Cyfoeth Naturiol Cymru
Natural Resources Wales

Kenfig
Dune Rejuvenation Works
Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 100

Date: March 2015

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Contents

1. Job Summary

KPAL Job No:	030315
Report Date:	03/09/2015
Client:	Natural Resources Wales
Client Job Title:	Kenfig Dune Rejuvenation Works
Survey conducted:	3rd, 4th and 11th March 2015
Instruments used:	Leica Viva NetRover controller and GS08 SmartAntenna mounted on GLS30 pole (2 m) Leica RX900 controller and ATX900 antenna mounted on GLS30 pole (2 m) Leica GX1230 RTK base station mounted on GST20-9 tripod Leica RX1210T Field Controller
No. of data points:	3281
RTK Control Station:	Wooden post surveyed-in using Leica Smartnet GPRS (BM1) to cover the Phase 1 and Phase 2 areas, surveyed 4 and 11 March 2015: Easting: 278274.566 m Northing: 182438.361 m Height: 10.845 m OD The above benchmark was considered too far from the northern limit of the site to ensure a good base-to-rover radio signal, so a separate wooden post was surveyed-in using Leica Smartnet GPRS (BM2) to cover the Phase 3 area, surveyed 3 March 2015: Easting: 278094.252 m Northing: 182640.235 m Height: 22.264 m OD
RTK Backup Station:	Wooden post (BM3) situated at the head of the Phase 1 parabolic dune.
Fixed profiles:	Eight existing profile lines (A to H) across the Phase 1 area, previously surveyed on 17 July 2012, 9 October 2012, 8 March 2013 and 27 May 2014. Eighteen existing profile lines (1-18) across the Phase 2 area, previously surveyed on 13 May 2013 and 10 March 2014. These lines were resurveyed and compared with data surveyed on 26 February 2006 using airborne LiDAR. Nineteen additional profile lines (19-37) were surveyed across the newly activated Phase 3 area and compared with the 2006 LiDAR survey. Chainages along profile lines were interpolated at positions on a theoretical straight-line between the zero and end points of the profile.

Survey undertaken by: S.J. Blott, A. Pye, K. Pye

2. Scope and purpose

The requirements and opportunities for sand mobility trials at Kenfig were identified in a report published in 2011 (Pye & Blott, 2011). Additional data relating to changes in bare sand area between the 1940s and 2009 were presented in Pye *et al.* (2014). Three phases of works have taken place at Kenfig since 2011 (Figure 1).

Phase 1 dune rejuvenation trials commenced in the winter of 2011-2012 and involved stripping of surface vegetation and topographic modification to expose bare sand and to enhance the potential for sand movement within a 3 ha area. Topographic monitoring surveys were carried out in July and October 2012 (KPAL, 2012a,b), March 2013 (KPAL, 2013a) and May 2014 (KPAL, 2014a); an overview report was produced in July 2013 (KPAL, 2013b).

The Phase 2 work began in January 2013 and involved vegetation stripping within an approximate 5 ha area adjacent to and immediately north of the Phase 1 rejuvenation area. Four notches (numbered here as 1 to 4) were also excavated in the frontal dune ridge in order to funnel the wind and encourage transfer of sand blown from the beach, and eroded from the sides and base of the notches, into the area behind the frontal dune ridge. An initial topographic monitoring survey of the Phase 2 area was undertaken in May 2013 (KPAL, 2013c), with a resurvey in March 2014 (KPAL, 2014b).

The Phase 3 work began in January 2015 and involved vegetation stripping within an approximate 3 ha area adjacent to and immediately north of the Phase 2 rejuvenation area. Four additional notches (numbered here as 5 to 8) were also excavated in the frontal dune ridge, again to funnel the wind and encourage transfer of sand blown from the beach into the area behind the frontal dune ridge. In addition, some ground works were undertaken on the Phase 2 site to remove vegetation which had regrown since the initial works and to deepen the wet slack areas to the east of the haul road in order to create permanent standing water areas.

This report summarises the results of an initial post-works topographic survey of the Phase 3 area and resurveys of the Phase 1 and Phase 2 areas, and compares the results with the earlier surveys.

At the time of survey in March 2015 the Phase 1 and Phase 2 areas still showed the after-effects of the wet and stormy winter of 2013-14, when the southern two thirds of the Kenfig frontage experienced significant wave erosion. The winter of 2014-15 experienced ‘average’ rainfall and storm activity, and parts of the Phase 1 area showed vegetation beginning to regrow into a continuous sward away from the actively blowing sand areas.

3. Survey methods and error checking

Elevations were determined at 3281 points using Leica RTK GPS SmartRover equipment listed in the Job Summary above. Many of the survey points were on profile lines which were also surveyed in earlier surveys (Figures 2 and 3). The limits of defined features, including areas of vegetation stripping and extent of windblown sand, were also mapped by survey points.

Average vertical and horizontal errors reported by the instrument during the March 2015 survey were well within the expected range (Table 1).

The benchmark post BM1, which was established in May 2013, was still present and was used to survey the Phase 1 and Phase 2 areas. The Phase 3 area was considered to be too far from BM1 for a strong radio signal to be received by the rover at the northern end of the site, so a new benchmark post BM2 was surveyed in on a high vegetated dune at the southern end of the Phase 3 area. Comparison of data for the wooden post at the head of the Phase 1 parabolic dune (BM3) for the previous surveys in 2013, 2014 and 2015 showed only small differences which are within acceptable limits (Table 2).

The locations of the survey points are shown in Figures 2 and 3.

Ground photographs were taken at a number of locations around the site; selected examples are presented in Appendix 1.

An estimate of the area of bare and substantially bare sand at the time of survey was made using the Golden Software Surfer and comparison made with the areas indicated in previous surveys (Table 6). The areas defined as 'bare' or 'substantially' bare include turf stripped areas, deposited sand mounds, and areas of post-works windblown sand deposition. It should be noted that in some areas a clear distinction between 'substantially bare' and 'substantially vegetated' is difficult to make, since the surface comprises a mosaic of bare areas and vegetation at varying scales. A more accurate estimate of bare sand area and vegetation cover could be made using additional GIS techniques, but such analysis did not form part of the topographic survey contract.

4. Sediment particle size analysis

During the topographic survey 58 surface sand samples were collected from the dunes and beach adjacent to the dune rejuvenation area (sampling locations within the rejuvenation area are shown on Figure 6, and a full list of samples is provided in Table 3). The samples were analysed for particle size by dry sieving and the data processed using Gradistat software (Blott & Pye, 2001). The sediments have been classified using the statistical summary parameters and terminology proposed by Folk (1954), Folk & Ward (1957) and Blott & Pye (2012).

5. Results - particle size analysis

The results of the particle size analysis are summarised in Tables 4 and 5. Most of the dune sediment samples collected can be classified as very well sorted or well sorted fine and medium sands (Tables 3 & 4). The higher dune crest and slip face samples typically have the best sorting, while some of the deflation hollow and artificial dune ridge samples are less well sorted. No samples contained silt and clay ('mud') or gravel. The median size showed a relatively narrow range of variation (240 to 340 microns). Material of fine sand size, when dry, is easily moved by the wind.

The upper beach along the whole frontage is comprised of a cobble ridge at approximately the level of storm wave height. Below the cobble ridge, the beach is sandy, with only two samples containing any gravel, and only two beach samples contained any gravel (KF12 with 4.6% gravel and KF30 with 0.3% gravel).

6. Profile comparisons

The raw survey data were mathematically 'corrected' to allow direct comparison of straight line profiles derived from the February 2006 LiDAR survey and the previous ground surveys. The vertical accuracy of the LiDAR has not been quantified directly but is estimated to be better than 10-15 cm. In total 45 profiles were surveyed across the three areas.

Phase 1 Area
Eight profiles across the Phase 1 area compared in Figure 7. Very little change was evident since 2014 in the position of the dune toe, and the only significant change on Profile A was the increased accumulation of cobbles on the upper beach ridge. The area west of the haul road has shown very little change since 2013. The frontal dunes at Profile C have lowered by up to 1 m since 2014, and further inland the central ridge (west of the haul road) has continued to experience wind scour (also evident on Profile D), with a marked depression now forming. This central ridge has experienced the greatest degree of sand-blowing activity within the Phase 1 area. Immediately to the west of the haul road wind velocities and much lower, and significant vegetation re-growth has occurred, with no significant topographic change since 2013.

To the east of the haul road, sand mobility continues to be low, with no measurable deflation of sand within the trough of the parabolic dune. Areas of standing water continue to be a feature. On the arms and in the narrower part of the upper parabolic dune vegetation is becoming more established, and in some areas forms a continuous sward. Mobile sand is only a feature in the upper 'bowl' of the dune, evident on Profile F, where the elevation has dropped by 30-50 cm since 2014.

Phase 2 Area
Eighteen profiles across the Phase 2 area are compared in Figure 8. The northern two notches 1 and 2 (Profiles 1 and 2) are still substantially bare, and sand is actively blowing through the notch and forming a large lobe to the rear. The accumulations of sand at the mouths of the notches seen in 2014 were not present in 2015, due partly to wind scour and partly due to physical removal as part of the ground works. The bases of the notches have lowered by up to 1 m (Profiles 5-6, now at c. 8 m OD), and the top edges have widened by 2-3 m, leading to slumping of blocks of vegetation down the sides of the notches.

Changes on the southern two notches (3 and 4) were more limited, although the notches are still bare, and bare sand lobes at the rear of the notches demonstrate that sand continues to blow from the beach through the notches to the area behind. Profiles 7-8 demonstrate that although the top lips of the notches continue to widen (by 2 to 3 m since 2014), the bottoms of the notches have not deepened as notches 1 and 2 have done; however, all four notches now have bases at c. 8 m OD.

The zone behind the notches is largely vegetation-free, with sand actively blowing onto and across the depositional lobes, although very little change in elevation of the areas is evident

from the profiles (10-12). The de-vegetated ridge (Profiles 13 & 14) also shows no evidence of deflation, although it continues to be largely vegetation-free.

Very little topographic change is evident in the area east of the haul road, although very little vegetation re-growth was evident during the survey. Areas of standing water continue to be a feature, and the northern wet slack (Profile 4) was deepened as part of the Phase 3 works to ensure standing water remains throughout the year. The only substantial change to the east of the haul road is on the ridge on the northern side, crossed by Profile 16, where sand from the excavation of the wet slack has been deposited to raise the ridge by 1-2 m.

Phase 3 Area

Nineteen profiles across the Phase 3 area are compared in Figure 9. At the northern end of the site, where the land behind the frontal dune is at a higher elevation (the haul road is at c. 8 m OD), the northern two notches (Profiles 21 & 22) were cut with their bases reaching 12-14 m OD, allowing sand lobes to form at the rear of the notches. Blown sand is continuing to accrete on these lobes, which can be expected to migrate eastwards over time. Sand is also spreading over the haul road and extending as thin sand sheets onto the vegetated dune area to the east of the haul road. The notches in the Phase 2 area have their bases substantially lower than those in the Phase 3 area (at c. 8 m OD), so it is likely that the Phase 3 notches will continue to deepen and widen over time, providing sand which will blow inland into the lobes and sand sheets east of the haul road.

Profile 9 in the Phase 2 area was extended northwards into the Phase 3 area. Although the dune crests between the notches have been turf stripped, there has been only limited reduction in elevation (0.2 to 0. 5 m) as a result of the works.

Bare sand extent

The approximate total area of bare and substantially bare sand within the rejuvenation area at the time of the March 2015 survey was 10.2 ha, comprising 2.42 ha in the Phase 1 area, 5.32 ha in the Phase 2 area and 2.46 ha in the Phase 3 area (Table 6). The bare sand area in Phase 1 has decreased by approximately 0.3 ha since March 2014 (and 0.6 ha since the rejuvenation works in 2012), due to vegetation regrowth both east and west of the haul road. With an absence of notches, there appears to be limited opportunity for sand to blow directly from the beach into the Phase 1 dune areas behind. The area of standing water / west sand to the east of the haul road also acts a as a trap for sand blown from the west. Much of the deflation corridor of the parabolic dune lies in the shelter of the haul road, built around 1967, and only the upper parts of the windward slope of the dune, close to the crest, have significant exposure to strong winds. Further reduction in bare sand area east of the haul road is therefore likely unless further maintenance stripping and/or spraying of vegetation is undertaken.

The bare sand area in Phase 2 has increased by approximately 1.1 ha since March 2014 (and by 0.8 ha since the rejuvenation works in 2013), representing an increase of 30%, due to the formation of the blown sand lobe to the east of the haul road behind Notches 1 and 2, and further vegetation stripping works behind Notches 3 and 4. The notches are evidently playing a key role in accelerating the flow of wind and sand between the beach and the area behind the frontal dune ridge.

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8. Tables

Table 1. Average error reported by the instrument for all 3281 data points

	1-D quality control (height)	2-D quality control (position)	3-D quality control (position and height)
Average	9.4 mm	5.9 mm	11.1 mm
StDev	1.6 mm	0.9 mm	1.7 mm

Table 2. Measured location and height of Benchmark 3 (wooden post) in metres

	Easting	Northing	Height
Surveyed with Smartnet corrections (17 July 2012)	278501.793	182271.641	21.178
Surveyed with base & rover (10 March 2014)	278501.963	182271.522	21.163
Surveyed with base & rover (11 March 2015)	278501.963	182271.641	21.171
Difference between 2012 and 2014 survey	+170 mm	-119 mm	-15 mm
Difference between 2012 and 2015 survey	+170 mm	0 mm	-7 mm
Difference between 2014 and 2015 survey	0 mm	+119 mm	+8 mm

Table 3. Locations of beach and dune sediment samples collected on 3-4 March 2015. Note that upper beach samples were sand samples taken below the cobble ridge.

ID	Easting	Northing	Sample type	Description
KF1	277602	183360	Beach, N of Phase 3	Lower beach, near Kenfig River
KF2	277795	183556	Beach, N of Phase 3	Upper beach, near Kenfig River
KF3	277659	183216	Beach, N of Phase 3	Lower beach, near Kenfig River
KF4	277930	183516	Dune, N of Phase 3	Frontal dune, near Kenfig River
KF5	277713	182824	Beach, Phase 3	Lower beach, in line with Notch 5
KF6	277890	182815	Beach, Phase 3	Mid beach, in line with Notch 5
KF7	277967	182826	Beach, Phase 3	Upper beach, in line with Notch 5
KF8	278012	182833	Dune, Phase 3	Mouth of Notch 5
KF9	278053	182837	Dune, Phase 3	Notch 5, crest in centre of notch
KF10	278078	182840	Dune, Phase 3	Notch 5, rear sand lobe
KF11	277697	182705	Beach, Phase 3	Lower beach, in line with Notch 6
KF12	277828	182726	Beach, Phase 3	Mid beach, in line with Notch 6
KF13	277979	182748	Beach, Phase 3	Upper beach, in line with Notch 6
KF14	278030	182754	Dune, Phase 3	Mouth of Notch 6
KF15	278068	182749	Dune, Phase 3	Notch 6, crest in centre of notch
KF16	278096	182761	Dune, Phase 3	Notch 6, rear of notch
KF17	277748	182623	Beach, Phase 3	Lower beach, in line with Notch 7
KF18	277897	182681	Beach, Phase 3	Mid beach, in line with Notch 7
KF19	277993	182710	Beach, Phase 3	Upper beach, in line with Notch 7
KF20	278042	182723	Dune, Phase 3	Mouth of Notch 7
KF21	278075	182724	Dune, Phase 3	Notch 7, crest in centre of notch
KF22	278107	182709	Dune, Phase 3	Notch 7, rear sand lobe
KF23	278133	182713	Dune, Phase 3	Notch 7, rear sand lobe
KF24	277702	182493	Beach, Phase 2	Lower beach, in line with Notch 8
KF25	277828	182521	Beach, Phase 2	Mid beach, in line with Notch 8
KF26	278021	182587	Beach, Phase 2	Upper beach, in line with Notch 8
KF27	278076	182613	Dune, Phase 2	Mouth of Notch 8
KF28	278105	182622	Dune, Phase 2	Notch 8, crest in centre of notch
KF29	278133	182634	Dune, Phase 2	Notch 8, rear sand lobe
KF30	277855	182425	Beach, Phase 2	Lower beach, in line with Notch 2
KF31	277968	182449	Beach, Phase 2	Mid beach, in line with Notch 2
KF32	278076	182466	Beach, Phase 2	Upper beach, in line with Notch 2
KF33	278134	182478	Dune, Phase 2	Notch 2, crest in centre of notch
KF34	278180	182490	Dune, Phase 2	Notch 2, rear sand lobe
KF35	277911	182268	Beach, Phase 2	Lower beach, in line with Notch 4
KF36	278003	182313	Beach, Phase 2	Mid beach, in line with Notch 4
KF37	278094	182327	Beach, Phase 2	Upper beach, in line with Notch 4
KF38	278143	182344	Dune, Phase 2	Mouth of Notch 4
KF39	278179	182356	Dune, Phase 2	Notch 4, crest at rear of notch
KF40	278207	182365	Dune, Phase 2	Notch 4, rear sand lobe
KF41	277973	182173	Beach, Phase 1	Lower beach, in line with Profile B
KF42	278037	182194	Beach, Phase 1	Mid beach, in line with Profile B
KF43	278133	182232	Beach, Phase 1	Upper beach, in line with Profile B
KF44	278166	182245	Dune, Phase 1	Frontal dune cliff, Profile B
KF45	277943	182087	Beach, Phase 1	Lower beach, in line with Profile D
KF46	278072	182122	Beach, Phase 1	Mid beach, in line with Profile D
KF47	278155	182140	Beach, Phase 1	Upper beach, in line with Profile D
KF48	278194	182163	Dune, Phase 1	Frontal dune cliff, Profile D
KF49	278239	182156	Dune, Phase 1	Top of high dune
KF50	278229	182234	Dune, Phase 1	Crest of first inland dune ridge
KF51	278401	182260	Dune, Phase 1	Deflation trough of parabolic dune
KF52	278497	182281	Dune, Phase 1	Top of parabolic dune nose
KF53	278831	180386	Beach, S of Phase 1	Upper beach, near Sker Point
KF54	278843	180432	Dune, S of Phase 1	Frontal dune cliff, near Sker Point
KF55	278865	180311	Beach, S of Phase 1	Upper beach, near Sker Point
KF56	278887	180337	Dune, S of Phase 1	Frontal dune cliff, near Sker Point
KF57	278927	180291	Dune, S of Phase 1	Frontal dune cliff, near Sker Point
KF58	278947	180206	Beach, S of Phase 1	Upper beach, near Sker Point

Table 4. Particle size characteristics of dune samples collected on 3-4 March 2015. Statistics are calculated using GRADISTAT software (Blott & Pye, 2001), mean and sorting using the formulae of Folk & Ward (1957). Mean size class abbreviations: MS (medium sand); FS (fine sand). Sorting class abbreviations: VWS (very well sorted); WS (well sorted), MWS (moderately well sorted).

