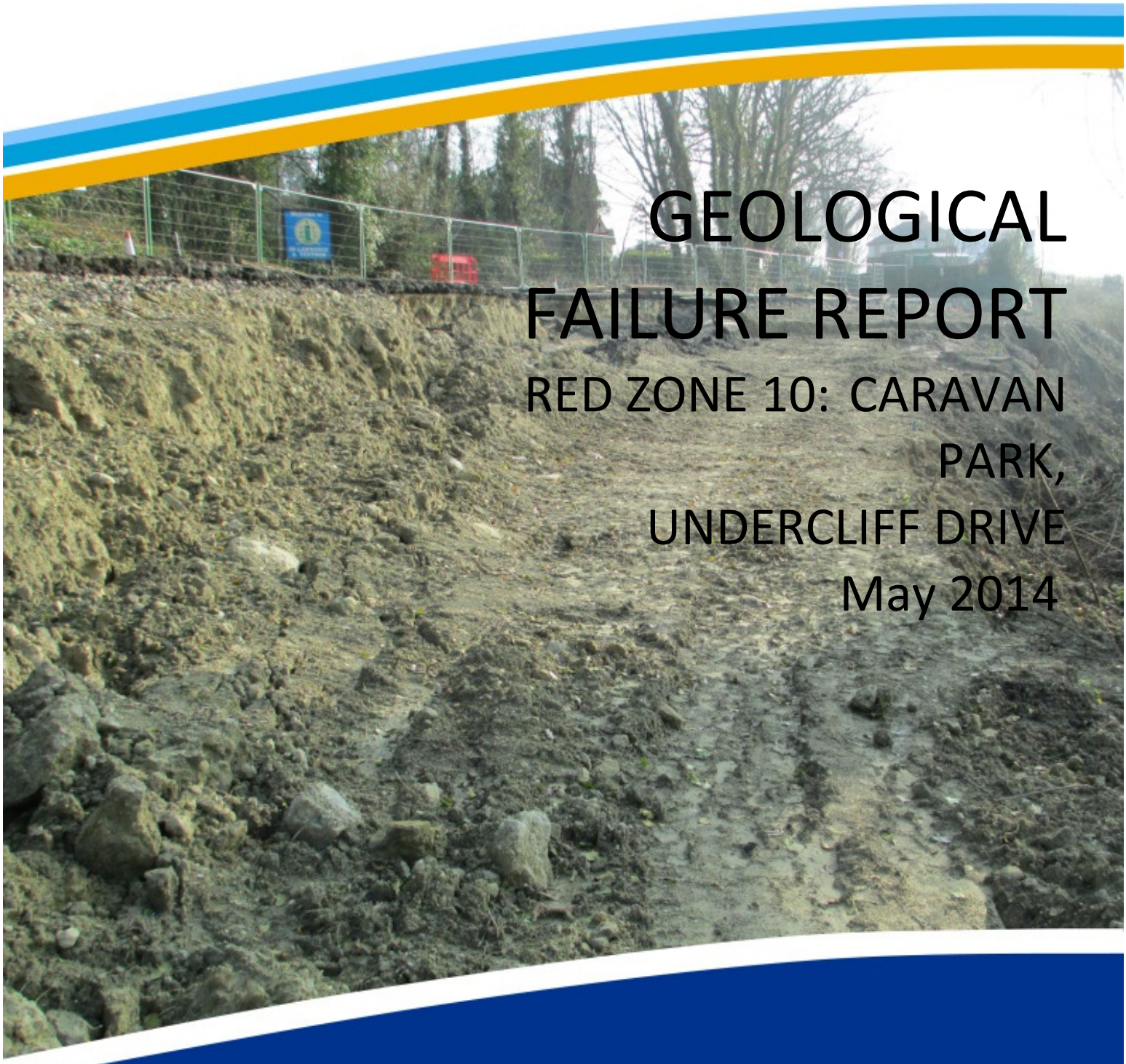
Island Roads



GEOLOGICAL FAILURE REPORT

RED ZONE 10: CARAVAN PARK, UNDERCLIFF DRIVE

May 2014

www.islandroads.com

Title	**Geological Failure Report – Red Zone 10: Caravan Park**
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4			

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1 INTRODUCTION

A Geological Failure occurred at Red Risk Site 10: Caravan Park on 6th January 2014. A section of the road that had undergone movement previously has failed during the period of construction works to stabilise the road.

Clause 12.11.1 of the Highways PFI contract stipulates that the Service Provider must provide a failure report detailing the nature and proposed costs of remediation, management and or rectification for each Amber or Red zone Geological Failure. This report follows on from the Failure Notice issued by the Service Provider to the Isle of Wight Council in March 2014. Below is a response to each of the clauses required within the contract. They are further considered within a specific Geological Failure Report undertaken by Ramboll who were appointed by Island Roads to specifically address the issues surrounding the failure.

2 CONTRACT RESPONSE

2.1 Contract Clause 12.11.1.1

For details of the Geological Failure refer to Appendix 1 Ramboll Geotechnical Report Sections 1 and 2 which provide updated and more detailed information of those matters contained in the original Failure Notice. An introduction is provided within Section 1 together with reference to construction activities that have occurred in the area to date. Under Section 2 details the works location and an insight into the history of construction works within the area.

Under Section No. 2, information is provided on historical landslide behaviour together with findings from the site inspection undertaken on 07th January 2014. Ramboll have provided observations derived from monitoring equipment data indicating that the full effects of recent and continued heavy rainfall may not yet have fully expressed themselves.

The failure at Site 10 Caravan Park occurred in early January 2014 towards the western end of the site. Only preliminary excavations (removal of vegetation, removal of tarmac and excavation to depth for a distance of approximately 5m from the eastern end of the scheme) were completed at Site 10 Caravan Park at the time of failure. No further construction works commenced after the Geological Failure.

In addition to the information given in Appendix 1, a plan showing the extent of the ground movement caused by reactivation of the landslide along Undercliff Drive over January/February 2014 is shown in Appendix 3. The main line of the failure at Site 10 Caravan Park has cut through the footprint of the west bound carriageway and onto the east bound side along pre-existing cracks (see Fig 1a). The failure has also retrogressed towards

the eastbound carriageway and extends downslope for a distance of approximately 300m to the sea. The failure in this part of the landslide is characterised by large scale tension cracks (see Fig 1b and 1c) and fallen trees.

Figure 1a. *Site 10 Caravan Park Geological Failure*: Failure of the carriageway on the eastbound side and retrogression in-land.

Figure 1b. *Site 10 Caravan Park Geological Failure*: Failure cutting across the footprint of the westbound carriageway and along existing cracks.

Figure 1c. *Site 10 Caravan Park Geological Failure*: Large tension cracks approximately 100m downslope of the site.

2.2 Contract Clause 12.11.1.2

Within Appendix 1 Section 3 the implications of failure have been considered. Construction works were forced to cease following the 2013/14 Christmas shut down period as a result of ground movement that had occurred. The site was made safe to the public.

The report in Appendix 1 further recommends that construction works should not commence again until ground movement has stopped. The report also states that and that the current Undercliff solution will most likely be inadequate in its current form.

Since gradual movement is still ongoing at the site the monitoring programme will be continued for the foreseeable future. Island Roads will continue to undertake weekly surveys and a CCTV system will be put in place to provide security for empty properties and the remaining residents.

The immediate requirement for Island Roads is to maintain safety (as far as reasonably possible). Since it has been determined by Ramboll that the original proposed solution is now unlikely to be suitable for this site, Island Roads will continue to develop a scheme that considers the land instability further and will provide a more long term solution. Any solution will depend upon the actual recorded movement over the coming few months.

2.3 Contract Clause 12.11.1.3

In order to make the site safe it has been contained using lengths of Heras fencing running the length of the failure between the western extent of the site and the boundary of Site 10 Caravan Park.

Warning and danger signs have been attached to the fence. Since the area has had to remain accessible to residents, an easily moveable fence panel has been placed at the western extent of the site. The footpath accessing the area below the site has been closed by the Isle of Wight Council Rights of Way department.

Inside the site the area has been completely cleared of all construction equipment, vehicles and barriers. Photos of the current condition of the site are provided in Fig. 2a, 2b and 2c.

Figure 2a. Site 10 *Caravan Park Geological Failure*: Barriers at the western extent of the site.

Figure 2b. *Site 10 Caravan Park Geological Failure*: Barriers through the centre of the site.

Figure 2c. *Site 10 Caravan Park Geological Failure*: Barriers at the eastern extent of the site.

2.4 Contract Clause 12.11.1.4

Site inspections are undertaken weekly by Island Roads. Ground movement monitoring and groundwater level measurements are taken from existing instrumentation along the length of the site (from Site 10 Caravan Park to Site 8 Above Hunt's Road). The most recent survey has shown that movement has almost ceased at this site although there has been some residual millimetre scale movements towards the east of the site.

A number of recommendations for increased monitoring of the landslide were outlined by Ramboll in their January report (see Section 5 of Appendix 1 which includes the report updated to June 2014). The following were implemented by the Service Provider from January 2014:

- Increase inclinometer survey frequency to once per fortnight
- Monitor width of cracks and surface points in the road at Sites 8, 9 and 10 weekly
- Collect and carry out regular reviews of monitoring and rainfall data
- Review remediation proposals in view of revised ground conditions
- Once ground movement has ceased, the area seaward of the site will be re-surveyed

2.5 Contract Clause 12.11.1.5

Although final details concerning rectification of the Geological Failure cannot be produced until ground movements at the site have stopped (as indicated by Ramboll Geotechnical Report Appendix 1 Section 6). A number of outline options for remediation of Undercliff Drive are detailed in Appendix 5.

2.6 Contract Clause 12.11.1.6

Failure costs incurred to date and ongoing weekly costs associated with the failure are included within Appendix 3.

Since movement at the site is still on-going it is not yet possible to provide nor price a Proposed Failure Solution as referred to in Ramboll Geotechnical Report Sections 6 and 7.

2.7 Contract Clause 12.11.2

Resurfacing of Undercliff Drive was due to be commenced immediately after completion of the original stabilisation works at Site 8 Above Hunts Road, Site 9 Woodlands and Site 10

Caravan Park. Seeing as the stabilisation works at Site 9 Woodlands and Site 10 Caravan Park have not been completed due to the Geological Failure, the resurfacing works will not be completed until such time as a proposal for rectification is agreed and implemented.

APPENDICES

APPENDIX 1:

Ramboll Report – Caravan Park Site 10, Undercliff Drive Geological Failure

Intended for
RINGWAY ISLAND ROADS

Document type
REPORT

Date
January 2014

ISLE OF WIGHT HIGHWAYS PFI

UNDERCLIFF SITE 10, CARAVAN PARK

GEOLOGICAL FAILURE REPORT

RAMBOLL

ISLE OF WIGHT HIGHWAYS PFI
UNDERCLIFF SITE 10, CARAVAN PARK
GEOLOGICAL FAILURE REPORT

Revision	**0**
Date	**09.01.2014**
Made by	
Checked by	
Approved by	
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Prepared By	Reviewed By	Approved By

Ramboll
Carlton House
Ringwood Road, Woodlands
Southampton SO40 7HT
United Kingdom
T +44 (0)23 8081 7500
F +44 (0)23 8081 7600
www.ramboll.co.uk

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1. INTRODUCTION

Geological failure of the landslide complex at *Undercliff Site 10 – Caravan Park* was first reported on 6th January 2014 after returning from the Christmas holiday period. Undercliff Site 10 is located at National Grid Reference 4522 0761 immediately adjacent to and west of the Caravan Park along Undercliff Drive (Figure 1). The site is 301 metres long and begins just to the west of the traffic lights and extends 115 metres east of the Caravan Park. The existing road was been reduced to single carriageway following a major land slippage event in 2001. Ground movement occurred in the winter 2012/13 prior to the award of the Highways PFI Contract. As a result of the 2012/13 ground movement Undercliff site 10 was prioritised, with work planned in the first year of the Highways PFI scheme. The Contract required the works to be carried out over the Winter Period. The scheme was designed and construction works at this site had begun on 28th November 2013. Construction works had progressed to partial excavation and removal of the westbound carriageway. The east bound lane remained open. Groundwater levels reached amber trigger levels on 23rd December 2013 and red trigger levels on 29th December 2013.

Following the initial notification a site inspection by Ramboll Geotechnical Engineer was carried out on 7th January 2014. A site inspection record is presented in Appendix A. This document was initially issued as a geological failure action plan, but now has been renamed the Failure Report as per Section 12.11.1 of the highways PFI contract, and additional sections added to cover the full requirements of a Failure Report.

