

GEOTECHNICAL ASSESSMENT

Client: Swanage Town Council

Swanage Seafront

Report No. 12660

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Version 1



SOUTH WEST GEOTECHNICAL

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1 INTRODUCTION

1.1 General

South West Geotechnical (SWG) was instructed by Swanage Town Council (the Client) to carry out a slope stability assessment on land at Swanage Seafront, Dorset.

This assessment comprises a desk study, intrusive investigation with associated geotechnical testing, installation monitoring and interpretive reporting. An important part of the investigation includes the installation and monitoring of inclinometers and groundwater monitoring standpipes in the boreholes.

It is understood that the Client is potentially planning to redevelop the site although, proposals have not been finalised and will be dependent in part, on the findings of this investigation.

1.2 Site Description

The site is located in the centre of Swanage, and forms the coastal transition zone between the town itself and the beach. The site is centred on National Grid Reference 403025, 79297. The site's location is shown on the Site Location Plan, Appendix A. A series of photos are contained in Appendix B and referred to in this Section and Section 2.2. Annotated Geomorphological Maps of the site are also included in Appendix B.

The overall site comprises a linear parcel of land trending north-south between De Moulham Road to the west, Shore Road to the east, and is split by Walrond Road, which runs east-west through the centre. It can be split into four definable sections by the various land uses:

The northern most section comprises a gently then steeply sloping grass area (again, from west to east) with a combination of steps and retaining walls which work their way down to Shore Road below. The entire slope is showing signs of gradual instability, including cracks within the path (see photo 2) and tilting of paving stones (see photo 3)

The northern central section comprises a largely terraced hillside upon which timber holiday cabins are situated. The slope has been extensively modified and terraced to

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accommodate the holiday cabins with steps and small (1-2m) to medium (~2-3m) retaining walls. The entire section displays signs of slope instability with the stone wall along the western boundary is tilting down slope (as seen on photo 1.) Several of the retaining walls exhibit cracks with sections of blockwork repaired and rebuilt towards the south of this section (see photo 7.) There is significant seepages through the two large retaining walls towards the east of this section, with calcite deposition encountered <1.5m up the wall (as seen in photo 6.)

There is also seepage along the retaining wall along the sections eastern boundary (photo 9) and an adjacent blocked drain along Shore Road (photo 4).

The southern-most part of the northern section is bordered to the south by Walrond Road, to the east by Shore Road and to the west by De Moulham Road. The northern boundary is defined by a stone wall with holiday cabins beyond (northern central section). It generally comprises a partly terraced grassed area that slopes gently down from the west to the east. The eastern boundary is defined by a ~2m high retaining that has seepages (see photo 11) and cracks (see picture 12) visible towards the south of the wall. A path runs north-south approximately ten metres from the eastern boundary on which park benches are placed. There are tension cracks along this path that have been filled in with concrete towards the north of the section (see picture 10.) A weather station is located in the south western corner.

This section is approximately +14.5m at its highest point at the western margin and approximately +3.0m at its lowest point before the retaining wall in the east. The slope angle of the banks joining each terrace differ throughout this section between 15 and 28 degrees (as seen on the Geomorphological Map)

The southern section, known locally as Sandpit Field, is bordered to the south by the A351, to the east by Shore Road with the beach beyond, to the west by De Moulham Road and to the north by Walrond Road. The majority of this section comprises a generally flat, undeveloped grassy area. A bank, approximately + 9.0m above Shore Road to the east forms the eastern boundary of this section, The slope angle of this bank varies from 26 to 40 degrees measured from crest to toe. Tension cracks have been identified along some sections of this slope (see picture 20).

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The slope is landscaped and maintained as a formal public garden with terraced grassed areas and formally planted beds that are tilting down slope towards shore road in areas (see photo 17 and 19.). Towards the middle to southern areas of this section, significant soil saturation was noted during the site works, with ponding water (see photo 21) and overland flow as the field slopes off towards the path in the south east of the section (see photo 22.)

The vegetation across the site consists largely of maintained grass, with bushes and the occasional small tree along the banks in the north and south, however there is a small number of large trees disseminated across the southern most field ('Sandpit field.'). These trees are confined to the perimeters of the site. The north and western perimeter of this section is bound by a hedge line approximately 2.0m tall.

1.3 Previous Investigation

SWG have previously undertaken an investigation on the site, Report No 5951 (2014). This included undertaking a series of window sample boreholes across the site for both geotechnical and geo-environmental purposes.

A study of historical maps shows the site to have been formalised as at the seafront area by 1928. Prior to this, the site appears to have remained undeveloped as undeveloped arable land, with the exception of a quarry / sand pit. At approximately the same time and through the 30's and 40's the surrounding area also underwent significant change, with extensive residential housing being built.

1.3.1 Geotechnical Findings

Initial stability analysis undertaken as part of that investigation, utilised Hoek and Bray stability charts rather than detailed computer modelling and recommended this was undertaken. The results determined that the site was marginally stable although some signs of shallow "creep" like ground movement was identified although, no sensitivity analysis was undertaken to determine the effect of groundwater on the slopes. This was primarily due to groundwater not being encountered during the investigation works which were undertaken in March 2014.

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The report recommended that for structures that require more traditional foundations on the level parts of the site, it is considered that a safe nett allowable bearing pressure of 100 kN/m² may be placed on the firm clay by traditional spread / trench fill foundations at around 1.50m depth. Foundations must fully penetrate the near surface clays into the firmer material below. When taking into account the relatively soft near surface soils, consideration could also be given to adopting a piled foundation, with some form of driven or bored pile extending into the firm stiff clays at depth.

1.3.2 Geo-environmental Findings

The investigation found generally low concentrations of contaminants on the site and confirmed that the site was fit for use in a commercial context.

2 DESK STUDY

2.1 Geology

The geology of Swanage Bay comprises relatively weak rocks of the Wealden Group comprising clays, silts and sandstones. The sedimentary strata comprise interbedded layered sequences of mudstones, siltstones and sandstones which have undergone limited uplift and deformation.

Superficial beach deposits are noted to east of the site.

Some made ground is recorded in the southern part of the site relating to the ground workings / sand pit noted on the historical maps. In addition, based on the historical mapping, the site has been previously developed and landscaped (with some cut slopes noted). Therefore, some made ground and reworked natural ground is expected.

The geology report noted a moderate risk of landslides and the local area is well documented as an area of slope instability (predominantly translational and rotational failures).

2.2 Geomorphological Survey

The site walkover geomorphological survey was conducted on 9 December 2020. A full description, obtained from the walkover, is given in Section 1.2. Various signs of on-going movement were noted around the site. The locations of these are documented on the Geomorphological Features Plan, Appendix B photos of these features are also included in Appendix B. The majority of the features are indicative of shallow creep/ translational ground movements (Figures 1 and 2) rather than deep seated (Figure 2) landslide features.

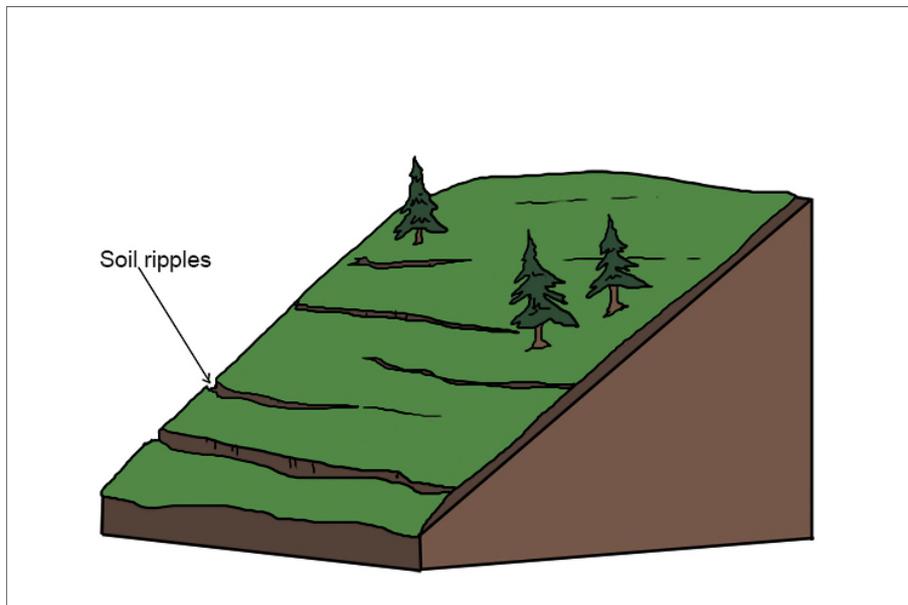


Figure 1: Illustration of Soil Creep Movement

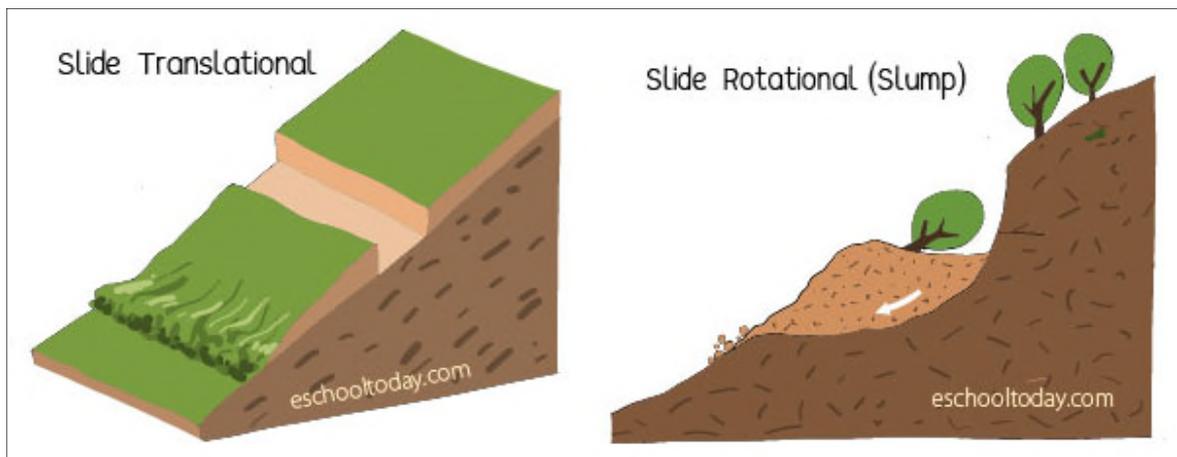


Figure 2: Shallow Translational and Rotational Landslide Illustration

Several of the retaining wall issues on the site, particularly around Sandpit Field are associated with inadequate drainage and poor construction.

At the northern end of the site, on the footpath adjacent to De Moulham Road, a series of cracks (Photo 1) were noted in the tarmac to the rear of the stone boundary wall. The wall was noted to be tilting downslope.

Significant quantities of both surface water and groundwater were seen issuing from all over the site. At the northern end in the vicinity of the Beach Huts, the retaining wall at

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Shore Road level was wet with groundwater issuing from it up to 1.4m up from pavement level (photos 8 and 9). Calcite deposition on a retaining wall higher up is up to around 2.0m from ground level suggesting very high groundwater levels in this area (photo 6).

A historic aerial photograph from 1950 (Photo 24) suggests the area of current beach huts may be formed on a historic landslip feature with the associated “tables” created by the landslip used to construct the various terraces on. This is not confirmed, but could explain why there is so much groundwater and has been so much historic movement (evidenced by the rebuilds of multiple walls) in this area.

The drains along the seafront (Shore Road) and Walrond Road are blocked/ full of water/ sediment (Photos 4, 13 and 18).

Significant deformation was noted on Shore Road, at the southern end of Sandpit Field (Photos 18 and 23). This may be indicative of a collapsed drain.

3 GROUND INVESTIGATION

3.1 Fieldwork

An intrusive investigation was carried out from the 7th to the 12th of December 2020. The exploratory hole location plan, exploratory hole logs, in-situ test data / results, laboratory testing results and associated photographs are contained in Appendices C and D respectively.

The fieldwork was carried out following the guidelines of BS 5930 (2015): Code of Practice for Ground Investigation; British Standard BS10175 (2011): Investigation of Potentially Contaminated Sites – Code of Practice and BS EN 1997-2:2007 (Eurocode 7) – Geotechnical Design – Part 2: Ground investigation and testing).

The fieldwork consisted of:

- Seventeen (17 no) Window Sample boreholes.
- Six (6 no) of the above boreholes were followed on using a Rotary Percussive method.
- Nine (9 no) inclinometer installations.
- Five (5 no) standpipe piezometer water monitoring installations.
- Three (3 no) standpipe water monitoring installationa.

The exploratory holes were positioned at accessible locations targeting areas of visible and potential instability.

3.2 Multi-Technique Boreholes

Six (6 No) multi-technique boreholes were undertaken using a Commachio Geo 205 drilling rig, to assist with determining ground conditions on the site. In the first instance, the boreholes were undertaken by dynamic sampling through the soils. Once rock head was encountered, the boreholes were advanced by rotary percussive techniques to approximately the base elevation of the slope.

3.3 Window Sampling

Window sampling was carried out using a Competitor percussive rig, which used a 63.5kg weight dropping a vertical distance of 750mm (BS 5930 Section 4, Clause 22.9). The boring produces a continuous sample in diameters ranging from 100mm down to 36mm, in clear rigid plastic liners.

Window sample holes included in-situ Standard Penetration Tests (SPTs), generally at metre centres. Where SPT blow counts exceed 50 without reaching the full 300mm penetration, the actual penetration was recorded and the extrapolated N-value for the full penetration was calculated.

3.4 Inclinerometers

Inclinometers were installed in BHs 01, 03, 06, 07 and 10, 12 and 16, to assist with determining the rate at which the failure of the slope is occurring.

The inclinometers were installed with a cement grout mix and finished with a flush cover.

3.5 Groundwater Monitoring Wells

Groundwater monitoring pipes were installed in the boreholes as detailed in Table 1.

Table 1: Groundwater Monitoring Installation Type

Pipe Type	BH02	BH04	BH05	BH08	BH09	BH11	BH13	BH15	BH17
50mm Standpipe	x		x	x	x	x		x	
19mm Piezometer		x					x		x

These have been positioned along the seafront to monitor the groundwater level within the slope, the level of which will have a significant effect on the stability of the site.

The wells comprise a combination of: a 50mm diameter slotted pipe with gravel cell from the base to 1.0m below ground level, where a plain section of pipe with a bentonite seal extends to ground level.

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Other wells have been fitted with a 19mm piezometer pipe, to target particular potential zones of ground water flow and obtaining a piezometric surface at the tip, which is indicated by the head of water which develops inside the standpipe tubing.

All installations have been fitted with flush covers.

4 LABORATORY TESTING

4.1 Geotechnical Laboratory Testing

All geotechnical testing was carried out in the SWG UKAS accredited laboratory in accordance with BS 1377; 1990, Methods of tests for soils for civil engineering purposes. Table 2 summarises geotechnical testing undertaken. The geotechnical laboratory test results are enclosed as Appendix F.

Table 2: Geotechnical Testing

Test	No. Tests
Moisture Content	14
Atterberg Limits	14
Particle Size Distribution Sieve	2
Sedimentation by pipette	2
Shear Box Peak Strength	1
Shear Box Peak and Residual Strength	5

For completeness, the laboratory testing undertaken as part of the previous investigation has been included in this assessment.

5 GROUND CONDITIONS

5.1 General

The investigation generally encountered made ground overlying cohesive residual soils of the Wealden Group, trending to extremely weak, highly weathered siltstone of the Wealden Group in the deeper boreholes.

The ground conditions have been summarised in Table 3.

Table 3: Stratum summary

Stratum	Depth to base of stratum (m BGL)					
	BH01	BH02	BH03	BH04	BH05	BH06
Topsoil	0.15	0.3	0.2	0.15	0.15	0.3
Made Ground	1.2	1.65	1.9	1.6	2.2	3.1
Cohesive Soil	2.25	2.7	3.5	4.9	4.5	3.9
Wealden Group Sand	-		-			
Wealden Group Siltstone	>13.5	15.0	>5.45	5.45	>8.0	9.0
Groundwater	-	7.0	-			0.98
Stratum	Depth to base of stratum (m BGL)					
	BH07	BH08	BH09	BH10	BH11	BH12
Topsoil		0.3		0.4	0.13	0.13
Made Ground	0.80	2.2	1.4	2.9	1.3	1.3
Cohesive Soil	>4.45	>5.45			3.1	3.1
Wealden Group Sand			>2.45	>3.38		
Wealden Group Siltstone					4.45	>4.45
Groundwater						
Stratum	Depth to base of stratum (m BGL)					
	BH13	BH14	BH15	BH16	BH17	
Topsoil	0.2	0.2	0.2	0.2	0.2	
Made Ground	0.8	0.9	2.1	2.6	0.8	
Cohesive Soil	>2.75	>3.0	>5.45	>4.0		
Wealden Group Sand					>7.0	
Wealden Group Siltstone						
Groundwater	0.9	0.9	3.0	2.0		

Standard Penetration Tests (SPTs) were undertaken at frequent intervals in the majority of the boreholes holes to allow the relative strength / density of near surface soils to be assessed. The SPT N values have been plotted against depth in Figure 1.

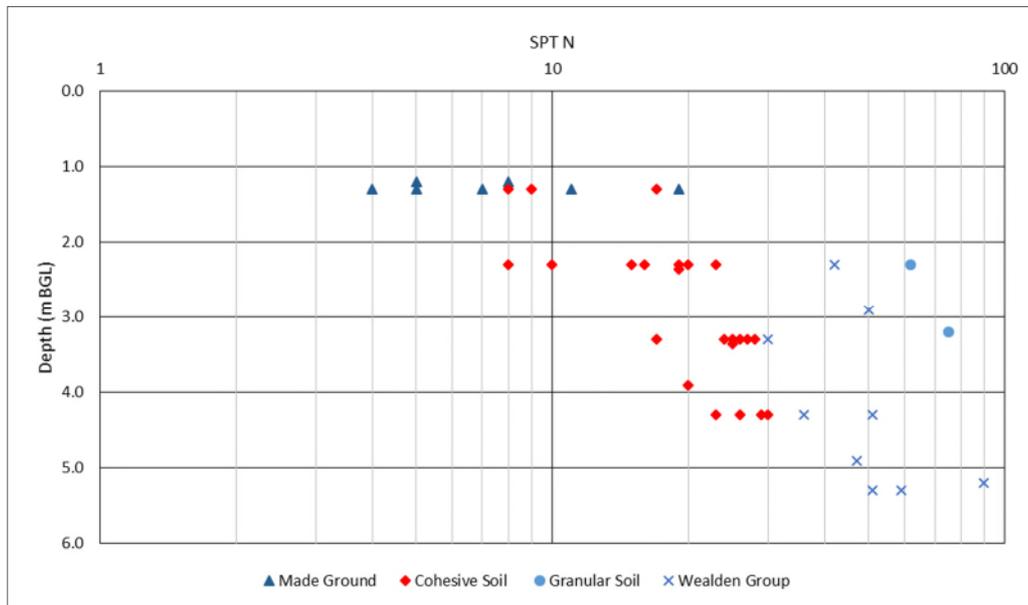


Figure 3: SPT N Vs Depth Plot

The N values show significant scatter near surface which is reflective of the variable nature of the made ground and near surface cohesive soils. Below a depth of approximately 3.0m the scatter decreases.

5.2 Made Ground

The made ground consists primarily of brown sandy, slightly gravelly silt topsoil overlying, reworked natural soils. The reworked natural soils comprise, soft to firm and firm consistency, gravelly silty clays extending from ground level to between 0.8 to 3.1mbgl (as seen in Table 3.) The gravel is of varied composition including siltstone, flint, quartz and occasional white shell and charcoal fragments.

Fissuring is present in the near surface made ground indicating the materials are moving downslope. These were particularly noted in the boreholes located close to the crest of the slopes.

Liquid and Plastic (Atterberg) Limit testing undertaken on the cohesive made ground materials indicate the soils are of intermediate to high plasticity (CI/CH).

SPT N values recorded in the made ground range from 4 to 19. Using correlations between SPT N and undrained shear strength proposed by Stroud and Butler (1975), undrained shear strength values of between 20 and 95 kPa with an average of 42 kPa.

A drained shear box test undertaken on the cohesive made ground materials gave peak values of cohesion and friction of 24 kPa and 29° respectively. Residual drained shear strength parameters of 12 kPa and 26° were recorded during the tests. The friction values are slightly higher than the value derived from correlations between Plasticity Index and friction angle (24°).

5.3 Cohesive Soil

Soils derived from the weathering of the Wealden Group are present below depths of between 0.8 and 3.1m. These materials comprise generally of generally stiff and very stiff consistency, orange to grey to purple, silty slightly sandy clay.

There is occasionally a gravel constituent consisting of fine to coarse, sub-angular to sub-rounded siltstone.

Fissuring was encountered in boreholes including: BH01, BH03, BH07, BH11, BH13 and BH14 again indicating downslope movement. These were locally (BH03) encountered to a depth of 3.0m.

A 10mm lignite band had been encountered in BH04 at a depth of 3.20-3.30mbgl. Recovered as fine to medium, angular lignite coal gravel.

Liquid and Plastic (Atterberg) Limit test undertaken on the materials indicates the soils have intermediate to high plasticity.

SPT N values recorded in the residual soils range from 8 to 33. Undrained shear strength values at varying depths have been calculated using the average SPT N values in Figure 4.

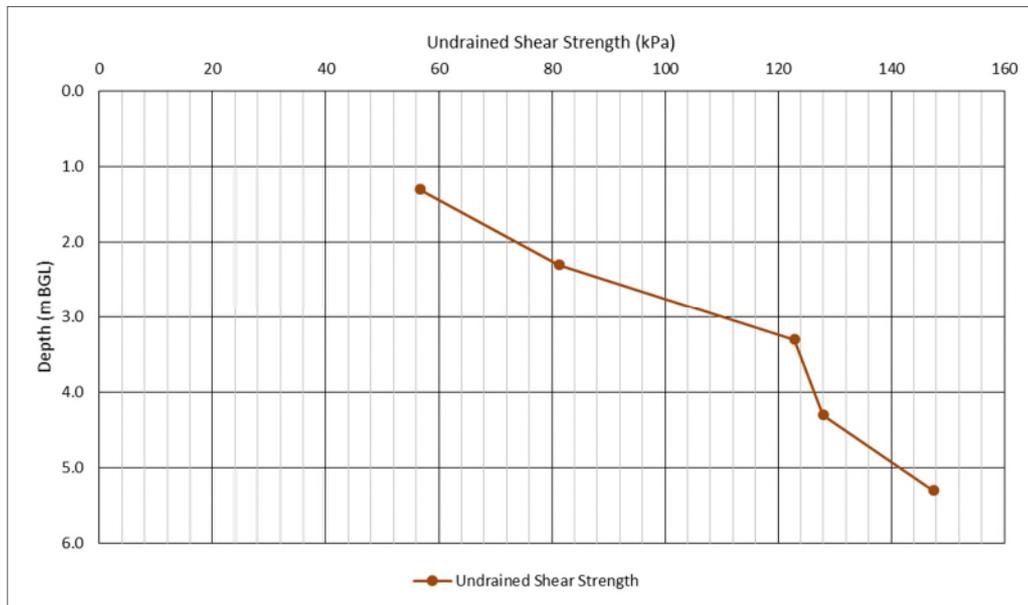


Figure 4: Cohesive Soil - Undrained Shear Strength Vs Depth

Four drained shear box tests undertaken on the cohesive soils gave peak values of cohesion and friction of between 8-14 kPa and 22-27° respectively. Residual drained shear strength parameters of 6-10 kPa and 17-26° were recorded during the tests. The friction values are in line with the value derived from correlations between Plasticity Index and friction angle (25°).

5.4 Wealden Group Sand

A sand unit forming part of the Wealden Group is present trending east west through the 'Sandpit Field' in BH09, BH10 and BH17. This unit is encountered in BH09 and BH10 between 1.50 - >2.45mbgl and comprises very dense, yellow, slightly clayey sand. The clay is confined to occasional clay pockets.

In BH17, this unit comprises of dense, clayey sand from 0.80mbgl to a depth of 2.00mbgl at which refusal was reached against extremely weak, yellow to grey, extremely closely to very closely spaced sandstone. To note, an open hole drilling method was undertaken through this unit, and therefore the Geology is assumed.

Particle size distribution sieve and sedimentation pipette test have been undertaken on the materials and confirm the soils are predominantly fine to medium sand with a high fines (clay and silt) content ranging from 24 to 31%.

Two SPT N values of 62 and 75 were recorded in the sand soils confirming the materials are very dense.

A shear box undertaken on the materials gives values of cohesion and friction of 1.5 kPa and 31° respectively.

The approximate extent of the former Sand Pit where the sand is present is shown on the Geomorphological Map, Appendix B.

5.5 Wealden Group Siltstone

The upper surface of the Wealden Group siltstone was encountered below depths of between 2.25 and 4.9m. This unit comprised of extremely weak, mudstone and siltstone.

SPT N values recorded in the residual soils range from 30 to 90 (average 50).

5.6 Groundwater

Groundwater was noted issuing from around the site during the investigation, particularly through the retaining walls adjacent to Shore Road at the lower (eastern) end of the site.

Subsequent monitoring visits have recorded groundwater at various depths in the boreholes, as indicated in Figure 5. The monitoring indicates that the groundwater levels are particularly susceptible to climatic weather conditions with changes in groundwater levels across the site of between 3.0 and 7.0m depending on the recent weather conditions. Figure 5 shows that groundwater levels steadily declined during the dry period of mid-March to early May 2021, with a rapid increase in groundwater levels following the particularly wet May 2021.

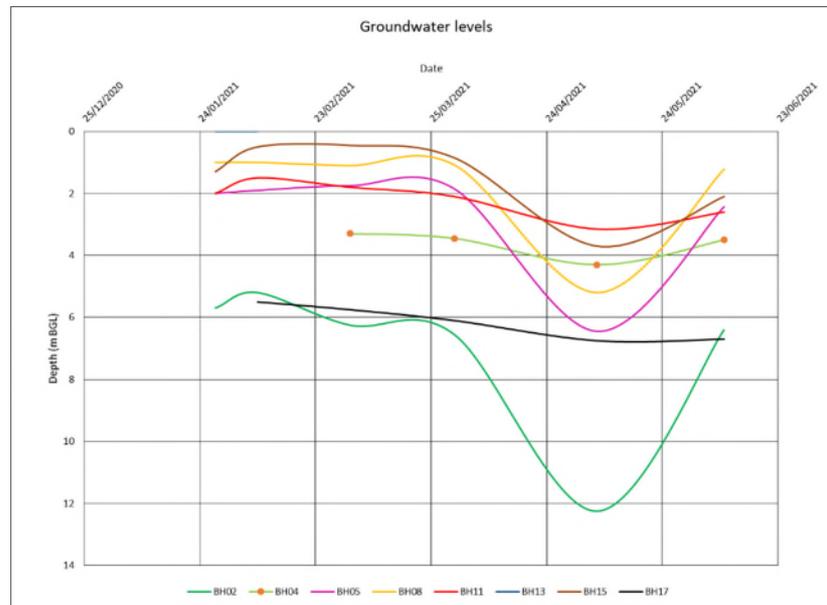


Figure 5: Groundwater Monitoring Summary

Groundwater was recorded at ground level in BH13 during the initial visits. Subsequently the protective cover has been damaged and it has not been possible to monitor this borehole since.

5.7 Inclinerometers

The inclinometer readings are presented graphically in Appendix G. The monitoring has confirmed that the slopes are moving to varying degrees as follows;

BH01 a maximum deflection of approximately 2.0mm recorded at surface in BH01 over the five month monitoring period. The inclinometer indicates that there are two separate ground movements occurring at the northern end of the site. The 2.0mm deflection near surface is associated with the over steep soils on the crest of the slope. More significantly, BH01 indicates that there is movement occurring to a depth of approximately 12.0m. The movement to this depth is currently quite limited (<1.0mm over the 5 months). It is likely that this rate varies through the year with varying groundwater levels although, the data set is currently limited and this has not been confirmed.

BH03 indicates that movement is occurring to a depth of 2.5m, again associated with over steep soils and poorly constructed retaining structures at the northern end of the site. A

maximum deflection of 1.7m was recorded over the five months prior to the protective cover being lost.

BH06, installed at the northern end of the “weather station field” shows some minor movement to a depth of approximately 5.5m although, the total movement is <0.5mm over the five month monitoring period.

BH07 was installed to the rear of the retaining wall in the south east corner of the “weather station field”. This shows some minor movement to a depth of approximately 2.7m, which is concordant with the base of the retaining wall. The greatest movement is near surface (0.5m) and is approximately 0.5mm over the five months.

In the “sand pit” area of Sandpit Field, BH10 shows some movement associated with the overly steep soils on the slope crest adjacent to the covered seating area. The movement is taking place to a depth of 1.5m and is a total of 1.0mm over the monitoring period, again with the greatest deflection near surface (0.5m).

BH12 was installed on the crest of the steep slope where tension cracks are visible in the slope at the southern end of Sandpit Field. This confirms that the slope here is moving to a depth of 3.0m with the majority of the movement (1.2mm) in the upper 2.0m of the slope as would be expected.

In the lowest part of Sandpit Field, BH14 is indicating very little movement, as would be expected given the low angle of the slope in this area.

BH16 was installed in the flat area of Sandpit Field and essentially shows very little movement is occurring in this area. This is expected as the area is essentially flat and level.

5.8 Existing Retaining Structures

It is evident from the geomorphological / walkover survey that the existing retaining walls are not built to modern construction standards and many have been built as ad-hoc repairs to failed walls. The walls are likely founded in the unstable soils on the slopes rather than at depth within stable ground.

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The drainage for much of the site is in poor condition which will not be helping to improve the stability of the site.

The existing structures are expected to be providing support to the slopes preventing larger scale failures occurring at this time although, as the structures deteriorates/ are removed larger failures could propagate.

6 GEOTECHNICAL ASSESSMENT

6.1 General

The investigation and subsequent monitoring indicates that across the majority of the site the ground movement is largely limited to the near surface soils on the face of the slopes. However, at the northern end of the site, the inclinometers installed at depth indicate that movement is occurring to a depth of approximately 12.0m below ground level in this area.

Groundwater at the time of the investigation and during the subsequent monitoring visits is very high over the winter months and is particularly susceptible to periods of inclement weather, which will be contributing to the speed and scale of instability of the slopes.

Four Geological Cross Sections have drawn through the site at what are considered critical locations. These are included in Appendix E and have been used to undertake the stability analysis.

6.2 Stability Assessment

In terms of general stability, the site can be separated into the three areas to the north and south of Walrond Road.

The far north of the area to the north of Walrond Road (i.e. the area with the Beach Huts and north) is much steeper, and the geometry means that this area is less stable than the remainder of the site. This is evidenced by the many repairs to the retaining walls in this area and the on-going cracking. The inclinometer readings undertaken to date confirm this.

The area immediately north of Walrond Road (adjacent to the weather station) appears to be experiencing translational creep, evidenced by the deformation of the tarmac footpath crossing this area. Again the walls at the base of this area are showing signs of movement.

To the south of Walrond Road, the current instability is limited to the slope along the eastern and northern parts of the site rather than the area as a whole.

6.2.1 Limit Equilibrium Stability Analysis

In order to confirm the findings of the investigation, limit equilibrium slope stability analysis has been undertaken using RocScience Slide™ software using the Morgenstern Price method, with circular failure modes considered. The British Standard approach rather than a Eurocode 7 approach has been used for the assessment. Given the natural slope is not “designed”, the traditional Factor of Safety (FoS) approach is considered more appropriate as it replicates what is actually occurring rather than providing additional conservatism to a designed slope. Therefore a FoS of 1.0 indicates a slope is in equilibrium (i.e. is marginally stable). FoS in excess of 1.2 to 1.3 are considered appropriate for the long term stability.

Groundwater was standing at shallow depth during the winter months and following periods of inclement weather, and is considered to have a significant influence on the stability of the slope. Groundwater surfaces observed during the monitoring have been included in the stability analysis. The saturated analysis represents the groundwater observed during the winter months. The drained analysis is based on the lower groundwater levels observed during the May 2021 monitoring visit.

In addition, a Ru value of between 0.1 and 0.2 has been applied to the ground above the water table to represent a degree of seasonal saturation which was evident at the time of the investigation works in the winter of 2020.

A 10kN/m² surcharge has been applied to the top of the entire slope for conservatism.

6.2.2 Geotechnical Parameters

The geotechnical design parameters detailed in Table 4 have been used for the analysis. These are based on the findings of the investigation, laboratory test results and back analysis of the slopes. These parameters have been used for the stability analysis.

