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Newborough Phase 1 Dune Rejuvenation Works Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 93

Date: May 2013



About Natural Resources Wales

Natural Resources Wales is the organisation responsible for the work carried out by the three former organisations, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. It is also responsible for some functions previously undertaken by Welsh Government.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future.

We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

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Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

This Evidence Report series serves as a record of work carried out or commissioned by Natural Resources Wales. It also helps us to share and promote use of our evidence by others and develop future collaborations. However, the views and recommendations presented in this report are not necessarily those of NRW and should, therefore, not be attributed to NRW.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

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Contents

About Natural Resources Wales..... ii

Evidence at Natural Resources Wales iii

Contents..... v

1. Job Summary 1

2. Error Checking..... 2

3. Monitoring Results..... 3

4. Field Photographs 41

Data Archive Appendix..... 53

1. Job Summary

KPAL Job No: 160513
Report Date: 30/05/2013
Client: Natural Resources Wales
Client Job Title: Newborough Dune Rejuvenation Works – Phase 1

Survey conducted: 16th and 17th May 2013
Instruments used: Leica ATX1230 SmartRover mounted on GLS30 pole (2 m)
Leica GX1230 RTK base station mounted on GST20-9 tripod
Leica RX1250XC and RX1210T Field Controllers
Pacific Crest ADL Vantage radio transceiver (430-470 MHz)

No. of data points: 2737
RTK Control Station: Wooden post surveyed-in using Leica Smartnet GPRS:
Easting: 242096.666 m
Northing: 363312.415 m
Height: 21.475 m OD

Summary report
Compiled by: Simon J. Blott BSc MRes PhD FGS
Checked by: Kenneth Pye ScD PhD MA CGeol FGS
Date: 30 May 2013

2. Error Checking

Table 1. Average quality control for all 2737 data points:

	1-D (height) quality control	2-D (position) quality control
Average	20.5 mm	12.7 mm
StDev	10.6 mm	7.2 mm

Table 2. Measured location of Benchmark 2 (wooden post set in dunes):

	Easting	Northing	Height
Surveyed with Smartnet corrections	242104.105	363335.967	14.099
Surveyed with base & rover (Day 1 start) Error:	242104.123 +18 mm	363335.930 -37 mm	14.086 -13 mm
Surveyed with base & rover (Day 2 start) Error:	242104.139 +34 mm	363335.937 -30 mm	14.095 -4 mm
Surveyed with base & rover (Day 2 end) Error:	242104.079 -26 mm	363335.947 -20 mm	14.099 0 mm
Closing error (start to finish)	-44 mm	+17 mm	13 mm