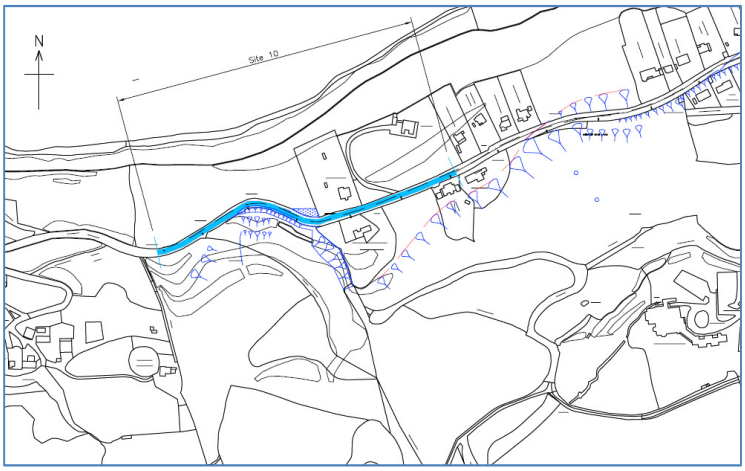

Figure 1 Undercliff Site 10 - Caravan Park Location Plan

The contract requires a Failure Report to include information as summarised in Table 1.

Failure Report Clause	Text	Reference in this Report
12.11.1.1	Updated and more detailed information of those matters contained in the Failure Notification and Failure Notice;	Section 1 and 2
12.11.1.2	A full and detailed explanation of the impact of the rectification, management and/or mitigation (as applicable) of the Red Zone Failure.	Section 3
12.11.1.3	A full and detailed explanation of how the OpCo has made the affected Project Network Parts and its surroundings safe to the public (including the remediation of all Category 1 Defects in accordance with the provisions of Schedule 2 (*Output Specification*)).	See Island Roads report
12.11.1.4	A full and detailed explanation of what further actions the OpCo is to undertake (including any inspections, tests, surveys and/or assessments in order to determine the full extent of the Red Zone Failure, Amber Zone Failure and/or Geological Failure);	Section 4 and 5
12.11.1.5	A full and detailed explanation of how the OpCo proposes to rectify, manage and/or mitigate (as appropriate) the Red Zone Failure, Amber Zone Failure and/or Geological Failure (**"Proposed Failure Solution"**) which shall, where the OpCo believes no action is required, provide a full explanation of the reasons for such belief, including any implications arising from taking no action.	Section 6 and 7
12.11.1.6	An estimate of the total amount of Failure Costs which the OpCo shall calculate acting reasonably (including all Failure Costs incurred up to the issue of the Failure Report) required to carry out the Proposed Failure Solution, together with documentary evidence such as full bills of quantity where practicable.	See Island Roads report
12.11.2	The OpCo shall at the same time as submitting the Failure Report, amend and submit to the Service Provider pursuant to Schedule 20 (*Review Procedure*) any OpCo Programmes affected by the Proposed Failure Solution.	See Island Roads report

Table 1 Summary of Failure Report Information

2. INITIAL OBSERVATIONS OF LANDSLIDE FAILURE/ BEHAVIOUR

2.1 Site Inspection

The site inspection note in Appendix A describes the observations made during the site visit. The main points from the site inspection are:

- The existing landslide from the sea to the Undercliff Site 10 has been remobilised.

- Existing and multiple new tension cracks have developed within the undercliff carriageway.
- The form of the landslide varies making it difficult from site observations to ascertain relative movement, but where visible surface effects appear more severe lower down the complex. At the time of the inspection ground movement comprised opening of tension cracks in the road, whereas metre scale ground movement is evident approximately 70 to 80 metres downslope of the site.
- The tension cracks in the existing road are opening in response to the movement further downslope.
- The movement is understood to have started around Christmas 2013.
- There has been loss of ground at the seaward end of the landslide complex through sea erosion during the stormy weather.
- Surface water on the landslide complex is significantly higher and more extensive than that observed during site visits carried out during the tender period (2010, 2011 and 2013) and during the design period (2013).
- Construction work had involved excavation and removal of the westbound carriageway; unloading the top of a landslide is beneficial to overall stability. In addition, the size of the excavation relative to the landslide is very small.

2.2 Historical Landslide Behaviour

Over the last ten years there have been three significant ground movement events at the Undercliff Site 10 Caravan Park. In 2001 a prolonged period of wet weather caused a major landslide. The rear extent of this landslide reached Undercliff Drive and the area of land adjacent to the road occupied by the Caravan Park. This event resulted in a number of large tension cracks developing and subsequently this section of the west bound carriageway was closed. A single carriageway and traffic light system was installed.

Subsequent to previous large scale ground movements along the Undercliff, a landslide forecast model was developed for the Undercliff by High-Point Rendel in 1996 based on the work by Lee et al (1991)[1]. In order to try and predict the likelihood of future movements along the Undercliff, data was collected concerning the occurrence and location of previous landslides and the volume of rainfall preceding them. The model gave a threshold value of effective rainfall (the percentage of total rainfall that enters the ground) over a preceding 4 month period which would be likely to cause instability or increased ground movement rates within the Undercliff landslide complex. When comparing the occurrence of previous landslide events with the corresponding 4 month antecedent effective rainfall (4AER) value it appears to correlate with ground movement events with a good degree of accuracy (Figure 2). Once the 4AER drops back to below the threshold value the likelihood of further movements at that point in time is reduced. The Isle of Wight Council has employed this model in order to aid in assessing the likelihood of ground movements in areas throughout the Undercliff. Table 2 summarises the trigger threshold values. This placed the rainfall during February and March 2014 as Class 3, and at risk of major instability.

Landslide Forecast Class			
Class	Trigger Value (4AER mm)	Location	
		Major	Minor
Class 1	< 410	Blackgang	The landslip, Luccombe,

			Mirables
Class 2	410 - 540	The landslip, Luccombe, Mirables, Blackgang	Woodlands
Class 3	540 - 640	ALL	Bonchurch, Ventnor, St Lawrence
Class 4	>640	ALL	ALL

Table 2 Summary of Landslide Forecast Trigger Values based on rainfall

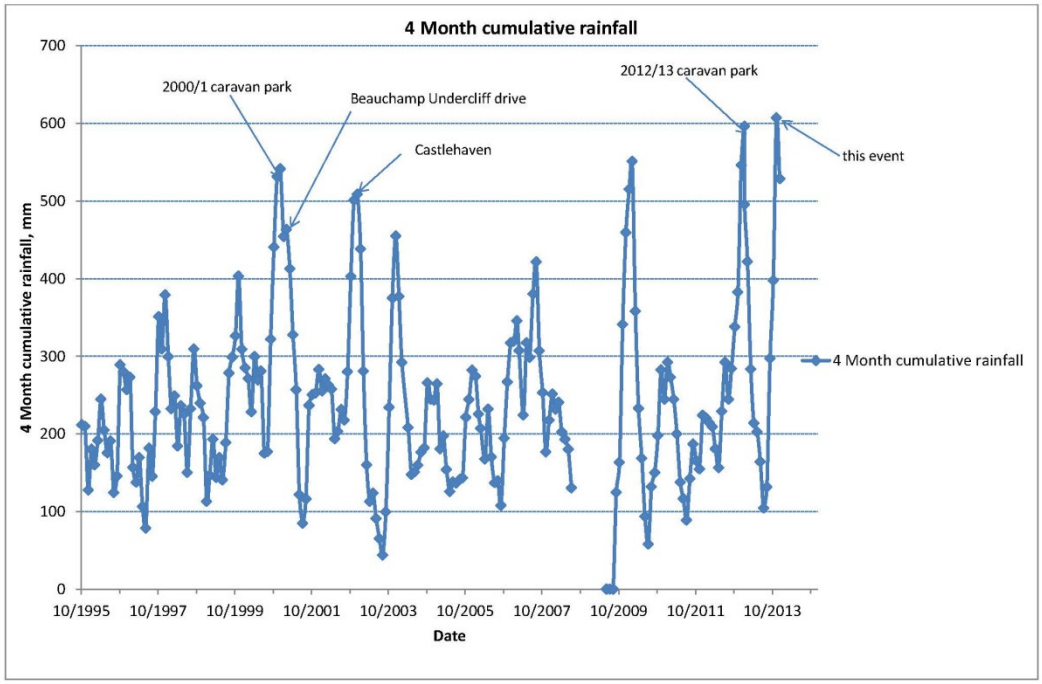

Figure 2 Four Month Moving Average Rainfall and Landslide Events

In December 2012 another period of heavy rainfall caused new cracks to develop in the open east bound carriageway and extension of those already present on the west bound side. During similar heavy rainfall in December 2013/January 2014 significant ground movements occurred throughout the area of the 2001 landslide characterised by the opening of large tension cracks across the adjacent footpath, very slow moving clay flows (within the landslide and down to the beach at Binnel Bay) and a number of fallen trees. Movement was also evident on the carriageway with the extension and propagation of the tension cracks in the west bound carriageway.

A location of the available monitoring points is shown in Figure 3, which comprise piezometers installed at a range of depths to monitor groundwater, and inclinometers to 50 metres depth to measure ground movement.

Records of ground instrumentation are presented in Appendix B.

During the 2012/13 landslide event surface ground markers were installed in Undercliff Site 10 and the adjacent Site 9 Woodlands. A summary of the records from this is presented in Appendix C. Surface movement of the road continued up to last available record that was taken in 14/3/2013.

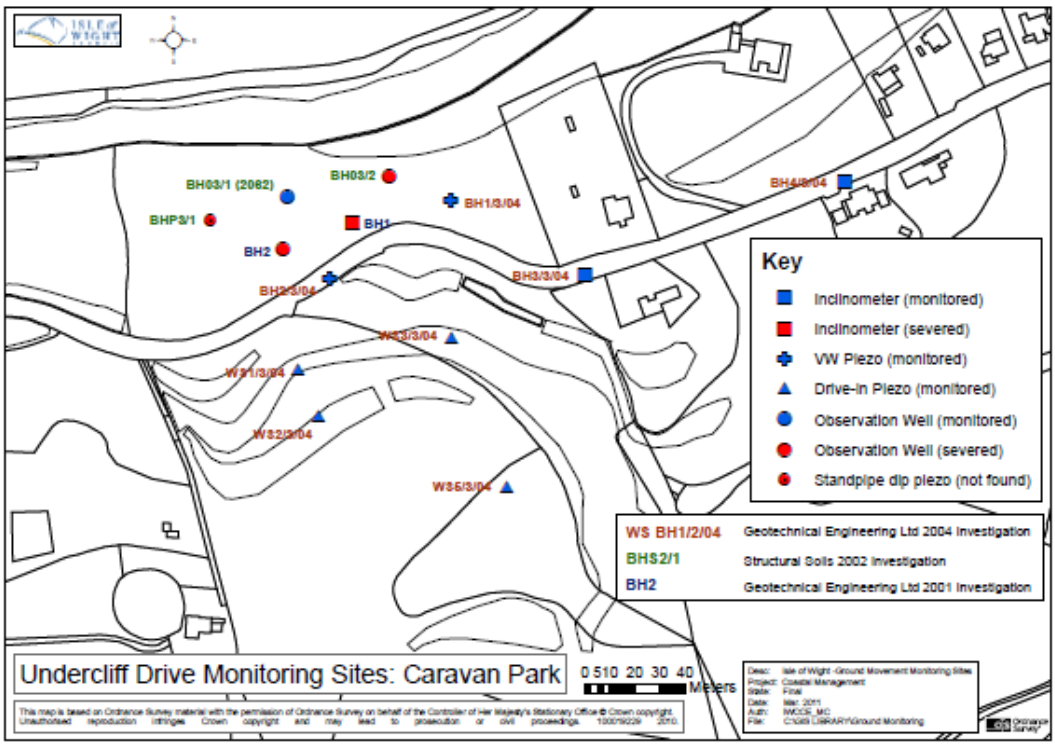

Figure 3 Undercliff Drive Site 10 Monitoring Location Plan

Observations from monitoring data:

- Ground water levels have been and remain above set trigger levels for movement (see Piezometer 2062 plot). The amber level was reached on 23rd December and the Red trigger level on 29th December 2013.
- Ground water levels are much higher than levels at the same time after heavy rain the previous year over December 2012/January 2013 and exhibit a rapid rise beginning around 17th December 2013.
- The four monthly cumulative rainfall preceding this landslide event exceeds those that triggered landslide events in 2001, and 2012/13.
- The groundwater regime is complex, and deeper piezometers have lower associated groundwater pressures, however they do show increases in response to rainfall
- Inclinometer readings showed ground movement over a period of approximately 4 months during the 2012/13 event; this was initially relatively rapid, and then reduced in its rate as the landslide complex found its next resting position.
- In the 2012/13 event surface movement on the carriageway continued to at least the middle of March 2013, three and a half months after its initiation.
- The full effects of the recent and continued heavy rainfall may have not fully expressed themselves in the landslide groundwater regime and movement at and forward of the Undercliff Site 10- Caravan Park during this current landslide event to date.