Table 4: Geotechnical Design Parameters

Material	Parameter Source	Cohesion (kPa)	Friction (°)	Unit Weight (kN/m ³)
Made Ground	Laboratory Testing	0	17	19*
Cohesive Soil	Laboratory Testing	0	20	19*
Granular Soil	Laboratory Testing	0	31	19*
Wealden Siltstone	Laboratory Testing/ Assumed	0	20	20*

*Unit weights, typical of materials (BS8004, 2015)

The friction value for the made ground is taken from the residual strength parameters undertaken on the cohesive soils. Back analysis of the shallow translation features in the weather station field with observed groundwater conditions suggest this value is appropriate.

The parameters for the Wealden Siltstone is considered sufficiently conservative especially given the deep seated movement recorded in BH01.

6.2.3 Stability Analysis Results

The results of the analysis of the four geological cross sections confirm that varying degrees of instability are affecting the slopes, with the degree of instability dependent on the slope geometry, soils present and groundwater conditions. Graphical plots of the stability analysis undertaken on the four sections are included in Appendix H. These show all potential failure circles with a FoS <1.0.

The limit equilibrium analysis cannot be used to accurately model multiple small retaining walls such as those present on the site therefore, for Section 1 through the northern most section of the site, the FoS determined is a “global” FoS rather than for individual sections of wall and considered indicative of what could happen if the walls were removed. The inclinometer readings and site observations confirm that the stone walls are in general not providing sufficient support to the soils to guarantee long term stability.

Section 1 represents the northern most area of the site including the existing Beach Huts and the ground to the north of the beach huts. The inclinometer in BH01 indicates that

Geotechnical Assessment

ground movement is occurring to a depth of approximately 12.5m. The stability analysis undertaken on the ground slightly to the south, which has slightly different geometry (i.e. it is not at steep) indicates theoretical ground movement (i.e. FoS <1.0) can occur to a depth of approximately 10.6m which is considered to be concordant with the slightly different geometry to the north (i.e. BH01). The analysis indicates that the largest failure circle with a FoS <1.0 extends 14.7m back from the slope crest. This aligns with the edge of the pavement on De Moulham Road.

The instability associated with the Weather Station field (Section 2) is generally more translational/creep related (See Figures 1 and 2) with shallow failures affecting the steeper soils on the lower sections of the slope (as observed by the deformed footpath) and associated with the stone wall at the lower level. Large, deep seated failure of the slope, if left in its current state is not expected to occur, although larger failures would occur if the retaining wall at Shore Road level is left to deteriorate/ is removed.

The sand present beneath the made ground in the “sand pit” area of Sandpit Field (Section 3) have significantly better frictional properties than the other soils. As such failures in this area are associated with the made ground soils overlying the sand and are limited in extent (FoS <1.0 a maximum of 6.6m from the slope crest).

Through Section 4, the instability is due to the very steep cohesive soils forming the slope crest although again, the poorly constructed retaining walls are also not providing sufficient support to the slopes.

The results of the stability analysis are summarised in Table 5 with the distance from the crest of the slope that have a FoS <1.0 (i.e. is mathematically unstable), this is shown on the graphical results in Appendix H. Also included in Table 5 is the distance from the slope crest where a FoS >1.3 occurs (i.e. where the ground has sufficient mathematical long term stability).

Table 5: Stability Analysis Results

Section	Drainage Condition	Distance from slope crest affected by instability (m) i.e. FoS <1.0	Surface FoS	Distance from slope crest to FoS 1.3 (m)
Section 1	Saturated	14.7	0.41	35.0
	Drained	13.8	0.56	29.3
Section 2	Saturated	1.9	0.6	29.8
	Drained	1.9	0.7	15.9
Section 3	Saturated	6.6	0.2	8.2
	Drained	6.6	0.2	8.2
Section 4	Saturated	9.2	0.56	16.6
	Drained	4.3	0.56	14.2

The results summarised in Table 5 have been used to create a Hazard Map for the site (Appendix I). The map is shaded green, amber and red and is based on the results of the stability analysis and the potential impact instability of the slopes may have in their current state and the complexity of any engineering works in the future. The three categories are defined as follows;

- Green (low hazard) – Mathematically stable ground (i.e. global FoS at least 1.3), shallow foundations suitable providing any made ground penetrated.
- Amber (medium hazard) – Marginally stable ground (i.e. global FoS <1.3), instabilities likely occur if left in current state, particularly associated with the existing retaining walls. Piles required to transfer loads for new structures to stable ground at depth. Potential for large landslips to propagate if large linear excavations take place. Sequencing of construction works need to be considered to prevent mobilisation of large scale failures.
- Red (high hazard) – Mathematically unstable ground (i.e. global FoS <1.0). Historic construction works have exacerbated instability of slopes. Instability of varying degrees will occur if left in current state. Potential for large landslips to propagate if large linear excavations take place without mitigation works prior to implementation. Piles required to transfer loads for new structures to stable ground at depth. Sequencing of construction works need to be considered to prevent mobilisation of large scale failures. Engineering Geologist to supervise any works to check for shear surfaces and instability.

6.3 Foundations

For the northern part of the site, including in the area of the Weather Station, and along the slopes on the northern and eastern elevations of Sandpit field, it is recommended that piled foundations are utilised for any new structures and replacement retaining structures. This will ensure the marginally stable slopes are not further affected by additional loads from shallow foundations and that loads are transferred to stable ground at depth.

Various types of support have been considered. However, when taking into account the sensitivity of the slope and that there are several sensitive receptors (e.g. road at the toe of the slope and top of slope (northern end)), it is recommended that some form of some form of permanent bored piled wall would provide the most workable solution. A secant bored pile retaining wall is considered to be the most preferable from a health and safety and construction practicality perspective. The secant piles will ensure groundwater flow is not affected and allow drainage to be improved.

The use of soil nails to provide additional support to the slopes, could also be considered. The low friction values afforded by the cohesive soils will mean long, closely spaced soil nails will be required to provide sufficient support to the slopes.

Any retaining structures would need to be designed by a suitably qualified Engineer and approved by the Local Authority.

6.3.1 Piles/ Piled Walls

It is expected that piles and piled walls will be the most appropriate solution to transfer loads from any structures to competent ground at depth and ensure both the temporary and long term stability of the slopes and surrounding areas are maintained.

A bored pile or percussively formed ODEX pile is likely to be the most appropriate given the ground conditions and marginal stability of the slope. Driven piles are not considered suitable.

Piles for retaining structures may not need to take significant vertical loads but will rather need to resist horizontal forces through the wall. Where piles are used as free standing

(i.e. anchors are not utilised), the embedment of the pile is typically twice the retained height, subsequently longer rock sockets would allow higher capacity. Utilising raking anchors to provide additional support to a piled wall will reduce the length of pile required. In addition, the toe of piles should be taken down below any potential failure surfaces at depth.

Final pile design should take into account additional factors such as the soil /rock effective stress parameters, pile settlement and structural limits on settlement acceptability, lateral pressures, the effects interaction between neighbouring piles and pile group effects.

This report should be forwarded to piling contractors who will design and warrant the piles.

6.3.2 Shallow Foundations

In some areas of Sandpit field (i.e. along the western elevation, adjacent to De Moulham Road, shallow foundations could be considered although the depth of the made ground (2.1-2.6m) will likely mean piled foundations will be more economical. Recommendations on shallow foundations detailed in the SWG Report 5951 (2014) should be followed for shallow foundations.

6.4 Groundwater and Excavations

Groundwater was encountered at shallow depth and is having a significant impact on the stability of the slopes, in particular the size of the potential instability (See Table 5). Installing deep drainage to reduce the groundwater levels in the slopes will be beneficial in increasing the stability. Drainage could be in the form of horizontal drains drilled the Shore Road level back into the slope to allow the groundwater levels to be reduced at the slope face. This is likely to be the most appropriate method of dewatering to the north of Walrond Road.

To the south of Walrond Road, deep drainage could be installed with large excavation plant although, this would obviously involve significant earthworks to install drainage down to Shore Road level.

Any large excavation into the slope face carried out without installing stabilisation measures prior will likely result in instability in the slopes. The scale of any instability will be dependent

Geotechnical Assessment

on the area. To the north of Walrond Road and especially at the far north end of the site, including where the existing Beach Huts are, instability that may impact on De Moulham Road to the west may occur. Installing support prior to or during excavation will ensure that large scale failures do not occur.

To the south of Walrond Road, the geometry means that large scale failures that would impact on De Moulham Road are unlikely to occur and maintenance/ repair works to the existing retaining walls may be possible with conventional tracked plant. Larger excavations (i.e. removing the toe of the slope entirely) may result in large failures.

Removal of existing retaining walls to replace/ upgrade will lead to the risk of larger instabilities occurring. The length of excavation and construction sequencing together with temporary or permanent additional support will need to be considered to ensure the stability of the slopes is maintained.

7 FURTHER WORKS BY GEOTECHNICAL SPECIALIST

The inclinometer and groundwater monitoring undertaken to date has confirmed that the slopes are moving albeit at a low rate (maximum of <2.0mm over a 5 month period). In addition, the groundwater levels change significantly depending on climatic conditions. It is recommended that further inclinometer and groundwater monitoring is undertaken to further understand the movement and groundwater conditions.

The inclinometer readings should be undertaken on a monthly basis over the winter months, restarting in September. Electronic level loggers should be installed in the groundwater monitoring standpipes to allow more accurate (hourly) groundwater level readings to be taken.

8 CONCLUSIONS

The investigation and subsequent monitoring indicates that across the majority of the site the ground movement is currently largely limited to the near surface soils on the face of the slopes. However, at the northern end of the site, the inclinometers installed at depth indicate that movement is occurring to a depth of approximately 12.0m below ground level in this area.

Groundwater at the time of the investigation and during the subsequent monitoring visits is very high over the winter months and is particularly susceptible to periods of inclement weather, which will be contributing to the instability of the slopes.

The results of the stability analysis confirm that varying degrees of instability are affecting the slopes, with the degree of instability dependent on the slope geometry, soils present and groundwater conditions.

The results of the stability analysis have been used to create a Hazard Map for the site. The map is shaded green (low hazard), amber (medium hazard) and red (high hazard) and is based on the results of the stability analysis and the potential impact instability of the slopes may have in their current state and the complexity of any engineering works in the future.

For the northern part of the site, including in the area of the Weather Station, and along the slopes on the northern and eastern elevations of Sandpit field, it is recommended that piled foundations are utilised for any new structures and replacement retaining structures. This will ensure the marginally stable slopes are not further affected by additional loads from shallow foundations and that loads are transferred to stable ground at depth.

In some areas of Sandpit field (i.e. along the western elevation, adjacent to De Moulham Road), shallow foundations could be considered although the depth of the made ground (2.1-2.6m) will likely mean piled foundations will be more economical.

Groundwater was encountered at shallow depth and is having a significant impact on the stability of the slopes. Installing deep drainage to reduce the groundwater levels in the slopes will be beneficial in increasing the stability.

Geotechnical Assessment

Any large excavation into the slope face carried out without installing stabilisation measures prior will likely result in instability in the slopes. The scale of any instability will be dependent on the area. To the north of Walrond Road and especially at the far north end of the site, including where the existing Beach Huts are, instability that may impact on De Moulham Road to the west may occur.

To the south of Walrond Road, the geometry means that large scale failures that would impact on De Moulham Road are unlikely to occur and maintenance/ repair works to the existing retaining walls may be possible with conventional tracked plant. Larger excavations (i.e. removing the toe of the slope entirely) may result in large failures.

Further inclinometer readings should be undertaken on a monthly basis over the winter months, restarting in September. Electronic level loggers should be installed in the groundwater monitoring standpipes to allow more accurate (hourly) groundwater level readings to be taken.

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Principal
Author

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Checker

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Stroud, M. A. & Butler, F. G. (1975). The standard penetration test and the engineering properties of glacial materials. The engineering behaviour of glacial materials: proceedings of the symposium held at the University of Birmingham, 21-23 April, 1975. 2nd Ed. Norwich: Geo Abstracts Ltd

The Standard Penetration Test (SPT): Methods and Use (1995) CIRIA Report 143

10 LIMITATIONS

This report has been prepared by SWG solely for the benefit of Swanage Town Council. It shall not be relied upon or transferred to any third party without the prior written authorisation of SWG.

All information given in this report is based on the ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the site which have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes.

It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

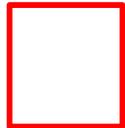
British Standards Institute (BSI, 2015) ordinarily recommends that laboratory measurements of strength in cohesive soils be undertaken only on high-quality (Category 'A') undisturbed samples, necessitating the use of wire-line drilling or thin-wall samples tubes. However, given the relatively low geotechnical risk presented and the low probability of being able to recover Category 'A' samples from the anticipated strata, it is considered that the use of such techniques is neither appropriate nor cost-effective.

Appendix A

Site Location Plan



SWANAGE



Site Location



SOUTH WEST GEOTECHNICAL

Swanage Seafront

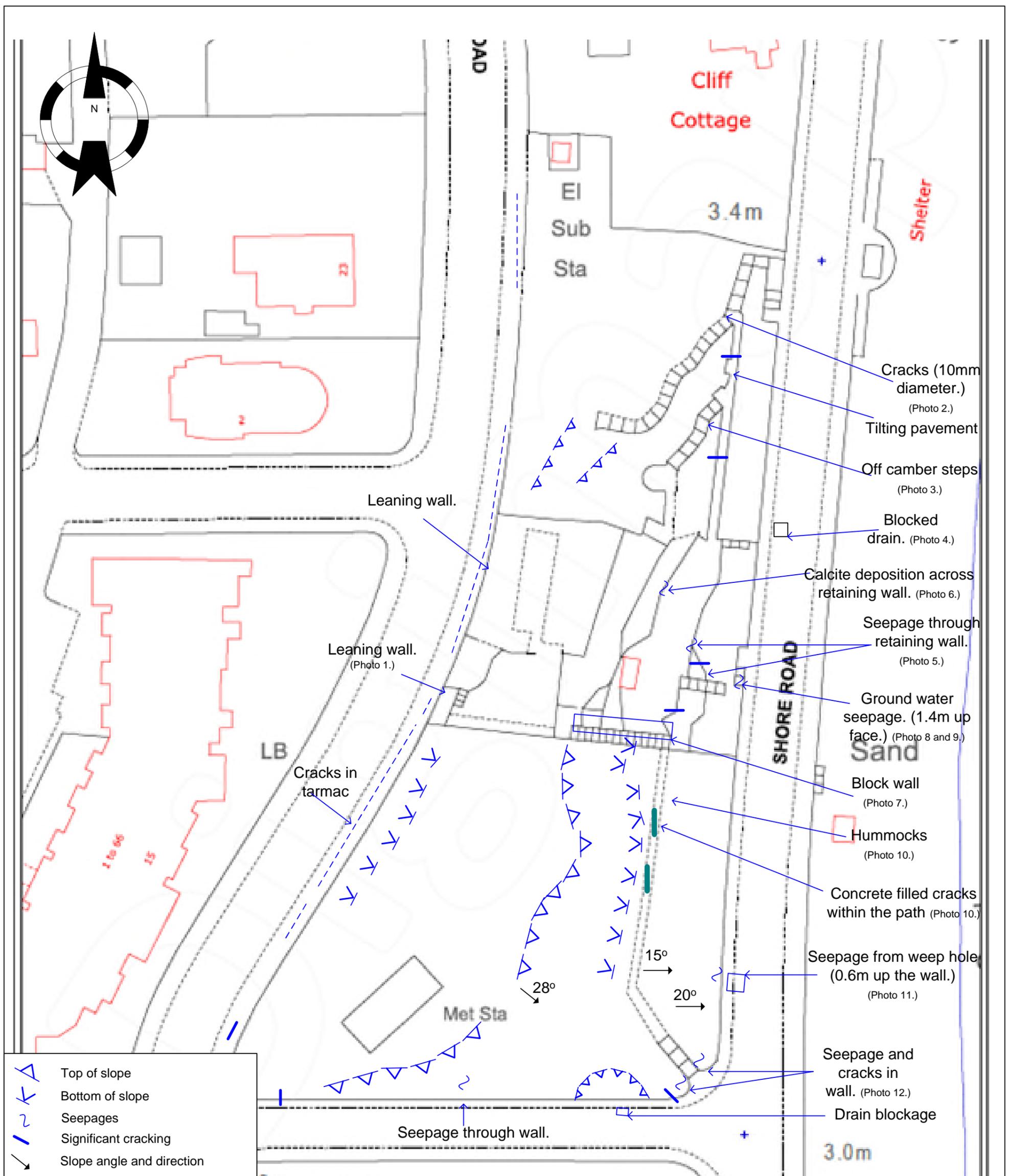
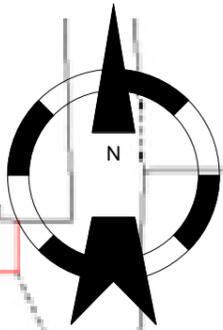
Site Location Plan

01884 252444		SIZE	JOB NO	DWG NO	REV
Drawn: ZM		A4	12660	DWG1	0
SCALE	1:25000	7-15/12/2020	SHEET	1 of 1	



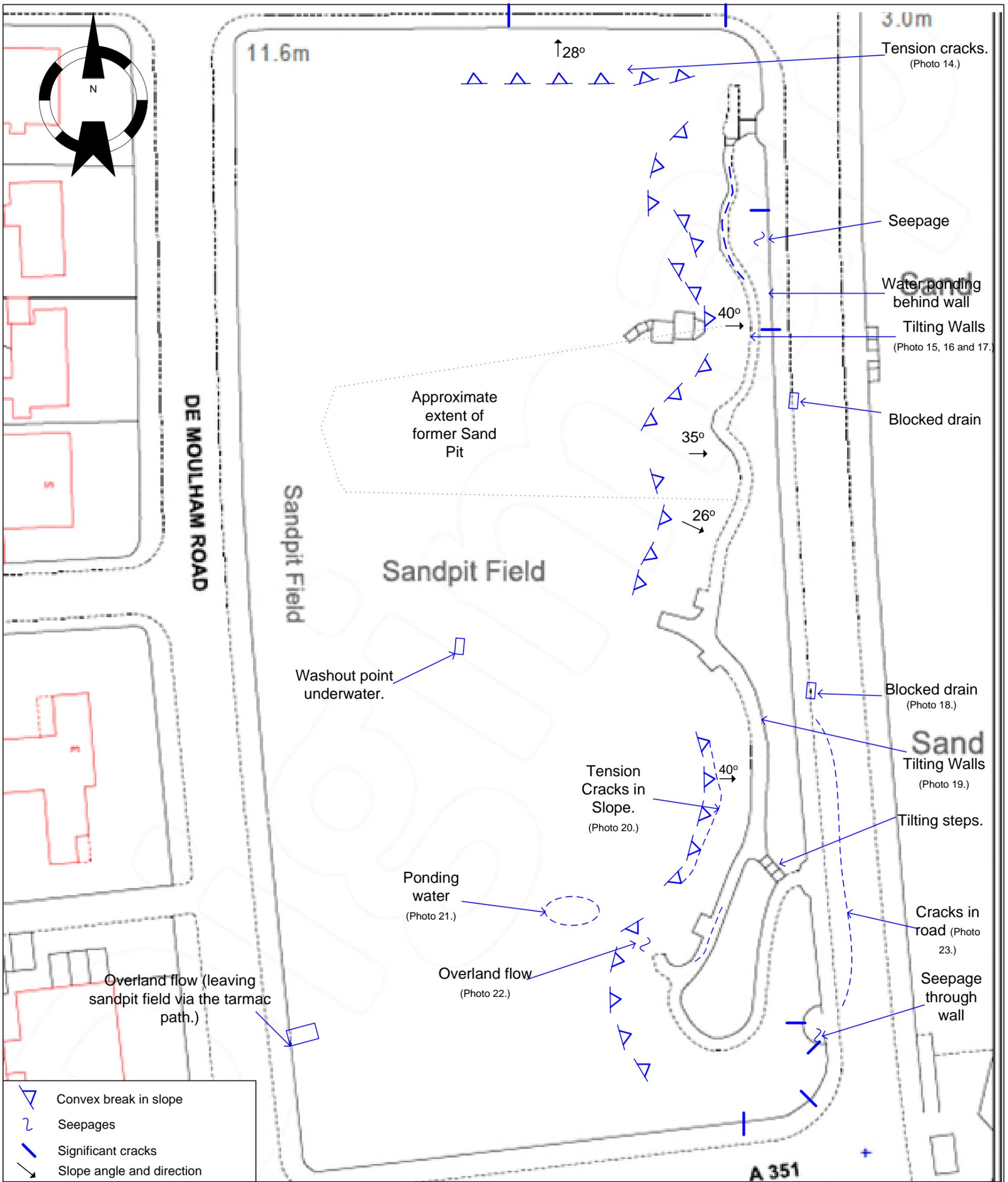
Appendix B

Geomorphological Maps and Site Walkover Photos



- Top of slope
- Bottom of slope
- Seepages
- Significant cracking
- Slope angle and direction

		Swanage Seafront			
		Geomorphologic Map – Area A			
01884 252444	SIZE	JOB NO	DWG NO	REV	
Drawn: ZM	A3	12660	DWG1	0	
	SCALE	1:500	10/12/2020	SHEET	1 of 1



SOUTH WEST GEOTECHNICAL

Swanage Seafront

Geomorphologic Map – Area B

01884 252444

SIZE

JOB NO

DWG NO

REV

A3

12660

DWG1

0

Drawn: ZM

SCALE

1:500

10/12/2020

SHEET

1 of 1



Photo 1 – Leaning wall and cracks in pavement (looking north.)

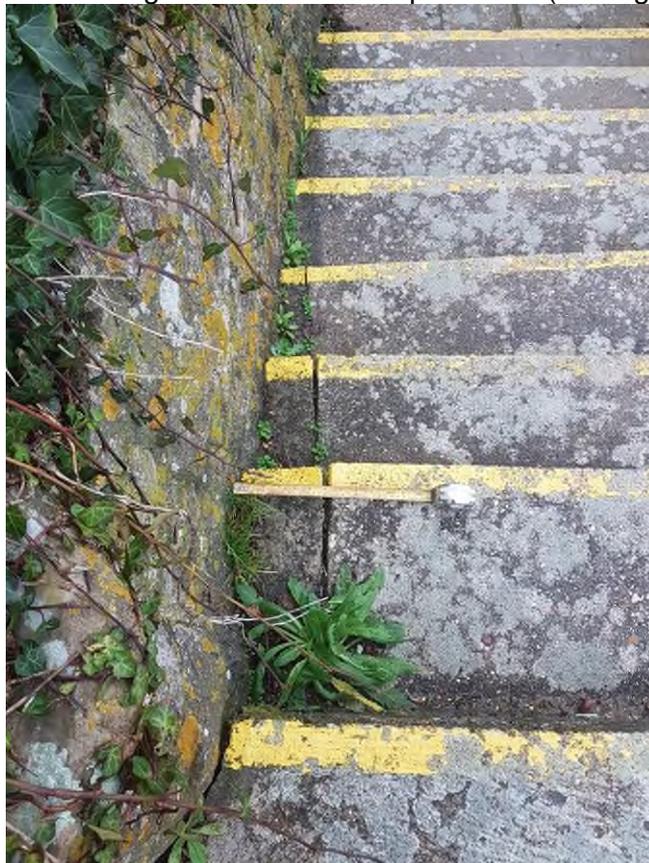


Photo 2 – 10mm diameter cracks.



Photo 3 – Steps off camber (looking south west.)



Photo 4 – Blocked drain.



Photo 5 – Seepage through retaining wall and drain



Photo 6 – Calcite deposition along retaining wall (looking south west)



Photo 7 – Repaired wall (looking south west.)



Photo 8 – Groundwater seepage through retaining wall, at 1.4m up wall (looking south west west.)



Photo 9 - Groundwater seepage through retaining wall at 1.4m up wall (looking west.)



Photo 10 – Hummocky terrain and concrete filled cracks in tarmac (Looking north.)



Photo 11 – Seepage from weep hole in the wall. (Looking south west west.)



Photo 12 – Cracks in wall. Seepages through wall



Photo 13 – Drain blockage

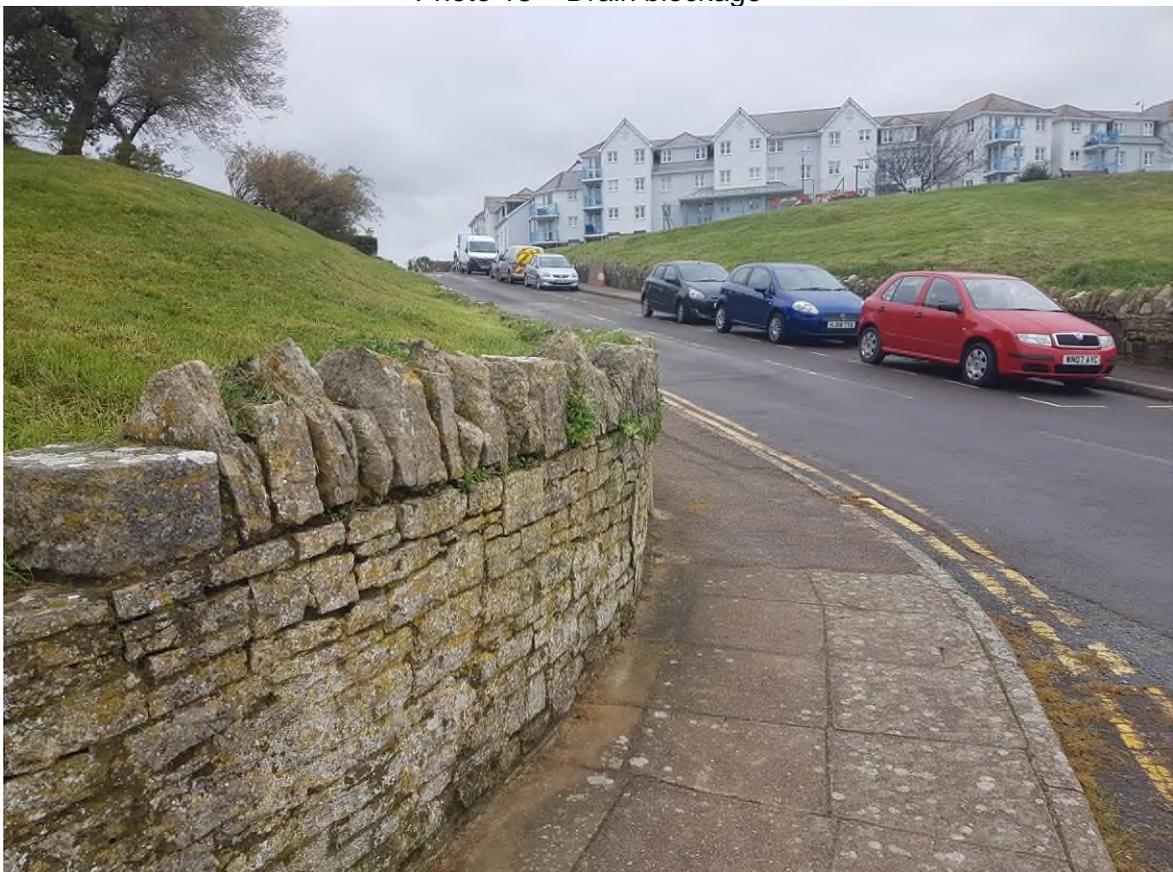


Photo 14 – Tension cracks (looking east.)



Photo 15 – Tilting wall. Looking south.



Photo 16 – Tilting path wall. (Looking north.)



Photo 17 – Tilting wall. (Looking north west.)



Photo 18 – Blocked drain (looking north.)

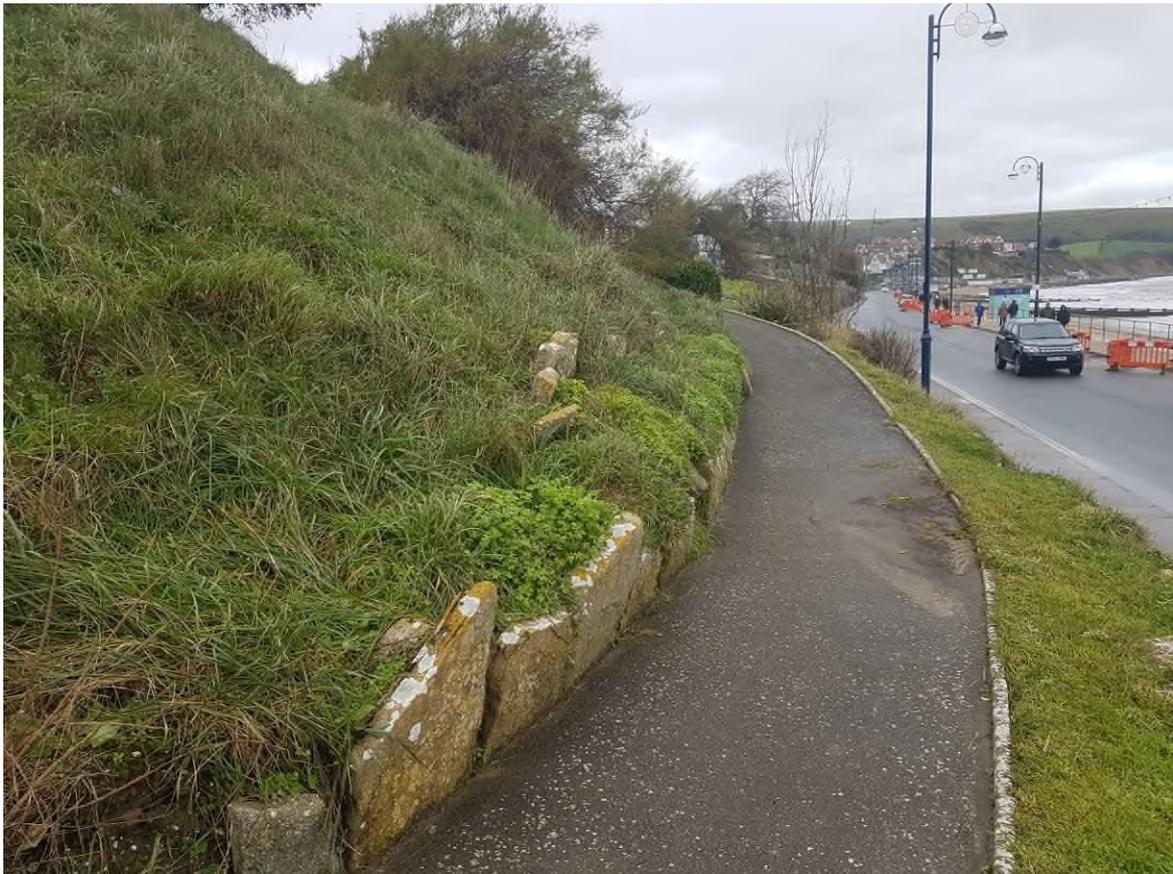


Photo 19 – tilting wall – Looking north.



Photo 20 – Tension cracks.



Photo 21 – Ponding water (looking north.)



Photo 22 – Seepage through slope. (Looking north west.)



Photo 23 – Cracks in the road. (Looking east.)