ID	Mean (µm & class)		D50 (µm)	Mode (µm)	Mean (phi)	Sorting (phi & description)		Gravel (%)	Sand (%)	Mud (%)
KF1	269	MS	276	303	1.89	0.36	WS	0.0	100.0	0.0
KF2	278	MS	285	303	1.85	0.34	VWS	0.0	100.0	0.0
KF3	219	FS	215	215	2.19	0.33	VWS	0.0	100.0	0.0
KF4	237	FS	229	215	2.08	0.30	VWS	0.0	100.0	0.0
KF5	346	MS	347	428	1.53	0.45	WS	0.0	100.0	0.0
KF6	266	MS	273	303	1.91	0.34	VWS	0.0	100.0	0.0
KF7	247	FS	244	215	2.01	0.32	VWS	0.0	100.0	0.0
KF8	260	MS	261	303	1.94	0.41	WS	0.0	100.0	0.0
KF9	256	MS	255	215	1.97	0.40	WS	0.0	100.0	0.0
KF10	258	MS	258	303	1.96	0.38	WS	0.0	100.0	0.0
KF11	301	MS	300	303	1.73	0.44	WS	0.0	100.0	0.0
KF12	316	MS	308	303	1.66	0.59	MWS	4.6	95.4	0.0
KF13	261	MS	266	303	1.94	0.34	VWS	0.0	100.0	0.0
KF14	275	MS	282	303	1.86	0.38	WS	0.0	100.0	0.0
KF15	275	MS	281	303	1.86	0.41	WS	0.0	100.0	0.0
KF16	263	MS	267	303	1.93	0.39	WS	0.0	100.0	0.0
KF17	275	MS	281	303	1.86	0.39	WS	0.0	100.0	0.0
KF18	296	MS	297	303	1.76	0.35	WS	0.0	100.0	0.0
KF19	305	MS	308	303	1.71	0.46	WS	0.0	100.0	0.0
KF20	254	MS	250	215	1.98	0.40	WS	0.0	100.0	0.0
KF21	271	MS	276	303	1.89	0.39	WS	0.0	100.0	0.0
KF22	262	MS	268	303	1.93	0.34	VWS	0.0	100.0	0.0
KF23	264	MS	268	303	1.92	0.38	WS	0.0	100.0	0.0
KF24	271	MS	277	303	1.88	0.39	WS	0.0	100.0	0.0
KF25	264	MS	269	303	1.92	0.36	WS	0.0	100.0	0.0
KF26	252	MS	252	215	1.99	0.32	VWS	0.0	100.0	0.0
KF27	250	FS	245	215	2.00	0.39	WS	0.0	100.0	0.0
KF28	240	FS	233	215	2.06	0.35	VWS	0.0	100.0	0.0
KF29	240	FS	231	215	2.06	0.34	VWS	0.0	100.0	0.0
KF30	341	MS	357	428	1.55	0.43	WS	0.3	99.7	0.0
KF31	282	MS	288	303	1.82	0.31	VWS	0.0	100.0	0.0
KF32	249	FS	247	215	2.01	0.32	VWS	0.0	100.0	0.0
KF33	260	MS	259	215	1.95	0.39	WS	0.0	100.0	0.0
KF34	265	MS	267	303	1.92	0.41	WS	0.0	100.0	0.0
KF35	295	MS	292	303	1.76	0.49	WS	0.0	100.0	0.0
KF36	263	MS	262	215	1.92	0.42	WS	0.0	100.0	0.0
KF37	244	FS	236	215	2.04	0.31	VWS	0.0	100.0	0.0
KF38	271	MS	260	215	1.89	0.48	WS	0.0	100.0	0.0
KF39	254	MS	249	215	1.98	0.43	WS	0.0	100.0	0.0
KF40	257	MS	258	303	1.96	0.43	WS	0.0	100.0	0.0
KF41	272	MS	277	303	1.88	0.42	WS	0.0	100.0	0.0
KF42	261	MS	264	303	1.94	0.37	WS	0.0	100.0	0.0
KF43	241	FS	234	215	2.05	0.34	VWS	0.0	100.0	0.0
KF44	287	MS	272	215	1.80	0.56	MWS	0.0	100.0	0.0
KF45	275	MS	282	303	1.86	0.40	WS	0.0	100.0	0.0
KF46	269	MS	275	303	1.89	0.39	WS	0.0	100.0	0.0
KF47	259	MS	263	303	1.95	0.32	VWS	0.0	100.0	0.0
KF48	296	MS	291	303	1.76	0.50	WS	0.0	100.0	0.0
KF49	271	MS	274	303	1.89	0.41	WS	0.0	100.0	0.0
KF50	245	FS	240	215	2.03	0.32	VWS	0.0	100.0	0.0
KF51	295	MS	292	303	1.76	0.49	WS	0.0	100.0	0.0
KF52	240	FS	233	215	2.06	0.35	VWS	0.0	100.0	0.0
KF53	264	MS	270	303	1.92	0.33	VWS	0.0	100.0	0.0
KF54	452	MS	438	428	1.15	0.32	VWS	0.0	100.0	0.0
KF55	372	MS	364	303	1.43	0.58	MWS	0.0	100.0	0.0
KF56	221	FS	217	215	2.18	0.32	VWS	0.0	100.0	0.0
KF57	250	MS	234	215	2.00	0.42	WS	0.0	100.0	0.0
KF58	266	MS	271	303	1.91	0.38	WS	0.0	100.0	0.0

Table 5. Sediment textural classifications, according to Folk (1954) and Blott & Pye (2012), from the samples collected on 3-4 March 2015

ID	Folk (1954)	Blott & Pye (2012)
KF1	Sand	Sand
KF2	Sand	Sand
KF3	Sand	Sand
KF4	Sand	Sand
KF5	Sand	Sand
KF6	Sand	Sand
KF7	Sand	Sand
KF8	Sand	Sand
KF9	Sand	Sand
KF10	Sand	Sand
KF11	Sand	Sand
KF12	Slightly Gravelly Sand	Very slightly gravelly sand
KF13	Sand	Sand
KF14	Sand	Sand
KF15	Sand	Sand
KF16	Sand	Sand
KF17	Sand	Sand
KF18	Sand	Sand
KF19	Sand	Sand
KF20	Sand	Sand
KF21	Sand	Sand
KF22	Sand	Sand
KF23	Sand	Sand
KF24	Sand	Sand
KF25	Sand	Sand
KF26	Sand	Sand
KF27	Sand	Sand
KF28	Sand	Sand
KF29	Sand	Sand
KF30	Slightly Gravelly Sand	Sand
KF31	Sand	Sand
KF32	Sand	Sand
KF33	Sand	Sand
KF34	Sand	Sand
KF35	Sand	Sand
KF36	Sand	Sand
KF37	Sand	Sand
KF38	Sand	Sand
KF39	Sand	Sand
KF40	Sand	Sand
KF41	Sand	Sand
KF42	Sand	Sand
KF43	Sand	Sand
KF44	Sand	Sand
KF45	Sand	Sand
KF46	Sand	Sand
KF47	Sand	Sand
KF48	Sand	Sand
KF49	Sand	Sand
KF50	Sand	Sand
KF51	Sand	Sand
KF52	Sand	Sand
KF53	Sand	Sand
KF54	Sand	Sand
KF55	Sand	Sand
KF56	Sand	Sand
KF57	Sand	Sand
KF58	Sand	Sand

Table 6. Areas of bare sand at Kenfig Burrows, in hecatres.

Site	**July 2012**	**May 2013**	**March 2014**	**March 2015**
Phase 1	2.97	2.97	2.69	2.42
Phase 2	n/a	4.52	4.20	5.32
Phase 3	n/a	n/a	n/a	2.46
Total	2.97	7.49	6.88	10.20

9. Figures

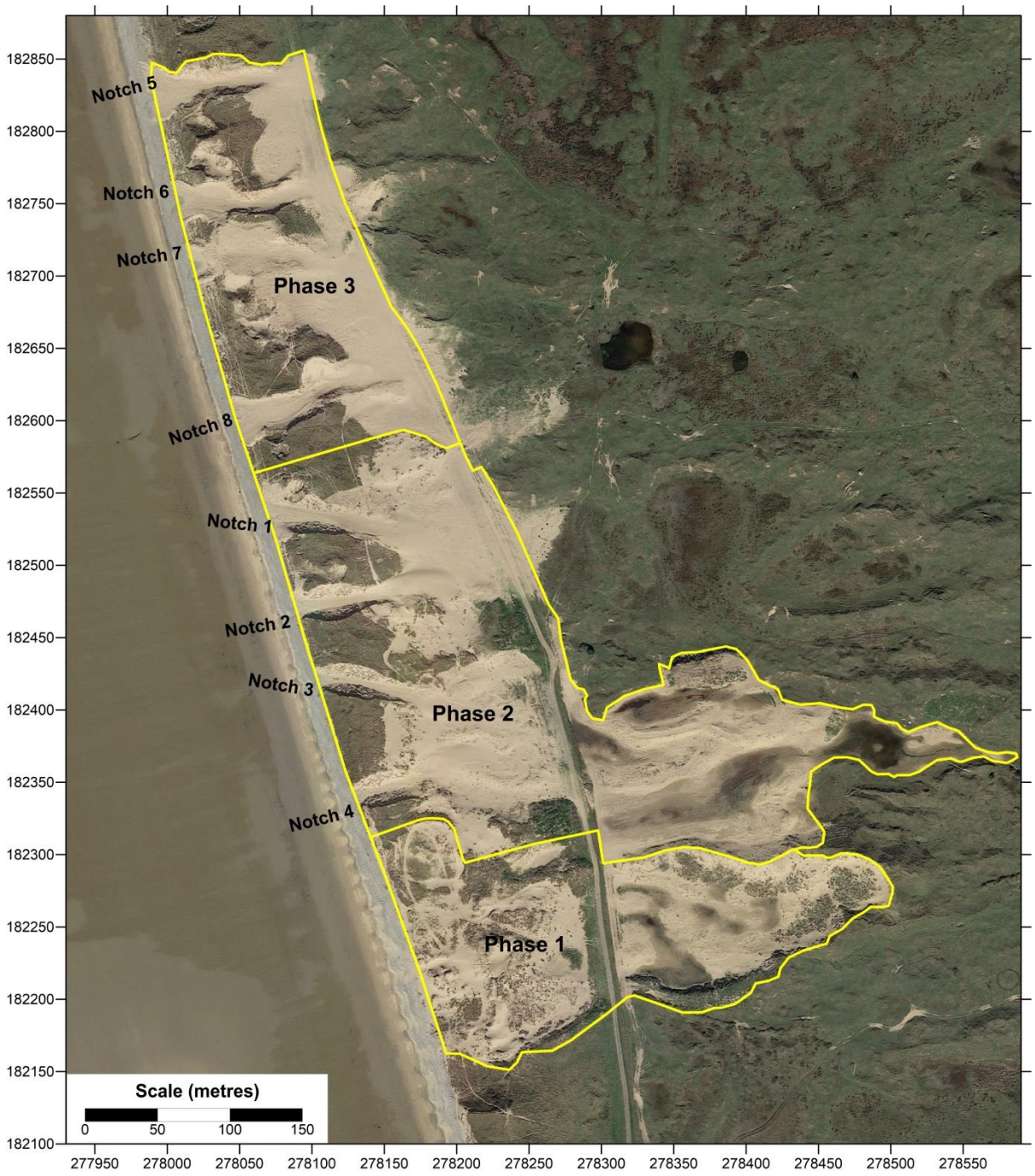


Figure 1. The three phases of dune rejuvenation works at Kenfig Burrows, undertaken in winter 2011-12 (Phase 1), January 2013 (Phase 2) and January 2015 (Phase 3). Base aerial photography flown 18 April 2015 (source: Google Earth)

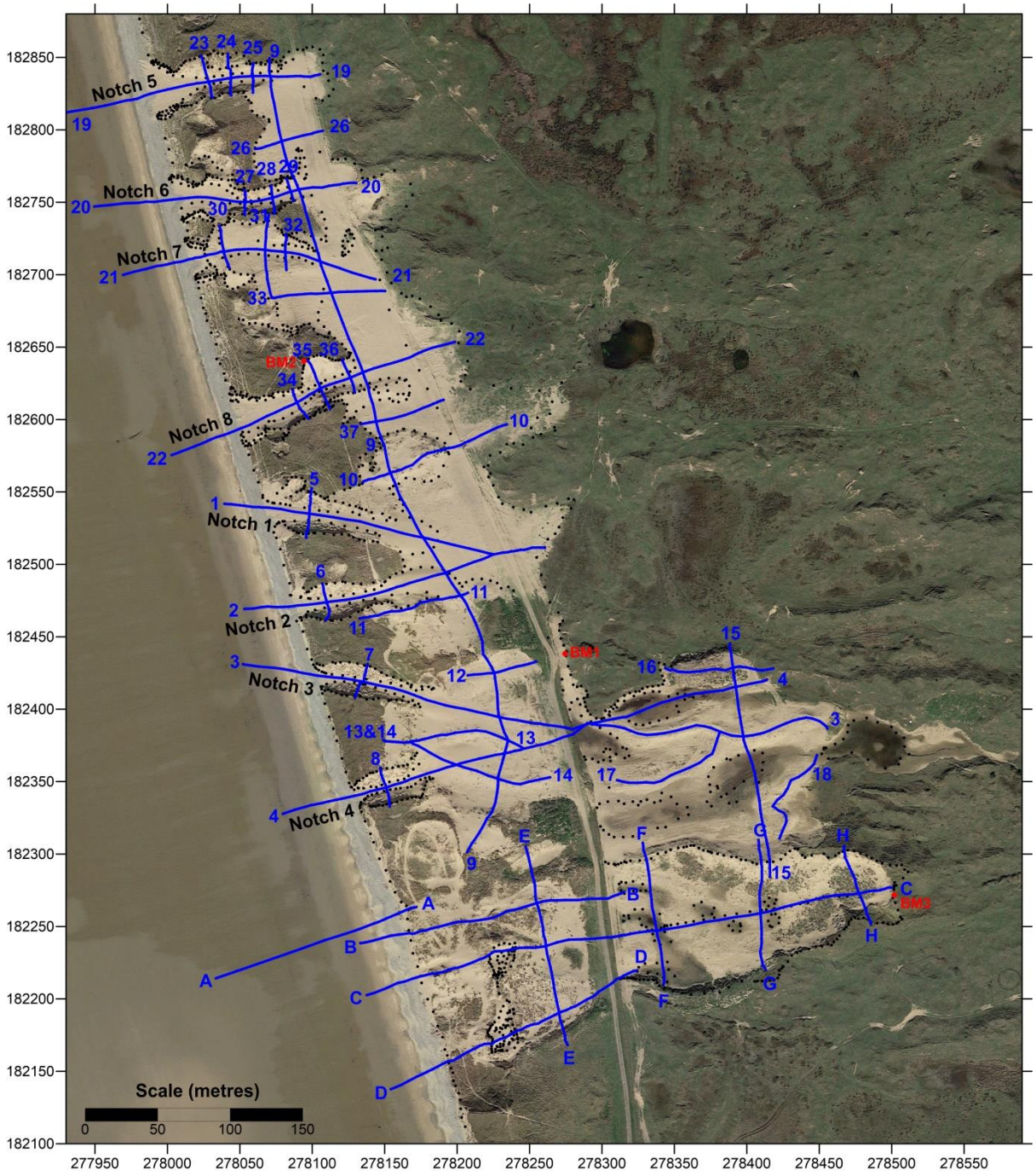


Figure 2. Locations of March 2015 data points (black dots), benchmarks (red dots) and cross-profiles (blue lines)

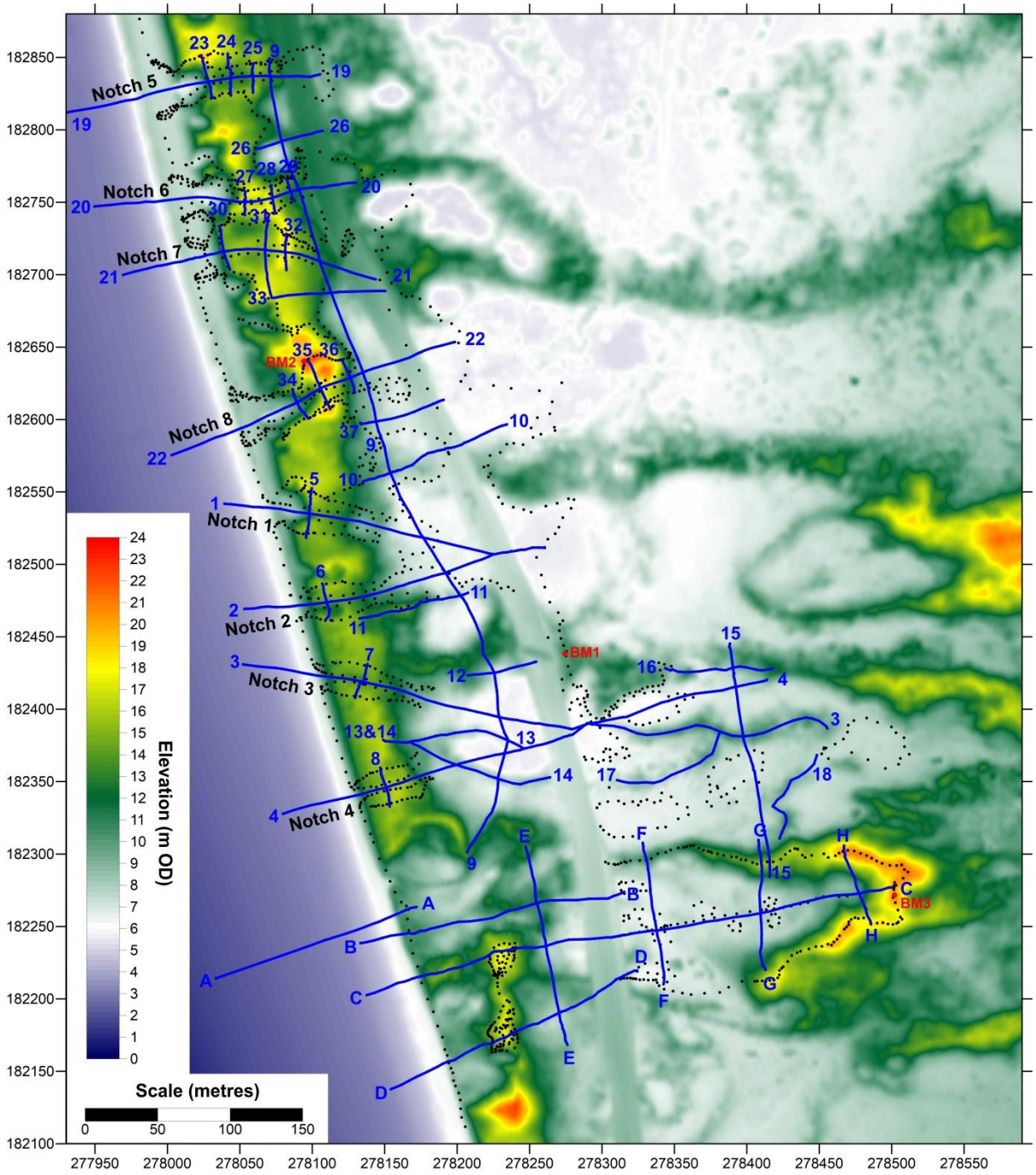


Figure 3. Locations of March 2015 data points (black dots), benchmarks (red dots) and cross-profiles (blue lines), overlaid on LiDAR DEM flown on 26 February 2006.

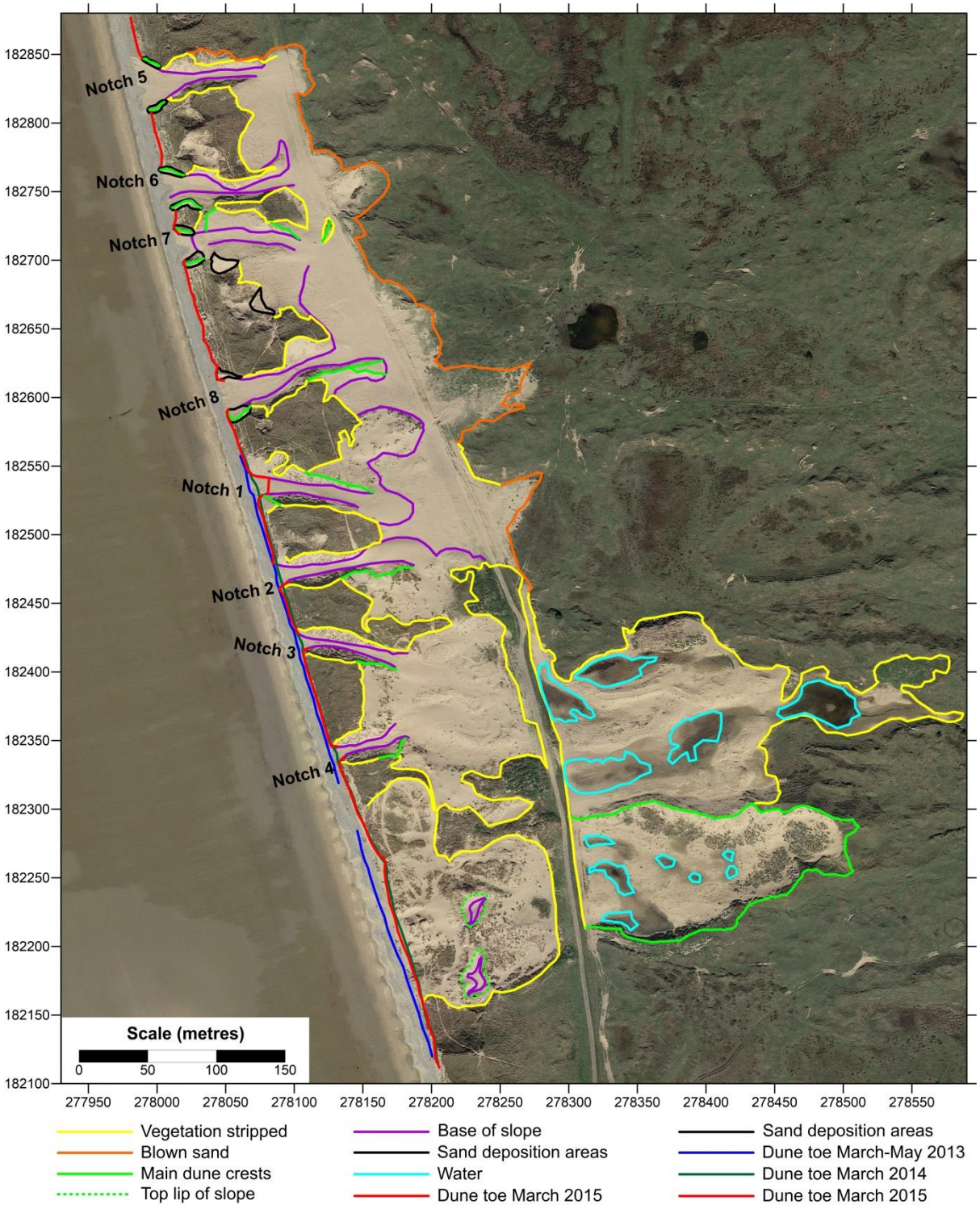


Figure 4. Feature mapping at Kenfig Burrows, overlaid on aerial photography flown 18 April 2015 (source: Google Earth). Areas stripped of vegetation, the main dune crests, base of slopes, and areas of blown sand, standing water and depositional sand heaps mapped in the field are also shown