- The Amber and Red Trigger levels previously established in Piezometer 2062 differ by only 5 cm

3. IMPLICATIONS OF FAILURE

- A geological failure has occurred prior to implementing the proposed stabilisation works.
- Construction works began on 28th November 2013.
- Groundwater levels have risen and amber trigger levels were reached on 23rd December 2013 and red alert levels on 29th December 2013. On reaching the amber levels groundwater levels rose sharply.
- Ground movement was first reported on 6th January after returning from the Christmas period.
- Ground movement is most probably continuing and likely to continue for a period of months.
- It is possible that the full effects of rainfall and movement of the toe of the landslide complex have not fully expressed themselves at the site to date.
- The current geotechnical solution cannot be implemented within a moving mass for reasons of both safety and adequacy/effectiveness.
- The sensitivity of the current proposal to landslide movement (geological failure) seaward of the site was considered at the design stage. This indicated that proposal was sensitive to ground loss due to landsliding seaward of the site.
- A range of options, including dewatering, were considered during the tender process. However, this was not taken forward due to environmental constraints
- It is likely that the current solution will be inadequate in its current form. Depending on the actual recorded movement over the next few months it is likely only to return the site to its original stability condition and no better than its 2012/2013 condition i.e. at the point of failure. It is considered most likely that additional measures will be required.

4. INTERIM MEASURES

A large scale geological failure has been initiated with groundwater pressures providing the main driving mechanism. The following measures have been carried out:

- Following failure the site works included trimming of site levels, and demobilising.
- Consideration was given to managing surface water; sealing cracks was attempted but as the cracks were developing they opened again.
- Covering the surface was considered to control rain infiltration however this was not carried out as the driving mechanism for the failure was subsurface groundwater, and surface disposal would be downslope back into the moving landslide. There were health and safety concerns with placing surface covering as this would mask any developing landslide features. Covering the surface cracks was assessed to have negligible benefit as rising groundwater levels were and remain the driving mechanism.

- The road has been closed to vehicular access as the geological failure has left 1.2 metres wide remnant of the eastbound carriageway.

5. INFORMATION TO ASSESS EXTENT OF GEOLOGICAL FAILURE

The following information and actions have been implemented to assess the extent of the geological failure.

- Review remediation proposals given the revised site conditions
- Continue to collect all monitoring data available to date and rainfall data
- Increase frequency of inclinometer readings to fortnightly
- Monitor surface points in road surface at weekly intervals
- Monitor width of cracks in road surface at weekly intervals
- Likely period of monitoring 4 months but continue with monitoring with interim reviews say at monthly intervals
- Resurvey the ground surface seaward of the site along the same cross section as that carried out during the design to establish the change in ground profile once the landslide event is complete
- Carry out reviews of monitoring data with Island Roads to assess continuation of movement

6. ESTIMATE FOR TIME FRAME FOR GEOLOGICAL FAILURE RECTIFICATION

At the time of preparing this report the full extent of the landslide and its effect on Undercliff Drive Site 10 has not been fully realised. Since the first issue of this report ground movement has continued. As a result a full programme for rectification of the red site has not been developed at this stage; this is dependent on the length of time ground movement continues. It is likely that movement will continue until groundwater levels drop to below trigger levels for ground movement. A timeframe for rectification but will be developed subsequent to this failure report (or as to be agreed with the Isle of Wight Council). The initial outline programme of the proposed actions which have now been completed is given in Appendix C.

7. ESTIMATE OF FAILURE COST

An estimate of failure cost has not been established as the geological failure is still continuing. Given the movement that has occurred the current ground anchor solution is no longer suitable. If the road is to remain in its current alignment then significant fill would be required to raise the road back to an acceptable alignment. Remedial measures, if they were deemed possible, are likely to use a combination of techniques, and most likely include as one of the components deep wells to control groundwater levels. Groundwater control was initially proposed by Island Roads during the tender, however subsequently not taken forward due to environmental restrictions associated with the site.

REFERENCES

Lee E M and Moore R 1991. Coastal Landslip Potential Assessment: Isle of Wight Undercliff, Ventnor. Report to the DoE.

APPENDIX A

SITE INSPECTION RECORD

RECORD OF SITE VISIT

JOB TITLE	IOW PFI	JOB NO.	61030594
DATE	10/01/2014	FILE REF.	GEOTECHNICAL
VISIT TO	UNDERCLIFF SITE 10	BY	ROSS ADAMS
MET	KIERON BLAMEY, MADELINE CLEWETT	CIRCULATION	DAVID GIBBY, BOB BINDER
PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

Notes of Site Inspection 7th January 2014

I attended the Undercliff site 10 on Tuesday 7th January 2014 following reports that there had been movement of the Ventnor landslide complex over the Christmas period.

I arrived at 10:15am and met with Kieron Blamey and Madeline Clewett from Island Roads, as well as a representative from John Peck Construction. Kieron informed me that he had heard from the owner of the caravan park that movement had begun after Christmas. Kieron had walked down the footpath on Boxing Day and the footpath was intact. No work had been carried out on site since 20th December and the westbound lane remained in a state of partial excavation. An excavator was removing material from the excavation during my visit in an effort to unload the slope, but this stopped later on in the afternoon and has not been resumed.

We began by walking down the footpath from the western end of the site, following it all the way down to the beach. The walk down was used to familiarise ourselves with the extent and direction of the movement, as well to see if there were any signs of movement at the toe of the landslide. Madeline informed us that is was difficult to see any signs of movement at the toe of the landslide, as it creeps forward and is constantly being eroded by the sea. There is likely to have been significant toe erosion in the weeks preceding the site visit due to the stormy seas that were prevalent during that time. There were no visible signs of movement in the lower half of the landslide. It is expected that this is because this section is creeping forward as a degraded mass with little differential movement between blocks. We were able to orientate ourselves with the site by looking up and seeing the arm of the excavator that was working at road level.

On the way back up, I mapped the tension cracks and failures that were visible from the footpath as accurately as possible. The footpath winds its way down the landslide following the top of the scarp slopes, and so the damage to the path was very visible. Movement was seen from approximately halfway up the landslide all the way to the road, with the most severe movements occurring lowest down the landslide. Movement tended to be shown as large cracks with large drops in the ground surface lower down the landslide, and as developing tension cracks as you moved closer towards road level. Tension cracks up to 1m wide were seen in the lower slopes, with a change in height of up to 1m (Photo 1). As we progressed up the footpath, there were areas where a number blocks had formed, with an approximate height difference of 1m between blocks (Photo 2). Just below the level of the road large tension cracks were evident in the footpath, with up to 300mm differential movement (Photo 3).

At road level, a long tension crack was evident in the excavation made for the installation of the anchor blocks (Photo 4). From the western end of the site the crack followed the curve in the road at the base of the temporary cut, and then turned downslope before the caravan park (Photo 5). A total of seven tension cracks had appeared in the road surface. The longest two, approximately 10m and 15m long respectively, are cracks that have re-opened having previously been sealed. Differential movement is 20mm. The remaining cracks are generally all new cracks in the road surface, and not in the same location as a historic crack (Photo 6).

Following the site visit a conference call was held between Ramboll and Island Roads on Wednesday 8th January to discuss the landslide and any resulting action. It was agreed that no work is to be carried out at Site 10 until a full review of the available data has been completed, including stability analyses to assess the adequacy and effectiveness of the ground anchor solution with the landslide in its current form. It is expected that further ground movements will occur over the course of the next few months, as the groundwater level responds to the recent very heavy rainfall.

Following completion of this site visit report the following actions are required;

RECORD OF SITE VISIT

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VISIT TO	UNDERCLIFF SITE 10	BY	ROSS ADAMS
MET	KIERON BLAMEY, MADELINE CLEWETT	CIRCULATION	DAVID GIBBY, BOB BINDER
PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

- Programme for work drawn up
- Review of monitoring data (piezometers and inclinometers)
- Review of movement of landslide
- Stability analysis carried out of landslide in current form
- Analyses to determine the adequacy and effectiveness of the proposed ground anchor solution.

Photograph notes

Refer to sketch for locations (locations are approximate).

Photo 1.

Taken approximately 80 metres seaward of the site. This shows the edge of the landslide, where surface vegetation has been pulled downslope due to landslide movement. Lateral displacement estimated to be at least 2 metres

Photo 2
Severe tension crack development disrupting the existing footpath approximately 70 metres seaward of the site. Cumulative affects 1 to 2 metres relative vertical displacement.

Photo 3
Tension crack within existing footpath 20 to 30 metres seaward of the site

Photos 4 , 5 and 6

Tension cracks within the construction area.

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Photographs

Photo 1

Photo 2

Photo 3

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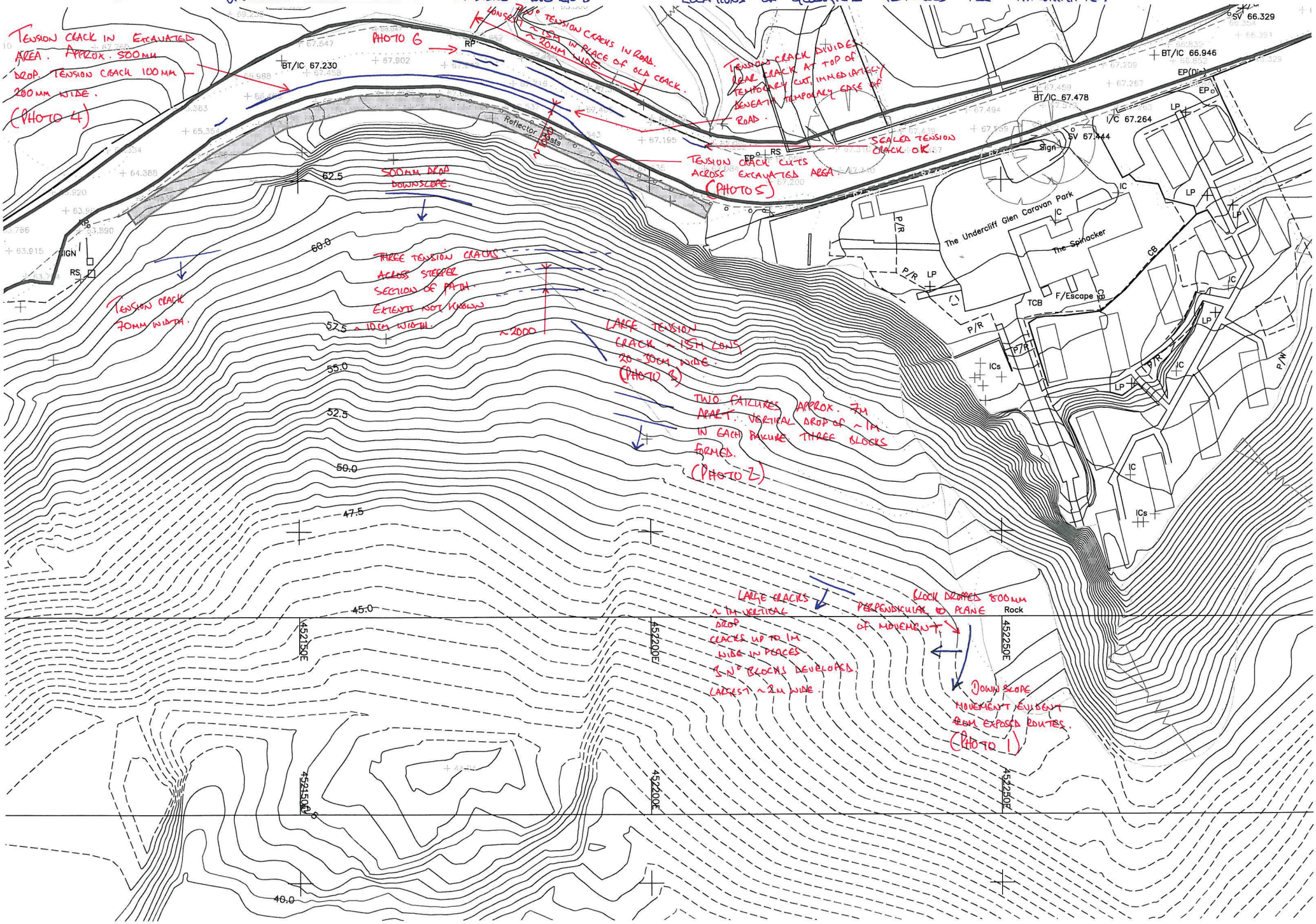
Photo 4