Photo 24 – Aerial Photo 1925



Photo 24 – Aerial Photo 1950

Appendix C

Exploratory Hole Location Plan



 Bore hole



Swanage Seafront – Plan A

Exploratory Location Plan

01884 252444

SIZE
A4

JOB NO
12660

DWG NO
DWG1

REV
0

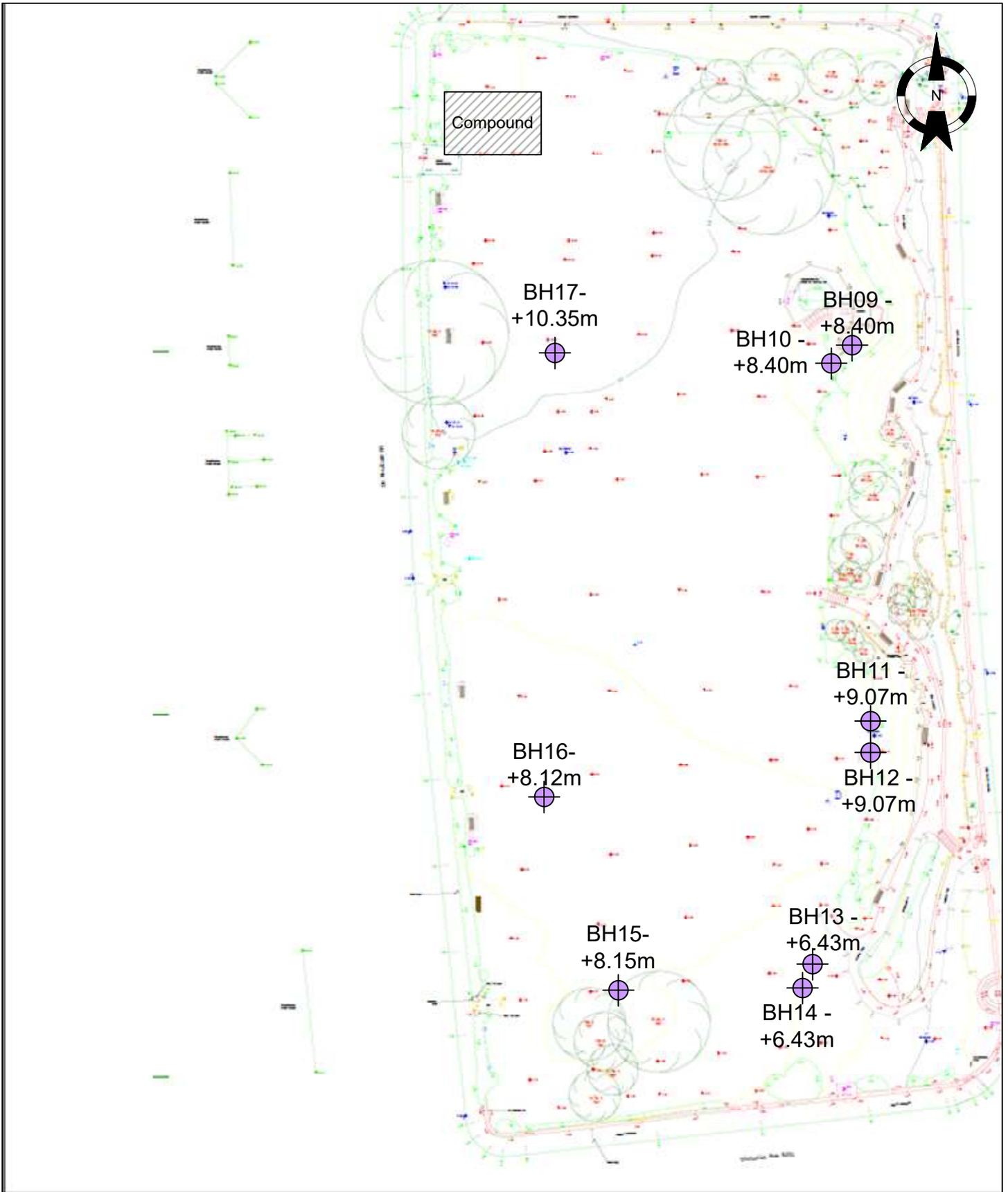
Drawn: ZM

SCALE NTS

7-15/12/2020

SHEET

1 of 1



 Bore hole  Compound		Swanage Seafront – Plan B			
		Exploratory Location Plan			
01884 252444	SIZE	JOB NO	DWG NO	REV	
Drawn: ZM	A4	12660	DWG1	0	
	SCALE	NTS	7-15/12/2020	SHEET 1 of 1	



Appendix D

Exploratory Hole Logs and Photos



KEY TO EXPLORATORY HOLE LOGS

SAMPLING

Undisturbed

U	Driven tube sample (Blow count recorded in results column i.e. U = 20)
TW	Pushed thin wall tube sample
P	Pushed piston sample
L	Liner sample
CBR	CBR mould sample
BLK	Block sample
WS	Window sample
CS	Core sample

Disturbed

D	Small sample
B	Bulk sample

Other

W	Water sample
G	Gas sample
ES	Soil sample for environmental analysis
EW	Water sample for environmental analysis

IN-SITU TESTING

SPT S or SPT C Standard Penetration Test, open shoe (S) or solid cone (C)

As defined in BS 1377 : Part 9 (1990). Standard Penetration Test (SPT): a 50mm split spoon or solid cone sampler is driven 450mm into the base of the borehole using a 63.5 kg hammer with a 760mm drop. The penetration resistance (e.g. 21) is expressed as the N-value, and represents the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm.

The depth on the borehole/ trial pit record is that of the start and end of the test. Where full penetration for the test has not been achieved, the final penetration depth is recorded.

HVP (kPa) In-situ Hand Vane shear strength: a hand shear vane test (or average of a series), conducted on undisturbed samples or within trial pits.

GIVN (kPa) Geonor in-situ vane shear strength carried out in base of borehole or self bored hole

VN (kPa) Hand Vane shear strength, conducted on disturbed or remoulded samples.
PP (kg/cm²) Pocket penetrometer test: a pocket Penetrometer reading (or average of a series). If reported in kPa, the value has been converted to an equivalent undrained shear strength.

Ik In situ permeability test
ICBR In-situ CBR test
IPBT In-situ plate bearing test
IPST In-situ plate settlement test

All test results are provided in Results column

DRILLING RECORDS

TCR Total Core Recovery %
SCR Solid Core Recovery %
RQD Rock Quality Designation %
FI Fracture Spacing mm. Minimum, typical and maximum spacings are recorded.

GR002

Version 6

27/07/2018

GR002 Key to exploratory records



GROUNDWATER



Groundwater Strike



Groundwater level after standing time

INSTALLATION

Standpipe/ piezometer

Details of standpipe/piezometer installations are given on the left side of the log. The column shows installed instrument depths including slotted pipe section or tip depth, response zone filter material type and layers of backfill.

SP	Standpipe
SPIE	Standpipe piezometer
PPIE	Pneumatic piezometer
EPIE	Electronic piezometer

NOTES

Water level observations of discernible entries during the advancing of the exploratory hole are given at the foot of the log and in the Legend column. The term "none observed" is used where no discrete entries are identified although this does not necessarily indicate that the hole has not been advanced below groundwater level. Under certain conditions groundwater cannot be observed, for instance, drilling with water flush or over water, or boring at a rate much faster than water can make its way into the borehole.

The declination of bedding and joints is given with respect to the normal to the core axis. Thus in a vertical borehole this will be the dip.

Remarks on chiselling times can be affected by a variety of factors not always related to the geotechnical properties of the strata. Chiselling records are given at the foot of the log.

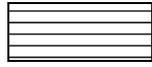
The assessment of SCR, RQD and Fracture Spacing excludes artificial fractures.

KEY TO SOIL LEGENDS

	CLAY
	SILT
	SAND
	GRAVEL
	PEAT
	COBBLES
	BOULDERS
	TOPSOIL
	MADE GROUND



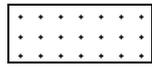
KEY TO ROCK LEGENDS



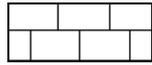
MUDSTONE



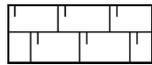
SILTSTONE



SANDSTONE



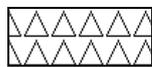
LIMESTONE



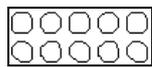
CHALK



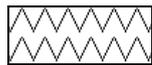
COAL



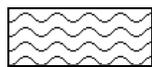
BRECCIA



CONGLOMERATE



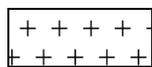
FINE GRAINED METAMORPHIC



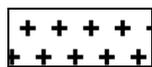
MEDIUM/COARSE GRAINED METAMORPHIC



FINE GRAINED IGNEOUS



MEDIUM GRAINED IGNEOUS



COARSE GRAINED IGNEOUS

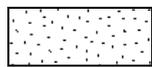
KEY TO BACKFILL LEGENDS



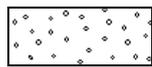
BENTONITE



ARISINGS



SAND



GRAVEL

REFERENCES

BS 1377 : 1990 : British Standard Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930 : 1999 : Code of practice for site investigations. British Standards Institution.

GR002

Version 6

27/07/2018

GR002 Key to exploratory records



Borehole Log

Borehole No.

BH01

Sheet 1 of 2

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403044.00 - 79417.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 16.00

Scale
1:50

Client: Swanage Council.

Dates: 07/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.15	15.85		MADE GROUND, turf over brown, soft to firm, silty sandy clay.	
					0.80	15.20		MADE GROUND, firm, brown, sandy, silty, fissured clay. Contains occasional charcoal fragment.	
		1.00		N=9 (2,1/2,2,2,3)	1.20	14.80		<i>Frequent fissures encountered.</i> MADE GROUND, firm to stiff, light grey to light brown, slightly silty, sandy clay.	1
					2.00	14.00		<i>Occasional fissures encountered.</i> Stiff, brown to orange to grey, very clayey, very sandy SILT (locally very silty, very sandy clay). (Residual soil) WEALDEN GROUP.	
		2.00		N=42 (2,5/9,10,10,13)	2.25	13.75		Stiff, yellow (locally orange), very sandy SILT. (Residual soil) WEALDEN GROUP.	2
		2.60		N=50 (7,8/12,11,12,15)				Extremely weak, light yellow, extremely closely spaced fractured clayey SILTSTONE. Highly weathered. Recovered as a stiff, clayey silt. WEALDEN GROUP.	3
								<i>Open hole drilling from 3.05mbgl. (Geology inferred.)</i>	4
									5
									6
									7
									8
									9
									10

Continued on next sheet

Remarks

1.) Window Sampled to 3.05mbgl. 2) Open holed to 13.5mbgl. 3) No groundwater encountered. 4) Inclinator install from 0-13.5mbgl.





Borehole Log

Borehole No.

BH02

Sheet 1 of 2

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403037.00 - 79391.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 15.50

Scale
1:50

Client: Swanage Council.

Dates: 08/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30	15.20		MADE GROUND, turf over brown, soft to firm, silty sandy, slightly gravelly clay. Gravel consists of fine rounded chalk. Contains occasional brick and charcoal fragment.	1
					1.30	14.20		MADE GROUND, firm, red to orange to brown, silty, sandy, slightly gravelly clay. Gravel is fine, sub-rounded to rounded, white chalk and siltstone.	
					1.65	13.85		MADE GROUND, orange, medium sand.	2
					2.10	13.40		Stiff, grey, slightly clayey, slightly gravelly SILT. Gravel is fine to coarse, sub-angular to sub-rounded and composed of siltstone. (Residual soil.) WEALDEN GROUP.	
					2.70	12.80		Stiff, grey to brown to orange, very silty CLAY. Occasional fine black charcoal fragments. (Residual soil) WEALDEN GROUP.	3
					Extremely weak, light yellow, extremely closely spaced fractured clayey SILTSTONE. Highly weathered. Recovered as a stiff, clayey silt. WEALDEN GROUP.				
					<i>Open hole drilling from 3.00mbgl. (Geology inferred.)</i>				
								4	
								5	
								6	
								7	
								8	
								9	
								10	

Continued on next sheet

Remarks

1) Dynamic sampled from 0-3mbgl. 2) Open holed from 0-15mbgl. 3) Groundwater encountered at 7.0mbgl. 4) Piezometric install 0-12mbgl (sand response zone between 6.50-12mbgl.)





Borehole Log

Borehole No.

BH03

Sheet 1 of 1

Project Name: Swangape Seafront	Project No. 12660	Co-ords: 403046.00 - 79387.00	Hole Type WLS
Location: Swangape Seafront, Dorset.		Level: 14.00	Scale 1:50
Client: Swangape Council.		Dates: 07/12/2020 -	Logged By ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20	13.80		MADE GROUND, turf over brown, soft to firm, silty sandy, slightly gravelly clay. Gravel consists of fine rounded chalk. Contains occasional brick and charcoal fragment. <i>Frequent fissures encountered.</i>	
		1.00		N=19 (1,2/4,4,4,7)	1.20	12.80		MADE GROUND, firm, brown, silty, slightly sandy, slightly gravelly clay. Gravel is of varied composition, including fine to medium, sub-angular, red siltstone, white sub-angular flint, white shell fragments, charcoal.	1
		2.00		N=23 (2,4/4,6,6,7)	1.90	12.10		MADE GROUND, Firm, orange to grey, slightly sandy, silty clay.	2
		3.00		N=25 (3,3/5,6,7,7)				Stiff, grey to orange (locally red), clayey, slightly sandy SILT. (Residual soil) WEALDEN GROUP. <i>Frequent fissures encountered.</i>	3
		4.00		N=36 (4,6/8,8,8,12)	3.50	10.50		Extremely weak, light yellow, extremely closely spaced fractured clayey SILTSTONE. Highly weathered . Recovered as a stiff, clayey silt. WEALDEN GROUP.	4
		5.00		N=59 (4,8/12,15,15,17)	5.45	8.55		End of borehole at 5.45 m	5

Remarks
 1.) Window Sampled to 5.45 mbgl. 2) No groundwater encountered. 3) Inclinator install from 0-5mbgl.





Borehole Log

Borehole No.

BH04

Sheet 1 of 1

Project Name: Swangage Seafront	Project No. 12660	Co-ords: 403036.00 - 79368.00	Hole Type WLS
Location: Swangage Seafront, Dorset.		Level: 13.60	Scale 1:50
Client: Swangage Council.		Dates: 08/12/2020 -	Logged By ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.15	13.45		MADE GROUND, turf over, soft to firm, brown, sandy, slightly gravelly silt. Gravel is fine and varied composition including, flint, siltstone. Occasional glass fragment encountered. Contains rootlets.	
		1.00		N=5 (0,1/2,1,1,1)				MADE GROUND, firm to stiff, brown, slightly clayey, sandy, slightly gravelly silt. Gravel is of varied composition, including red, fine to medium, sub-angular siltstone, white sub-angular flint and quartz, white shell fragments, charcoal.	1
		2.00		N=10 (1,1/2,2,3,3)	1.60	12.00		Occasional fissure encountered. Stiff, orange to grey, clayey, sandy SILT. (Residual Soil) WEALDEN GROUP.	2
		3.00		N=27 (2,3/4,5,8,10)					3
					3.20 3.30	10.40 10.30		Black lignite coal band. Recovered as Black, fine to medium, angular, lignite coal gravel. (Residual Soil) WEALDEN GROUP.	
		4.00		N=29 (4,5/6,6,8,9)				Stiff, grey (locally orange), slightly silty, slightly gravelly CLAY. Gravel consists of extremely weak, fine to medium, angular to sub-angular, grey siltstone. (Residual Soil) WEALDEN GROUP.	4
		5.00		N=51 (8,8/10,12,14,15)	4.90	8.70		Extremely weak, grey, extremely closely spaced fractured clayey SILTSTONE. Highly weathered. WEALDEN GROUP.	5
					5.45	8.15		End of borehole at 5.45 m	6
									7
									8
									9
									10

Remarks
 1.) Window Sampled to 5.45 mbgl. 2) No groundwater encountered. 3) Standpipe install from 0-4mbgl.





Borehole Log

Borehole No.

BH05

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403021.00 - 79318.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 11.15

Scale
1:50

Client: Swanage Council.

Dates: 08/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.15	11.00		MADE GROUND, turf over, soft, brown, slightly clayey, sandy silt. Contains rootlets.	
		1.00		N=5 (0,0/1,1,1,2)	0.90	10.25		MADE GROUND, soft, brown, (locally orange), slightly gravelly silt. Gravel is fine, rounded chalk.	
		2.00		N=15 (2,3/3,3,4,5)	2.20	8.95		MADE GROUND, firm, orange, silty clay.	1
		3.00		N=17 (2,2/3,3,5,6)				Stiff (locally firm to stiff), orange to purple to grey, silty, slightly sandy CLAY. (Residual soil) WEALDEN GROUP.	2
		3.60		N=20 (3,3/4,5,5,6)					3
		4.60		N=47 (4,5/8,9,12,18)	4.50	6.65			4
		5.00		68 (5,11/68 for 225mm)				Extremely weak, light yellow to grey, extremely closely spaced fractured clayey SILTSTONE. Highly weathered. Recovered as a stiff, clayey silt. WEALDEN GROUP. <i>Open hole drilling from 5mbgl. (Geology inferred.)</i>	5
					8.00	3.15			6
									7
									8
									9
									10

Remarks

1) Window sampled from 0-5.45mbgl. 2) Open holed from 5-8mbgl 3) No groundwater 4) Piezometric install (sand response zone between 6.50-7.5mbgl.)





Borehole Log

Borehole No.

BH06

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403028.00 - 79348.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 11.70

Scale
1:50

Client: Swanage Council.

Dates: 09/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
1	▼				0.30	11.40	[Cross-hatch pattern]	MADE GROUND, turf over, soft, brown, slightly clayey, sandy silt. Contains rootlets.	1
					1.00	10.70		MADE GROUND, soft, brown, (locally orange), slightly gravelly silt. Gravel is fine, rounded chalk.	
					1.80	9.90	[Cross-hatch pattern]	MADE GROUND, soft to firm, mottled orange to grey to light blue, silty, slightly gravelly clay. Occasional fine, rounded, chalk and charcoal.	
					3.10	8.60		MADE GROUND, firm, mottled orange to grey to light blue, silty, slightly gravelly clay. Occasional fine, rounded, chalk and charcoal.	
					3.90	7.80	[Cross-hatch pattern]	Stiff (locally firm to stiff), orange to purple to grey, silty, slightly sandy CLAY. (Residual soil) WEALDEN GROUP.	
						[Horizontal lines pattern]	Extremely weak, grey, extremely closely spaced fractured clayey silty MUDSTONE. Highly weathered. WEALDEN GROUP. <i>Open hole drilling from 4mbgl. Geology Inferred.)</i>	4	
								5	
								6	
								7	
								8	
					9.00	2.70		End of borehole at 9.00 m	9
								10	

Remarks

1) Dynamic sampled from 0-4mbgl. 2) Open holed from 4-9mbgl. 3) Groundwater encountered at 0.98mbgl. 4.) Inclinator installed from 0 -9mbgl.





Borehole Log

Borehole No.

BH07

Sheet 1 of 1

Project Name: Swangape Seafront	Project No. 12660	Co-ords: 403045.00 - 79308.00	Hole Type WLS
Location: Swangape Seafront, Dorset.		Level: 7.40	Scale 1:50
Client: Swangape Council.		Dates: 09/12/2020 -	Logged By ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
1		0.05			0.05	7.35		MADE GROUND, turf over, soft, brown, slightly clayey, sandy silt. Contains rootlets. MADE GROUND, black asphalt. MADE GROUND, black, light yellow, brown, slightly clayey gravel. Gravel is fine to coarse, angular, siltstone and sandstone. Sub-base. MADE GROUND, firm, very sandy, gravelly (locally slightly gravelly) clay. Gravel is fine to medium, round to sub-angular chalk and flint. <u>Slight fissuring encountered.</u> <u>Fissures encountered.</u> Firm, orange to grey to red, silty, slightly gravelly CLAY. Gravel is fine, rounded chalk.	1
		0.08			0.08	7.32			
		0.20			0.20	7.20			
		1.00		N=8 (0,1/2,1,2,3)	0.80	6.60			
		2.00		N=19 (1,2/4,4,5,6)	2.50	4.90			
3		3.00		N=24 (3,3/5,5,6,8)	3.00		Stiff, grey (locally brown), very silty, slightly sandy CLAY. (Residual soil) WEALDEN GROUP.	3	
		4.00		N=30 (2,4/6,6,8,10)	4.45	2.95			
End of borehole at 4.45 m								5	
								6	
								7	
								8	
								9	
								10	

Remarks
 1.) Window Sampled to 4.45 mbgl. 2) No groundwater encountered. 3) Inclinator install from 0-4mbgl.





Borehole Log

Borehole No.

BH08

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403049.00 - 79345.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 7.50

Scale
1:50

Client: Swanage Council.

Dates: 09/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30			7.20		MADE GROUND, turf over, brown, sandy, slightly gravelly silt. Gravel is fine to coarse, angular and composed of siltstone.		
		1.00		N=7 (1,1/2,1,1,3)			MADE GROUND, firm, brown to orange, silty clay.	1	
		1.40			6.10		MADE GROUND, Soft (locally soft to firm), brown, clayey, slightly sandy, SILT.		
		2.00		N=8 (0,1/2,1,2,3)				2	
		2.20			5.30		Firm, yellow to orange to grey, silty CLAY. (Residual soil.) WEALDEN GROUP.		
		2.70			4.80		Stiff orange to purple, silty CLAY. (Residual soil) WEALDEN GROUP.		
		3.00		N=26 (3,4/5,5,7,9)				3	
		4.00		N=23 (4,4/4,5,6,8)				4	
		5.00		N=26 (4,4/6,6,6,8)				5	
		5.45			2.05		End of borehole at 5.45 m	6	
								7	
								8	
								9	
								10	

Remarks

1.) Window Sampled to 5.45 mbgl. 2) No groundwater encountered. 3) Piezometric install (sand response zone between 3-5mbgl.)





Borehole Log

Borehole No.

BH09

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403048.00 - 79249.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 8.40

Scale
1:50

Client: Swanage Council.

Dates: 10/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	8.20		MADE GROUND, turf over, brown to black, sandy, gravelly silt. Gravel includes, flint and siltstone. Occasional plastic, brick and asphalt encountered.
					0.30	8.10		
		1.00		N=5 (0,1/1,1,1,2)				MADE GROUND, brown, clayey sand. MADE GROUND, firm, brown to orange to grey, very silty, gravelly clay. Gravel is fine, rounded and of varied composition including chalk, siltstone. Occasional white shell fragment encountered.
					1.40	7.00		
		2.00		N=62 (7,11/12,16,16,18)	1.50	6.90		Soft to firm, brown, clayey, slightly gravelly SAND. Gravel is fine, sub-rounded to rounded, flint, siltstone and white chalk. (Residual soil) WEALDEN GROUP.
				2.45	5.95			
								Very dense, yellow, slightly clayey SAND. (Clay is localised to pockets).
								End of borehole at 2.45 m

Remarks
1.) Window Sampled to 2.45 mbgl. 2) No groundwater encountered. 3) Piezometric install (sand response zone between 1-2mbgl.)





Borehole Log

Borehole No.

BH10

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403047.00 - 79249.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 8.40

Scale
1:50

Client: Swanage Council.

Dates: 10/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40	8.00		MADE GROUND, turf over, brown to black, sandy, gravelly silt. Gravel includes, flint and siltstone. Occasional plastic, brick and asphalt encountered.
					2.00	6.40		MADE GROUND, firm, brown to orange to grey, very silty, gravelly clay. Gravel is fine, rounded and of varied composition including chalk, siltstone. Occasional white shell fragment encountered.
					2.90	5.50		MADE GROUND, firm (locally soft to firm), dark brown to brown, very silty, gravelly clay. Gravel is fine, rounded and of varied composition including chalk, siltstone. Occasional white shell fragment encountered.
				69 (7,9/69 for 275mm)	3.38	5.02		Very dense, yellow, slightly clayey SAND. (Clay is localised to pockets).
		3.00			End of borehole at 3.38 m			

Remarks

1.) Window Sampled to 3.38 mbgl. 2) No groundwater encountered. 3) Inclinator install from 0-3mbgl.





Borehole Log

Borehole No.

BH11

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403049.00 - 79195.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 9.00

Scale
1:50

Client: Swanage Council.

Dates: 10/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.13	8.87		MADE GROUND, turf over, brown, clayey, slightly sandy silt. Contains rootlets. MADE GROUND, firm, yellow to orange to grey, silty, slightly sandy clay.	1
		1.00		N=11 (1,1/2,3,2,4)	1.30	7.70		Stiff, orange to grey, silty, slightly sandy, CLAY (Residual soil) WEALDEN GROUP. <i>Fissuring encountered.</i>	2
		2.00		N=16 (1,2/3,3,4,6)	2.50	6.50		Stiff, light grey (locally orange), silty, slightly sandy, CLAY (Residual soil) WEALDEN GROUP.	3
		3.00		N=30 (2,5/6,6,8,10)	3.10	5.90		Extremely weak, grey, extremely closely spaced fractured clayey MUDSTONE. Highly weathered. Recovered as a stiff (locally very stiff), silty clay. WEALDEN GROUP.	4
		4.00		N=51 (3,7/10,11,14,16)	4.45	4.55		End of borehole at 4.45 m	5

Remarks

1.) Window Sampled to 4.45 mbgl. 2) No groundwater encountered. 3) Piezometric install (sand response zone between 3-4mbgl.)





Borehole Log

Borehole No.

BH12

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403049.00 - 79194.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

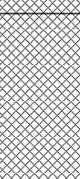
Level: 9.00

Scale
1:50

Client: Swanage Council.

Dates: 10/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.13	8.87	 <p>MADE GROUND, turf over, brown, clayey, slightly sandy silt. Contains rootlets. MADE GROUND, firm, yellow to orange to grey, silty, slightly sandy clay.</p>	1
					1.30	7.70		
					2.50	6.50	 <p>Stiff, light grey (locally orange), silty, slightly sandy, CLAY (Residual soil) WEALDEN GROUP.</p>	3
					3.10	5.90		
					4.45	4.55	<p>End of borehole at 4.45 m</p>	

Remarks

1.) Window Sampled to 4 mbgl. 2) No groundwater encountered. 3) Inclinator install from 0-4mbgl.





Borehole Log

Borehole No.

BH13

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403043.00 - 79159.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 6.20

Scale
1:50

Client: Swanage Council.

Dates: 11/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20			0.20	6.00		MADE GROUND, turf over, brown, clayey, slightly sandy silt. Contains rootlets.
		1.00		N=17 (2,3/3,4,4,6)	0.90	5.30		MADE GROUND, firm, yellow to orange to grey, silty, slightly sandy clay. Fine red brick fragments encountered at 0.7m)
		2.00		N=20 (2,3/4,5,5,6)				Stiff, purple to yellow to white, silty, slightly sandy, CLAY (Residual soil) WEALDEN GROUP.
		3.00		N=25 (2,4/4,6,7,8)	3.45	2.75		<i>Slight fissuring encountered.</i>
End of borehole at 3.45 m								

Remarks

1.) Window Sampled to 3.45 mbgl. 2) Groundwater encountered at 0.90mbgl. 3) Standpipe install from 0-1.5mbgl.





Borehole Log

Borehole No.

BH14

Sheet 1 of 1

Project Name: Swanage Seafront	Project No. 12660	Co-ords: 403043.00 - 79157.00	Hole Type WLS
Location: Swanage Seafront, Dorset.		Level: 6.20	Scale 1:50
Client: Swanage Council.		Dates: 11/12/2020 -	Logged By ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
	▼				0.20	6.00	[Cross-hatch pattern]	MADE GROUND, turf over, brown, clayey, slightly sandy silt. Contains rootlets.	1
					0.90	5.30		MADE GROUND, firm, yellow to orange to grey, silty, slightly sandy clay.	
					3.00	3.20	[X-pattern]	Stiff, purple to yellow to white, silty, slightly sandy, CLAY (Residual soil) WEALDEN GROUP.	
							<u>Slight fissuring encountered.</u>	3	
							End of borehole at 3.00 m	4	
								5	
								6	
								7	
								8	
								9	
								10	

Remarks
 1.) Window Sampled to 3 mbgl. 2) Groundwater encountered at 0.90mbgl. 3) Inclinator install from 0-3mbgl.





Borehole Log

Borehole No.

BH15

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 403015.00 - 79164.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 8.42

Scale
1:50

Client: Swanage Council.

Dates: 11/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20			8.22		MADE GROUND, turf over, brown, clayey, slightly sandy silt. Contains rootlets.	
		0.60			7.82		MADE GROUND, soft, brown, slightly clayey, very sandy silt.	
	1.00		N=8 (1,1/2,2,2,2)				MADE GROUND, firm, orange to red to grey, silty, slightly gravelly clay. Gravel is white, fine to medium, rounded, chalk.	
	2.00		N=19 (2,3/3,4,6,6)	2.10	6.32		Stiff, purple to grey, silty CLAY (Residual soil) WEALDEN GROUP.	
	3.00		N=28 (3,4/5,6,8,9)					
4.00		N=26 (4,5/6,6,8,6)						
5.00		N=33 (3,5/6,7,8,12)		5.45	2.97			
		End of borehole at 5.45 m						

Remarks

1.) Window Sampled to 5.45 mbgl. 2) Groundwater encountered at 3mbgl. 3) Piezometric install (sand response zone between 2.8-4mbgl.)





Borehole Log

Borehole No.

BH16

Sheet 1 of 1

Project Name: Swanage Seafront	Project No. 12660	Co-ords: 403001.00 - 79193.00	Hole Type WLS
Location: Swanage Seafront, Dorset.		Level: 8.55	Scale 1:50
Client: Swanage Council.		Dates: 14/12/2020 -	Logged By ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	8.35		MADE GROUND, turf over, soft, dark brown, clayey, slightly sandy silt. Contains rootlets.
					0.80	7.75		MADE GROUND, firm, light brown, very silty, sandy (locally very sandy) clay. Contains rootlets.
					2.60	5.95		MADE GROUND, Firm orange to grey, silty, slightly sandy clay.
					4.00	4.55		Stiff grey (locally purple), silty, slightly sandy CLAY. (Residual soil) WEALDEN GROUP.
End of borehole at 4.00 m								

Remarks
 1) Dynamic sampled from 0-4mbgl. 2) Ground water encountered at 2mbgl. 3) inclinometer from 0-4mbgl.





Borehole Log

Borehole No.

BH17

Sheet 1 of 1

Project Name: Swanage Seafront

Project No.
12660

Co-ords: 402999.00 - 79247.00

Hole Type
WLS

Location: Swanage Seafront, Dorset.

Level: 10.05

Scale
1:50

Client: Swanage Council.

Dates: 15/12/2020 -

Logged By
ZM

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	9.85		MADE GROUND, turf over, soft, dark brown, clayey, slightly sandy silt. Contains rootlets.
					0.50	9.55		MADE GROUND, firm, light brown, very silty, sandy (locally very sandy) clay. Contains rootlets.
					0.80	9.25		MADE GROUND, firm, orange, very silty, sandy (locally very sandy) clay. Contains rootlets.
								Dense, yellow to grey, clayey SAND. Clay is confined to pockets. (Residual soil) WEALDEN GROUP.
								Open hole drilling from 2-7mbgl (geology inferred.)
					7.00	3.05		End of borehole at 7.00 m

Remarks

1) Dynamic sampled from 0-2mbgl. 2) Open holed from 2-7mbgl. 3) No groundwater encountered. 4.) Stand pipe installed from 1-7mbgl.





Window Sample Rig set over BH01



Rotary Rig set up over BH01.



Site compound in Sandpit field.



BH01.