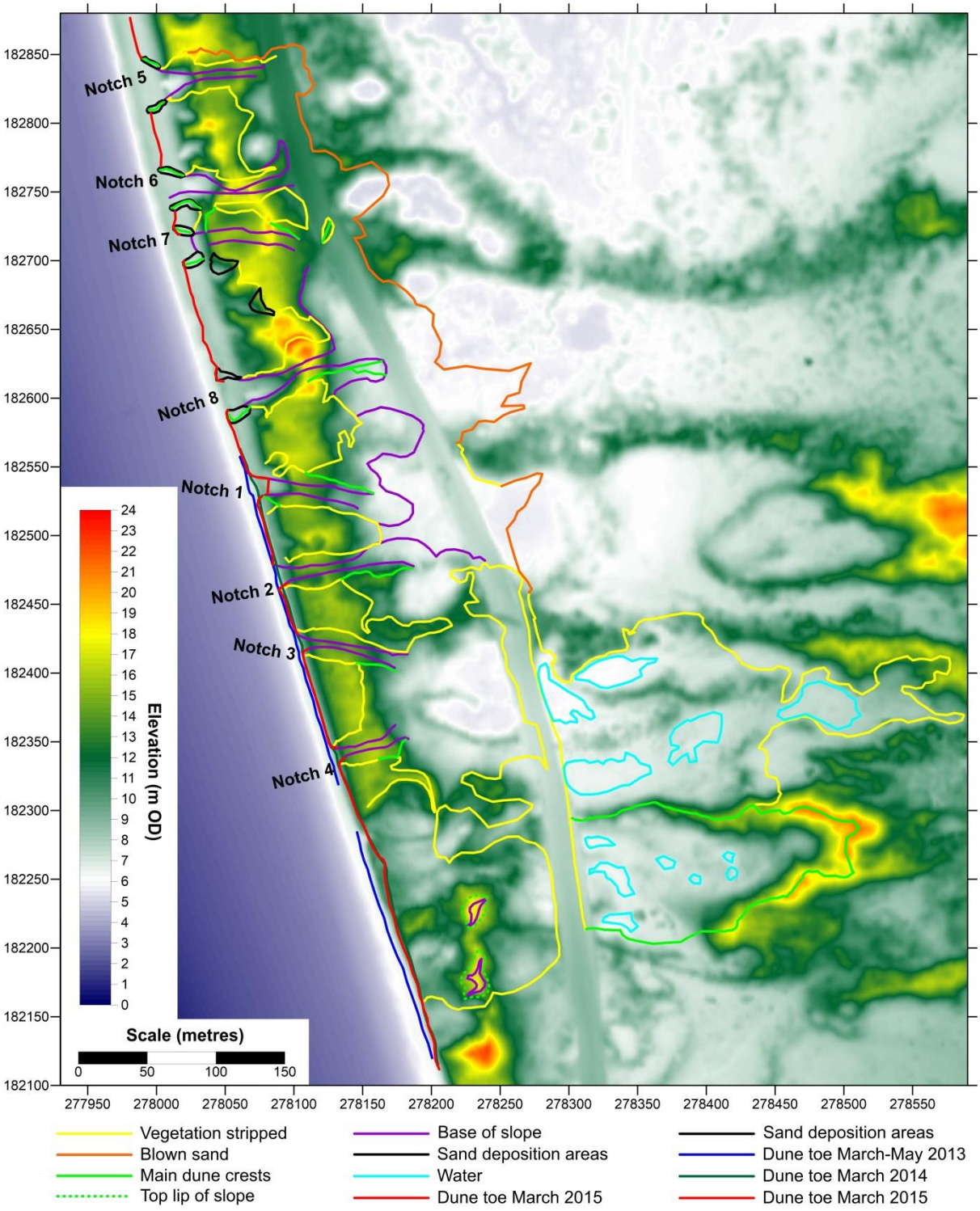


Figure 5. Feature mapping at Kenfig Burrows, overlaid on LiDAR DEM flown 26 February 2006 (source: Google Earth). Areas stripped of vegetation, the main dune crests, base of slopes, and areas of blown sand, standing water and depositional sand heaps mapped in the field are also shown

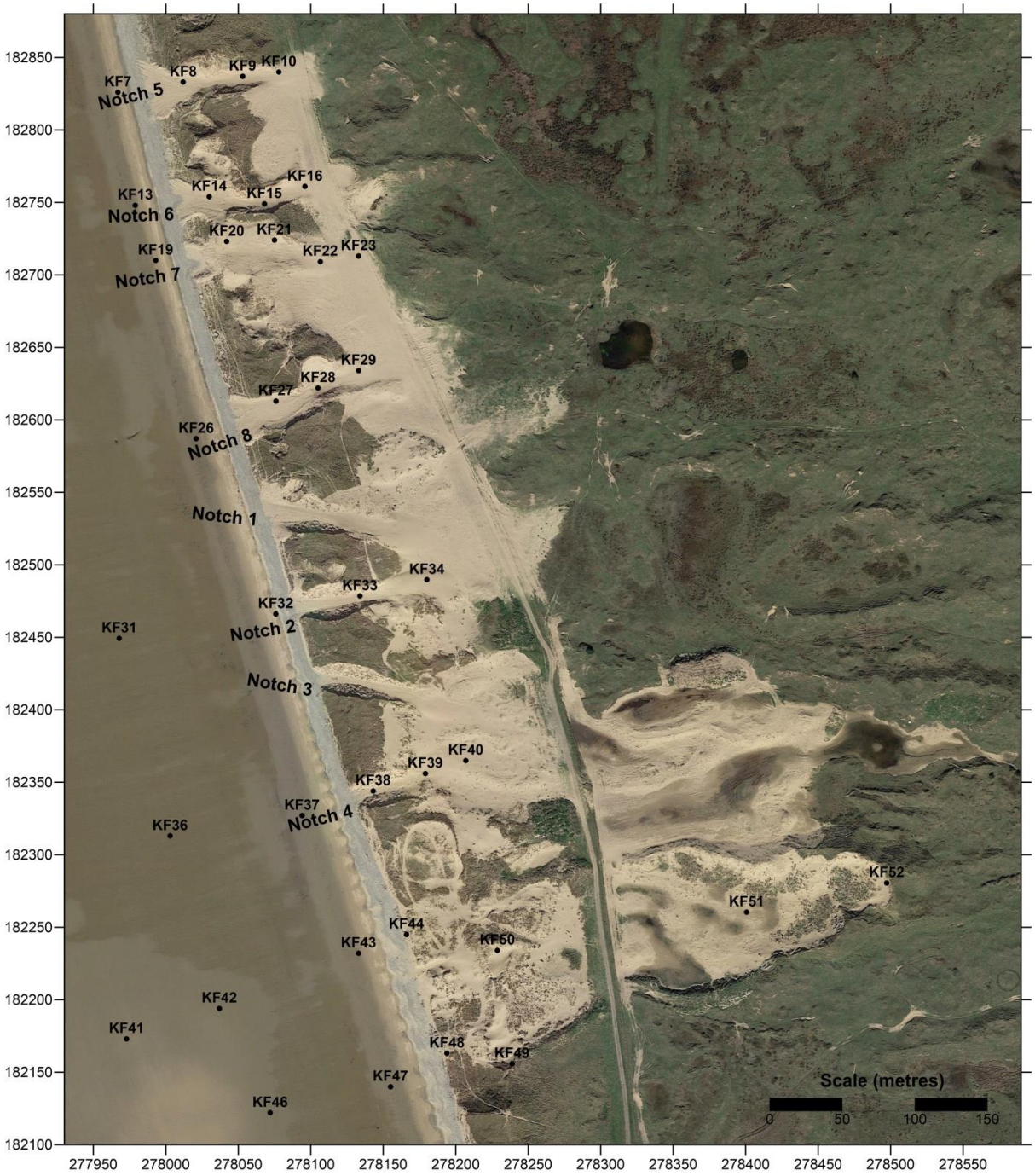


Figure 6. Locations of sediment samples collected within the dune rejuvenation area on 3-4 March 2015, overlaid on aerial photography flown 18 April 2015 (NB: some beach sample locations not shown; samples KF1-KF4 were taken north of Phase 3, near the Kenfig River; samples KF53-KF58 were taken south of Phase 1, near Sker Point)

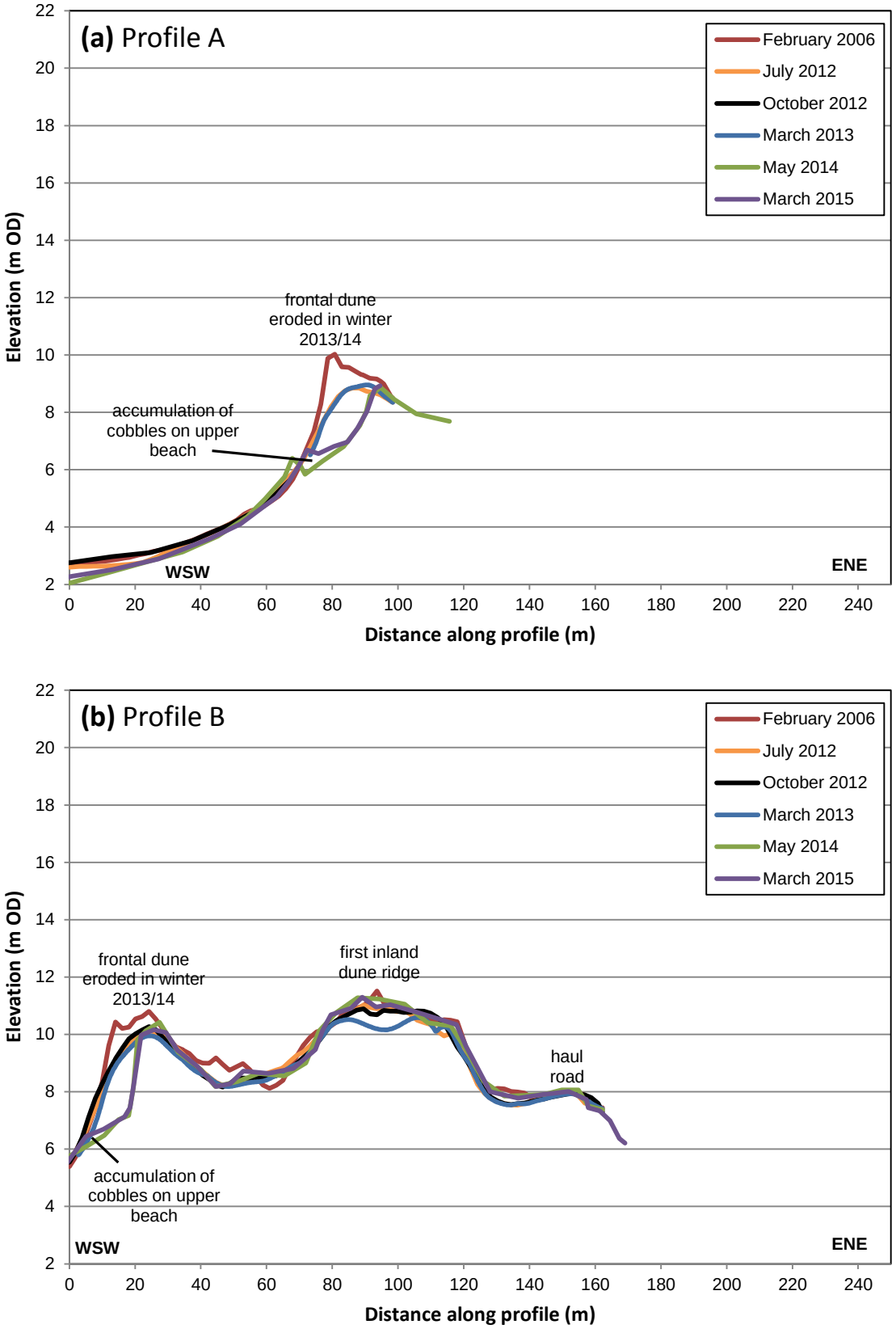


Figure 7. Comparison of surface levels at profiles A and B on the Phase 1 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 17 July 2012, 9 October 2012, 9 March 2013, 27 May 2014 and 3-11 March 2015

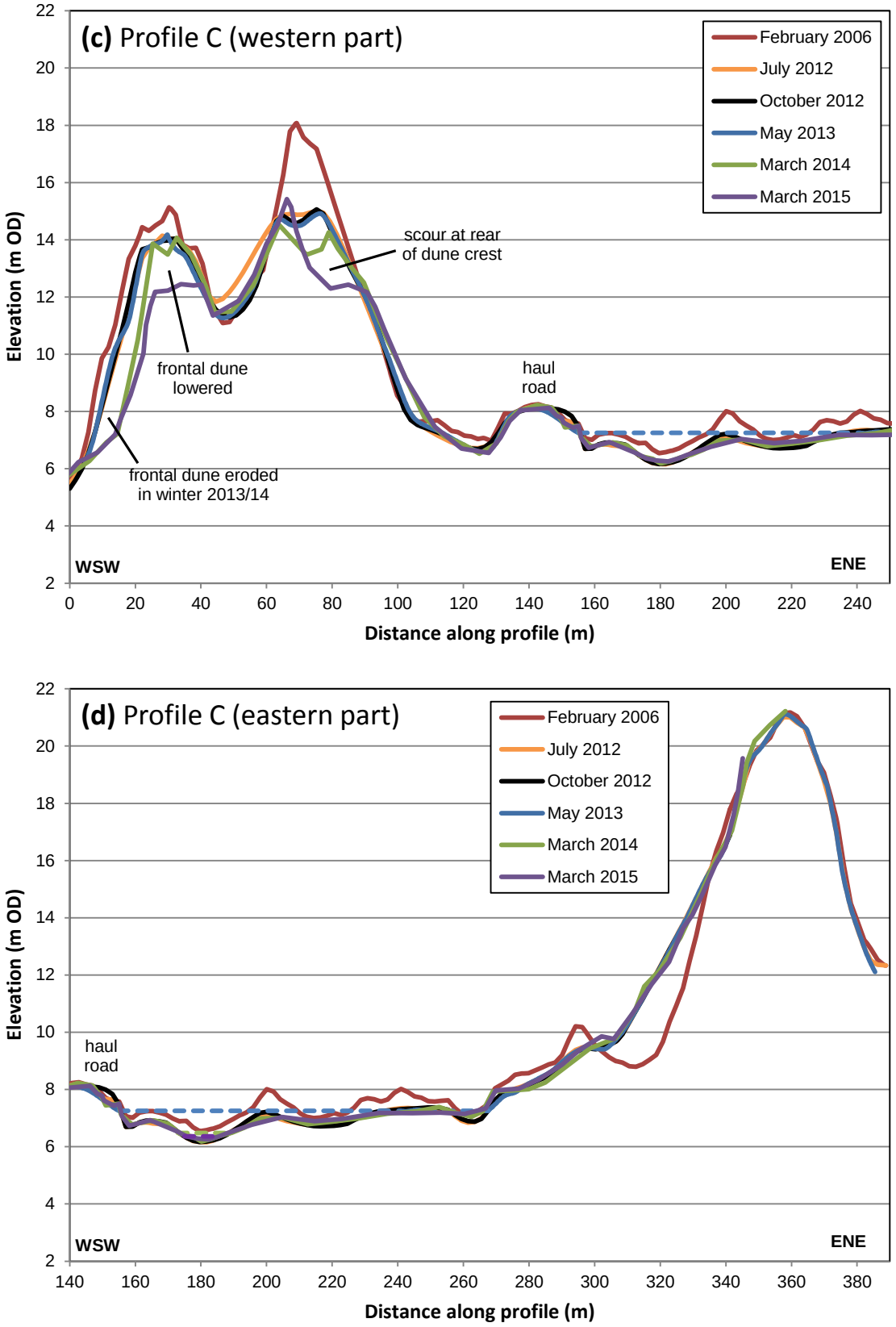


Figure 7 (continued). Comparison of surface levels at profile C on the Phase 1 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 17 July 2012, 9 October 2012, 9 March 2013, 27 May 2014 and 3-11 March 2015

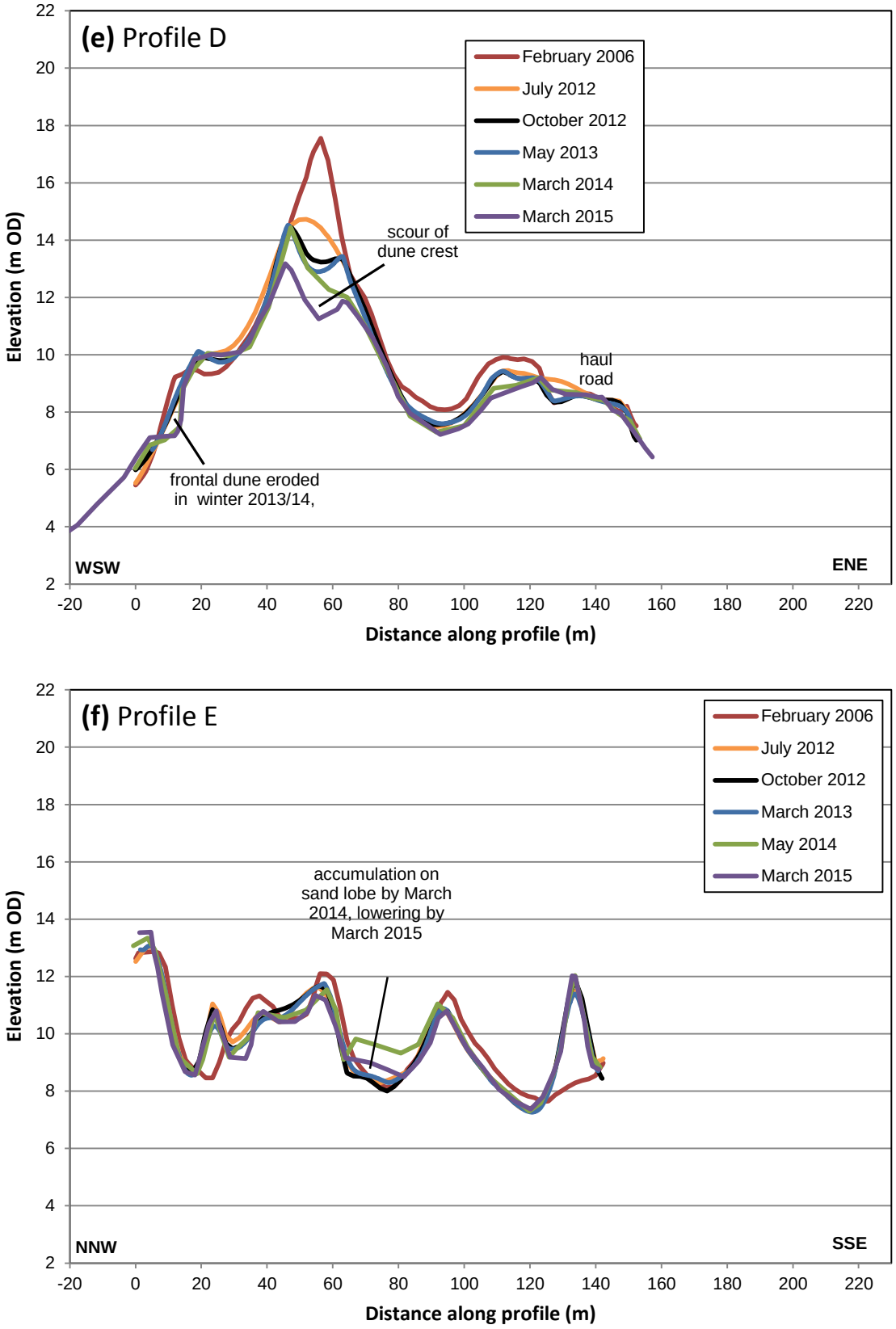
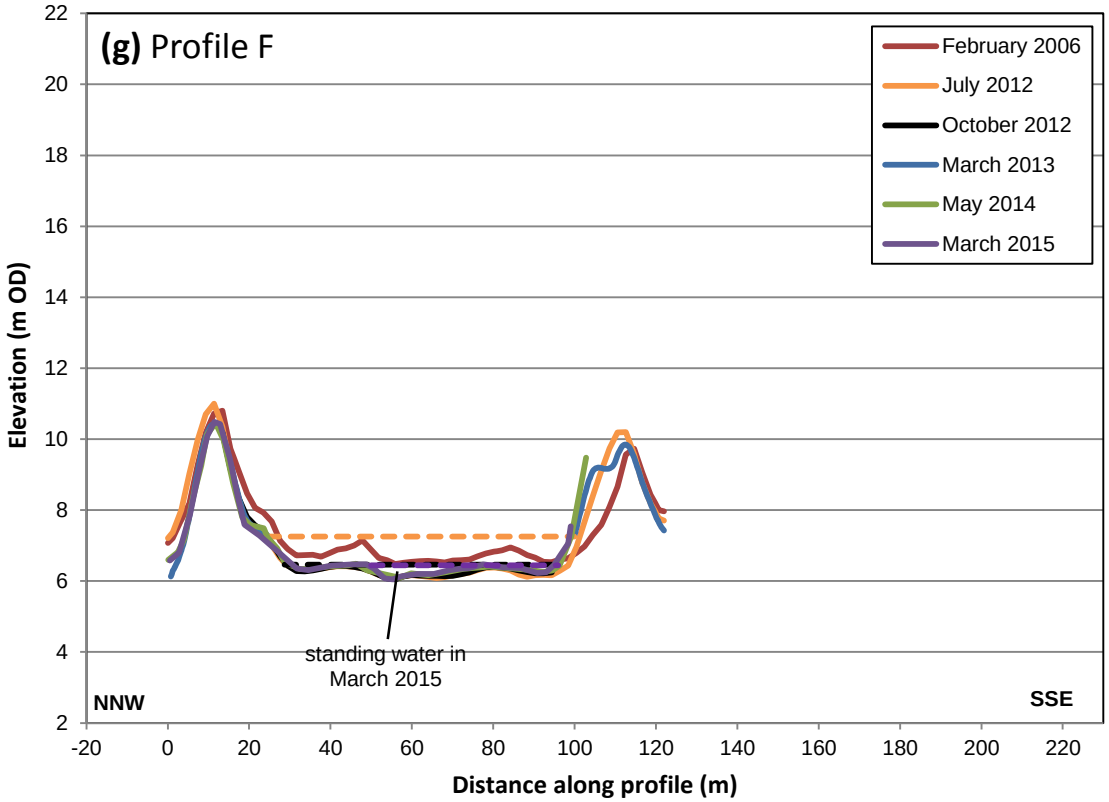


Figure 7 (continued). Comparison of surface levels at profiles D and E on the Phase 1 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 17 July 2012, 9 October 2012, 9 March 2013, 27 May 2014 and 3-11 March 2015