3. Monitoring Results

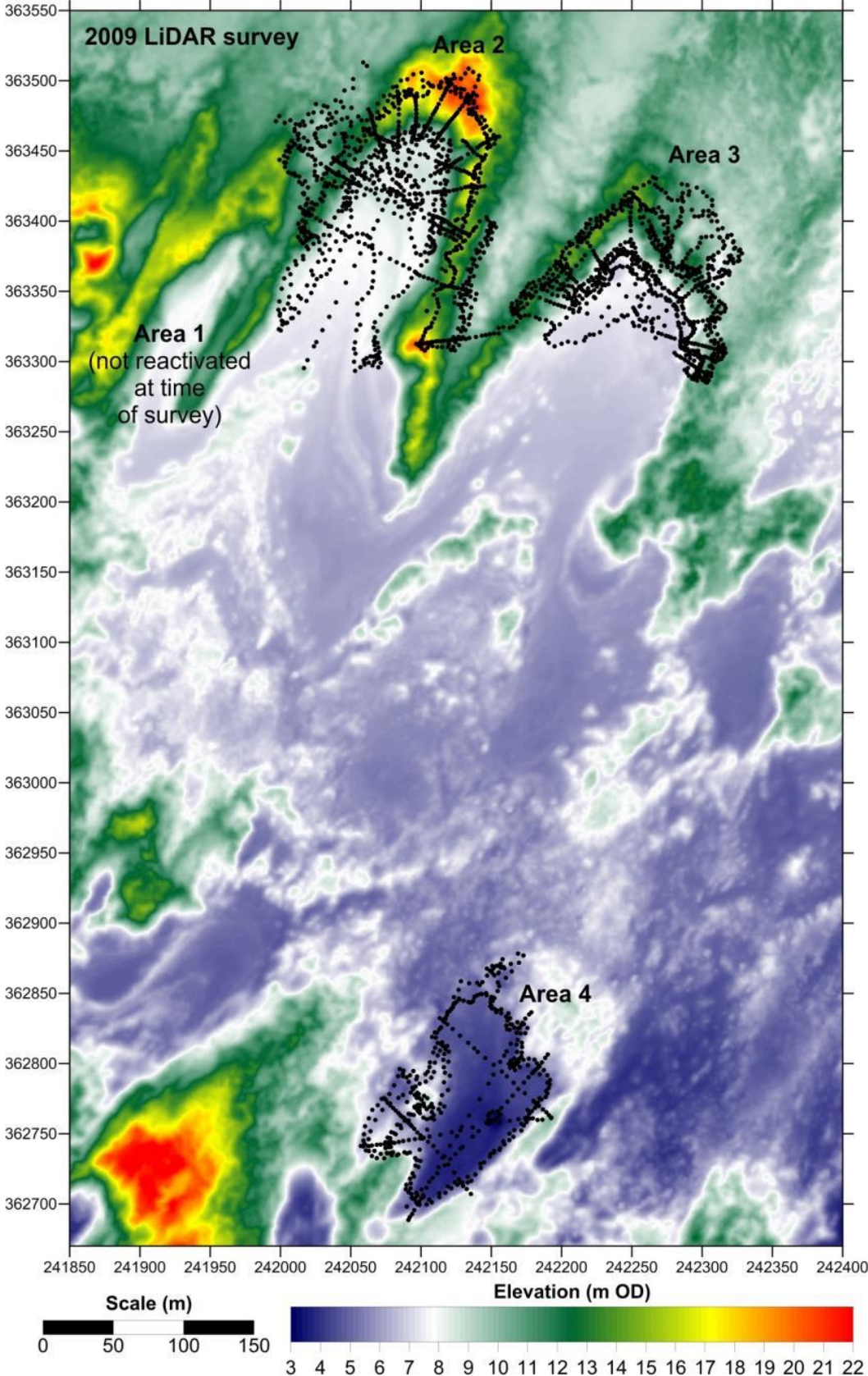


Figure 1. Locations of data points (black dots) overlaid on 2009 LiDAR DEM. The three reactivation sites surveyed (Areas 2, 3 and 4) are indicated.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

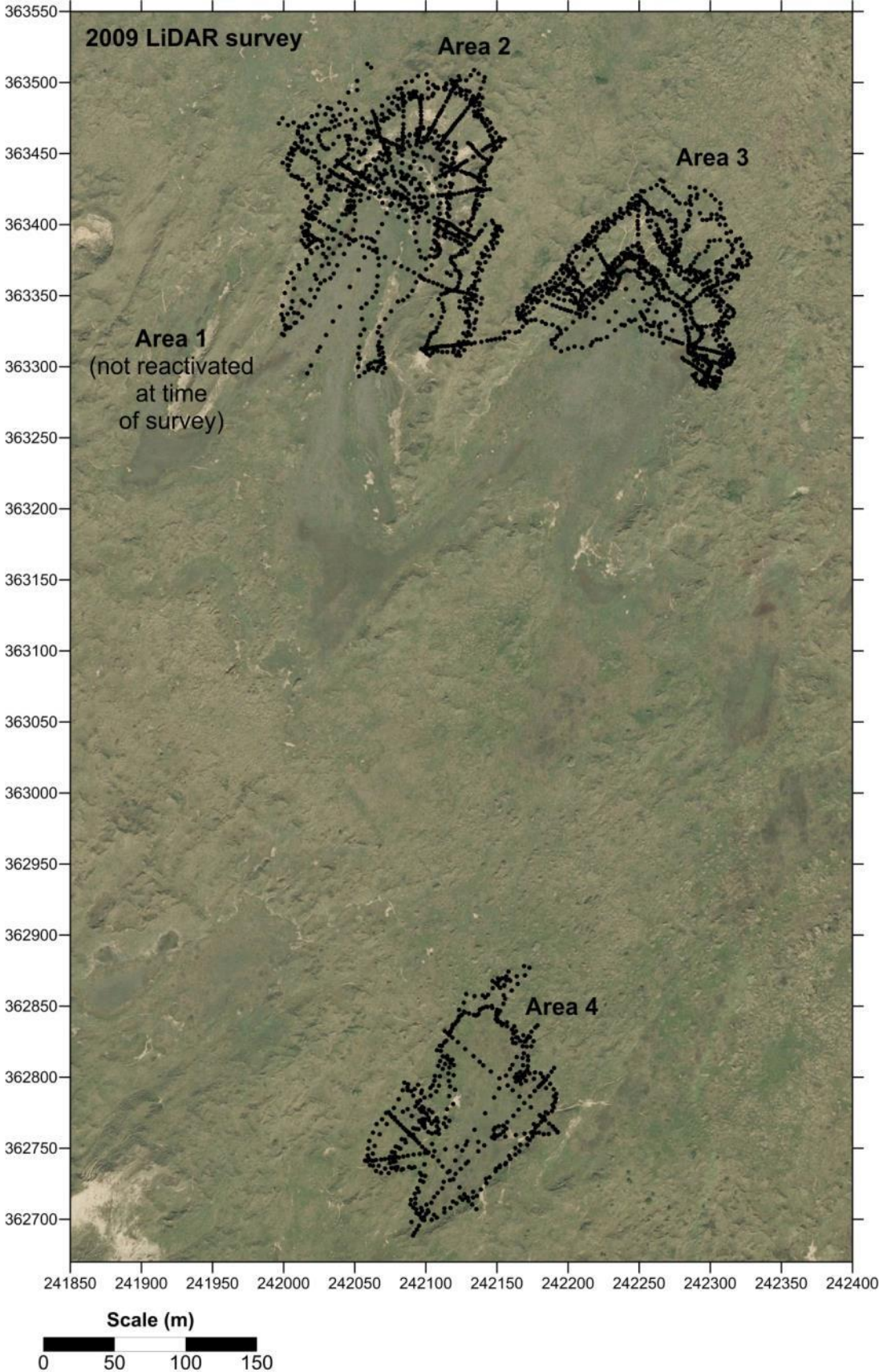


Figure 2. Locations of data points (black dots) overlaid on 2009 air photographs. The three reactivation sites surveyed (Areas 2, 3 and 4) are indicated.