BH02



BH03



BH04



BH05



BH06



BH07



BH08



BH09



BH10



BH11



BH13



BH14



BH15



BH16

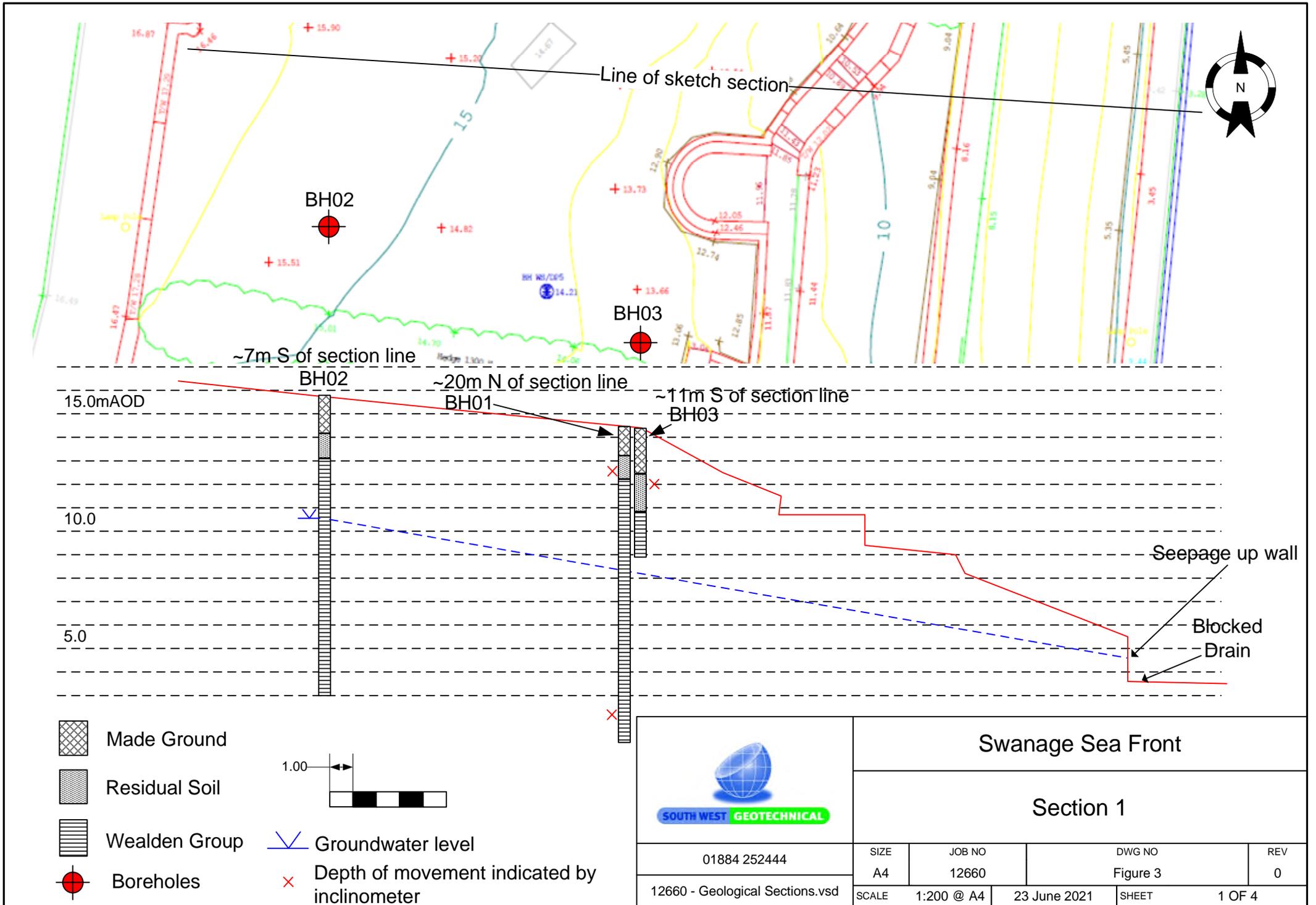


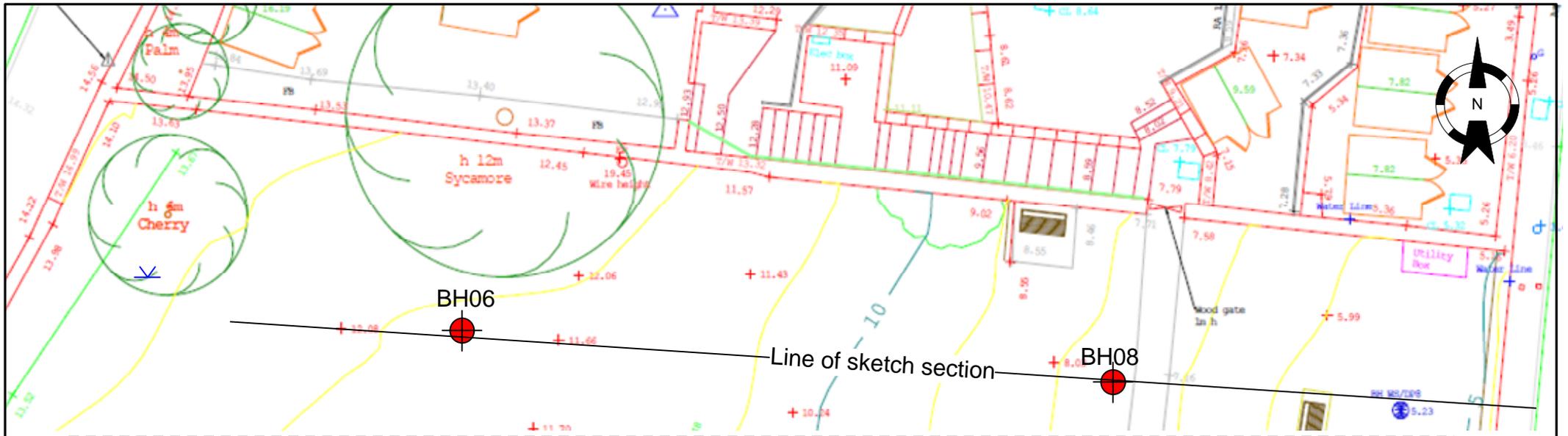
BH17



Appendix E

Geological Cross Sections





15.0m AOD

10.0

5.0

BH06

BH08

+9.00m

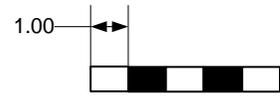
+5.45m

Groundwater level

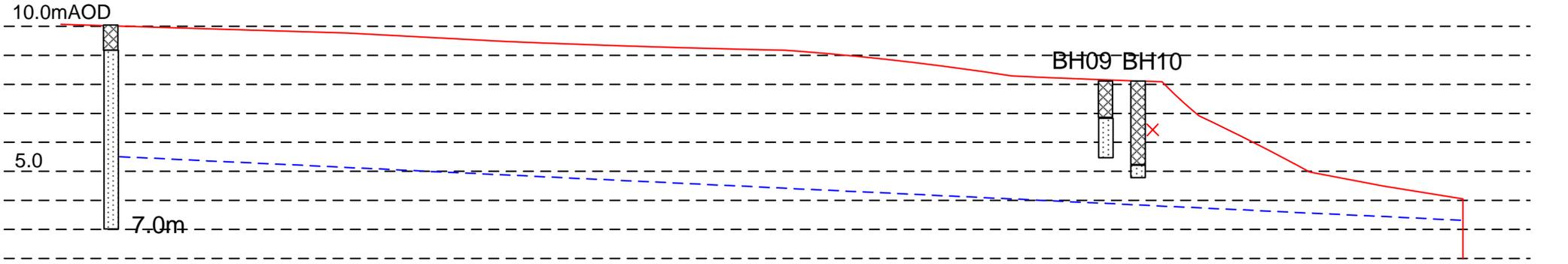
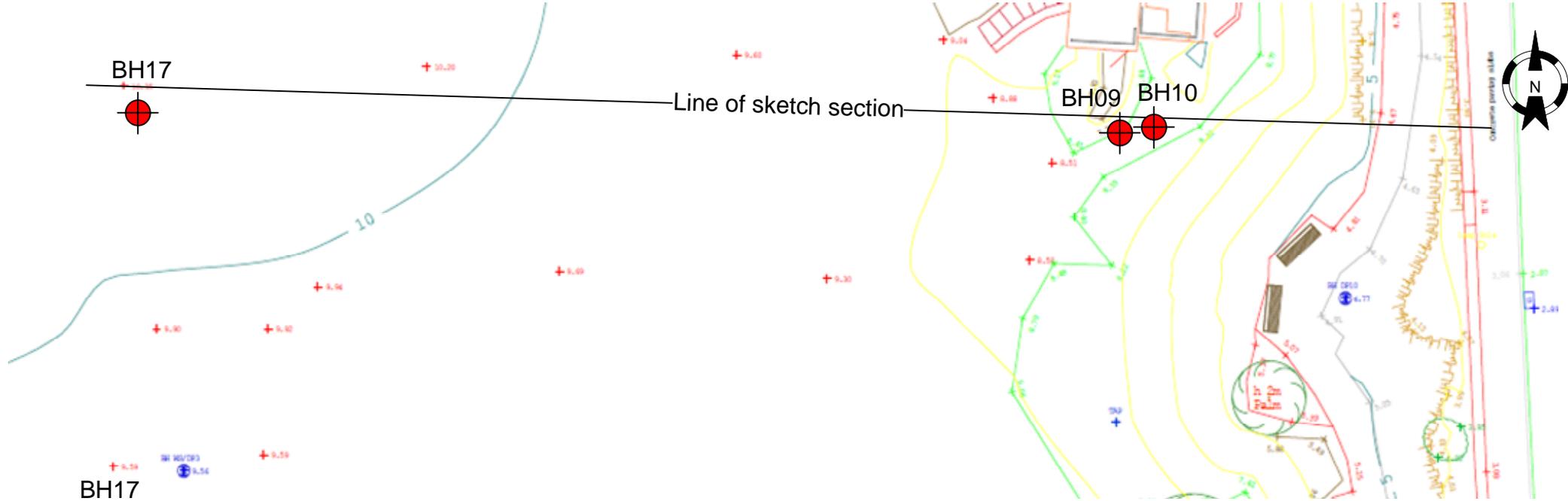
Inclinometer reading taken from BH07

Groundwater seepage = 0.6m up wall

-  Made Ground
-  Residual Soil
-  Wealden Group
-  Boreholes
-  Groundwater level
-  Depth of movement indicated by inclinometer

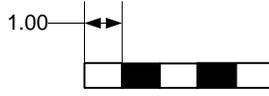


		Swanage Sea Front			
		Section 2			
01884 252444		SIZE A4	JOB NO 12660	DWG NO Figure 3	REV 0
12660 - Geological Sections.vsd		SCALE 1:200@A4	23 June 2021	SHEET	2 OF 4

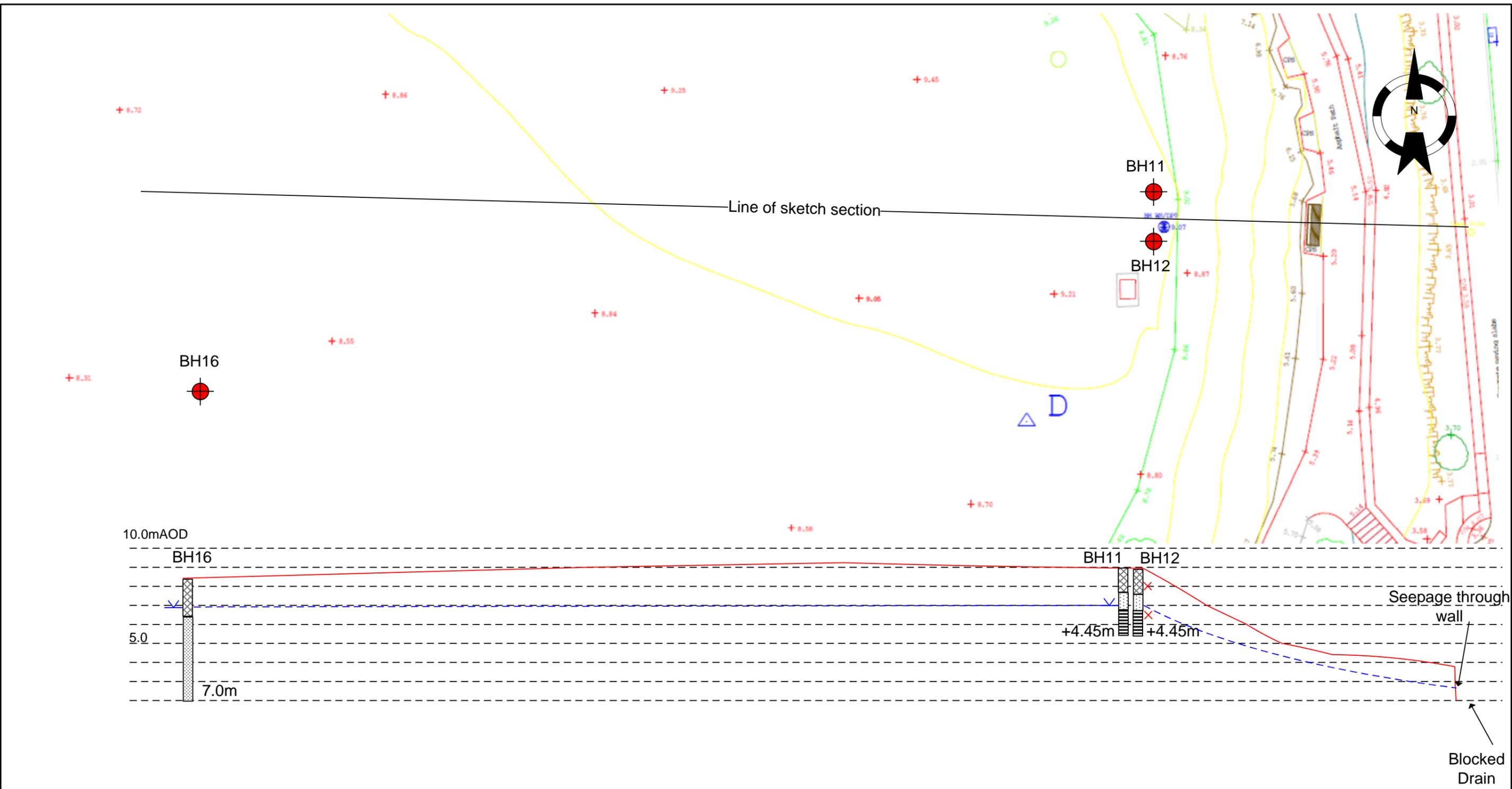


-  Made Ground
-  Sand
-  Boreholes
-  Groundwater level

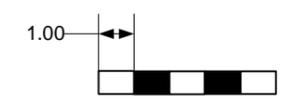
 Depth of movement indicated by inclinometer



	Swanage Sea Front			
	Section 3			
01884 252444	SIZE A4	JOB NO 12660	DWG NO Figure 4	REV 0
12660 - Geological Sections.vsd	SCALE 1:200@A4	23 June 2021	SHEET	3 OF 4



-  Made Ground
-  Residual Soil
-  Boreholes
-  Groundwater level
-  Depth of movement indicated by inclinometer



	Swanage Sea Front			
	Section 4			
01884 252444	SIZE A3	JOB NO 12660	DWG NO Figure 4	REV 0
12660 - Geological Sections.vsd	SCALE 1:200@A3	23 June 2021	SHEET	4 OF 4



Appendix F

Geotechnical Laboratory Test Results



Summary of Classification Test Results

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name	 8260 Accredited to ISO/IEC 17025:2017
12660	Swanage Seafront	
Client Job No.	Client	
-	South West Geotechnical Ltd	

Hole No.	Sample				Soil Description	WC	Passing 425µm	LL	PL	PI	Particle density	Remarks
	Type	Top	Base	Ref								
BH01	D	0.50			Dark brown slightly gravelly slightly sandy CLAY	21.0	89 - Sieved	39 - 1pt	19	20	-	
BH02	D	0.70			Brown and grey slightly gravelly slightly sandy CLAY	25.0	95 - Sieved	61 - 1pt	21	40	-	
BH02	D	3.50			Grey slightly sandy CLAY	18.0	100 - Natural	47 - 1pt	18	29	-	
BH03	D	0.70			Yellowish brown slightly gravelly slightly sandy CLAY	22.0	92 - Sieved	45 - 1pt	17	28	-	
BH04	D	0.50			Orangish brown slightly gravelly slightly sandy CLAY	27.0	98 - Sieved	50 - 1pt	19	31	-	
BH04	D	2.00			Dark grey and grey slightly gravelly slightly sandy CLAY	12.0	99 - Sieved	35 - 1pt	14	21	-	
BH05	D	0.40			Dark brown slightly gravelly slightly sandy CLAY	24.0	94 - Sieved	48 - 1pt	21	27	-	
BH06	D	3.80			Greenish grey slightly gravelly slightly sandy CLAY	28.0	95 - Sieved	53 - 1pt	24	29	-	
BH07	D	1.20			Reddish brown slightly gravelly slightly sandy CLAY	27.0	96 - Sieved	56 - 1pt	23	33	-	
BH11	D	0.70			Orangish brown and grey slightly sandy CLAY	22.0	100 - Natural	42 - 1pt	15	27	-	

Preparation in accordance with BS1377-1:2016 where applicable. Atterberg 4 point preparation in accordance with BS EN ISO 17892-12:2018

Key Atterberg Limits 4pt - BS EN ISO 17892-12:2018 (30° cone and increasing water contents) unless : 1pt - BS1377-2:1990 (CL.4.4)	Water Content (wc) % BS EN ISO 17892-1:2014 Particle density BS1377-2:1990 sp - small pyknometer CL.8.3 gj - gas jar CL.8.2	Date	Approved By	Page No.	1
		10/02/2021	Matt Stokes - Senior Technician	KL001R Index Summary	



Summary of Classification Test Results

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name										
12660	Swanage Seafront										
Client Job No.	Client										
-	South West Geotechnical Ltd										



8260
Accredited to
ISO/IEC
17025:2017

Hole No.	Sample				Soil Description	WC	Passing 425µm	LL	PL	PI	Particle density	Remarks
	Type	Top	Base	Ref								
BH13	D	0.50			Brown slightly gravelly slightly sandy CLAY	23.0	97 - Sieved	46 - 1pt	17	29	-	
BH13	D	1.50			Purplish brown mottled orangish brown and grey slightly sandy CLAY	15.0	100 - Natural	40 - 1pt	16	24	-	
BH15	D	0.50			Brown slightly gravelly slightly sandy CLAY	22.0	80 - Sieved	30 - 1pt	15	15	-	
BH15	D	4.00			Grey and orangish brown slightly gravelly slightly sandy CLAY	21.0	90 - Sieved	45 - 1pt	22	23	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	

Preparation in accordance with BS1377-1:2016 where applicable. Atterberg 4 point preparation in accordance with BS EN ISO 17892-12:2018

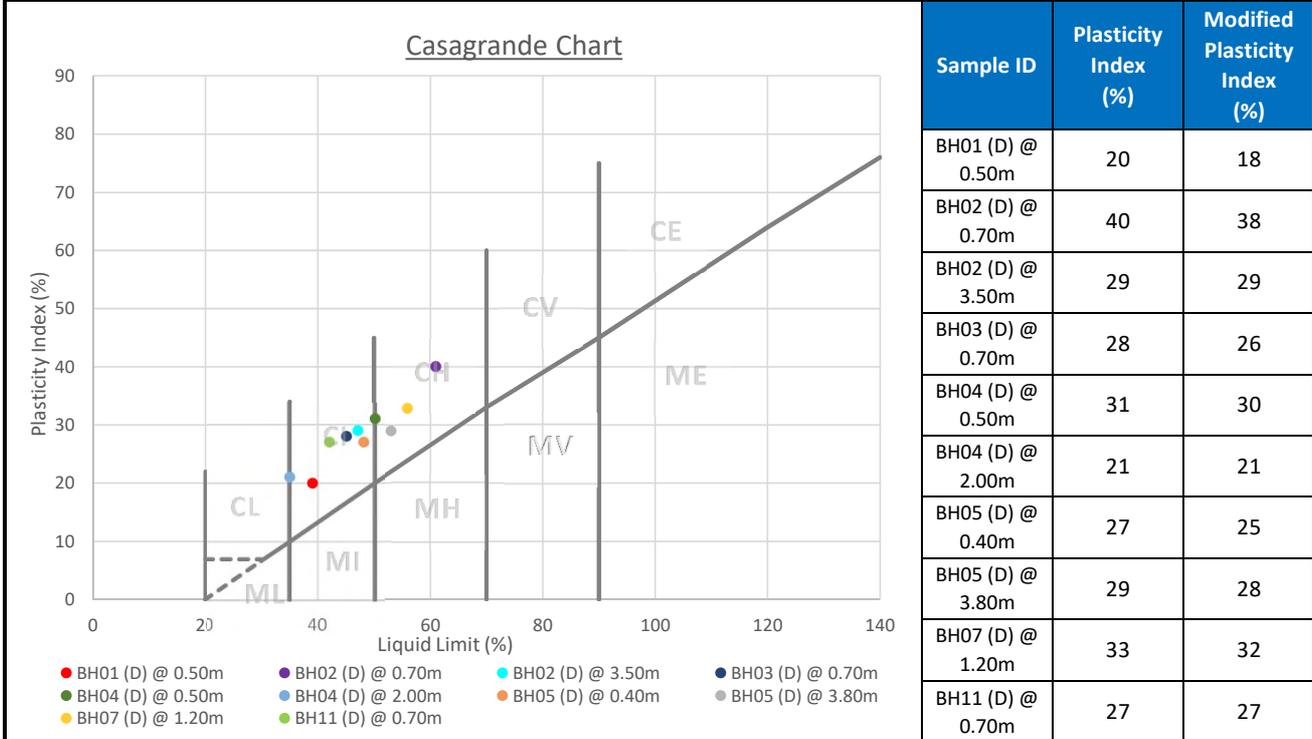
Key Atterberg Limits 4pt - BS EN ISO 17892-12:2018 (30° cone and increasing water contents) unless : 1pt - BS1377-2:1990 (CL.4.4)	Water Content (wc) % BS EN ISO 17892-1:2014 Particle density BS1377-2:1990 sp - small pyknometer CL.8.3 gj - gas jar CL.8.2	Date	Approved By	Page No.	2
		10/02/2021	Matt Stokes - Senior Technician	KL001R Index Summary	



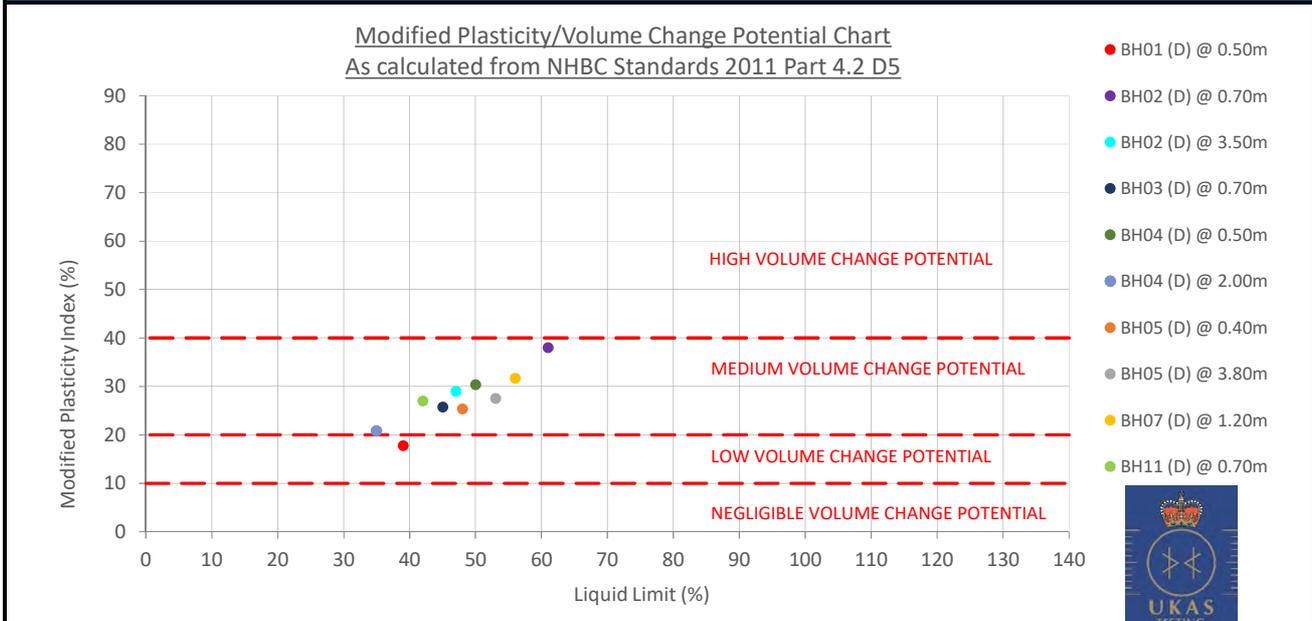
Graphical Summary of Atterberg Test Results

**Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW**

Project No.	Project Name
12660	Swanage Seafront
Client Job No.	Client
-	South West Geotechnical Ltd



**The Modified Plasticity Index (I_p) is defined as the Plasticity Index (I_p) of the soil multiplied by the percentage of particles less than 425µm.
ie. I_p x % less than 425µm/100%**



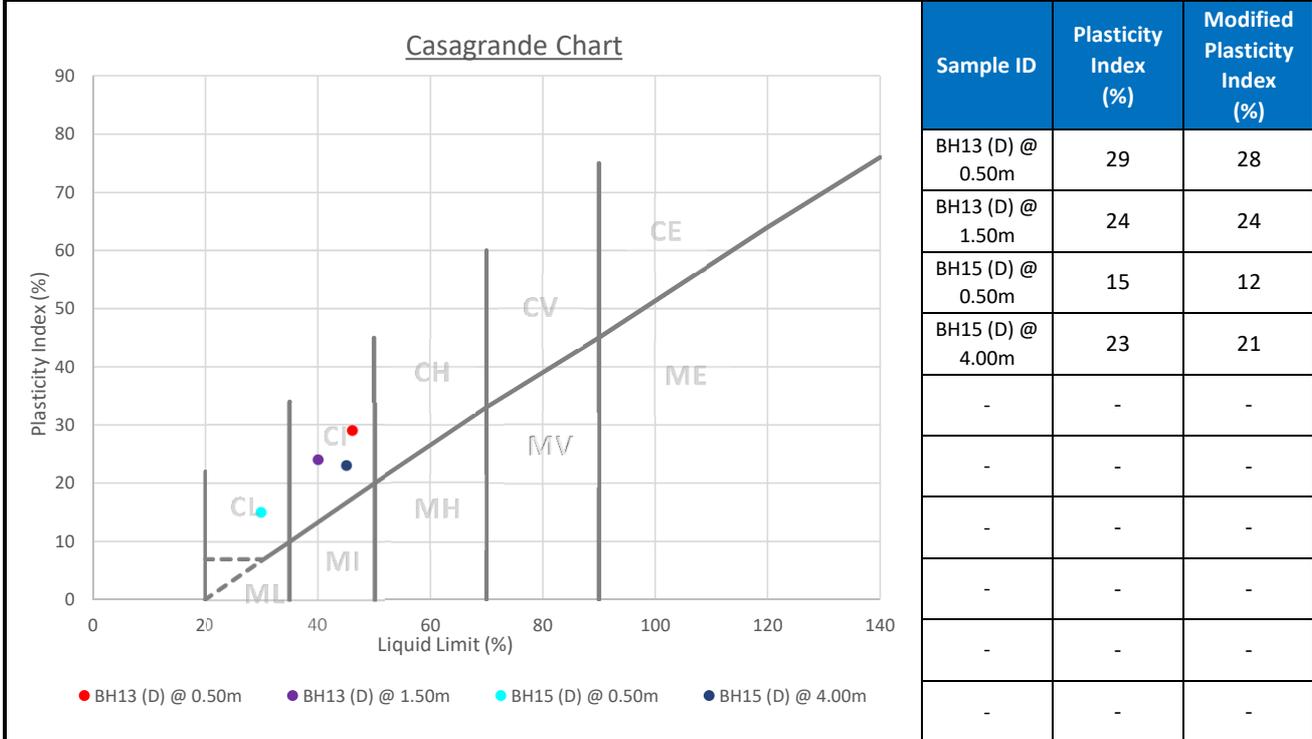
KL001a Index Graphical Summary	Approved By	Date
	David Trowbridge - Laboratory Manager	10/02/2021 09:50



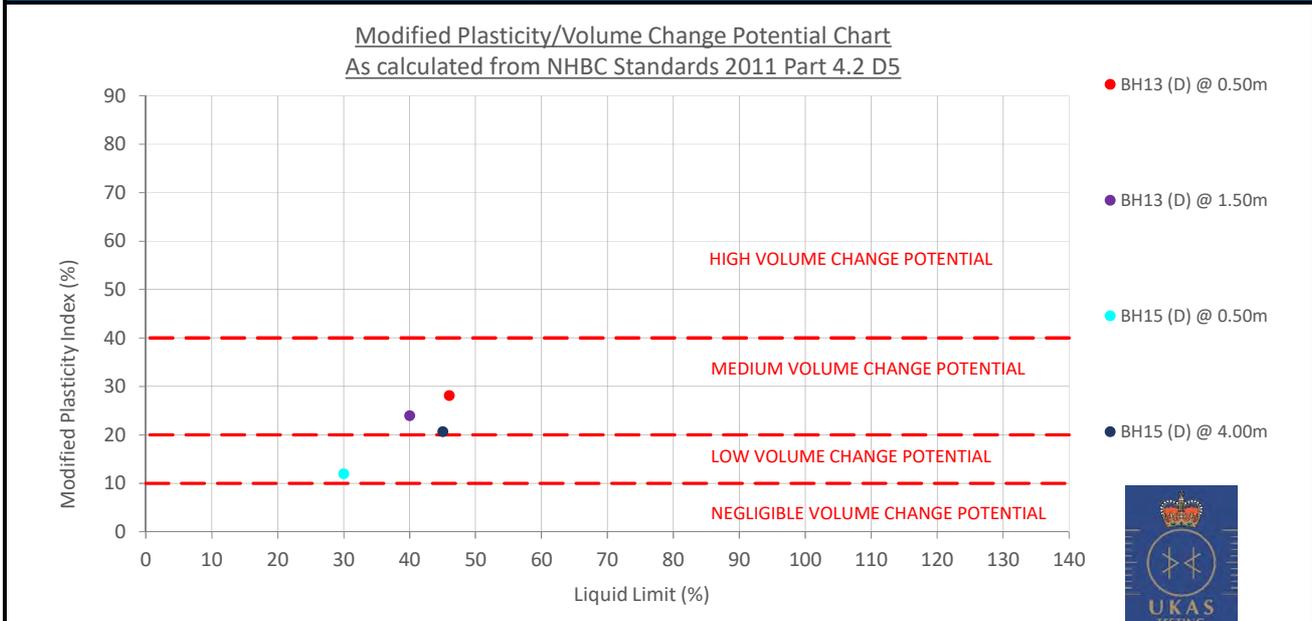
Graphical Summary of Atterberg Test Results

**Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW**

Project No.	Project Name
12660	Swanage Seafront
Client Job No.	Client
-	South West Geotechnical Ltd

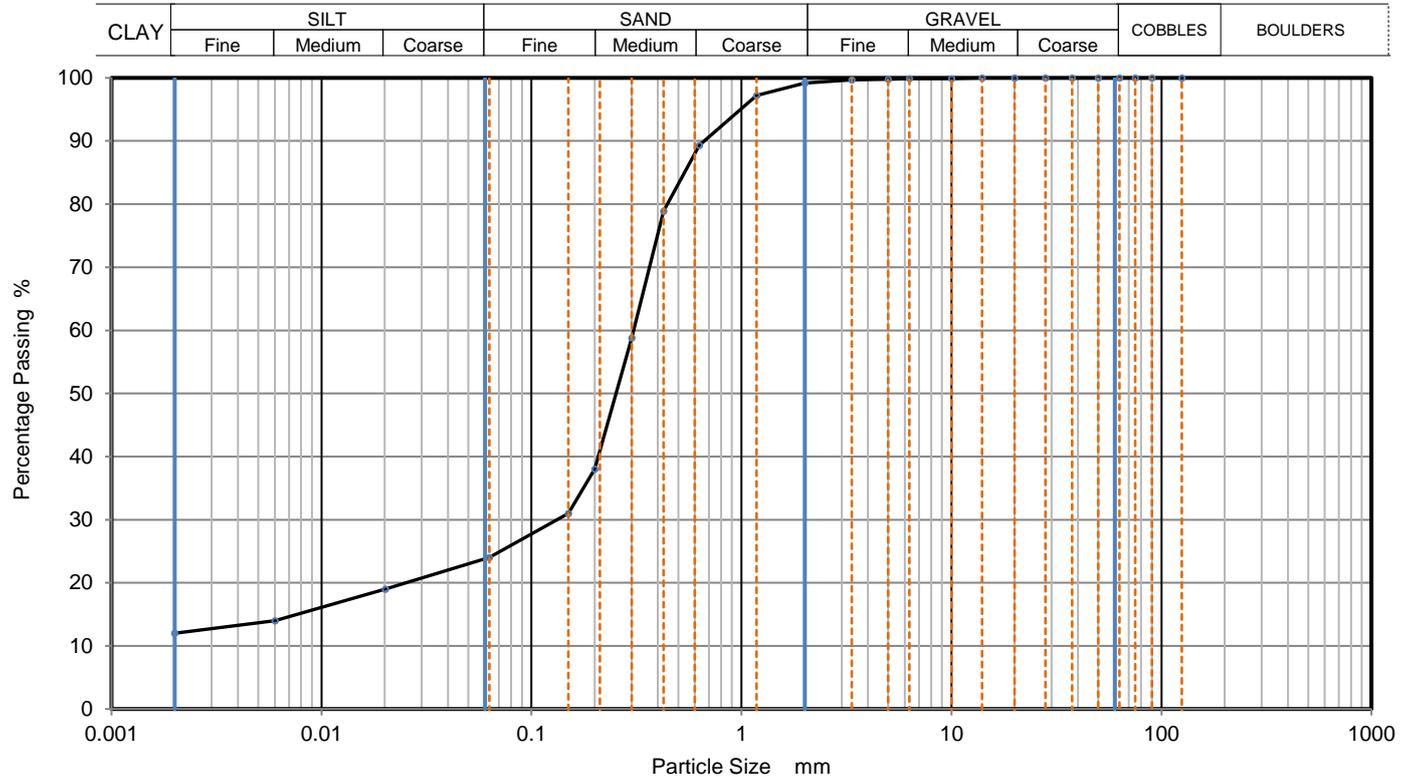


**The Modified Plasticity Index (I_p) is defined as the Plasticity Index (I_p) of the soil multiplied by the percentage of particles less than 425µm.
ie. I_p x % less than 425µm/100%**



KL001a Index Graphical Summary	Approved By	Date
	David Trowbridge - Laboratory Manager	10/02/2021 09:53

	PARTICLE SIZE DISTRIBUTION		Project No.	12660	
			Borehole/Pit No.	BH09	
Project Name	Swanage Seafront		Sample No.		
Soil Description	Light brown slightly gravelly very clayey SAND		Depth, m	1.50	
Specimen Reference	4	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.4				



