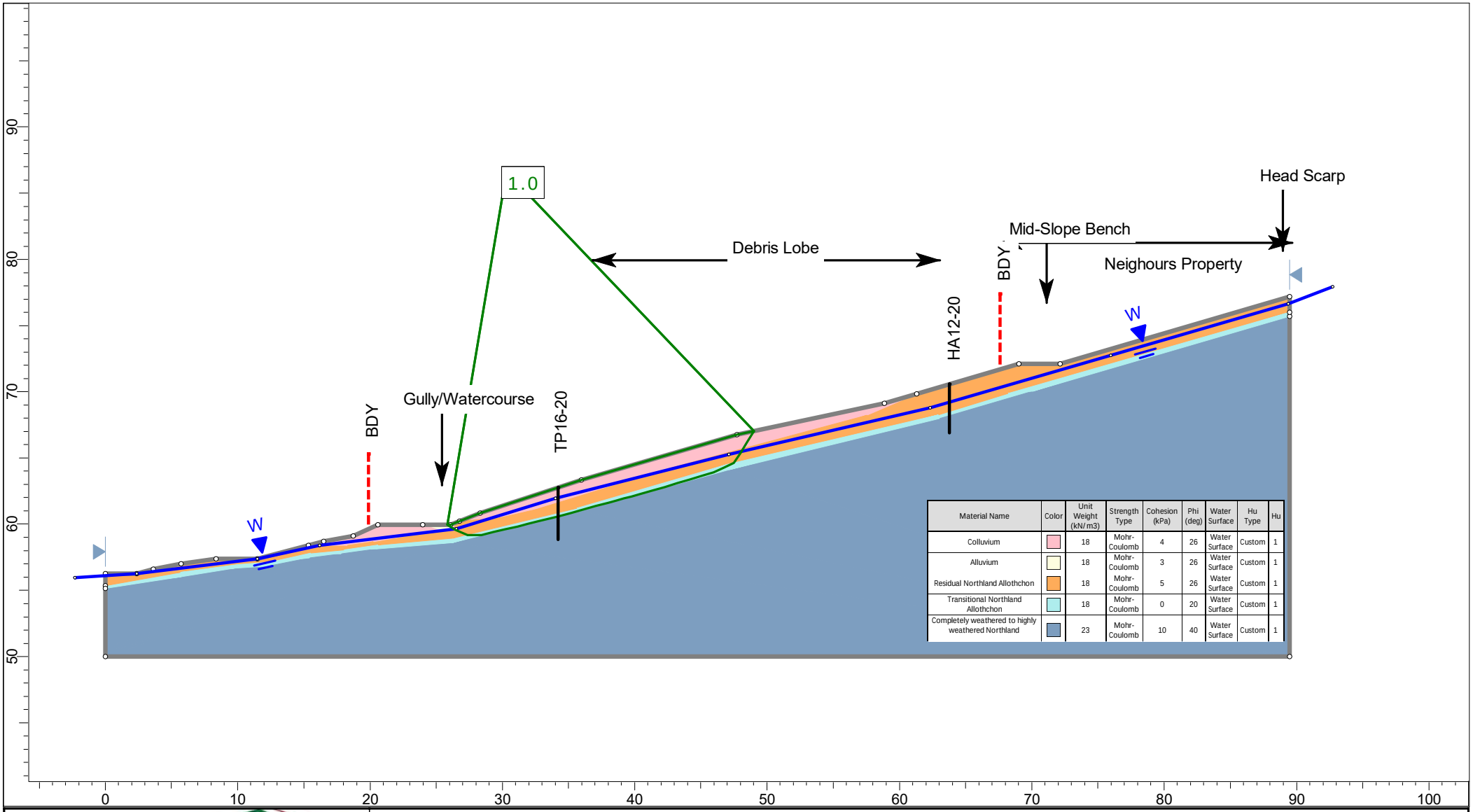
Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Existing Profile, Normal Groundwater			
Drawn By: SP	Date: 2/09/2021	Scale 1:400	Company	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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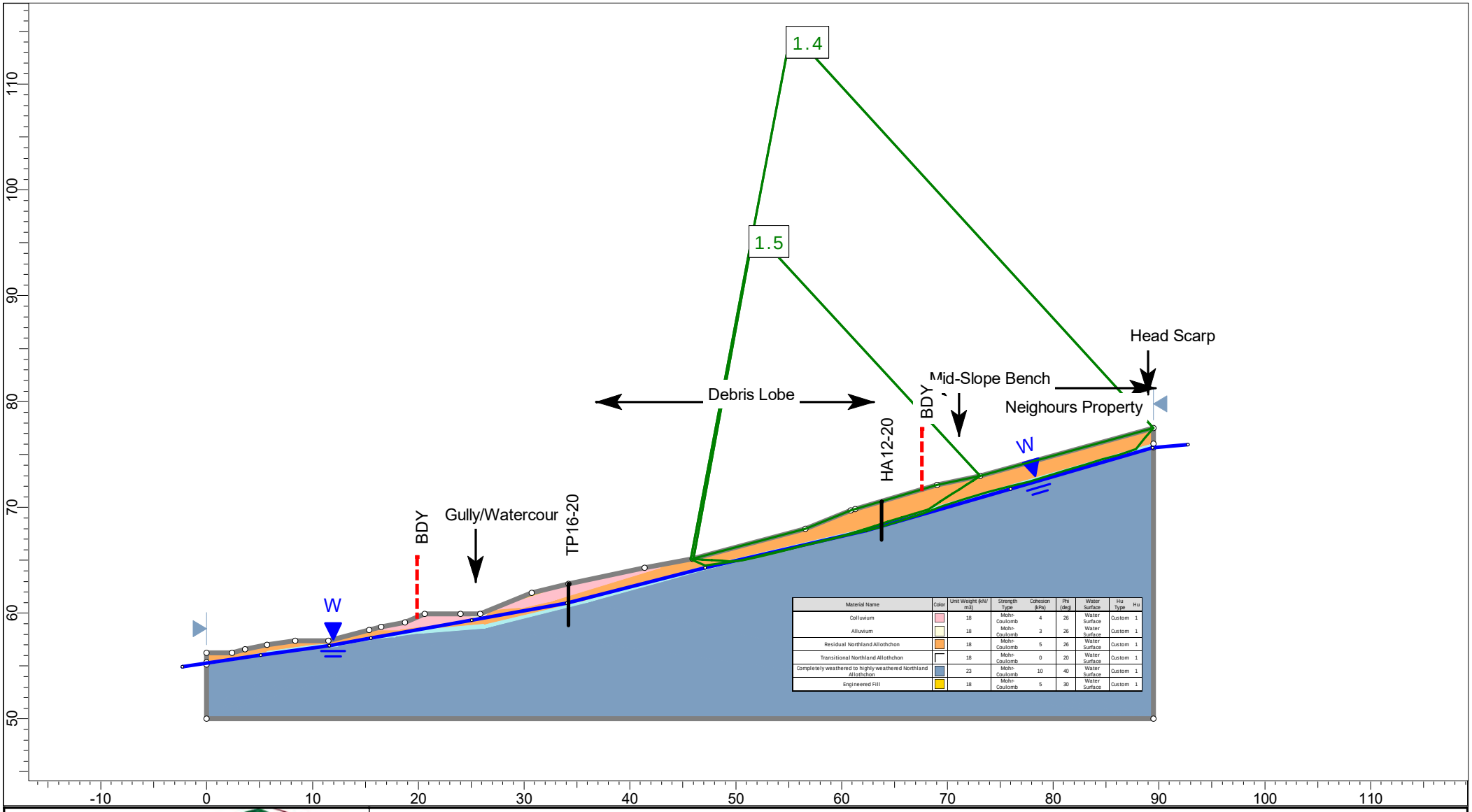
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



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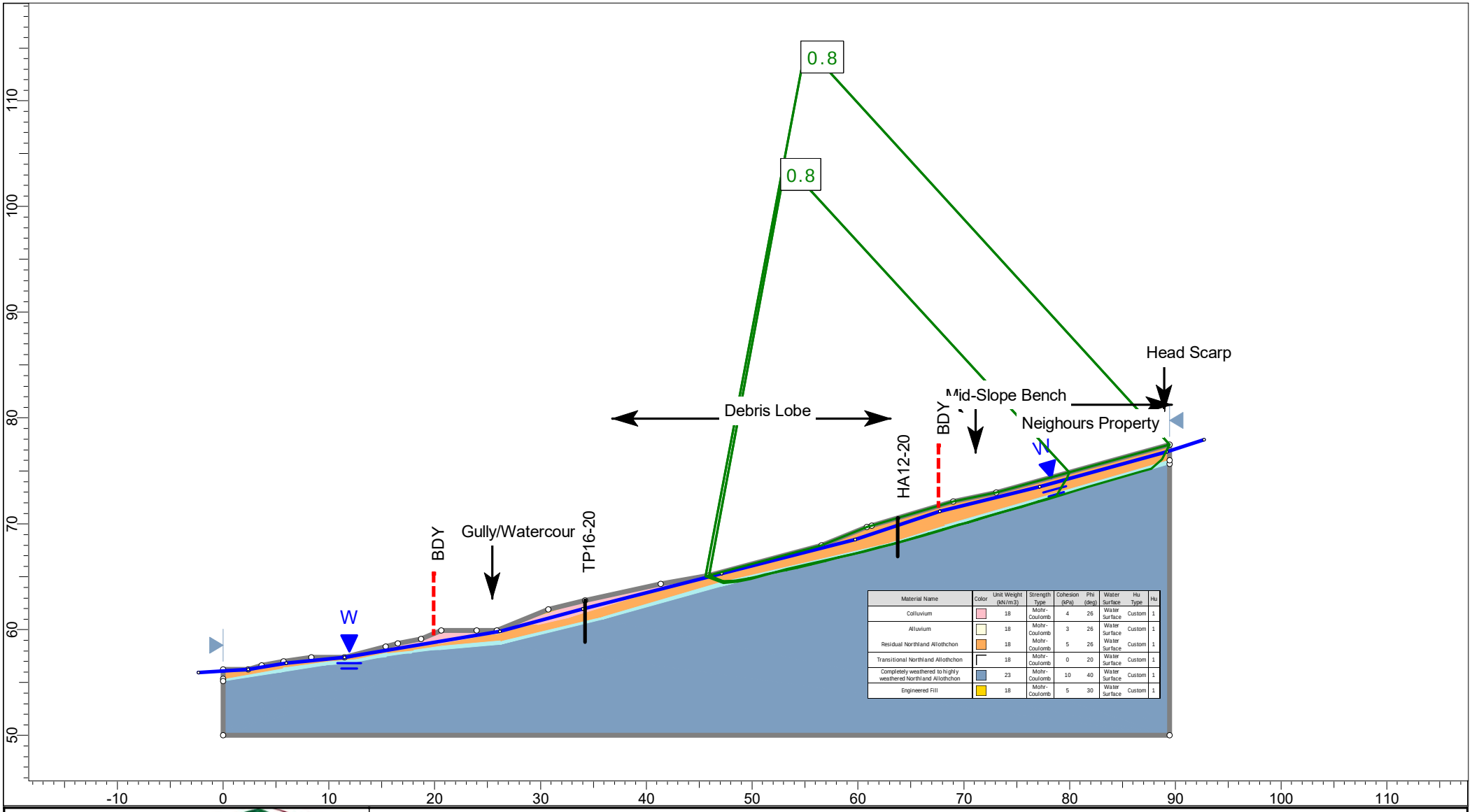
SLIDEINTERPR 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



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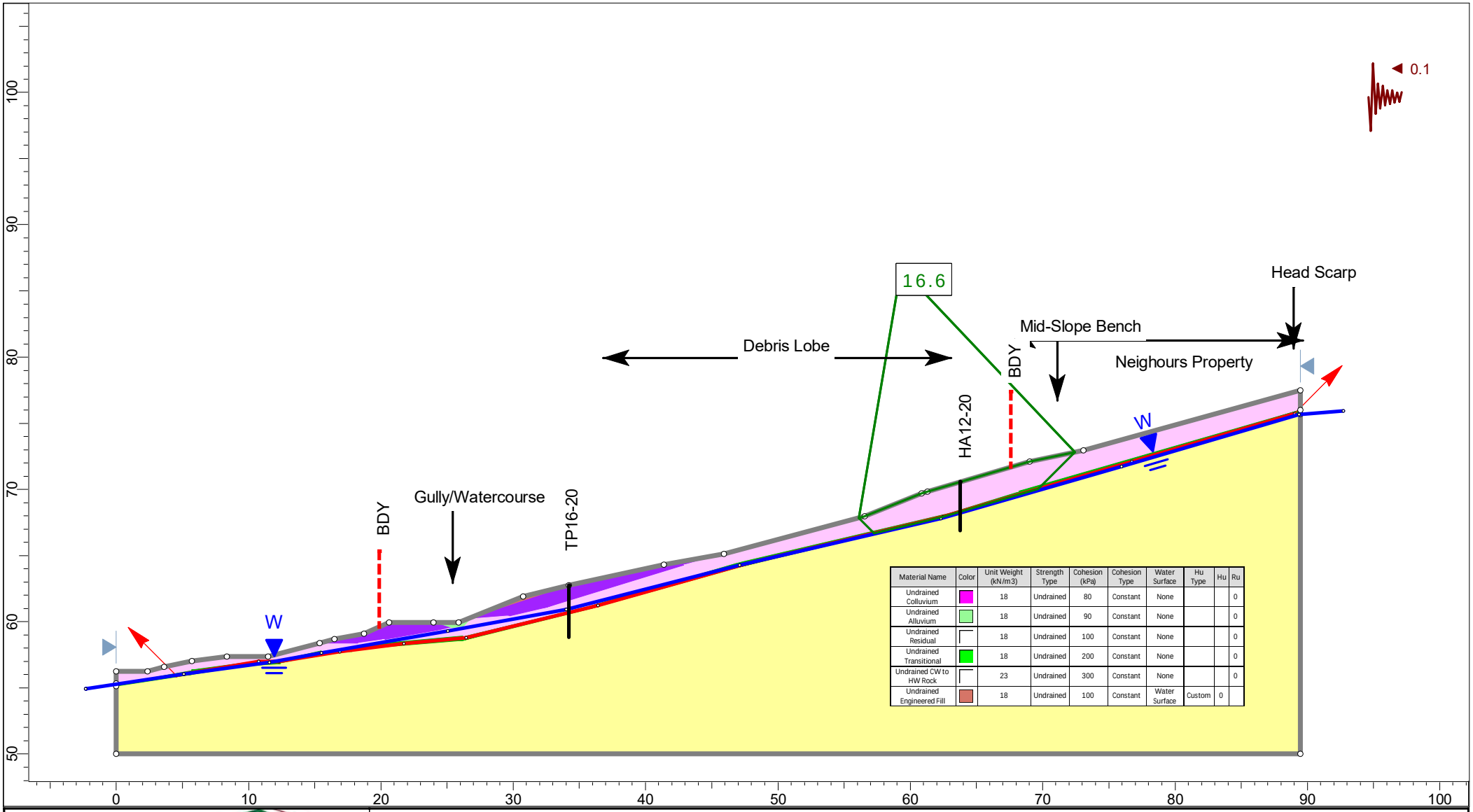
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu	Ru
Undrained Colluvium		18	Undrained	80	Constant	None			0
Undrained Alluvium		18	Undrained	90	Constant	None			0
Undrained Residual		18	Undrained	100	Constant	None			0
Undrained Transitional		18	Undrained	200	Constant	None			0
Undrained CW to HW Rock		23	Undrained	300	Constant	None			0
Undrained Engineered Fill		18	Undrained	100	Constant	Water Surface	Custom	0	

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Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Proposed Profile, Seismic			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
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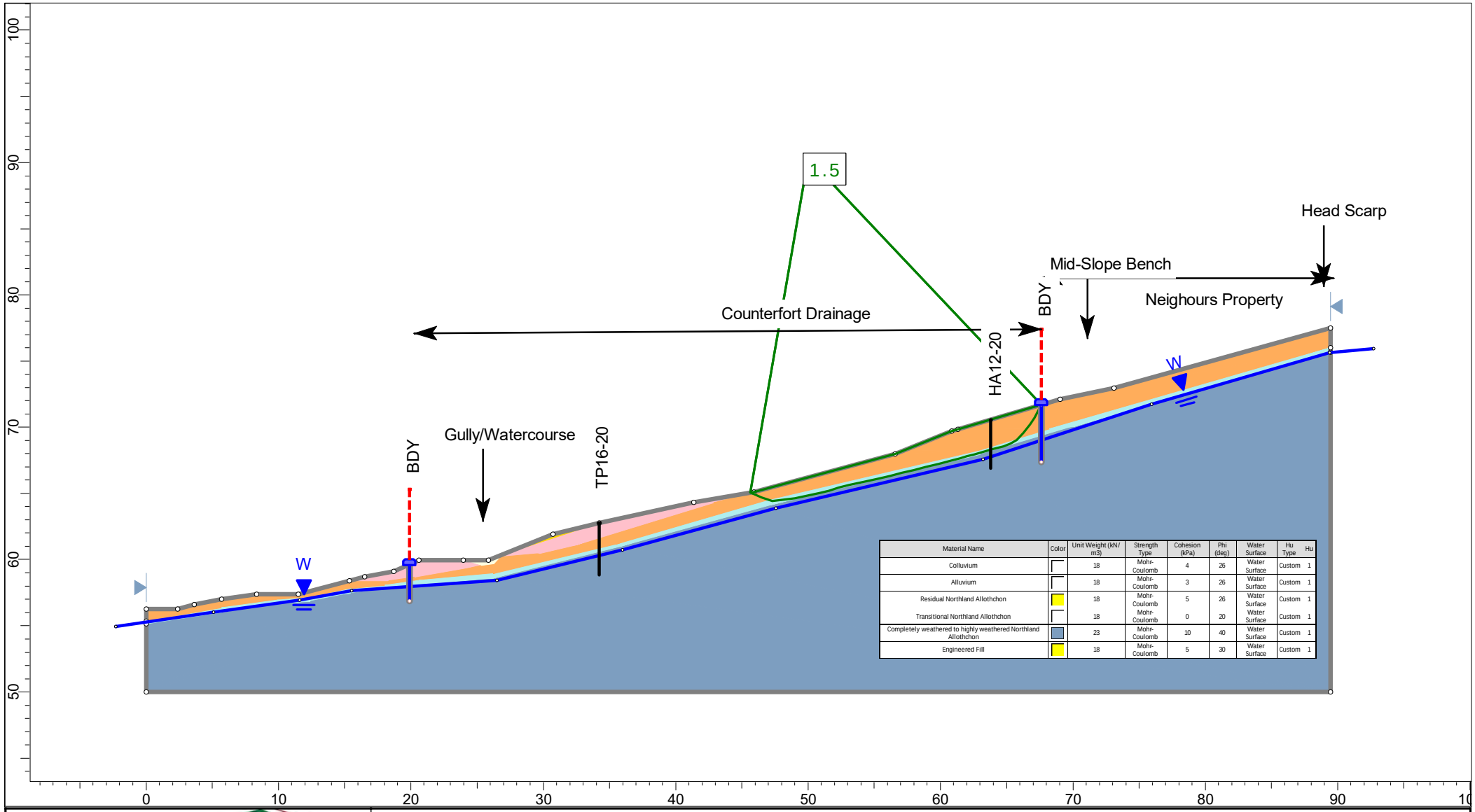

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Remediated , Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
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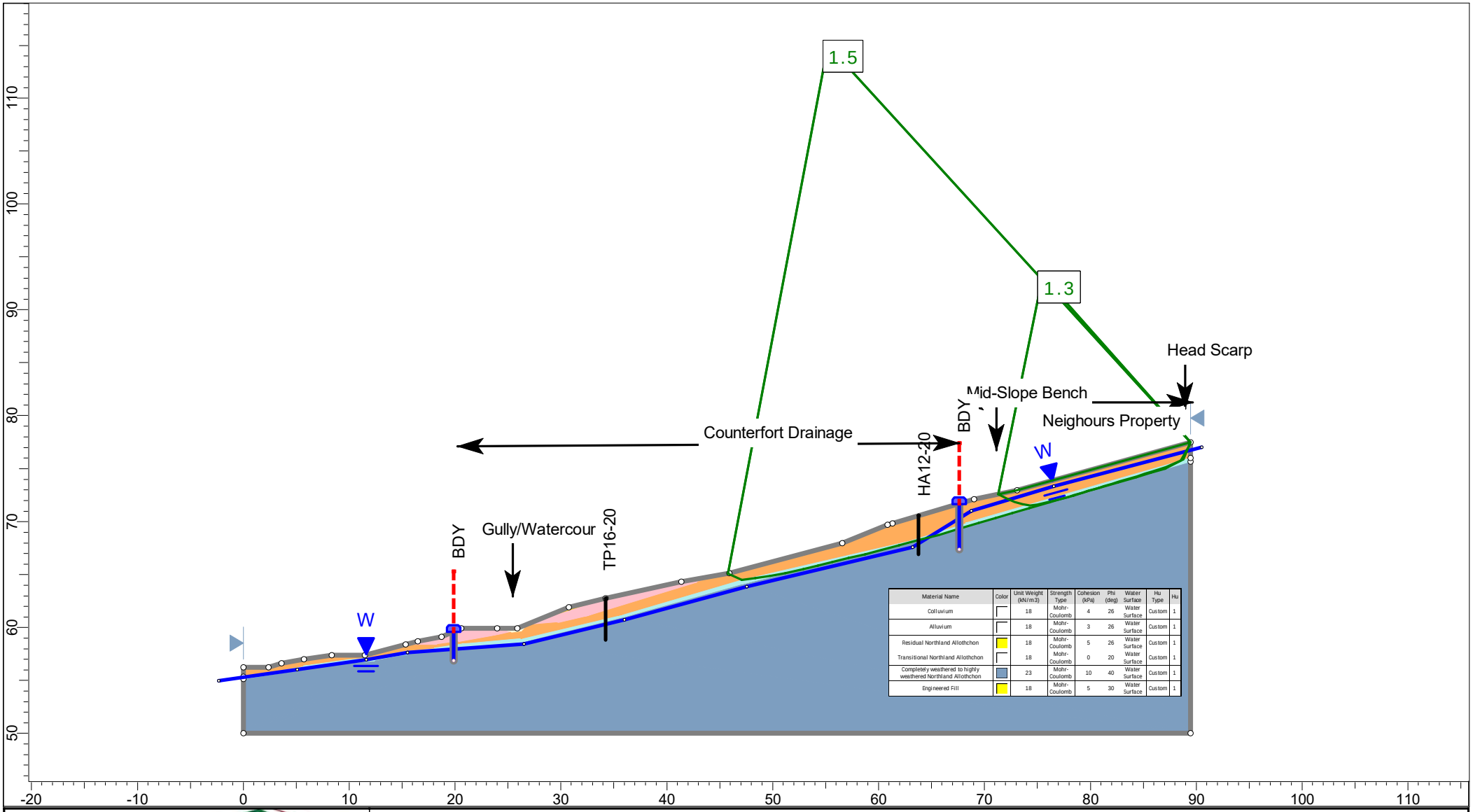

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SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Remediated , High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
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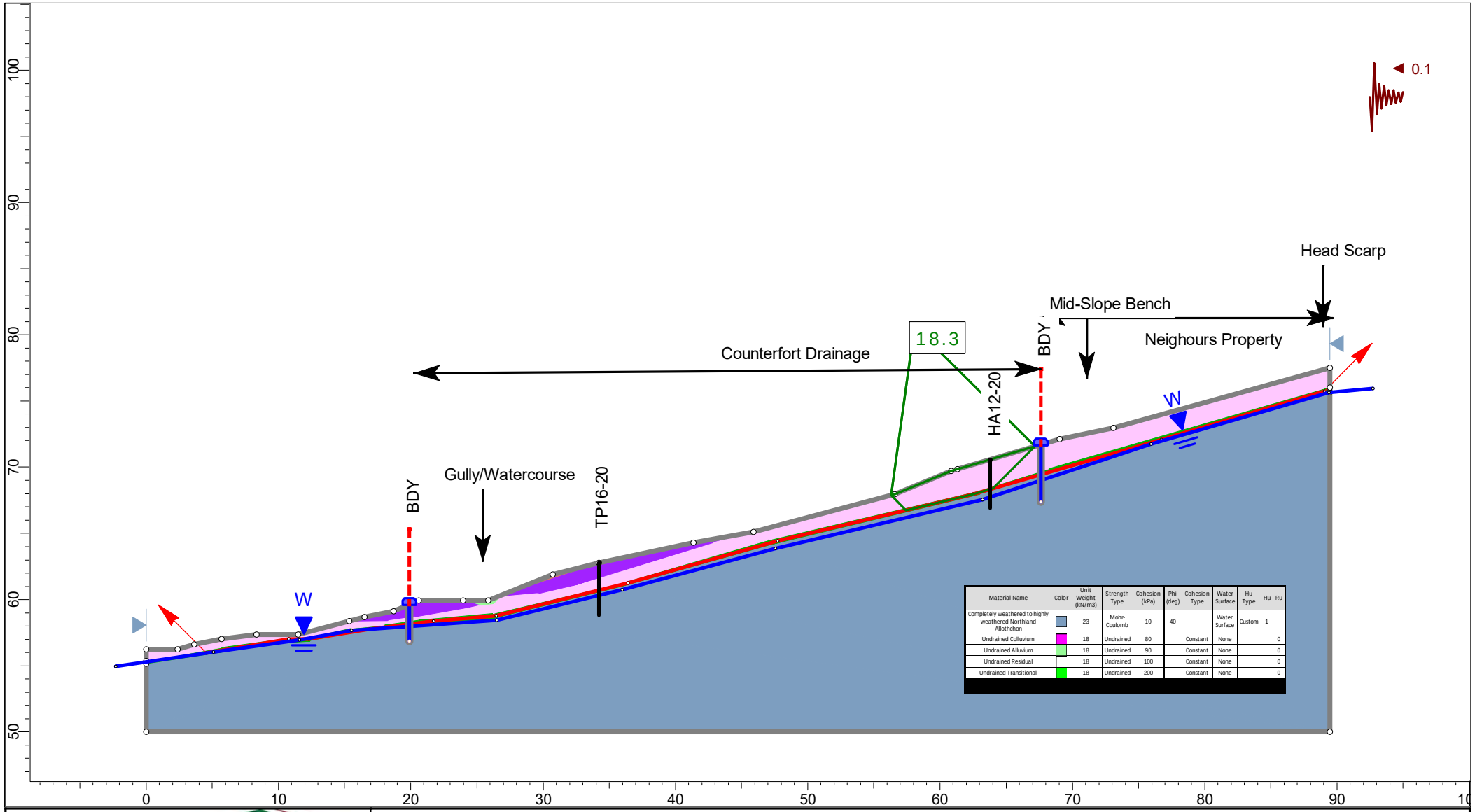

CMW Geosciences

SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Remediated , Seismic			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
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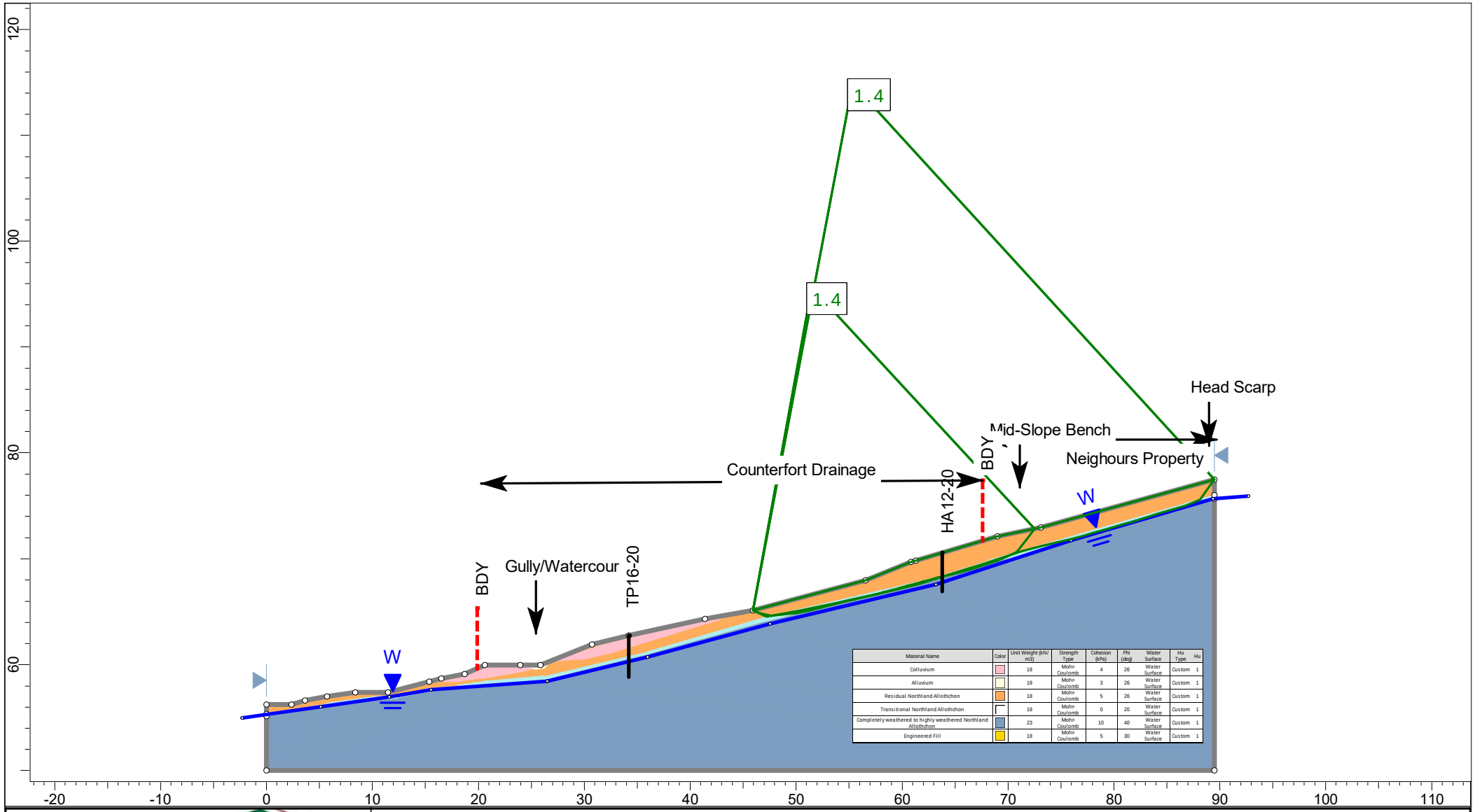

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
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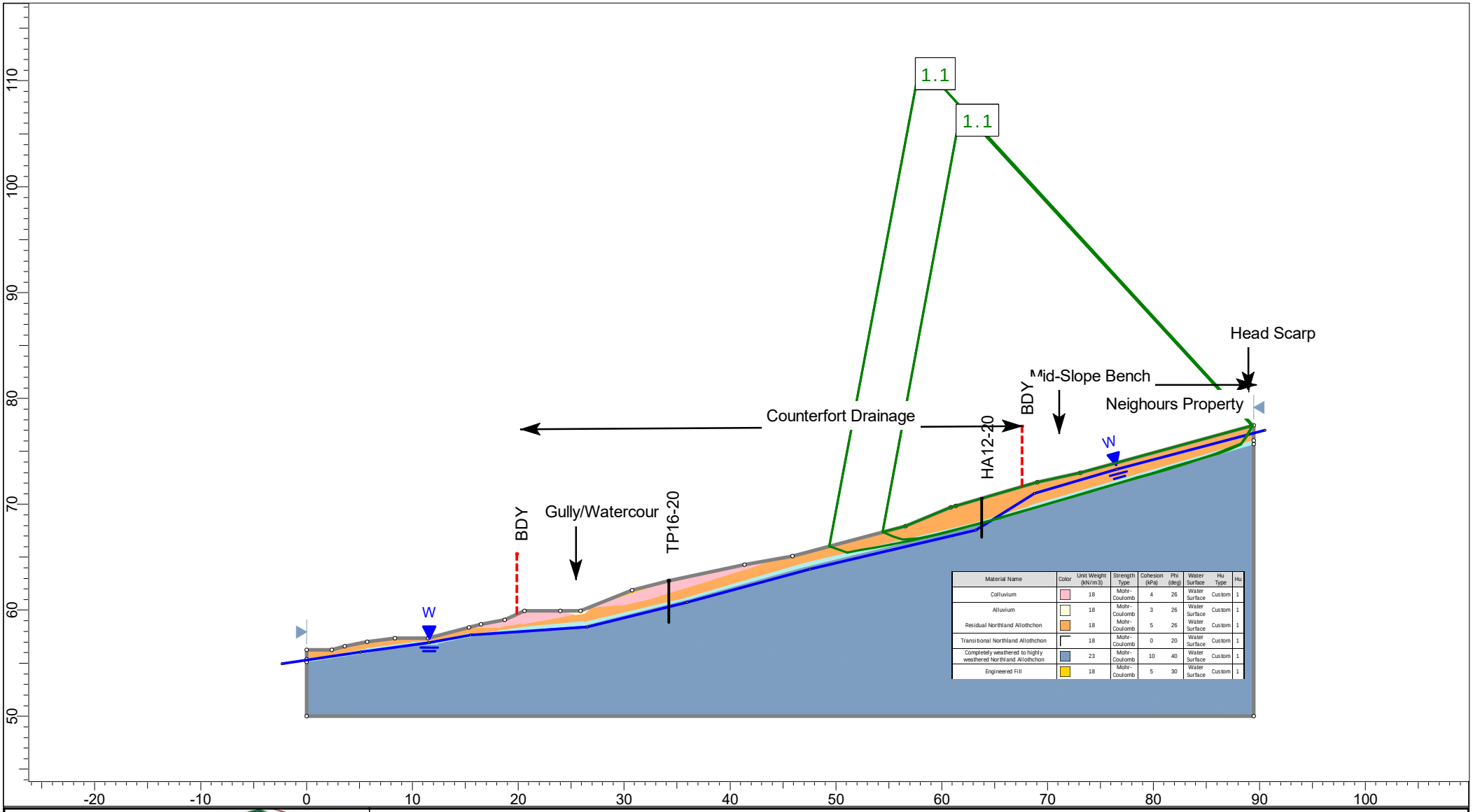