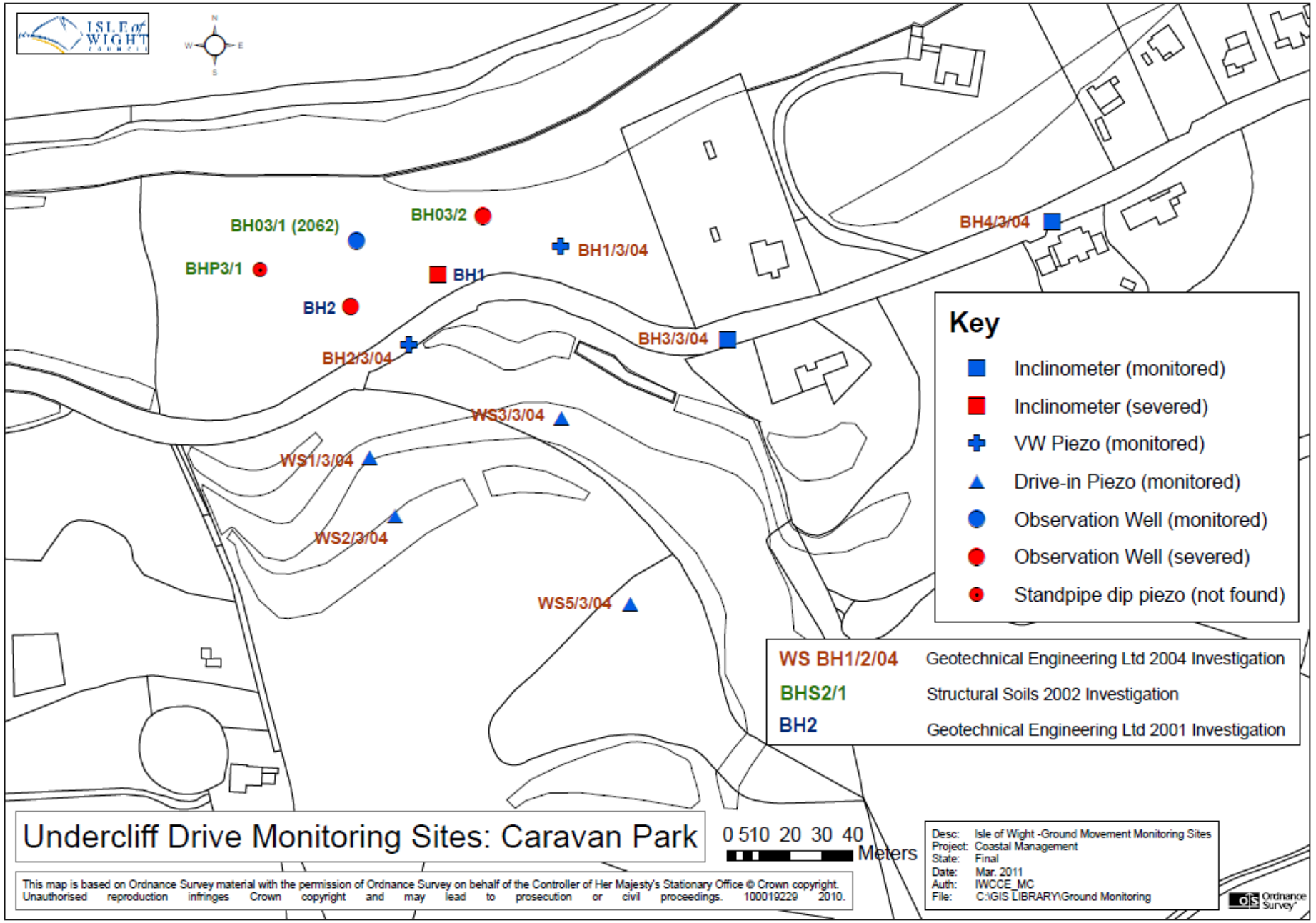
Photo 5

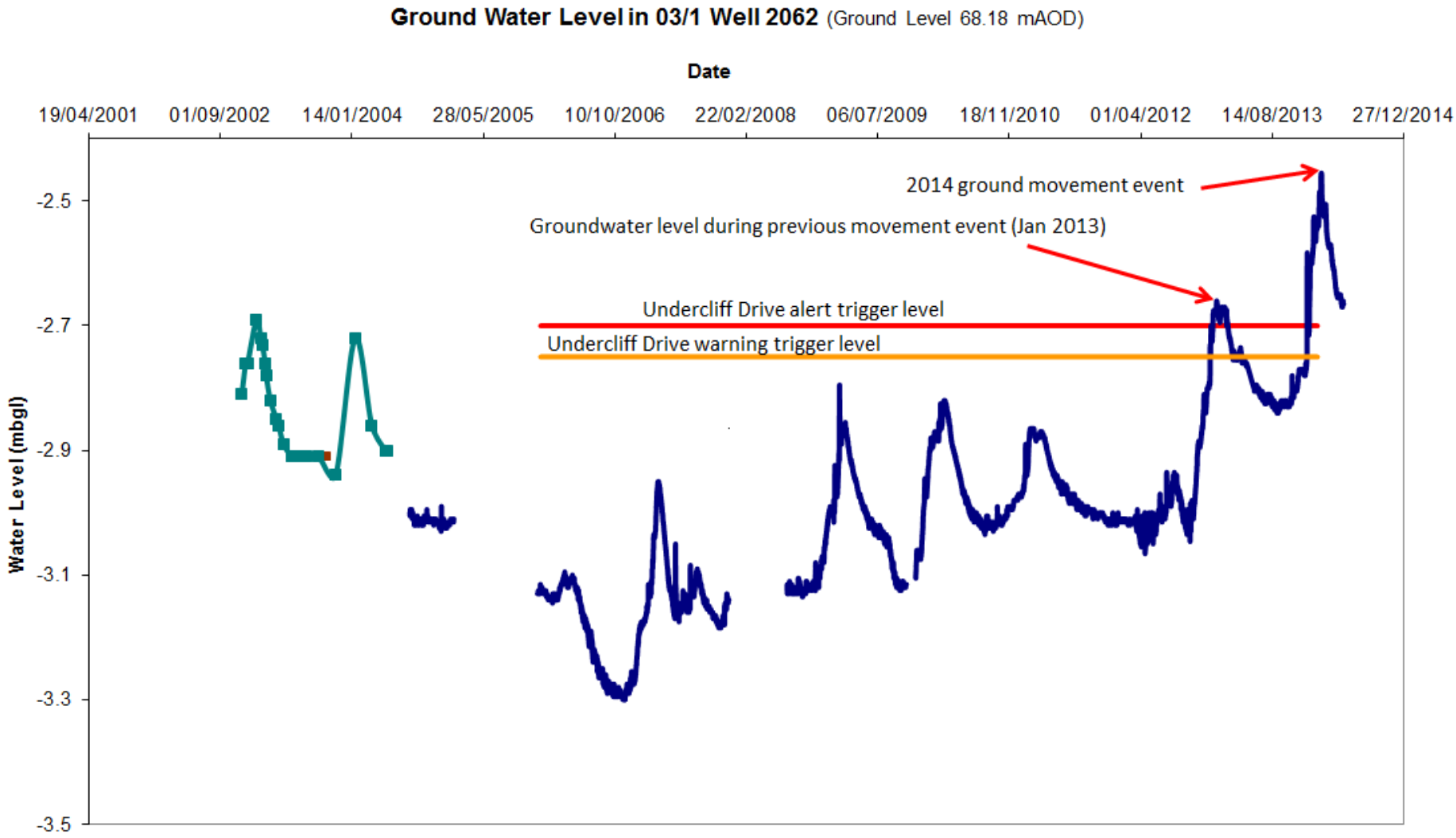
Photo 6


UNDERCLIFF DRIVE - SITE 10 - LANDSLIDE MOVEMENT
LOCATIONS OF GEOLOGICAL FEATURES ARE APPROXIMATE.
TENSION CRACK IN EXCAVATED AREA. APPROX. 500MM DROP. TENSION CRACK 100MM - 200MM WIDE. (PHOTO 4)
PHOTO 6
LONGER TWO TENSION CRACKS IN ROAD. ~15M IN PLACE OF OLD CRACK. ~20MM WIDE.
TENSION CRACK DIVIDES LEAD CRACK AT TOP OF TEMPORARY CUT, IMMEDIATELY BENEATH TEMPORARY CASE OF ROAD.
SCALED TENSION CRACK OK.
TENSION CRACK CUTS ACROSS EXCAVATED AREA. (PHOTO 5)
500MM DROP DOWNSLOPE.
THREE TENSION CRACKS ACROSS STEEPER SECTION OF PATH. EXTENTS NOT KNOWN
~2000
~10CM WIDTH.
TENSION CRACK 70MM WIDTH.
LARGE TENSION CRACK ~15M LONG 20-30CM WIDE. (PHOTO 3)
TWO FRACTURES APPROX. 7M APART. VERTICAL DROP OF ~1M IN EACH FRACTURE THREE BLOCKS FORMED. (PHOTO 2)
LARGE CRACKS ~1M VERTICAL DROP CRACKS UP TO 1M WIDE IN PLACES 3 NO° BLOCKS DEVELOPED LARGEST ~2M WIDE.
BLOCK DROPPED 800MM PERPENDICULAR TO PLANE OF MOVEMENT.
DOWN SLOPE MOVEMENT EVIDENT FROM EXPOSED ROOTES. (PHOTO 1)
BT/IC 67.230
BT/IC 67.478
BT/IC 66.946
I/C 67.264
SV 67.444
SV 66.329
EP(Dis)
EP
LP
RP
RS
IC
ICs
IGN
TCB
F/Escape
CB
P/R
Sign
Reflector Posts
The Undercliff Glen Caravan Park
The Spinnacker
Rock
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
40.0
452150E
452200E
452250E