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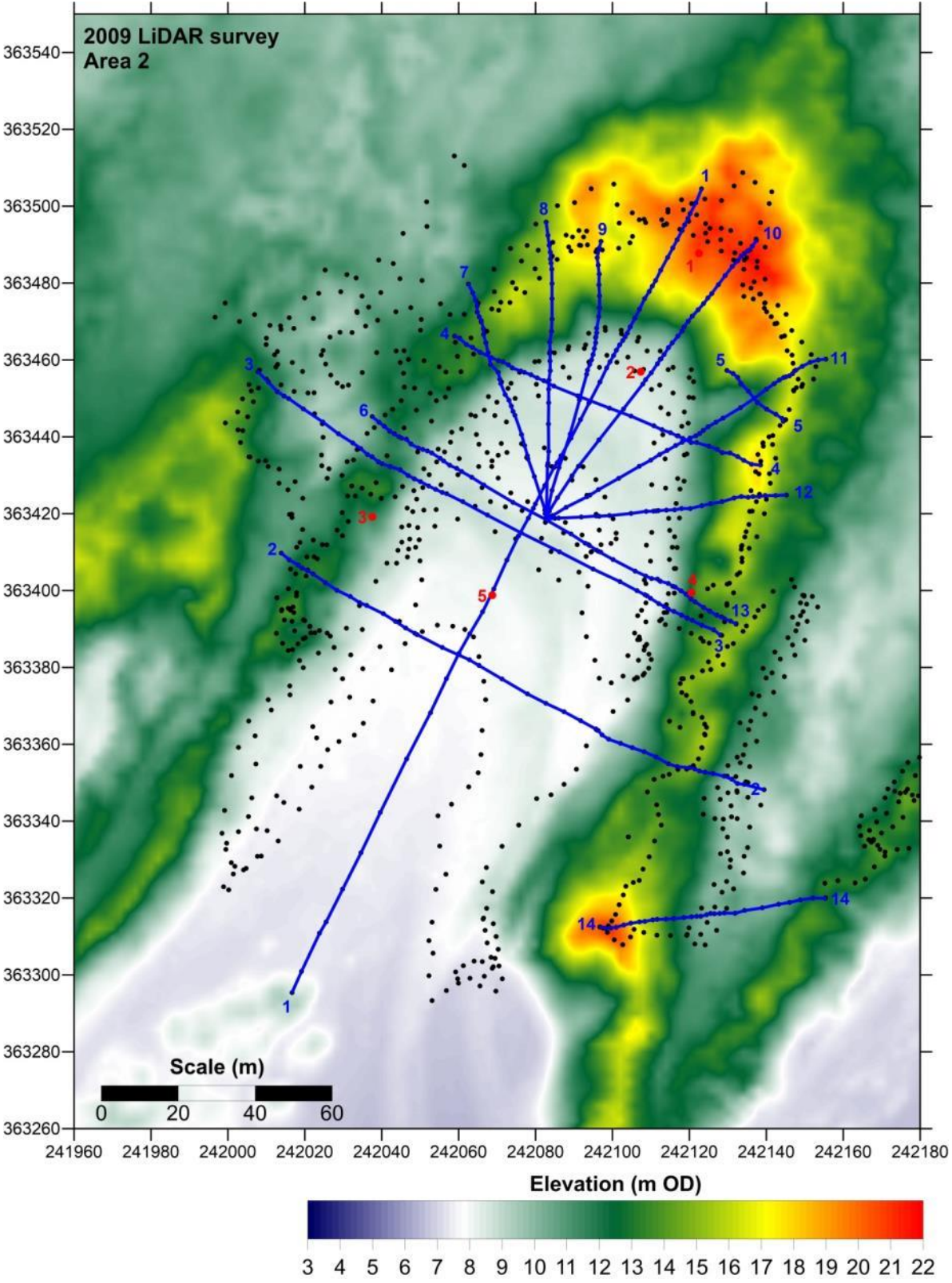


Figure 3. Locations of data points (black dots), sediment samples (red dots) and cross-profiles (blue lines), overlaid on 2009 LiDAR DEM, in Area 2