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SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
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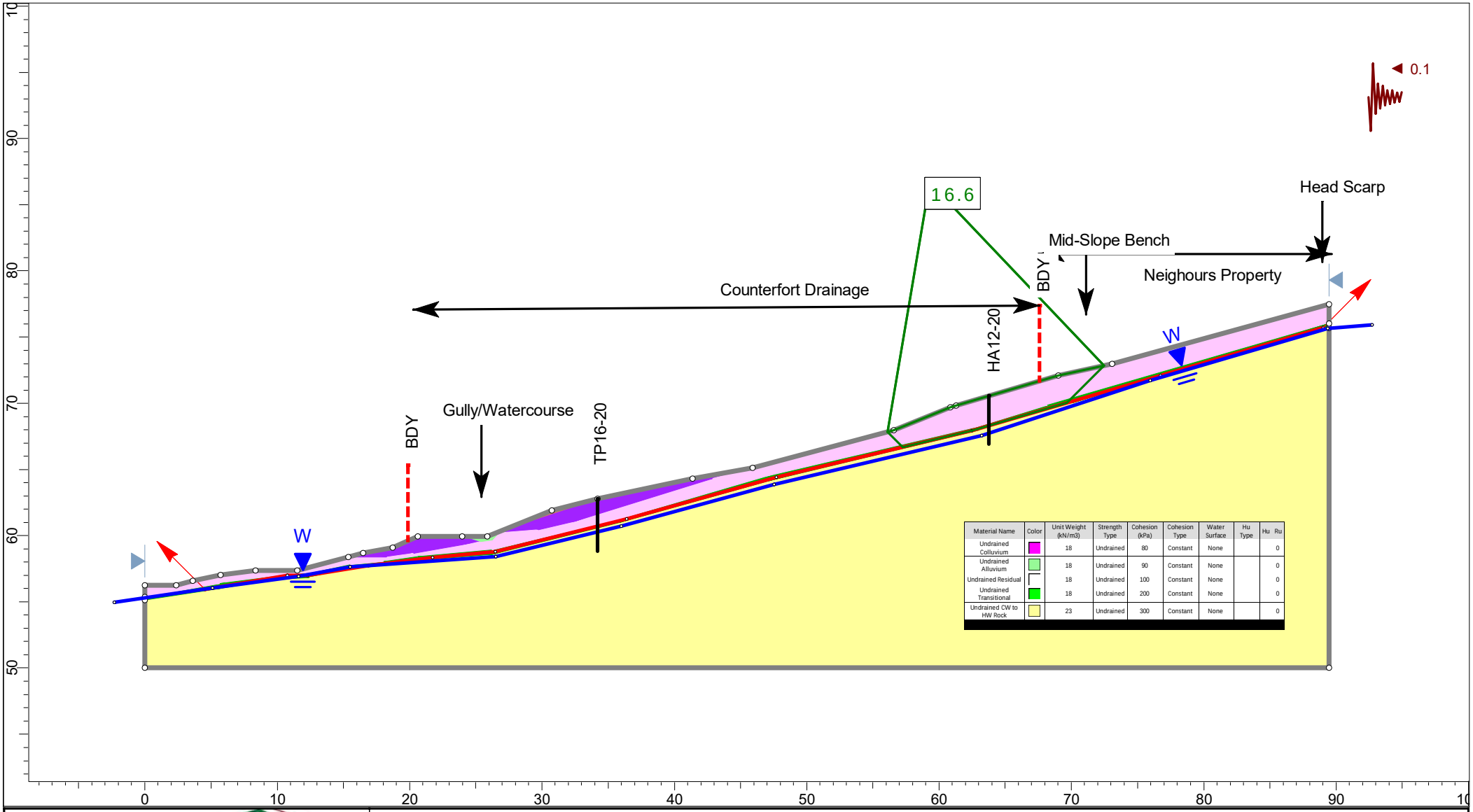

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SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, Seismic			
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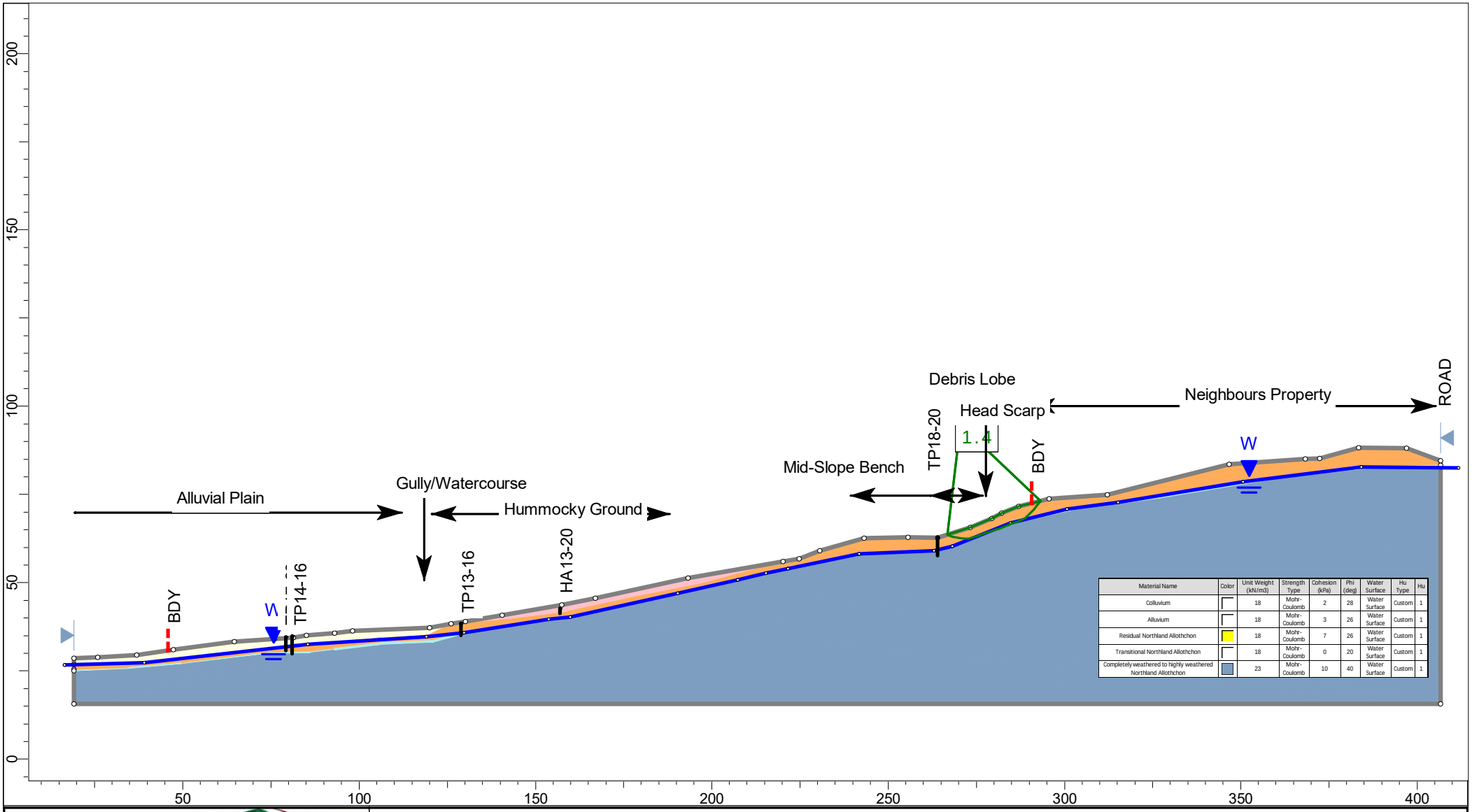

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section B - Existing, Normal Groundwater			
Drawn By SP	*Date:* 10/09/2021	*Scale* 1:1500	*Company*	Build Rich
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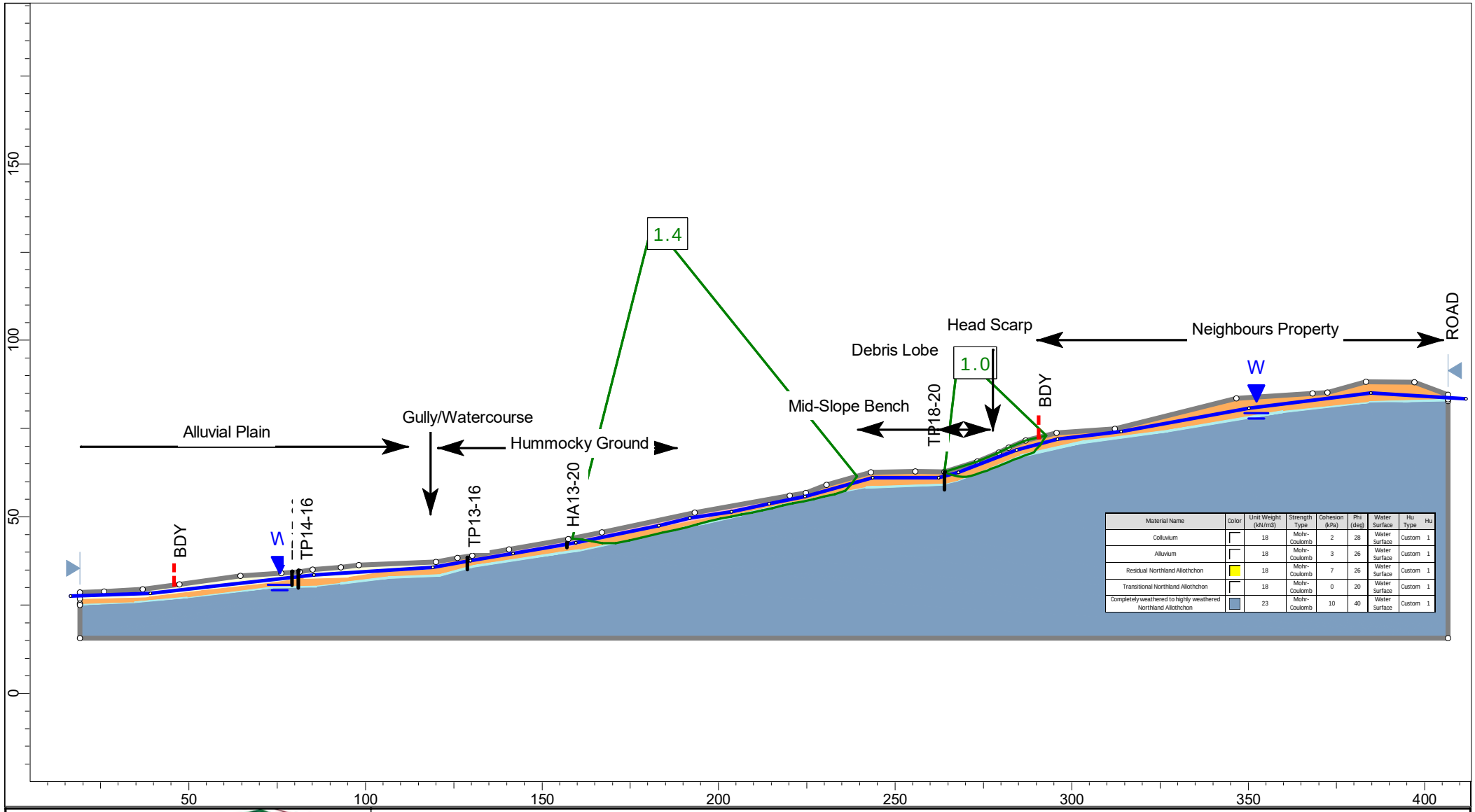

CMW Geosciences

SLIDEINTERPR 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section B - Existing, High Groundwater			
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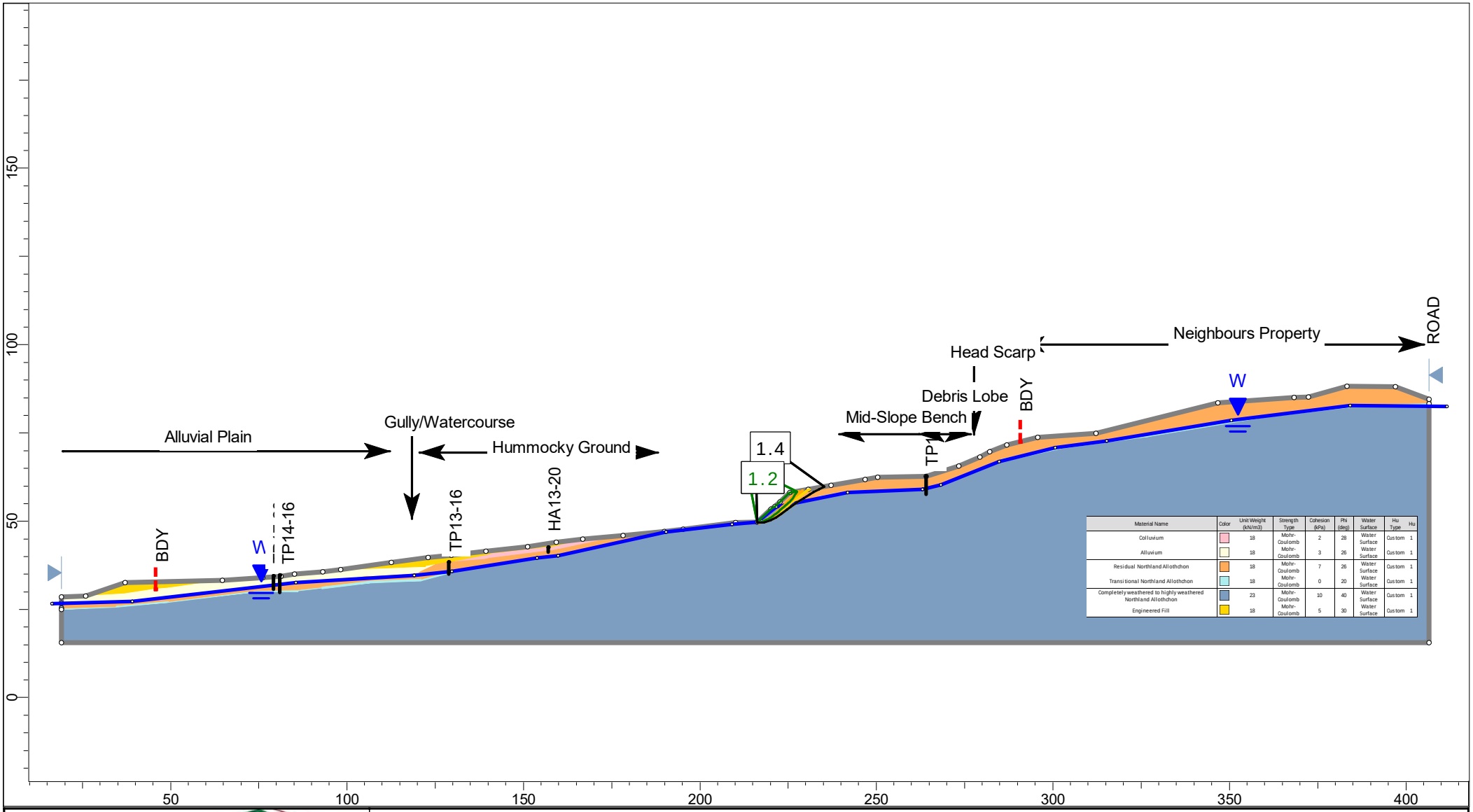

CMW Geosciences

SLIDEINTERPR 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company*	Build Rich
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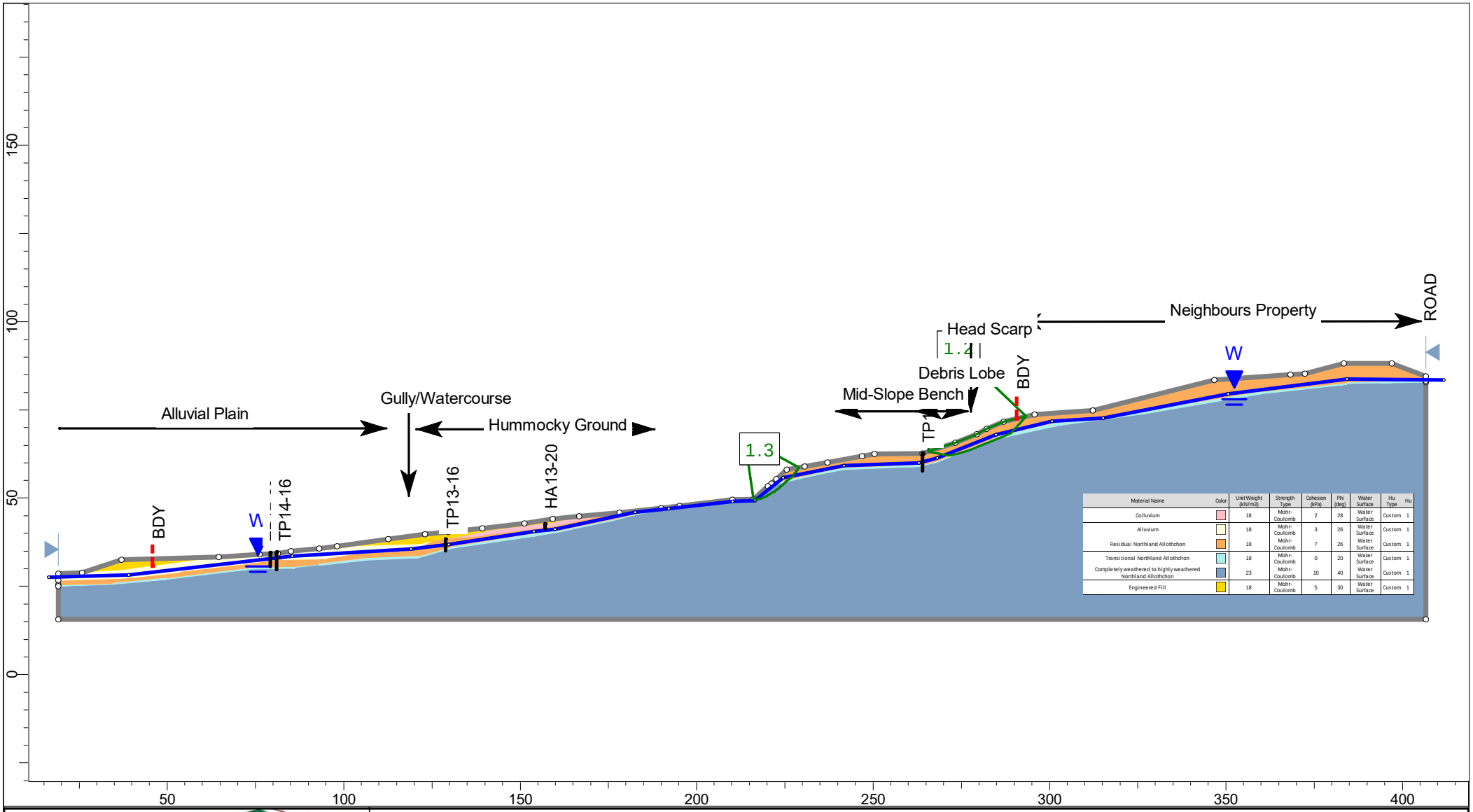

CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Proposed Profile, High Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
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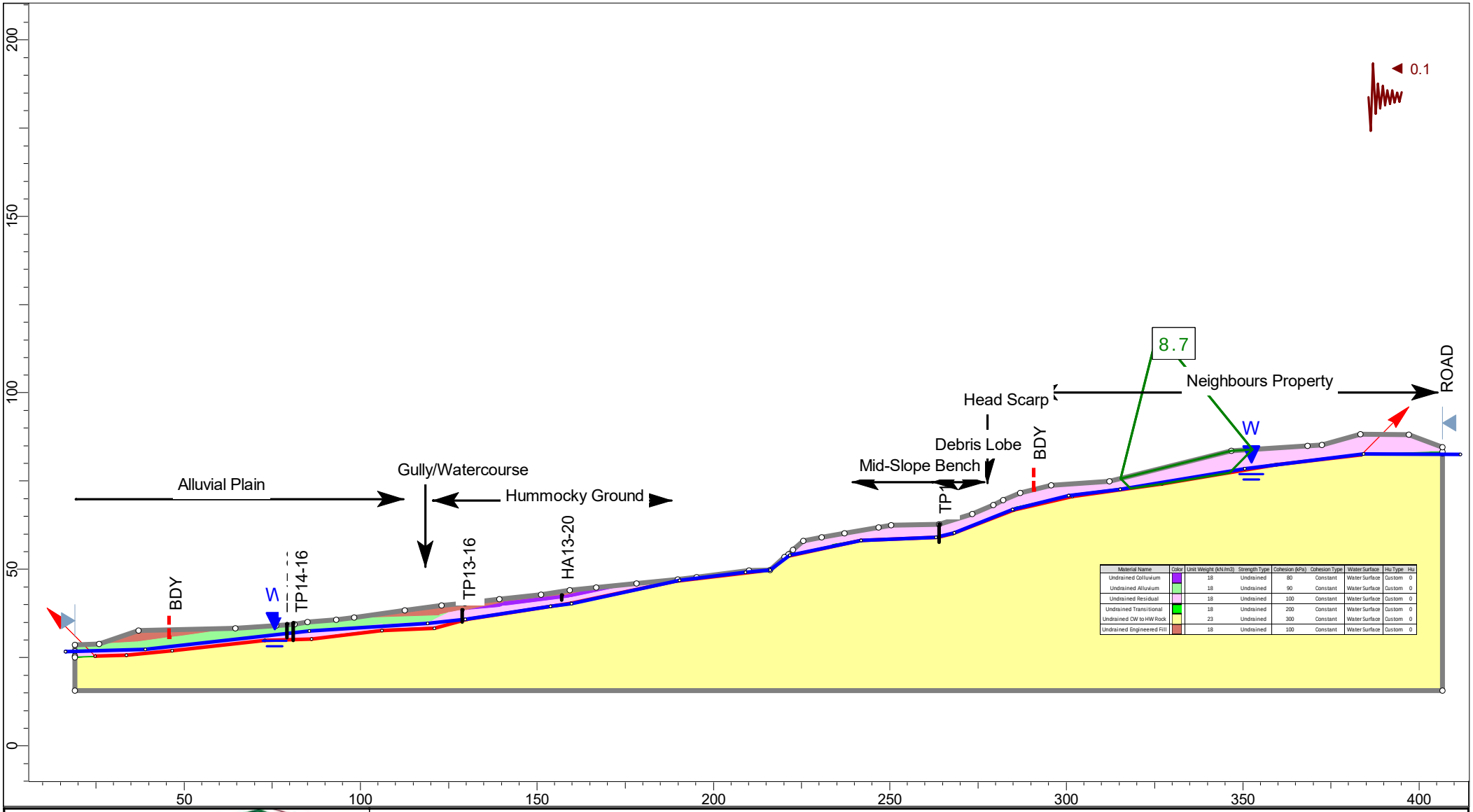
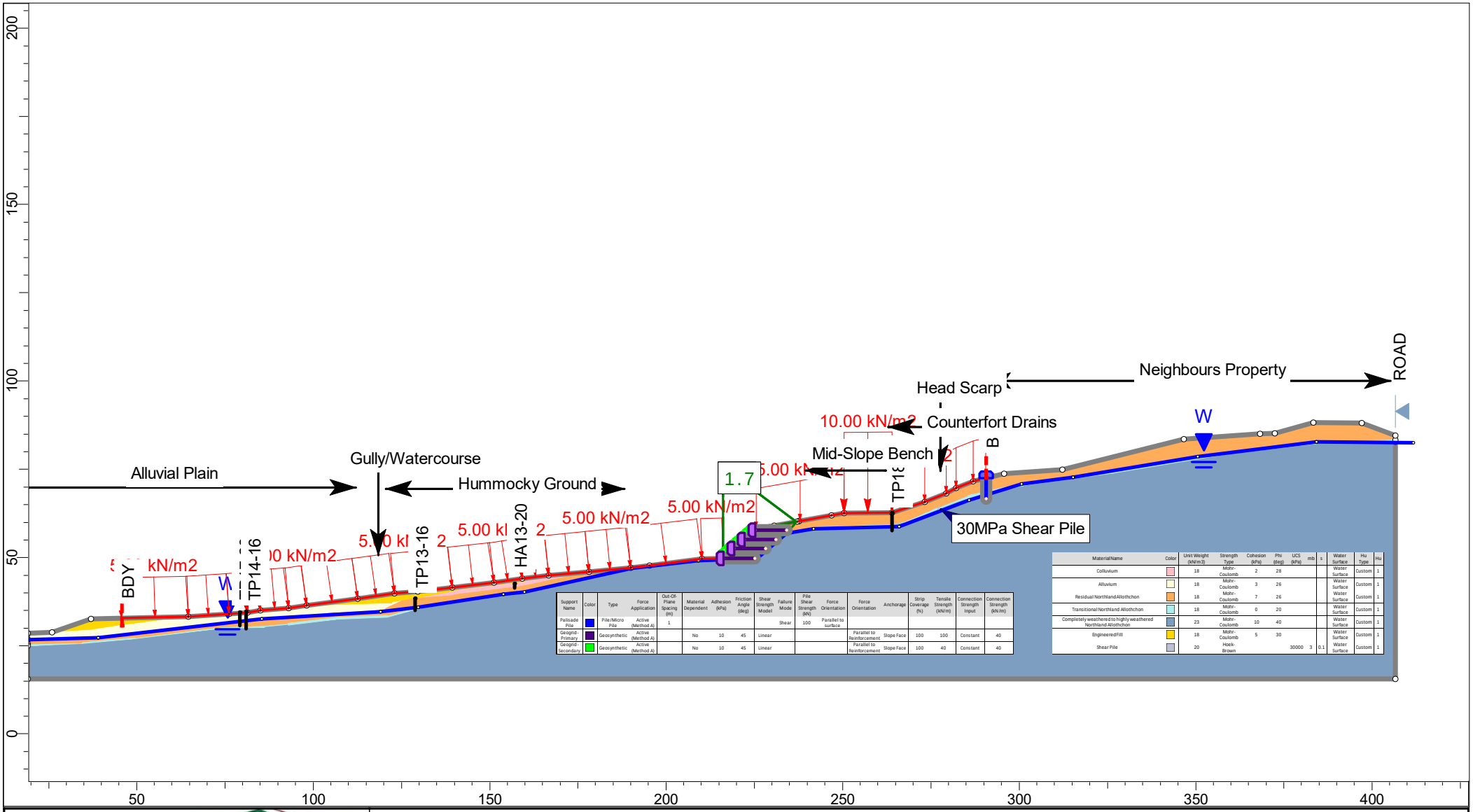
SLIDEINTERPRET 9.018



CMW Geosciences

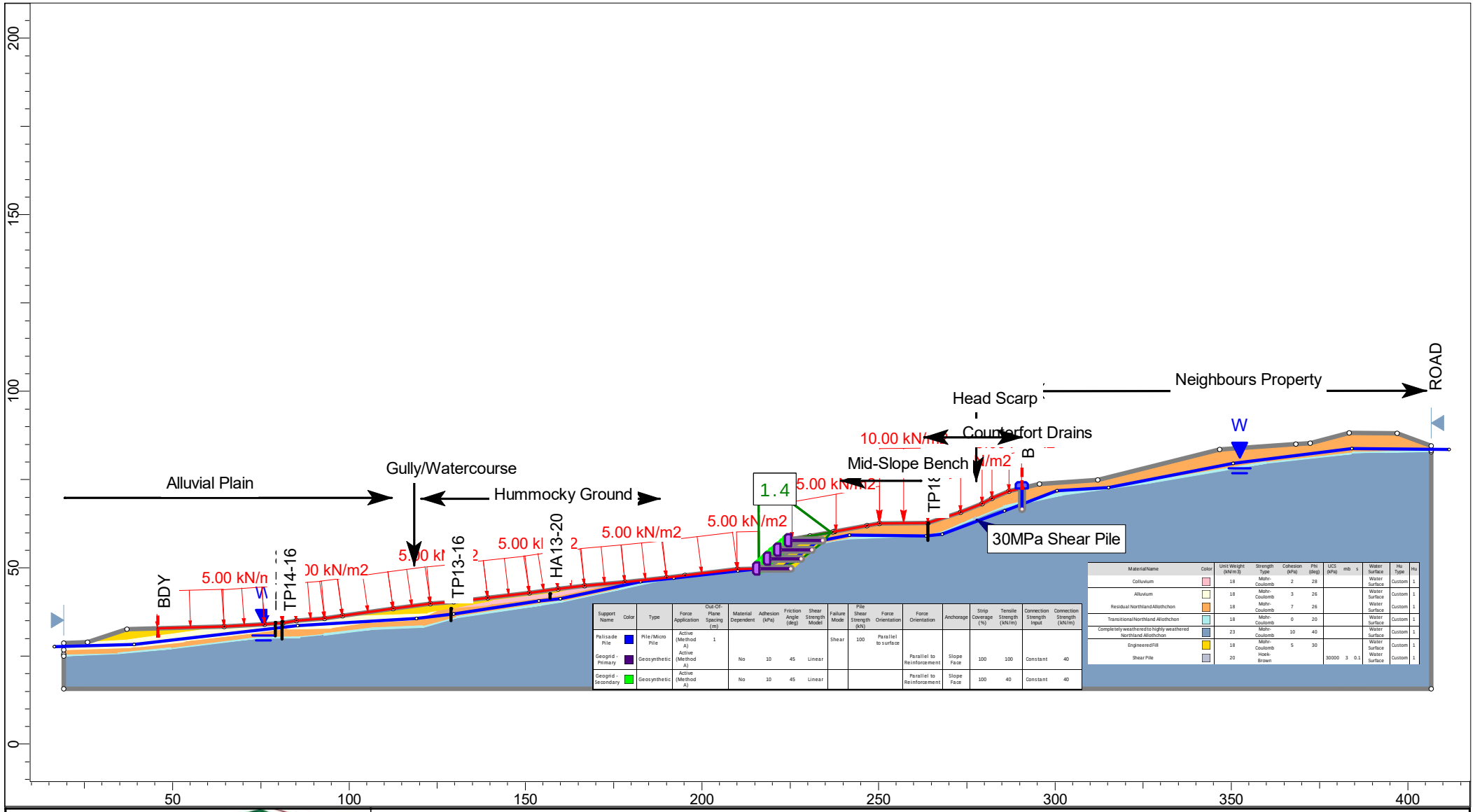
SLIDEINTERPR 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Proposed Profile, Seismic			
Drawn By: SP	Date: 3/09/2021	Scale 1:1500	Company	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4	
	Analysis Description	Section B - Remediated Profile MSE Wall, Normal Groundwater	
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500
	Company	Build Rich	
	File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd	

SLIDEINTERP 9.018



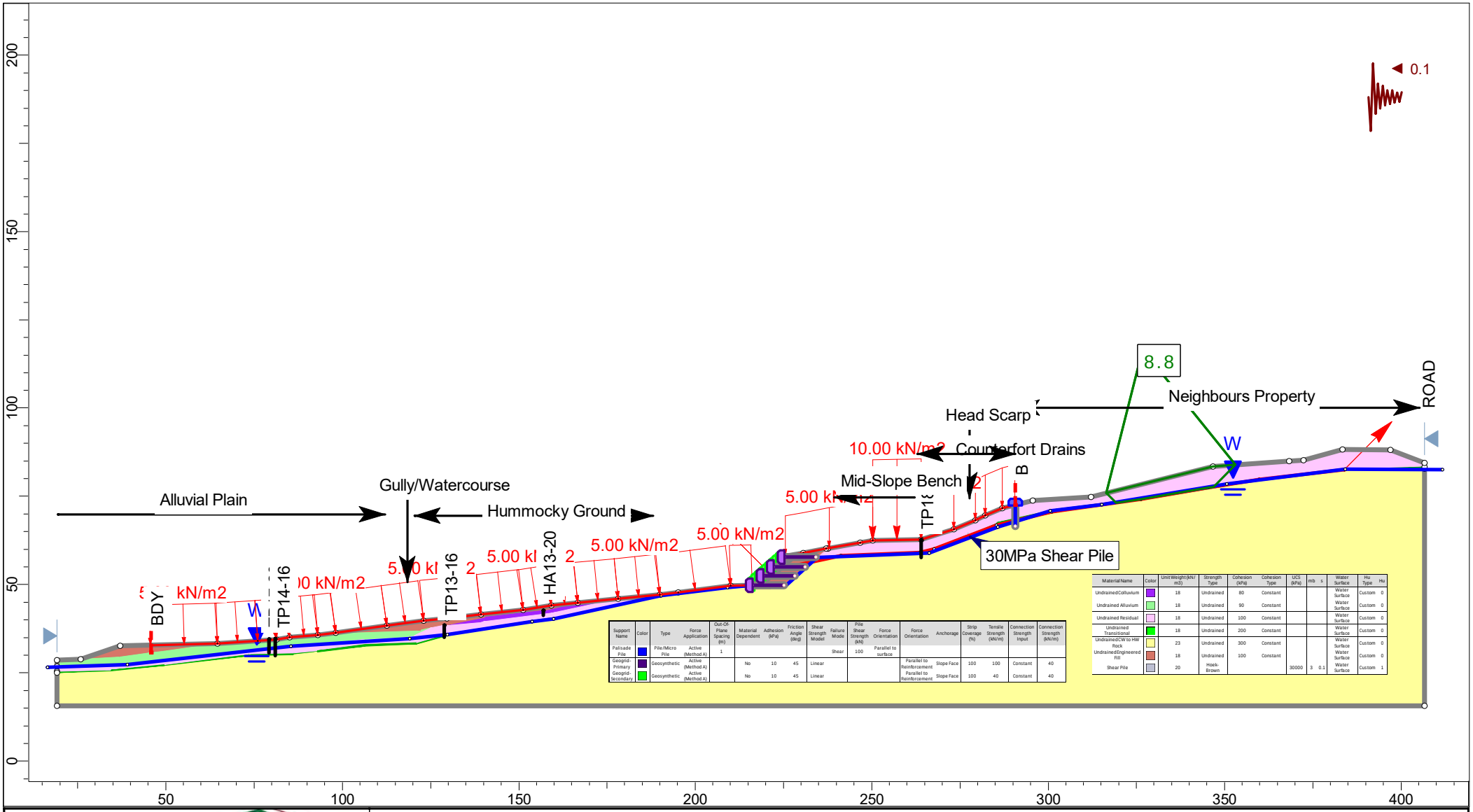
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

MaterialName	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28				Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30				Water Surface	Custom	1
Shear Pile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section B - Remediated Profile MSE Wall, High Groundwater		
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
			File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