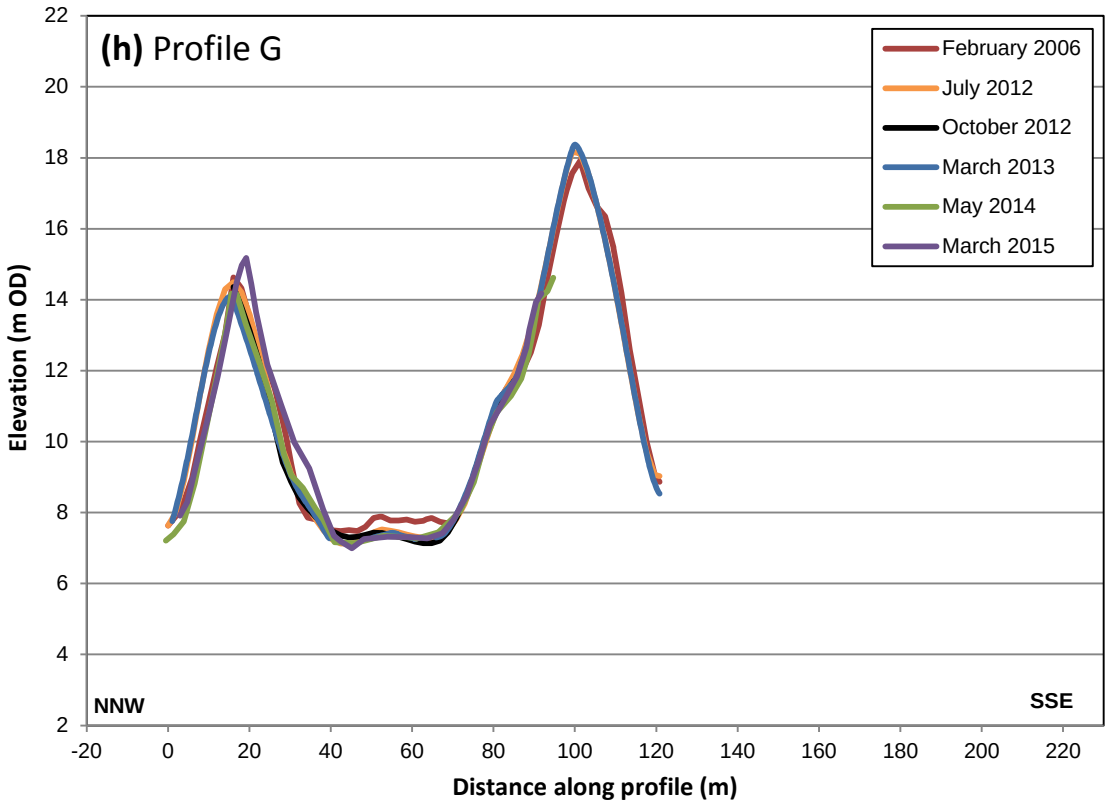


Figure 7 (continued). Comparison of surface levels at profiles F and G on the Phase 1 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 17 July 2012, 9 October 2012, 9 March 2013, 27 May 2014 and 3-11 March 2015

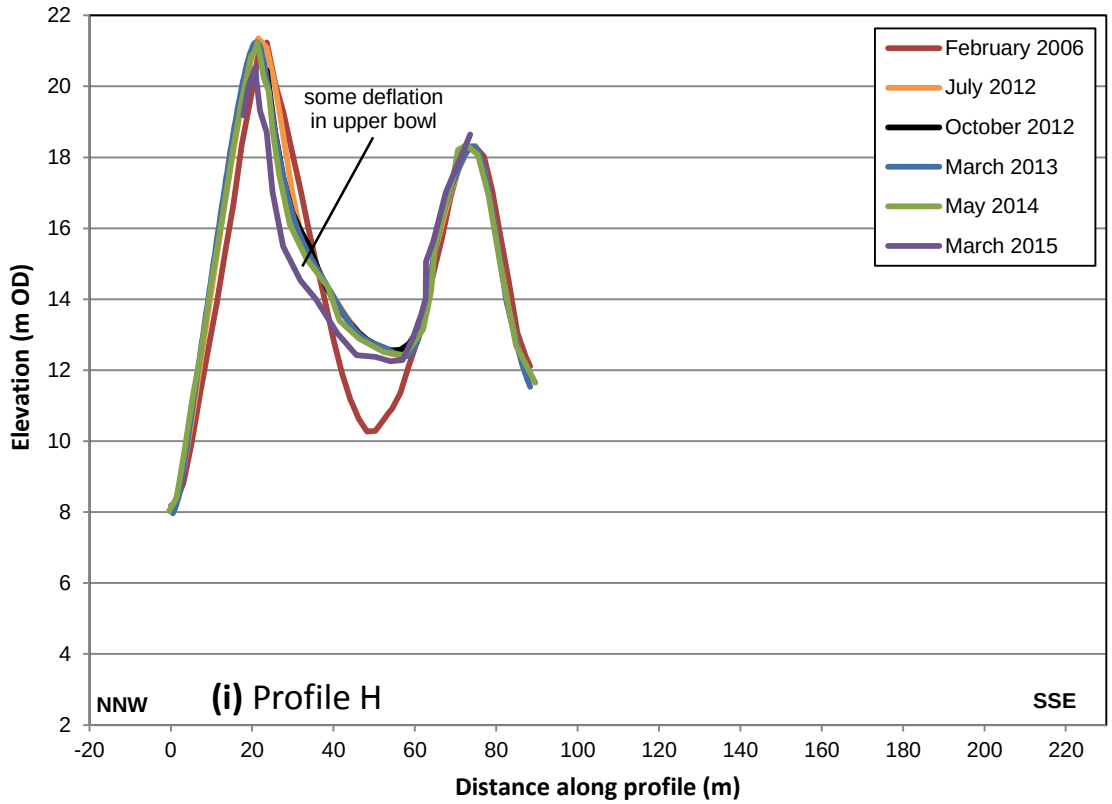


Figure 7 (continued). Comparison of surface levels at profile H on the Phase 1 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 17 July 2012, 9 October 2012, 9 March 2013, 27 May 2014 and 3-11 March 2015

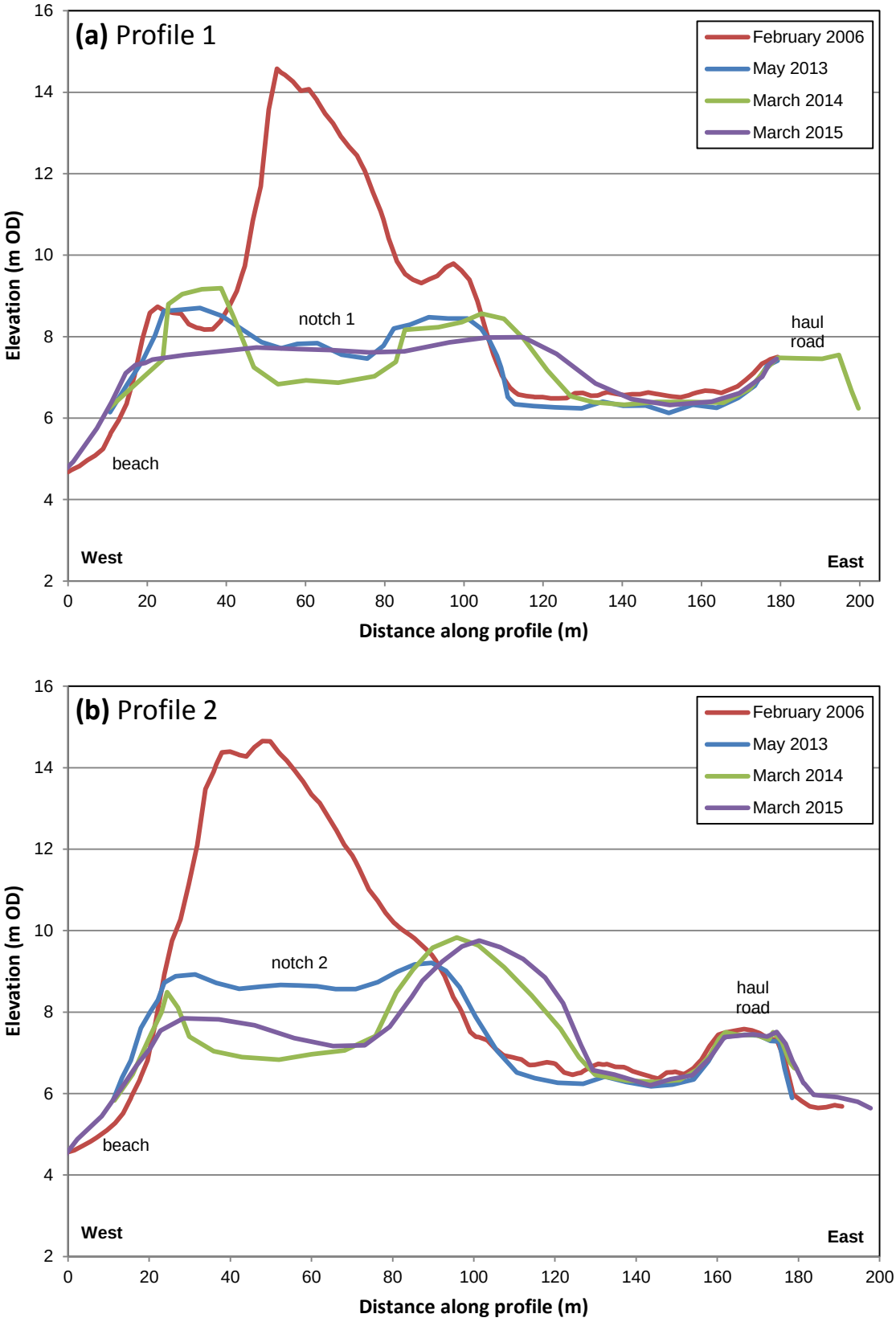
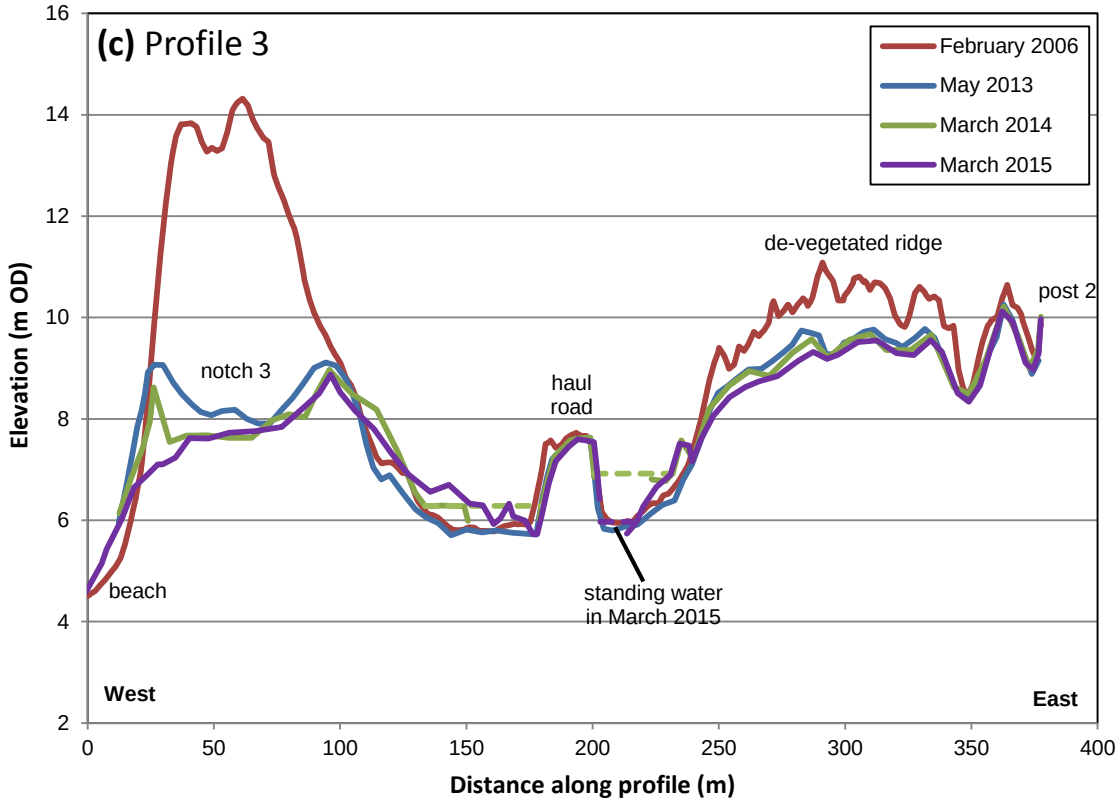


Figure 8. Comparison of surface levels at profiles 1 and 2 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



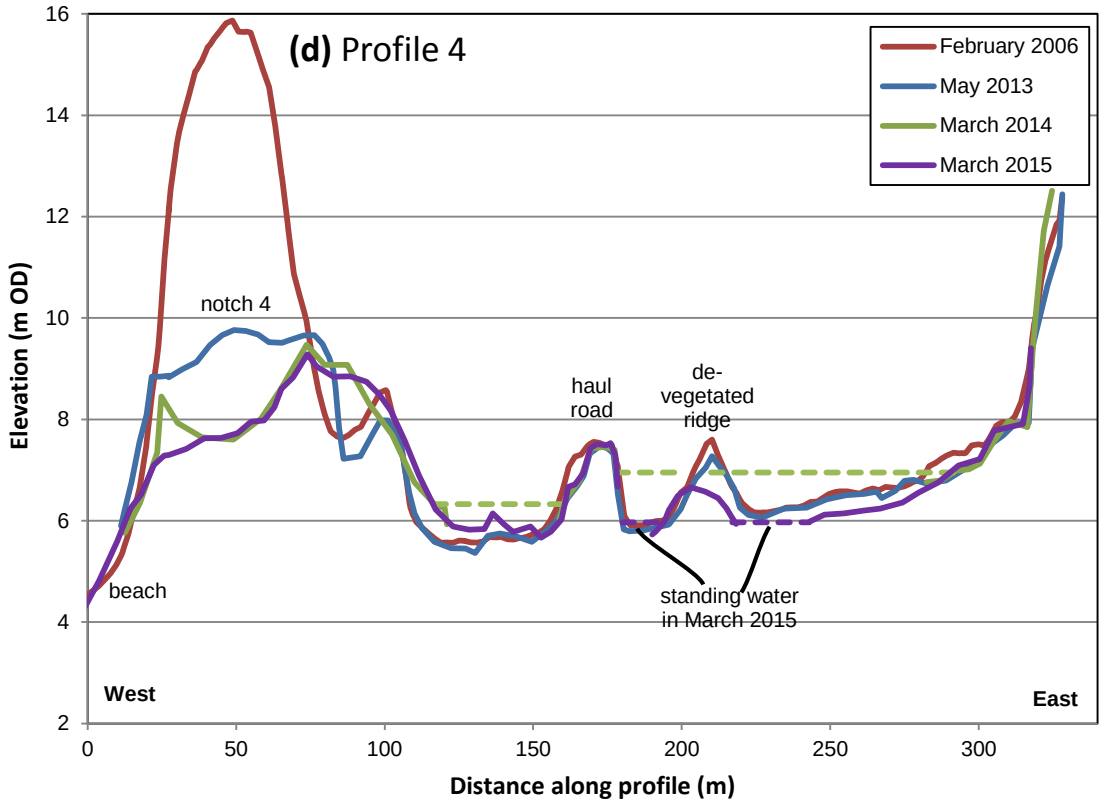


Figure 8 (continued). Comparison of surface levels at profiles 3 and 4 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

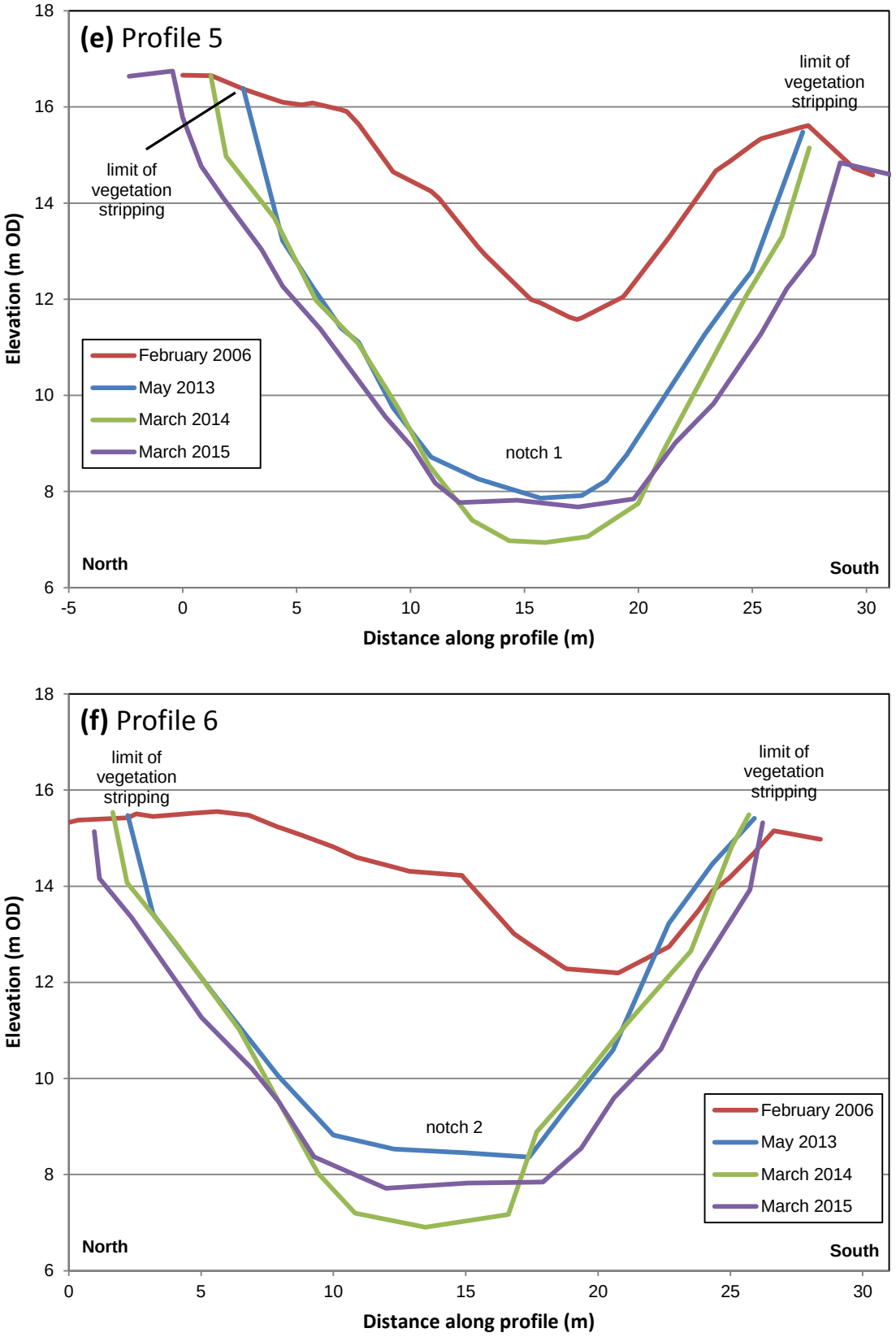
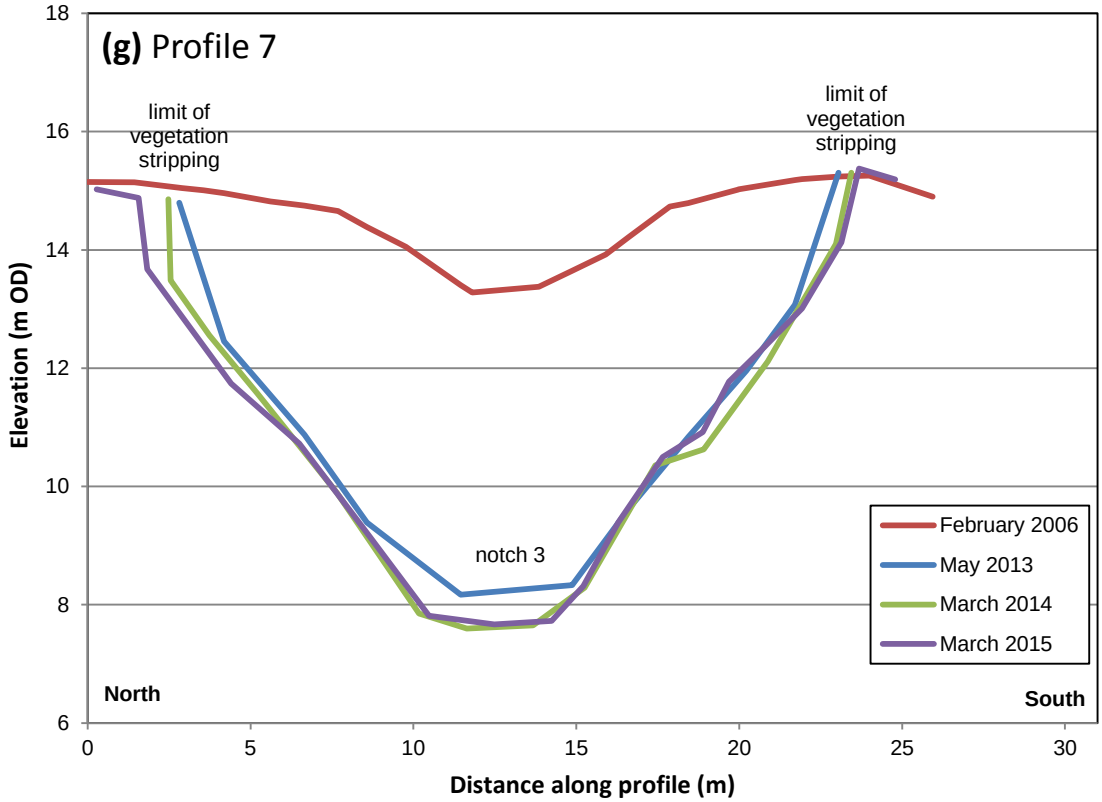


Figure 8 (continued). Comparison of surface levels at profiles 5 and 6 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