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0201	19
90	100	0.0060	14
75	100	0.0020	12
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	99		
1.18	97		
0.63	89		
0.425	79	Particle density (assumed)	
0.3	59	2.65	Mg/m3
0.2	38		
0.15	31		
0.063	24		

Dry Mass of sample, g	1960
-----------------------	------

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	75
Silt	12
Clay	12

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

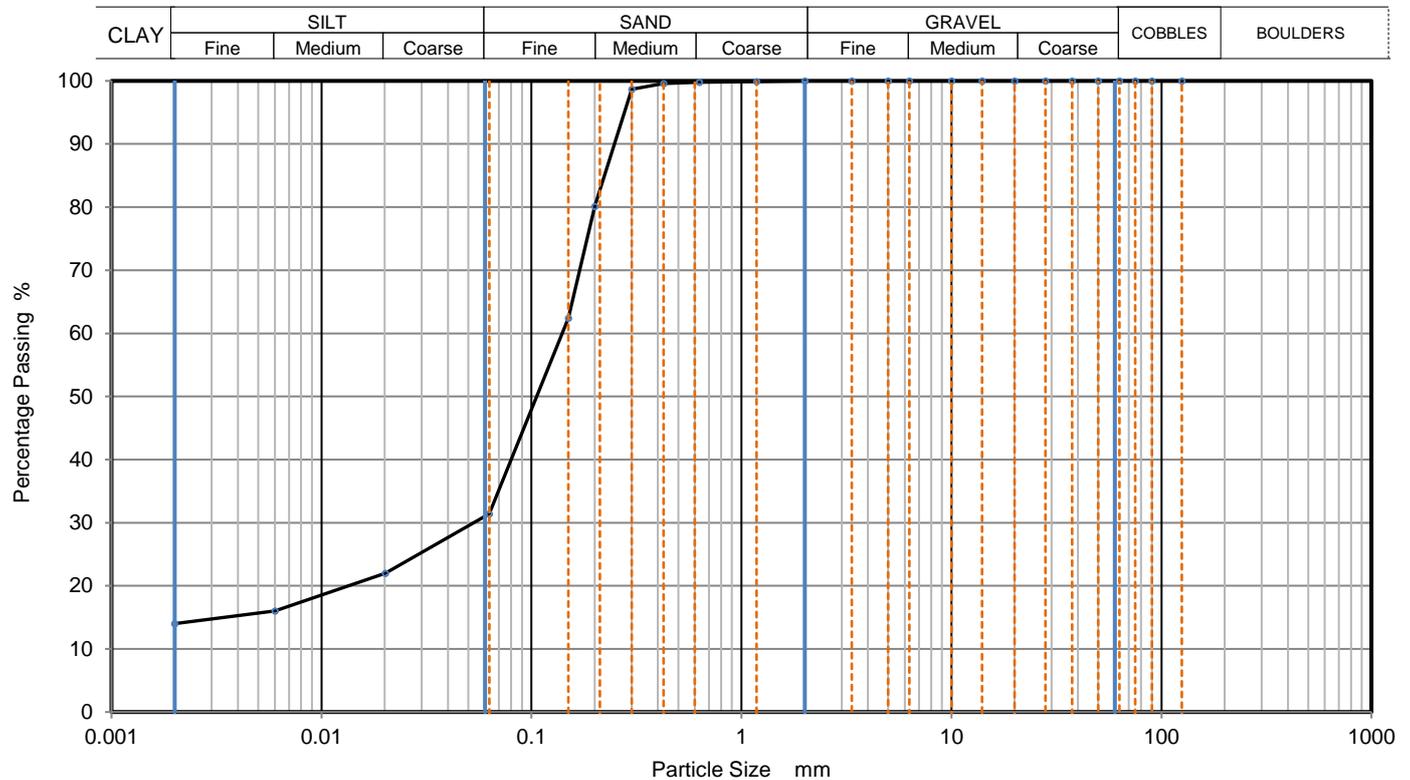
Remarks
Preparation and testing in accordance with BS1377 unless noted below
Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5



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Accredited to
ISO/IEC
17025:2017

Approved by	Date	Sheet ID:
Matt Stokes - Senior Technician	10/02/2021	KL002R PSD

	PARTICLE SIZE DISTRIBUTION		Project No.	12660	
			Borehole/Pit No.	BH17	
Project Name	Swanage Seafront		Sample No.		
Soil Description	Light brown very clayey SAND		Depth, m	1.10	
Specimen Reference	2	Specimen Depth	m	Sample Type	D
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.4				



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0201	22
90	100	0.0060	16
75	100	0.0020	14
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.63	100	Particle density (assumed)	
0.425	100	2.65	Mg/m ³
0.3	99		
0.2	80		
0.15	62		
0.063	31		

Dry Mass of sample, g	467
-----------------------	-----

Sample Proportions	% dry mass
Very coarse	0
Gravel	0
Sand	69
Silt	18
Clay	14

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks
Preparation and testing in accordance with BS1377 unless noted below
Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5



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ISO/IEC
17025:2017

Approved by	Date	Sheet ID:
Matt Stokes - Senior Technician	10/02/2021	KL002R PSD



Determination of Shear Strength using the Small Direct Shearbox Apparatus

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

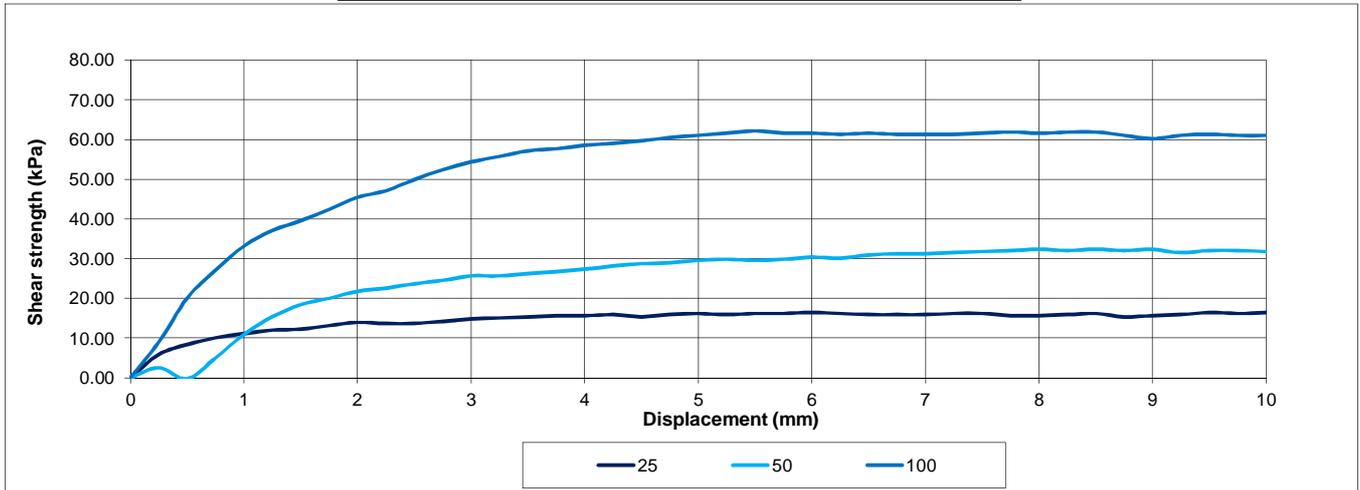
Project Name	Swanage Seafront	Project No.	12660
Client:	South West Geotechnical Ltd	Borehole / Pit No.	BH09
Soil Description	Light brown slightly gravelly very clayey SAND	Client Job No:	-
Specimen Description	Light brown very clayey SAND	Depth (m)	1.5
Test Method	Tests carried out in accordance with Clause 4 of BS1377: 1990: Part 7: CL 4.5.4 (Single Stage) using the fraction passing a 2.0mm sieve	Sample No.	-
Sample Type	Bulk sample	Date of test	01/02/2021

Preparation Details	Test prepared in accordance with BS1377:1990:Part 7: CL4.4.3.5	Assumed Particle Density (Mg/m3)	2.65
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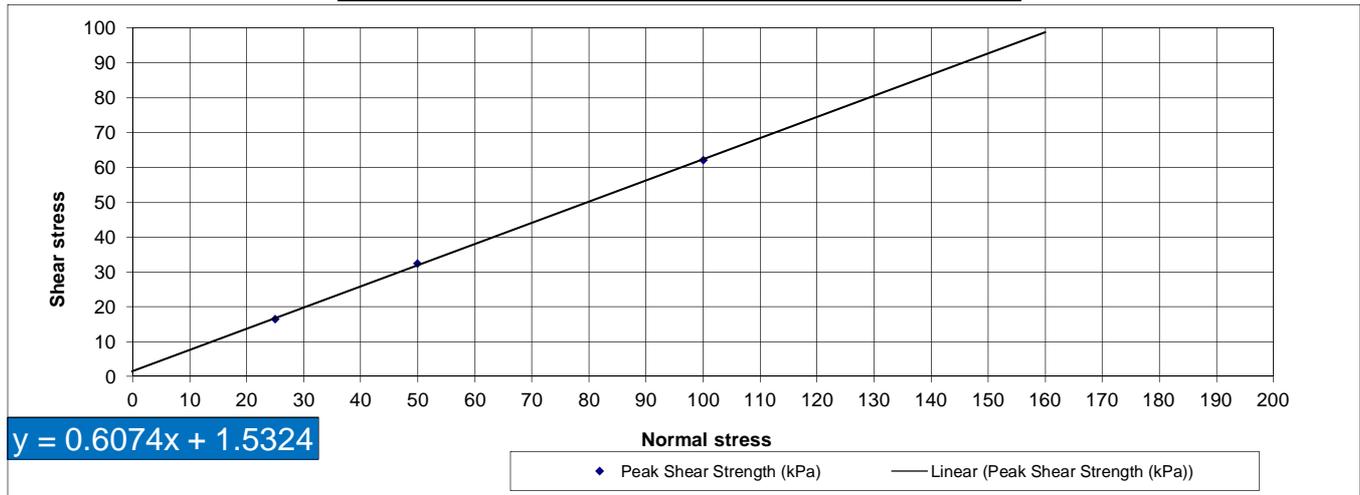
Rate of displacement (mm/min)	Test Dry or Submerged	Load Stage (kPa)	Initial Moisture Content %	Initial Height (mm)	Initial Bulk Density (Mg/m3)	Initial Dry Density (Mg/m3)	Specimen Width (mm)	Specimen Length (mm)	Consolidated Height (mm)	Peak Shear Strength (kPa)	Horizontal Displacement At Peak (mm)
1.969	Submerged	25	6.2	20.10	1.76	1.66	59.95	59.87	19.17	16	6.0
1.969		50		20.36	1.74	1.64			19.46	32	8.0
0.787		100		20.38	1.73	1.63			19.18	62	5.5

Angle of friction (Peak) °	31	Peak Cohesion (kPa)	1.5	Angle of friction (Residual) °	-	Residual Cohesion (kPa)	-
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Shear stress versus Horizontal Displacement



Maximum shear stress versus Normal Applied Stress



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Remarks:

Approved by	Date Approved
David Trowbridge - Laboratory Manager	10/02/2021 10:16



LABORATORY REPORT



4043

Contract Number: PSL21/0310

Report Date: 29 January 2021

Client's Reference: 12660

Client Name: South West Geotechnical
Unit 3 Brooklands
Howden Road
Tiverton
Devon
EX16 5HW

For the attention of: David Trowbridge

Contract Title: Swanage Seafront

Date Received: 12/1/2021
Date Commenced: 12/1/2021
Date Completed: 29/1/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)


S Royle
(Laboratory Manager)

L Knight
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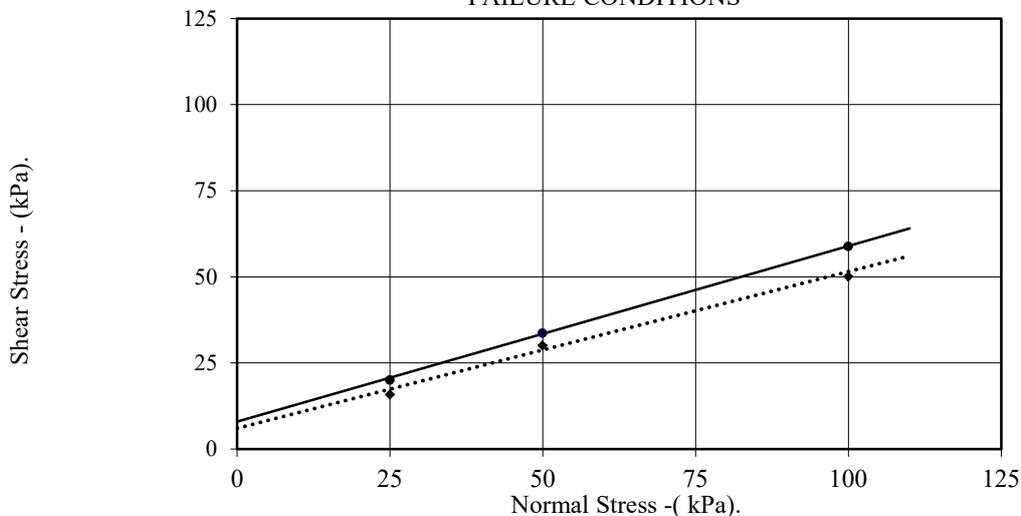
Page 1 of

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH01		Top Depth	1.50	
Sample Number:			Base Depth		
Sample Conditions:	Submerged		Sample Type	D	
Particle Density - Mg/m ³ :	2.65	Assumed	Remarks:		
Specimen Preparation	Material tested passing 2mm sieve Remoulded using 2.5kg effort				
Sample Description:	Brown slightly gravelly slightly sandy CLAY.				
STAGE		1	2	3	
Initial Conditions					
Height - mm:		20.05	20.05	20.05	
Length - mm:		59.97	59.97	59.97	
Moisture Content - %:		19	19	19	
Bulk Density - Mg/m ³ :		1.98	1.98	1.98	
Dry Density - Mg/m ³ :		1.66	1.66	1.66	
Voids Ratio:		0.593	0.593	0.593	
Normal Pressure- kPa		25	50	100	
Consolidation Stage					
Consolidated Height - mm:		19.46	18.70	18.19	
Peak Shear					
Rate of Strain - mm/min		0.051	0.051	0.051	
Displacement at peak shear stress - mm		5.10	9.00	6.90	
Peak shear Stress - kPa:		20	34	59	
Residual Shear					
Rate of Strain - mm/min		0.102	0.102	0.102	
Displacement at residual shear stress - mm		19.00	30.00	29.00	
Residual shear Stress - kPa:		16	30	50	
Final Consolidation Conditions					
Moisture Content - %:		25	23	21	
Bulk Density - Mg/m ³ :		2.04	2.12	2.18	
Dry Density - Mg/m ³ :		1.64	1.72	1.80	
Peak Shear					
Angle of Shearing Resistance:(θ)		27			
Effective Cohesion - kPa:		8			
Residual Shear					
Angle of Shearing Resistance:(θ)		25			
Effective Cohesion - kPa:		6			

FAILURE CONDITIONS



- Peak shear Stress - kPa: ——— Best Fit Line (Peak Shear Stress - kPa)
- ◆ Residual Shear Peak - kPa: Best Fit Line (Residual Shear Stress - kPa)



PSL
Professional Soils Laboratory

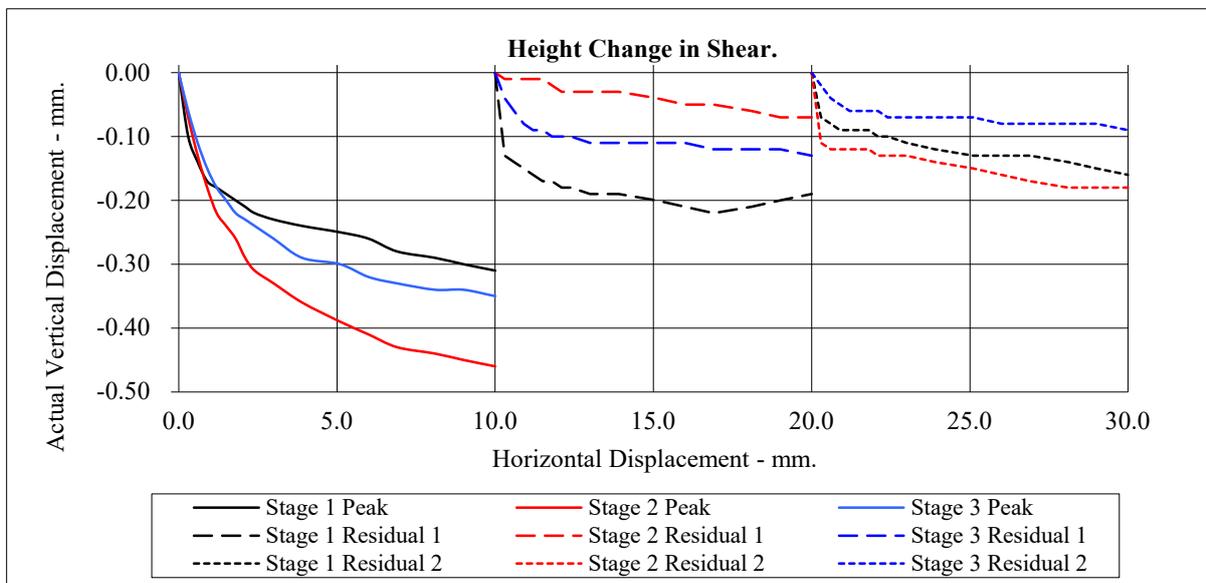
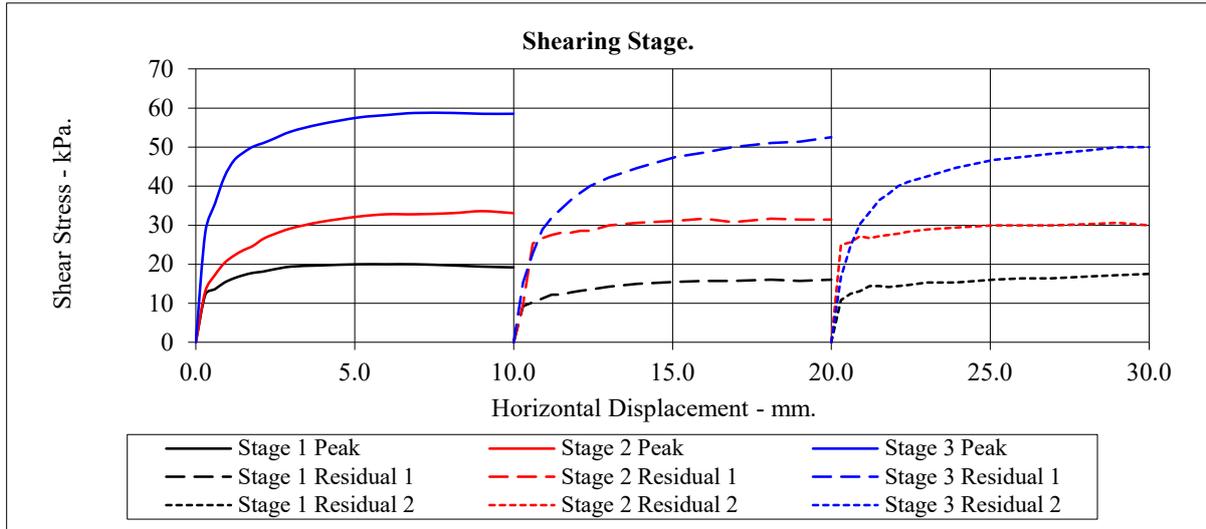
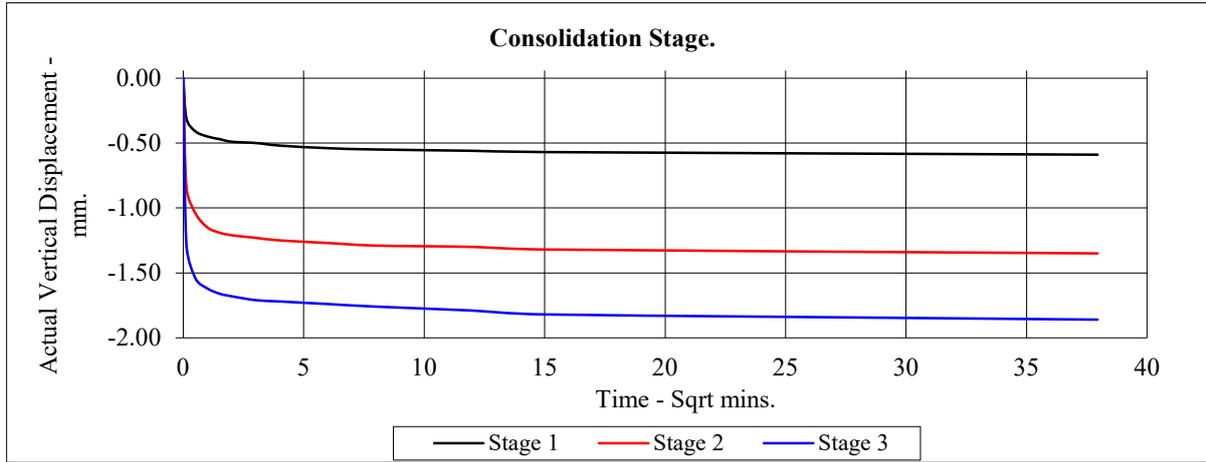
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH01	Top Depth:	1.50
Sample Number:		Base Depth:	



PSL

Professional Soils Laboratory

Swanage Seafront

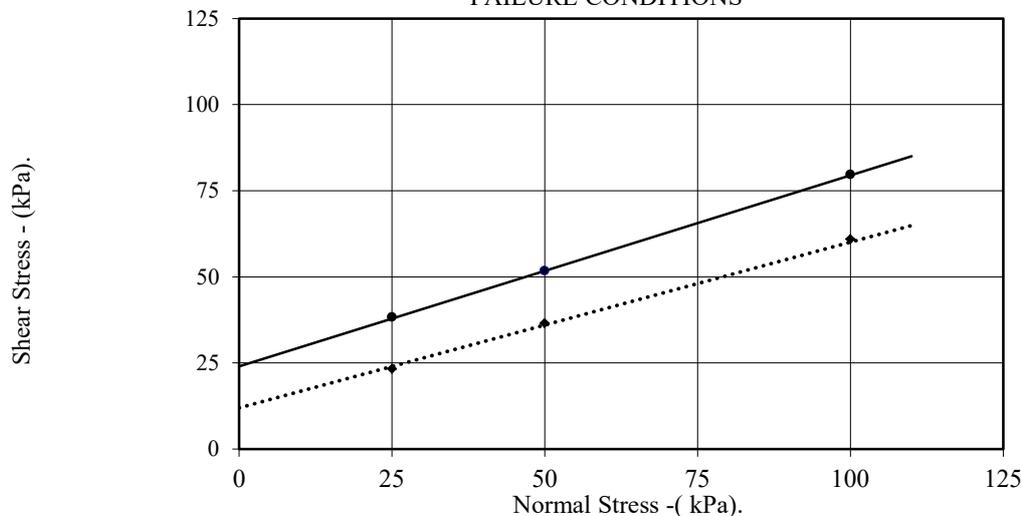
Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH04		Top Depth	1.00	
Sample Number:			Base Depth		
Sample Conditions:	Submerged		Sample Type	D	
Particle Density - Mg/m ³ :	2.65	Assumed	Remarks:		
Specimen Preparation	Material tested passing 2mm sieve Remoulded using 2.5kg effort				
Sample Description:	Brown slightly gravelly slightly sandy CLAY.				
STAGE		1	2	3	
Initial Conditions					
Height - mm:		20.05	20.05	20.05	
Length - mm:		59.97	59.97	59.97	
Moisture Content - %:		19	19	19	
Bulk Density - Mg/m ³ :		2.06	2.06	2.06	
Dry Density - Mg/m ³ :		1.73	1.73	1.73	
Voids Ratio:		0.529	0.529	0.529	
Normal Pressure- kPa		25	50	100	
Consolidation Stage					
Consolidated Height - mm:		19.78	19.42	19.17	
Peak Shear					
Rate of Strain - mm/min		0.047	0.047	0.047	
Displacement at peak shear stress - mm		3.00	10.00	8.10	
Peak shear Stress - kPa:		38	52	80	
Residual Shear					
Rate of Strain - mm/min		0.094	0.094	0.094	
Displacement at residual shear stress - mm		30.00	26.90	30.00	
Residual shear Stress - kPa:		23	37	61	
Final Consolidation Conditions					
Moisture Content - %:		23	22	21	
Bulk Density - Mg/m ³ :		2.09	2.13	2.16	
Dry Density - Mg/m ³ :		1.70	1.75	1.78	
Peak Shear					
Angle of Shearing Resistance:(θ)		29			
Effective Cohesion - kPa:		24			
Residual Shear					
Angle of Shearing Resistance:(θ)		26			
Effective Cohesion - kPa:		12			

FAILURE CONDITIONS



- Peak shear Stress - kPa: ——— Best Fit Line (Peak Shear Stress - kPa)
- ◆ Residual Shear Peak - kPa: Best Fit Line (Residual Shear Stress - kPa)



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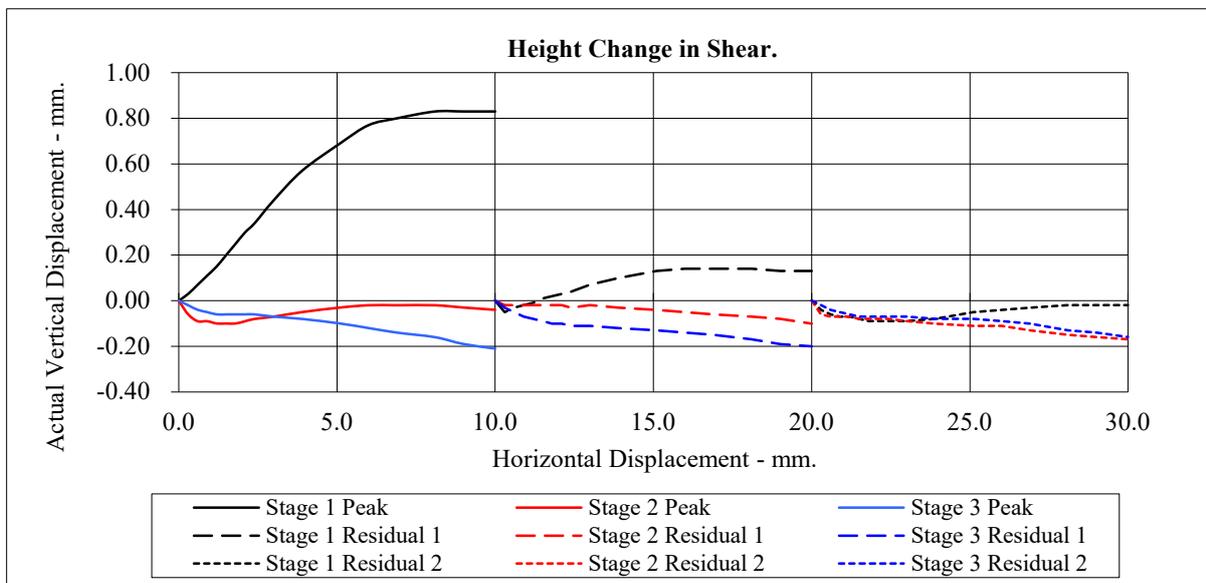
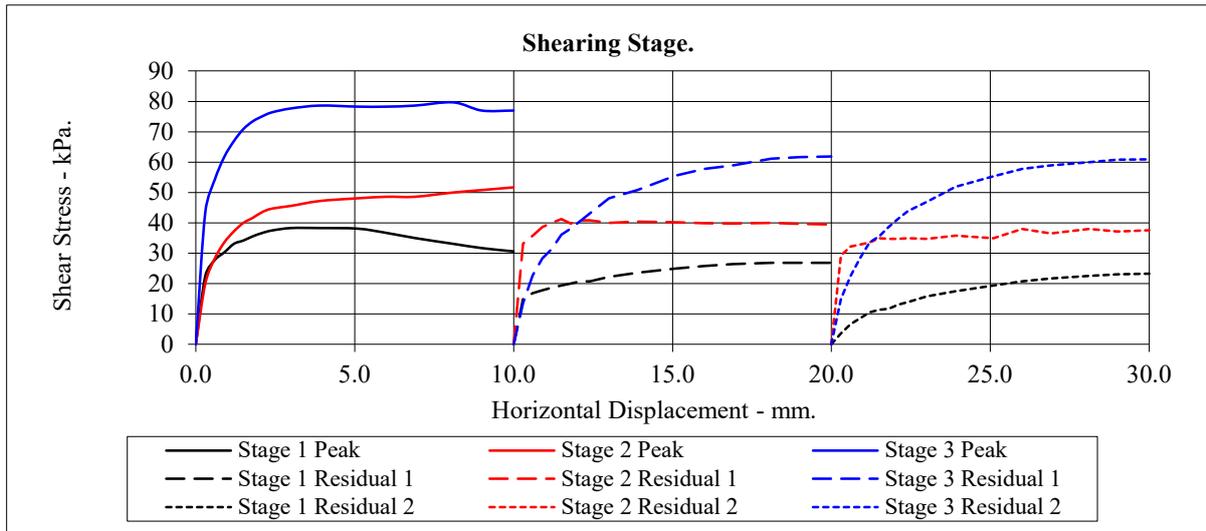
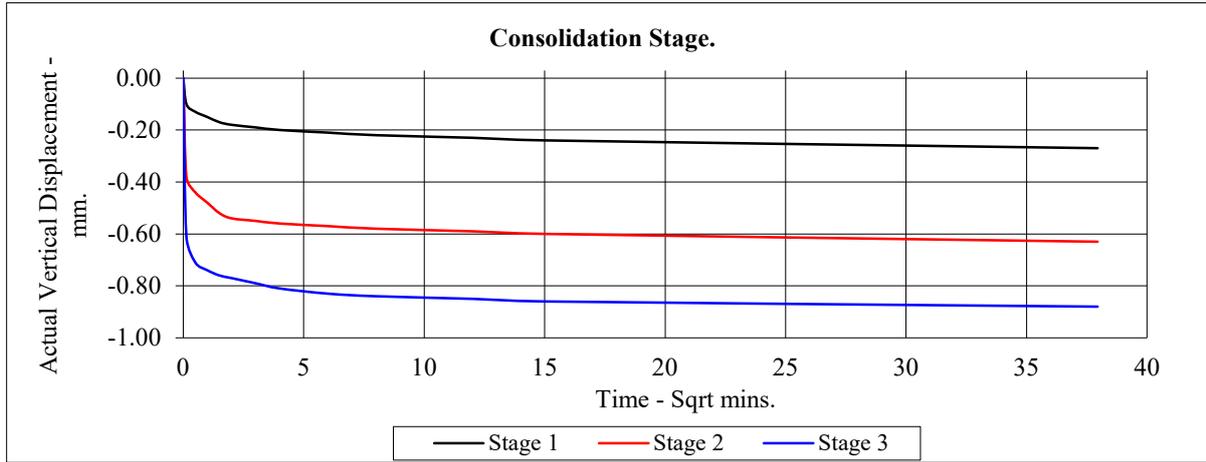
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH04	Top Depth:	1.00
Sample Number:		Base Depth:	