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

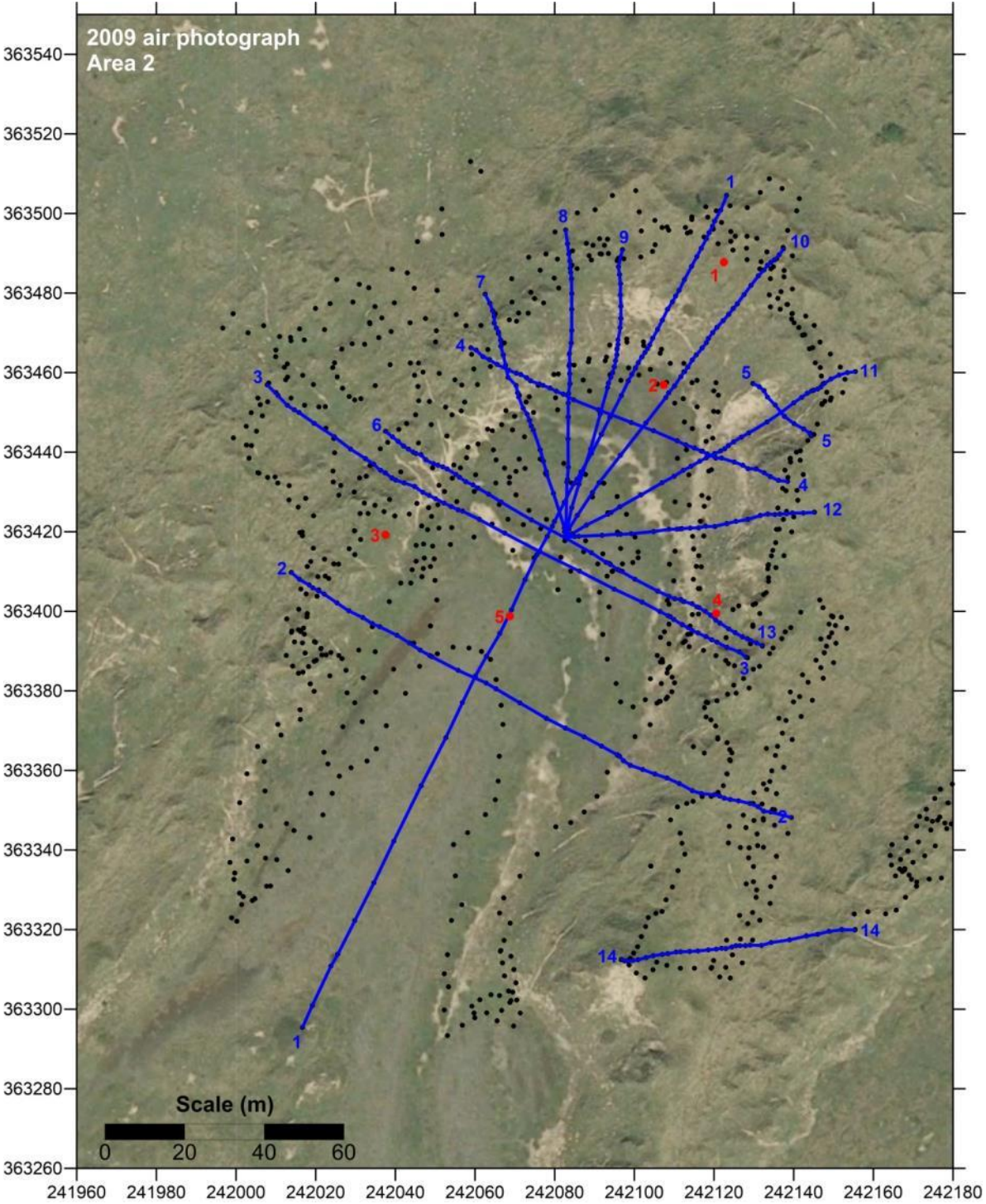


Figure 4. Locations of data points (black dots), sediment samples (red dots) and cross-profiles (blue lines), overlaid on 2009 air photographs, in Area 2