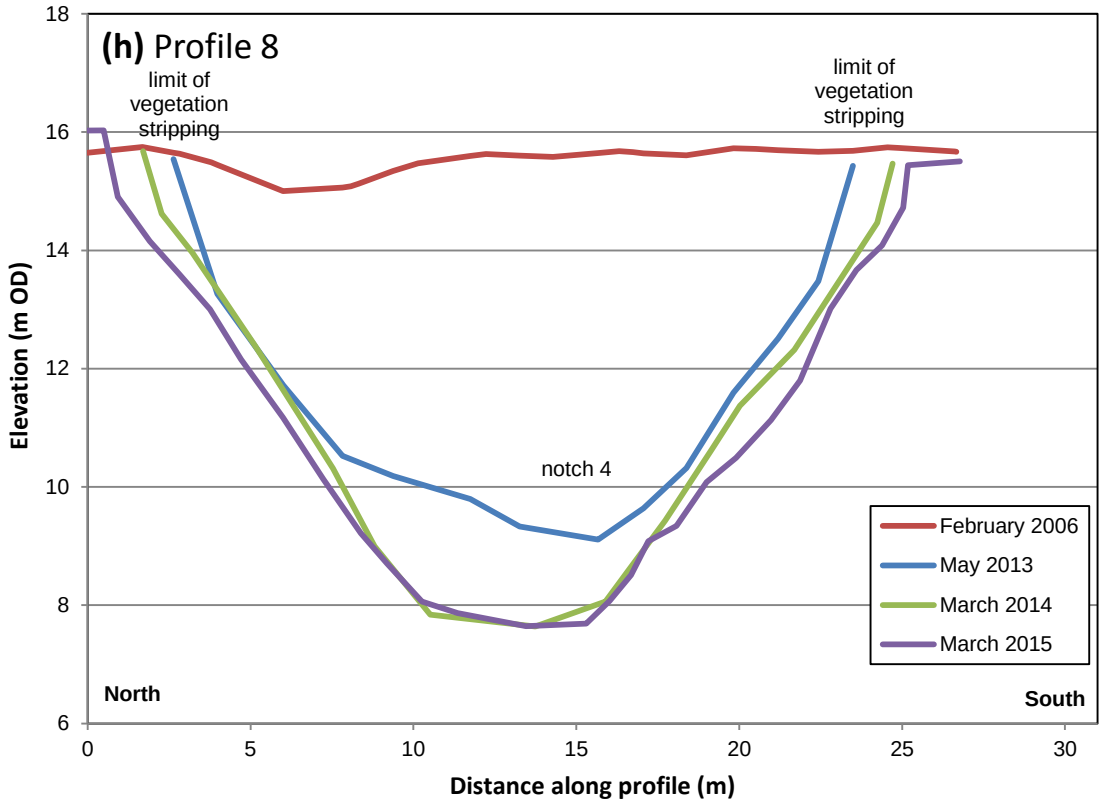


Figure 8 (continued). Comparison of surface levels at profiles 7 and 8 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

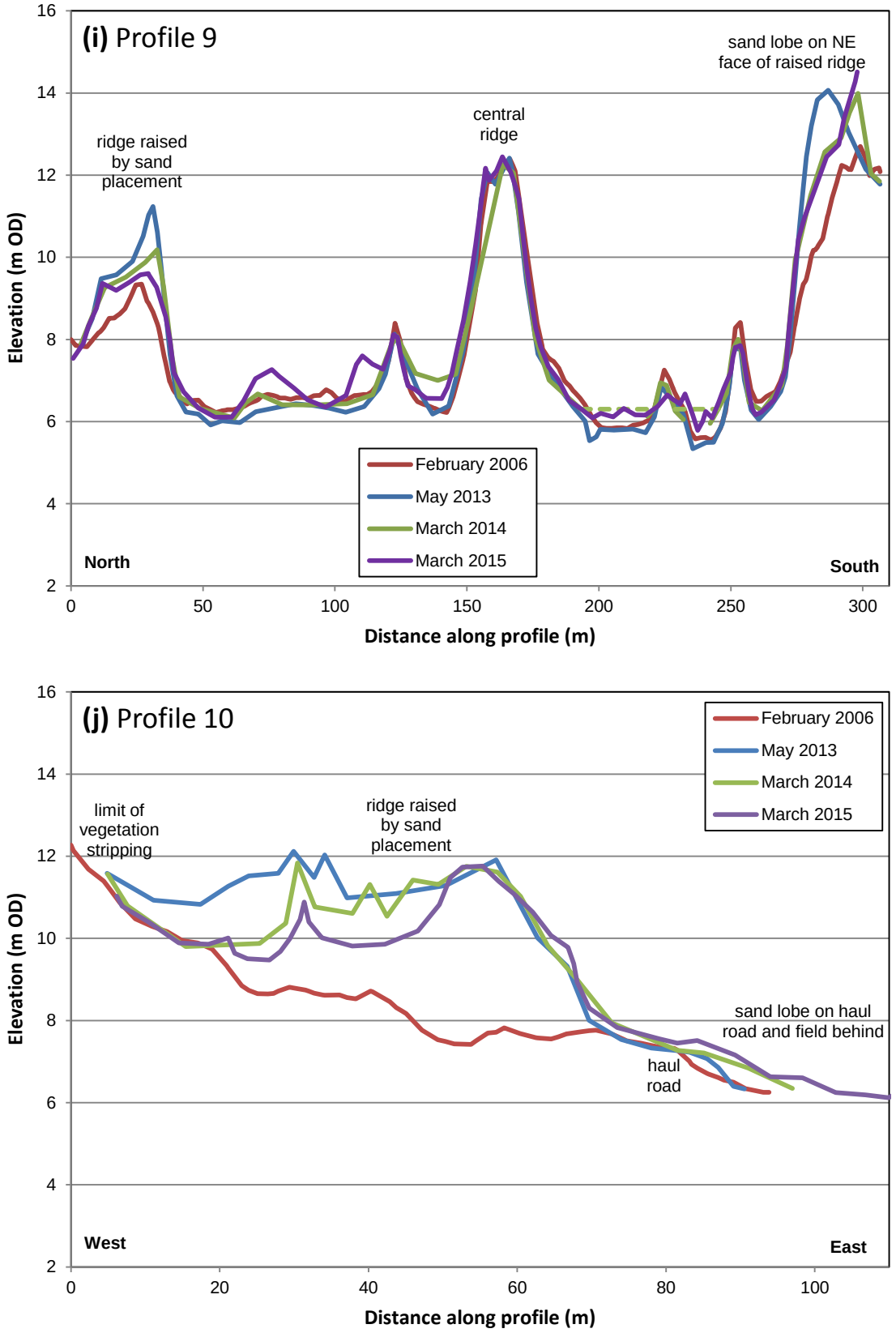
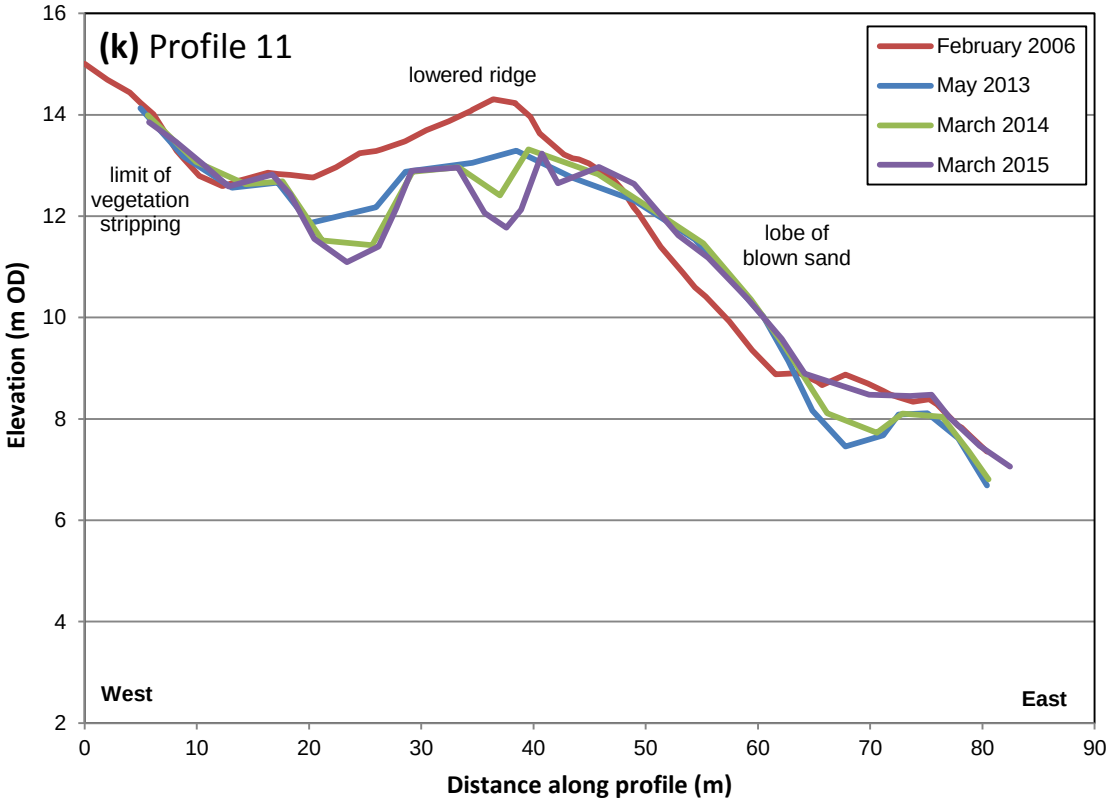


Figure 8 (continued). Comparison of surface levels at profiles 9 and 10 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



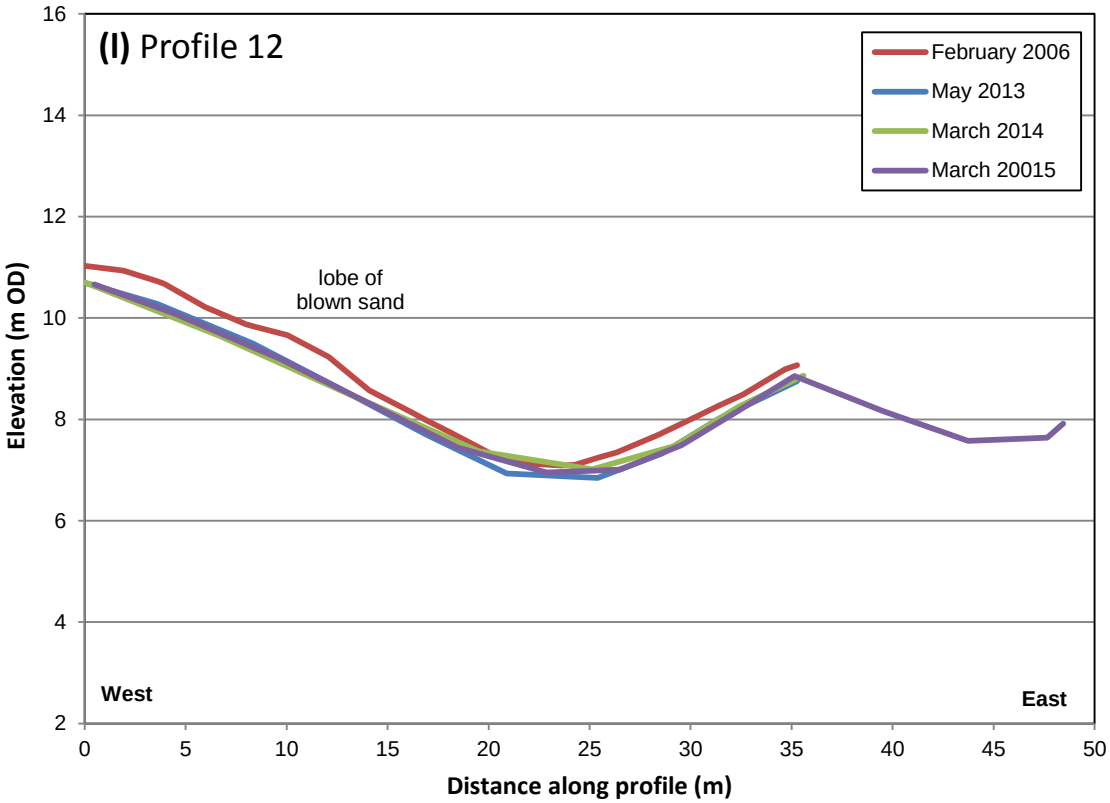
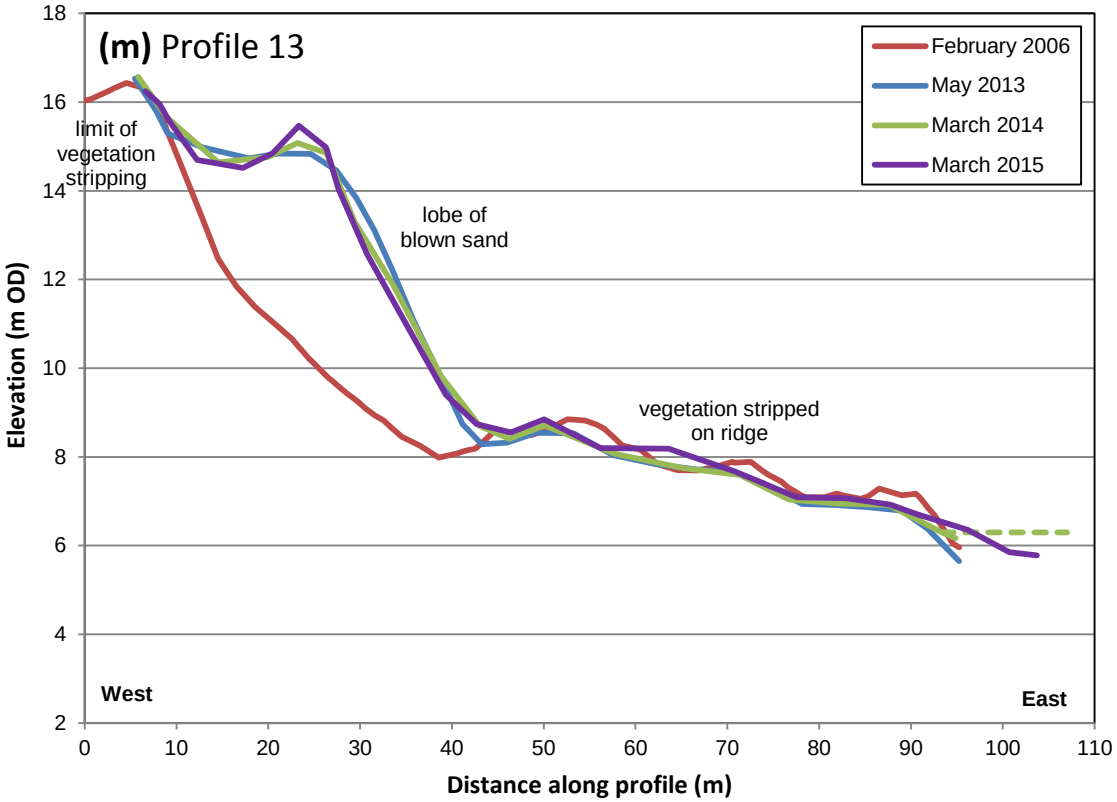


Figure 8 (continued). Comparison of surface levels at profiles 11 and 12 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



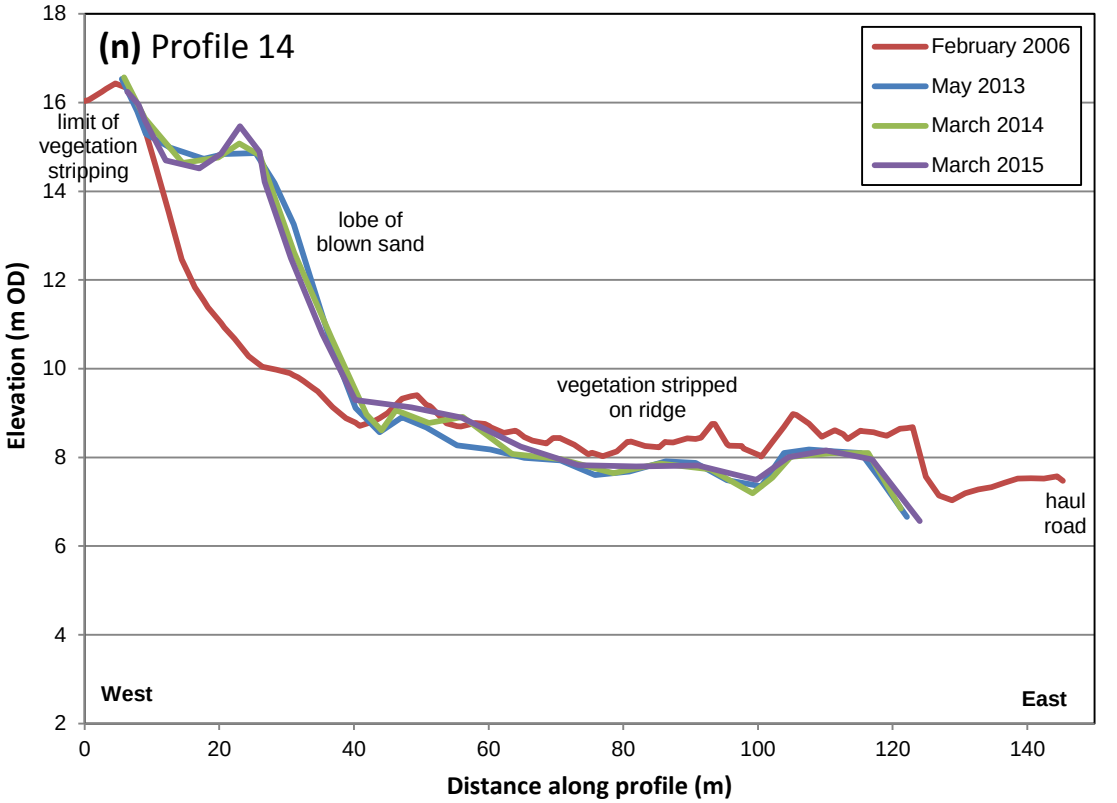


Figure 8 (continued). Comparison of surface levels at profiles 13 and 14 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

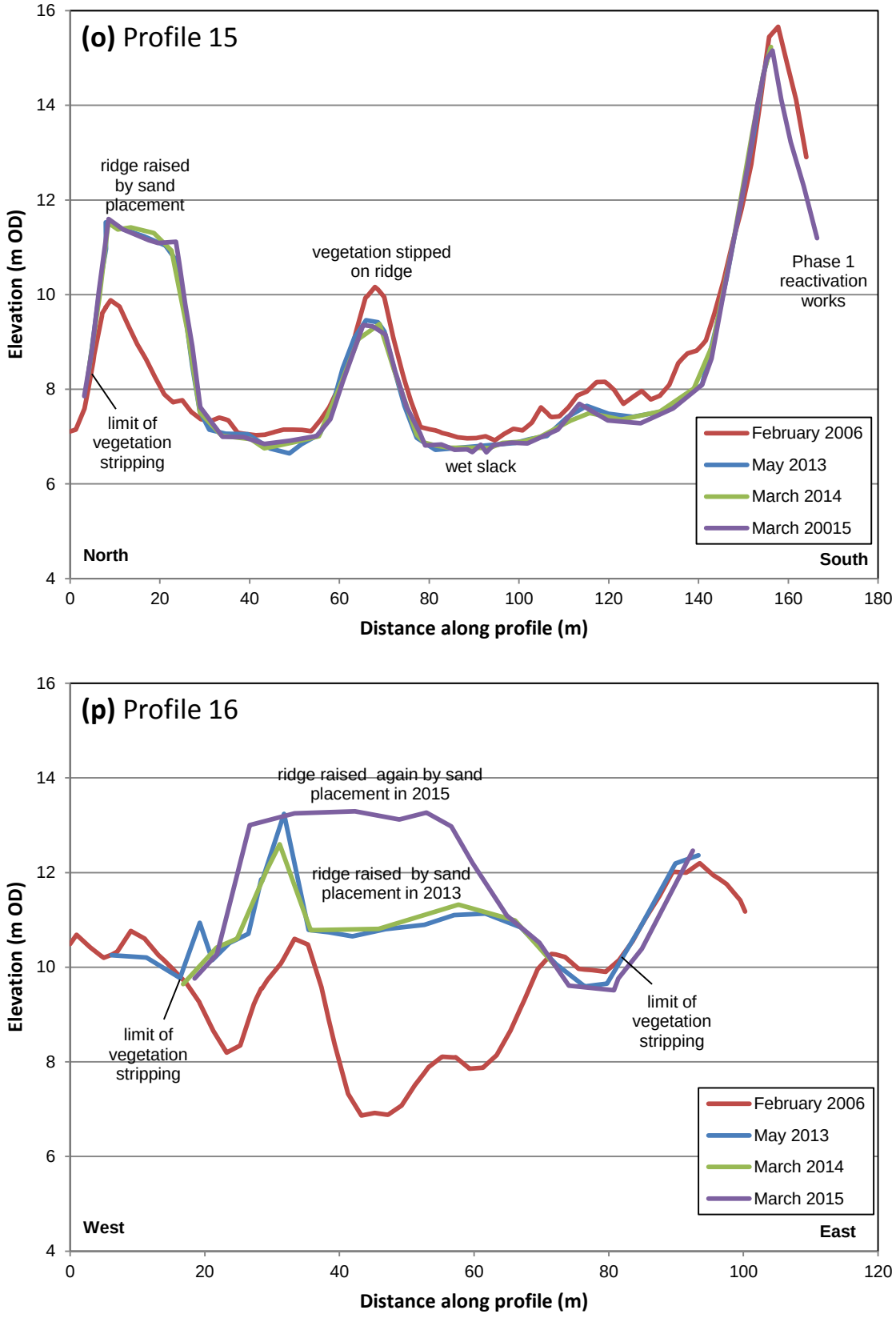
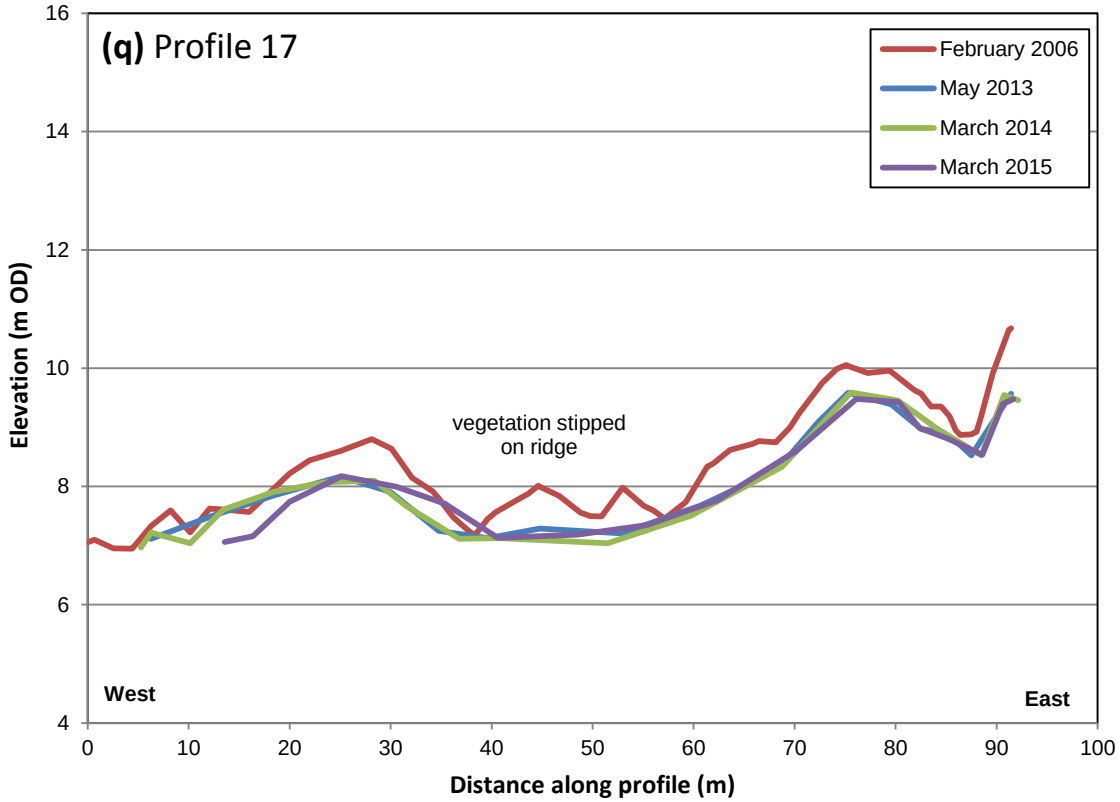