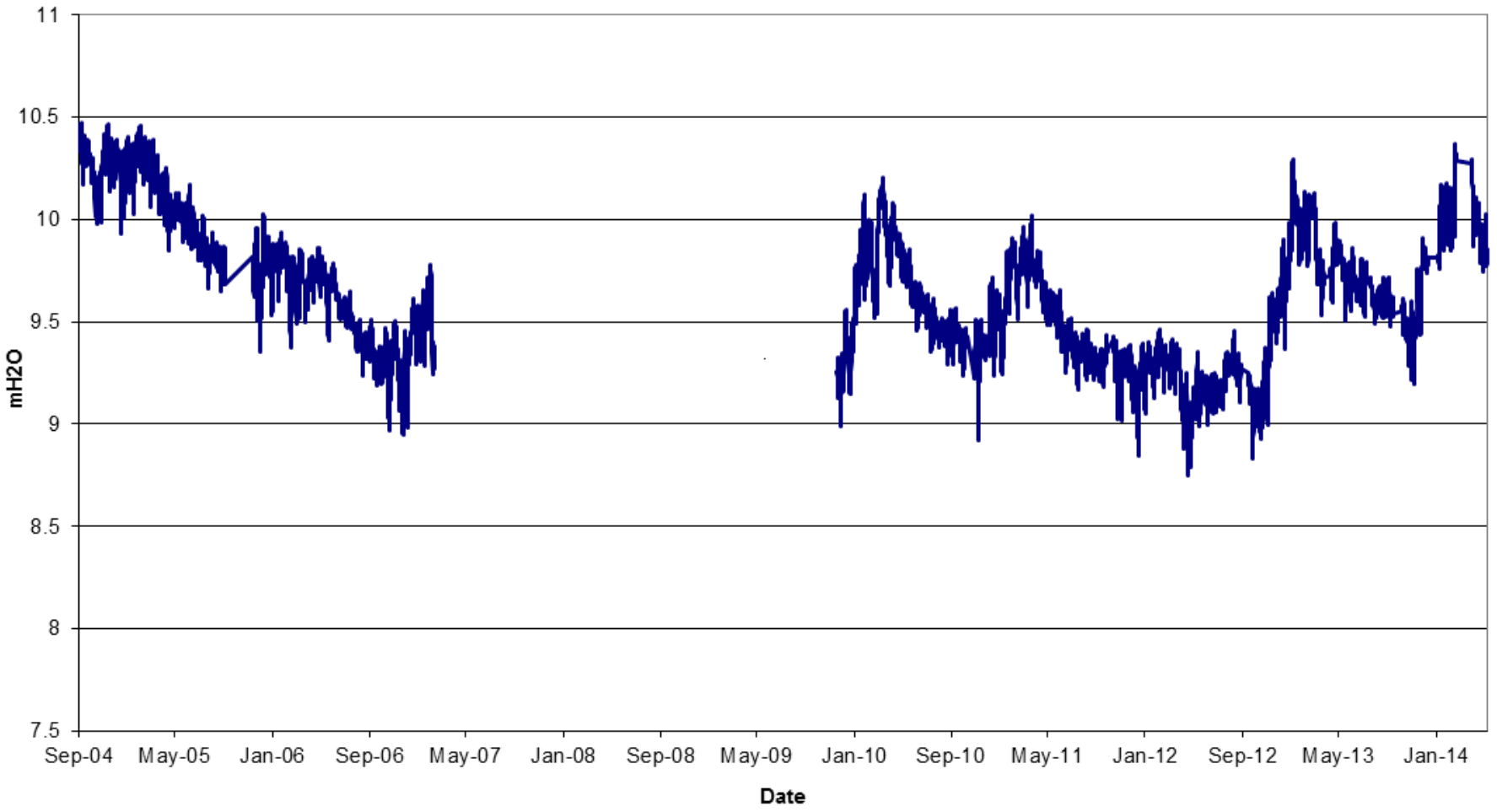
APPENDIX B

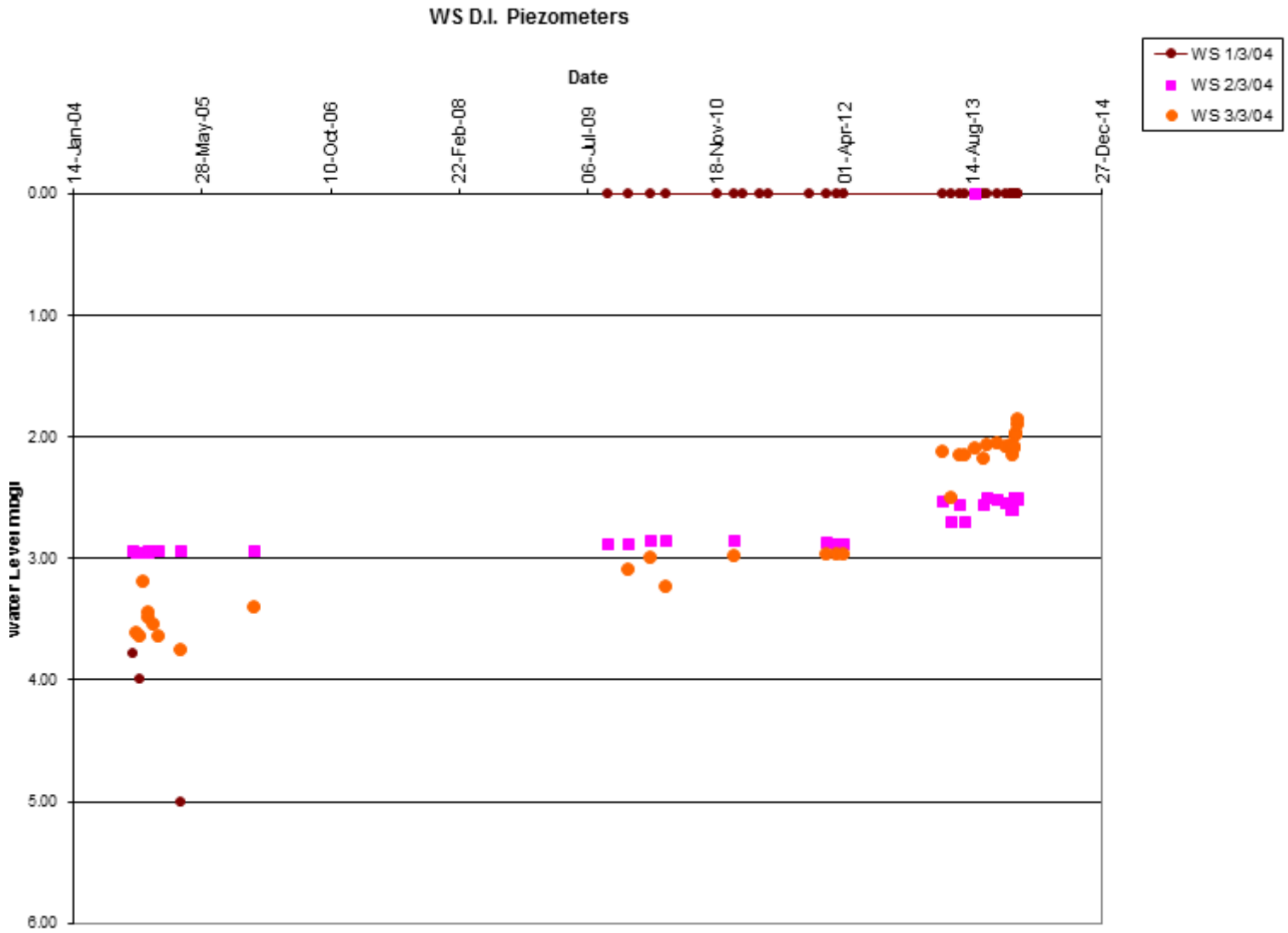
SUMMARY OF GROUND MONITORING DATA

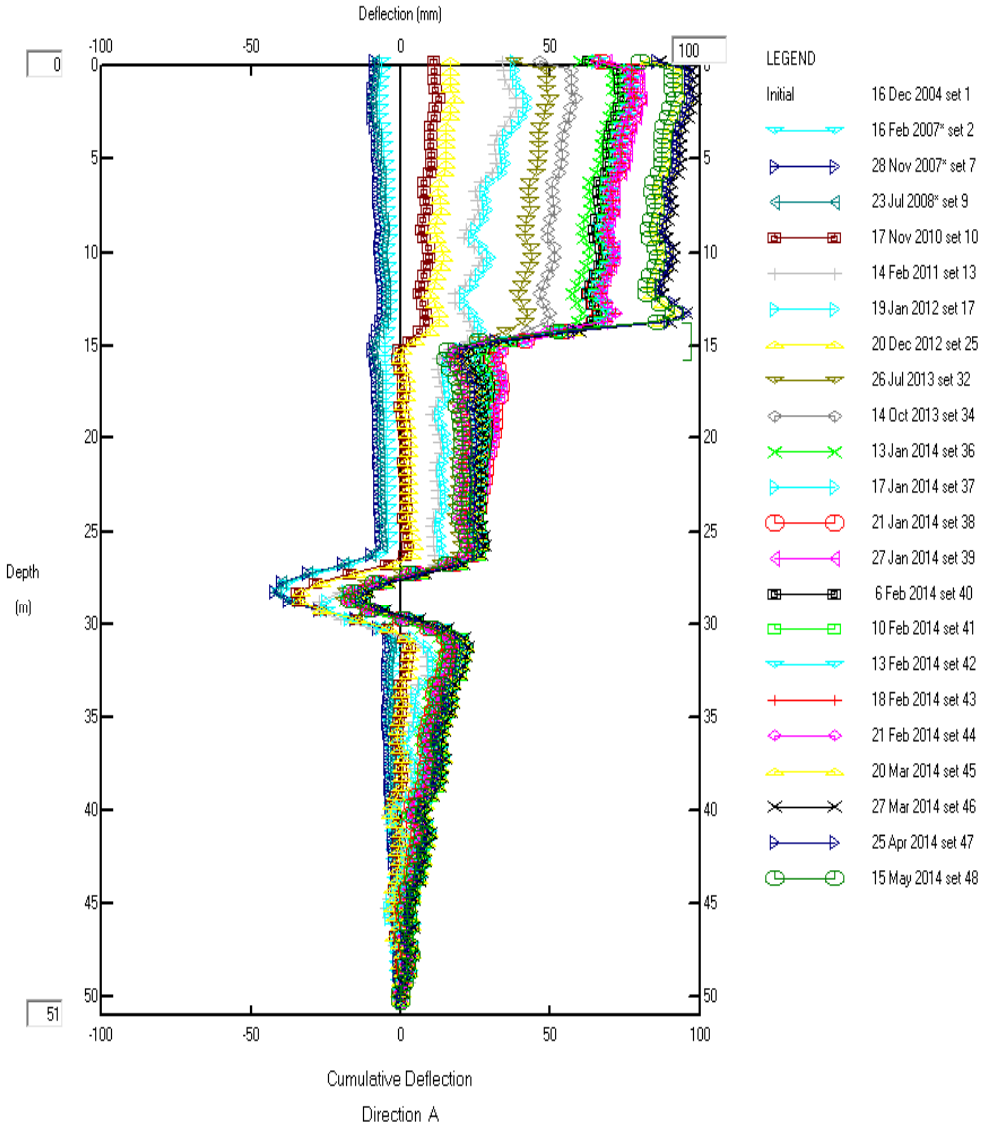

BH03/1 (2062)
BH03/2
BH1/3/04
BH4/3/04
BHP3/1
BH1
BH2
BH3/3/04
BH2/3/04
WS3/3/04
WS1/3/04
WS2/3/04
WS5/3/04
Key
Inclinometer (monitored)
Inclinometer (severed)
VW Piezo (monitored)
Drive-in Piezo (monitored)
Observation Well (monitored)
Observation Well (severed)
Standpipe dip piezo (not found)
WS BH1/2/04 Geotechnical Engineering Ltd 2004 Investigation
BHS2/1 Structural Soils 2002 Investigation
BH2 Geotechnical Engineering Ltd 2001 Investigation
Undercliff Drive Monitoring Sites: Caravan Park
0 5 10 20 30 40
Meters
This map is based on Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. 100019229 2010.
Desc: Isle of Wight -Ground Movement Monitoring Sites
Project: Coastal Management
State: Final
Date: Mar. 2011
Auth: IWCCE_MC
File: C:\GIS LIBRARY\Ground Monitoring
Ordnance Survey

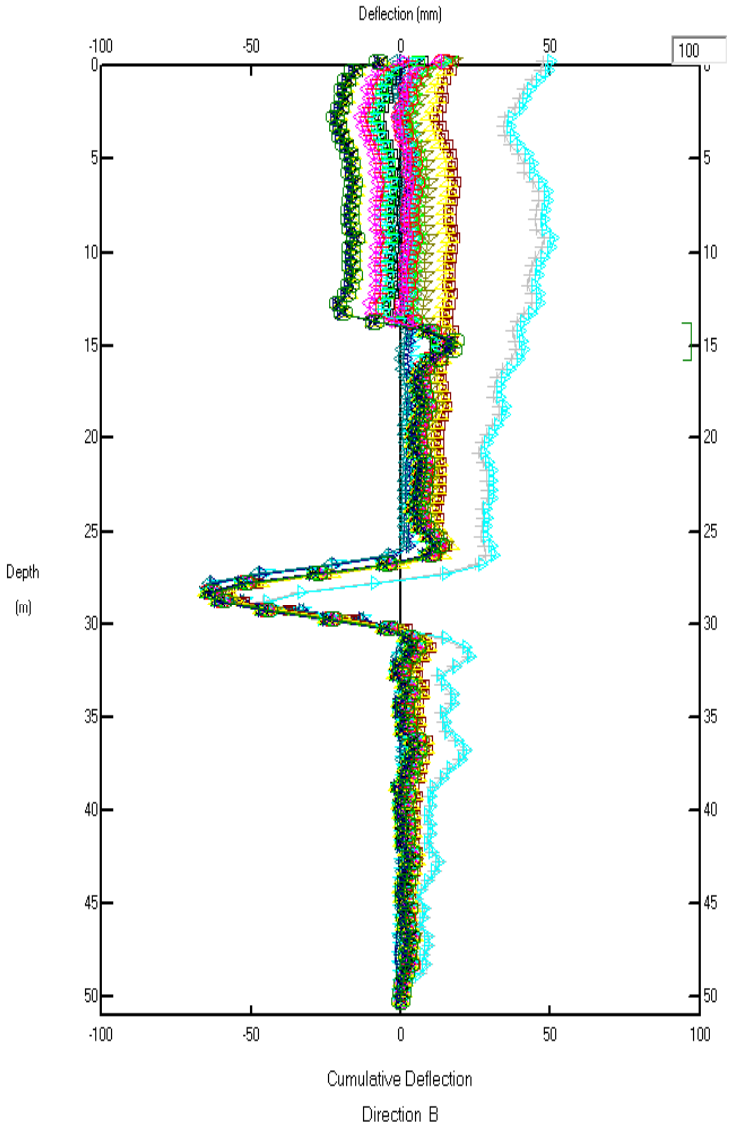

Ground Water Level in 03/1 Well 2062 (Ground Level 68.18 mAOD)
Date
19/04/2001
01/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
Water Level (mbgl)
-2.5
-2.7
-2.9
-3.1
-3.3
-3.5
2014 ground movement event
Groundwater level during previous movement event (Jan 2013)
Undercliff Drive alert trigger level
Undercliff Drive warning trigger level