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

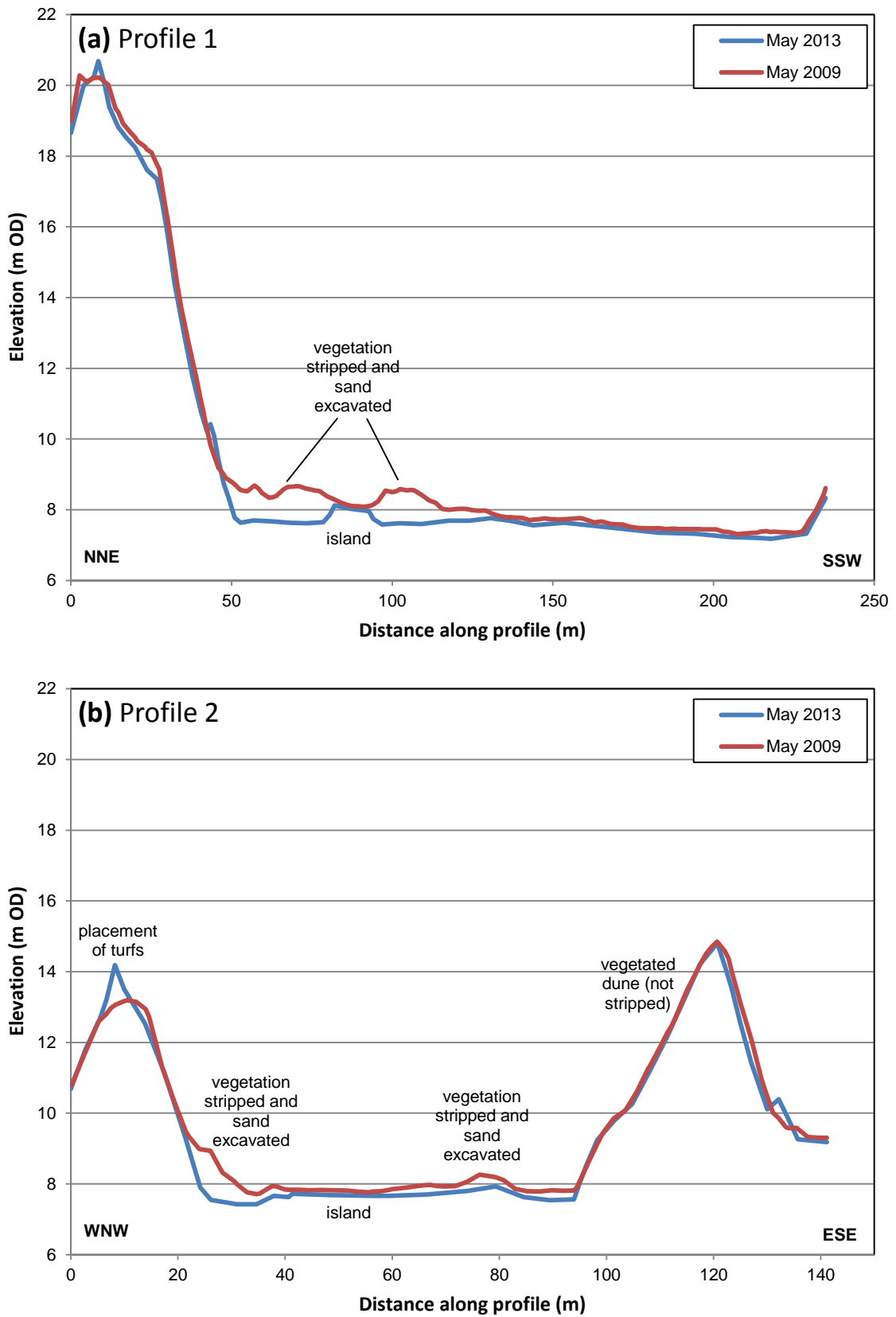


Figure 5. Cross-profiles at Area 2, at the locations indicated in Figure 3, measured from the ground survey on 16 and 17 May 2013, and LiDAR aerial survey in May 2009. Note that the horizontal and linear scales vary considerably.