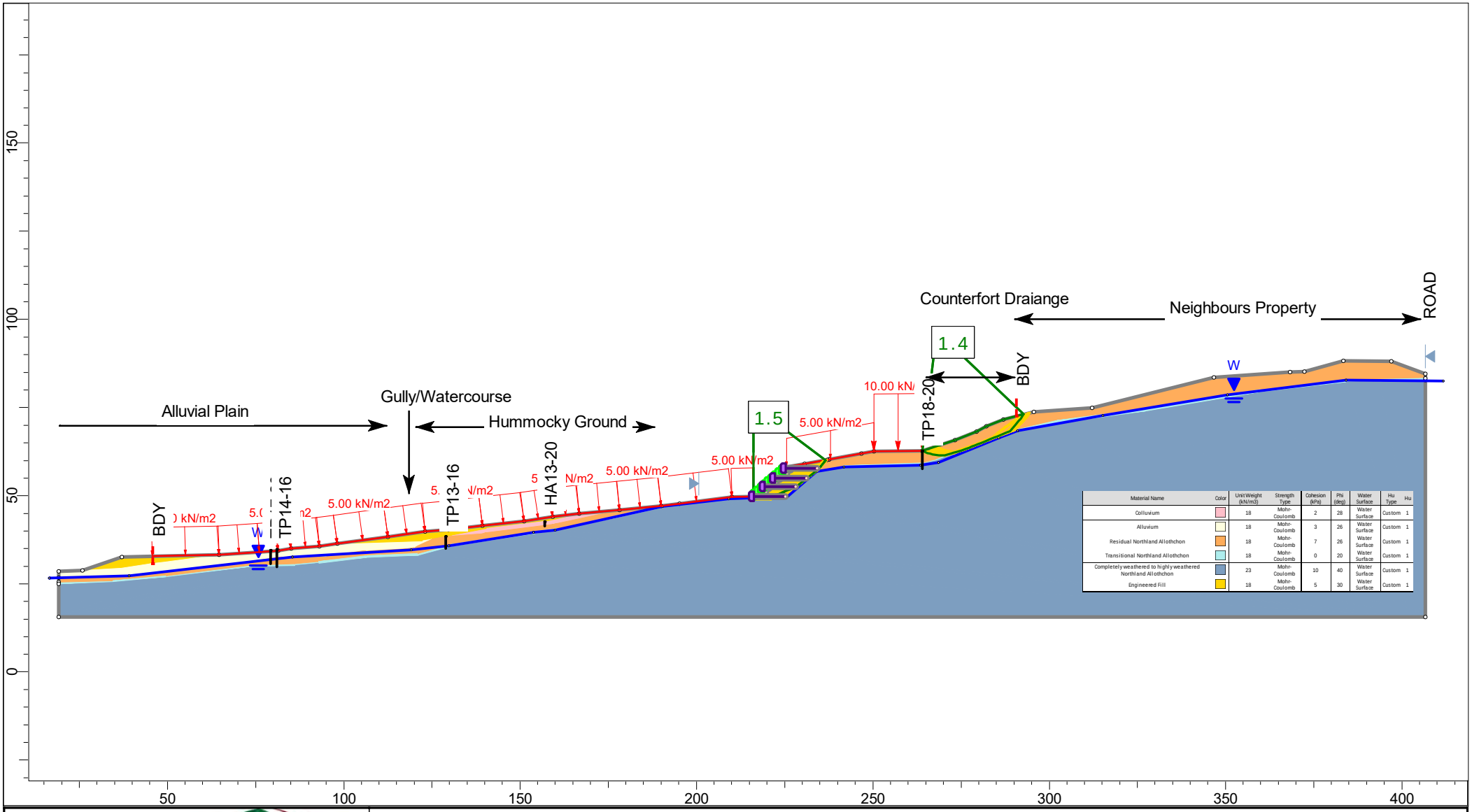


Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid-Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid-Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
UndrainedColluvium		18	Undrained	80	Constant				Water Surface	Custom	0
Undrained Alluvium		18	Undrained	90	Constant				Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant				Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant				Water Surface	Custom	0
UndrainedCW to HW Rock		23	Undrained	300	Constant				Water Surface	Custom	0
UndrainedEngineered Fill		18	Undrained	100	Constant				Water Surface	Custom	0
Shear Pile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1

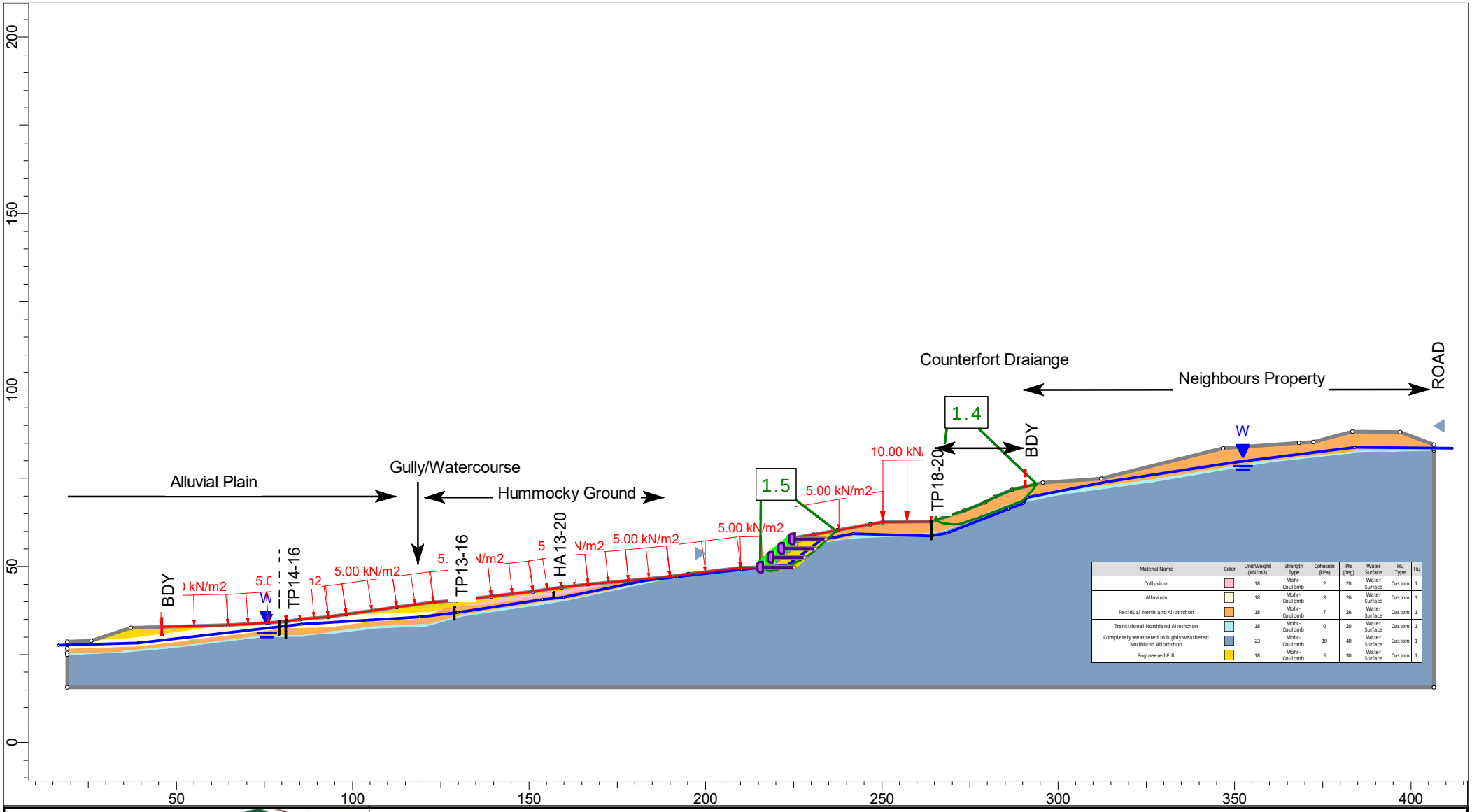
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Remediated Profile MSE Wall, Seismic			
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



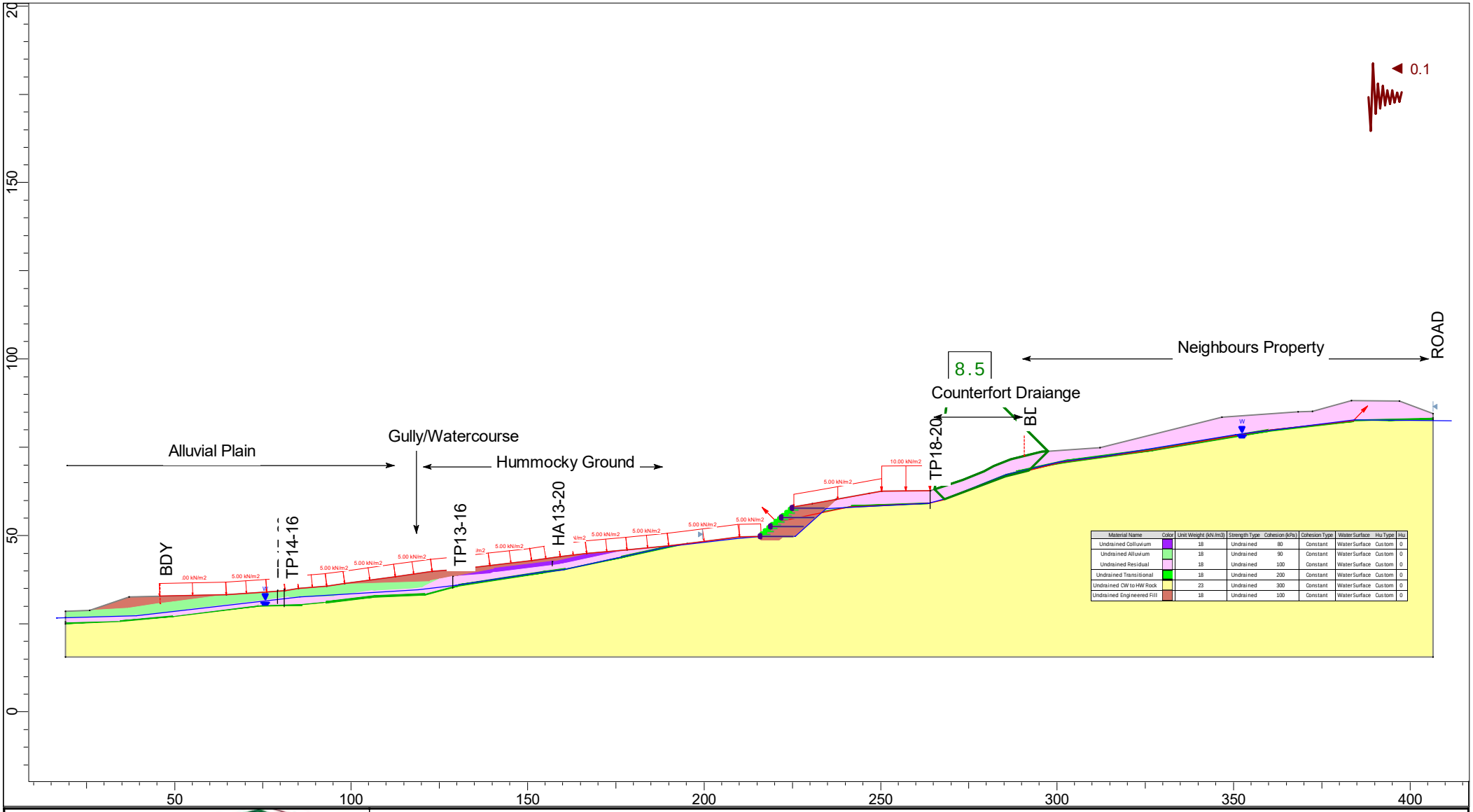
CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Counterfort Remediation Only, Normal Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

SLIDEINTERP 9.018



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Counterfort Remediation Only, High Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

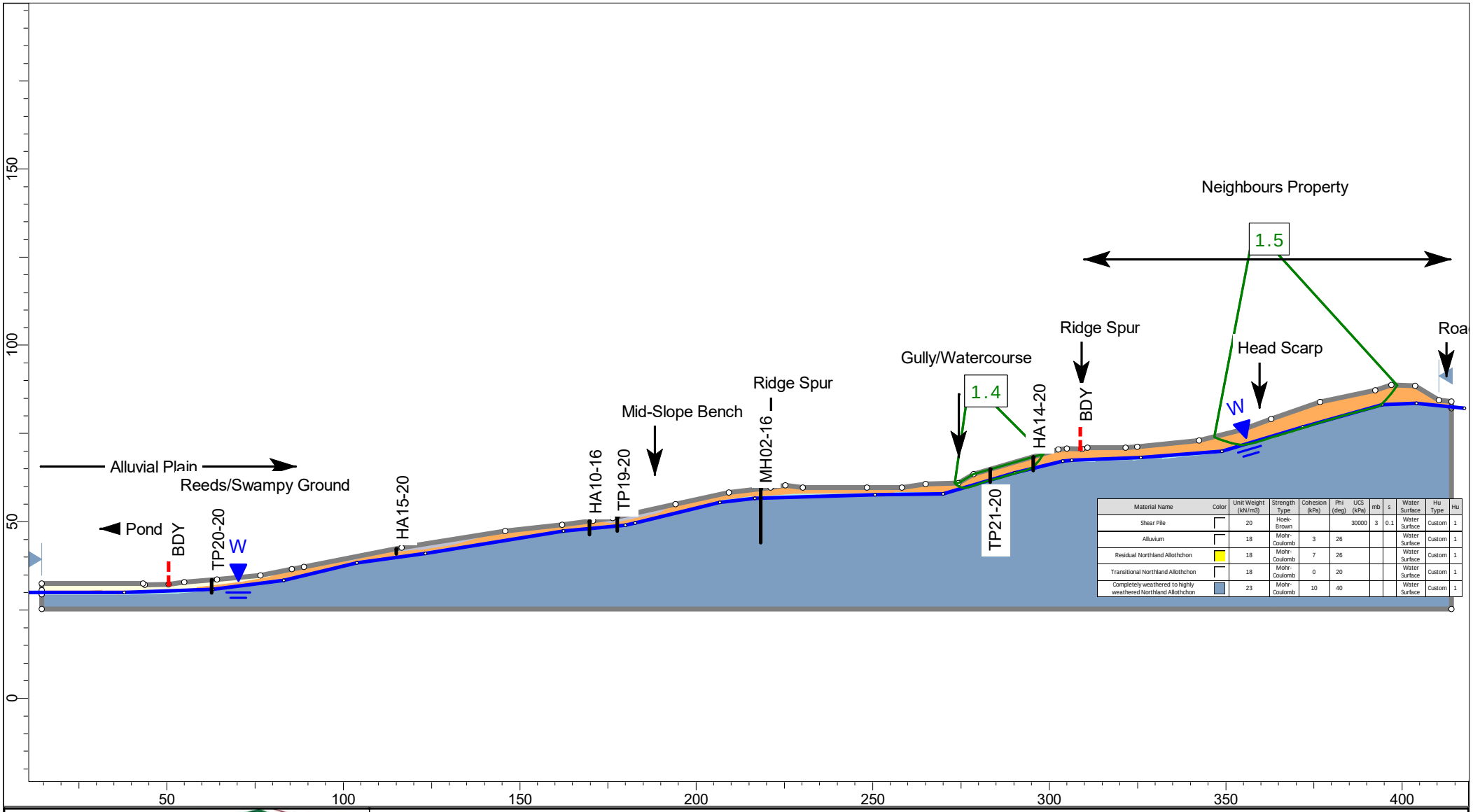
SLIDEINTERP 9.018



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Counterfort Remediation Only, Seismic			
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
Shear Pile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1

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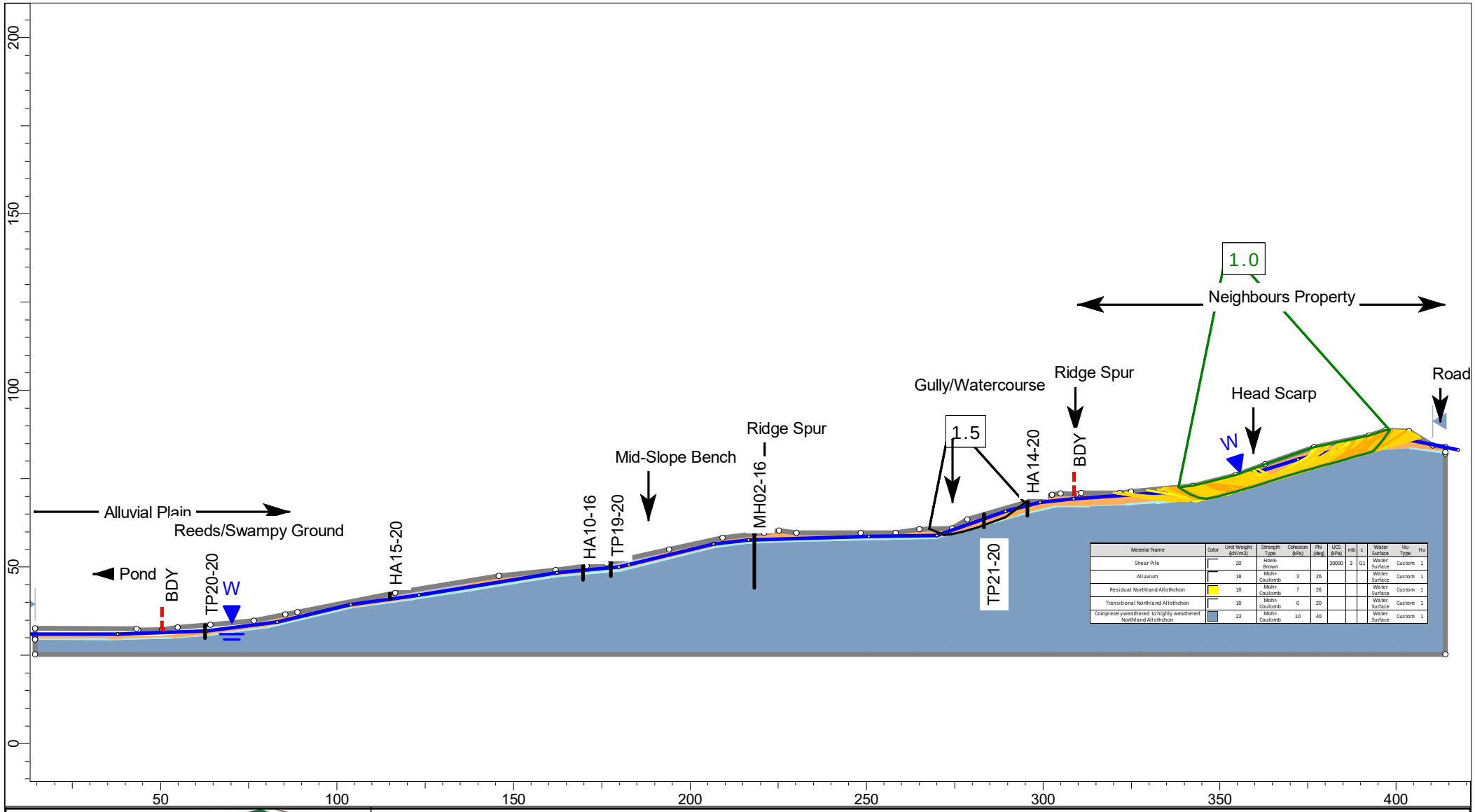
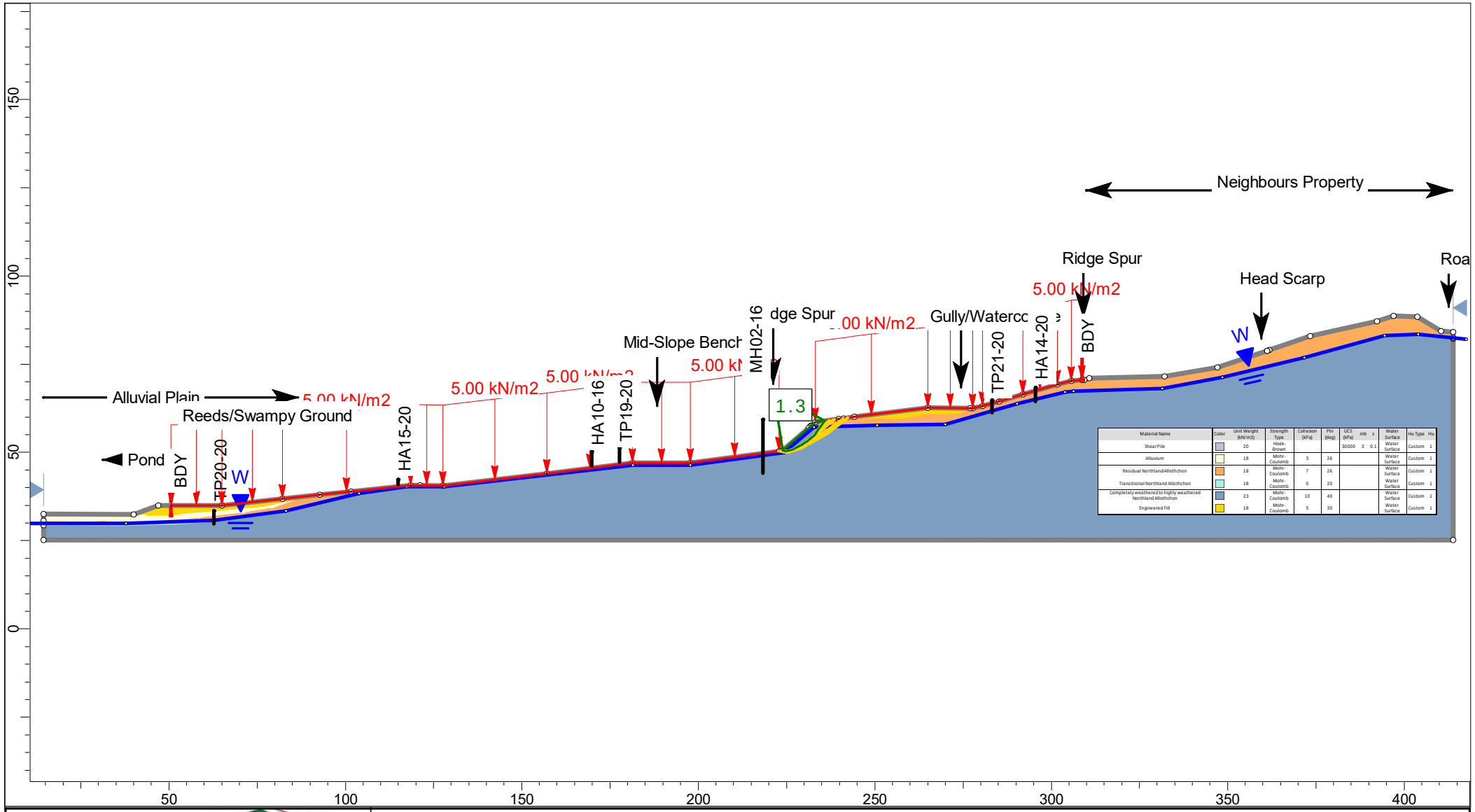
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section C - Existing Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
			File Name AKL2020-0125 Section C 6092021 SP.slmd



CMW Geosciences	Project	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Existing Profile, High Groundwater		
	Drawn By: SP	Date: 6/09/2021	Scale 1:1500	Company Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERPRET 9.018



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
ShearPile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30				Water Surface	Custom	1

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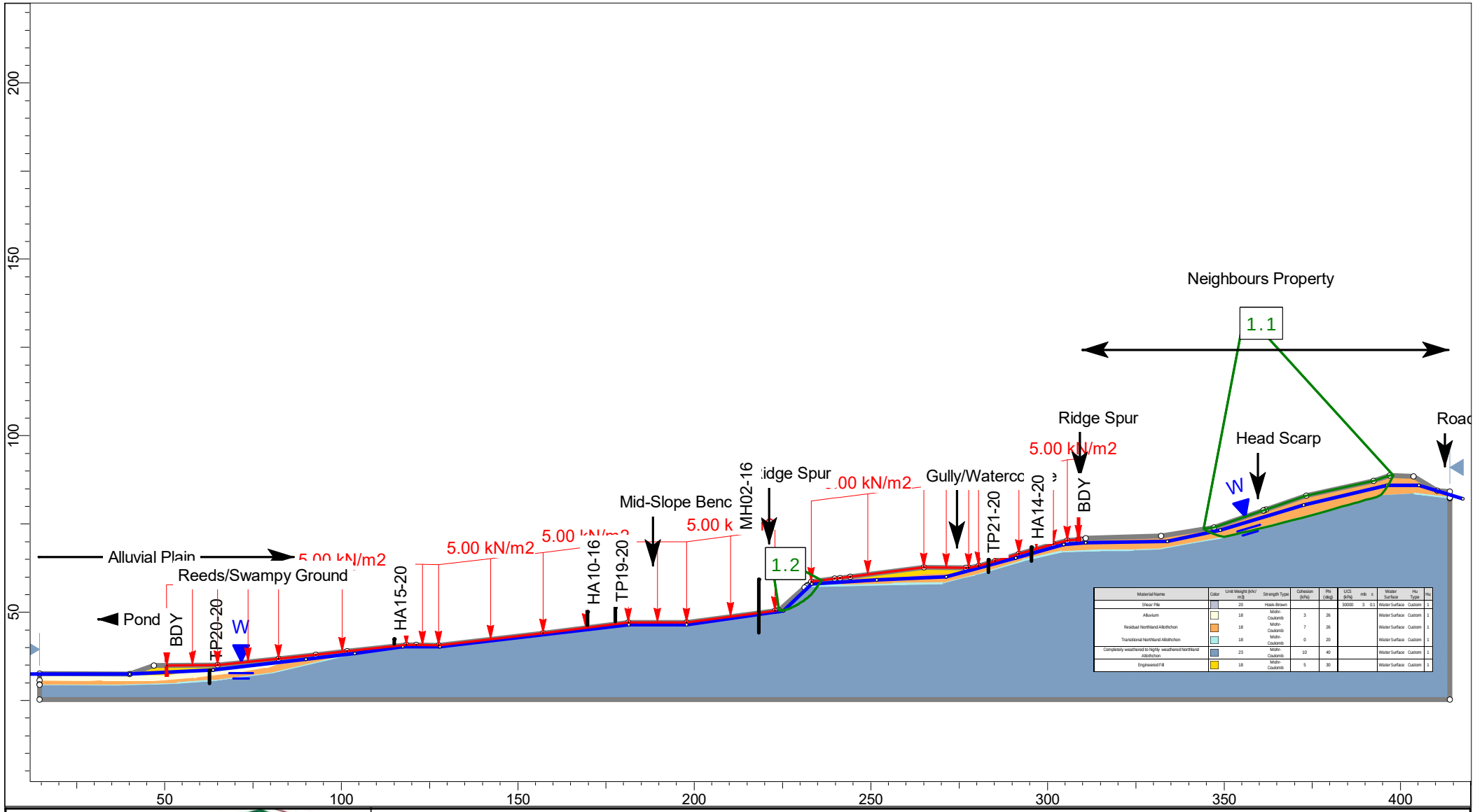
Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section C - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section C 6092021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
Shear Pile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30				Water Surface	Custom	1

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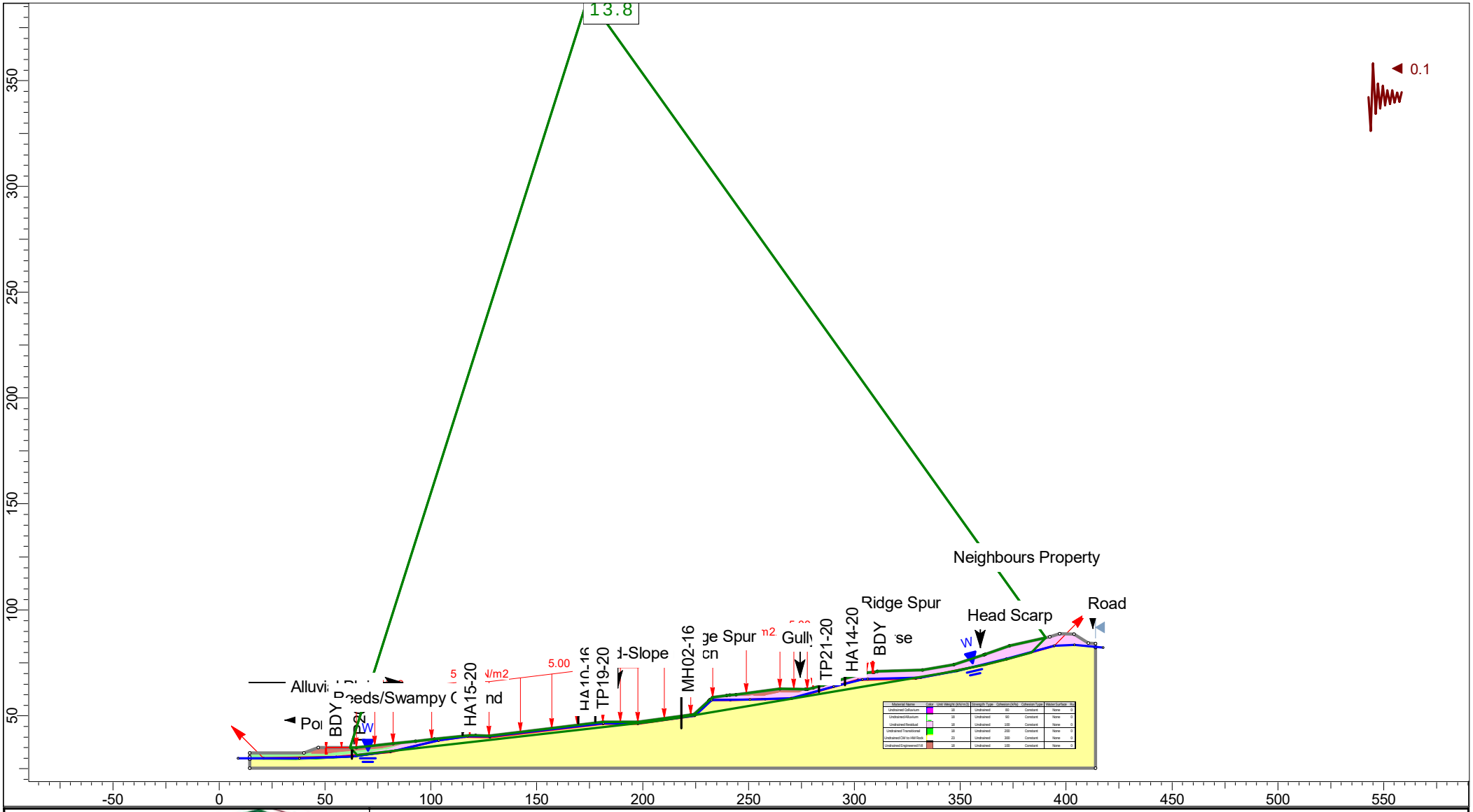
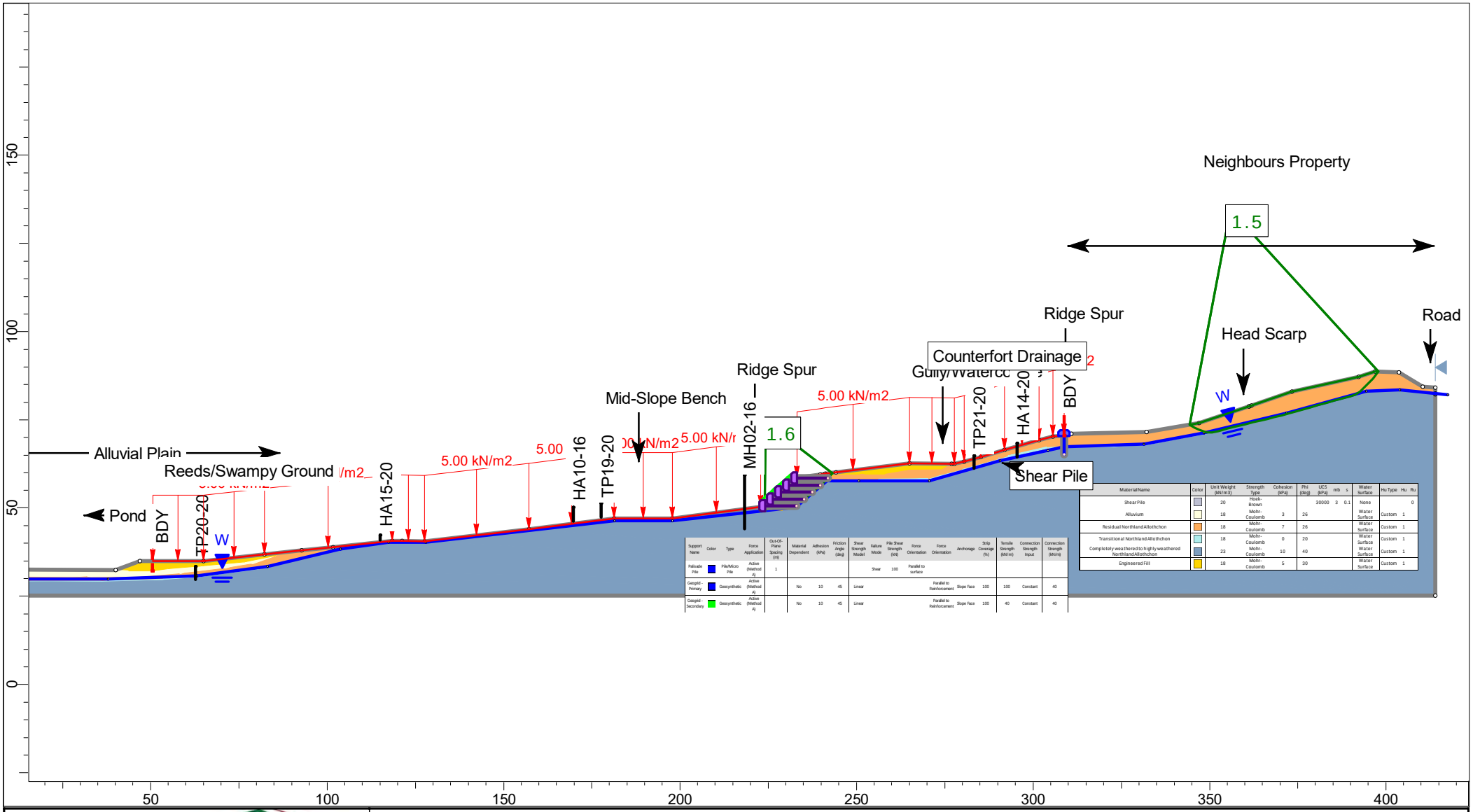
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section C - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section C 6092021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Proposed Profile, Seismic		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:2500	*Company* Build Rich
SLIDEINTERP 9.018				*File Name* AKL2020-0125 Section C 6092021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, Normal Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