BH 1.3.04 VW1 at 15.5 mbgl

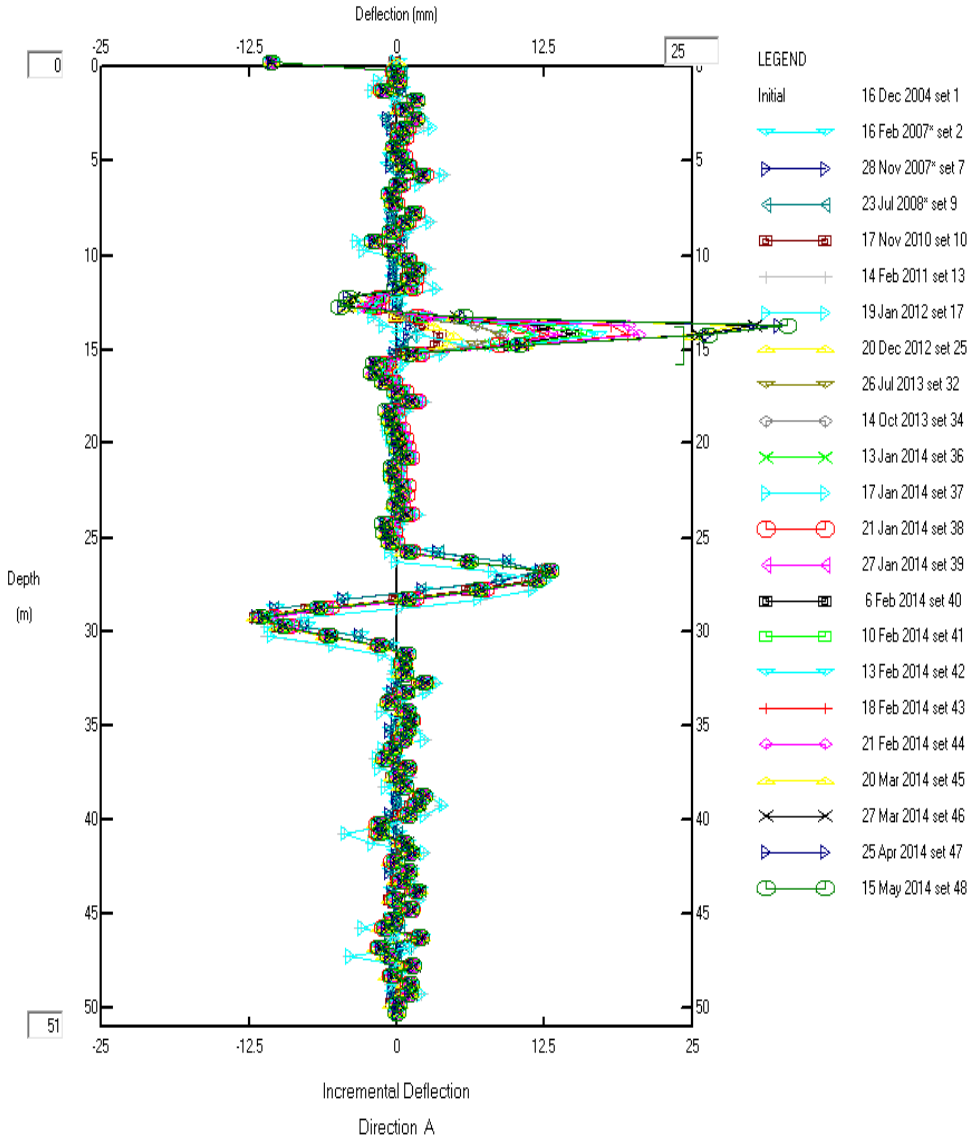


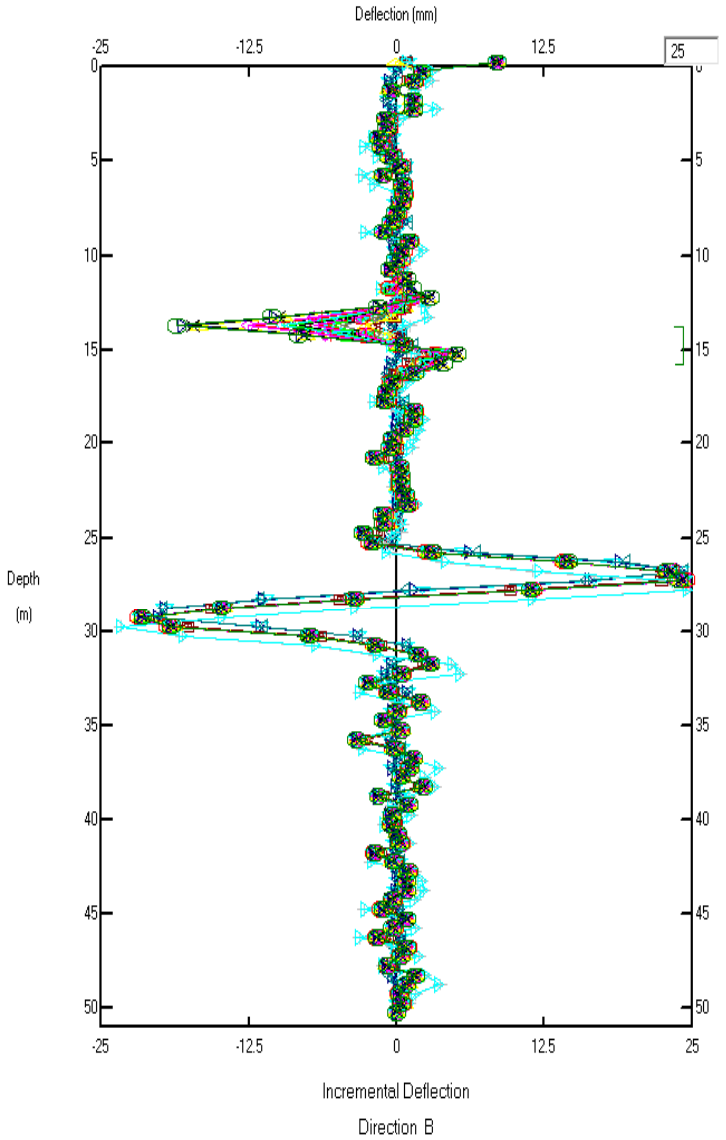

WS D.I. Piezometers
Date
14-Jan-04
28-May-05
10-Oct-06
22-Feb-08
06-Jul-09
18-Nov-10
01-Apr-12
14-Aug-13
27-Dec-14
0.00
1.00
2.00
3.00
4.00
5.00
6.00
WS 1/3/04
WS 2/3/04
WS 3/3/04