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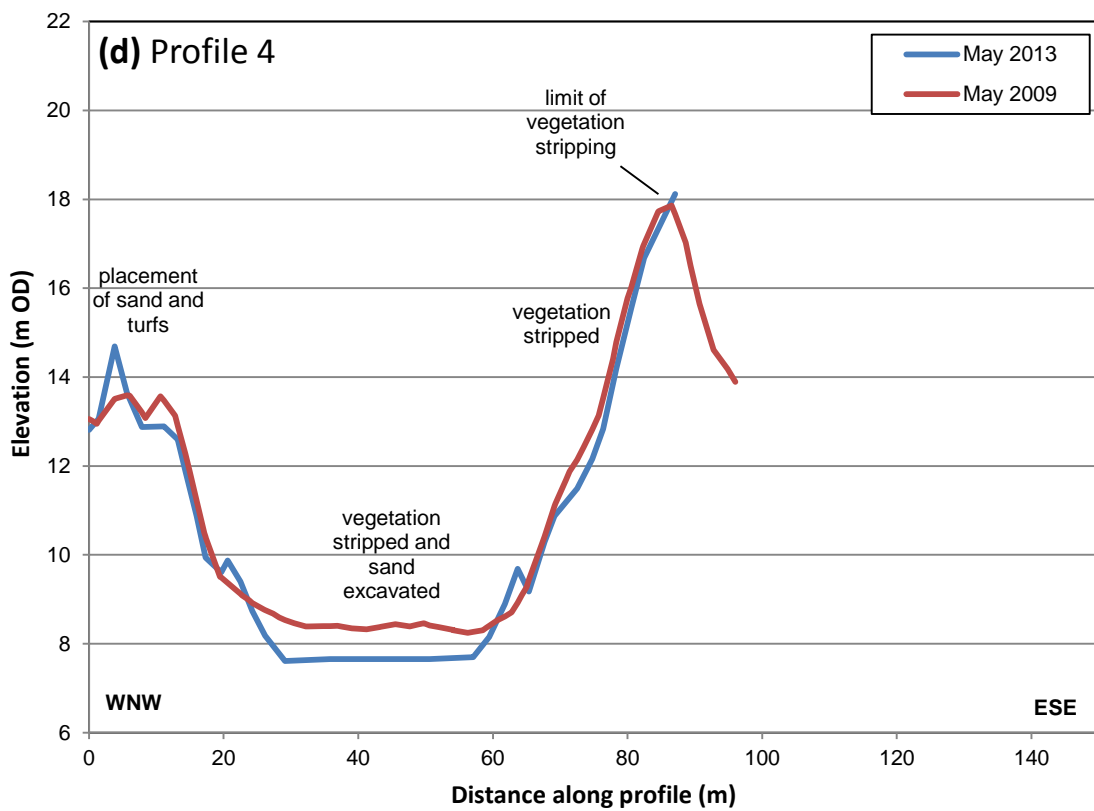
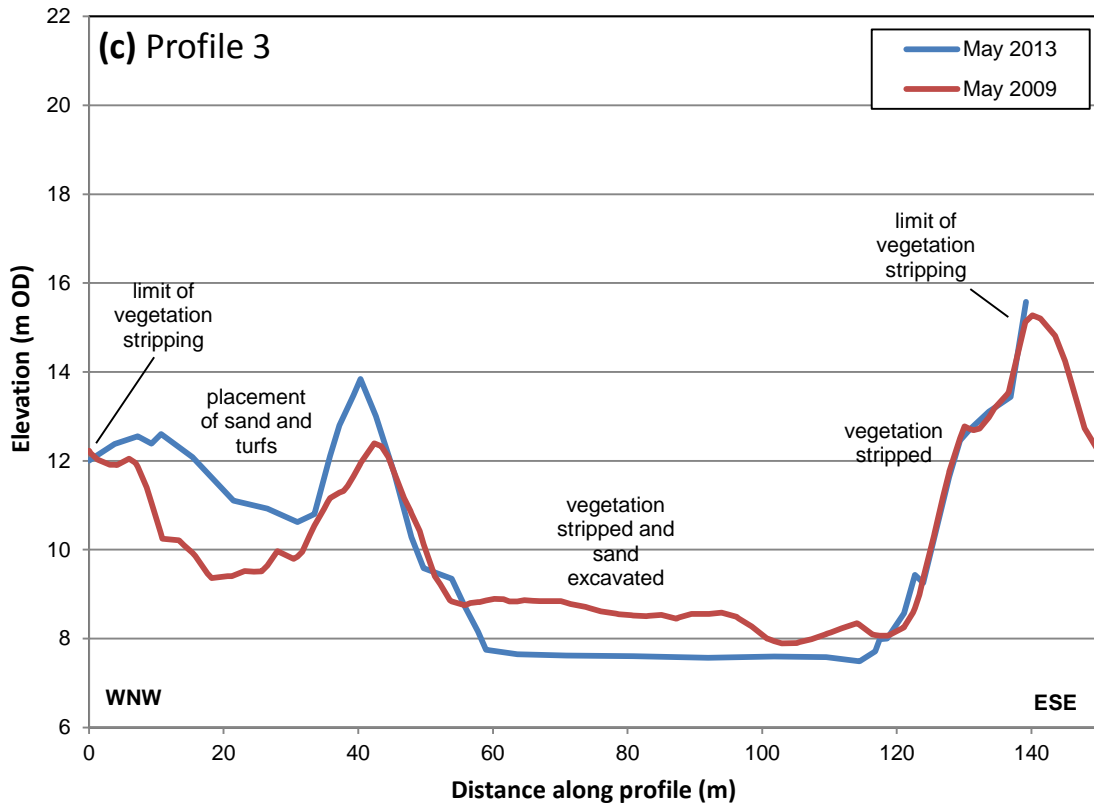


Figure 5. continued.