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Swanage Seafront

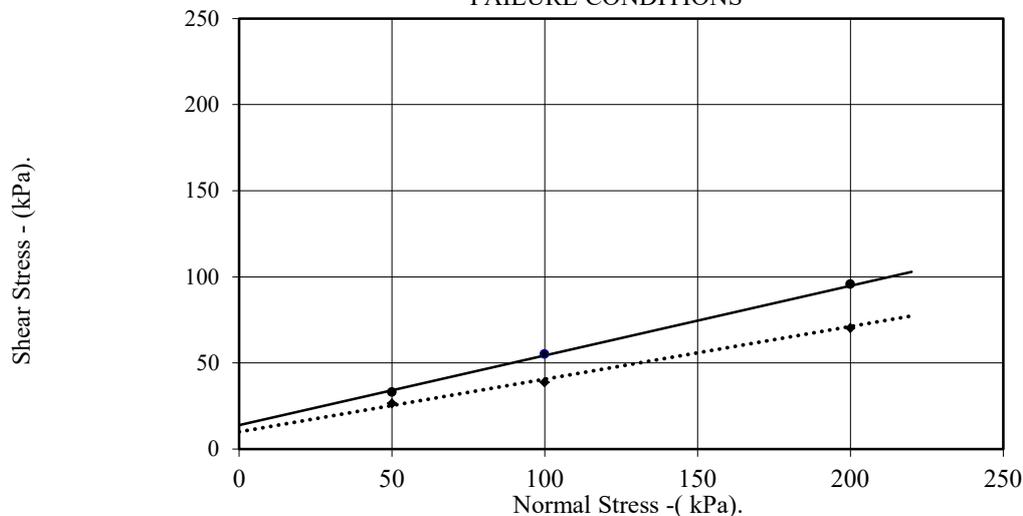
Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH05		Top Depth	3.00	
Sample Number:			Base Depth		
Sample Conditions:	Submerged		Sample Type	D	
Particle Density - Mg/m ³ :	2.65	Assumed	Remarks:		
Specimen Preparation	Material tested passing 2mm sieve Remoulded using 2.5kg effort				
Sample Description:	Brown slightly gravelly slightly sandy CLAY.				
STAGE		1	2	3	
Initial Conditions					
Height - mm:		20.05	20.05	20.05	
Length - mm:		59.97	59.97	59.97	
Moisture Content - %:		21	21	21	
Bulk Density - Mg/m ³ :		1.82	1.82	1.82	
Dry Density - Mg/m ³ :		1.51	1.51	1.51	
Voids Ratio:		0.760	0.760	0.760	
Normal Pressure- kPa		50	100	200	
Consolidation Stage					
Consolidated Height - mm:		18.43	17.53	16.75	
Peak Shear					
Rate of Strain - mm/min		0.038	0.038	0.038	
Displacement at peak shear stress - mm		6.90	6.00	3.90	
Peak shear Stress - kPa:		33	55	96	
Residual Shear					
Rate of Strain - mm/min		0.076	0.076	0.076	
Displacement at residual shear stress - mm		30.00	29.00	20.00	
Residual shear Stress - kPa:		26	39	70	
Final Consolidation Conditions					
Moisture Content - %:		27	26	24	
Bulk Density - Mg/m ³ :		1.98	2.08	2.18	
Dry Density - Mg/m ³ :		1.56	1.65	1.75	
Peak Shear					
Angle of Shearing Resistance:(θ)		22			
Effective Cohesion - kPa:		14			
Residual Shear					
Angle of Shearing Resistance:(θ)		17			
Effective Cohesion - kPa:		10			

FAILURE CONDITIONS



- Peak shear Stress - kPa: ——— Best Fit Line (Peak Shear Stress - kPa)
- ♦ Residual Shear Peak - kPa: Best Fit Line (Residual Shear Stress - kPa)



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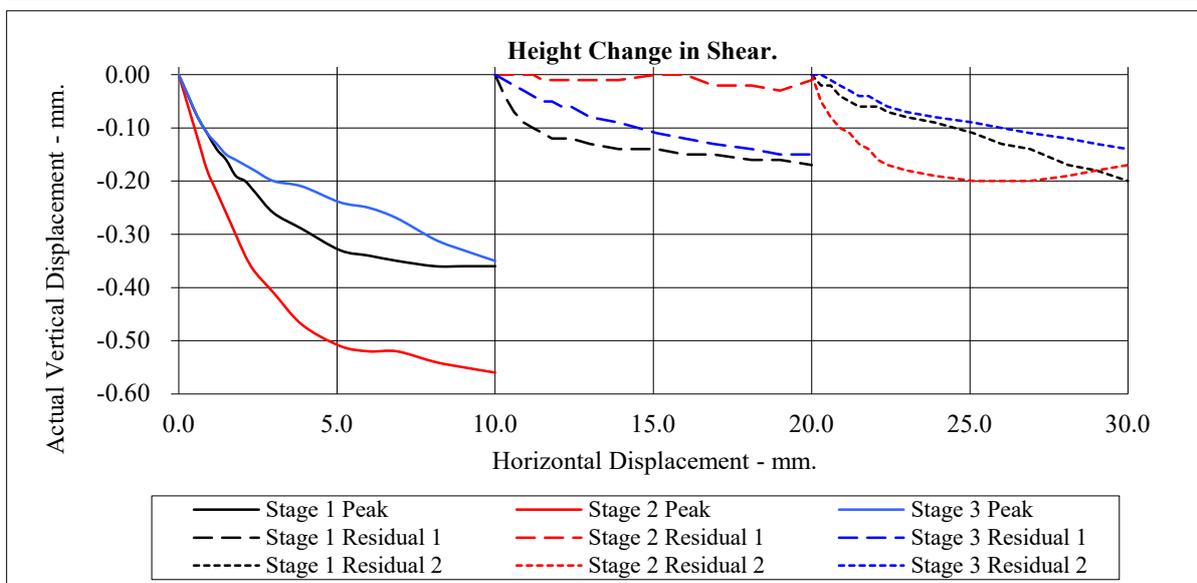
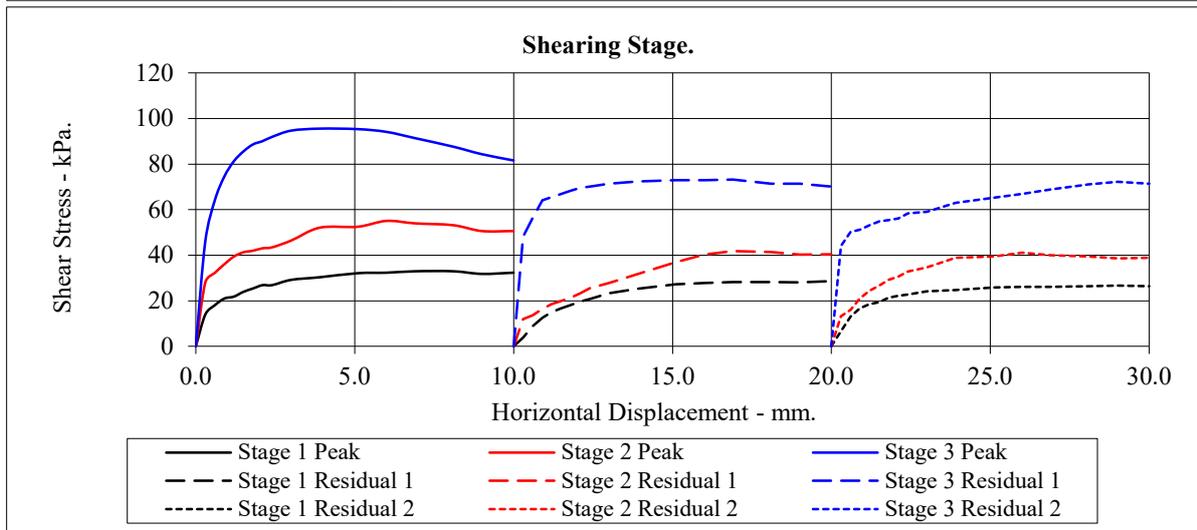
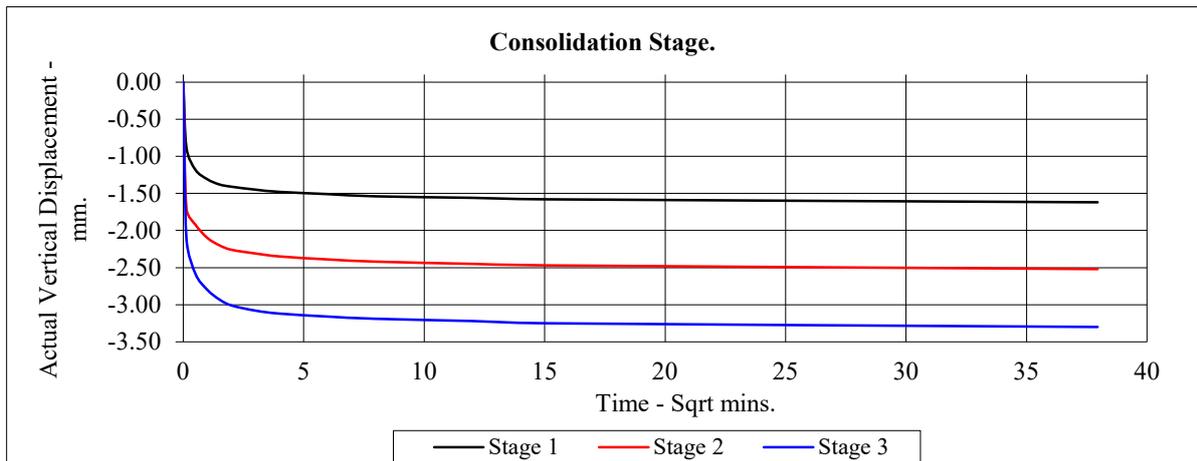
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH05	Top Depth:	3.00
Sample Number:		Base Depth:	



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Swanage Seafront

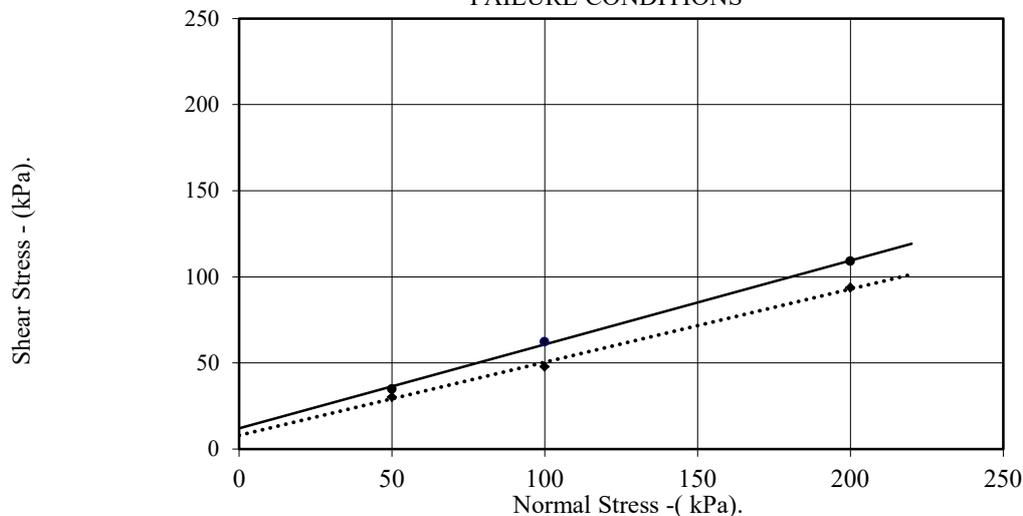
Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH11		Top Depth	1.80	
Sample Number:			Base Depth		
Sample Conditions:	Submerged		Sample Type	D	
Particle Density - Mg/m ³ :	2.65	Assumed	Remarks:		
Specimen Preparation	Material tested passing 2mm sieve Remoulded using 2.5kg effort				
Sample Description:	Brown slightly gravelly slightly sandy CLAY.				
STAGE			1	2	3
Initial Conditions					
Height - mm:			20.05	20.05	20.05
Length - mm:			59.97	59.97	59.97
Moisture Content - %:			20	20	20
Bulk Density - Mg/m ³ :			1.99	1.99	1.99
Dry Density - Mg/m ³ :			1.66	1.66	1.66
Voids Ratio:			0.597	0.597	0.597
Normal Pressure- kPa			50	100	200
Consolidation Stage					
Consolidated Height - mm:			19.21	18.93	18.84
Peak Shear					
Rate of Strain - mm/min			0.037	0.037	0.037
Displacement at peak shear stress - mm			3.90	8.10	6.00
Peak shear Stress - kPa:			35	62	109
Residual Shear					
Rate of Strain - mm/min			0.074	0.074	0.074
Displacement at residual shear stress - mm			20.00	25.10	30.00
Residual shear Stress - kPa:			30	48	94
Final Consolidation Conditions					
Moisture Content - %:			25	24	22
Bulk Density - Mg/m ³ :			2.08	2.11	2.12
Dry Density - Mg/m ³ :			1.67	1.70	1.73
Peak Shear					
Angle of Shearing Resistance:(θ)			26		
Effective Cohesion - kPa:			12		
Residual Shear					
Angle of Shearing Resistance:(θ)			23		
Effective Cohesion - kPa:			8		

FAILURE CONDITIONS



- Peak shear Stress - kPa: ——— Best Fit Line (Peak Shear Stress - kPa)
- ◆ Residual Shear Peak - kPa: Best Fit Line (Residual Shear Stress - kPa)



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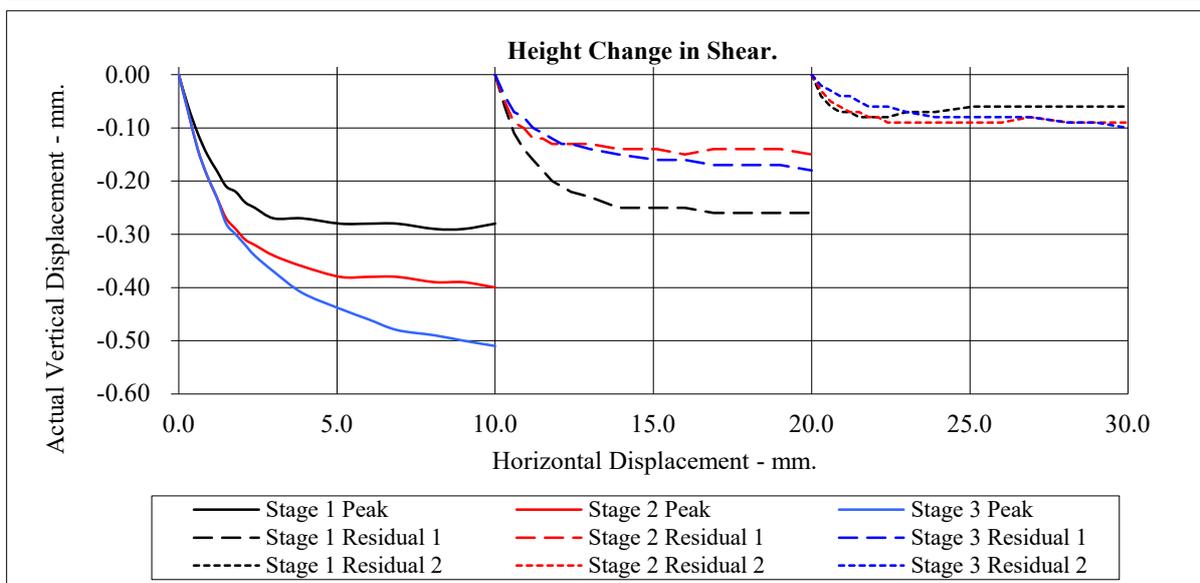
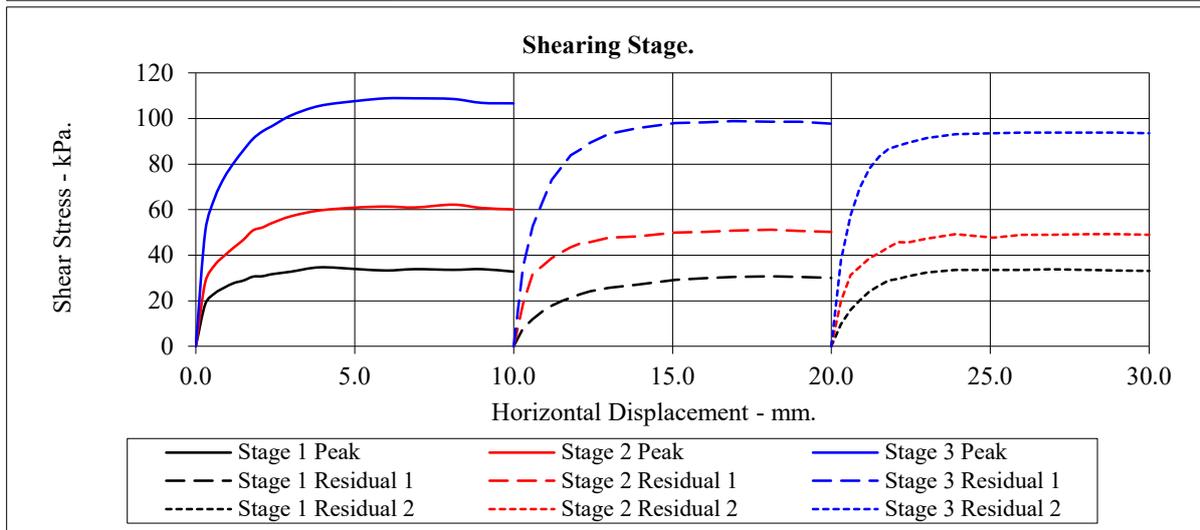
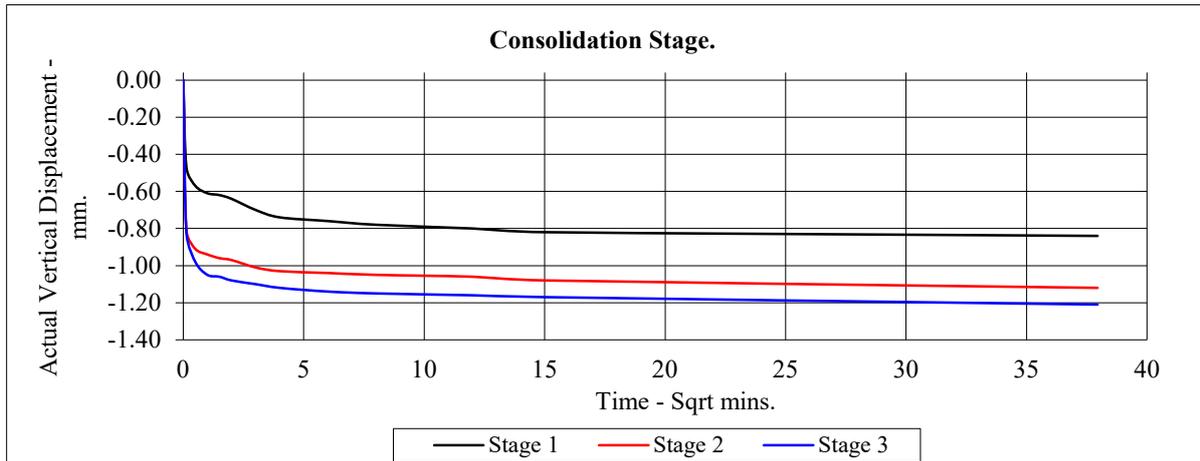
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH11	Top Depth:	1.80
Sample Number:		Base Depth:	



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Swanage Seafront

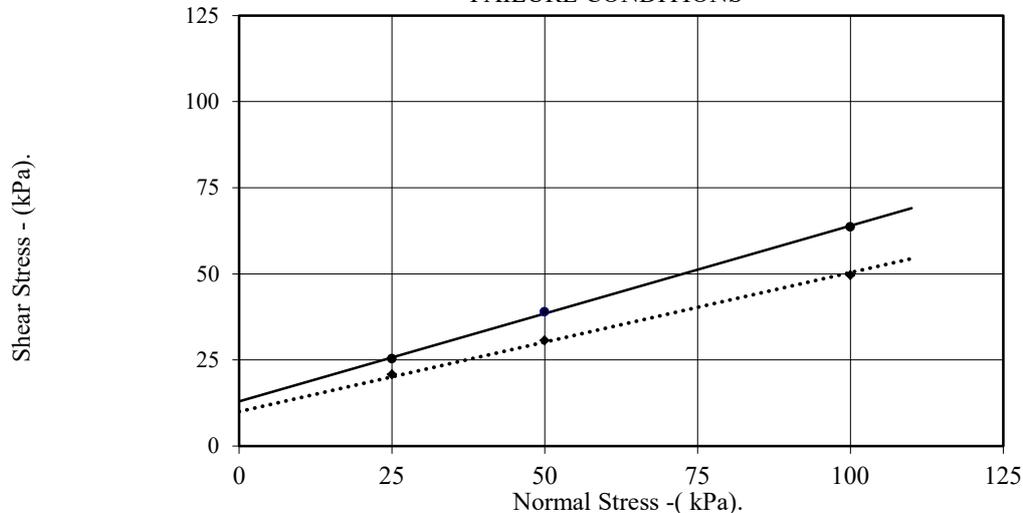
Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH13		Top Depth	1.50	
Sample Number:			Base Depth		
Sample Conditions:	Submerged		Sample Type	D	
Particle Density - Mg/m ³ :	2.65	Assumed	Remarks:		
Specimen Preparation	Material tested passing 2mm sieve Remoulded using 2.5kg effort				
Sample Description:	Brown slightly gravelly slightly sandy CLAY.				
STAGE		1	2	3	
Initial Conditions					
Height - mm:		20.05	20.05	20.05	
Length - mm:		59.97	59.97	59.97	
Moisture Content - %:		14	14	14	
Bulk Density - Mg/m ³ :		1.86	1.86	1.86	
Dry Density - Mg/m ³ :		1.63	1.63	1.63	
Voids Ratio:		0.623	0.623	0.623	
Normal Pressure- kPa		25	50	100	
Consolidation Stage					
Consolidated Height - mm:		19.14	18.17	17.37	
Peak Shear					
Rate of Strain - mm/min		0.040	0.040	0.040	
Displacement at peak shear stress - mm		10.00	9.00	10.00	
Peak shear Stress - kPa:		25	39	64	
Residual Shear					
Rate of Strain - mm/min		0.080	0.080	0.080	
Displacement at residual shear stress - mm		20.00	30.00	29.00	
Residual shear Stress - kPa:		21	31	50	
Final Consolidation Conditions					
Moisture Content - %:		25	24	22	
Bulk Density - Mg/m ³ :		1.95	2.05	2.15	
Dry Density - Mg/m ³ :		1.56	1.65	1.75	
Peak Shear					
Angle of Shearing Resistance:(θ)		27			
Effective Cohesion - kPa:		13			
Residual Shear					
Angle of Shearing Resistance:(θ)		22			
Effective Cohesion - kPa:		10			

FAILURE CONDITIONS



- Peak shear Stress - kPa: ——— Best Fit Line (Peak Shear Stress - kPa)
- ♦ Residual Shear Peak - kPa: Best Fit Line (Residual Shear Stress - kPa)



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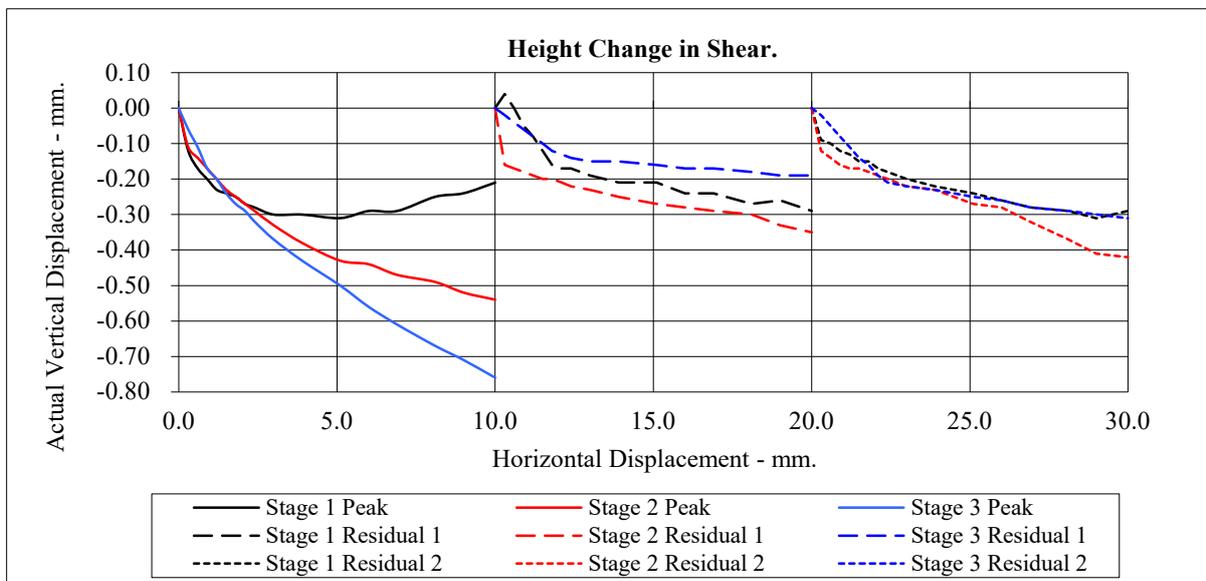
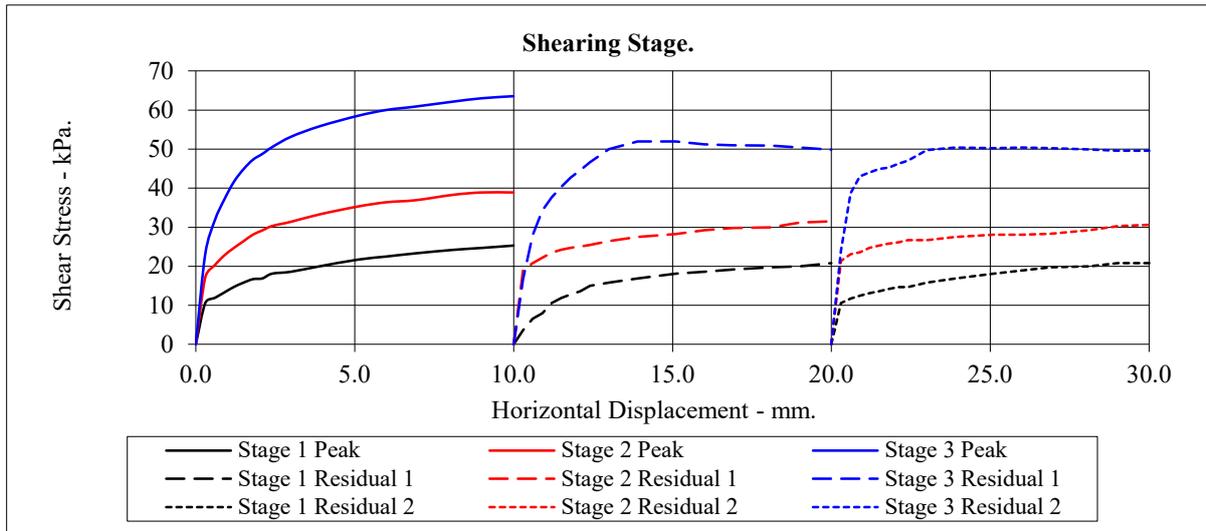
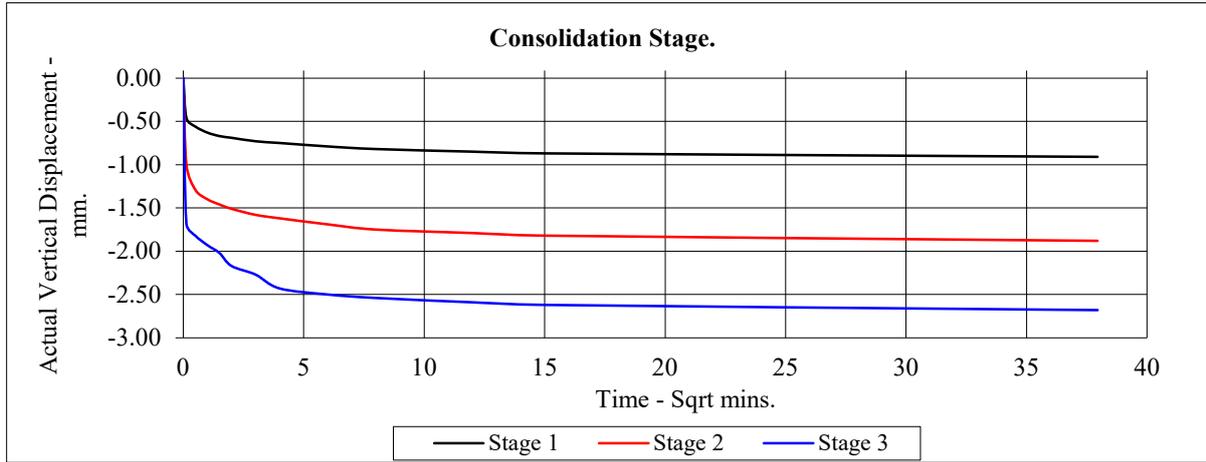
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660

CONSOLIDATED DRAINED SHEARBOX TEST

BS1377 : 1990 Part 7 Clause 4

Hole Number:	BH13	Top Depth:	1.50
Sample Number:		Base Depth:	



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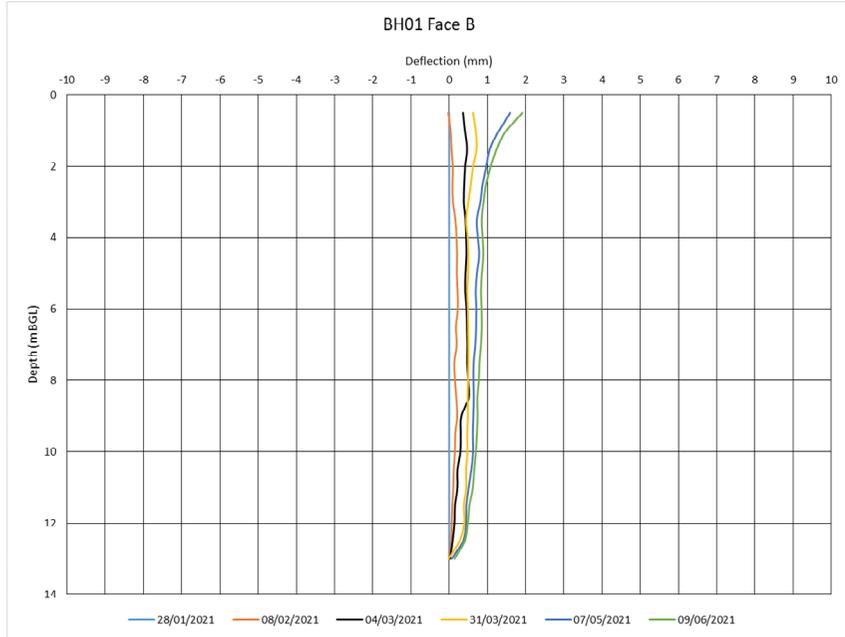
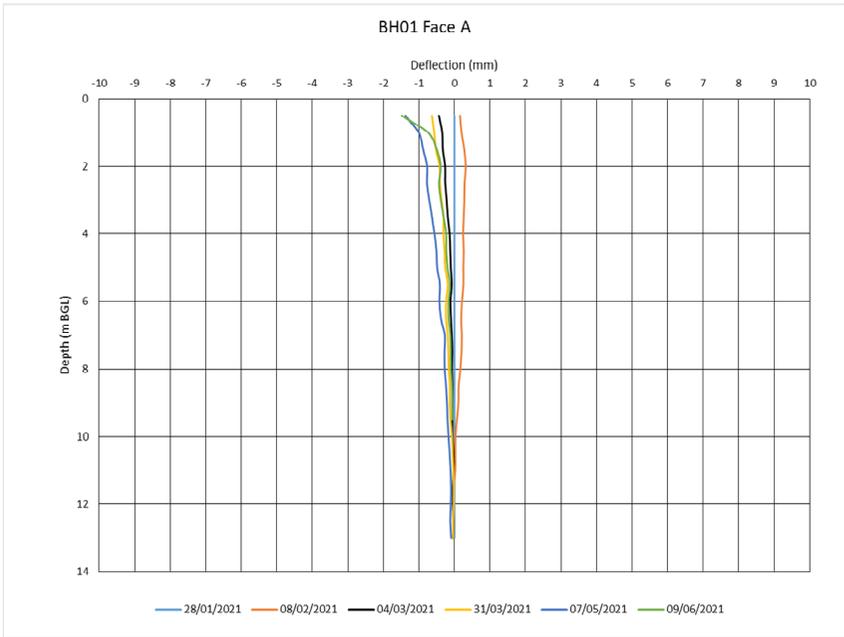
Swanage Seafront