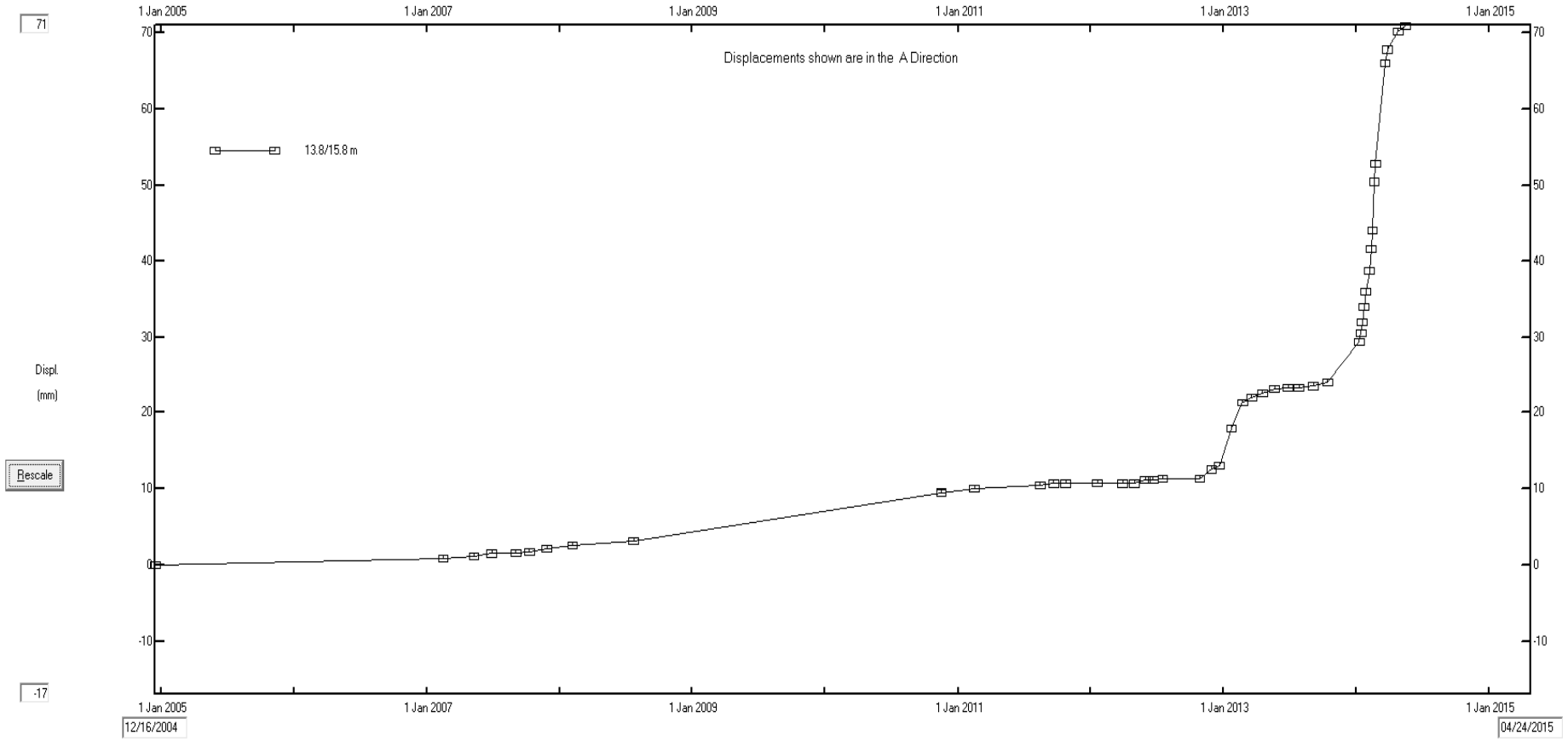


, Inclinometer 3304





, Inclinometer 3304

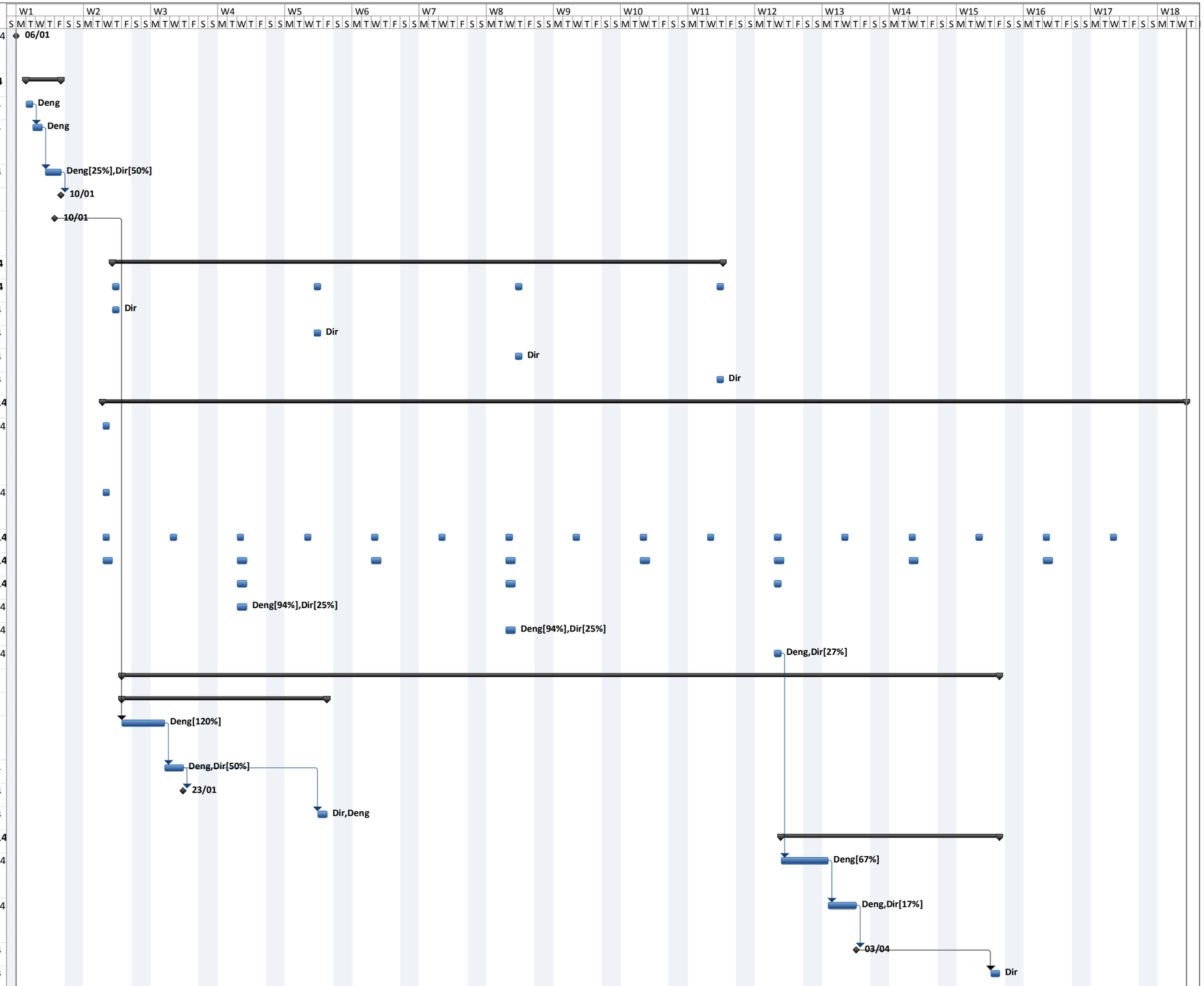


, Inclinometer 3304

APPENDIX C

PROGRAMME OF COMPLETED ACTIONS

ID	Task Mode	Task Name	Duration	Start
1		Undercliff Site 10- Caravan Park	0 days	Mon 06/01/14
2		**Initial Site Review**	**4.13 days**	**Tue 07/01/14**
3		Site Visit	1 day	Tue 07/01/14
4		Site Inspection report (factual)	1 day	Tue 07/01/14
5		Prepare Action Plan	2 days	Thu 09/01/14
6		Issue Action Plan to IR	0 days	Fri 10/01/14
7		Request Additional information	0 days	Fri 10/01/14
8		**Meetiings**	**49 days**	**Thu 16/01/14**
9		**IR**	**49 days**	**Thu 16/01/14**
10		IR 1	1 day	Thu 16/01/14
11		IR 2	1 day	Thu 06/02/14
12		IR 3	1 day	Thu 27/02/14
13		IR 4	1 day	Thu 20/03/14
14		**Monitoring**	**86.4 days?**	**Wed 15/01/14**
15		Establish surface peg monitoring in landslide forward of site	1 day?	Wed 15/01/14
16		Establish surface monitoring in road	1 day?	Wed 15/01/14
17		**monitor road surface**	**81.07 days**	**Wed 22/01/14**
34		**monitor inclinometers**	**75.73 days**	**Wed 15/01/14**
43		**interim monitoring review**	**65.07 days**	**Wed 29/01/14**
44		1	1.07 days	Wed 29/01/14
45		2	1.07 days	Wed 26/02/14
46		3	1 day	Wed 26/03/14
47		**Failure Report (Cl 12.8)**	**69.87 days?**	**Fri 17/01/14**
48		**Interim Failure Report**	**16.17 days?**	**Fri 17/01/14**
49		Review data up to failure	2.5 days	Fri 17/01/14
50		Prepare Report	2 days	Tue 21/01/14
51		Issue to IR	0 days	Thu 23/01/14
52		Meeting with IOW	1 day?	Thu 06/02/14
53		**Finalise report**	**17.67 days?**	**Wed 26/03/14**
54		Incorporate monitoring reviews	3 days	Wed 26/03/14
55		finalise assessment of existing	3 days	Mon 31/03/14
56		Issue Report	0 days	Thu 03/04/14
57		Meeting with IOW	1 day?	Thu 17/04/14

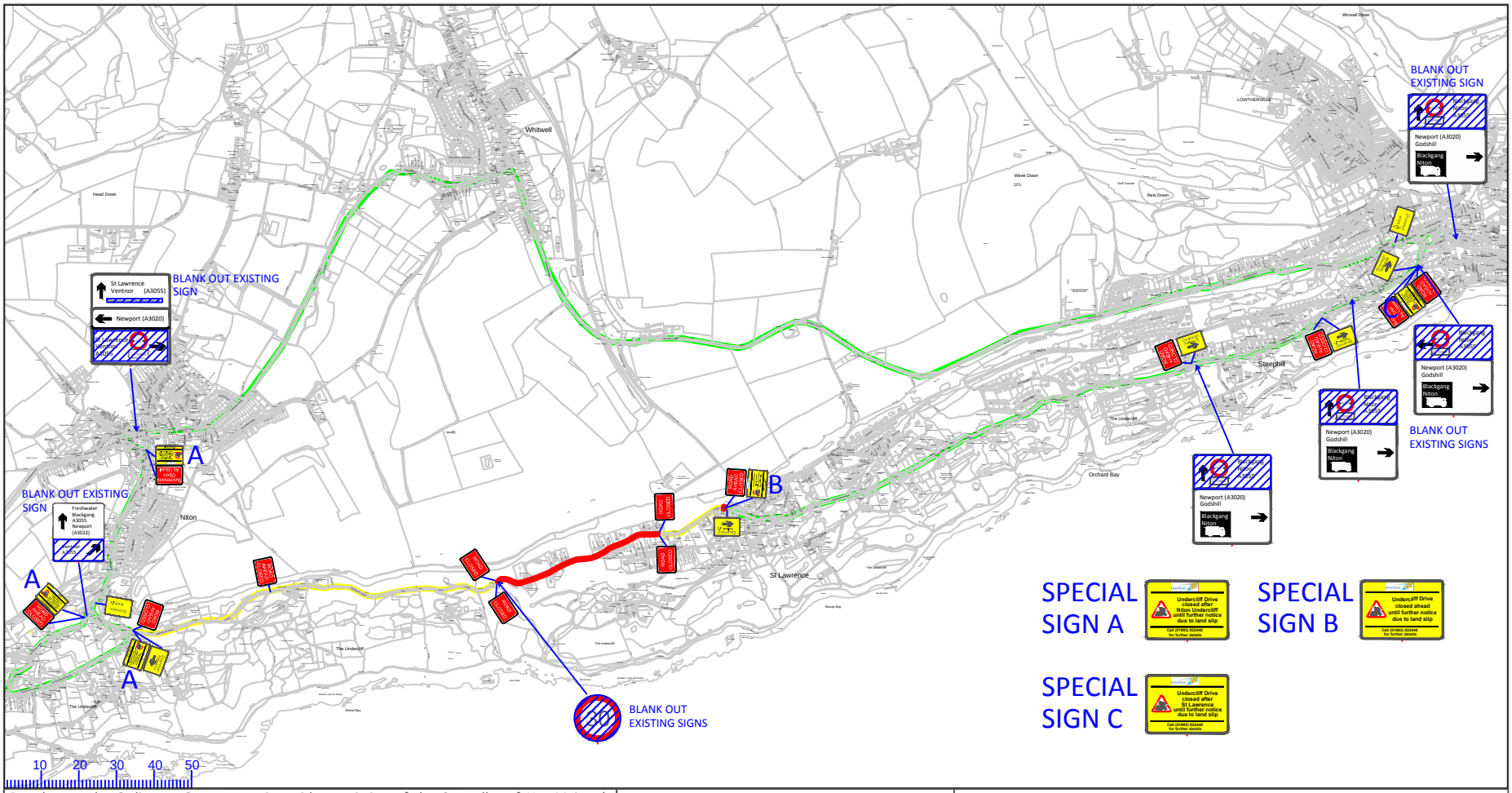


Project: Undercliff Site 10 action plan
Date: Wed 04/06/14

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only		
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline		
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress		

APPENDIX 2:

Drawing 1 – Undercliff Drive Landslip Diversion



UNMARKED

Rev.	Description	Initials	Date

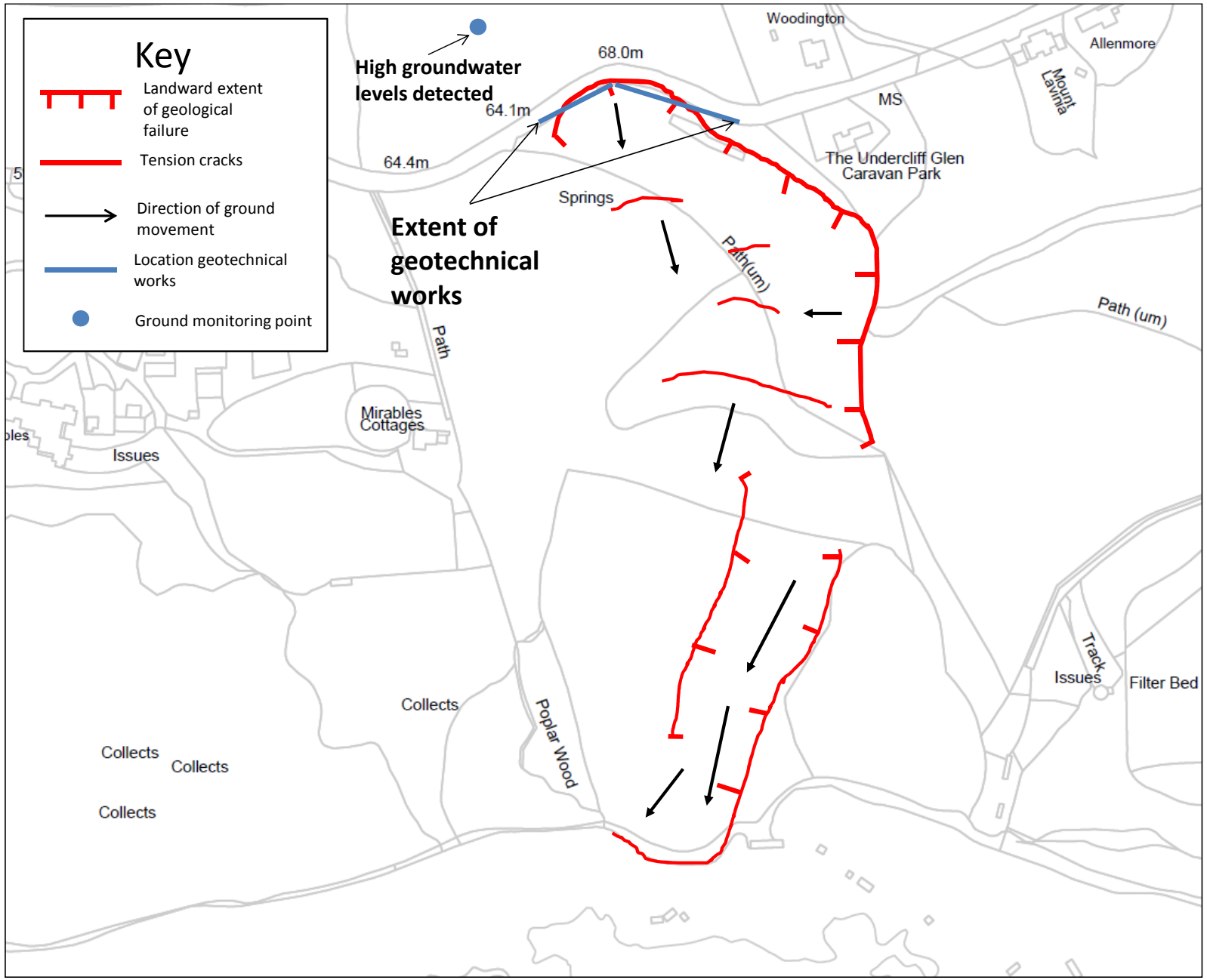
Island Roads

Paul Herbert, Service Director, Island Roads
Island Roads, St. Christopher House, 42 Daish Way, Newport, Isle of Wight, PO30 5XJ

Project	Geological Failure Report Red Zone 9: Woodlands, Undercliff Drive	Drawing Title	Drawing 1: Undercliff Drive Landslip Diversion
Checked	BM IS	Date	30/04/14
Approved	IS	Date	
Scale	Not to scale	Revision	
Classification		Contract Sheet No.	
Drawing Number	1	Sheet x of x	1 of 1

APPENDIX 3:

Drawing 2 – Extent of Ground Movement Along Undercliff Drive (2014 Event)



Notes

Rev.	Description	Initials	Date

Island Roads
St. Christopher House
42 Daish Way
Newport
Isle of Wight
PO30 5XJ

Paul Herbert
Service Director, Island Roads

Classification: UNMARKED

Project

Drawing Title

Drawing 2: Extent of ground Movement along Undercliff Drive

Drawn		Date	
Checked		Date	
Approved		Date	
Scale		Revision	
Contract Sheet No.		Sheet x of x	
Drawing Number			

APPENDIX 4:

Failure Costs Incurred and On-going Costs

Undercliff 10

Costs incurred

Item	Description	Quant	Unit	Rate	Total
	John Peck Construction Costs				
1	Costs from John Peck Construction for A.J Geotechnical Services Ltd (drillers) abortive cost. Island Roads agreed sum	1.00	sum		
2	Boring consumables relating to ground anchors such as disposable sleeves bought to match the anchors. Island Roads agreed sum	1.00	sum		
3	Seal cracks formed from failure with bitumen. Island Roads agreed sum	1.00	sum		
4	Supply and fill voids formed from failure with aggregate to site 10. Island Roads agreed sum	1.00	sum		
	Reports				
5	Failure Report from Ramboll (note that hopefully as conditions improve, Ramboll will be able to provide further recommendations, the costs of which will be considered seperately at a later date)	1.00	sum		
	Site Security				
6	Heras fencing (hire from Monday 06th January 2014 to 04th May 2014) 39 No panels	17.00	week		
7	Visit to maintain fence line and check security	17.00	visit		
8	Signage	8.00	No		
	Surveys				
9	Weekly Survey costs from Topographical & Engineering Surveys Ltd which commenced 06th March 2014	8.00	week		
	Hoarding				
10	Supply and install fixed hoarding complete with gate & lock at Niton end of site	1.00	sum		
	CCTV Cameras				
11	CCTV Cameras (cost split two ways between sites)	1.00	sum		
	Total				**£ 35,330.45**