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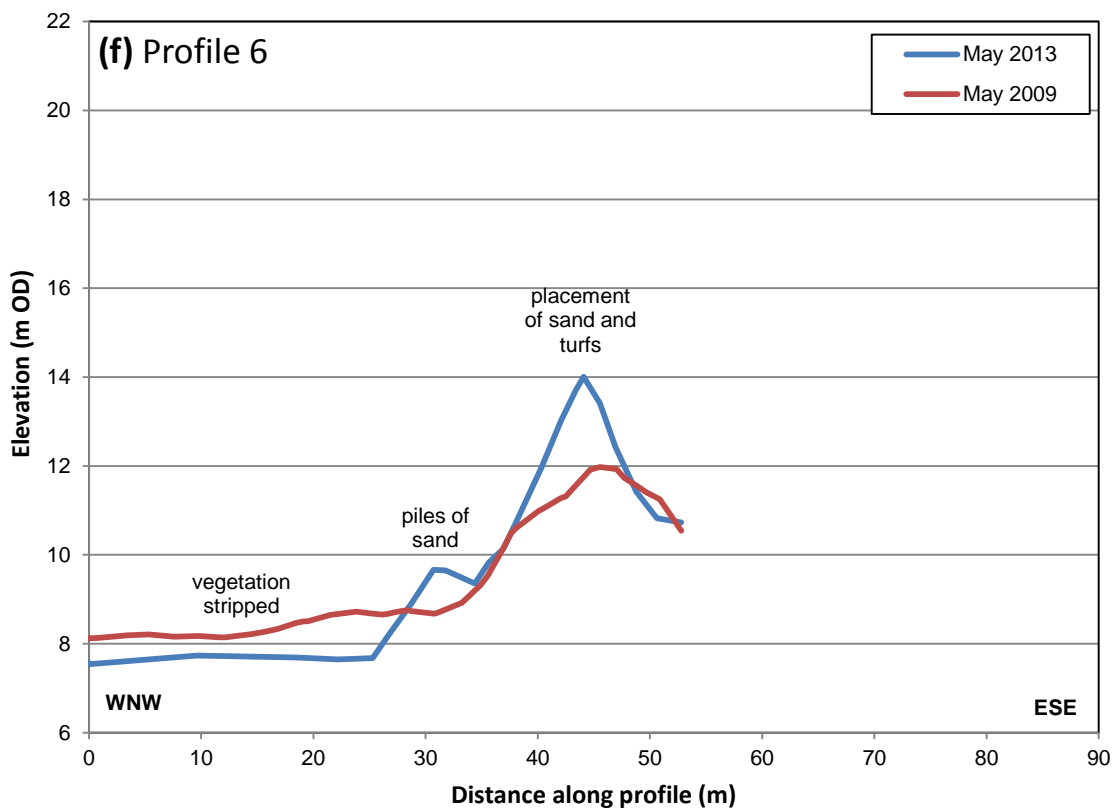
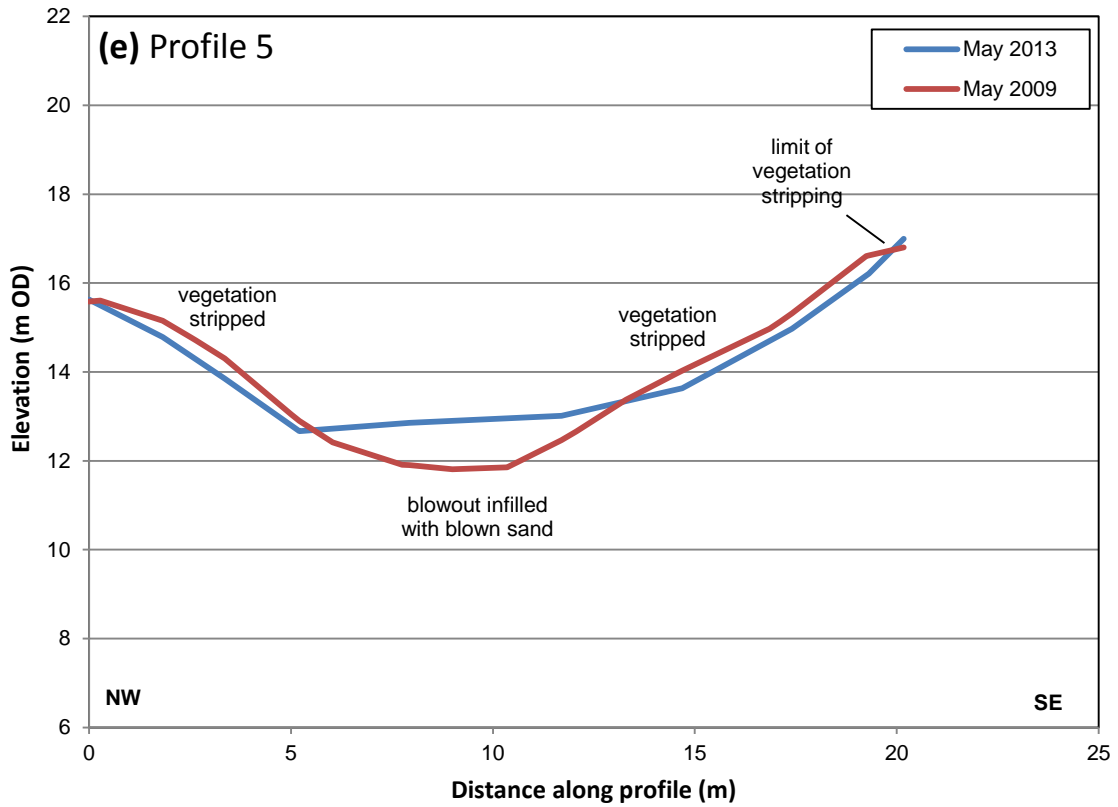


Figure 5. continued.