Contract No:
PSL21/0310
Client Ref:
12660



Appendix G

Inclinometer Monitoring Results

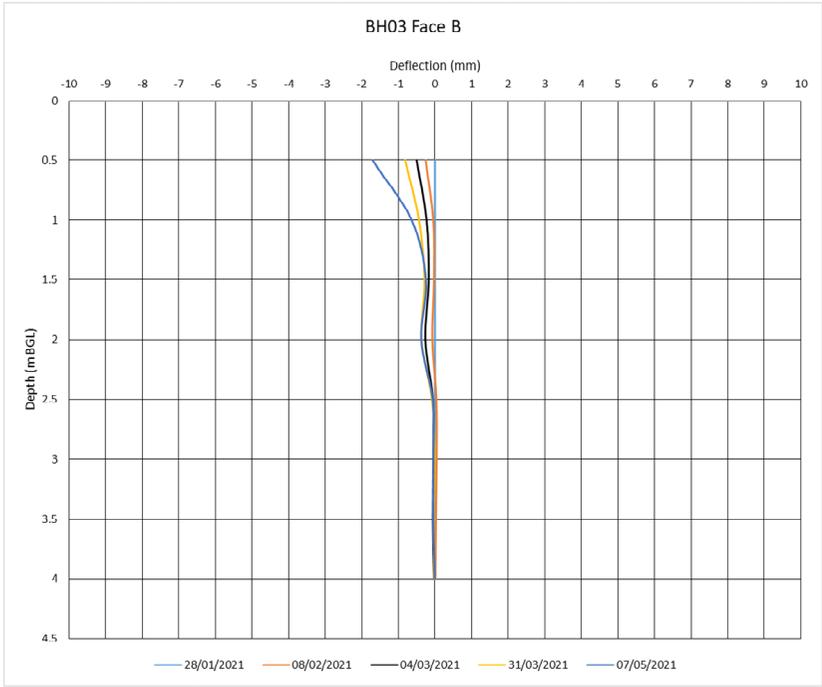
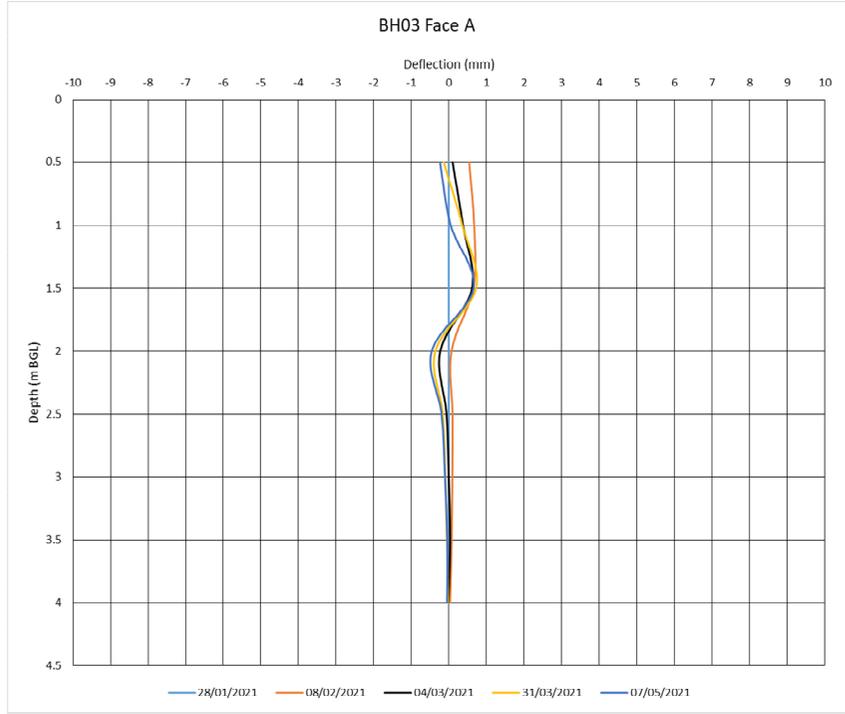


Swanage Seafront

BH01 Inclinometer Results

Job No 12660



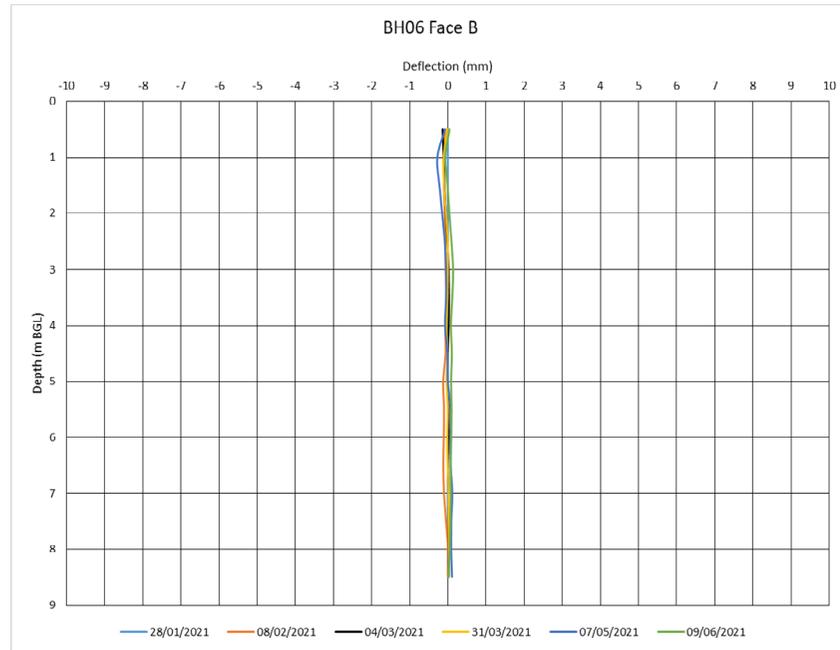
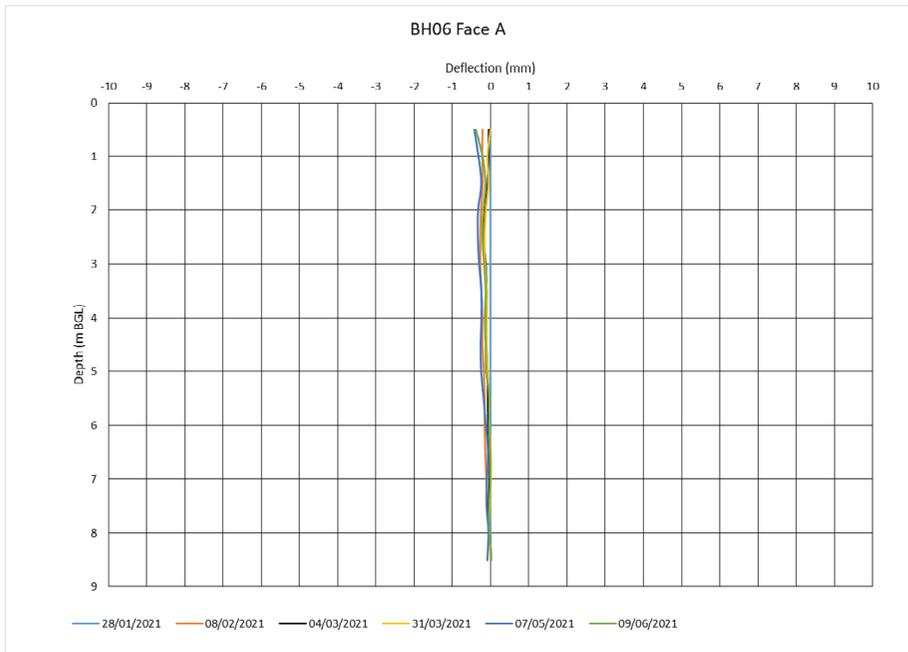


Swanage Seafront

**BH02 Inclinator
Results**

Job No 12660





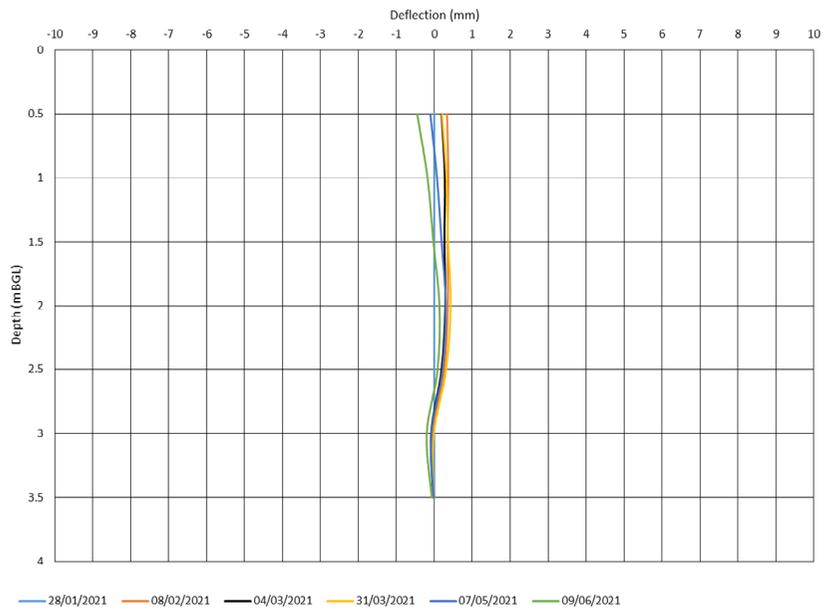
Swanage Seafront

**BH06 Inclinator
Results**

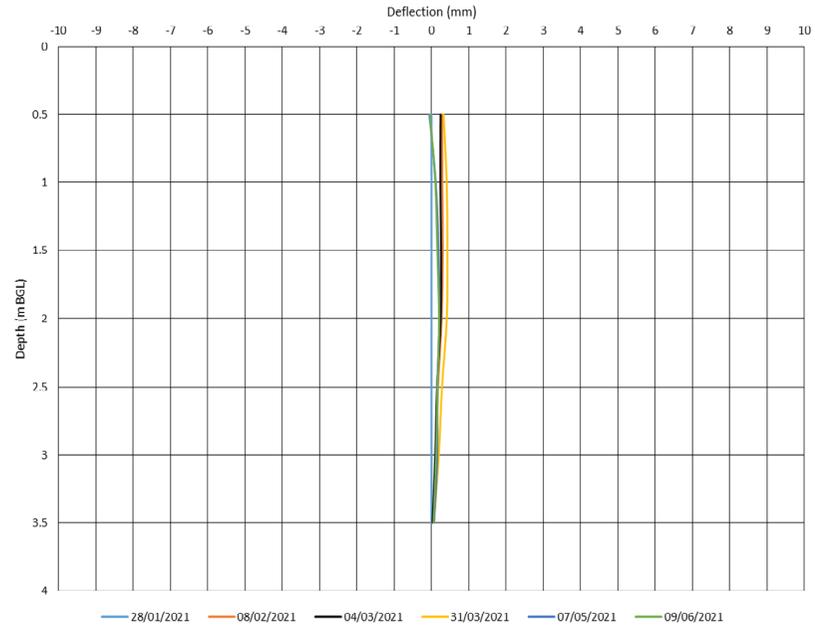
Job No 12660



BH07 Face A



BH07 Face B

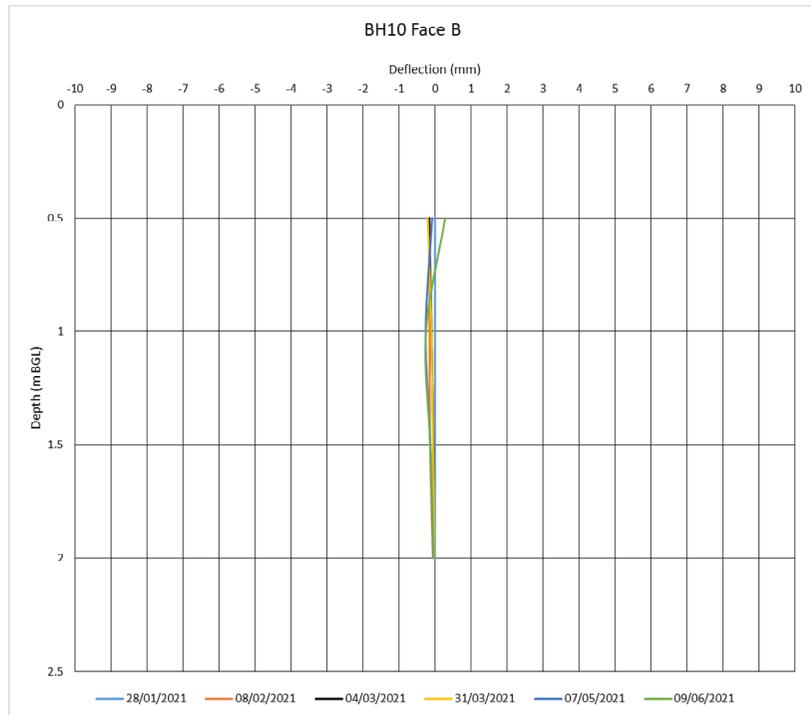
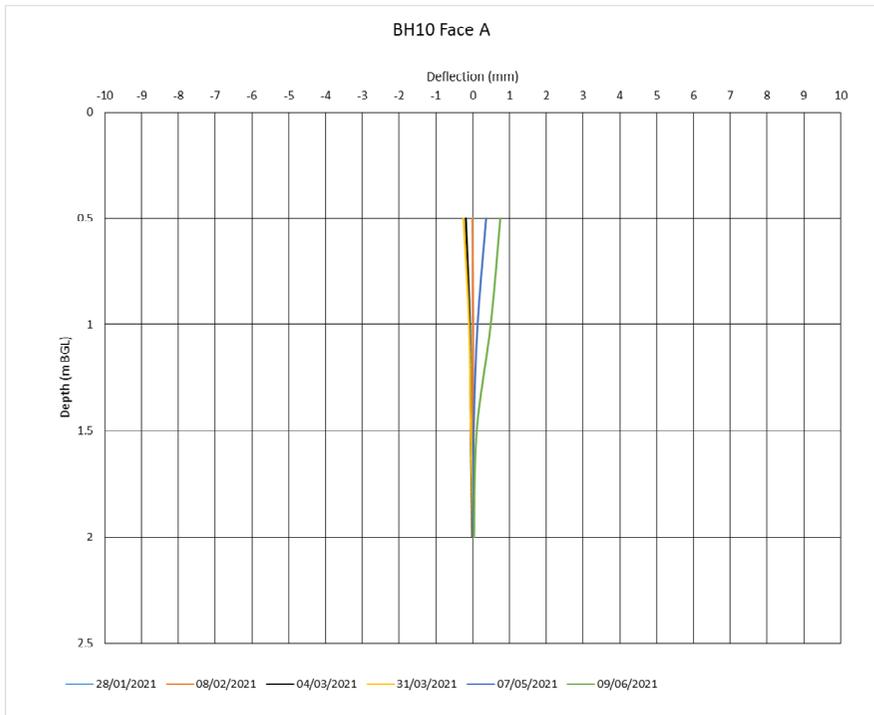


Swanage Seafront

BH07 Inclinometer Results

Job No 12660



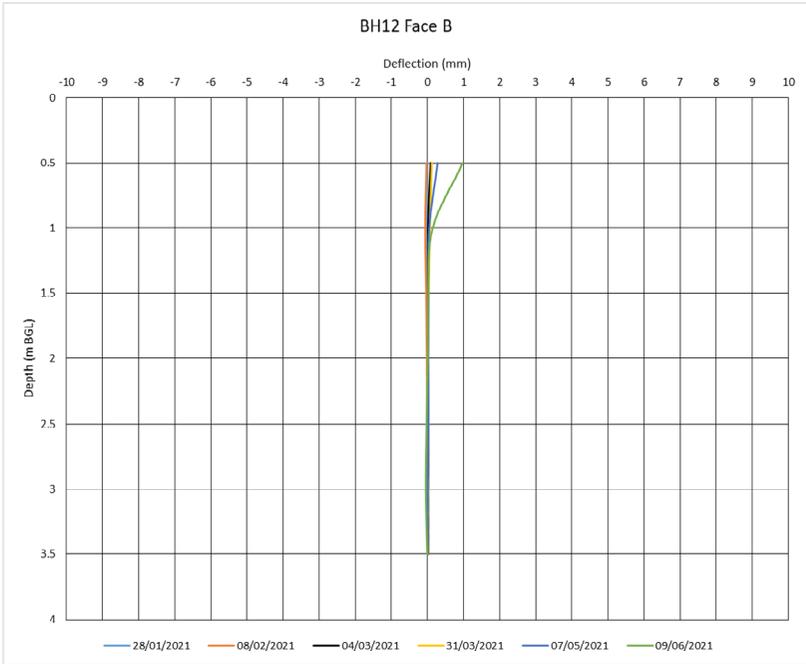
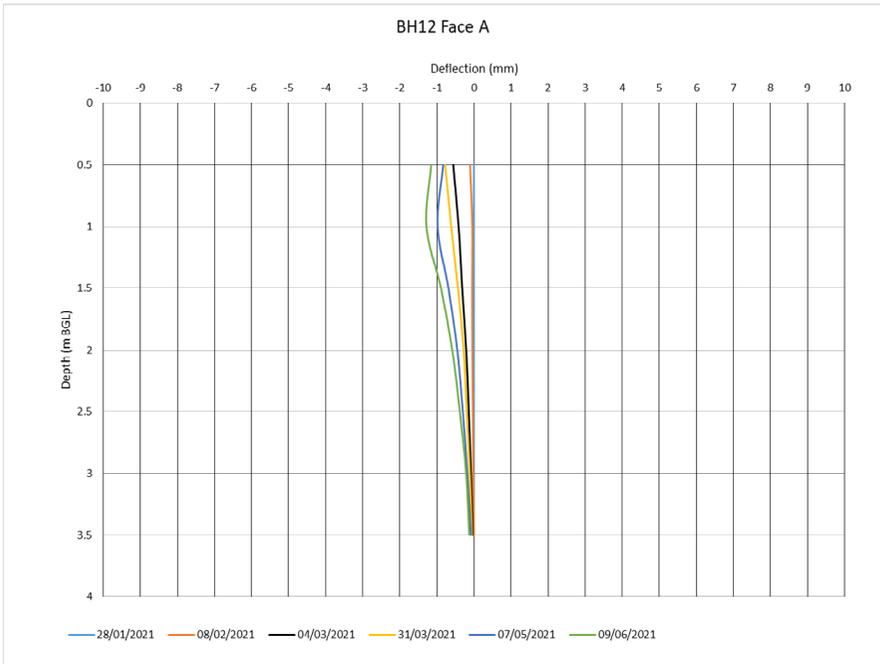


Swanage Seafront

BH10 Inclinometer Results

Job No 12660



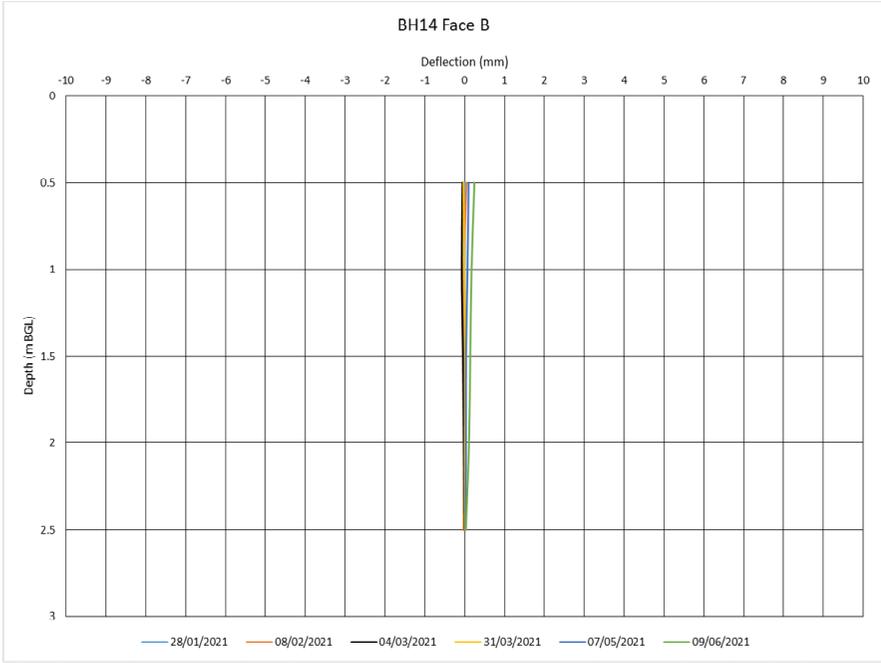
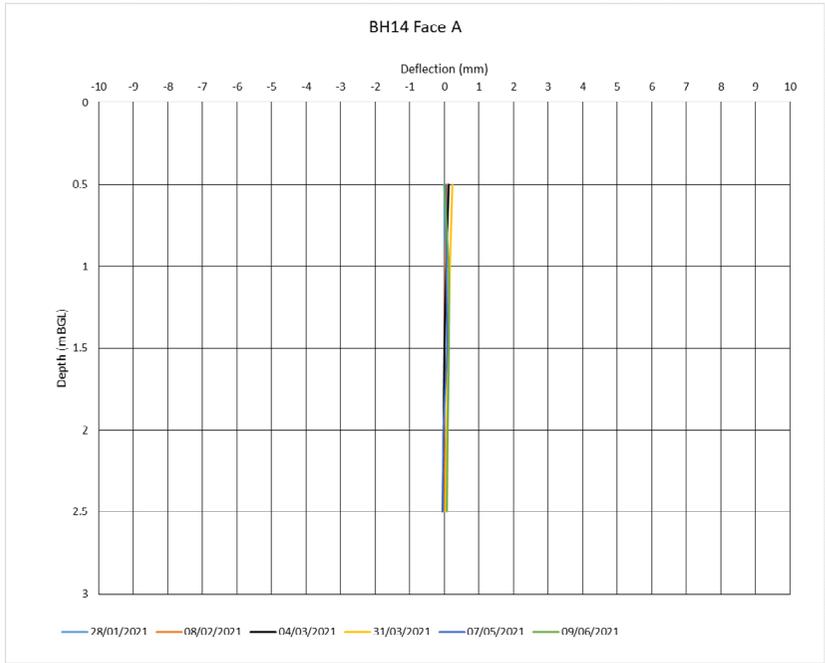


Swanage Seafront

BH12 Inclinometer Results

Job No 12660





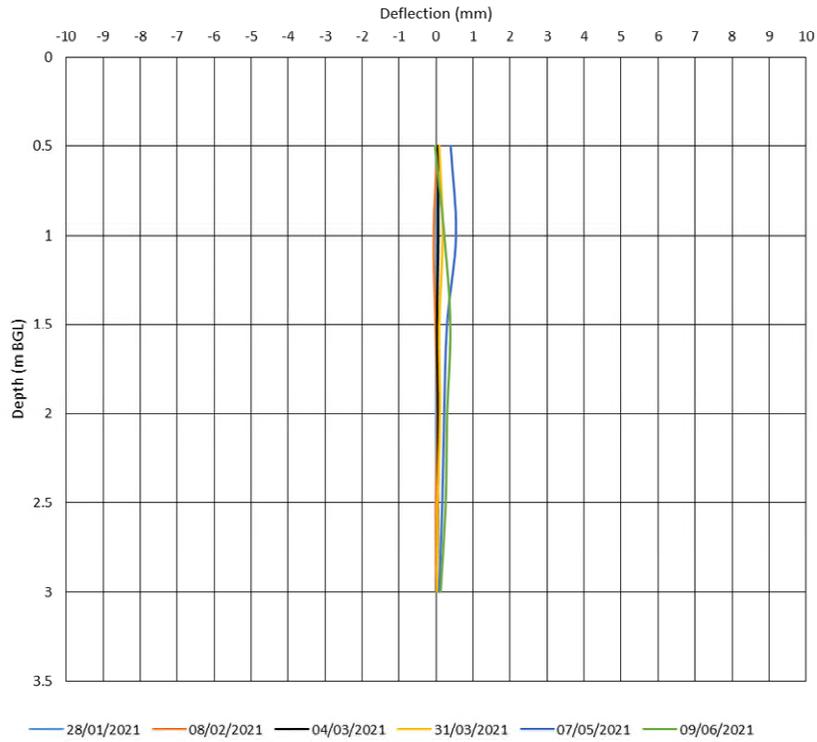
Swanage Seafront

**BH14 Inclinometer
Results**

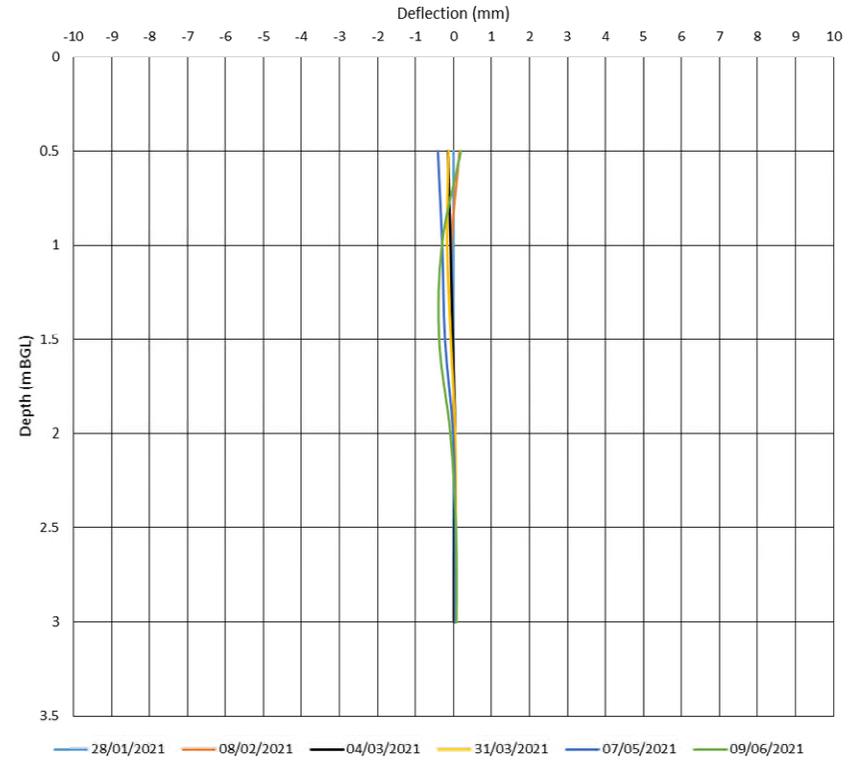
Job No 12660



BH16 Face A



BH16 Face B



Swanage Seafront

BH16 Inclinometer
Results

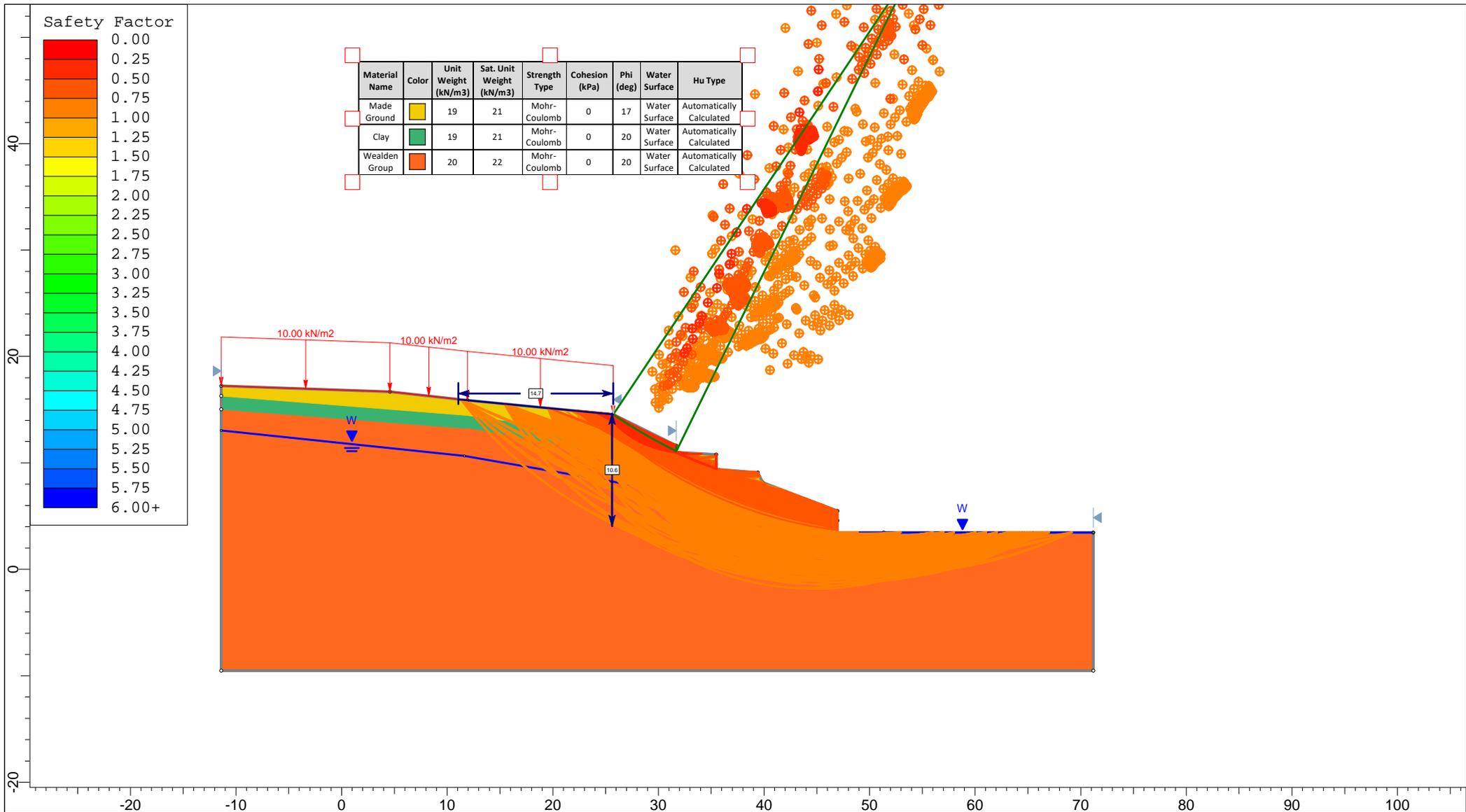
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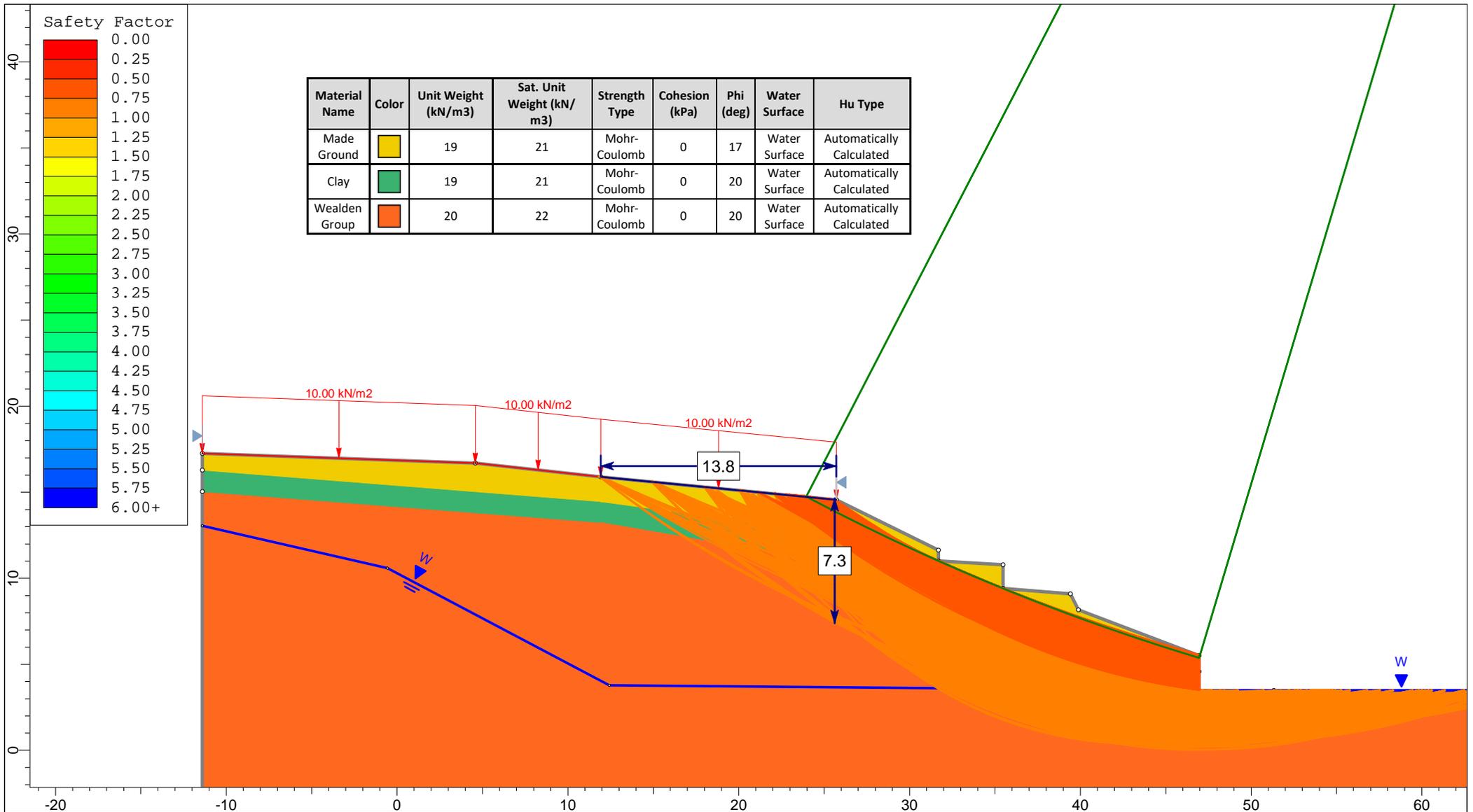