Figure 8 (continued). Comparison of surface levels at profiles 15 and 16 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



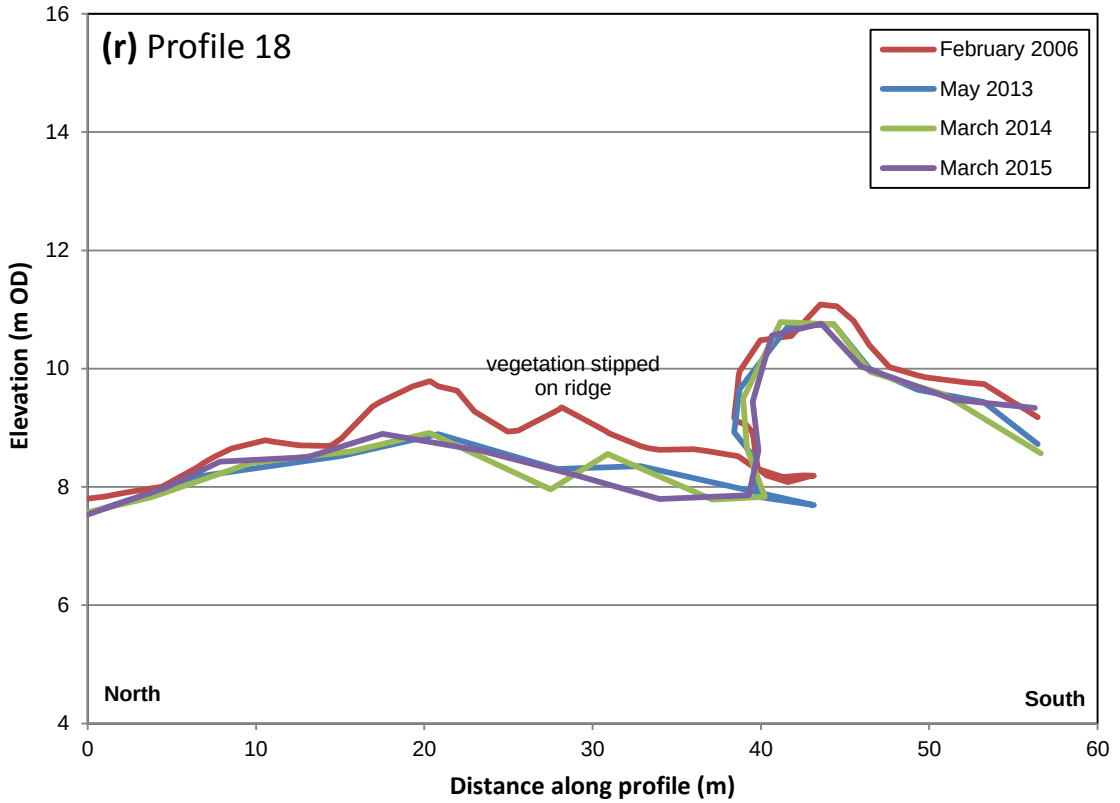


Figure 8 (continued). Comparison of surface levels at profiles 17 and 18 on the Phase 2 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

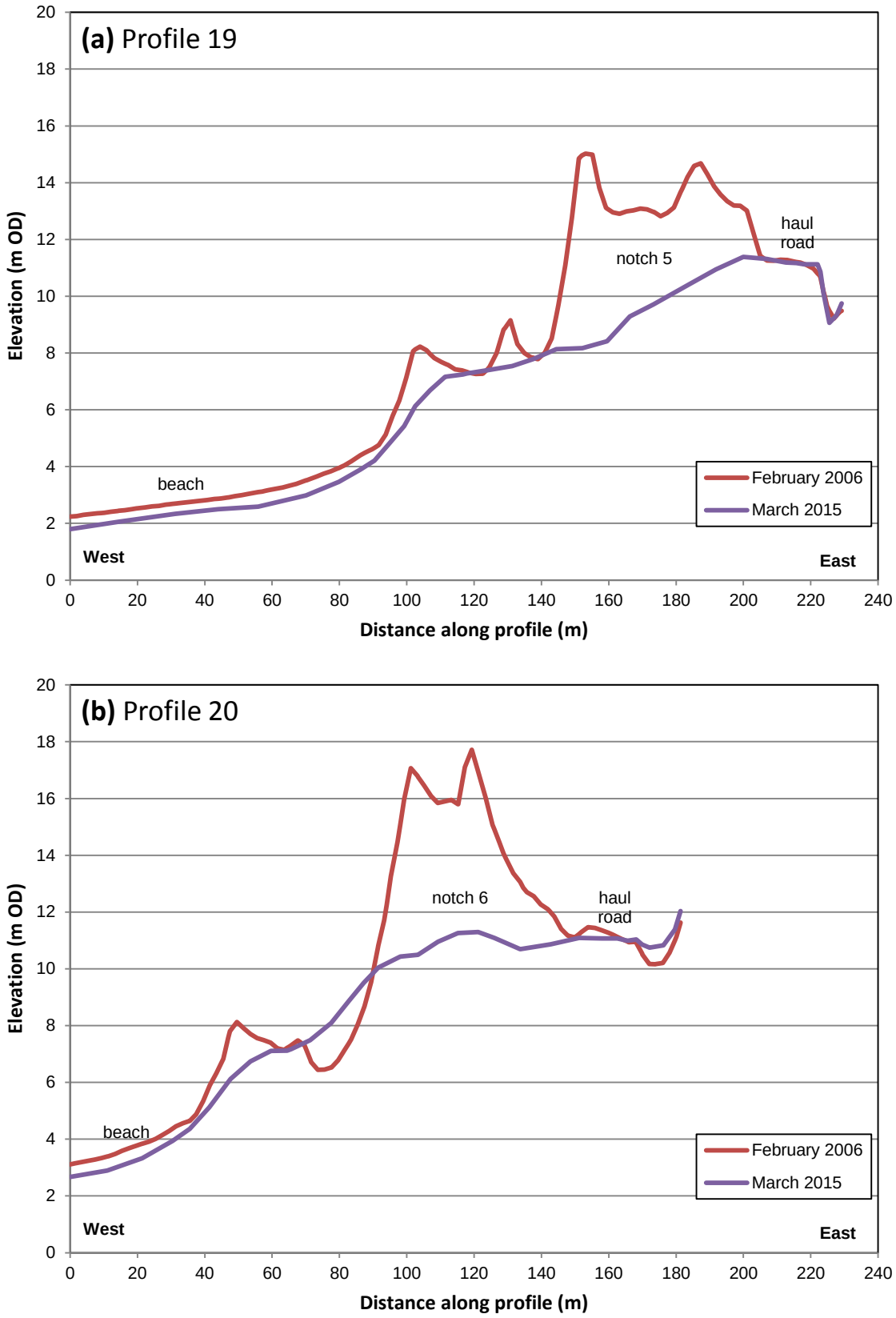
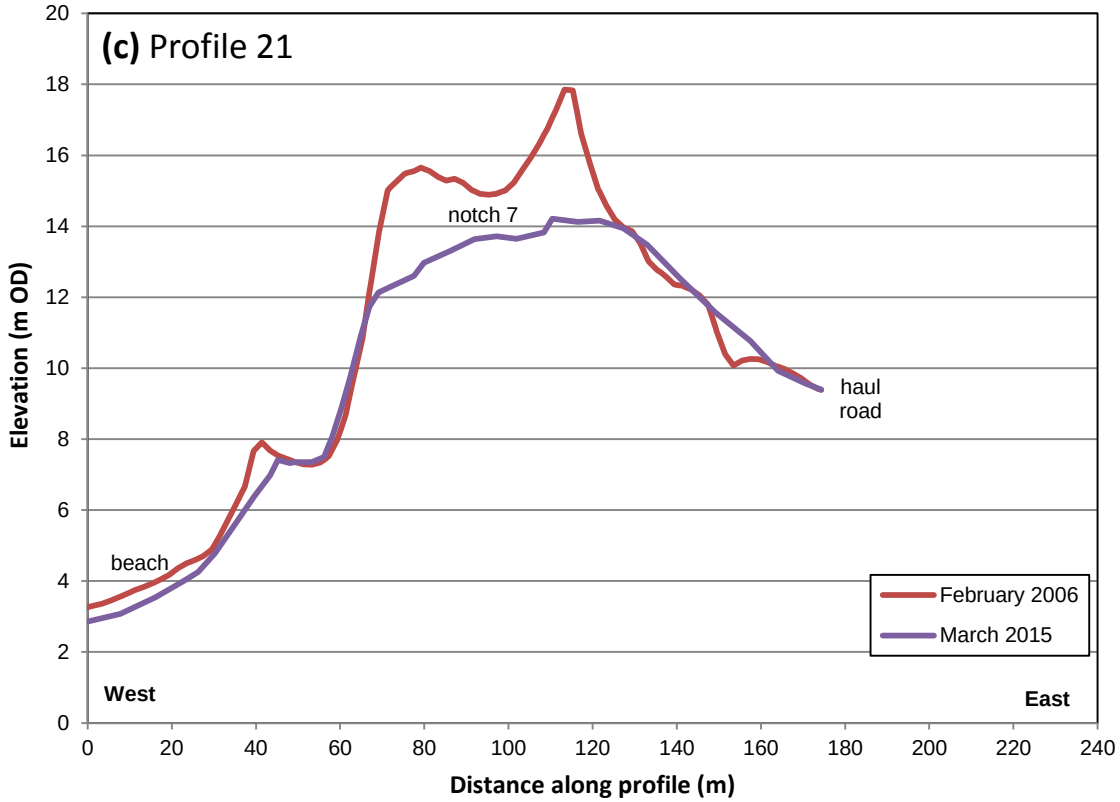


Figure 9. Comparison of surface levels at profiles 19 and 20 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



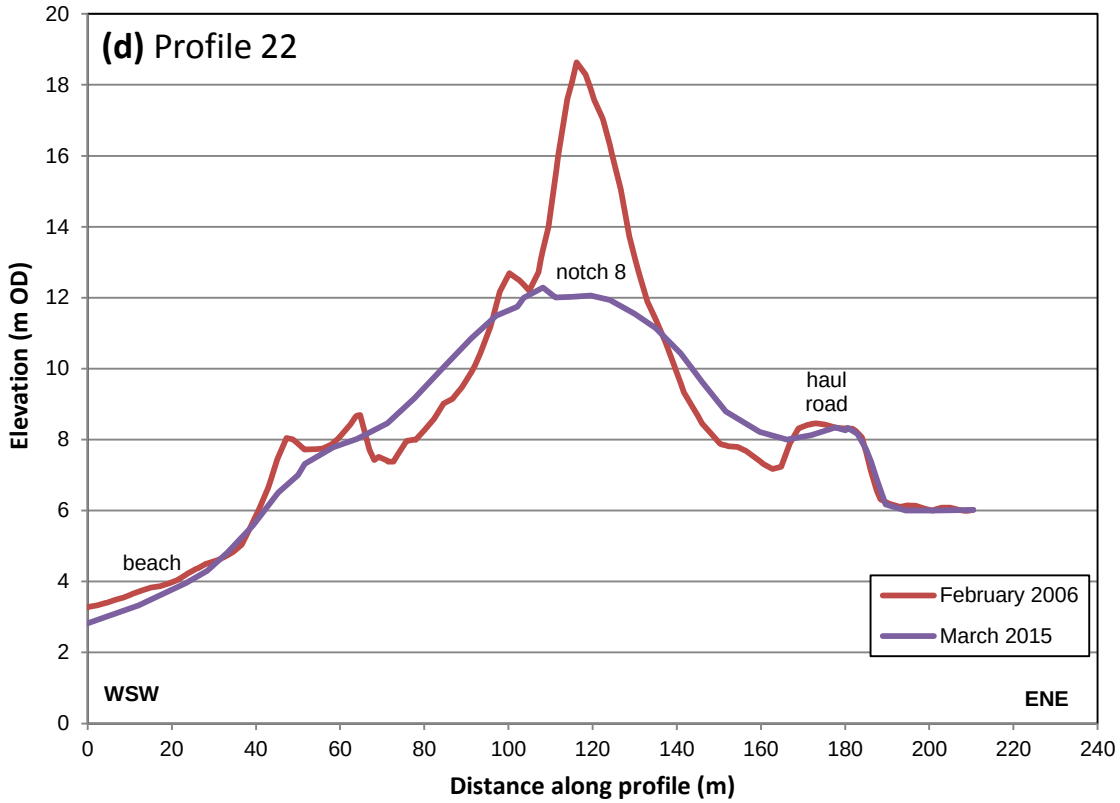
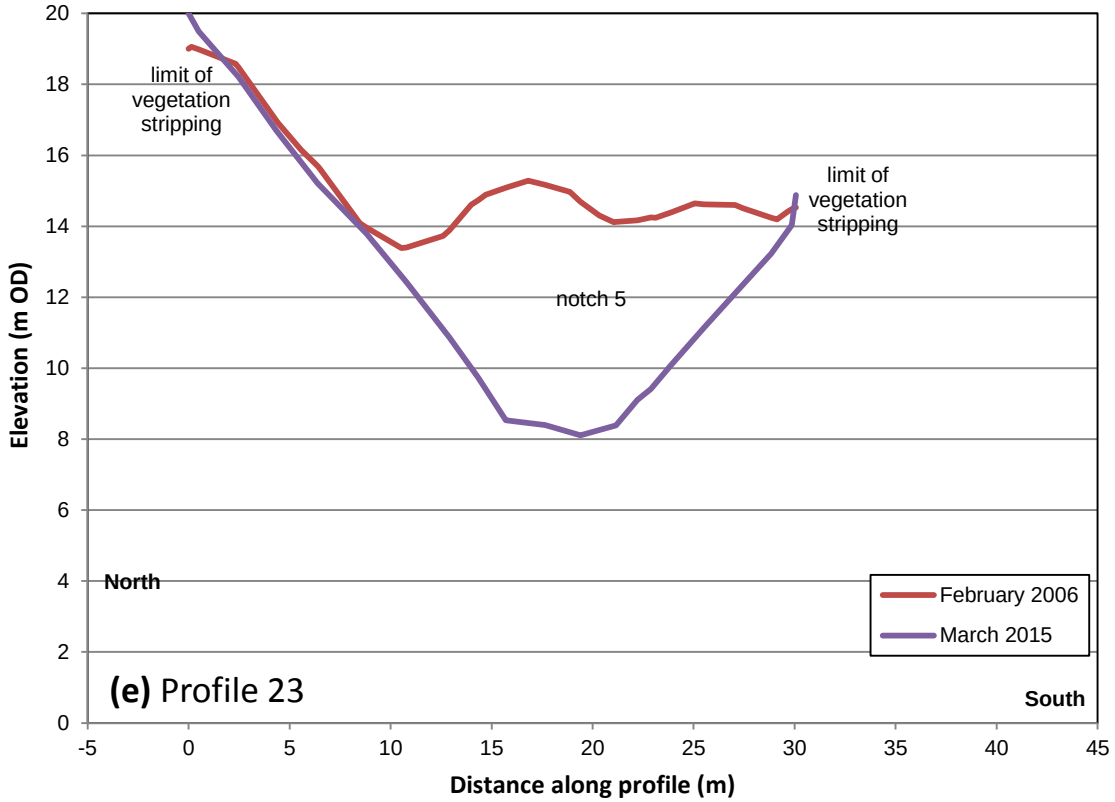


Figure 9 (continued). Comparison of surface levels at profiles 21 and 22 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



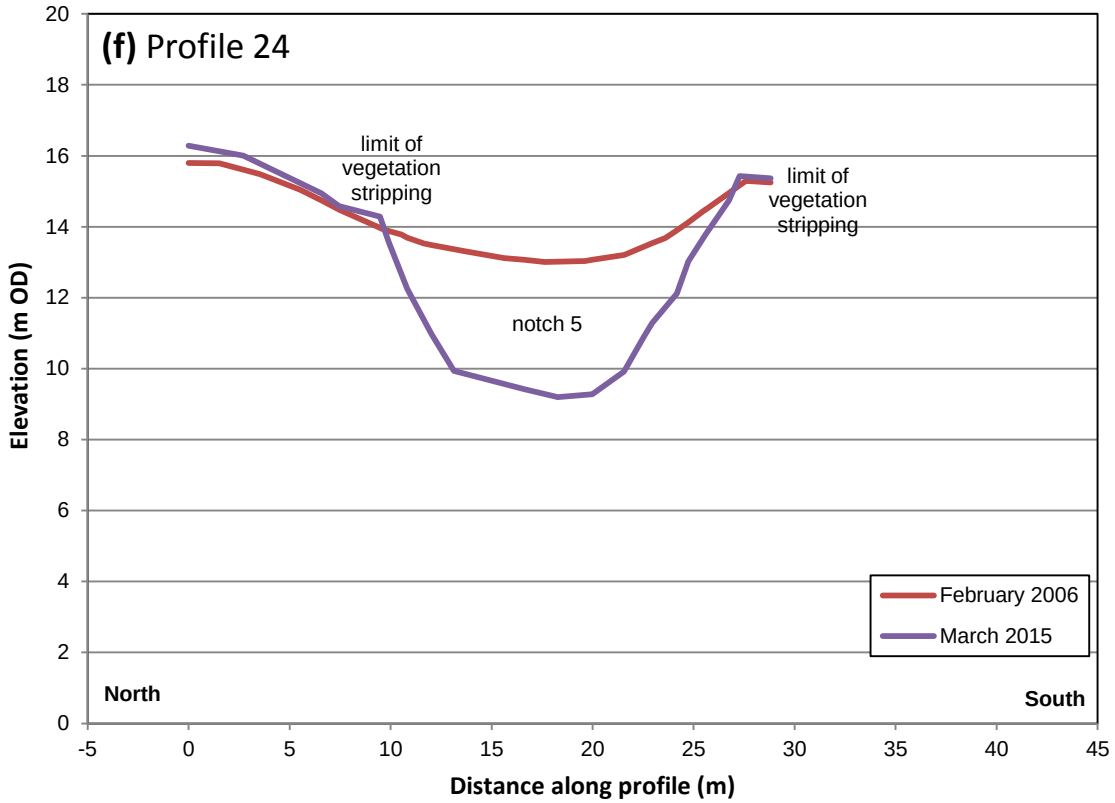
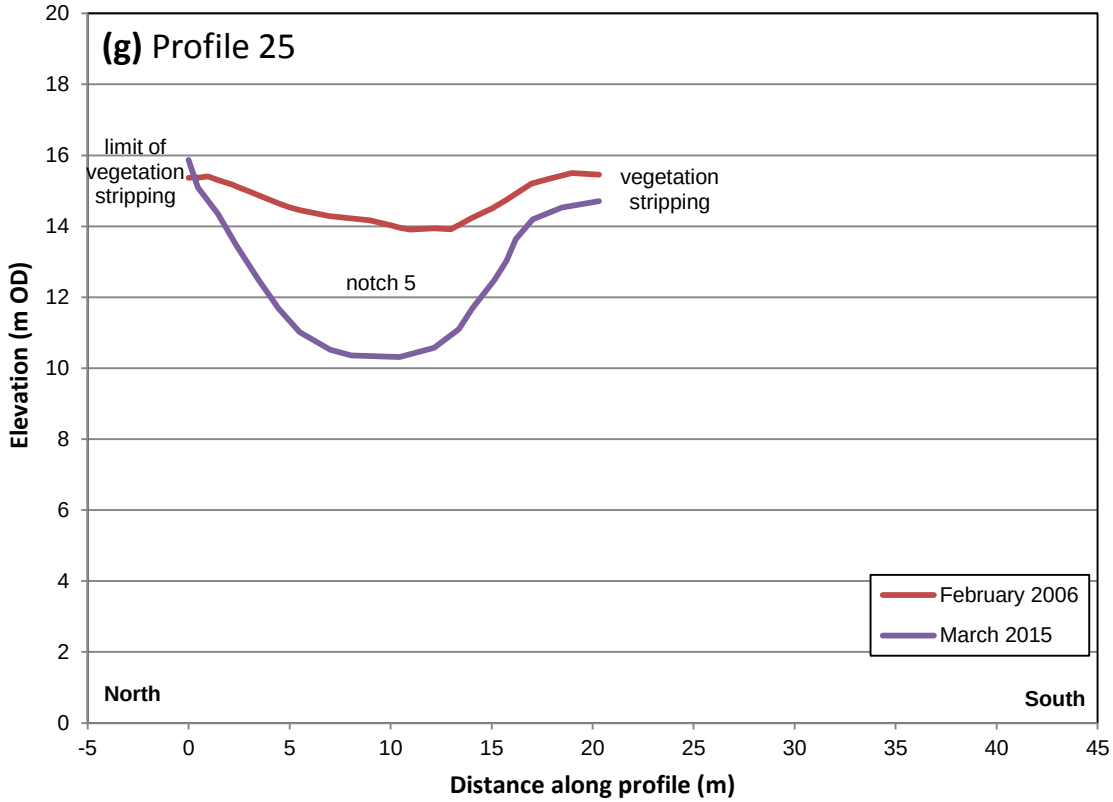