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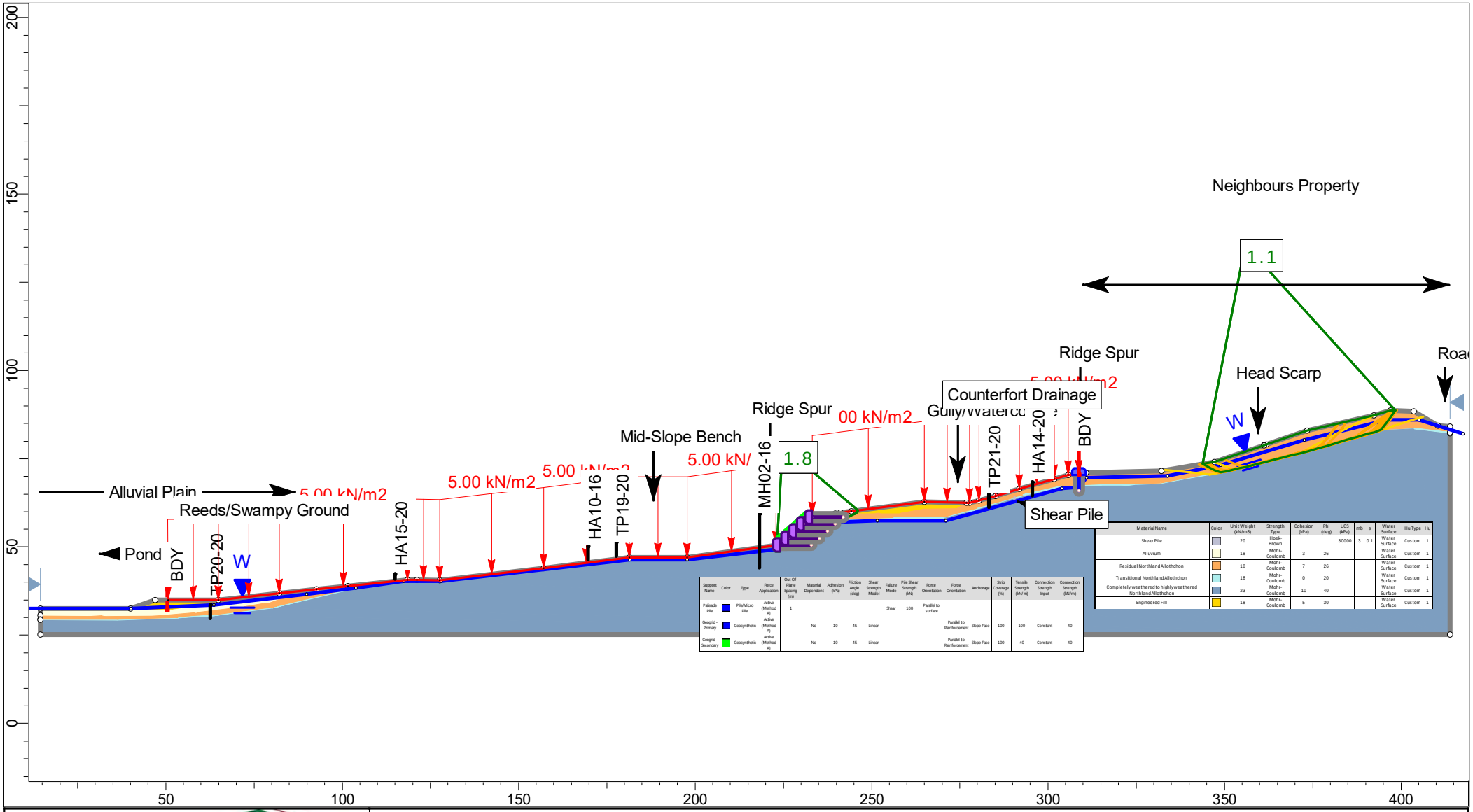
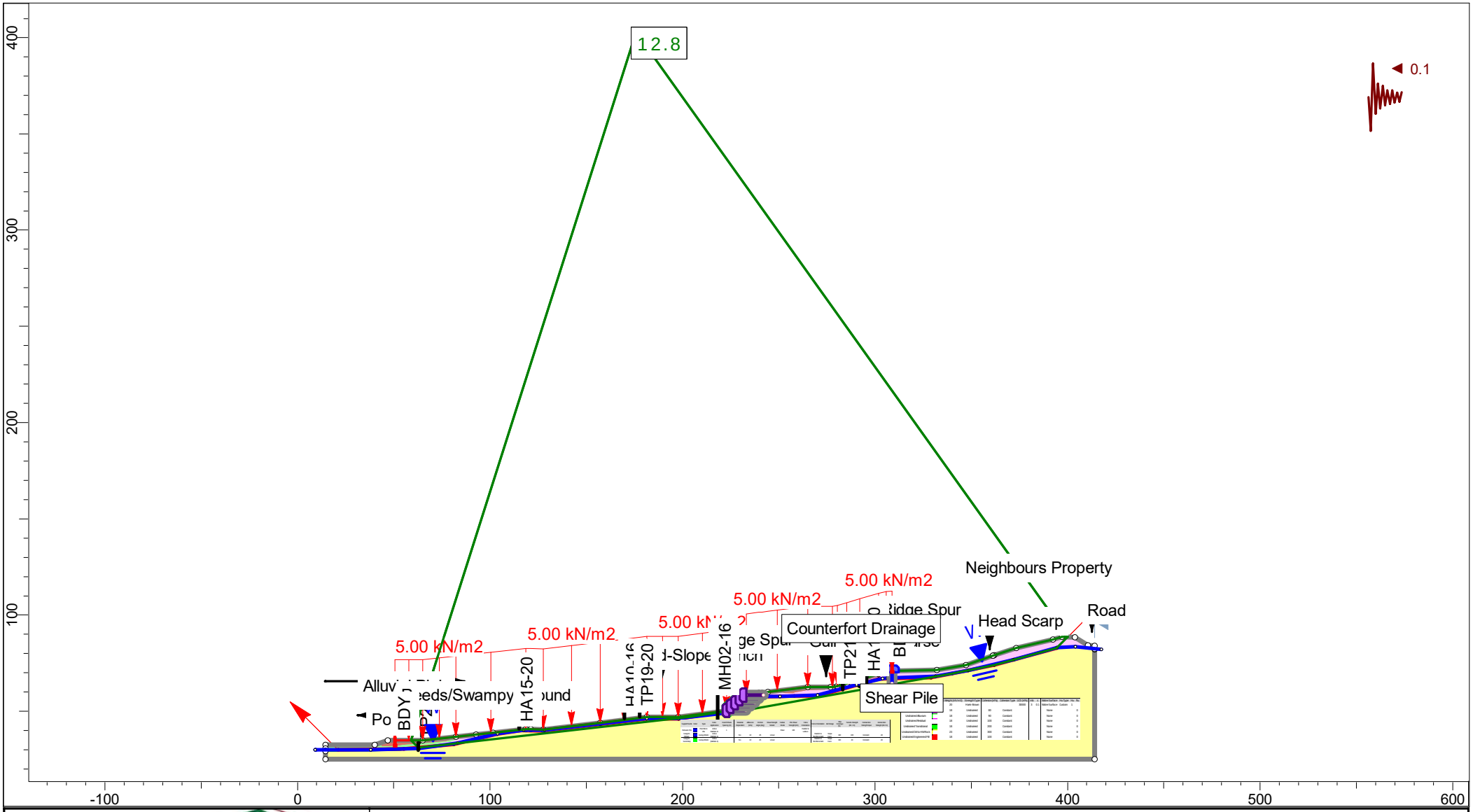


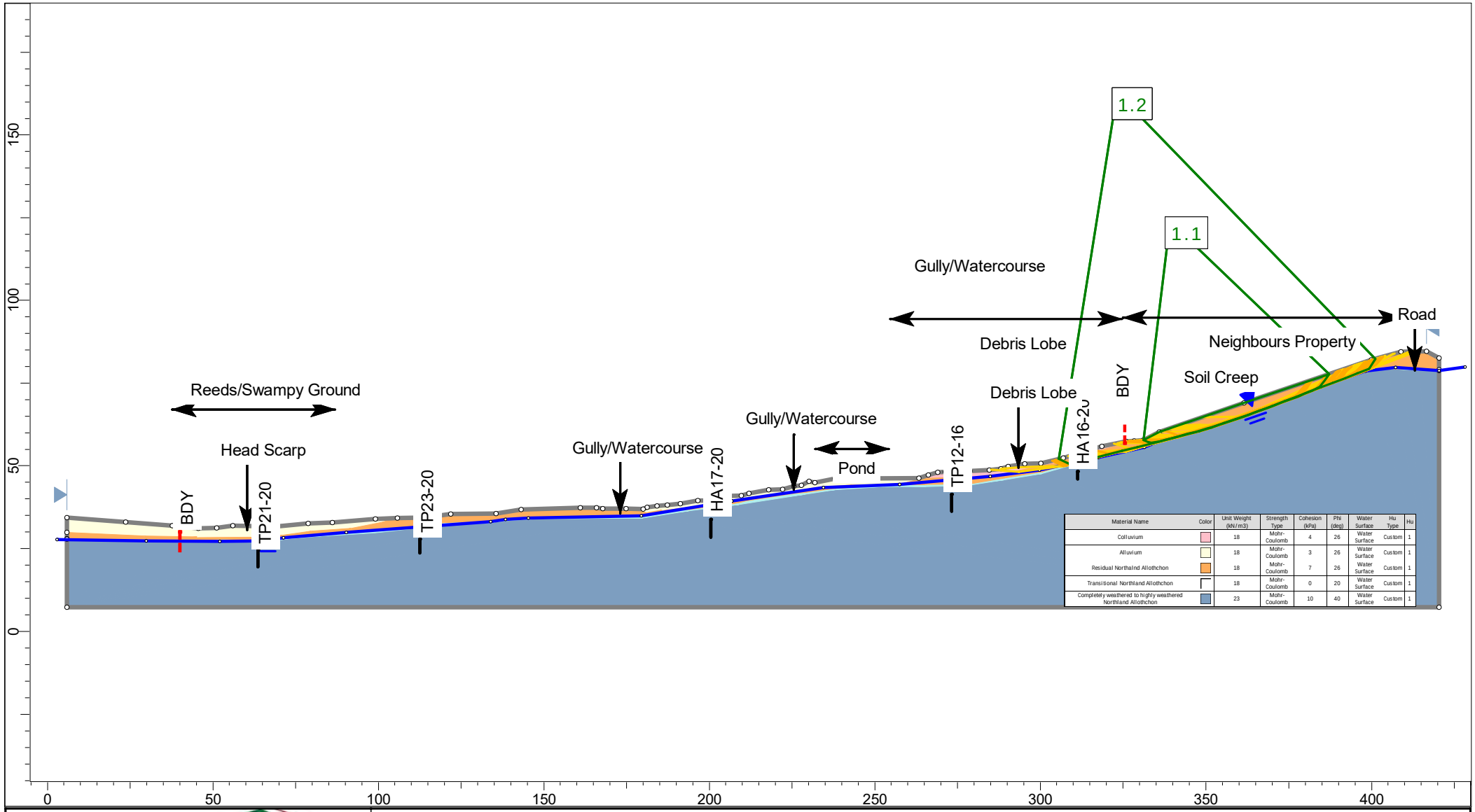
CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, High Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERP 9.018



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, Seismic		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:2750	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERPRET 9.018



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northalnd Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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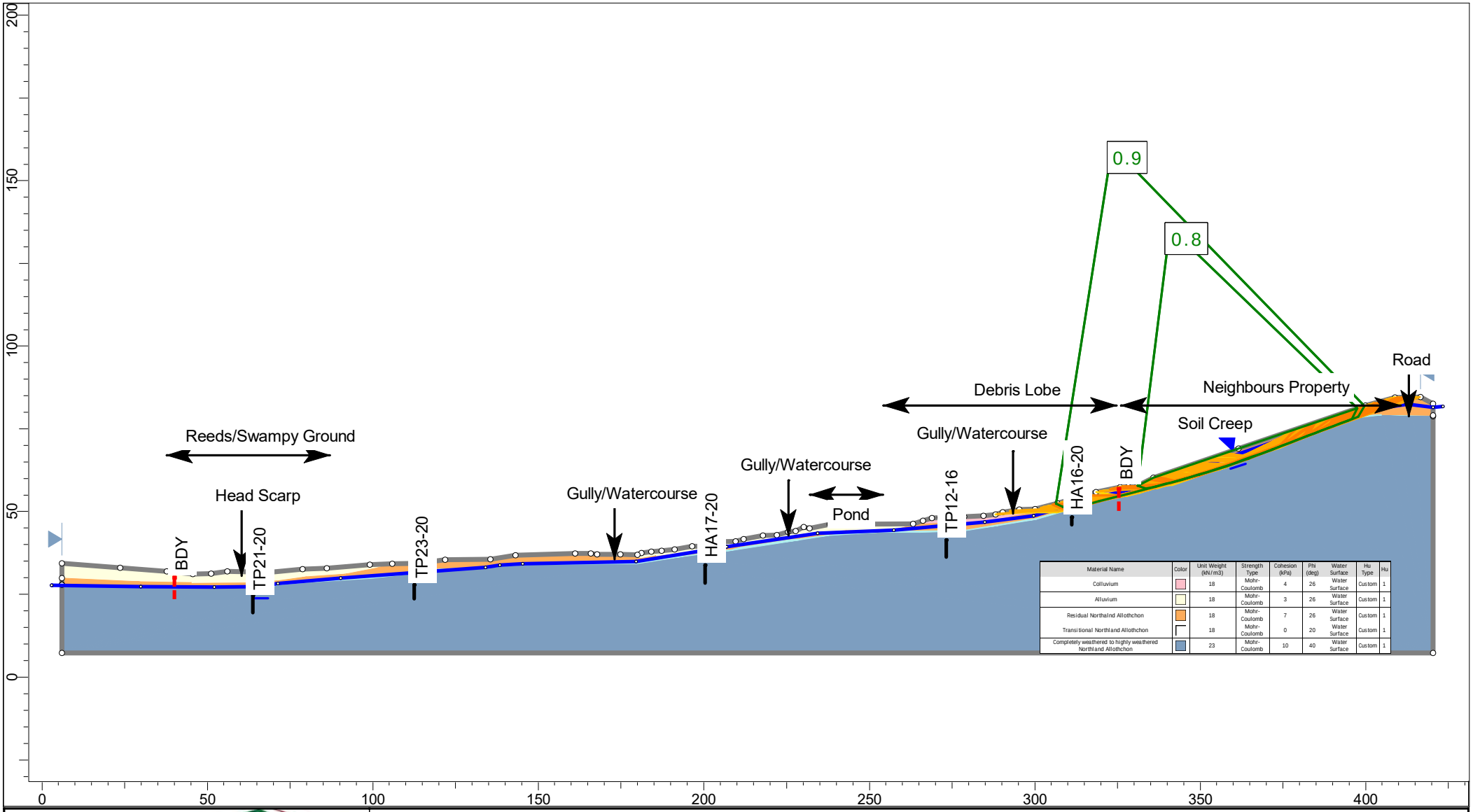
SLIDEINTERP 9.018

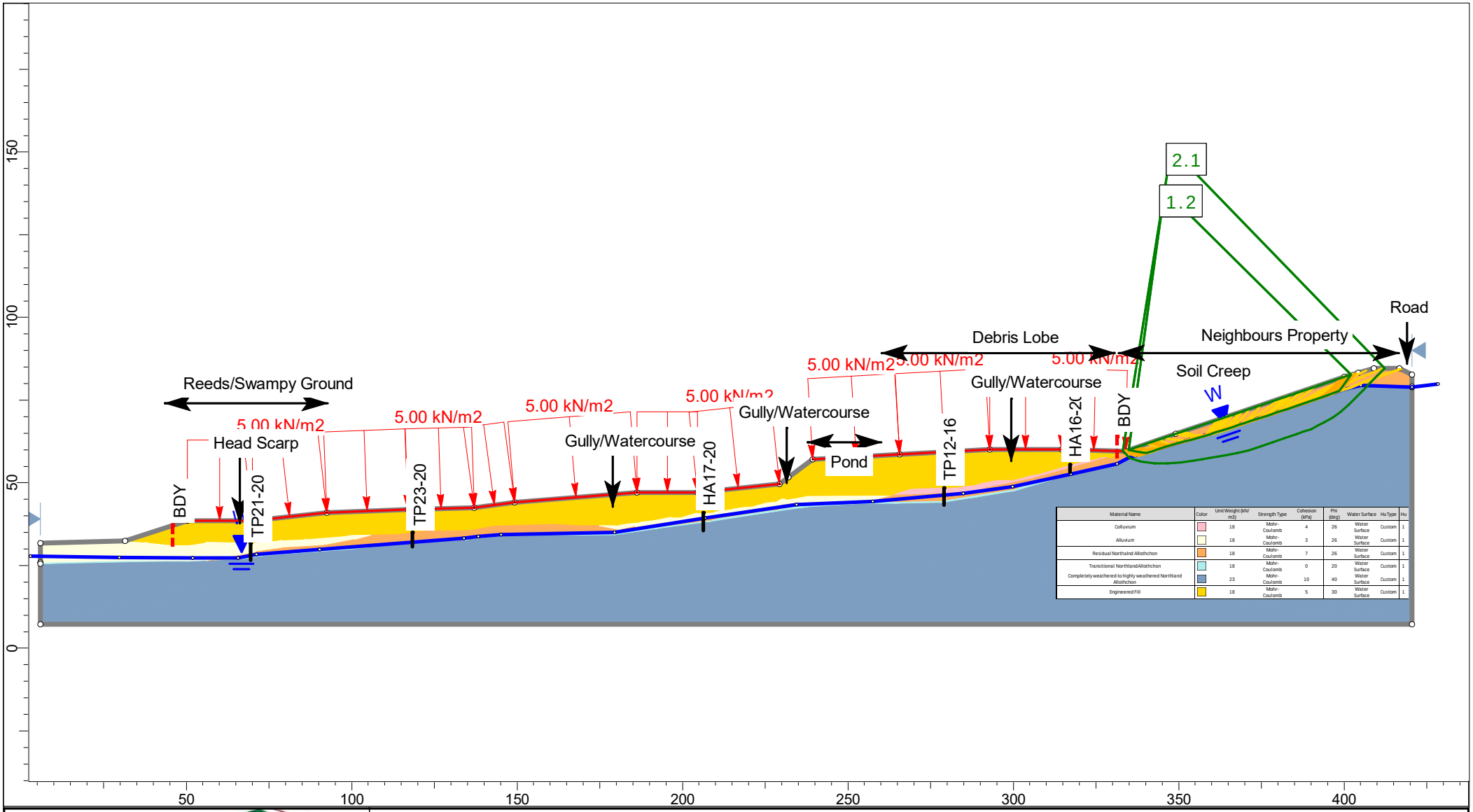
Project	Silverdale South Stage 3&4			
Analysis Description	Section D - Existing Profile, Normal Groundwater			
Drawn By SP	*Date:* 29/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



CMW Geosciences

SLIDEINTERPR 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section D - Existing Profile, High Groundwater		
Drawn By SP	*Date:* 29/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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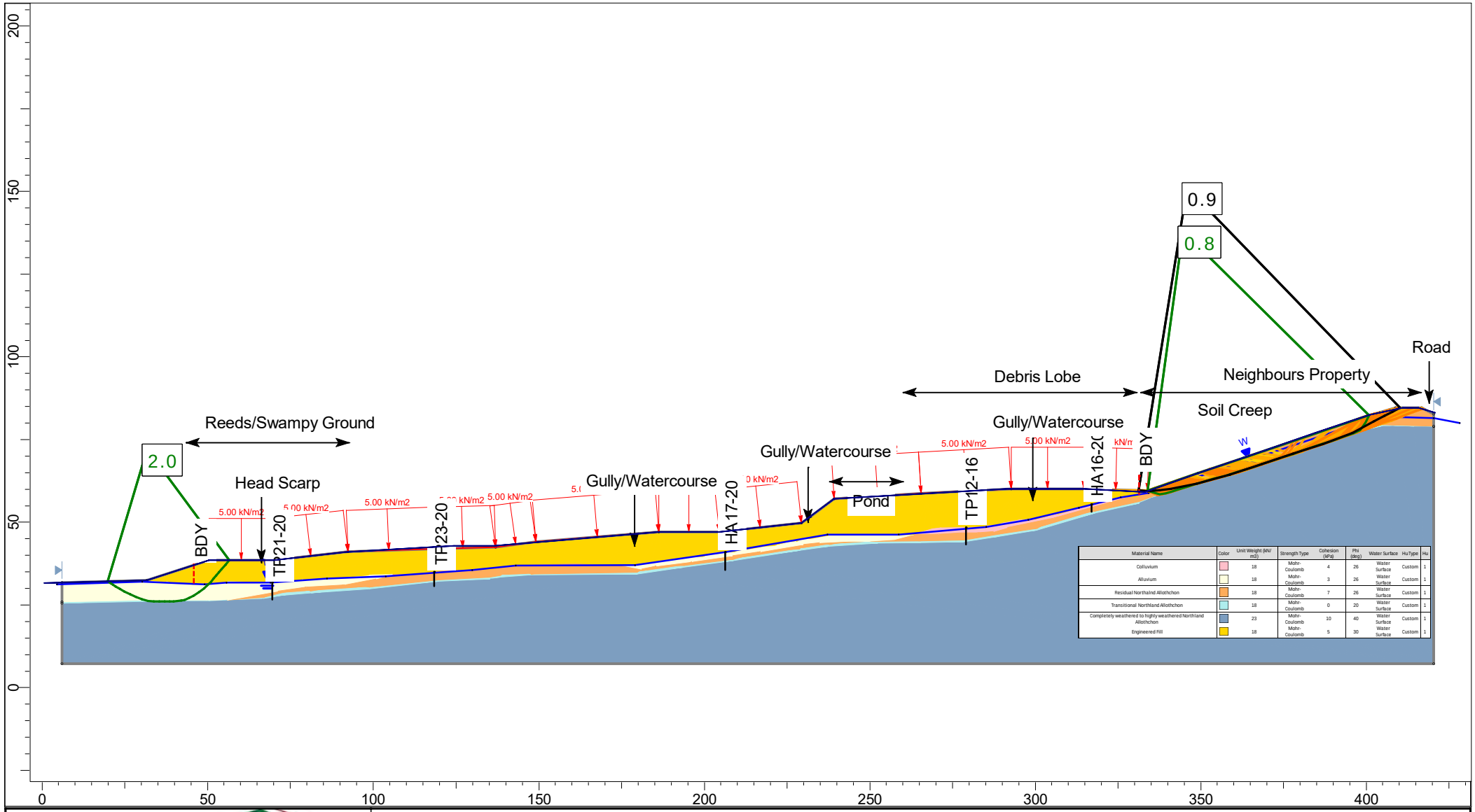
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	HuType	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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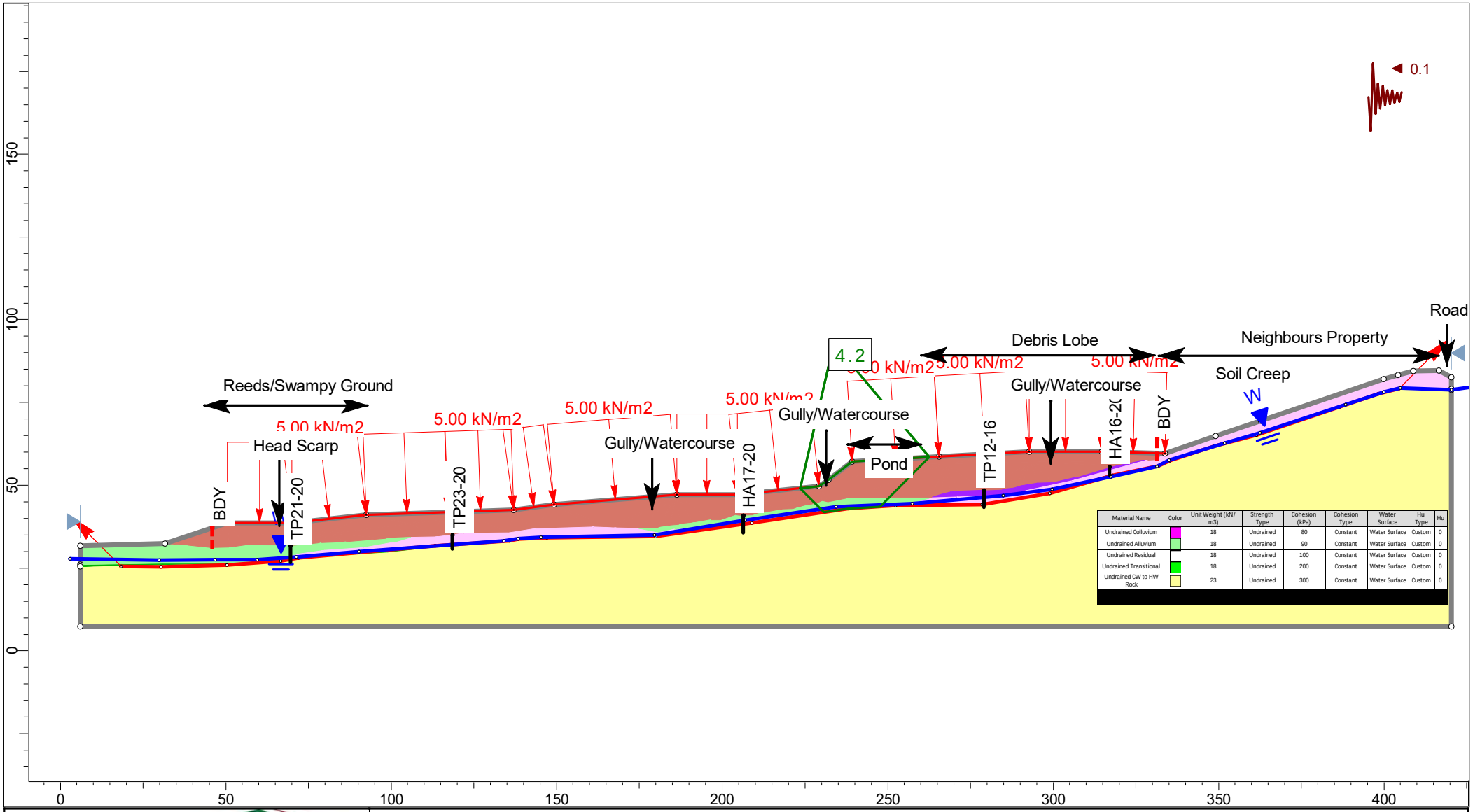
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



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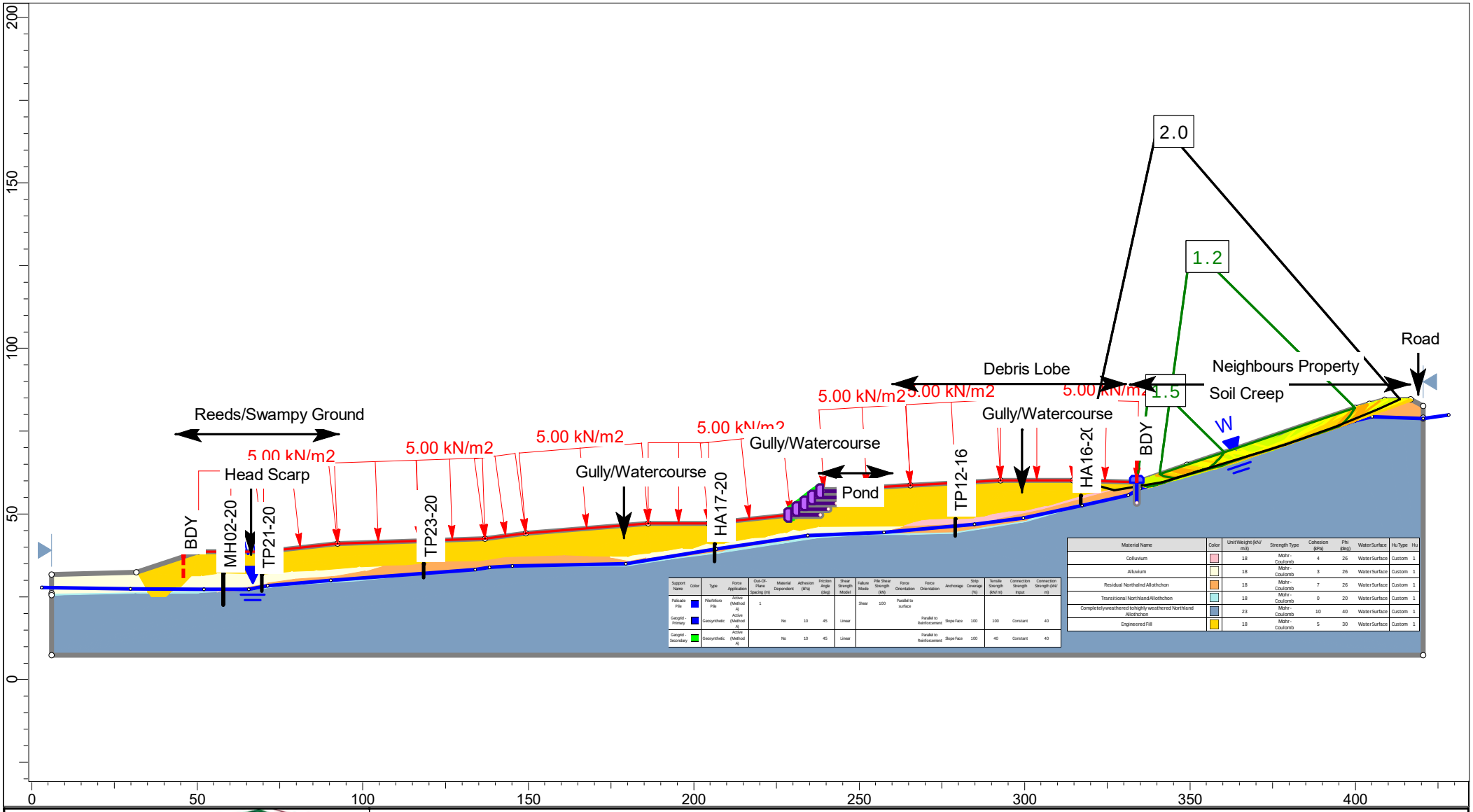
SLIDEINTERPR 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, Seismic			
Drawn By: SP	Date: 6/09/2021	Scale 1:1600	Company	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	WaterSurface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	WaterSurface	Custom	1
Residual Northalnd Allothchon		18	Mohr-Coulomb	7	26	WaterSurface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	WaterSurface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	WaterSurface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	WaterSurface	Custom	1

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

	Project	Silverdale South - Stage 3&4		
	Analysis Description	Section Section D - Remediated, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd

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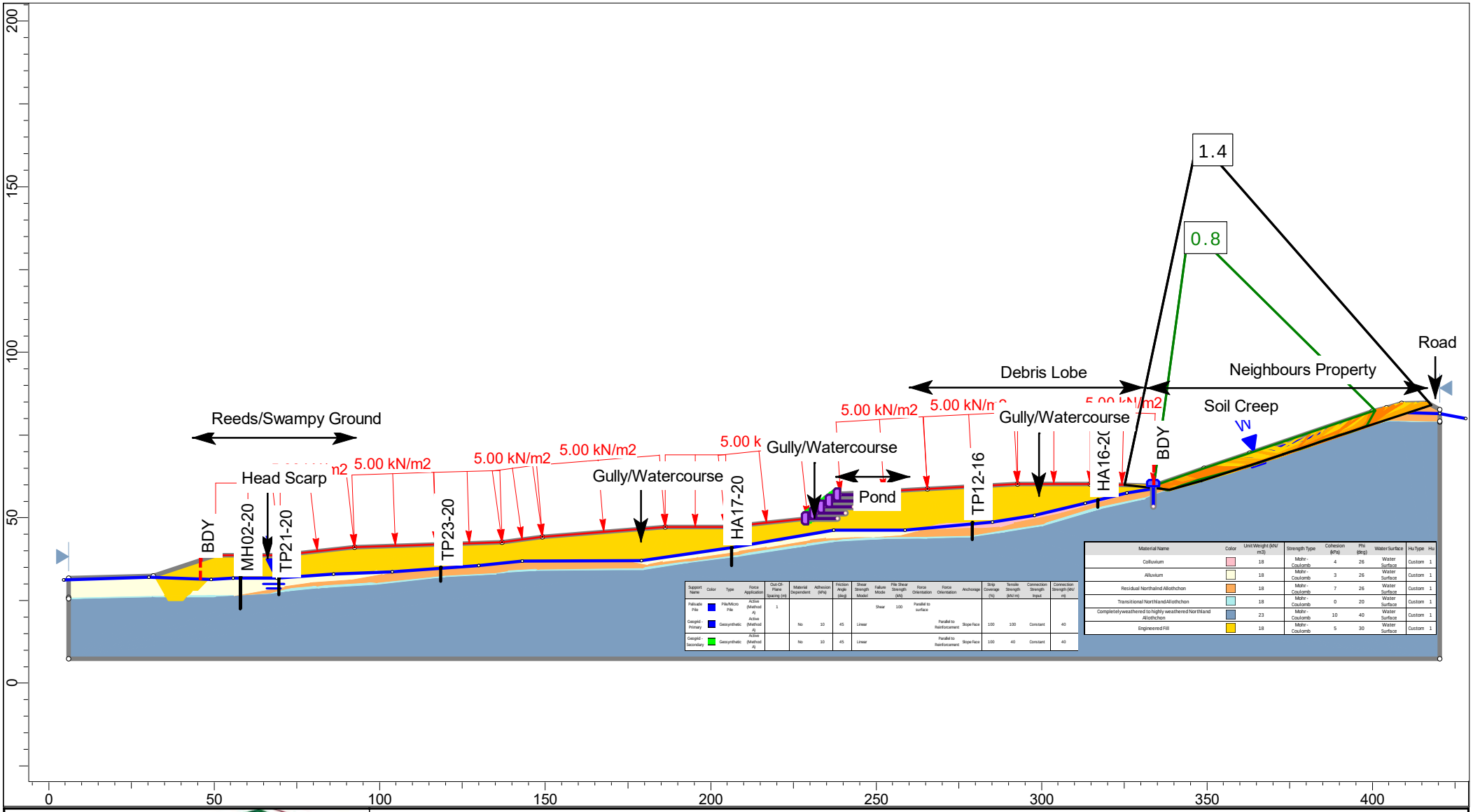

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Remediated, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd

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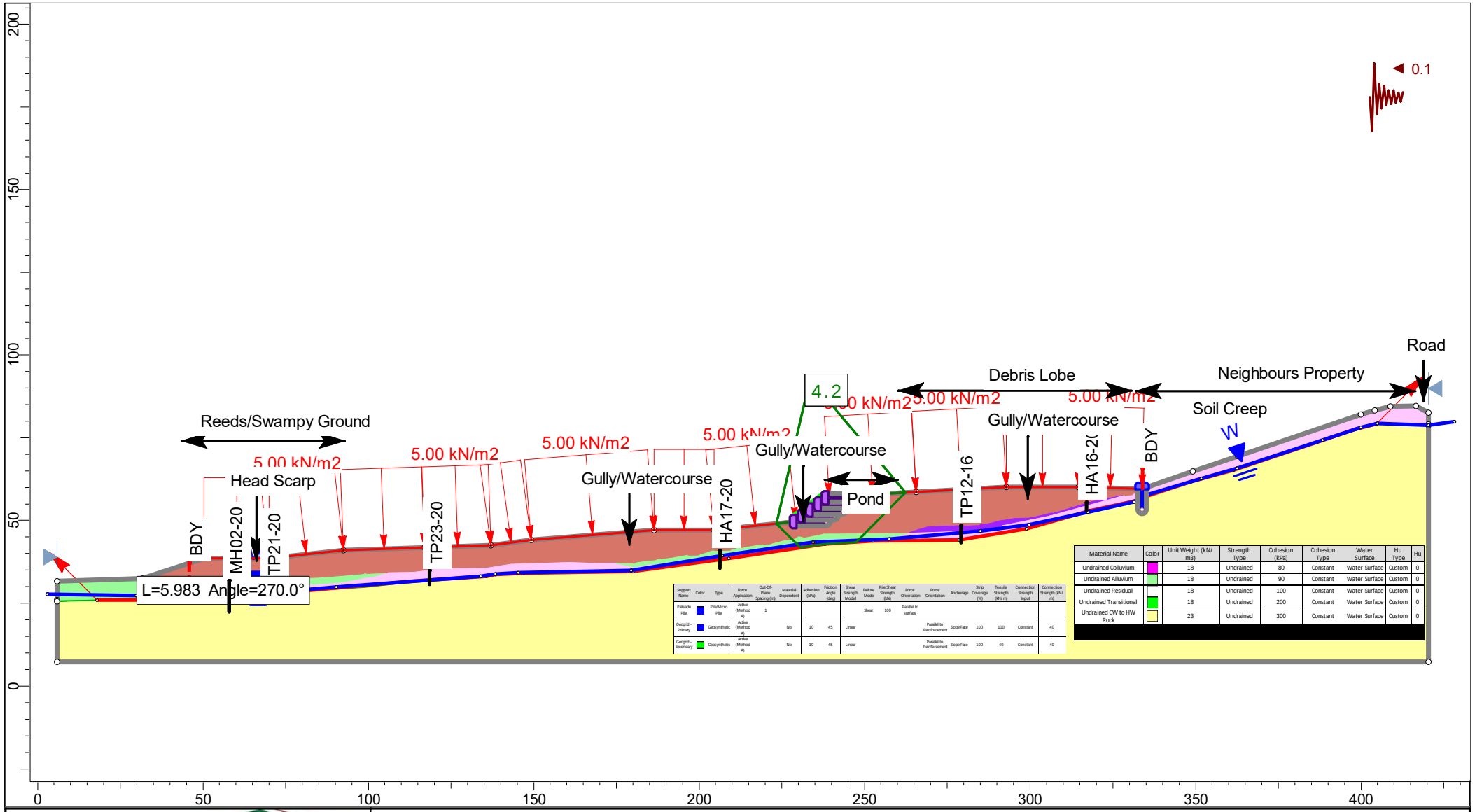

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Colluvium		18	Undrained	80	Constant	Water Surface	Custom	0
Undrained Alluvium		18	Undrained	90	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1				Shear		100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

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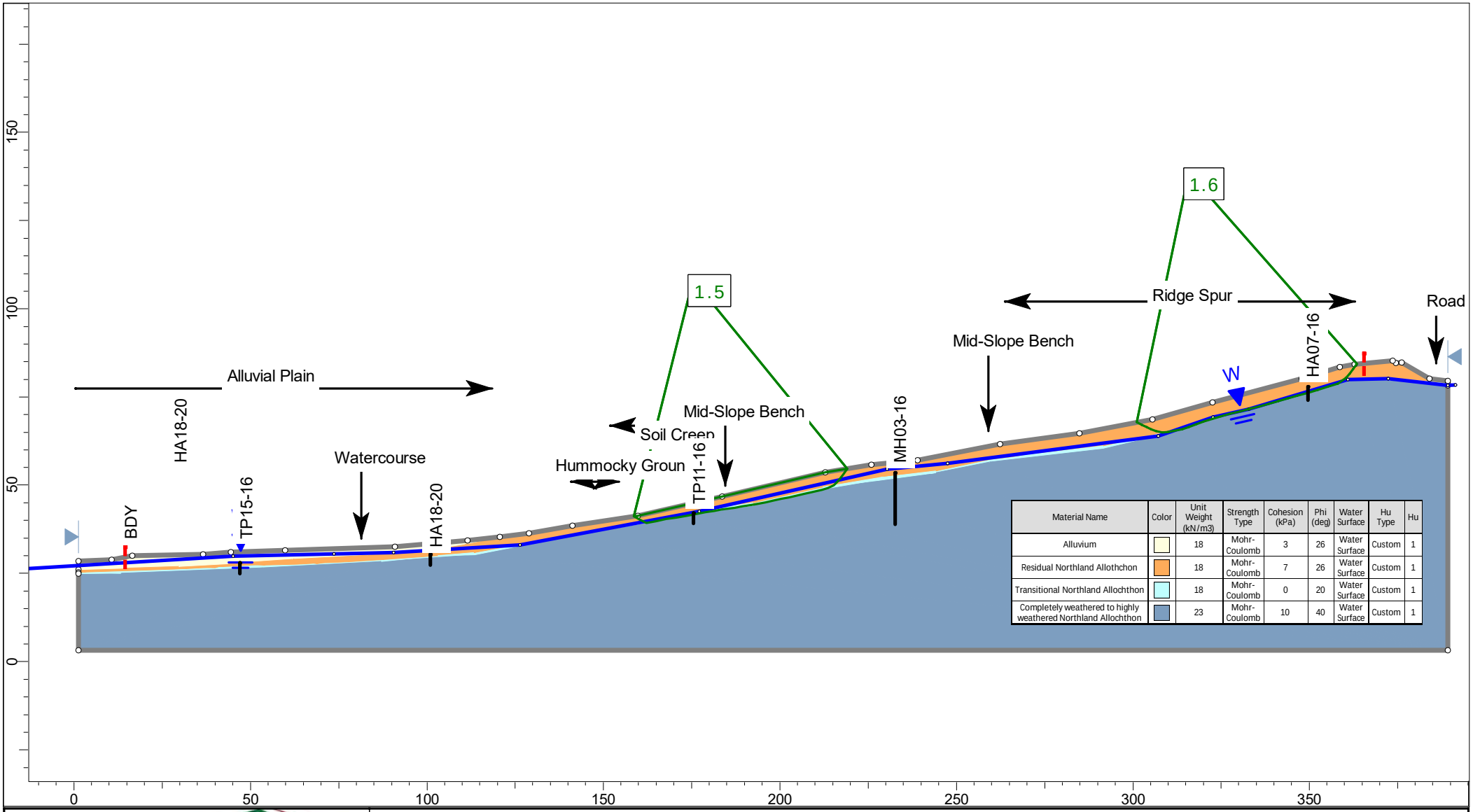
Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Remediated, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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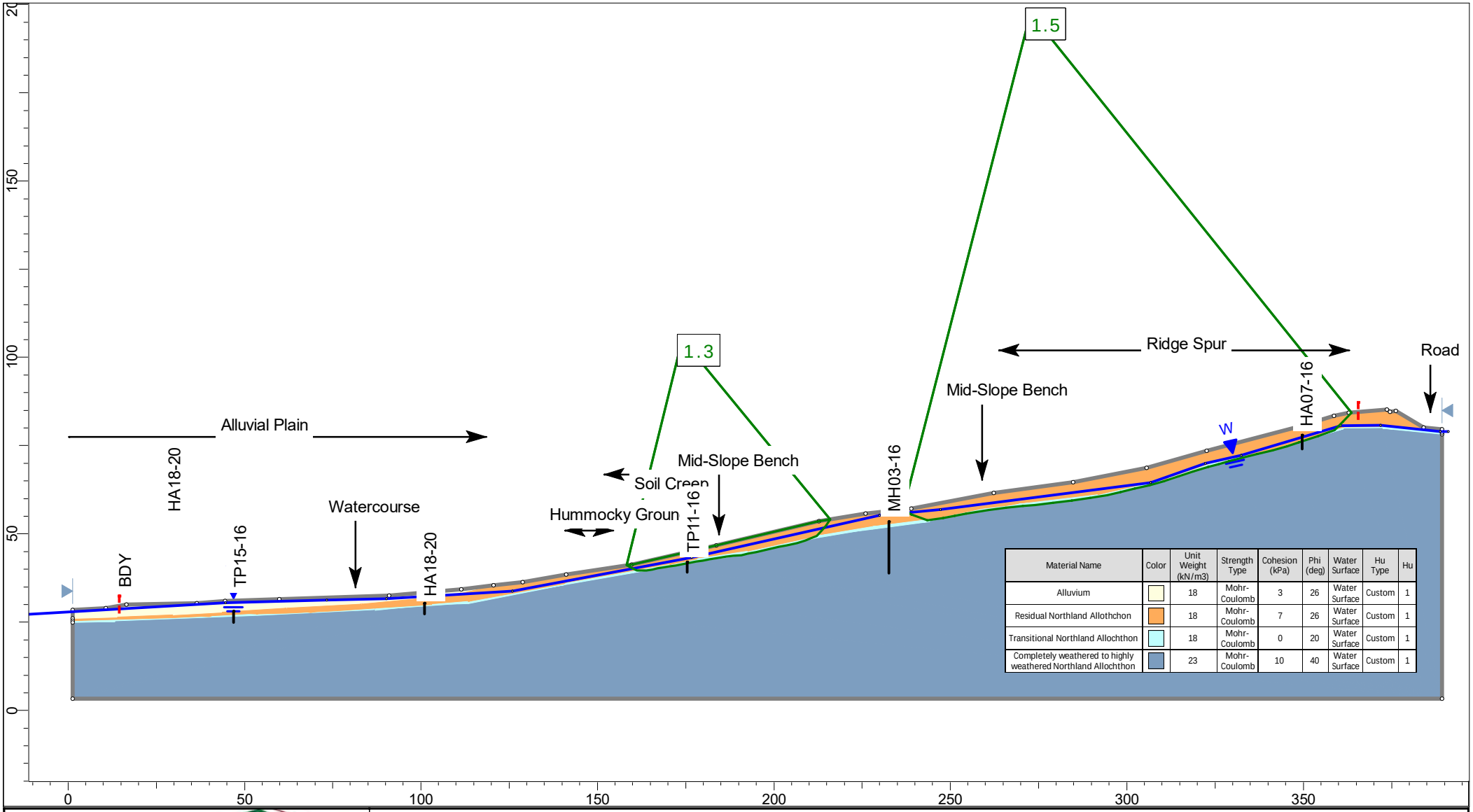
Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Exisiting Profile, Normal Groundwater		
Drawn By: SP	Date: 6/09/2021	Scale 1:1500	Company Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd

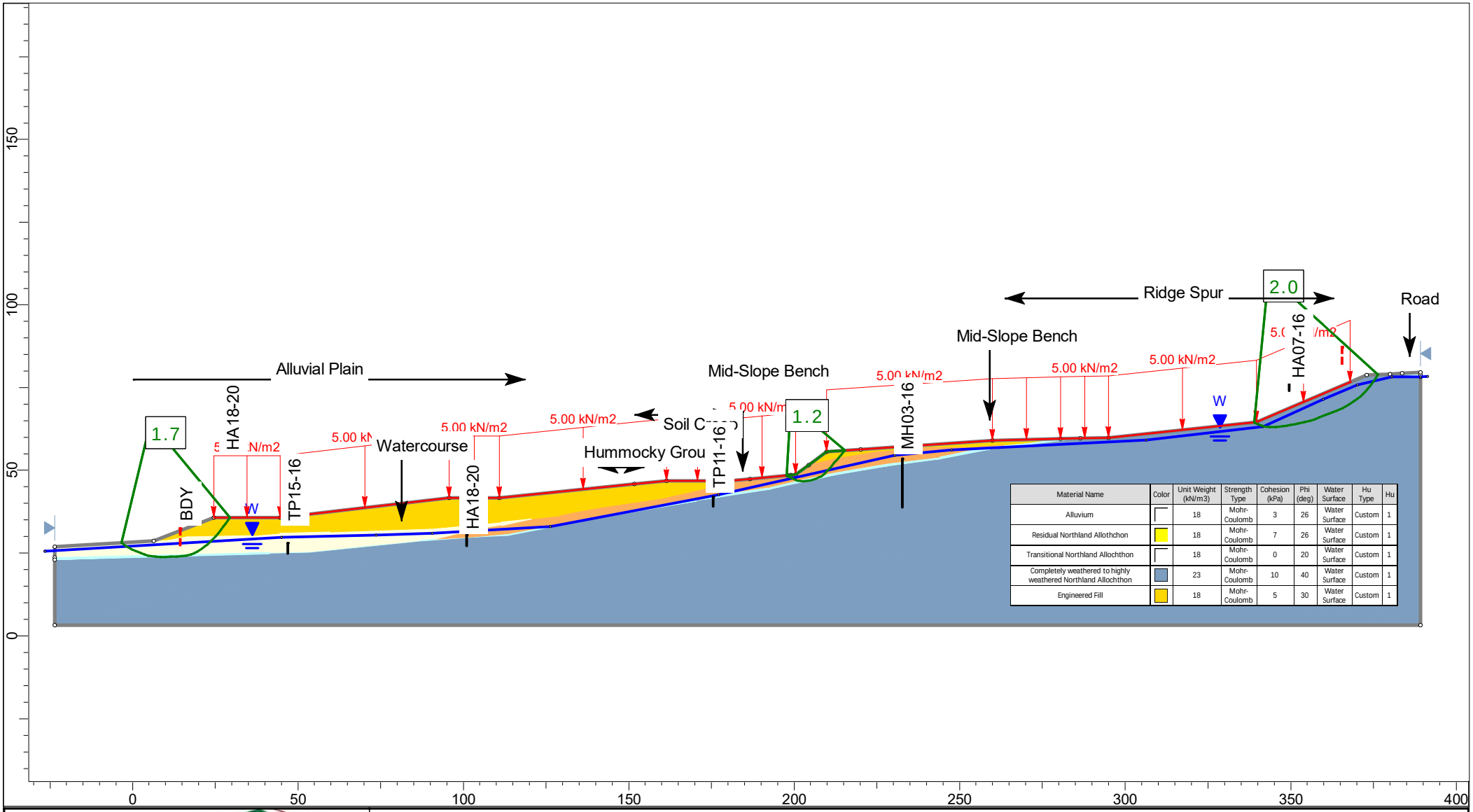


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Exisiting Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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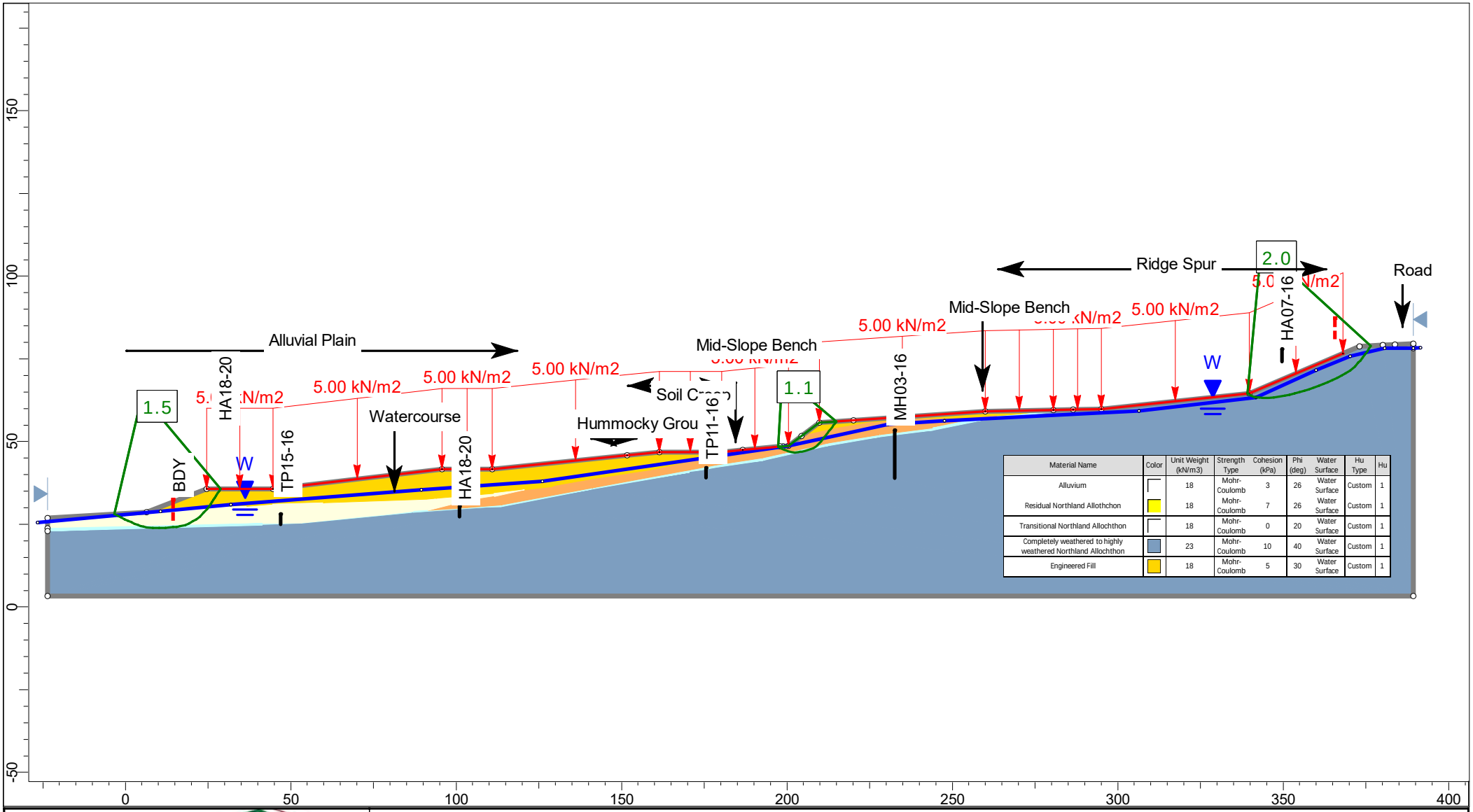
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Proposed Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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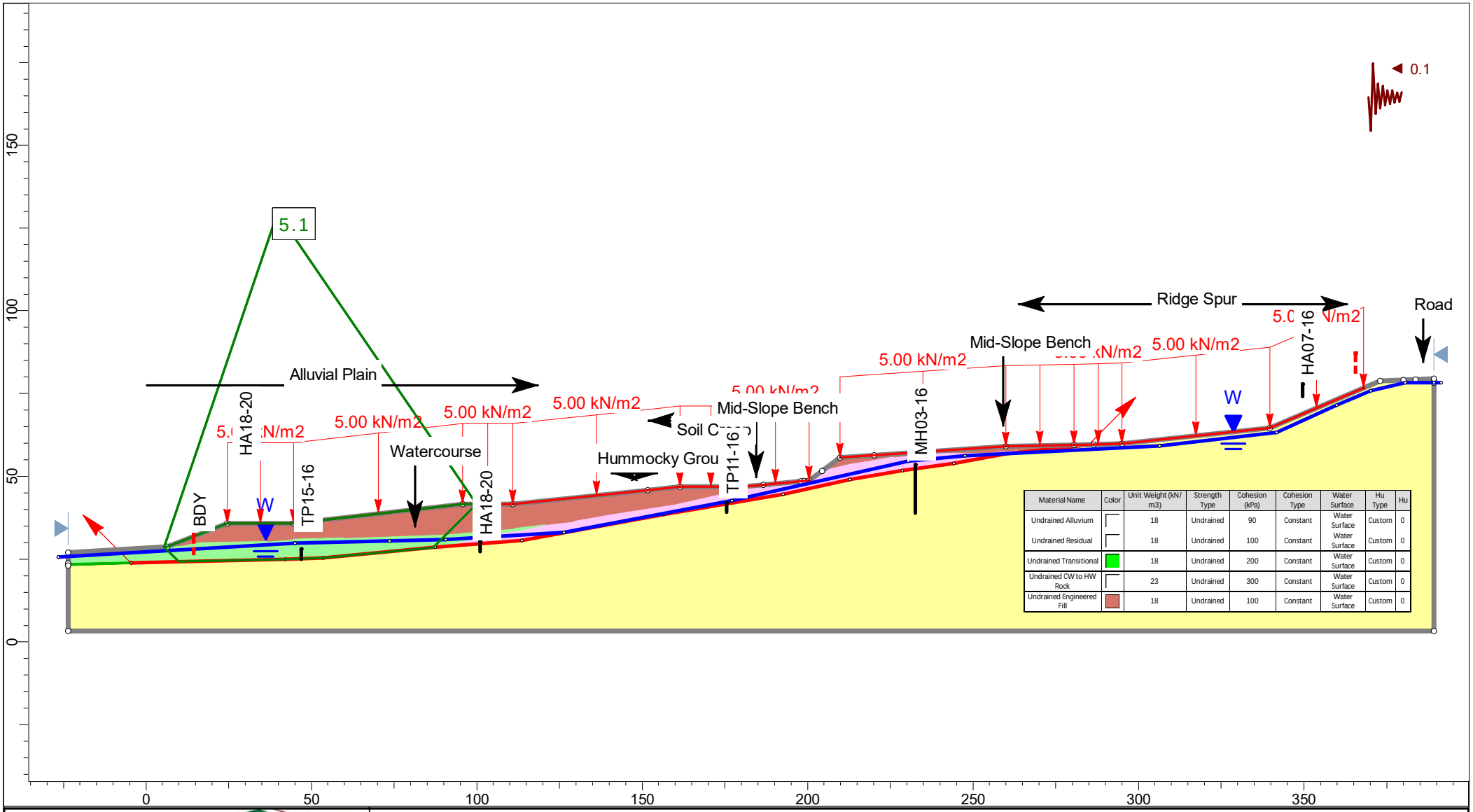
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Proposed Profile, High Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Alluvium		18	Undrained	90	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0
Undrained Engineered Fill		18	Undrained	100	Constant	Water Surface	Custom	0

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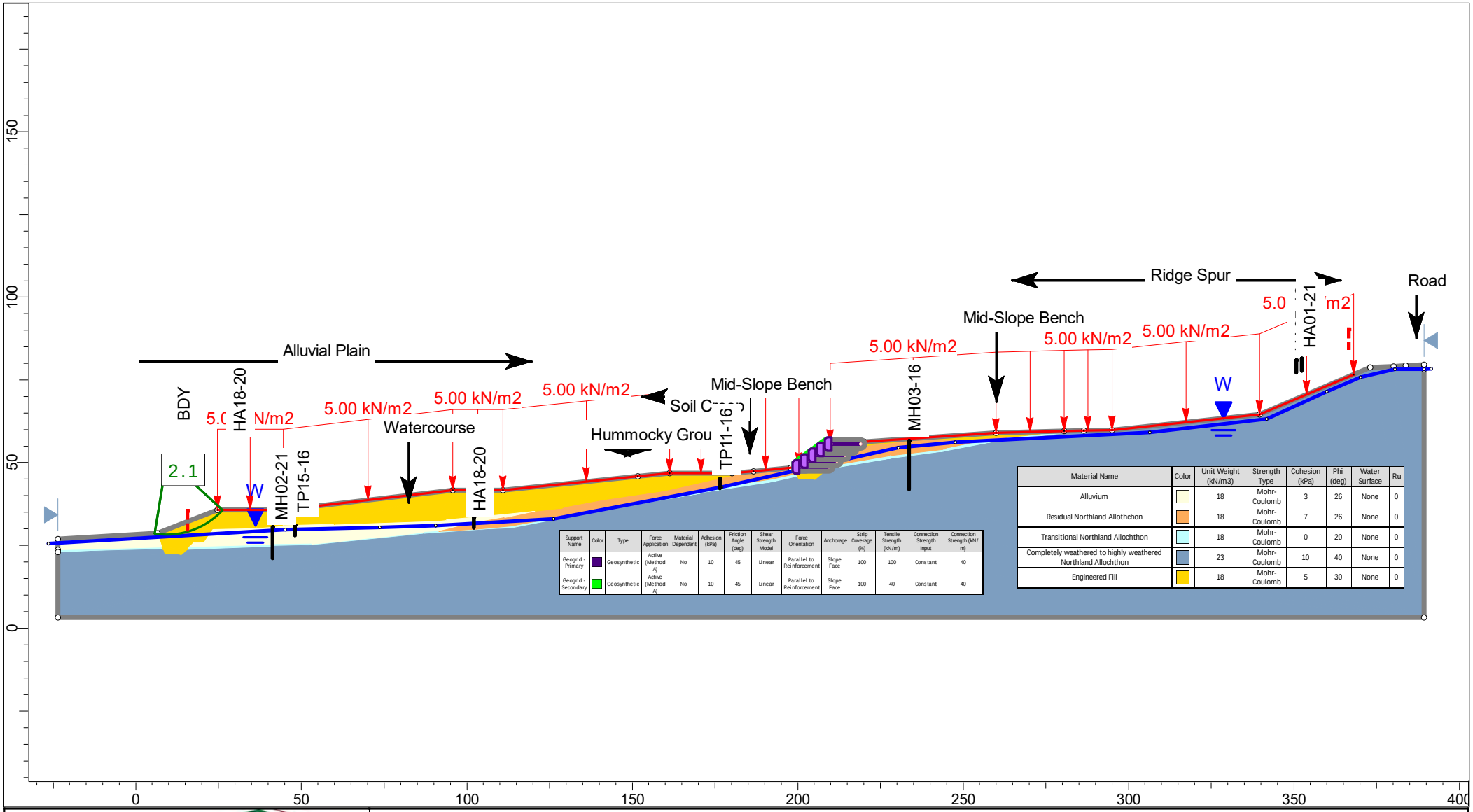
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Proposed Profile, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Alluvium		18	Mohr-Coulomb	3	26	None	0
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineered Fill		18	Mohr-Coulomb	5	30	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

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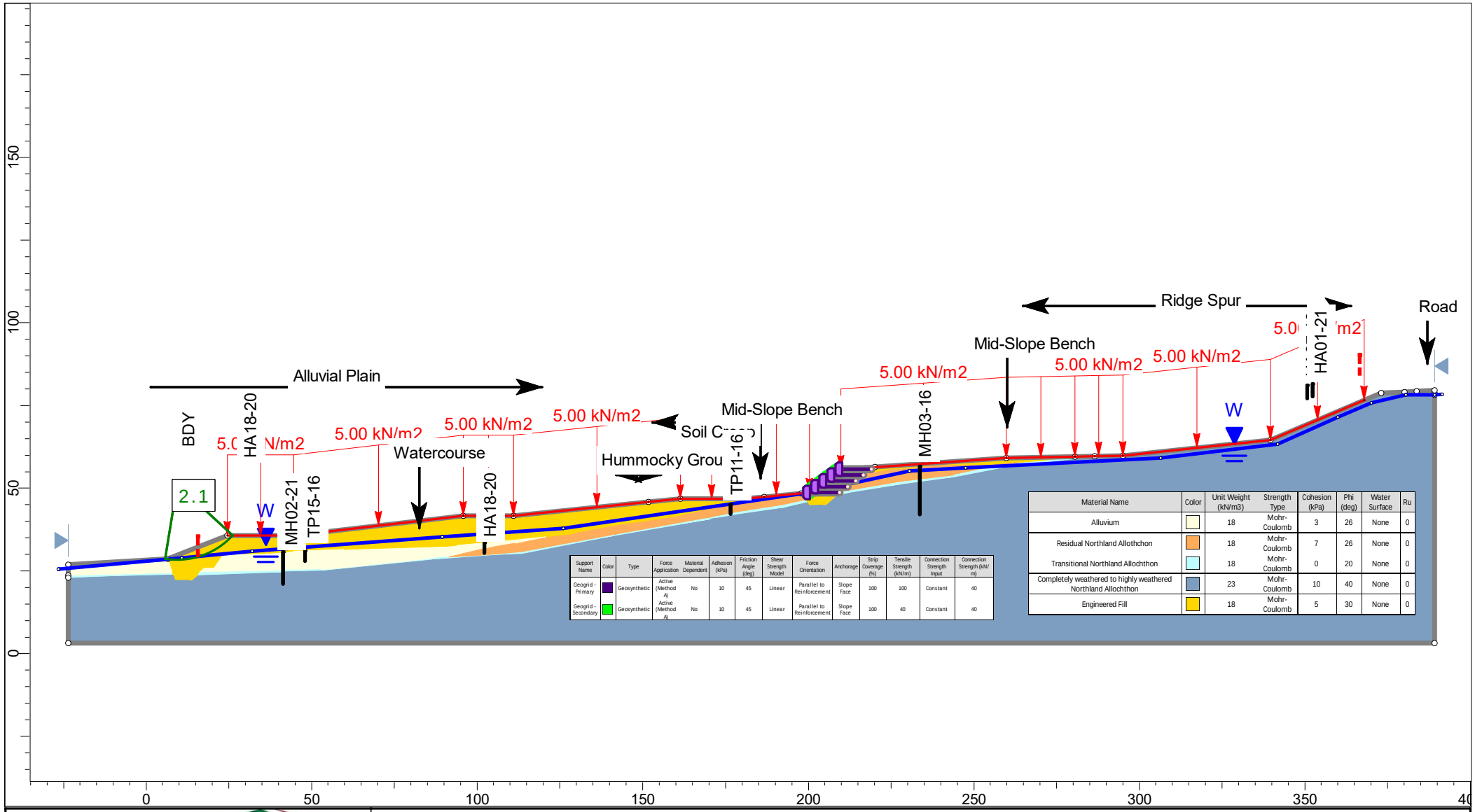
SLIDEINTERPRET 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Remediated, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Alluvium		18	Mohr-Coulomb	3	26	None	0
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineered Fill		18	Mohr-Coulomb	5	30	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

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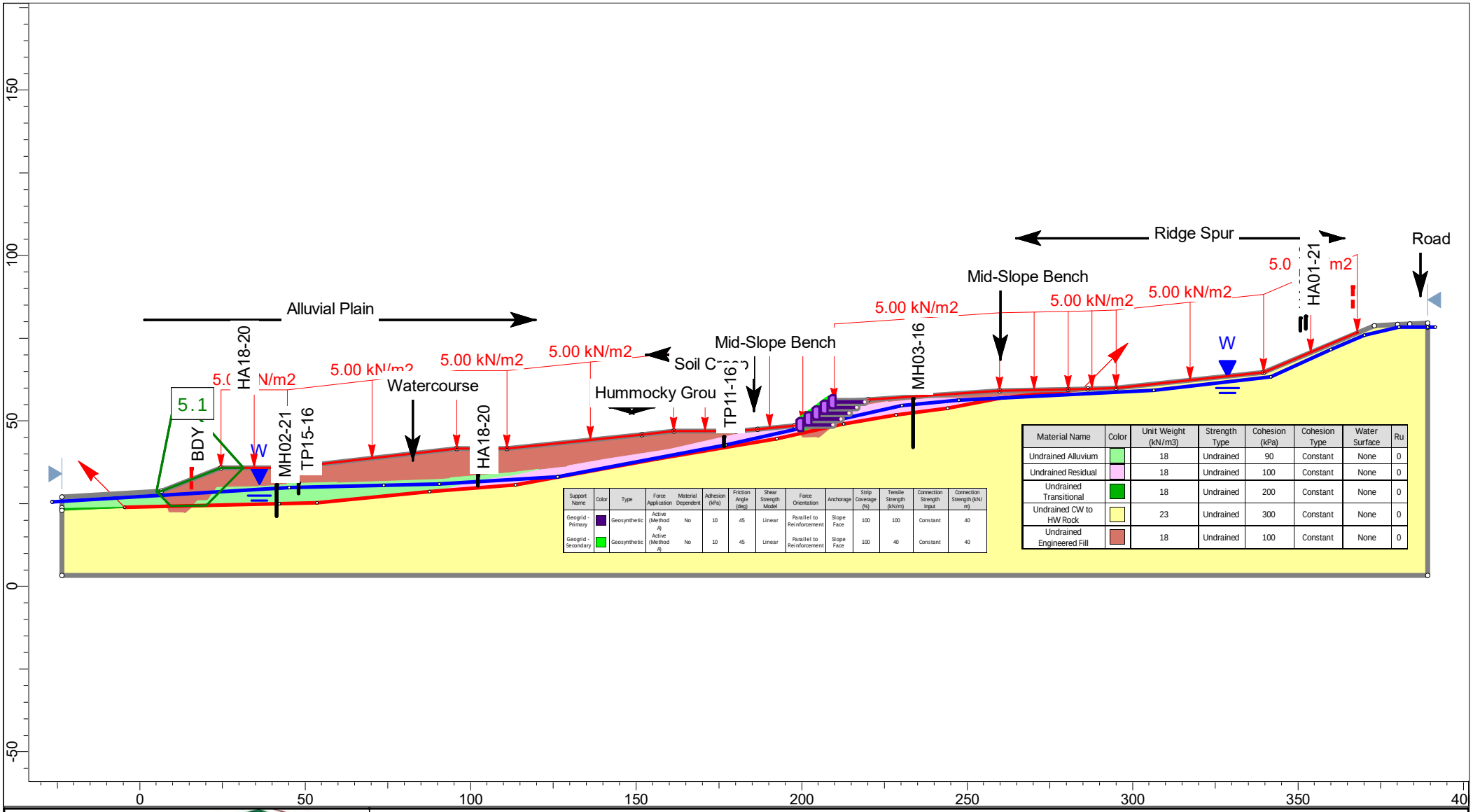
SLIDEINTERP 9.018

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section Section E - Remediated, High Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section E 18082021 SP.slmd



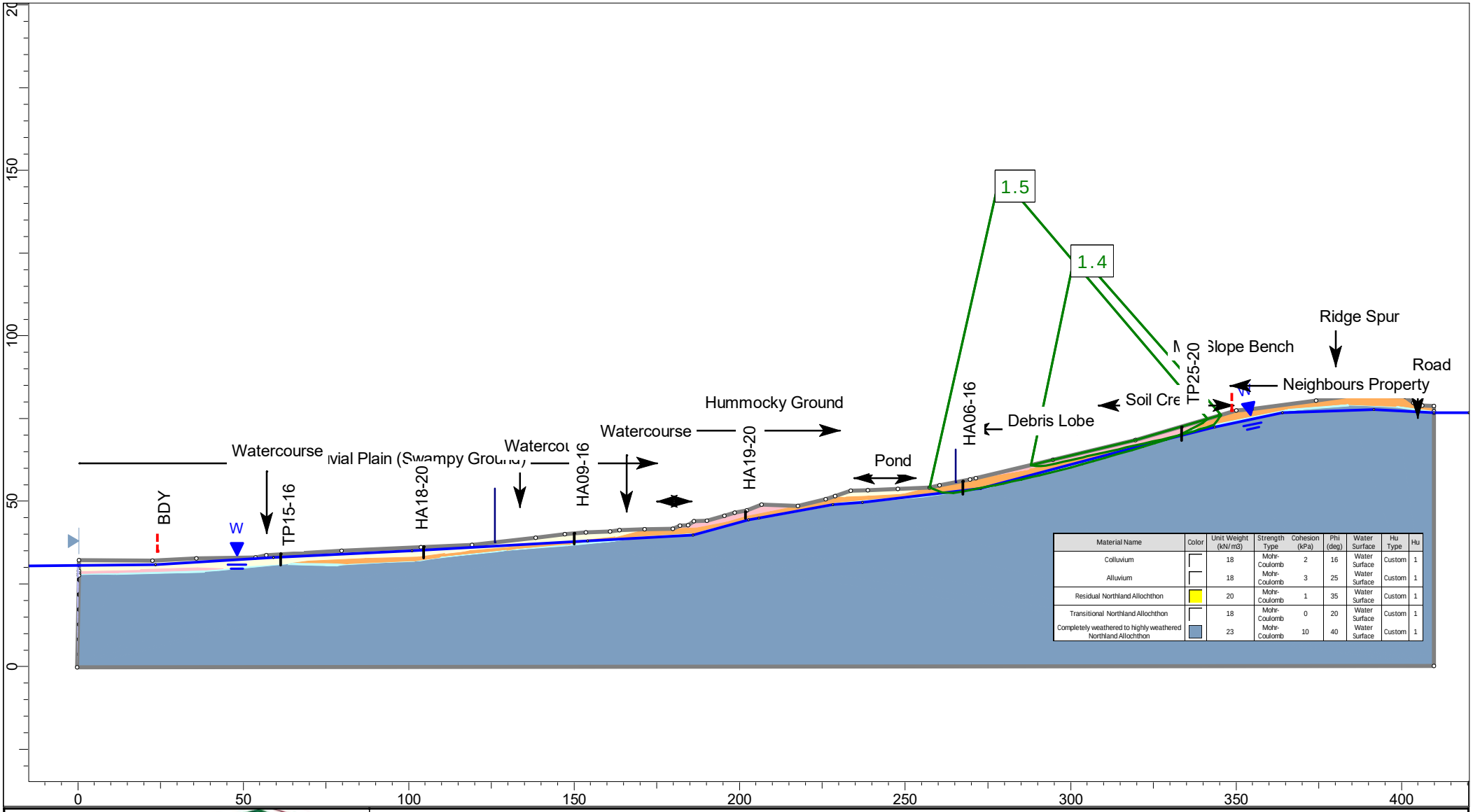
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		18	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