Appendix H

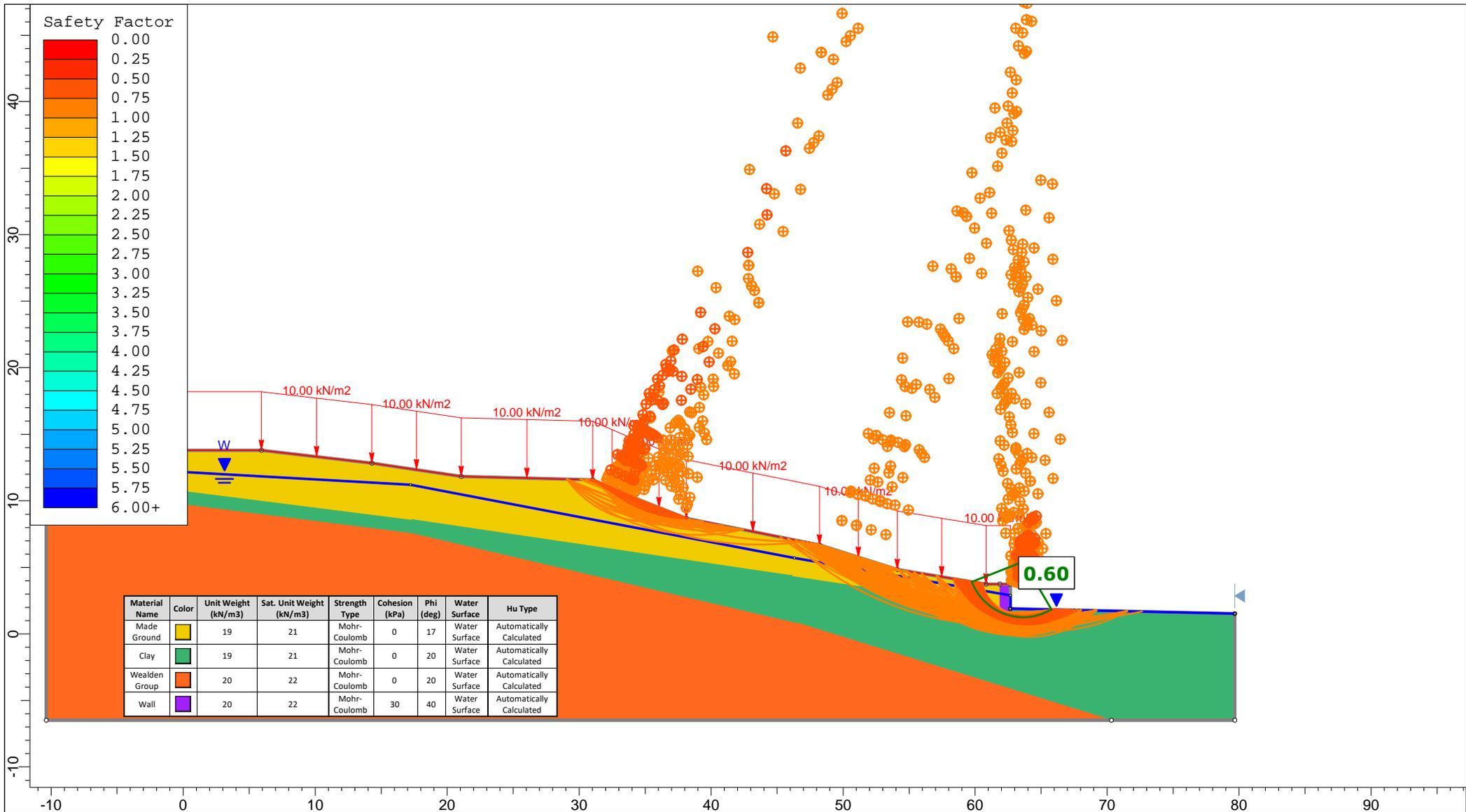
Stability Analysis Results



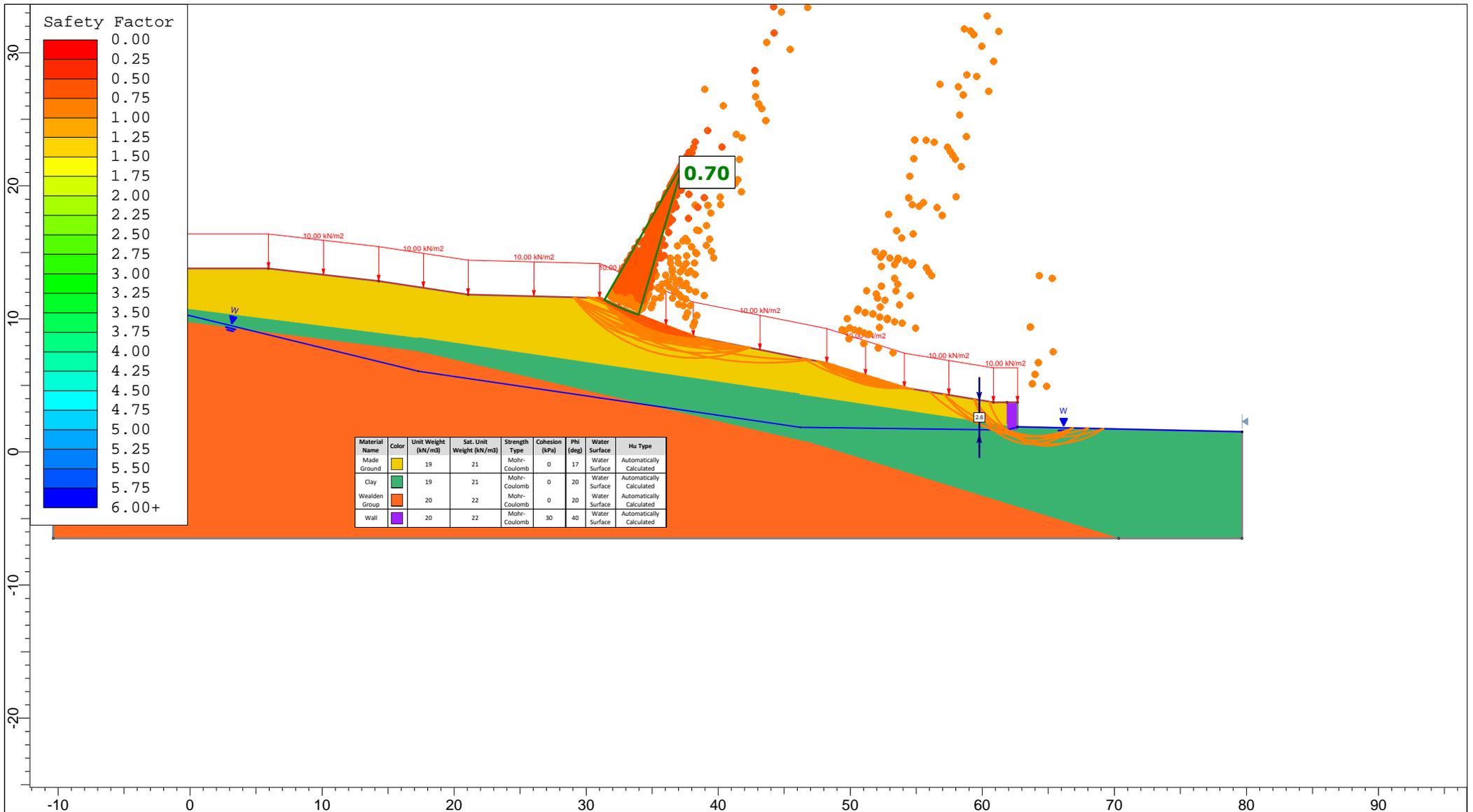
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	Group		Group 1	Scenario
	Drawn By			Company
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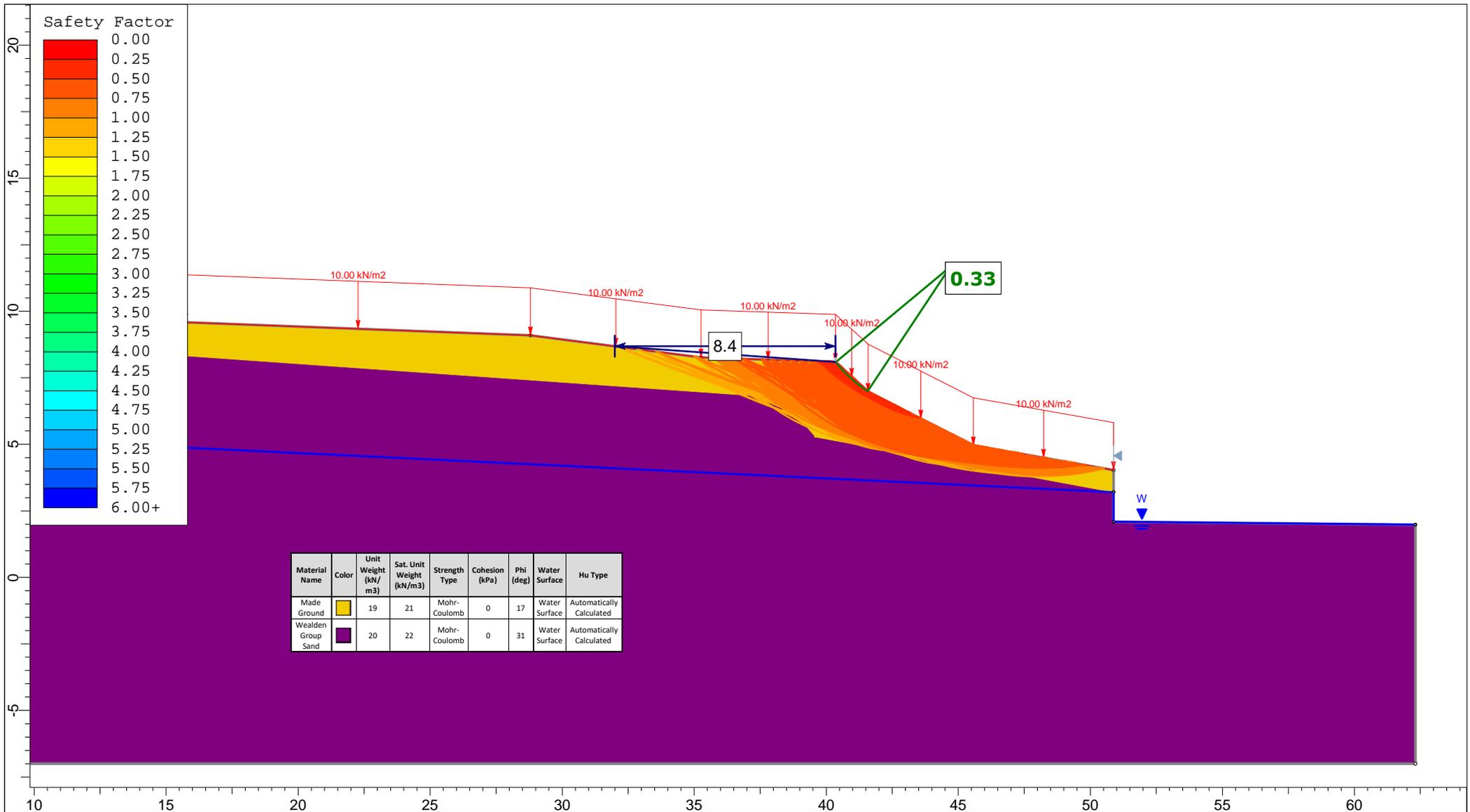
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	Group		Group 1	Scenario
	Drawn By			Company
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			12660 Section 1 - Drained.slmd	



	Project		Swanage Seafront - Section 2 Saturated	
	Group	Group 1	Scenario	Master Scenario
	Drawn By		Company	
	Date	10/05/2021, 13:59:31	File Name	12660 Section 2.slm

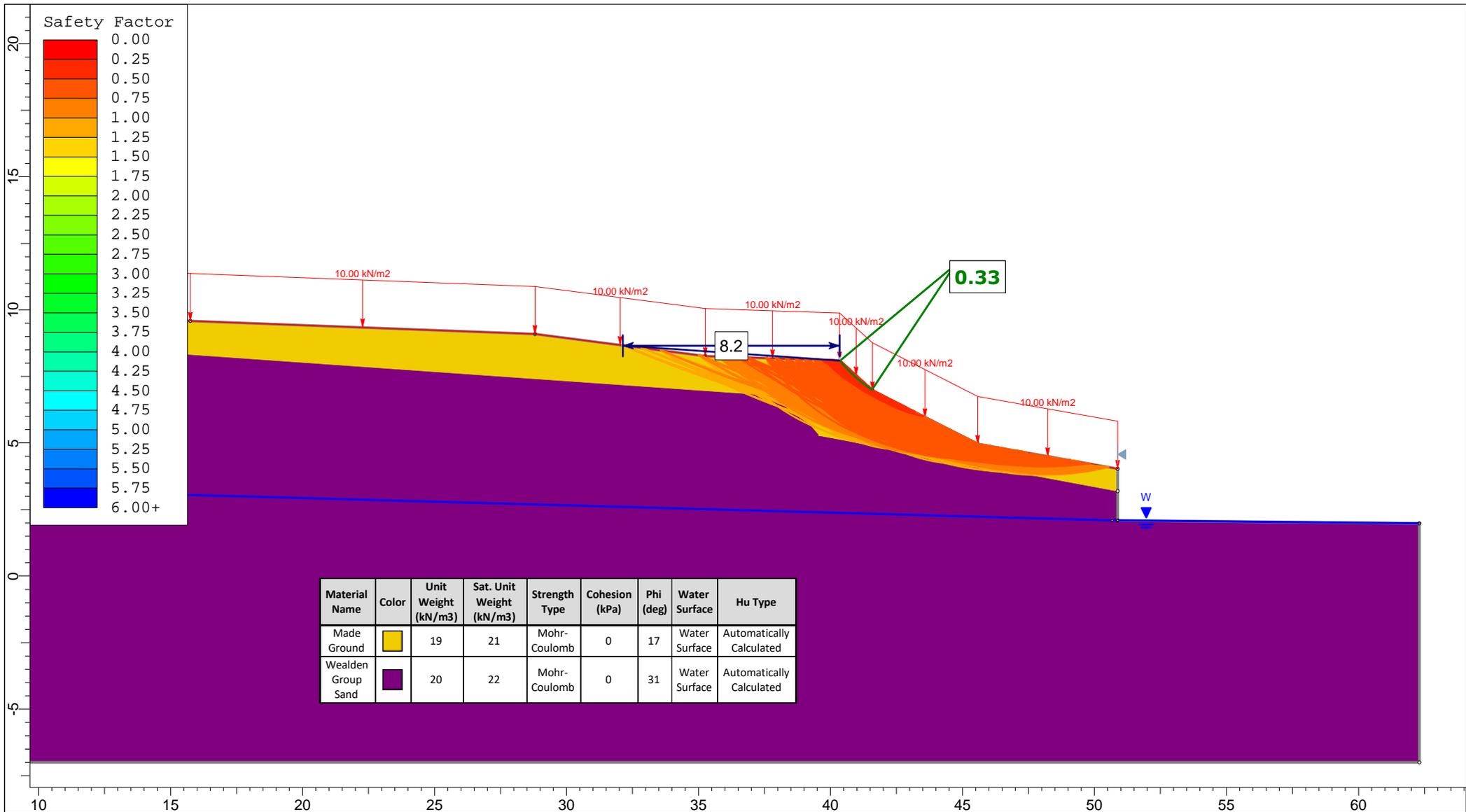


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	Group	Group 1	Scenario	Master Scenario
	Drawn By		Company	
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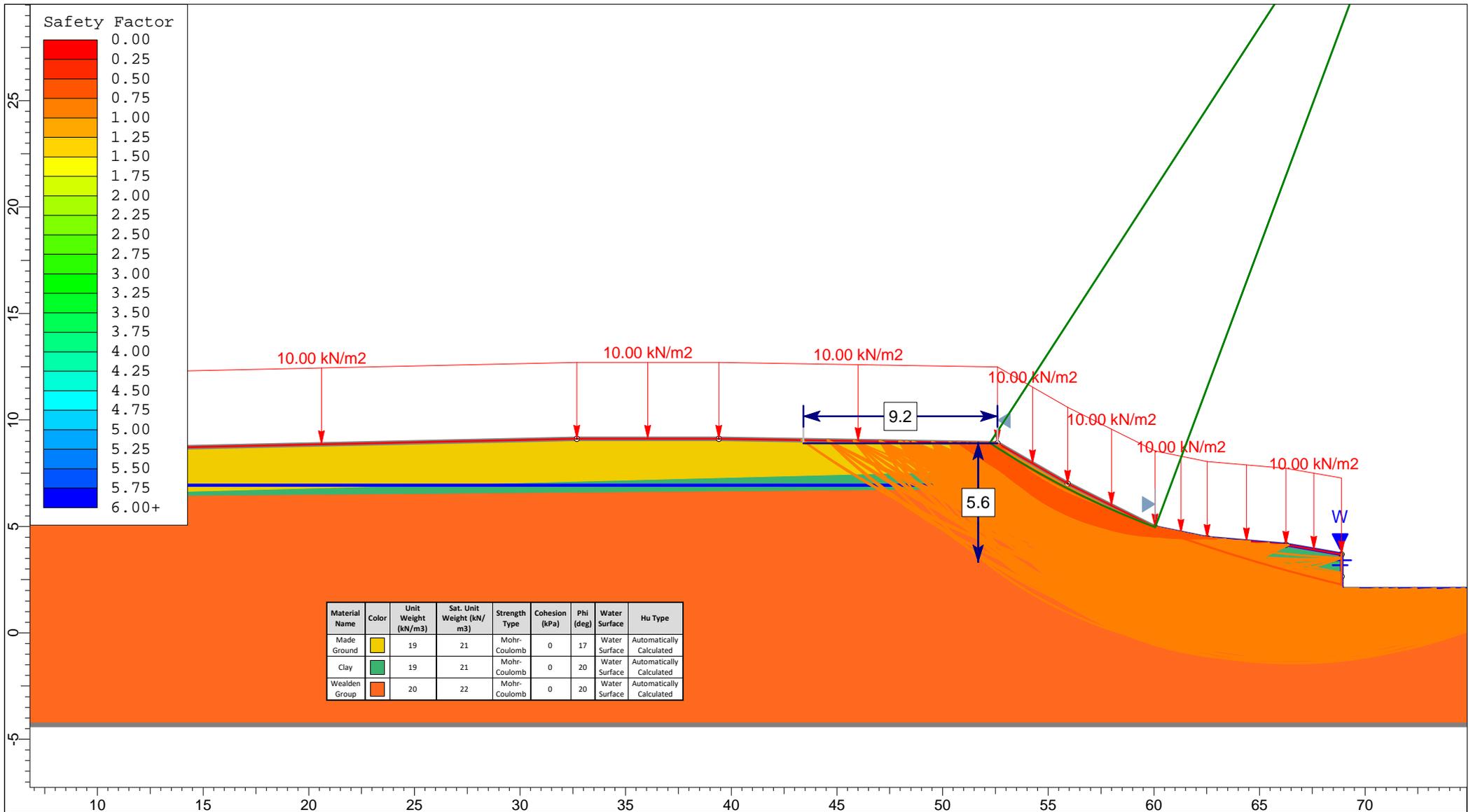


Material Name	Color	Unit Weight (kN/m ³)	Sat. Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Made Ground	Yellow	19	21	Mohr-Coulomb	0	17	Water Surface	Automatically Calculated
Wealden Group Sand	Purple	20	22	Mohr-Coulomb	0	31	Water Surface	Automatically Calculated

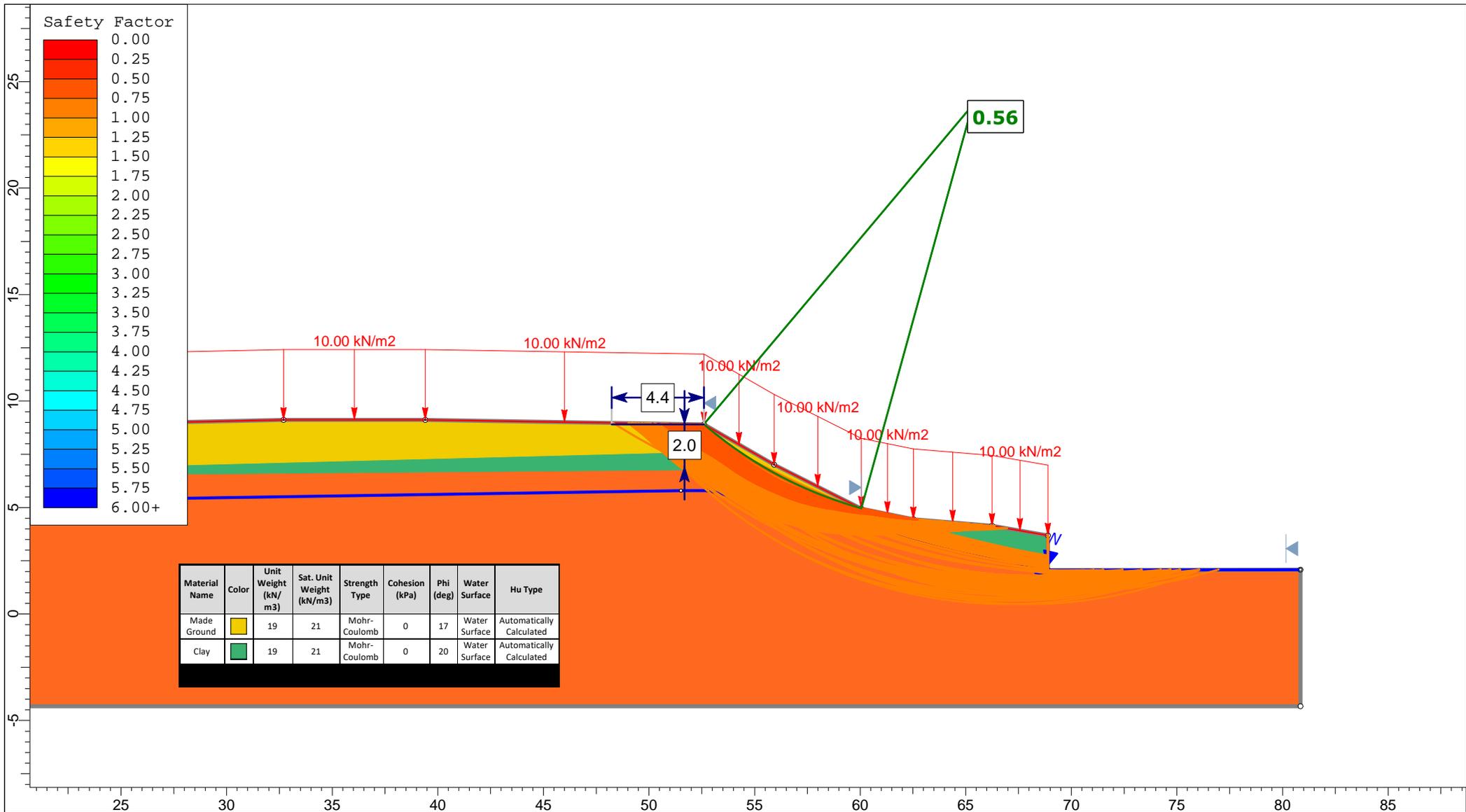
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	Group		Group 1	Scenario
	Drawn By			Company
	Date		10/05/2021, 15:37:26	File Name
				Master Scenario
				12660 Section 3.slmd



	Project		Swanage Seafront - Section 3 Drained	
	Group		Group 1	Scenario
	Drawn By			Company
	Date		10/05/2021, 15:37:26	File Name
			12660 Section 3 - Drained.slmd	



	Project		Swanage Seafront - Section 4 Saturated	
	Group		Group 1	Scenario
	Drawn By			Master Scenario
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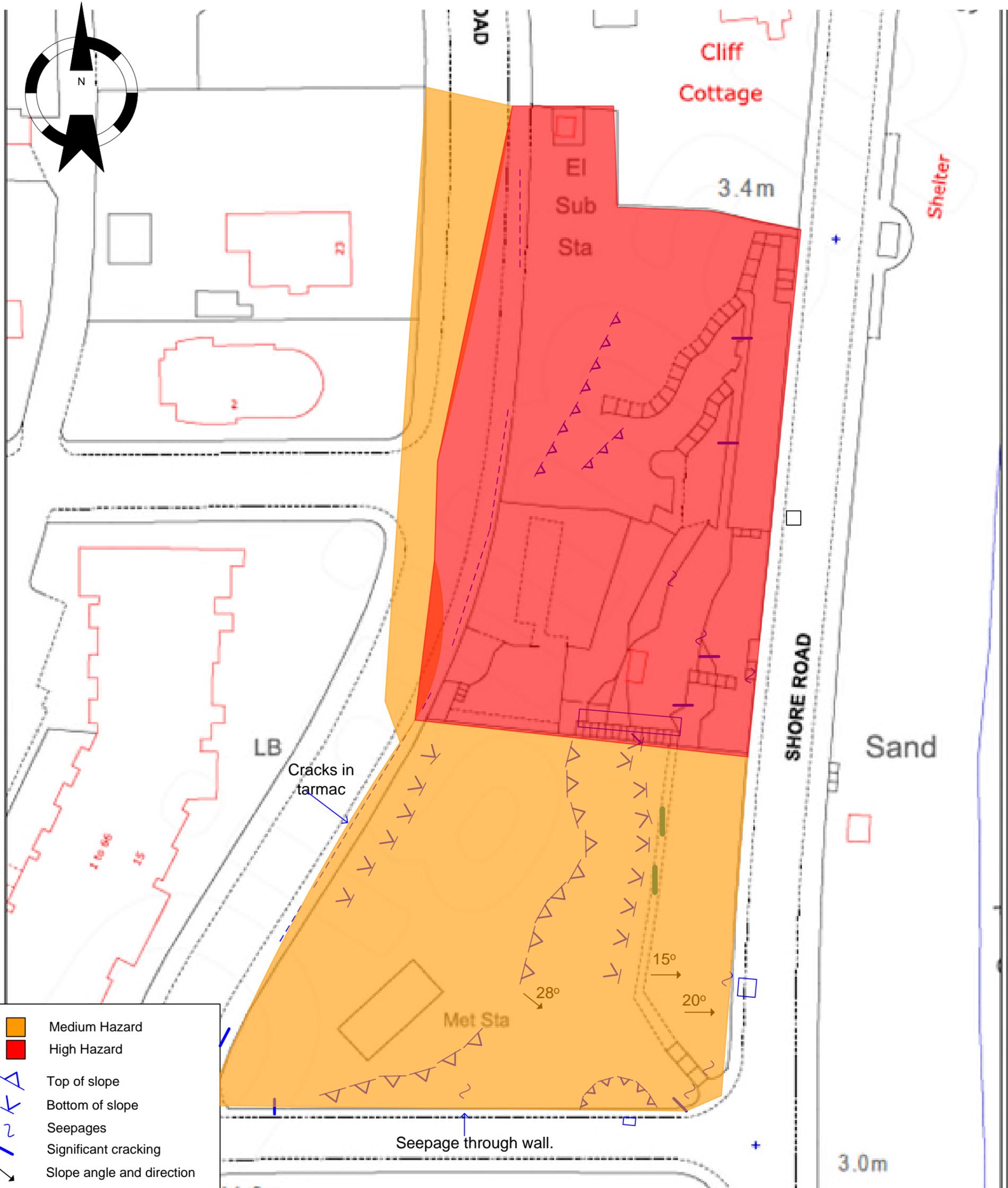
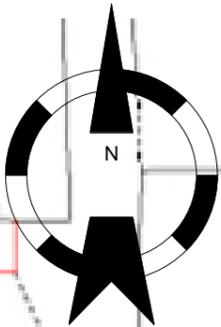
Material Name	Color	Unit Weight (kN/m³)	Sat. Unit Weight (kN/m³)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Made Ground	Yellow	19	21	Mohr-Coulomb	0	17	Water Surface	Automatically Calculated
Clay	Green	19	21	Mohr-Coulomb	0	20	Water Surface	Automatically Calculated

	Project		Swanage Seafront - Section 4 Drained	
	Group		Group 1	
	Scenario		Master Scenario	
	Company			
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Appendix I

Geological Hazard Maps



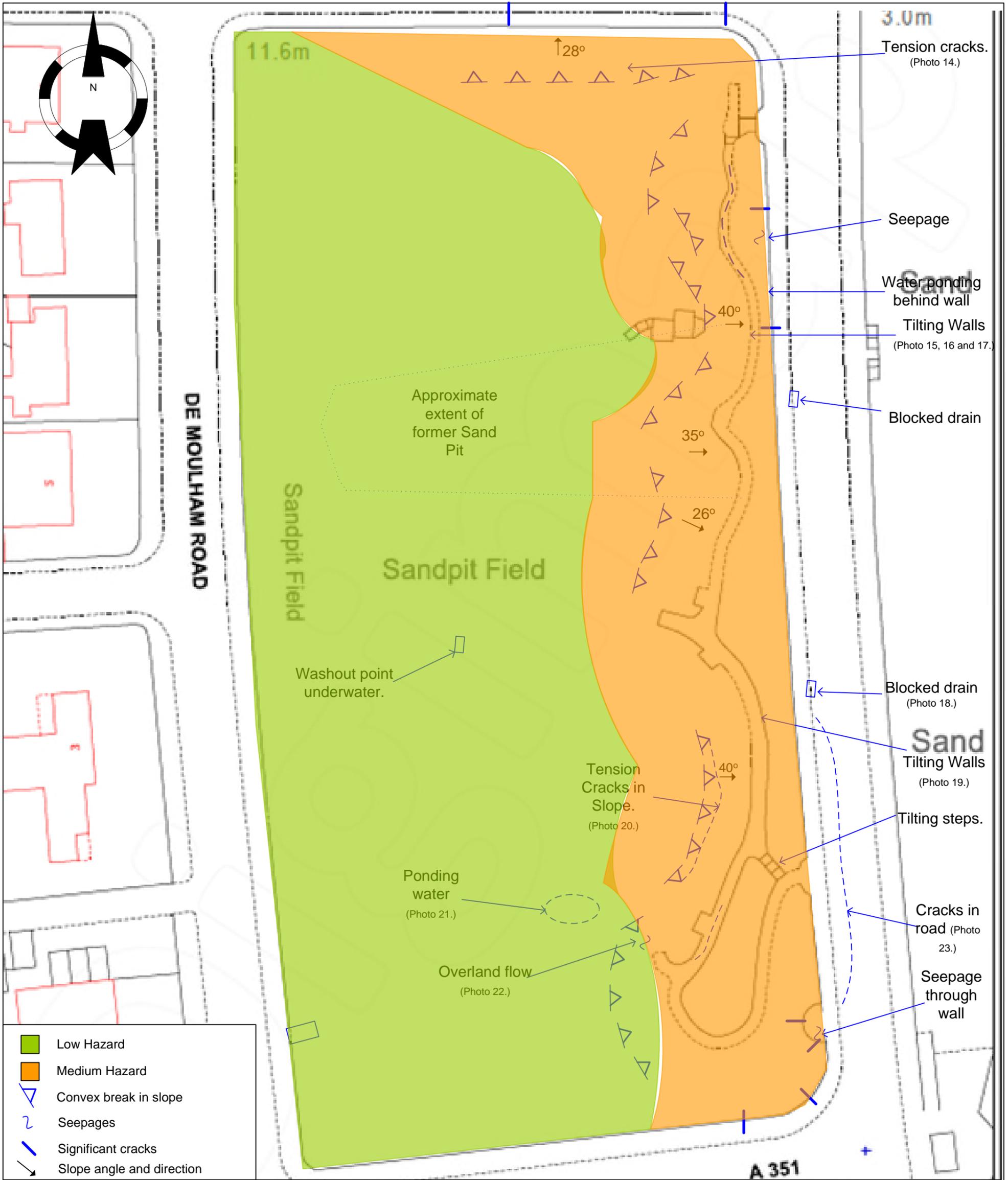
- Medium Hazard
- High Hazard
- Top of slope
- Bottom of slope
- Seepages
- Significant cracking
- Slope angle and direction

Swanage Seafront

Hazard Map – Northern Area



01884 252444	SIZE A3	JOB NO 12660	DWG NO DWG1	REV 0
Drawn: ZM	SCALE 1:500	10/12/2020	SHEET	1 of 1



- Low Hazard
- Medium Hazard
- Convex break in slope
- Seepages
- Significant cracks
- Slope angle and direction



SOUTH WEST GEOTECHNICAL

Swanage Seafrost

Hazard Map – Southern Area

01884 252444	SIZE A3	JOB NO 12660	DWG NO DWG1	REV 0
Drawn: ZM	SCALE 1:500	10/12/2020	SHEET	1 of 1