Figure 9 (continued). Comparison of surface levels at profiles 23 and 24 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



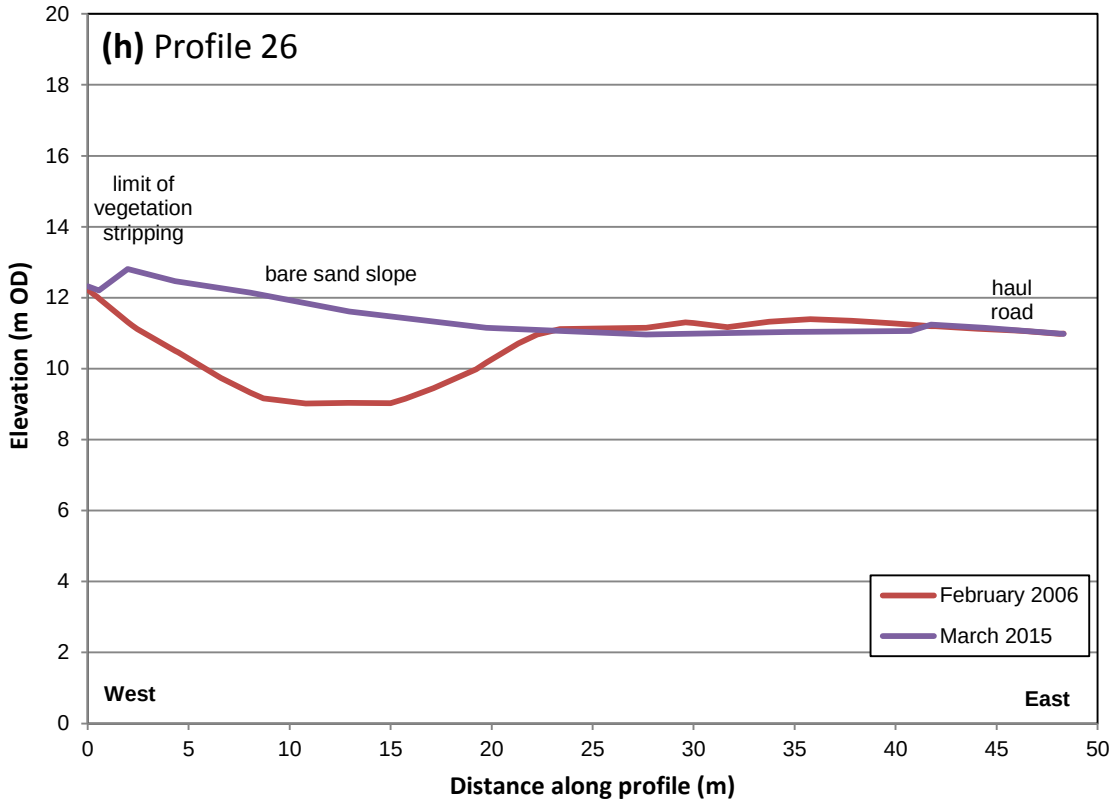


Figure 9 (continued). Comparison of surface levels at profiles 25 and 26 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

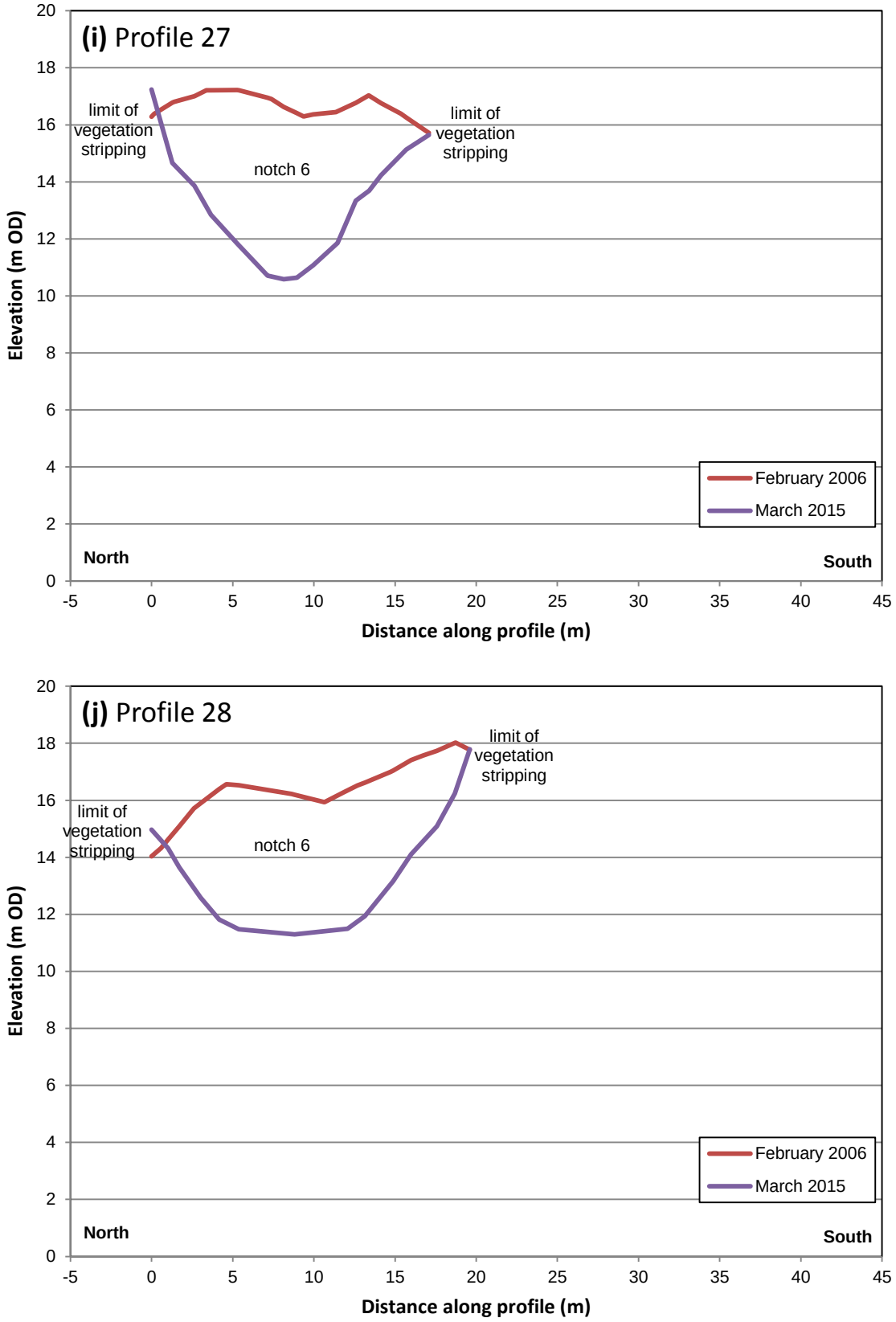


Figure 9 (continued). Comparison of surface levels at profiles 27 and 28 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

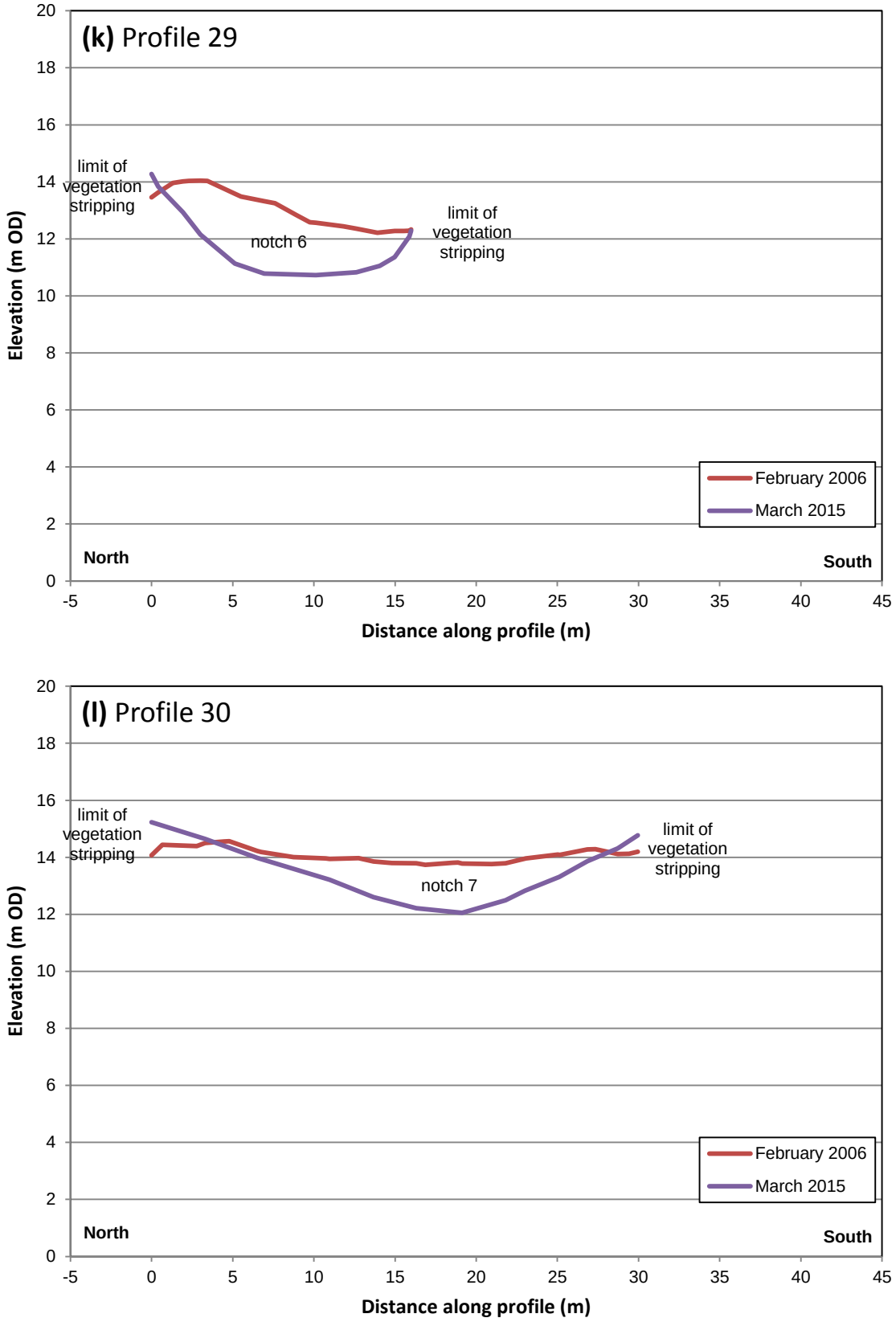


Figure 9 (continued). Comparison of surface levels at profiles 29 and 30 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

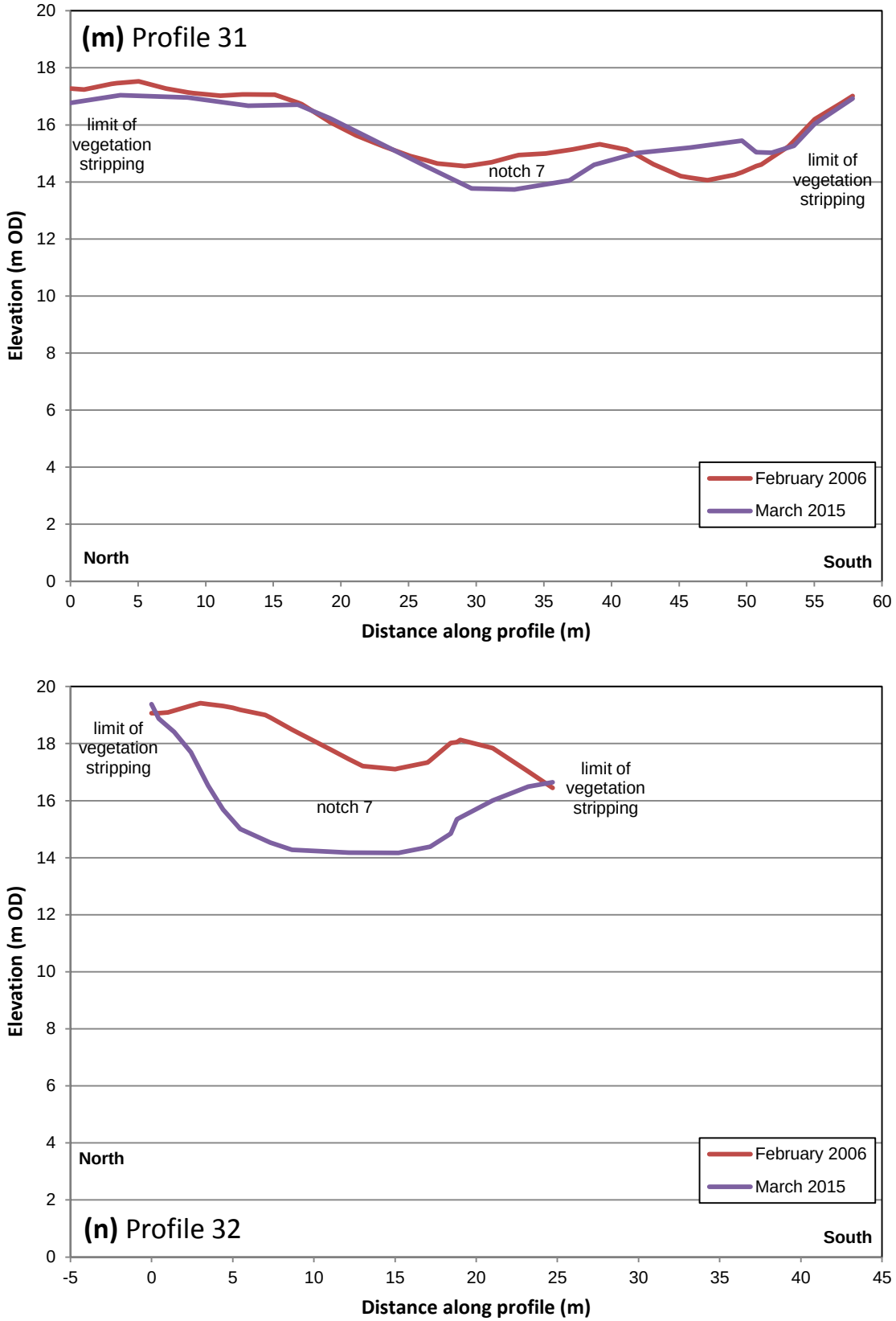
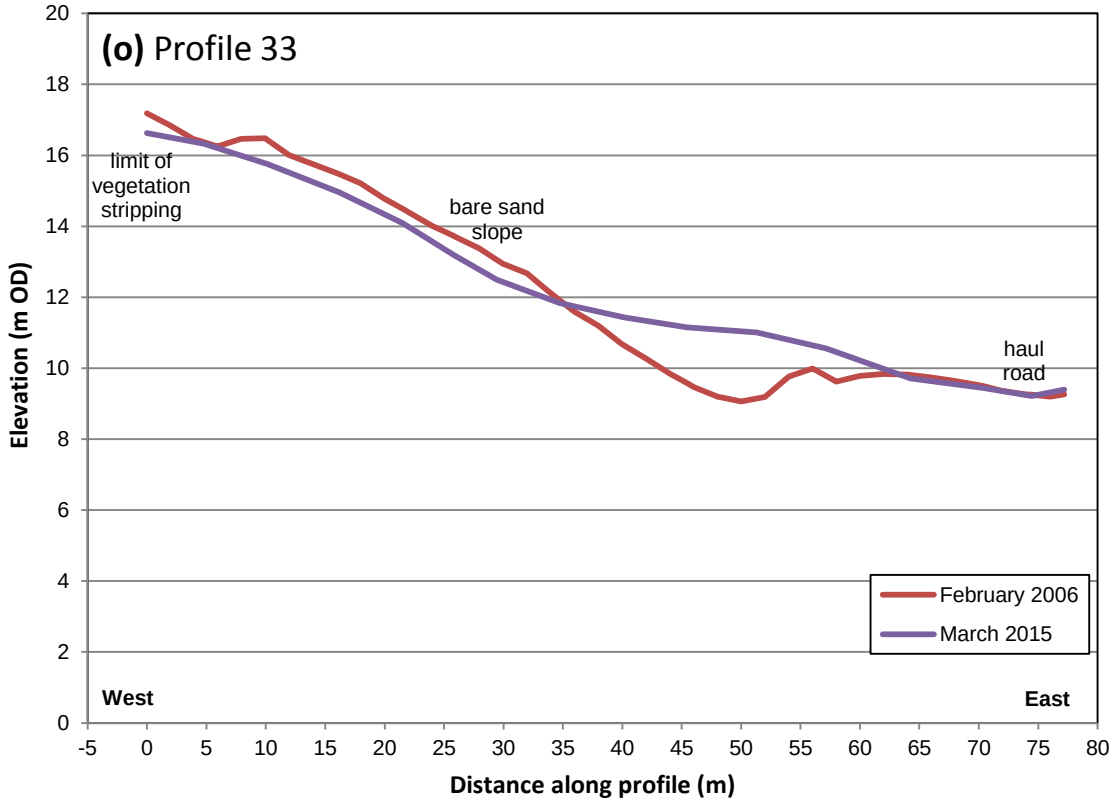


Figure 9 (continued). Comparison of surface levels at profiles 31 and 32 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



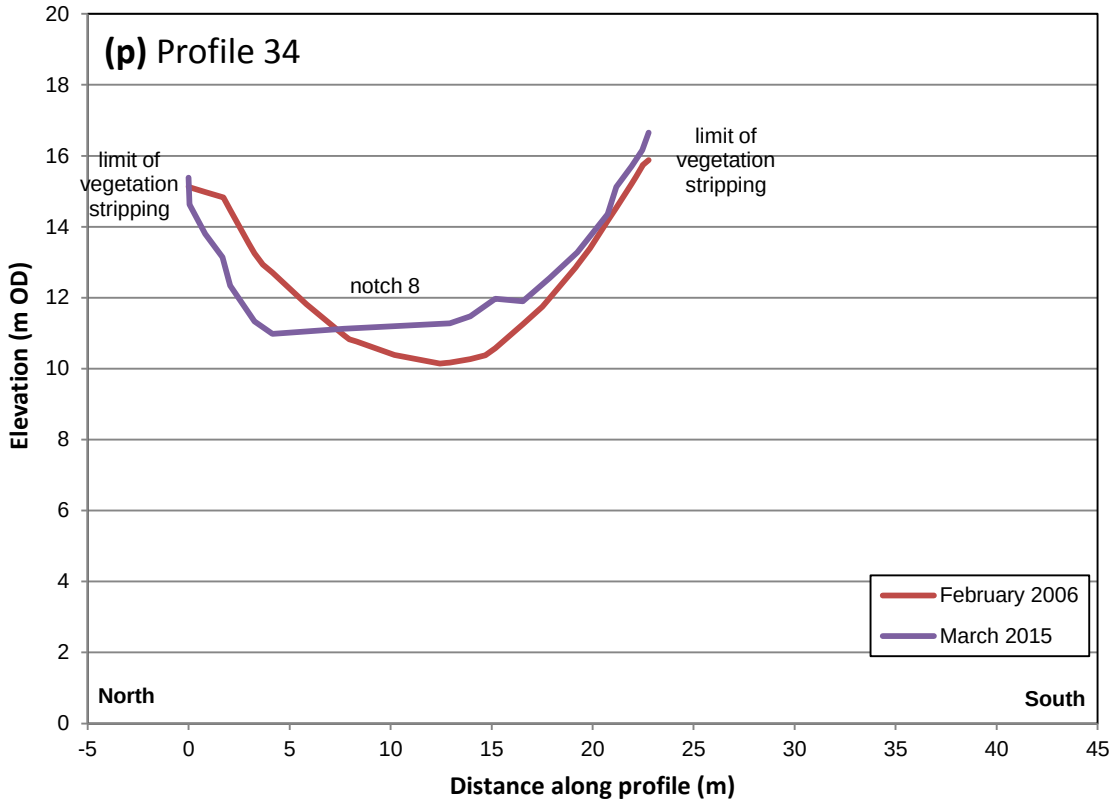
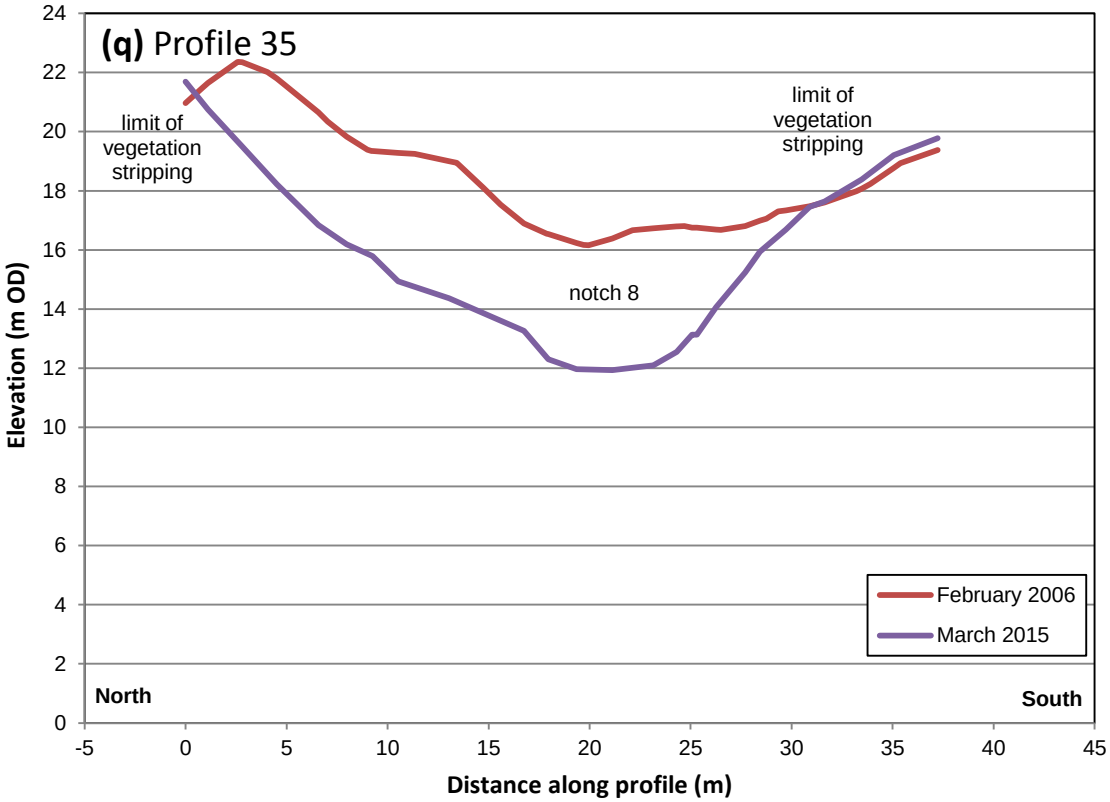