CMW Geosciences

SLIDEINTERP 9.018

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section Section E - Remediated, Seismic		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section E 18082021 SP.slmd

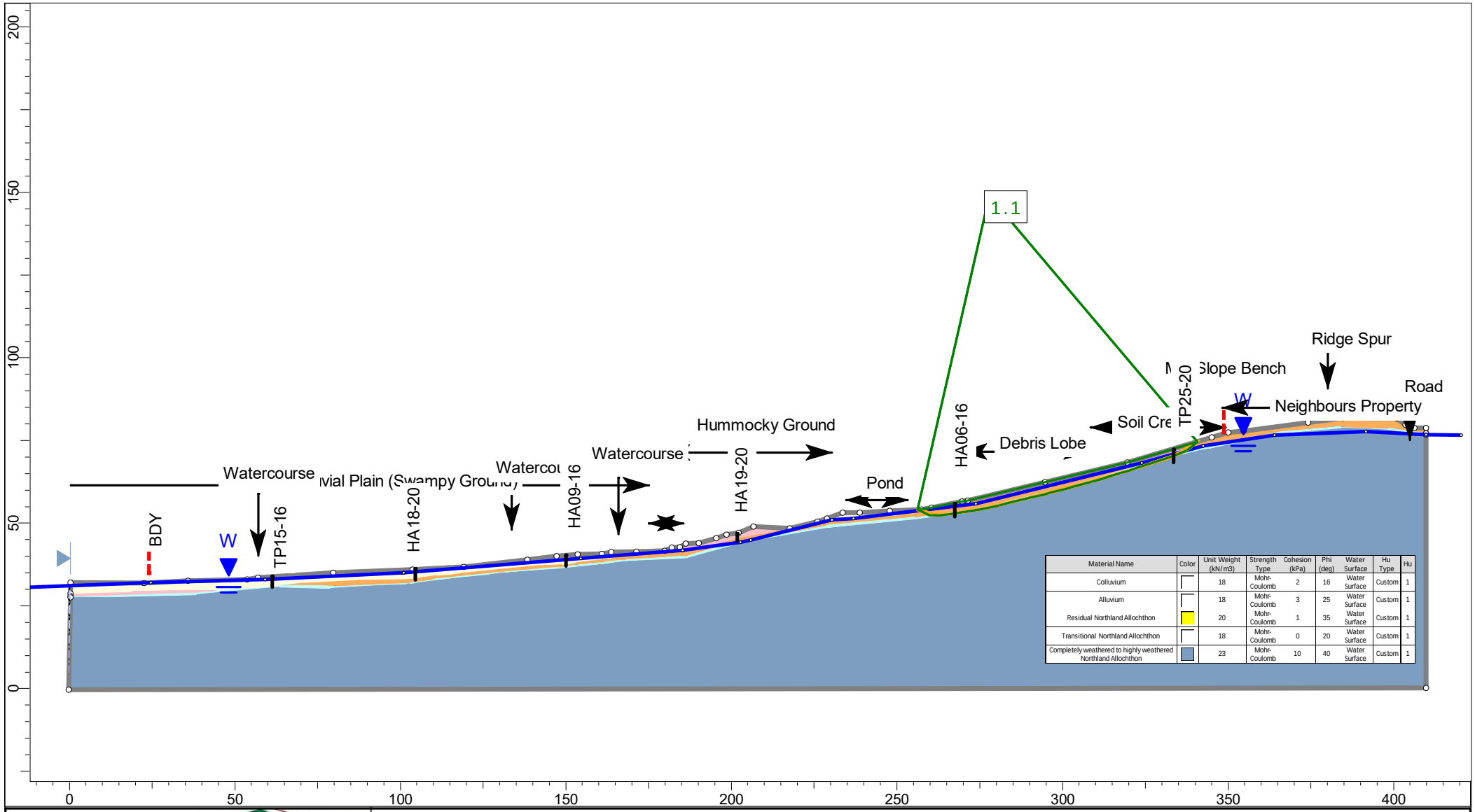


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section Section F - Existing Profile, Normal Groundwater			
Drawn By: SP	Date: 6/09/2021	Scale 1:1600	Company	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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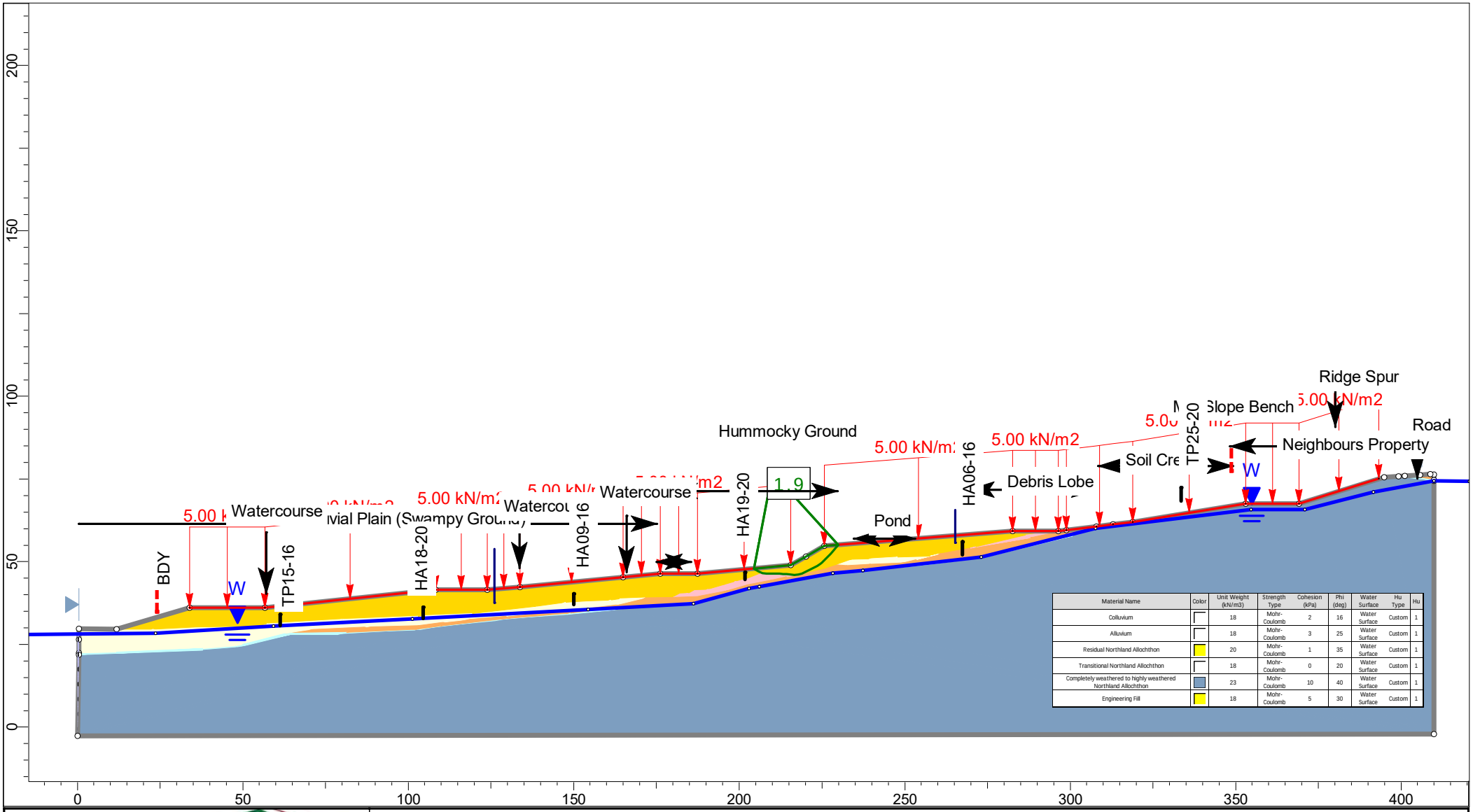
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section Section F - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineering Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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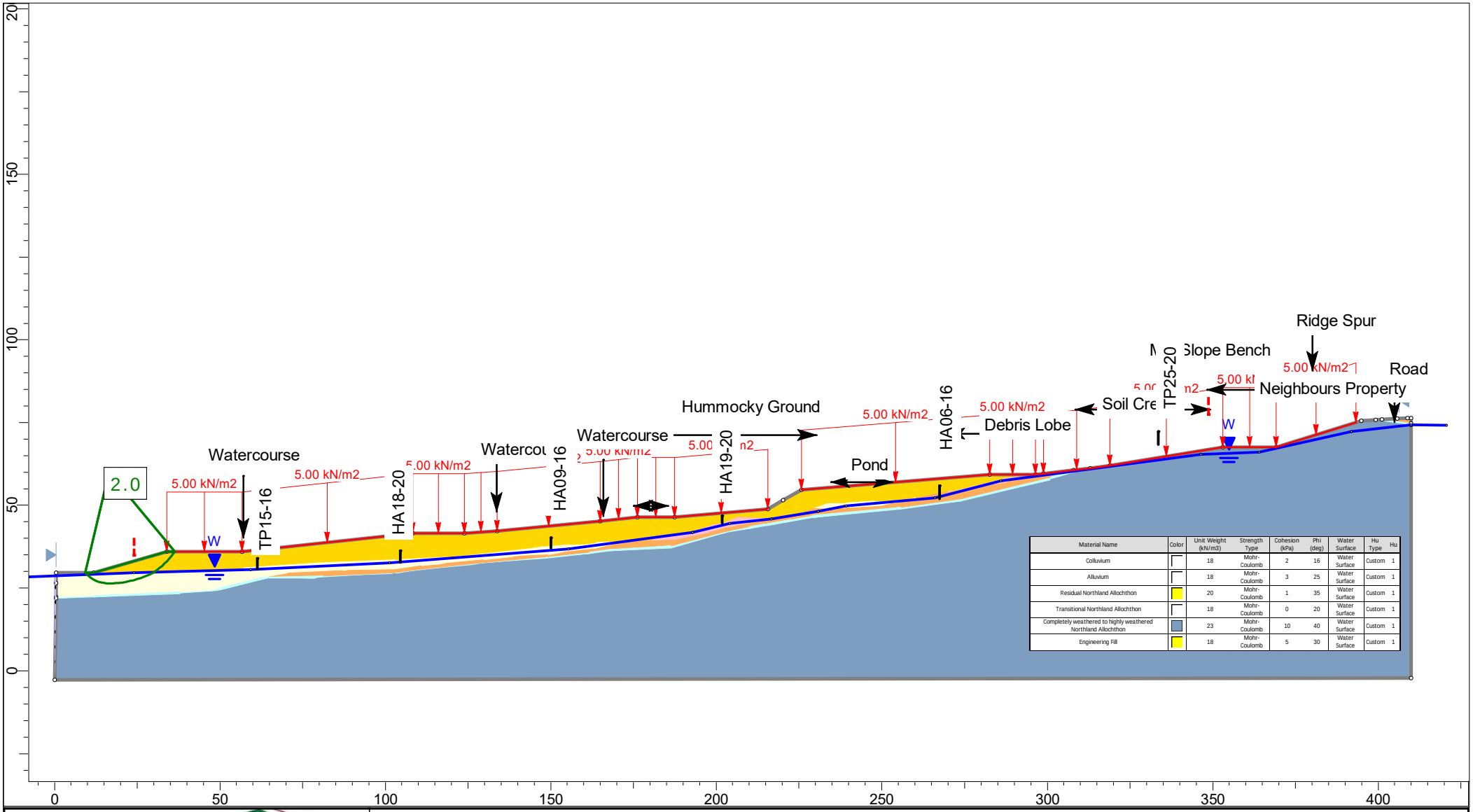
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4		
Analysis Description	Section F - Proposed Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineering Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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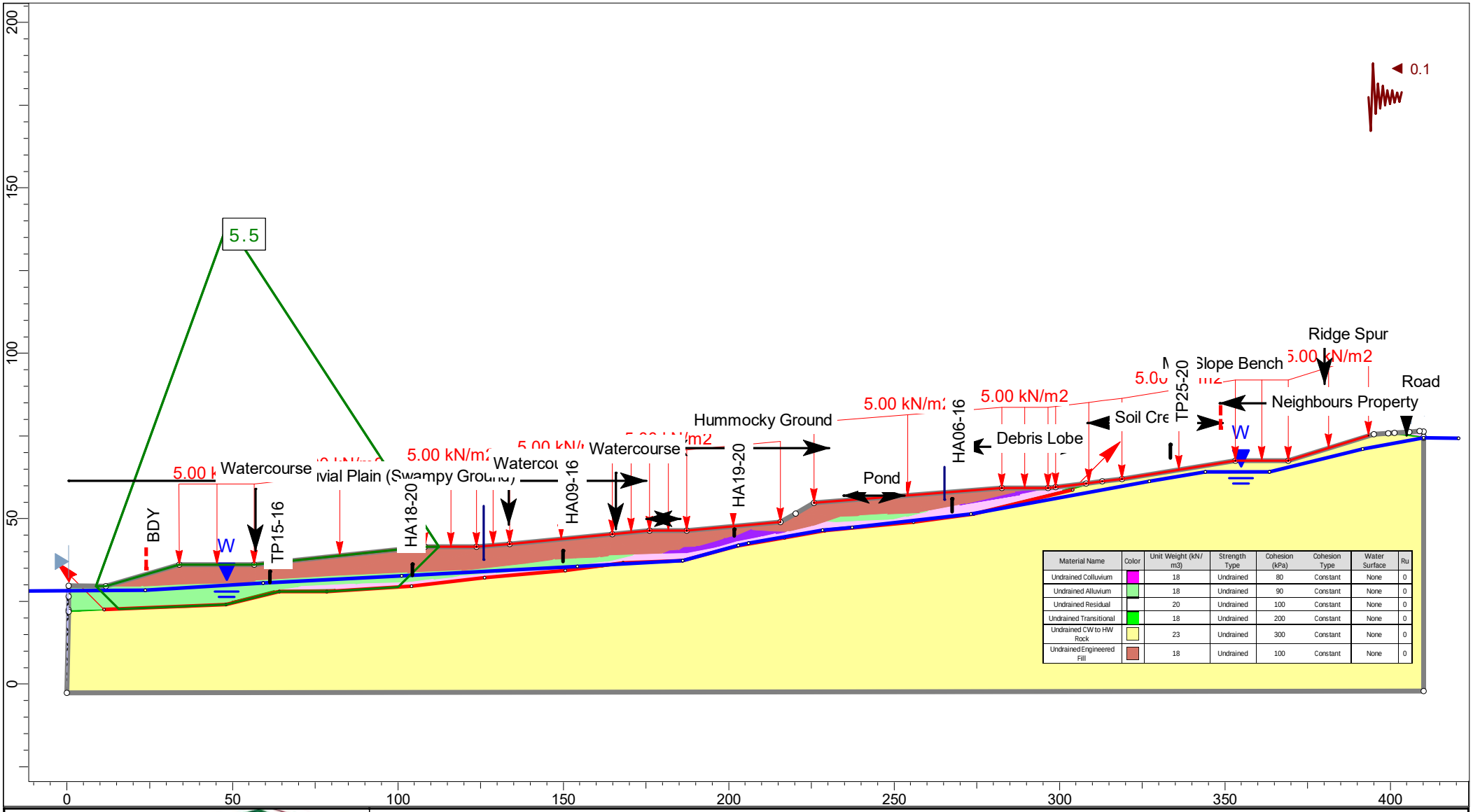
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section F - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Colluvium		18	Undrained	80	Constant	None	0
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		20	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

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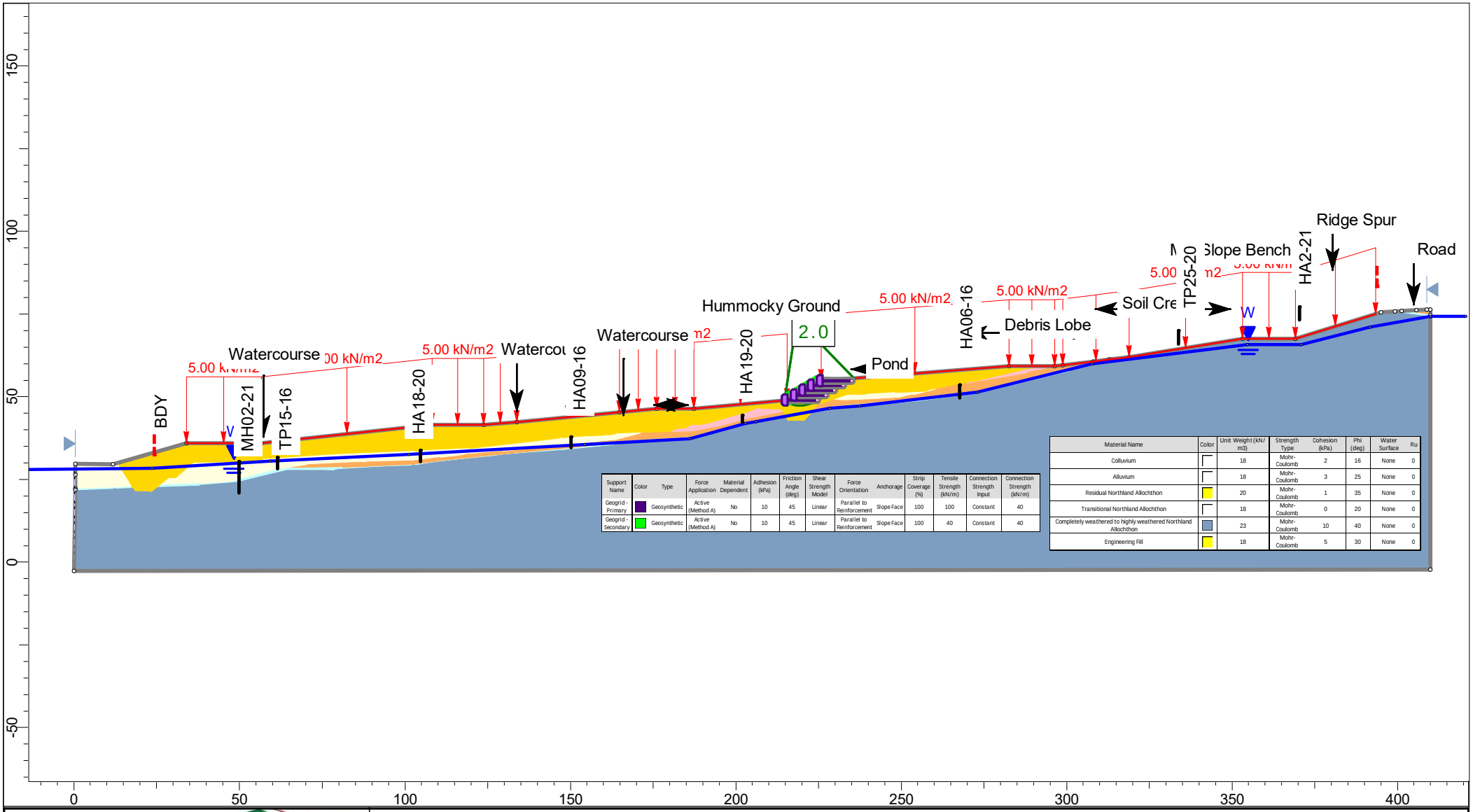
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section F - Proposed Profile, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Colluvium		18	Mohr-Coulomb	2	16	None	0
Alluvium		18	Mohr-Coulomb	3	25	None	0
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineering Fill		18	Mohr-Coulomb	5	30	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

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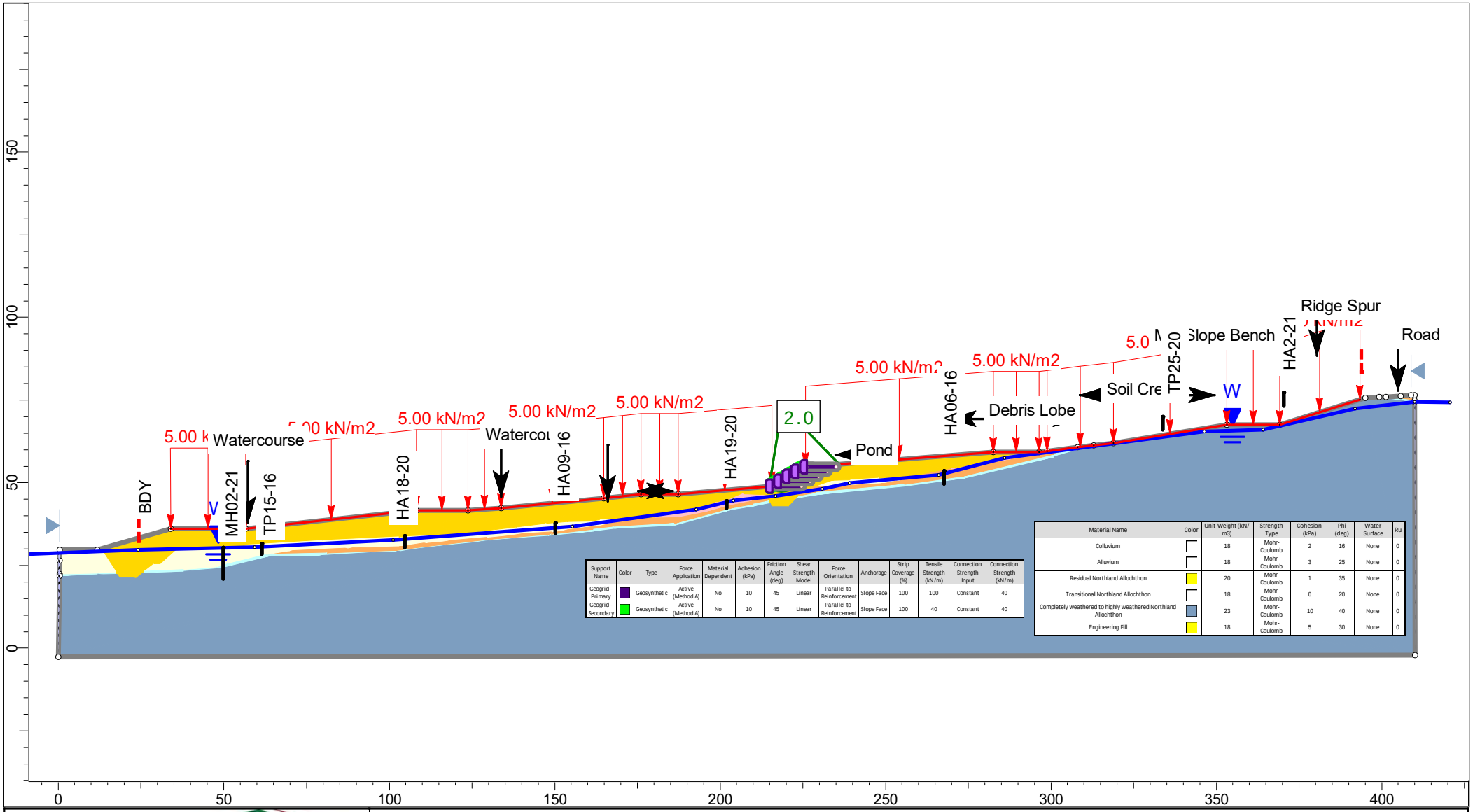
SLIDEINTERPRET 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section F - Remediated, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Colluvium		18	Mohr-Coulomb	2	16	None	0
Alluvium		18	Mohr-Coulomb	3	25	None	0
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineering Fill		18	Mohr-Coulomb	5	30	None	0

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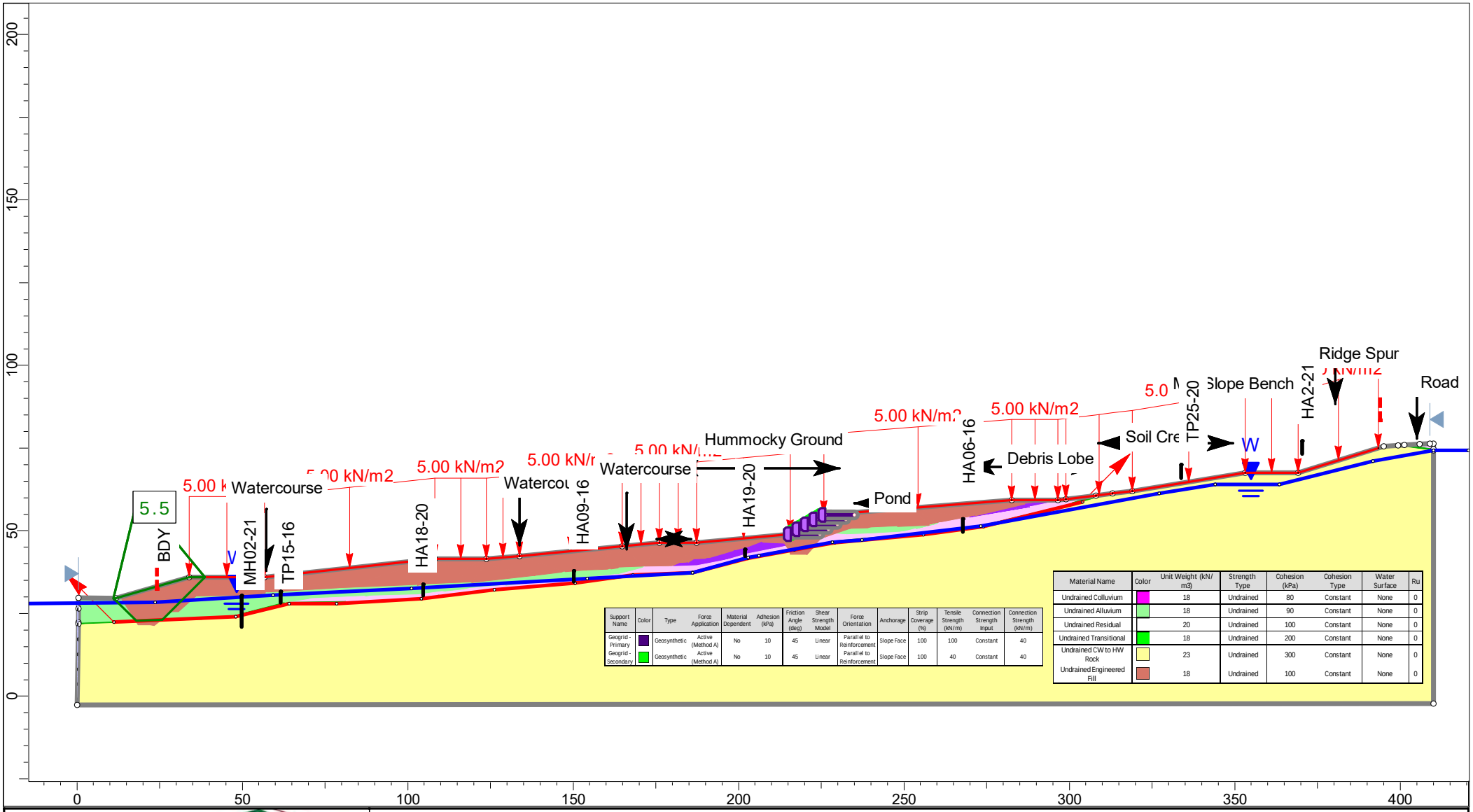
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section F - Remediated, High Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Colluvium		18	Undrained	80	Constant	None	0
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		20	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section F - Remediated, Seismic		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
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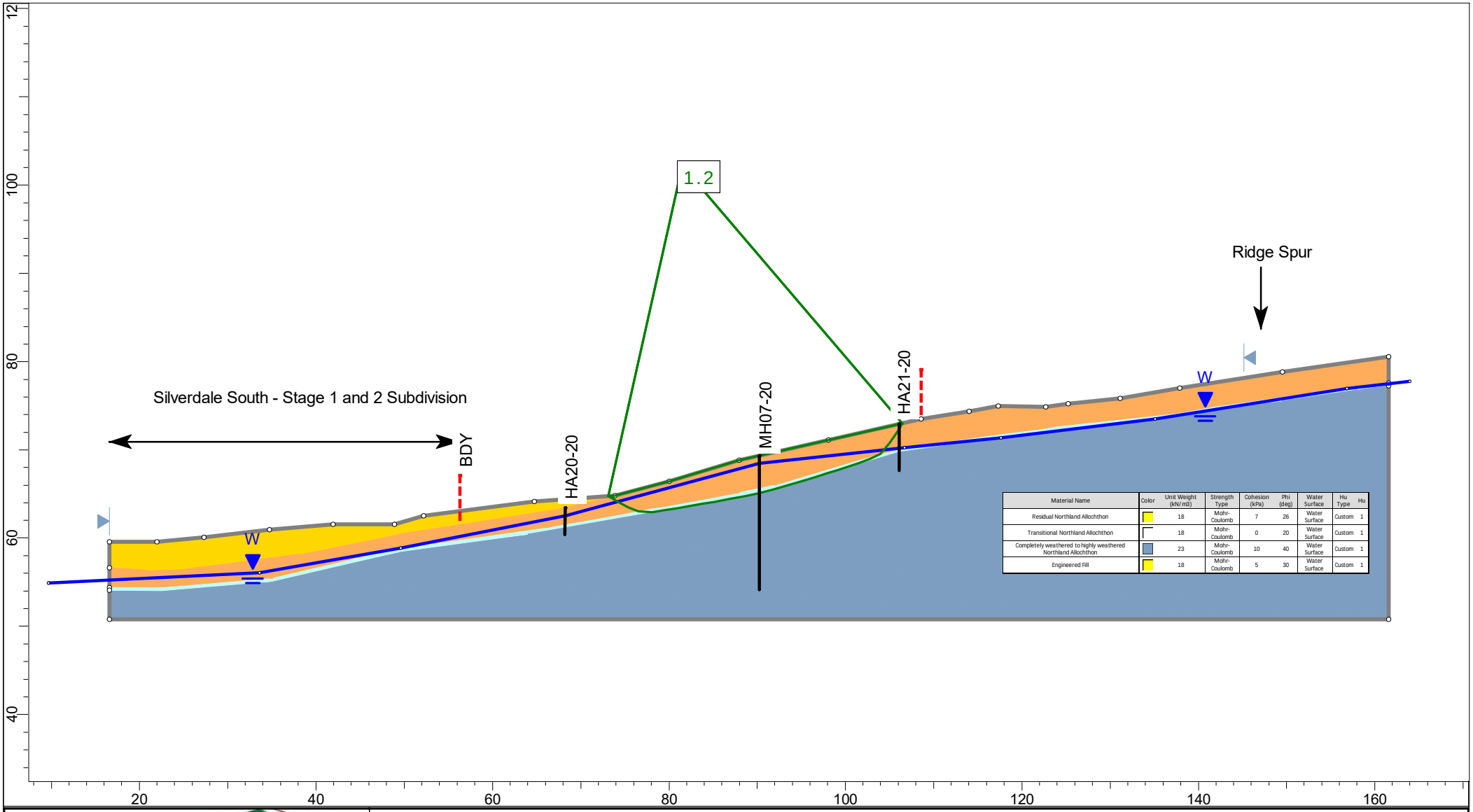

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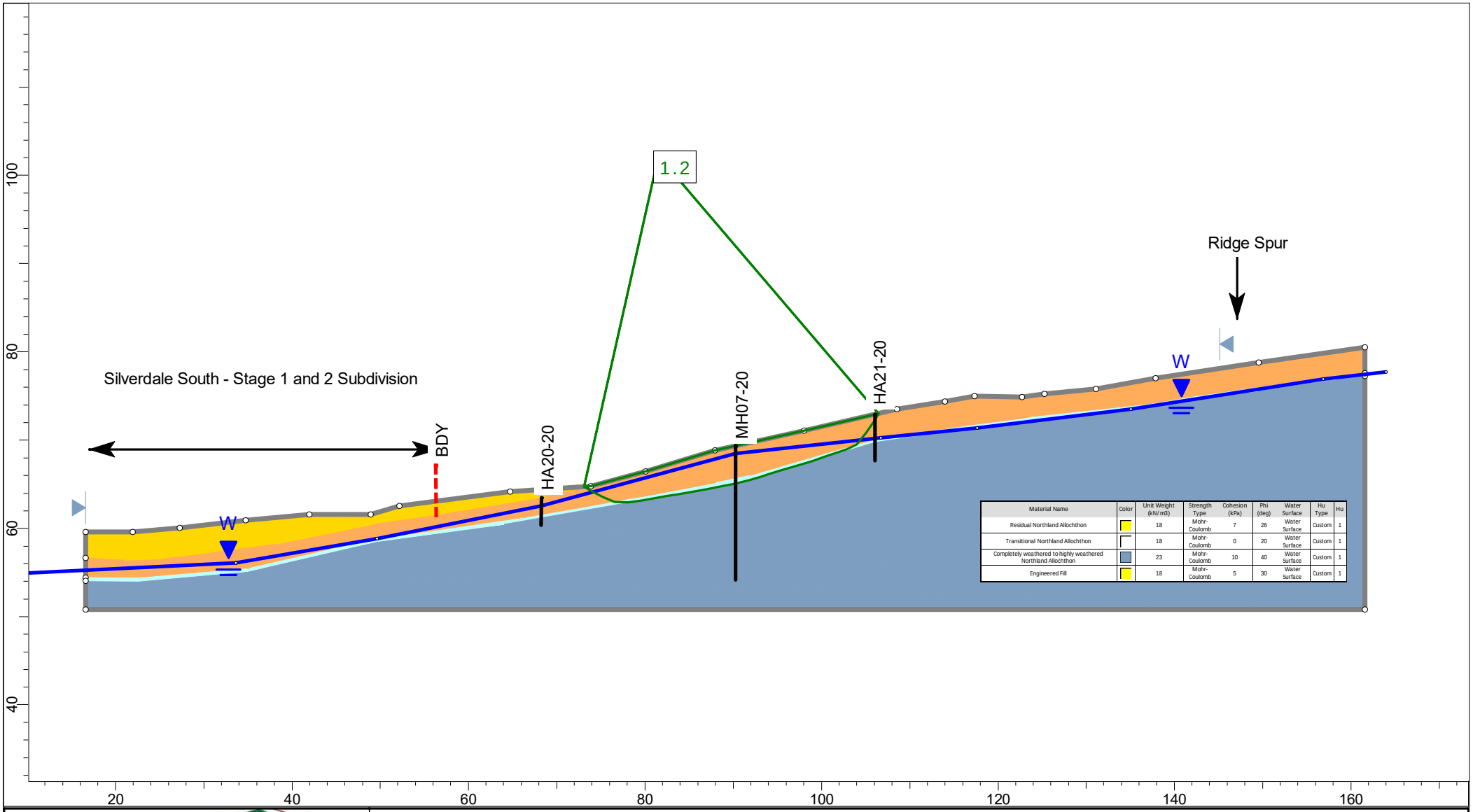
SLIDEINTERPRET 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Existing Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
			File Name	AKL2020-0125 Section G 20082021 SP.slmd