Ongoing Costs (w/c 05th May 2014 onwards)

Item	Description	Quant	Unit	Rate	Total
1	Weekly Survey Cost from Topographical & Engineering Surveys Ltd	tba	week		
2	Weekly Broadband Cost for CCTV cameras (provisional sum)	tba	week		
3	Weekly site visits to check site	tba	week		
4	Heras Fencing Panels in conjunction with permanent hoarding	tba	week		
	Total	**tba**	**week**	**315.95**	**tba**

APPENDIX 5: Remediation Options and Approximate Costs

Undercliff Highway Options

Key Access Options:

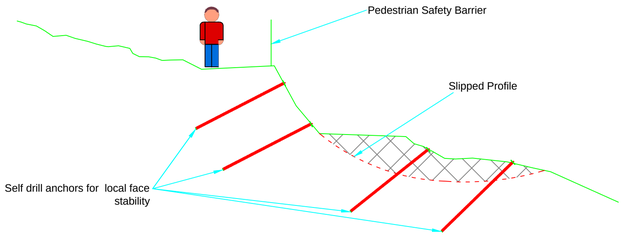
1. Re-establish Pedestrian Access Only
2. Repair and re-open road with access from one direction only
3. Repair and re-open road
4. Establish new inland access route to properties
5. Construct a temporary vehicle access route
6. Permanent road closure

Access Option	Stabilisation Option	Pros	Risks	Prelim outline cost range*
1	Self-drill anchors and pedestrian barrier	No substantial removal of failed material required	Does not address the long term geological risk	£250k - £500k
		Pathway can be moved further inland (north) to reduce requirements for stabilisation of slipped mass	Long term loss of vehicle access	
		Use of flexible footpath surface to absorb minor movements	Will require regular monitoring, inspection, and repair	
		Limited impact on environment		
2	Self-drill anchors and deep wells	Relatively quick construction method	Will require limited change inland of road route	£1m - £2.5m
		Only limited removal of slipped material required	Location still at risk from overall geological failure	
			Will require regular monitoring, inspection, and repair	
			Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
2	Reinforced Soil Block and Drainage	Will allow route of road along current alignment	Removal of slipped material required, temp works/monitoring needed to reduce	£2m - £4m

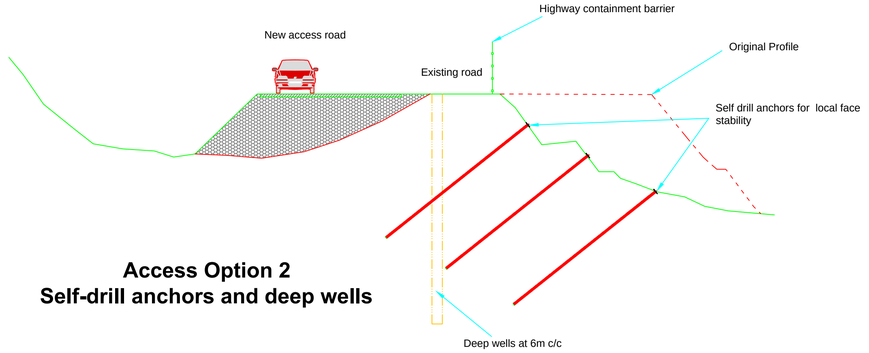
			risk of re-activation of slip	
		Drainage helps address overall geological failure mechanism	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
		'Soft' facing for the reinforced soil works to allow planting	Ongoing monitoring, inspection and maintenance regime required	
			Reduced risk of geological failure but still not complete removal of risk	
			Limited Working area, special measures may be required for safe access	
3	Reinforced soil block with hard facing, drainage, strand anchors	Drainage and strand anchors help address overall geological failure mechanism	Hard facing not in keeping with surrounding environment	£6m - £10m
		Hard facing reduces maintenance requirements	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
			The Environmental Impact of the Permanent Works will require approval from EA and associated agencies	
			Reduced risk of geological failure but still not complete removal of risk	
			Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
3	Pile supported road deck	Provide long term solution which is resistant to increased range of geological failures	Significant temporary works required for construction access	£12m - £20m
		Reduced scope of maintenance required	Will require cosmetic measures to bring in keeping with local environment	
		Can be designed to provide long term stabilisation for deep slips but this will	Disturbs sub-surface groundwater environment	

		have a cost implication		
			Potential for slope failure either side of the structure will need to be considered, potential need for non-piled stabilisation at either end of route	
			Long term monitoring required	
4	Up-slope face stabilised by bolting and netting	Provides longer term protection for road and properties	Return visits will be required to stabilise emerging failures	£200k - £500k
		Reduced quality route pavement can be used	Access for works will be difficult, almost certainly roped access	
		Route independent of overall geological failure mechanism	Long term maintenance of rock slope vegetation will be required	
4	Establish rock fall protection structure	Provides long term protection with no upslope measure needed	Rockfalls will still occur therefore continuing property risk	£300k - £500k
		Route independent of overall geological failure mechanism	Protection structure will have a visual impact	
			Protection structure will require regular inspection	
5	Temporary Road at Niton End of Failure	Low Cost	Short Life solution, will require further works in the near future	Less than £100k but will require further expenditure in future
		Low environmental impact	Ongoing monitoring of temporary road and slipped zone will be required	
6	Permanent Road Closure	Low cost and environmental impact	No vehicular or footpath access to properties between 'Woodlands' and Undercliff Glen Caravan Park'	Less than £100k

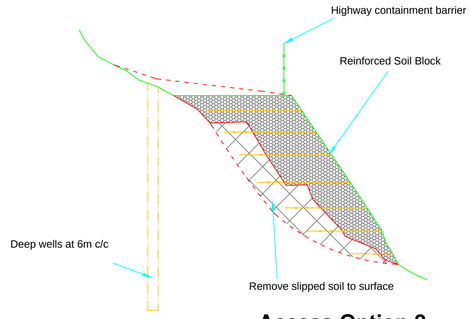
*Preliminary cost estimate based on cost of comparable schemes and industry data. A more detail cost assessment can be produced following further detailing of options and assessment of length of application.



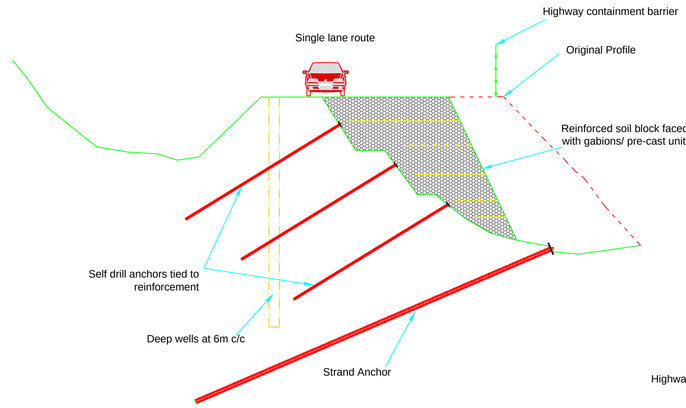
Access Option 1
Self-drill anchors and pedestrian barrier



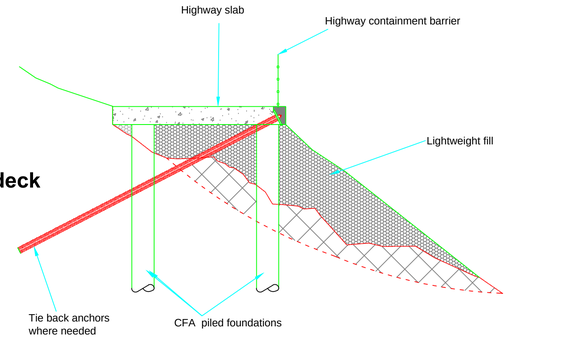
Access Option 2
Self-drill anchors and deep wells



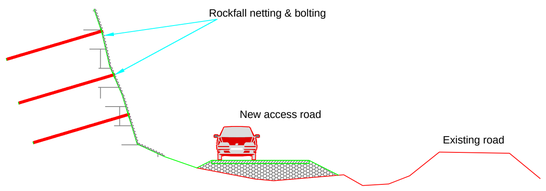
Access Option 2
Reinforced Soil Block and Drainage



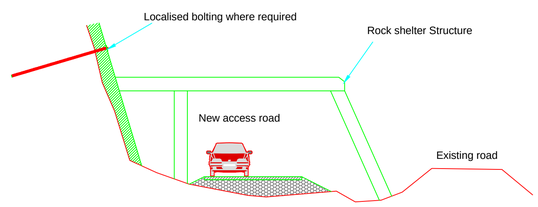
Access Option 3
Reinforced soil block with hard facing, drainage, strand anchors



Access Option 3
Pile supported road deck



Access Option 4
Up-slope face stabilised by bolting and netting



Access Option 4
Rock fall protection structure

Access Option	Stabilisation Option	Pros	Risks	Prelim outline cost range
1	Self-drill anchors and pedestrian barrier	No substantial removal of failed material required	Does not address the long term geological risk	
		Pathway can be moved further inland (north) to reduce requirements for stabilisation of slipped mass	Long term loss of vehicle access	
		Use of flexible footpath surface to absorb minor movements	Will require regular monitoring, inspection, and repair	
		Limited impact on environment		
2	Self-drill anchors and deep wells	Relatively quick construction method	Will require limited change inland of road route	
		Only limited removal of slipped material required	Location still at risk from overall geological failure	
			Will require regular monitoring, inspection, and repair	
			Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
2	Reinforced Soil Block and Drainage	Will allow route of road along current alignment	Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
		Drainage helps address overall geological failure mechanism	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
		'Soft' facing for the reinforced soil works to allow planting	Ongoing monitoring, inspection and maintenance regime required	
			Reduced risk of geological failure but still not complete removal of risk	
			Limited Working area, special measures may be required for safe access	
3	Reinforced soil block with hard facing, drainage, strand anchors	Drainage and strand anchors help address overall geological failure mechanism	Hard facing not in keeping with surrounding environment	
		Hard facing reduces maintenance requirements	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
			The Environmental Impact of the Permanent Works will require approval from EA and associated agencies	
			Reduced risk of geological failure but still not complete removal of risk	
			Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
3	Pile supported road deck	Provide long term solution which is resistant to increased range of geological failures	Significant temporary works required for construction access	
		Reduced scope of maintenance required	Will require cosmetic measures to bring in keeping with local environment	
		Can be designed to provide long term stabilisation for deep slips but this will have a cost implication	Disturbs sub-surface groundwater environment	
			Potential for slope failure either side of the structure will need to be considered, potential need for non-piled stabilisation at either end of route	
			Long term monitoring required	
4	Up-slope face stabilised by bolting and netting	Provides longer term protection for road and properties	Return visits will be required to stabilise emerging failures	
		Reduced quality route pavement can be used	Access for works will be difficult, almost certainly roped access	
		Route independent of overall geological failure mechanism	Long term maintenance of rock slope vegetation will be required	
4	Establish rock fall protection structure	Provides long term protection with no upslope measure needed	Rockfalls will still occur therefore continuing property risk	
		Route independent of overall geological failure mechanism	Protection structure will have a visual impact	
			Protection structure will require regular inspection	
5	Temporary Road at Niton End of Failure	Low Cost	Short Life solution, will require further works in the near future	

NOTES

Key Access Options:

1. Re-establish Pedestrian Access Only
2. Repair and re-open road with access from one direction only
3. Repair and re-open road
4. Establish new inland access route to properties

Rev.	Description	Drawn	Chkd.	Apprvd.	Date
-	FOR REVIEW	SKH	RA	SLW	20.05.14

Client: Island Roads

Project: ISLE OF WIGHT HIGHWAYS PFI

RAMBOLL
tel 023 8081 7500 fax 023 8081 7600 southampton@ramboll.co.uk
www.ramboll.co.uk

Drawing Title: UNDERCLIFF DRIVE
HIGHWAY STABILISATION OPTIONS
FOR REVIEW

Scale (at A1): AS SHOWN | Date: MAY 14 | Drawn: SKH

Drg. no.: 61030594/9/SK/600/06 | Rev.: -

10 0 10 20 50 100mm NATURAL SCALE

ORIGINAL DRAWING SIZE 841 x 594

Island Roads

www.islandroads.com