Figure 9 (continued). Comparison of surface levels at profiles 33 and 34 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015



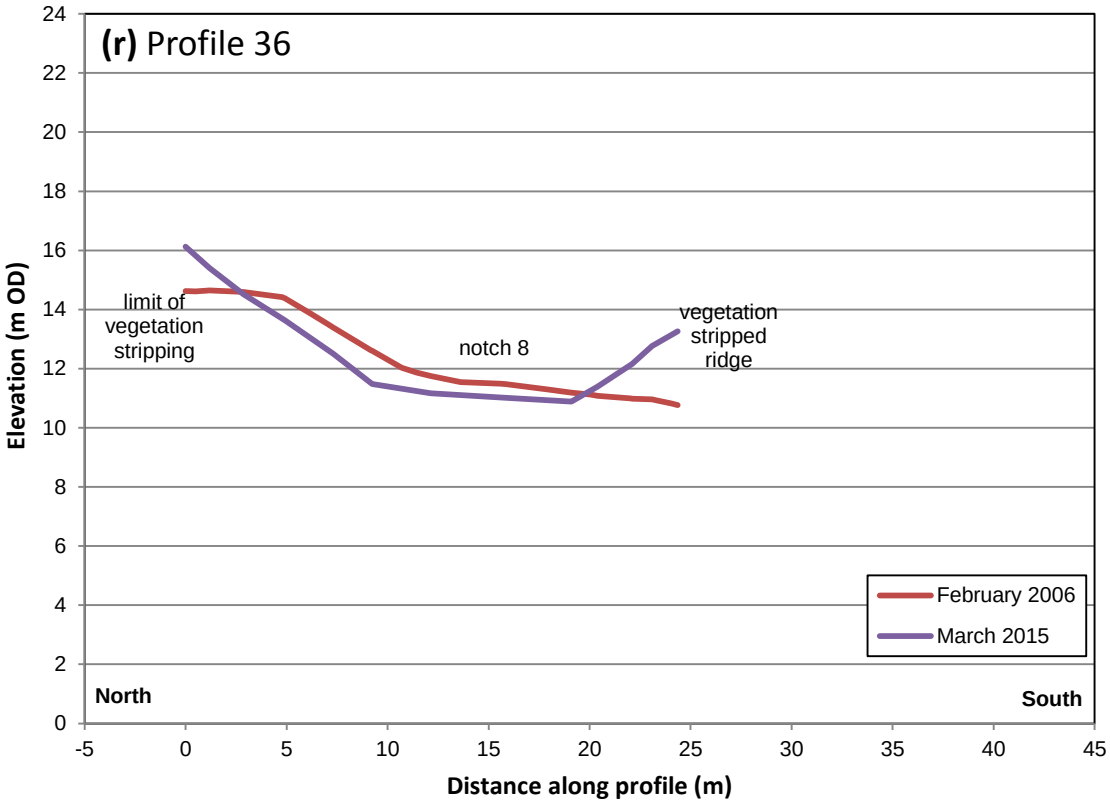


Figure 9 (continued). Comparison of surface levels at profiles 35 and 36 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

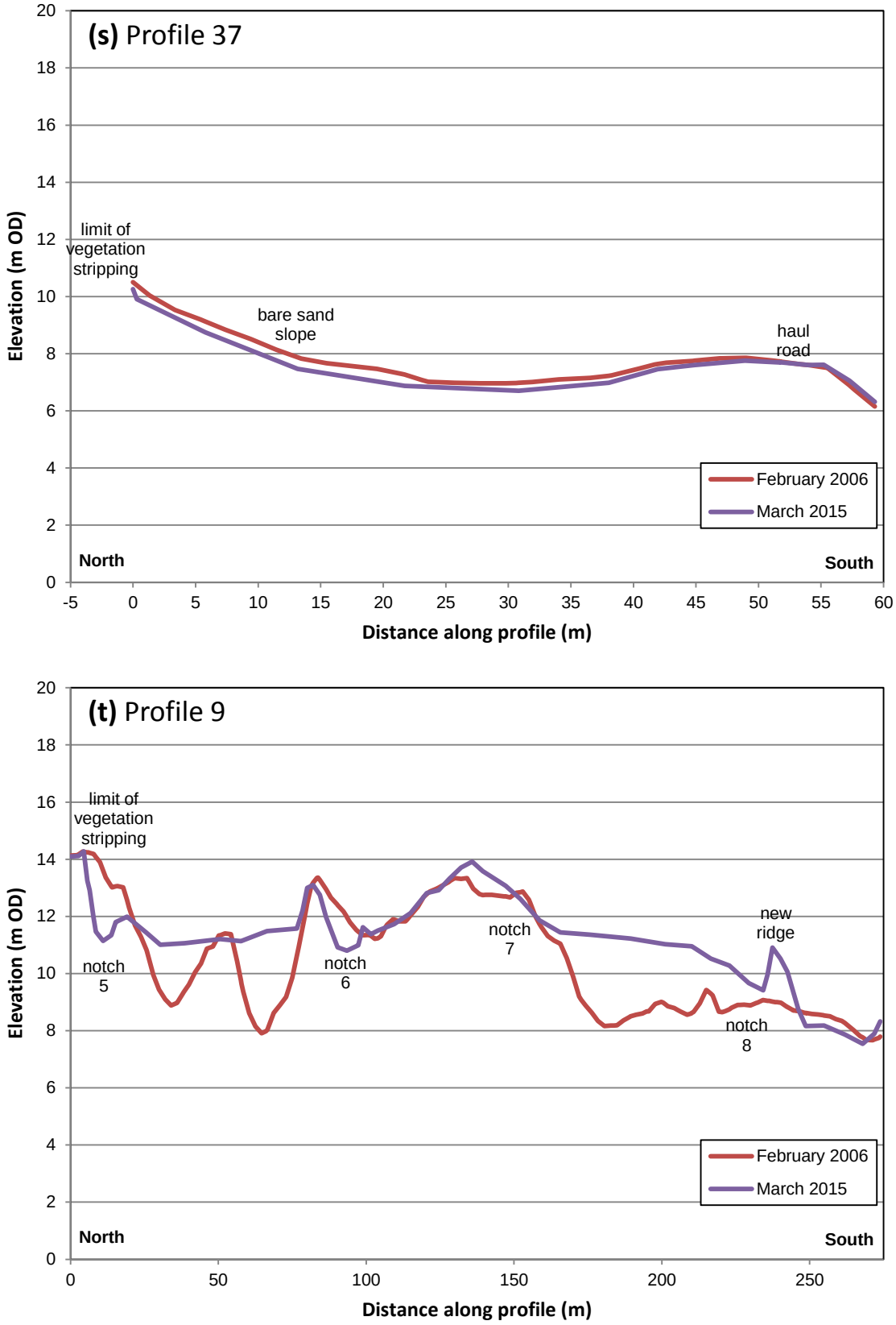


Figure 9 (continued). Comparison of surface levels at profile 37 and the northern part of profile 9 on the Phase 3 site indicated by LiDAR survey on 26 February 2006 (pre-trials) and ground surveys on 13 May 2013, 10 March 2014 and 3-11 March 2015

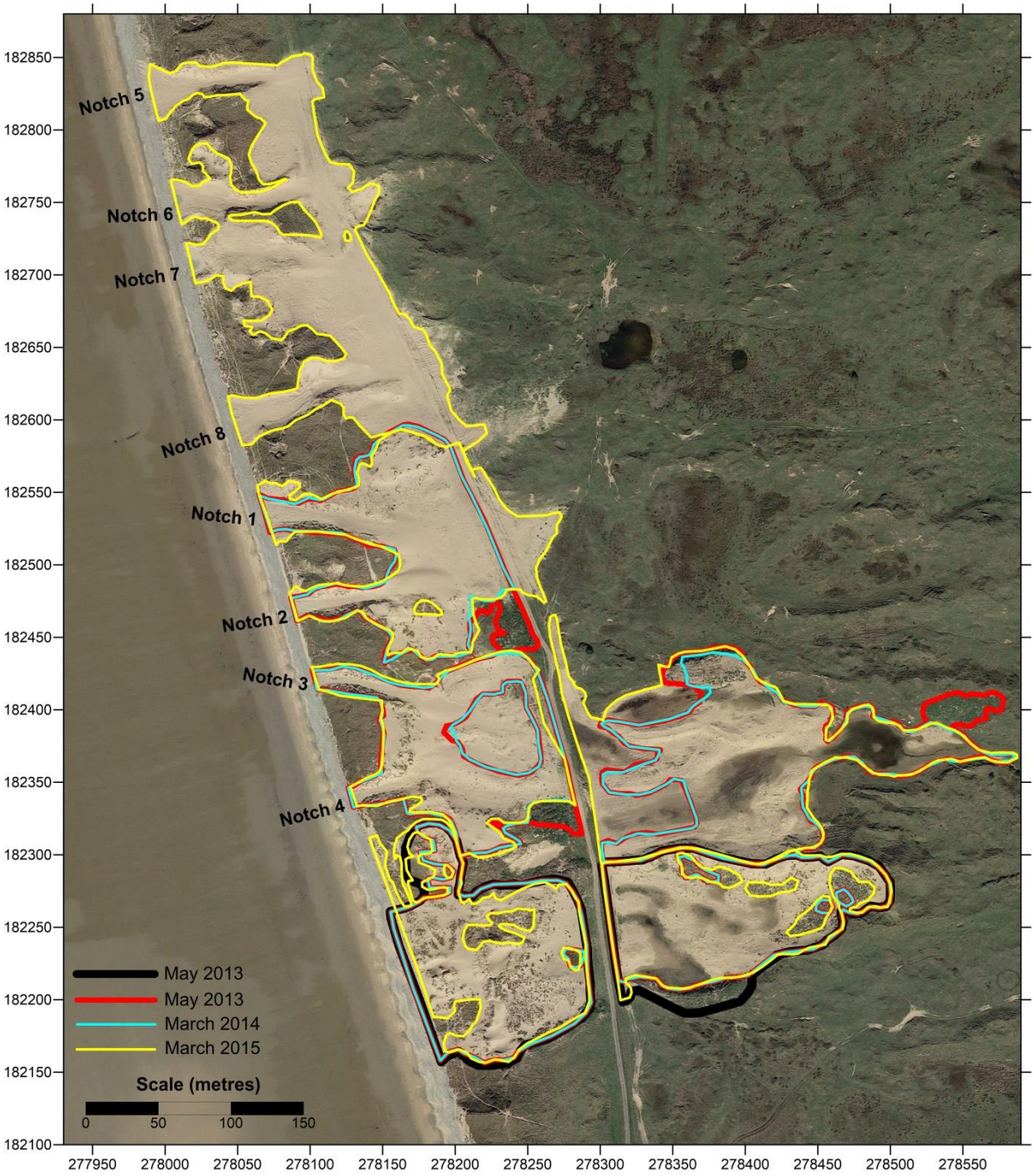


Figure 10. Digitisation of bare sand and partially vegetated areas during each of the ground surveys in 2012-2015, overlaid on aerial photography flown 18 April 2015 (source: Google Earth). The calculated areas (in hectares) are given in Table 6

10. Field photographs

Taken on 3-4 March 2015

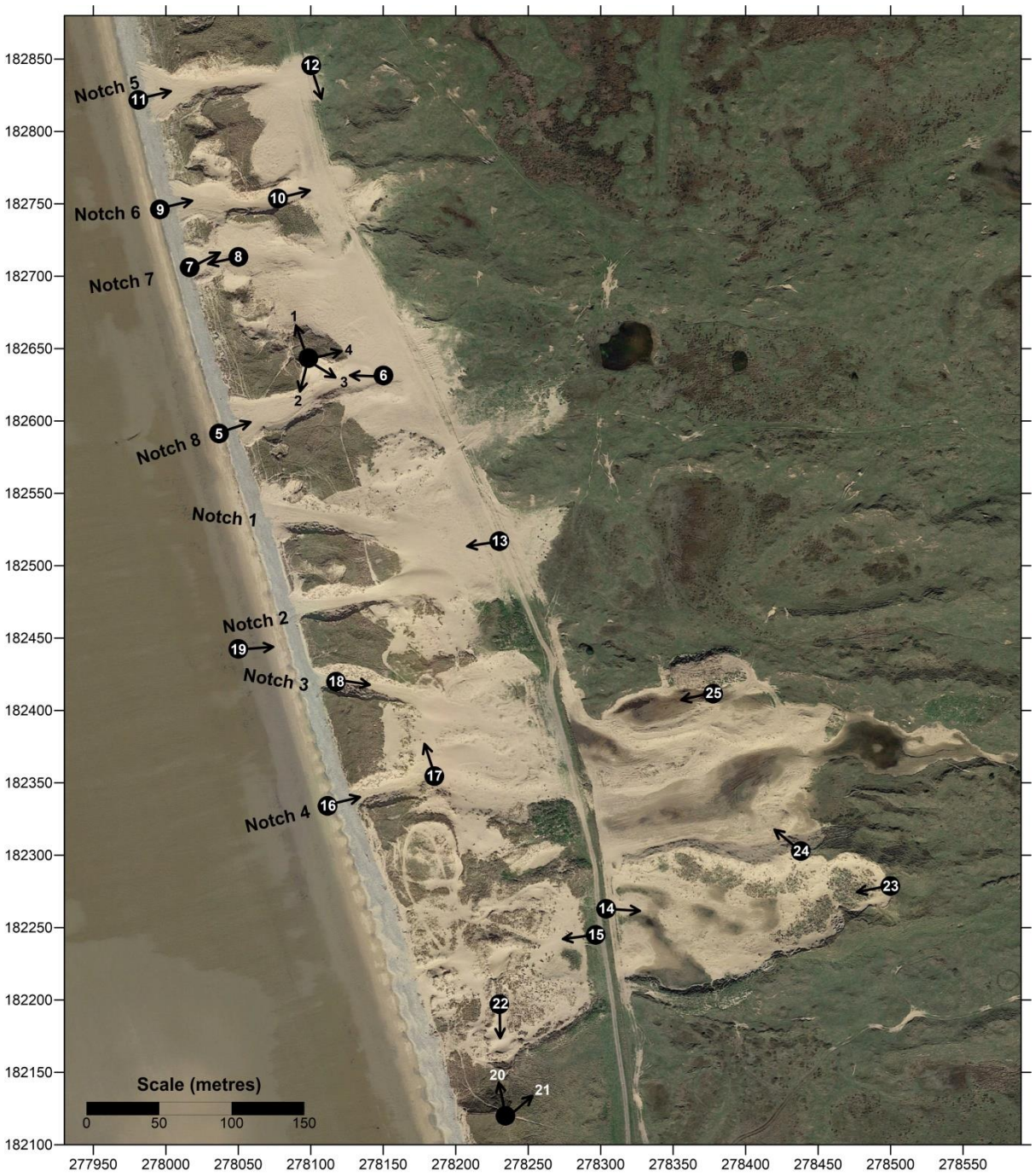


Figure A1. Locations of field photographs 1 to 25. Arrows indicate direction of view; base 2015aerial photography

Photograph 1. Centre of Phase 3 area, Notch 6 in the foreground, looking NW

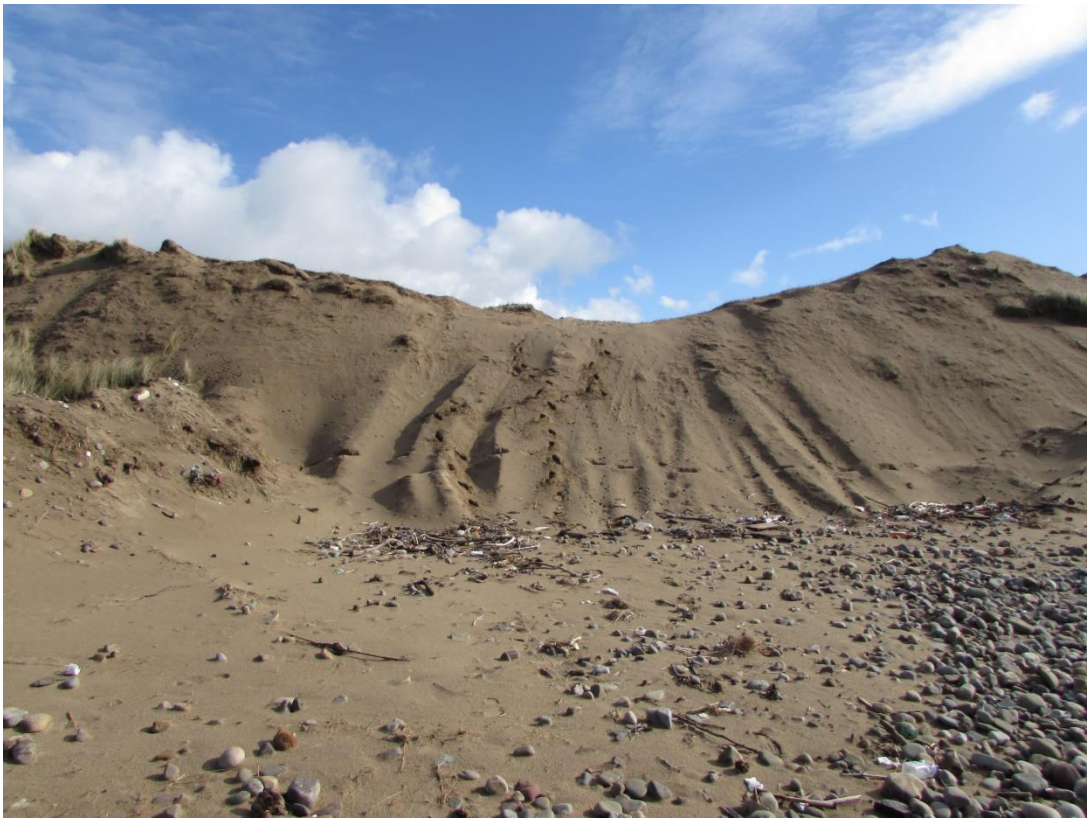
Photograph 2. Centre of Phase 3 area, Notch 7 in the foreground, looking south

Photograph 3. Area behind Notches 7 and 8, with sand lobes at the rear of the notches, looking SE

Photograph 4. Centre of Phase 3 area, looking NE

Photograph 5. The mouth of Notch 8, looking NE

Photograph 6. Sand lobe at the rear of Notch 8, looking SW



Photograph 7. The sand slope at the mouth of Notch 7, looking east

Photograph 8. The sand slope at the mouth of Notch 7, looking west

Photograph 9. The mouth of Notch 6, looking east

Photograph 10. Deflation corridor behind Notch 6, looking east

Photograph 11. Mouth of Notch 5, looking east

Photograph 12. Sand blowing over the haul road and vegetated dunes behind Notch 5, looking south

Photograph 13. Blown sand lobes at the rear of Notches 1 and 2, looking west

Photograph 14. West slack areas with newly vegetated parabolic dune behind in the Phase 1 area, looking east

Photograph 15. Vegetation beginning to regrow at the rear of the Phase 1 site, looking west

Photograph 16. The mouth of Notch 4, and cliffed frontal dune, looking east

Photograph 17. Blown sand lobe behind Notch 4, looking north

Photograph 18. The centre of Notch 3, looking east

Photograph 19. The mouth of Notches 2 and 3, looking SE

Photograph 20. View across the Phase 1 site, looking NW

Photograph 21. View inland across the Phase 1 site, looking east

Photograph 22. Wind scour of the central ridge in the Phase 1 area, looking south

Photograph 23. The head of the parabolic dune at the eastern end of the Phase 1 area, showing areas of vegetation regrowth, looking west

Photograph 24. The inland part of the Phase 2 area, looking NW

Photograph 25. Wet slack in the Phase 2 area, deepened as part of the Phase 3 works, looking west

Data Archive Appendix

Data outputs associated with this project are archived at 'Topographical Survey of Kenfig Dune Restoration Work project 420, media 1534' on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] An Excel file named (Kenfig Burrows Survey Data 3-11 March 2015.xlsx) of data points (x,y,z)

[C] A zip file named (Kenfig March 2015 profiles.zip) containing excel files of profile data contained within the report.

[D] A zip file named (Kenfig March 2015 shapefiles.zip) containing a series of GIS layers on which the maps in the report are based.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue http://libcat.naturalresources.wales/webview/ (English Version) and http://libcat.naturalresources.wales/cnc/ (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no [115776]

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