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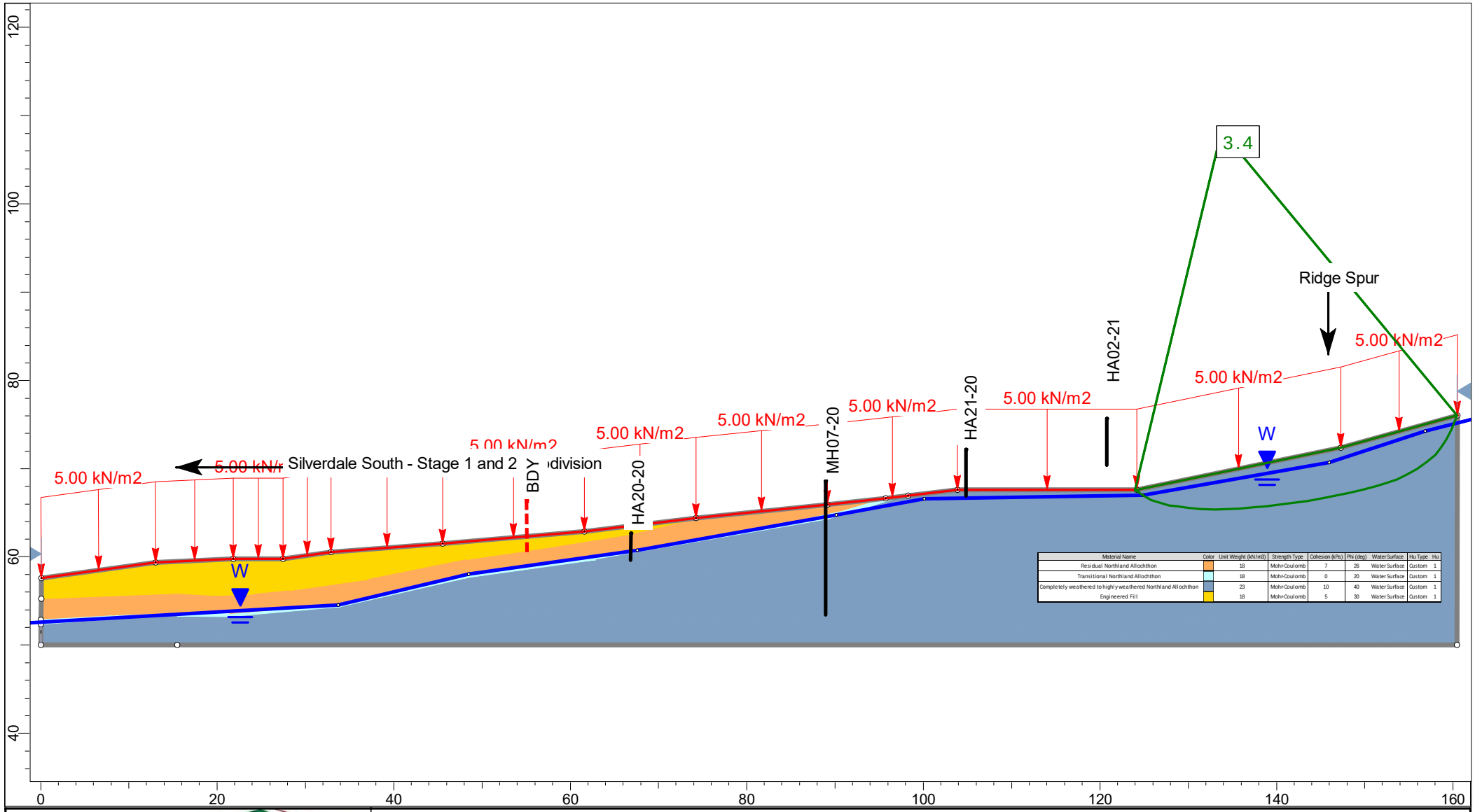
SLIDEINTERPR 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
			File Name	AKL2020-0125 Section G 20082021 SP.slmd



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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
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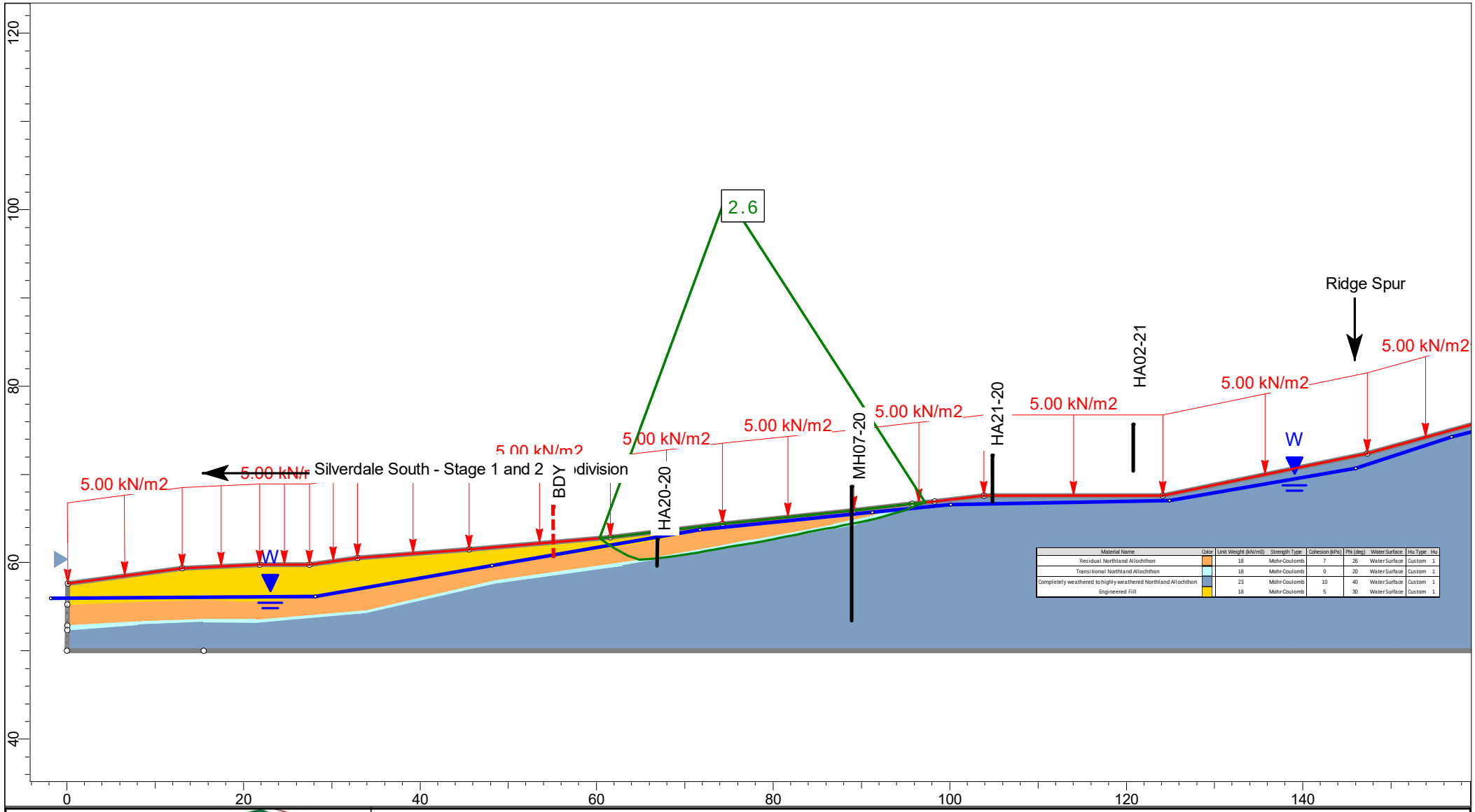

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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
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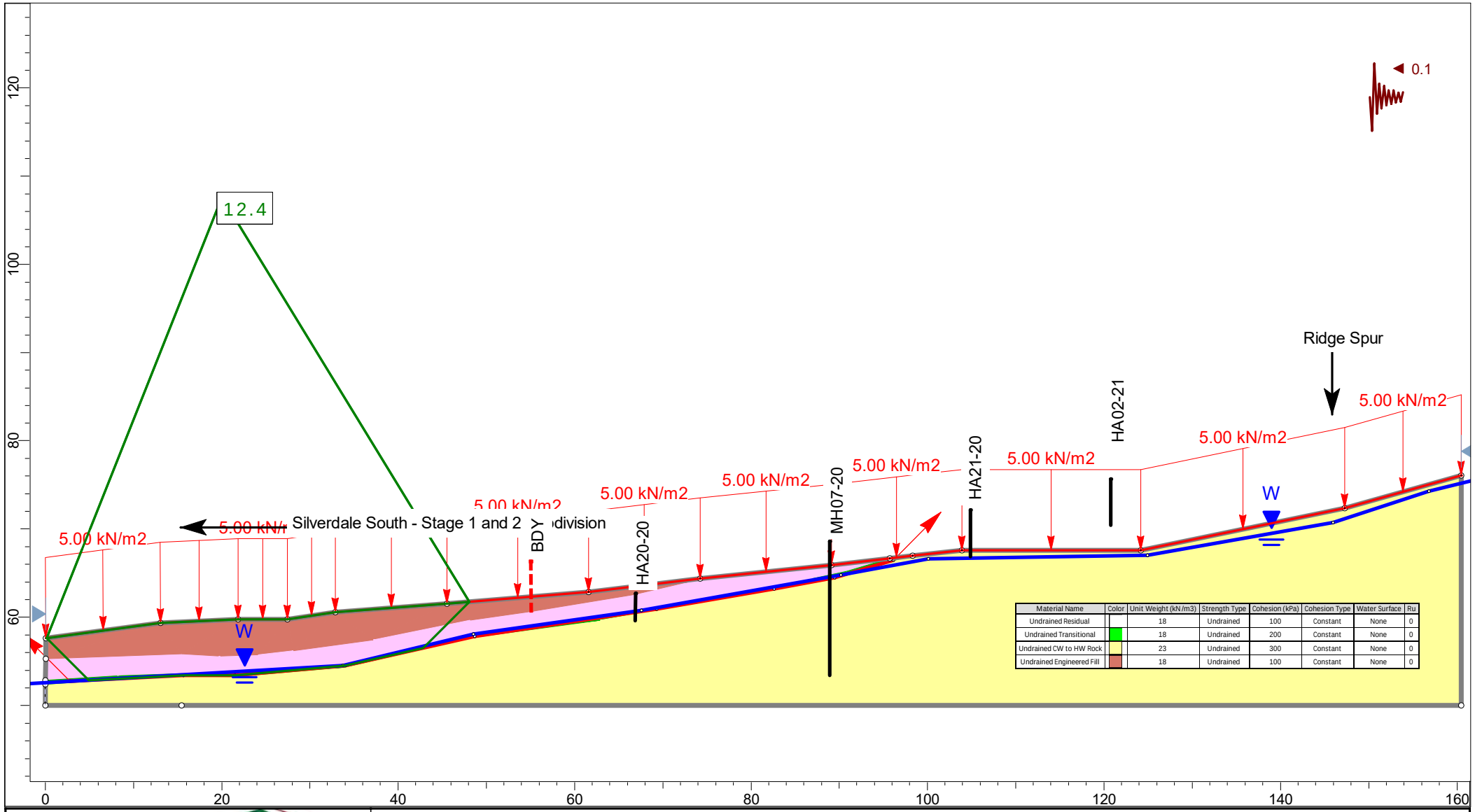

CMW Geosciences

SLIDEINTERPR 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, Seismic			
Drawn By: SP	Date: 6/09/2021	Scale 1:600	Company	Build Rich
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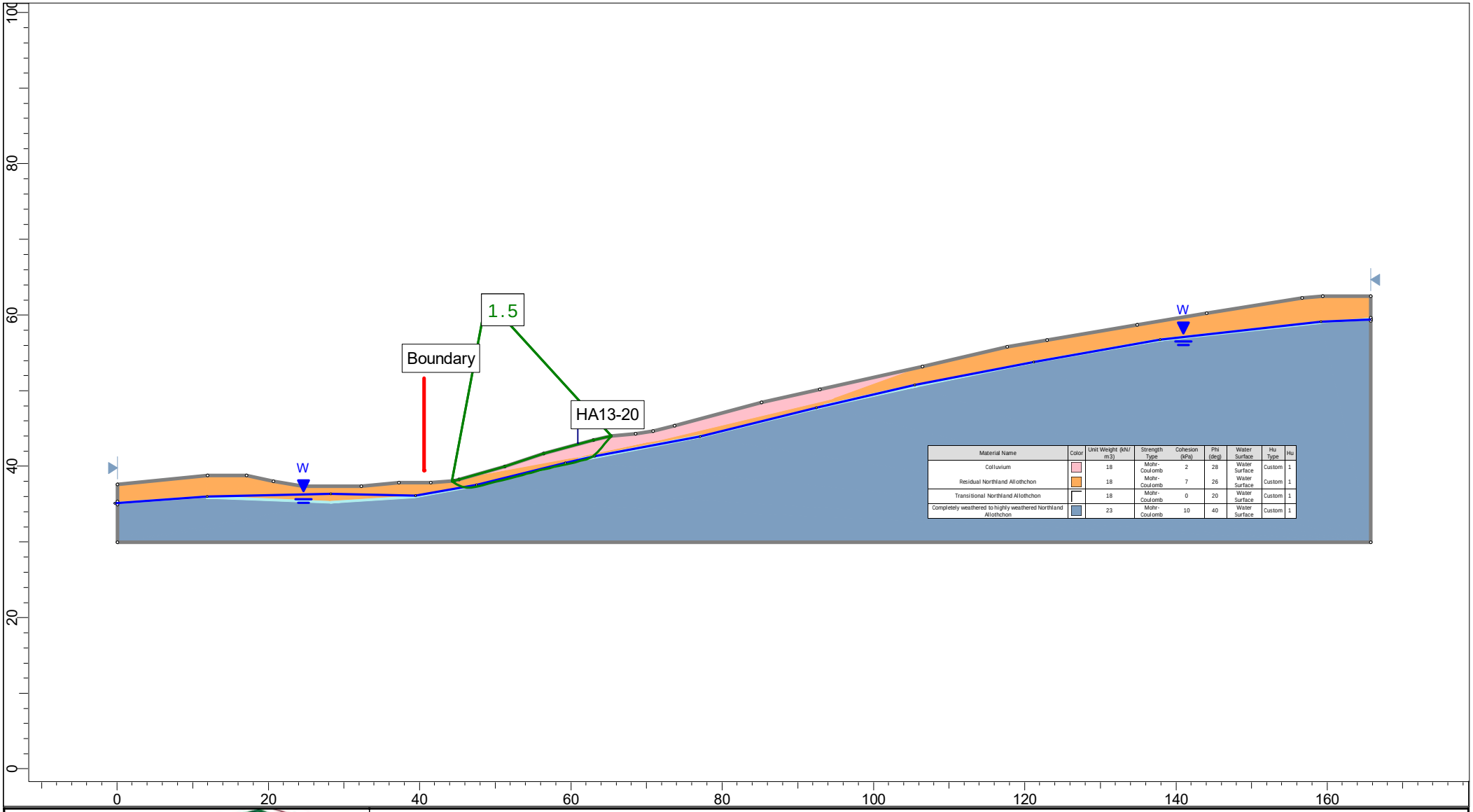

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Existing, NGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
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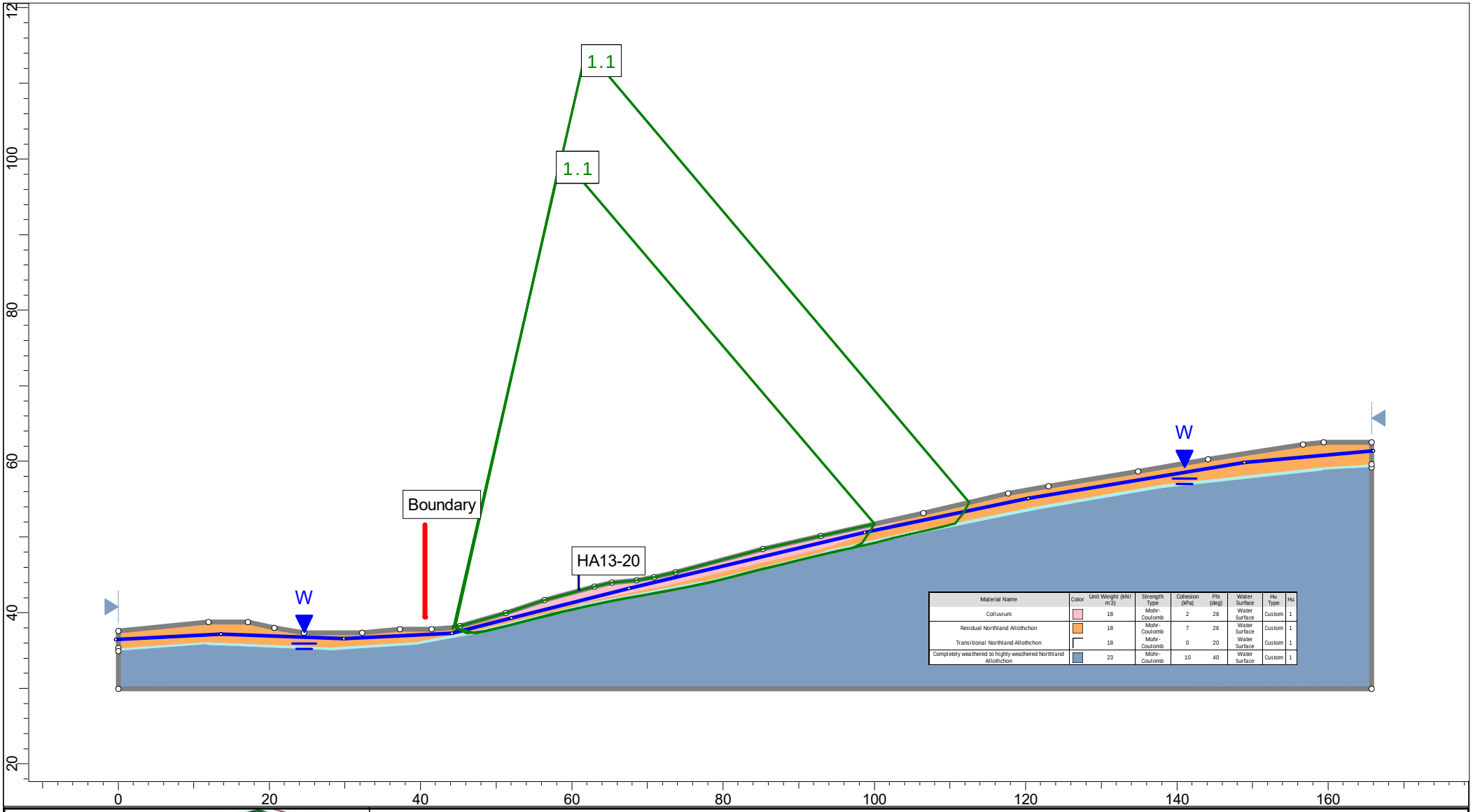
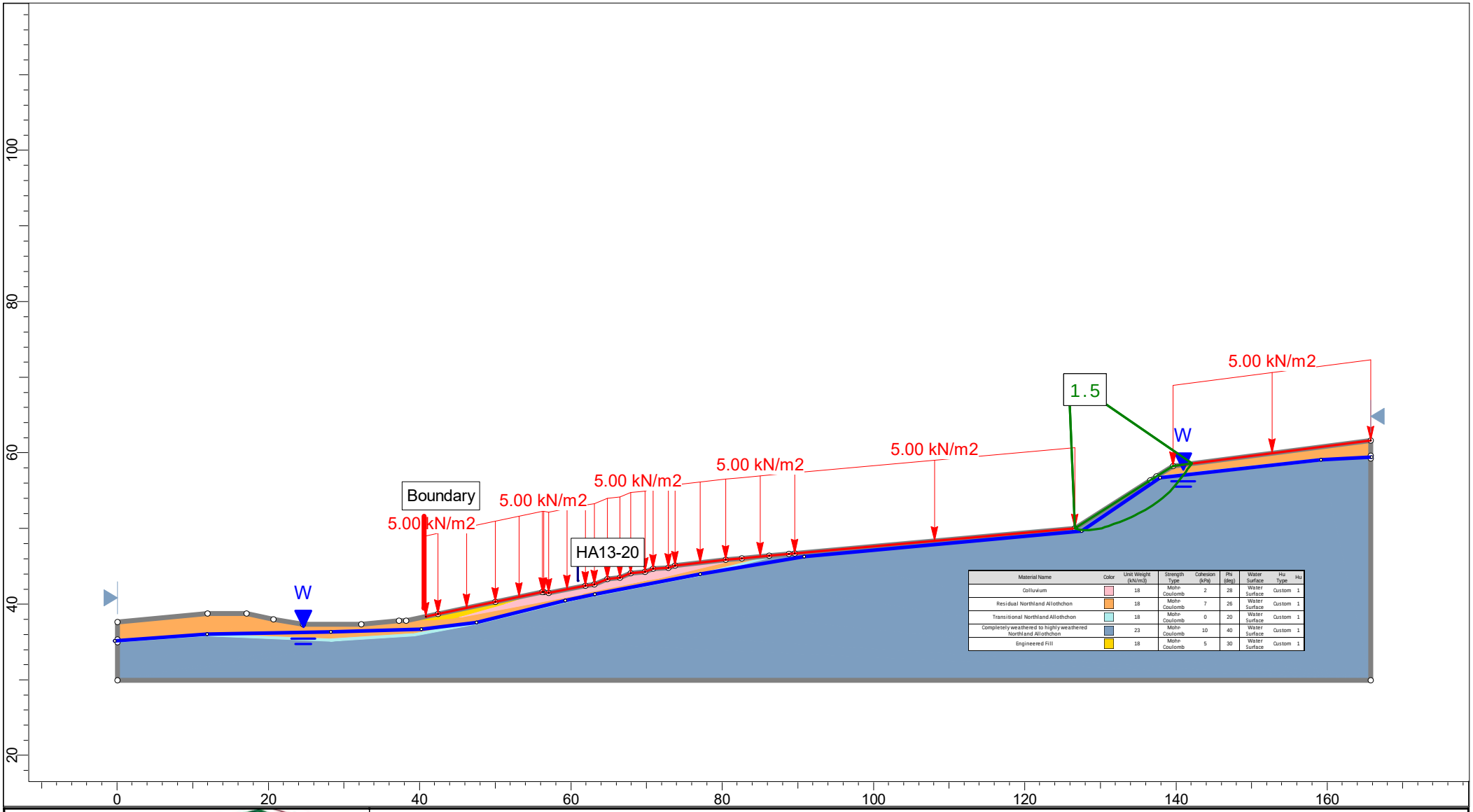


CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Existing, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd

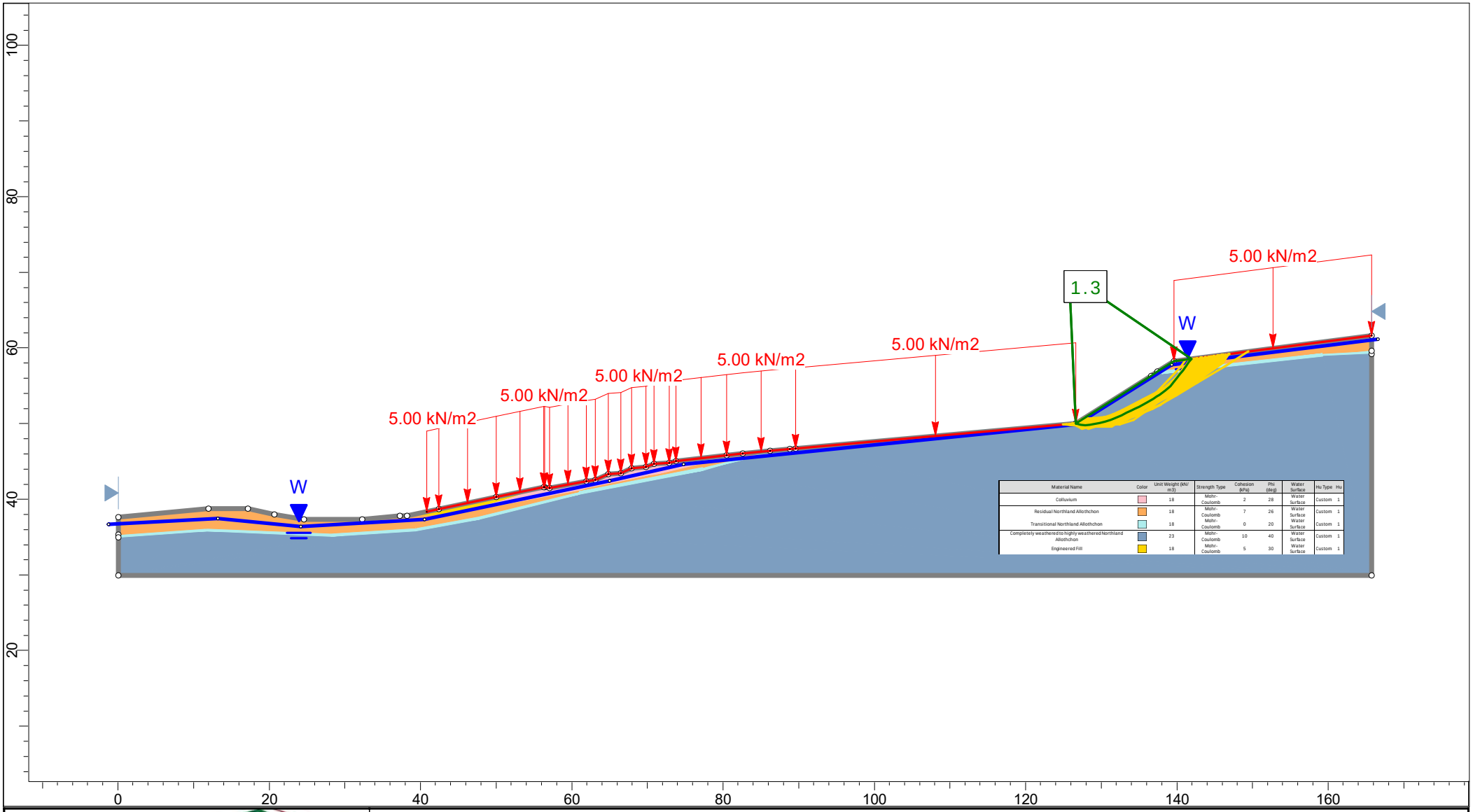


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, NGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



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SLIDEINTERPRET 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
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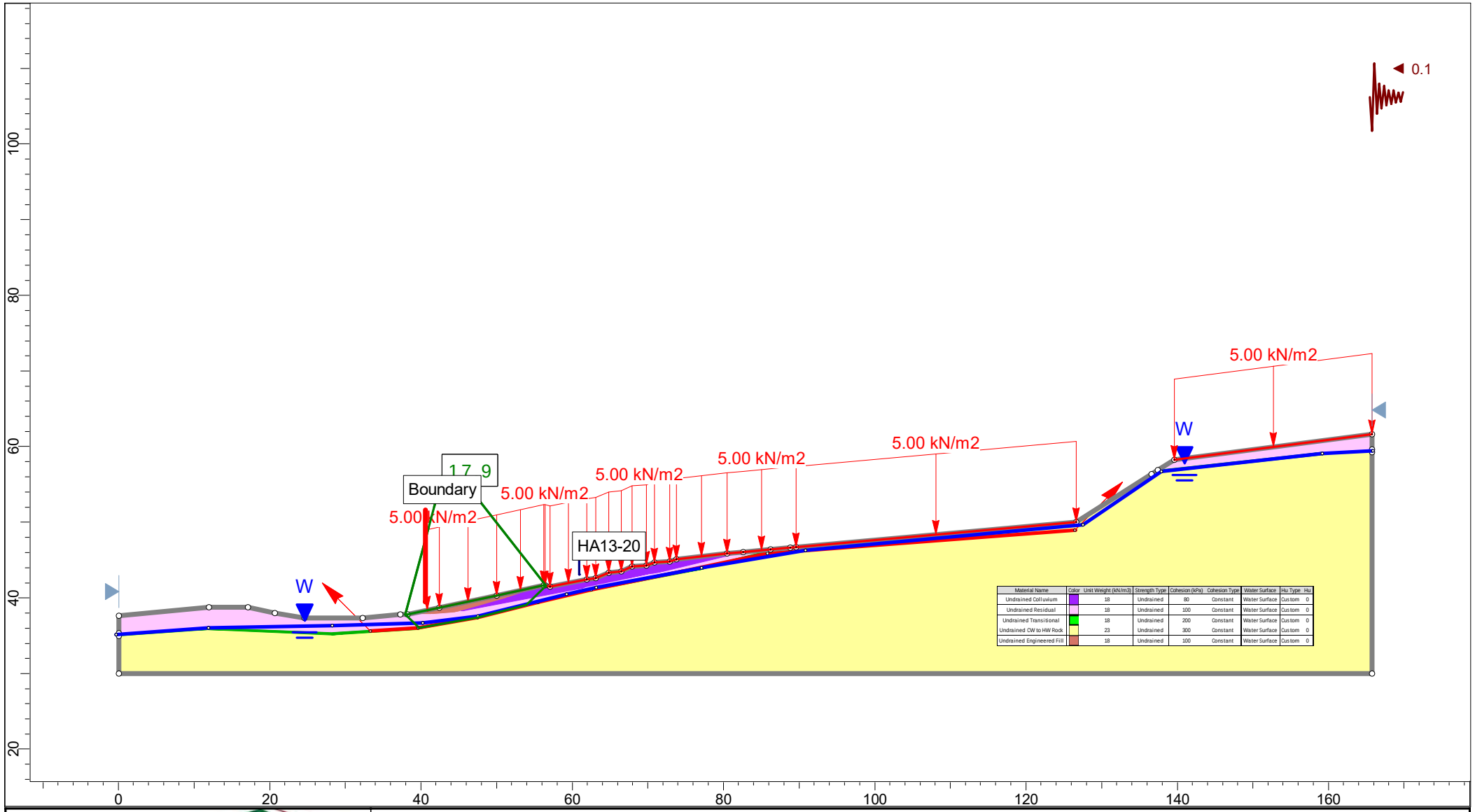
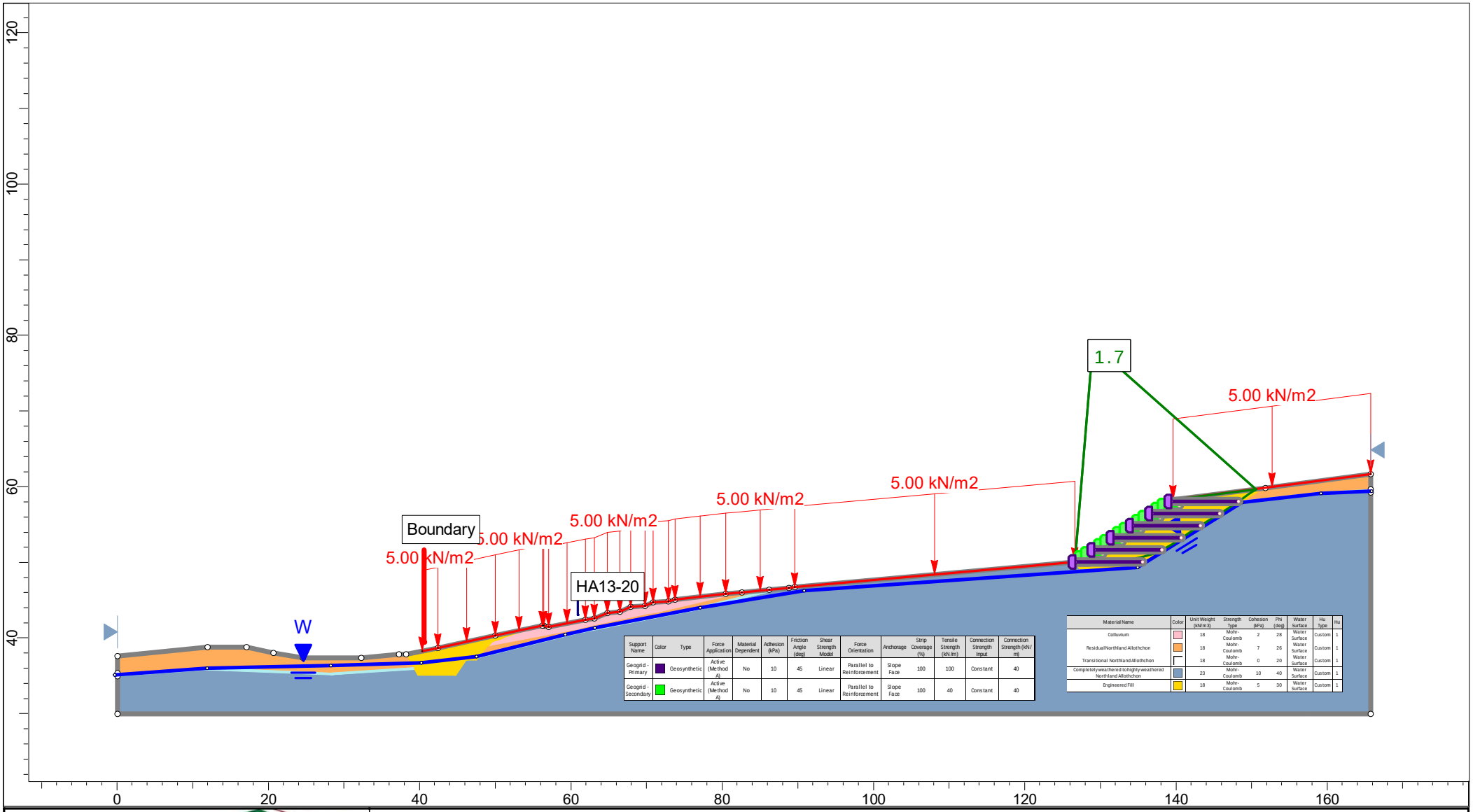


CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, SEISMIC			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



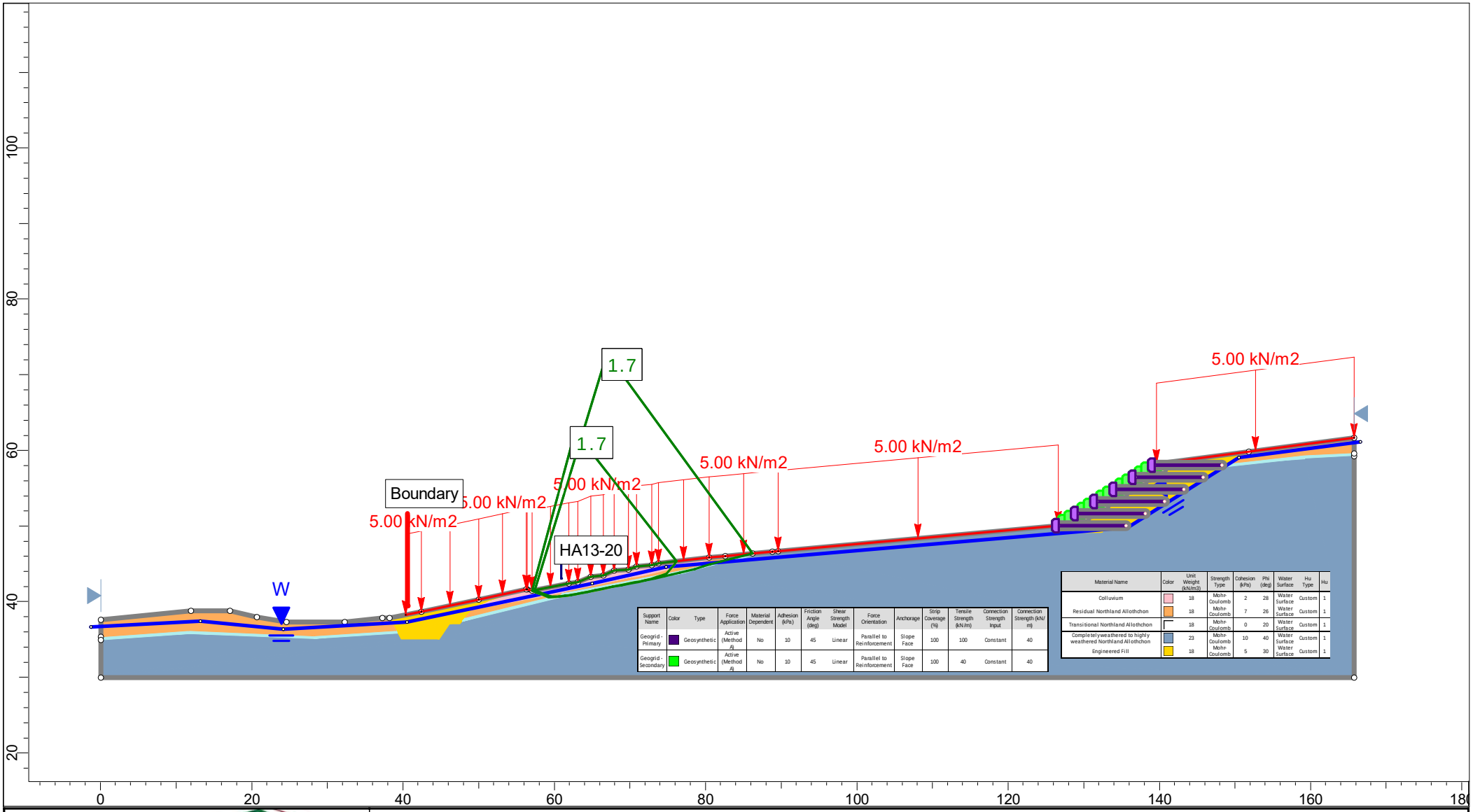
Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section H - Remediated, NGW		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company* Build Rich
			File Name Section H 31082021 SP.slmd



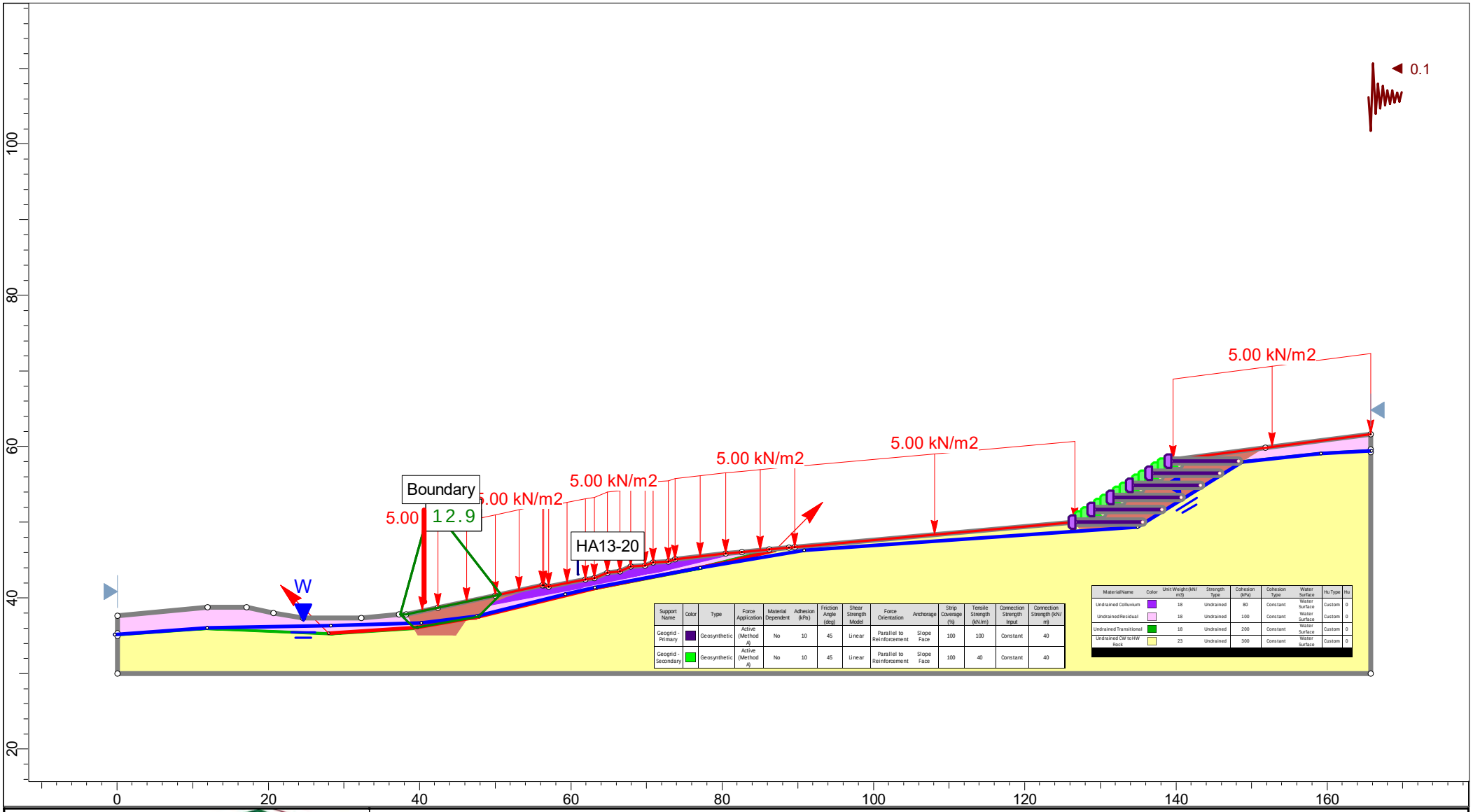
Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Remediated, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Colluvium		18	Undrained	80	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section H - Remediated, SEISMIC		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company* Build Rich
			File Name Section H 31082021 SP.slmd

Appendix E: Groundwater Assessment

Project no:

AKL2020-0125

Project name:

Silverdale South - Stage 3/4

Assessment of geotechnical aspects of proposed development with respect to the Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.6. Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10

Condition		Geotechnical Interpretation of Compliance
	Non-Compliant	
1. The water take must not be geothermal water		1. Groundwater is not geothermal
2. The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock		2. There are no peat soils identified on this site. Impact Assessment: Subsoil drains are to be installed that will follow existing alignments of surface water channels etc. Any groundwater intercepted will be returned to stream and/or wetlands in the same locations as present.
3. The water take must only occur during construction		3. Refer to impact assessments within this document.

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.10. Diversion of groundwater caused by any excavation, (including trench) or tunnel

Condition		Geotechnical Interpretation of Compliance
1.All of the following activities are exempt from the Standards E7.6.1.10(2) – (6)	Non-Compliant	
a. pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2m in external diameter		a. No pipes greater than 1.2m diameter are proposed.
b. pipes including associated structures up to 1.5m in external diameter where a closed faced or earth pressure balanced machine is used		b. Not proposed for this site.
c. piles up to 1.5m in external diameter are exempt from these standards		c. Not proposed for this site.
d. diversions for no longer than 10 days; or		d. Earthworks excavations will exceed 10 days. Impact Assessment: Significant cuts are proposed from the north-eastern corner of the site within the ridgeline and in the centre of the northern boundary that will exceed 10 days of operation. Overall groundwater levels will likely be lower in the northern elevated area as part of these operations.
e. diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is no longer than 10 days		e. Service trenches are to be open no longer than 10 days.
2.Any excavation that extends below natural groundwater level, must not exceed:	Non-Compliant	
a. 1ha in total area; and		a. Area is greater than 1 ha (refer to cut to fill plan)
b. 6m depth below the natural ground level		b. Maximum cut depth of 12.5m proposed Refer to Impact Assessment at 1(d) above.
3.The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	Non-Compliant	3. The proposed earthworks plan indicates an area adjacent to East Coast Road where significant cuts are proposed that could potentially lower the ground water by up to 1m at the boundary. However the proposed 11.0m cut here ties into the existing level of the road. Impact Assessment: No detrimental impact on the neighbouring property. Deep subsoil drains are proposed to be installed within this cut. The design of these however (depth/location) will ensure that they facilitate the ongoing, unimpeded progress of groundwater from the surrounding land. Termination of these subsoil drains no closer to the boundary then 10m to the boundary in these low permeability soils will ensure that they do not lower the groundwater across the boundary by 2m or more. Cut of approximately 5.0m is proposed along the western boundary. Impact Assessment: Groundwater was recorded in this area at 4.8m and therefore drawdown within this cut is not likely to be a risk along the boundary. The proposed cut is through a ridgeline and bare land is present on the extension of the ridgeline into the neighbouring property. The cut will be battered down into the site but due to the depth of recorded groundwater lowering of the groundwater table here is considered unlikely.
4.any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the si must not:	Compliant	
a. impede the flow of groundwater over a length of more than 20m; and		a. No potentially groundwater impeding structures of this nature are proposed for this site
b.extend more than 2m below the natural groundwater level.		b. No potentially groundwater impeding structures of this nature are proposed for this site
5.The distance to any existing building or structu re (excluding timber fences and small structures on the boundary) on an adjoining site from the edge	Compliant	
a.trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation		a. Adjacent infrastructure offset at least the depth of the excavation
b.tunnel or pipe with an external diameter of 0.2 - 1.5m that extends below natural groundwater level must be 2m or greater; or		b. Adjacent infrastructure and strutures are offset at least 2m
c.a tunnel or pipe with an external diameter of up to 0.2m that extends below natural groundwater level has no separation requirement.		c. Noted
6.The distance from the edge of any excavation that extends below natural groundwater level, must not be less than:	Compliant	
a.50m from the Wetland Management Areas Overlay		a. Greater than 50m from any Wetland Management Overlay
b.10m from a scheduled Historic Heritage Overlay; or		b. Greater than 10m from any Historic Heritage Overlay
c.10m from a lawful groundwater take.		c. Greater than 10m from any groundwater take

29 September 2021

Project: Silverdale South Stage 3/4

Client: Build Rich Limited

Project No: AKL2020-0125

1 GROUND WATER DRAWDOWN CALCULATIONS

Assume ground water drawdown of 1.6m along the Eastern boundary.

Hmax = 1.6m (Excavation and GW @ 0.9mbgl)

$R_o = C*h*k^{0.5}$ (CIRIA 113, 1986)

C = 2000

K = 10^{-7}m/s

R_o = 2000 x 1.6 x $\sqrt{10^{-7}}$

= 1.01m

Groundwater in HA20-20 recorded at 0.9m. Excavations along the eastern boundary (approx.) from earthworks contours estimated at 2.5m.

Appendix F: Geotechnical Work Specifications

19 May 2021 Document Ref: AKL2020-0125AE Rev.0

Land Development Geotechnical Works Specification

For: Silverdale South, Stage 3 & 4

1 INTRODUCTION AND SCOPE

This specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Investigation Report (GIR), referenced AKL2020-0125AB Rev.0. It supplements the information provided on the design drawings and GIR. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling;
- Geotechnical stabilisation works such as shear keys and stability undercuts;
- Subsoil drainage installation;
- Cut to fill earthworks operations;
- Fill materials and testing requirements;
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Excluded from the scope are geotextile reinforced slopes with a face and steeper than 30 degrees or retaining structures covered by a building consent. Such works will be carried out in accordance with an independent structure specific specification.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met in order for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the works.

2 RELEVANT DOCUMENTS

2.1 Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines and consents:

1. Health and Safety at Work Act 2015 and Regulations 2016;
2. All Project Resource Consent Conditions and Engineering Works Approvals;
3. The applicable Council Infrastructure Design Standard;
4. The Auckland Council, Erosion and Sediment Control Guidelines – Guidance document 2016/005;
5. NZS 4431:1989 Code of Practice for Earth Fill for Residential Development;

6. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes; and,
7. NZS 4404: 2010 Code of Practice for Urban Land Subdivision.
8. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2 Geotechnical Investigation Report

Details of the geotechnical investigation, soil and rock conditions encountered, and the design of the geotechnical remedial works are contained in the CMW report AKL2020-0125AE Rev.0. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3 Construction Drawings

The works shall comply with the following geotechnical design drawings and standard details:

- Aspire Consulting Engineers, 2182 East Coast Road, Silverdale (Stage 3 & 4) – Drawing number 1625 – RC – PG103 to 104 and EW201 to 202, dated March 2021.

2.4 Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3 GEOTECHNICAL OBSERVATION REQUIREMENTS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

1. Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement;
2. Shear key excavations and undercuts to confirm depth and extents prior to backfilling;
3. Subsoil drain excavations prior to placement of aggregate;
4. Any imported soil fill materials prior to placement on site;
5. Drainage aggregate quality prior to placement;
6. Geotextile layers once in place and prior to backfilling;
7. Filling placed at regular intervals to comply with the fill test frequency requirements below;
8. Compaction of backfilling in critical service trenches;
9. Flushing of the subsoil drainage system at the completion of earthworks;
10. Any unforeseen ground conditions that may impact on the construction works or future land use; and,

It is the contractor's responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

24 hours is considered reasonable notice.

4 SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as undercuts, temporary excavations, steep fill batters, shear key excavations, deep and shallow subsoil drains as specified in the Geotechnical report and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent part in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

Our SiD risk assessment is presented in ***Appendix G*** to our report referenced AKL2020-0125AB Rev.0. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

5 TEMPORARY BATTERS AND EXCAVATION STABILITY

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation;
- Over steepening of slope angles in temporary batters;
- Geological defects in the soil or rock mass, particularly where these are exposed in excavation faces;
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer (i.e. undisturbed rock) due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.

To help mitigate these risks the contractor should consider:

- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present and the earthworks equipment and methodology used;
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work;
- Benching or battering back of excavation faces;
- Ensuring good control of surface water runoff above excavations and batters;
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time;
- Avoiding loading the crests of slopes and excavations (including loading with working plant);
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability;
- Carrying out regular inspections upslope of excavations and of the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,

- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

6 CONSTRUCTION SPECIFICATION

6.1 Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings, and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

6.2 Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

6.3 Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

6.4 Fill Foundations and Benching of Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground.

This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

6.5 Shear Key, Fill Drainage Key and Buttress Fill Excavations

All shear keys, fill drainage keys and buttress fills required to improve long term stability conditions are to be constructed in accordance with the design drawings and standard details. The key/buttress base width, lateral extent and benching requirements need to be confirmed on site by the Geotechnical Engineer during construction. In most cases this requires detailed logging of the excavation faces by a geo-professional and may require trial pits to be dug in the base of the excavation. The contractor should make allowance for the time and plant required for these inspections in their work programme.

6.6 Fill Materials and Conditioning

6.6.1 Soil Fill, Rock Fill or Soil and Rock Mixed Fill

Site won materials used as engineered filling shall be free of topsoil, organic matter, rubbish and other unsuitable materials. The maximum particle size for soil and rock blended fill shall be 200mm and mixing and/ or crushing shall be carried in a manner that ensures that significant voids are not present in the filling between rock fragments.

For rock fill without soil blending, crushing is to occur to comply with the requirements for blended fills and needs to ensure that uniform compaction can occur without significant voids between particles in the absence of the soil fill.

6.6.2 Blending of Unsuitables

The blending of ‘unsuitables’ into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid inorganics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g. concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/ depth of blended fills within any specified fill area.

6.6.3 Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

6.6.4 Material Conditioning

The cut materials on site may require some drying prior to compaction to achieve the required specification. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

6.7 Fill Placement, Compaction and Testing Requirements

6.7.1 Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied. Alternative methods based on specified compaction techniques may be selected by the Geotechnical Engineer if the method below is considered inappropriate due to the granular nature of the materials.

There are three classes of filling defined:

1) General Fill: Structural engineered fill which does not fall into either of the other two classes below;
2) High Strength Fill: Where specified on the drawings or GDR. Typically used for critical batter faces, shear keys and road subgrades;
3) Landscape Filling: Lower strength filling (than General Filling) may be specified on a case by case basis by the Geotechnical Engineer where the strength and properties of General fill is not required and such filling is approved by the client and regulatory authorities.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

The test criteria and frequency for cohesive materials (Clays & Silts) are set out in Table 1 and 2 below. If non cohesive soils (i.e. Sands) are to be placed as engineered fill the matter should be referred to the Geotechnical Engineer to define the testing requirements.

Table 1 – Cohesive Materials (soil fill and soil/ rock blended fill) Compaction Test Criteria for Engineered Filling:

	Air Voids [1]		Vane Shear Strength [2]		Moisture Content[3]	Dry Density[3]
	Average	**Maximum Single Value**	**Average**	**Minimum Single Value**	**Maximum**	**Minimum**
General Fill	10%	12%	140 kPa	110 kPa	40%	1.25 t/m^3
High Strength Fill	8%	10%	150 kPa	120 kPa	40%	1.3 t/m^3
Landscape Fill	TBC by Geotechnical Engineer of case by case basis					

[1] Air Voids Percentage (as defined in NZS 4402:1986)

[2] Undrained Shear Strength (Measured by hand shear vane – calibrated using NZGS 2001 method)

[3] Moisture content and minimum dry density non-compliance may be accepted on site by the Geotechnical Engineer on a case by case basis depending on the nature of the material and the other criteria results.

Table 2 – Cohesive Materials (soil fill and soil/ rock blended fill) Compaction Testing Frequencies for Engineered Filling:

	Field Density & Air Voids %	Vane Shear Strength	Solid Density	Compaction Curve
General Fill	1 test per 1500m^3 of fill placed with not less than 1 test per 500mm lift of filling for each area.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling for each fill area.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
High Strength Fill	1 test per 1000m^3 of fill placed with not less than 1 test per 500mm lift of filling and for each 50m length of shear key excavation.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling per 25m of shear key excavation.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
Landscape Filling	TBC by Geotechnical Engineer of case by case basis			

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.7.2 Site Won Rock Fill

A compaction specification is to be determined by the Geotechnical Engineer based on site trials.

6.7.3 Compaction Testing Reporting Requirements

1 All test location coordinates to be recorded by hand held GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis). Alternatively the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.

2. The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.

3. Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

6.7.4 Hardfill

A plateau compaction test shall be carried out on site under the supervision of the Geotechnical Engineer, for each type of hardfill placed to determine the achievable maximum dry density (MDD) with no more than 20% total voids unless a laboratory derived MDD can be provided. The Geotechnical Engineer shall be given the opportunity to approve the size and type of compaction equipment to be used prior to any plateau testing.

Hardfill shall be placed and compacted to 95% of the MDD determined from the plateau test or laboratory MDD. If these conditions are not able to be met then appropriate adjustment of the moisture content or compaction equipment will be required.

In all cases, the dry density of the compacted fill at any one test site shall be not more than 5% below the minimum and the average of the dry densities of any ten consecutive test sites shall not be less than the specified minimum.

The Geotechnical Engineer may at their discretion, alter the compaction specification to a method compaction specification based on the plateau test result for materials with a maximum particle size greater than 65mm.

The test frequency shall be 1 test per 500m^3 of hardfill placed with not less than 1 test per 500mm lift of filling for each fill area.

The test frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.8 Subsurface Drainage

6.8.1 General

Drainage for shear keys, fill drainage keys, buttress fills, underfill gully drains and counterfort drains shall be constructed in accordance with the design drawings and standard details.

6.8.2 Materials

6.8.2.1 Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical

Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

6.8.2.2 Aggregate

Auckland Council now generally require that subsoil drainage has a 100-year design life and is essentially maintenance free, unless there is an entity such as body corporate or residents association that maintenance responsibility can be transferred to. Maintenance by individual owners is not practical as the subsoil drainage systems usually cross over, and generally benefit, multiple lots.

This requires a high quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter;
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is not critical to maintaining slope stability then a SAP20 or SAP50 may be used without a filter cloth wrap. Drains which fall into this category must be defined and confirmed as such by the Geotechnical Engineer. Additionally, where such materials are used, regular visual inspections and approval of the aggregate quality and laboratory grading curves is required. This is to comprise visual inspection of each site stockpile prior to material being placed in the trench. One wet sieve grading curve from each site stockpile per week is required while material is being imported to site to monitor the fines content. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is critical to maintaining slope stability then a TNZ/F2 or (approved) modified F2 aggregate must be used. In conjunction with this an approved high specification drainage pipe with filter cloth surround such as the Megaflo products may be specified.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

6.8.2.3 Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

6.8.2.4 Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to

help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

The subdivision drain laying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place.

6.8.3 Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

6.8.4 Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals shown on the drawings or as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

6.9 Finishing Works and Topsoil Respread

6.9.1 Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

6.9.2 Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

6.9.3 Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

6.9.4 Road Subgrades

Testing and formation of road subgrades will be carried out as part of the subdivision civil works package.

7 MONITORING

7.1 Settlement

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for residential building development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is to be agreed with the Geotechnical Engineer during construction.

It is the contractor's responsibility to ensure the integrity of the monitoring points is maintained during the works.

To ensure appropriate quality settlement data is collected for analysis, the following principles and procedure for the works must be adhered to:

Instrument Installation:

- Instruments must be installed on the stripped surface prior to the commencement of surcharge filling to capture the full effects of the surcharging. Partial placement of surcharge and excavation back down to install an instrument is not acceptable.
- Upon installation, the instrument locations are to be fixed with GPS.
- The RL must be recorded by precise levelling at that time.

Surcharge Loading

- Unless instructed otherwise by the Geotechnical Engineer to avoid bearing capacity failure, it is important that surcharge filling is placed to its design height and full lateral extents in its entirety in a single, rapid operation to allow for measurement of a single settlement curve.

During construction:

- It is important that the surcharge surface RL is recorded and reported together with the instrument data.
- Readings must be taken monthly or per 1m fill or pre-load lift height, whichever is more frequent.
- GPS level readings can be taken during fill and pre-load construction.

Preload height:

- Within 48 hours of full preload height being achieved, the RL must be recorded by precise levelling and the full extent of the surcharge must be surveyed and provided to the Geotechnical Engineer as soon as possible.
- Fortnightly monitoring must be undertaken unless advised otherwise by the Geotechnical Engineer.

7.2 Groundwater

The assumptions made in the design of the slope stabilising works with regard to long term groundwater levels are important. It is therefore considered prudent to reinstall several of the groundwater monitoring piezometers removed during construction in key areas to confirm the assumption made in the design and the performance of the subsoil drainage network.

The location of these will be determined by the Geotechnical Engineer at the completion of the earthworks.

8 ASBUILT INFORMATION REQUIREMENTS

In order to provide a Geotechnical Completion Report (GCR) certain as-built information must be provided to CMW. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

1. The location and invert of all sub surface drainage; and,
2. The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided for the GCR:

1. Cut and fill depth plan (including undercuts and shear keys);
2. Final contour plan;
3. Drainage locations and inverts (surface and subsurface);
4. Drainage outlet locations (surface and subsurface);
5. Details of any defined overland flow paths;
6. Location and heights of any retaining walls and Mechanically Stabilised Earth (MSE) structures;
7. Position and extent of any geogrid layers (in plan view);
8. Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification; and,
9. Any settlement Monitoring Data.

Appendix G: SiD Risk Assessment

CMW Safety in Design Risk Assessment

AKL20200-0125, Silverdale Sout, Stage 3 & 4 - 19 May 2021

Design Element	Hazard	Description	Assessed Risk			Controls Incorporated in Design	Residual Risk		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Earthworks	Falling from height	Injury to construction staff while constructing steep temporary or permanent earthworks cut or fill faces.	4	3	12	Temporary barrier fence or other means to be used to ensure persons cannot access to the edge of steep excavations	4	2	8
	Striking underground services	Injury to construction staff if live services are struck.	5	3	15	All sites cleared for services prior to site investigations and earthworks construction	5	1	5
	Moving Machinery	Injury to construction staff.	4	3	12	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations.	4	2	8
	Working at edges of excavations	Injury to construction staff.	3	3	9	Install safety barriers, exclusion zones, signage as necessary to warn of hazard.	3	2	6
	Trench excavation collapse	Injury to construction staff or persons due to crushing/impact injury.	4	3	12	Follow Worksafe requirements, trench shields or benching of excavations to be used. No staff to enter the trench without appropriate and approved measures already in place.	4	2	8
	Cut / fill batter collapse	Injury to construction staff during construction.	4	3	12	Safe distances and appropriate temporary slope gradients and heights to be assessed prior to construction and monitored during to confirm as appropriate, safe distances and barrier fencing to be used on site where deemed necessary.	4	2	8
	Excessive noise during construction	Damage to hearing of construction staff or persons adjacent to the site.	3	3	9	Comply with appropriate allowances for noise on site, ear protection to be worn where appropriate, setback distances from adjacent sites or notified working hours to avoid conflict with adjacent property inhabitants.	3	2	6
	Machinery rollover	Machinery trafficability over soft, wet or uneven ground.	4	3	12	Appropriate construction of temporary haul roads, implement drainage and geofabrics, appropriate driver training.	4	2	8
	Contaminated Soils	Airborne or in-ground contaminants affecting construction staff.	3	3	9	Perform an Environmental assessment of the site prior to construction.	3	2	6

NOTE: It is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect).

Safety in Design Assessment Framework

Risk Matrix		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Event Will Occur 5	Medium 5	High 10	High 15	Extreme 20	Extreme 25
	Event Almost Certain to Occur 4	Low 4	Medium 8	High 12	Extreme 16	Extreme 20
	Event May Occur 3	Low 3	Medium 6	High 9	High 12	High 15
	Event Not Likely to Occur 2	Low 2	Low 4	Medium 6	Medium 8	High 10
	Event Rarely Occurs 1	Low 1	Low 2	Low 3	Low 4	Medium 5

Appendix H: Natural Hazards Risk Assessment

NATURAL HAZARDS RISK ASSESSMENT FOR LAND SUBDIVISION SILVERDALE SOUTH, STAGE 3 & 4

A. CONTEXT

Section 106 of the Resource Management Act (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land, other land or structures (consequence).

Section 2 of the RMA defines natural hazards as any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

This appendix to CMW report reference AKL2020-0125AH Rev.0 sets out the criteria for and presents the results of an assessment of the geotechnical-related natural hazards associated with this proposed subdivision development. The remaining hazards, i.e. tsunami, wind, drought, fire and flooding hazards are not covered by this assessment.

B. BASIS OF ASSESSMENT

B.1. Risk Classification

The occurrence of natural hazards and their potential impacts on the proposed subdivision development is assessed in terms of risk significance, which is based on likelihood and consequence factors. A risk table is used to help assess the likelihood and consequence factors, the form of which used by CMW for this project is presented in Table B1.

Table B1: Natural Hazard Risk Classification

Risk Matrix		Consequence				
		Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Likelihood	**Almost Certain 5**	Medium 5	High 10	Very high 15	Extreme 20	Extreme 25
	Likely 4	Low 4	Medium 8	High 12	Very high 16	Extreme 20
	Moderate 3	Low 3	Medium 6	Medium 9	High 12	Very high 15
	Unlikely 2	Very low 2	Low 4	Medium 6	Medium 8	High 10
	Rare 1	Very low 1	Very low 2	Low 3	Low 4	Medium 5

B.2. Likelihood

With respect to assessing the likelihood or chance of the risk occurring, the qualitative definitions used by CMW for this project are provided in Table B2 for each likelihood classification.

Table B2: Qualitative Natural Hazard Likelihood Definitions		
1	Rare	The natural hazard is not expected to occur during the design life of the project
2	Unlikely	The natural hazard is unlikely, but may occur during the design life
3	Moderate	The natural hazard will probably occur at some time during the life of the project
4	Likely	The natural hazard is expected to occur during the design life of the project
5	Almost Certain	The natural hazard will almost definitely occur during the design life of the project

B.3. Consequence

In terms of determining the consequence or severity of the natural hazard occurring, the qualitative definitions used by CMW for this project are provided in Table B3 for each consequence classification.

Table B3: Qualitative Natural Hazard Consequence Definitions		
1	Insignificant	Very minor to no damage, not requiring any repair, no people at risk, no economic effect to landowners.
2	Minor	Minor damage to land only, any repairs can be considered normal property maintenance no people at risk, very minor economic effect.
3	Moderate	Some damage to land requiring repair to reinstate within few months, minor cosmetic damage to buildings being within relevant code tolerances, does not require immediate repair, no people at risk, minor economic effect.
4	Major	Significant damage to land requiring immediate repair, damage to buildings beyond serviceable limits requiring repair, no collapse of structures, perceptible effect to people, no risk to life, considerable economic effect.
5	Catastrophic	Major damage to land and buildings, possible structure collapse requiring replacement, risk to life, major economic effect, or possible site abandonment.

B.4. Risk Acceptance

It is recognised that the natural hazard risk assessment provided herein is qualitative and, due to the wide range of possible geohazards that could occur, is somewhat subjective. Other methods are available to quantitatively assess an acceptable level of geotechnical related natural hazard risk, such as defining an acceptable factor of safety with respect to slope stability or acceptable differential ground settlements with respect to recommended building code limits.

Therefore, to give this qualitative natural hazard risk assessment some relevance to more commonly adopted numerical or quantitative geotechnical assessment techniques, a residual risk rating of very low to medium (risk value = 1 to 9 inclusive) is considered an acceptable result for the proposed subdivision development.

A risk rating of high to extreme (risk value ≥ 10) is considered an unacceptable result for the proposed subdivision development.

C. RISK ASSESSMENT

The natural hazards relevant to this proposed subdivision development and adjacent, potentially affected land have been assessed with respect to the criteria outlined above.

Assessment is based on proposed post development ground conditions with and without any geotechnical controls. The latent risk was first assessed with the site in its proposed developed state to consider the risks to the development and surrounding land, including assessment of land modifications from the pre-existing natural state, without any implemented geotechnical controls. The specific geotechnical mitigation measures and engineering design solutions outlined in the table below and CMW report, where relevant, were then considered to determine the natural hazard residual risk remaining after the proposed controls have been implemented.

Results of this assessment are presented in Table C1 below.

Table C1: Natural Hazard Risk Assessment Results

RMA S2 Hazard	Description	Proposed Site Latent Risk of Damage to Land / Structures			Comments and Geotechnical Control	Proposed Site Residual Risk of Damage to Land / Structures OR Acceleration/ Worsening of Hazard with Geotechnical Controls Implemented		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Earthquake	Fault Rupture	2	3	Medium 6	48km from closest active fault (Waikapua fault, Whitford)	2	3	Medium 6
	Liquefaction Induced Flooding and/ or Subsidence	2	2	Low 4	Shallow cohesive soils not susceptible to liquefaction	2	2	Low 4
	Lateral Spread	2	3	Medium 6	Shallow cohesive soils not susceptible to lateral spread	2	3	Medium 6
Volcanic Activity	Ash & Pyroclastic Falls	1	5	Medium 5	No active volcanic activity	1	5	Medium 5
	Lava flows & Lahars	1	5	Medium 5	No active volcanic activity	1	5	Medium 5
Geothermal Activity	Formation of geysers, hot	1	5	Medium 5	No geothermal activity. Closest geothermal	1	5	Medium 5

	springs, fumaroles, mud pools				location 10km north at Waiwera			
Erosion	Cut Batters	5	2	High 10	Max 1:3 gradient	2	2	Low 4
	Fill Batters	5	2	High 10	Surface water controls applied on batters and restrict gradients to 1:3. Geogrids to be used to construct MSE wall	2	2	Low 4
Landslip	Global Slope Instability	4	5	Extreme 20	Due to steep slope gradients and depth of fills, shear keys, palisade walls, shear piles and drainage are required to control global stability	1	5	Medium 5
	Soil Creep	5	4	Extreme 20	Batter gradients max 1:3. Geogrids to be used to construct MSE wall. Palisade walls and drainage.	2	4	Medium 8
	Bearing Capacity Failure	2	4	Medium 8	Undercut and replace and shear key	1	4	Low 4
	Cut & Fill Batter Instability	2	5	High 10	Surface water control, geogrids, facing system on MSE wall	1	5	Medium 5
Subsidence	Expansive Soils	4	3	High 12	Foundation design	2	4	Medium 8
	Soft Soils	5	3	Very High 15	Undercut and remove	2	3	Low 4
	Effects of Dewatering	3	3	Medium 9	Dewatering likely to occur in rock. Neighbouring dwellings far enough away not to be impacted	1	3	Low 3
Sedimentation	Rockfall, Debris Inundation	4	4	Very High 16	Palisade wall / barrier wall	2	4	Medium 8

Notes:

- Assessments include the impact of the proposed subdivision works on adjacent properties.
- The following reference(s) contain information on the hazards contained in this assessment and the non-geotechnical hazards that have not been included:
    - **Auckland**
      https://aucklandcouncil.maps.arcgis.com/apps/MapSeries/index.html?appid=81aa3de13b114be9b529018ee3c649c8