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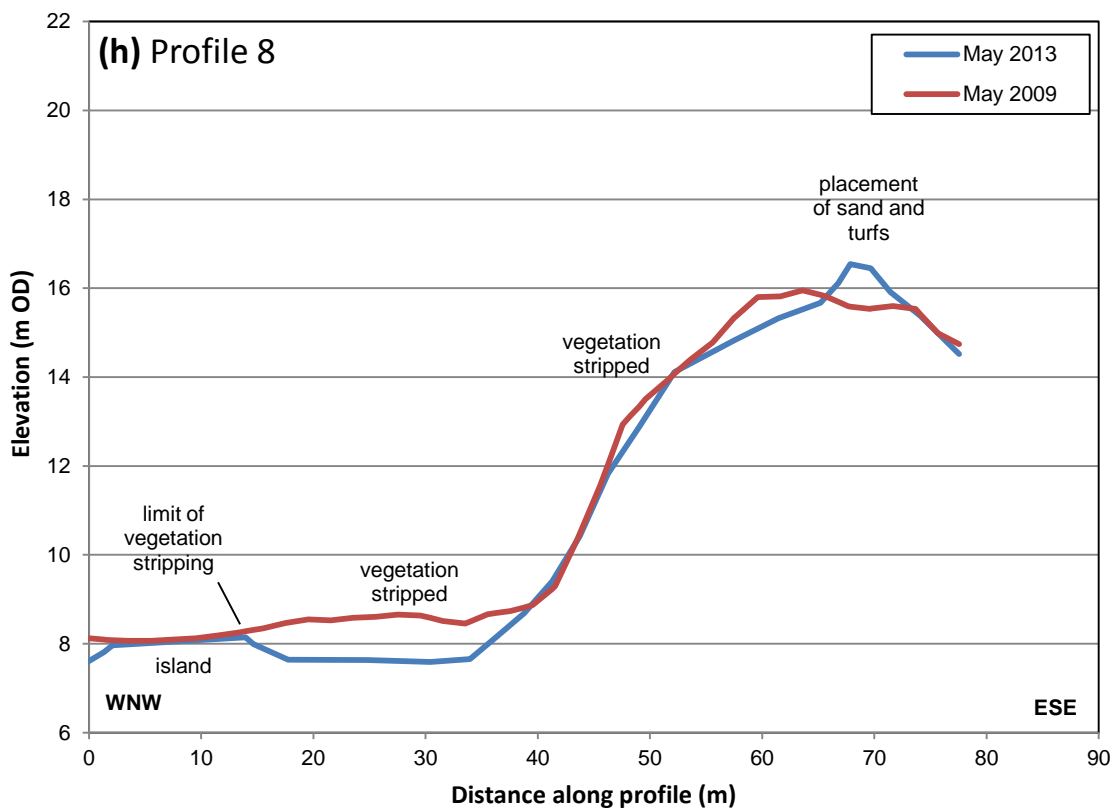
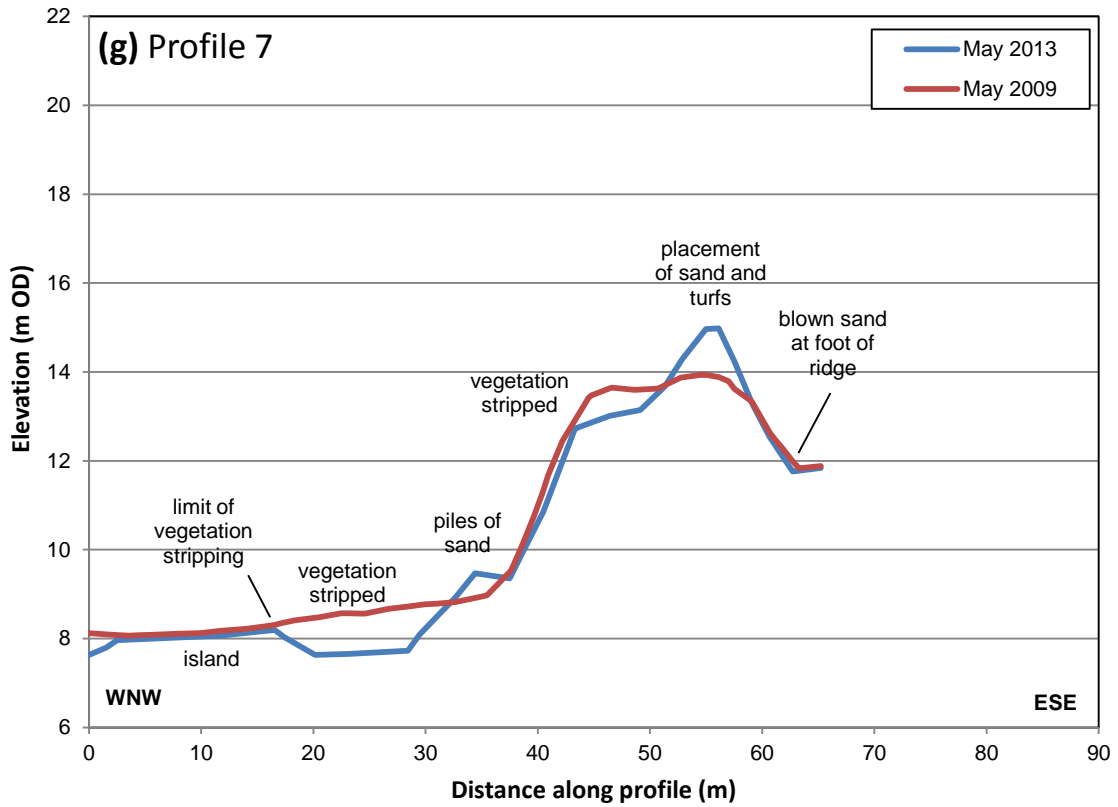


Figure 5. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

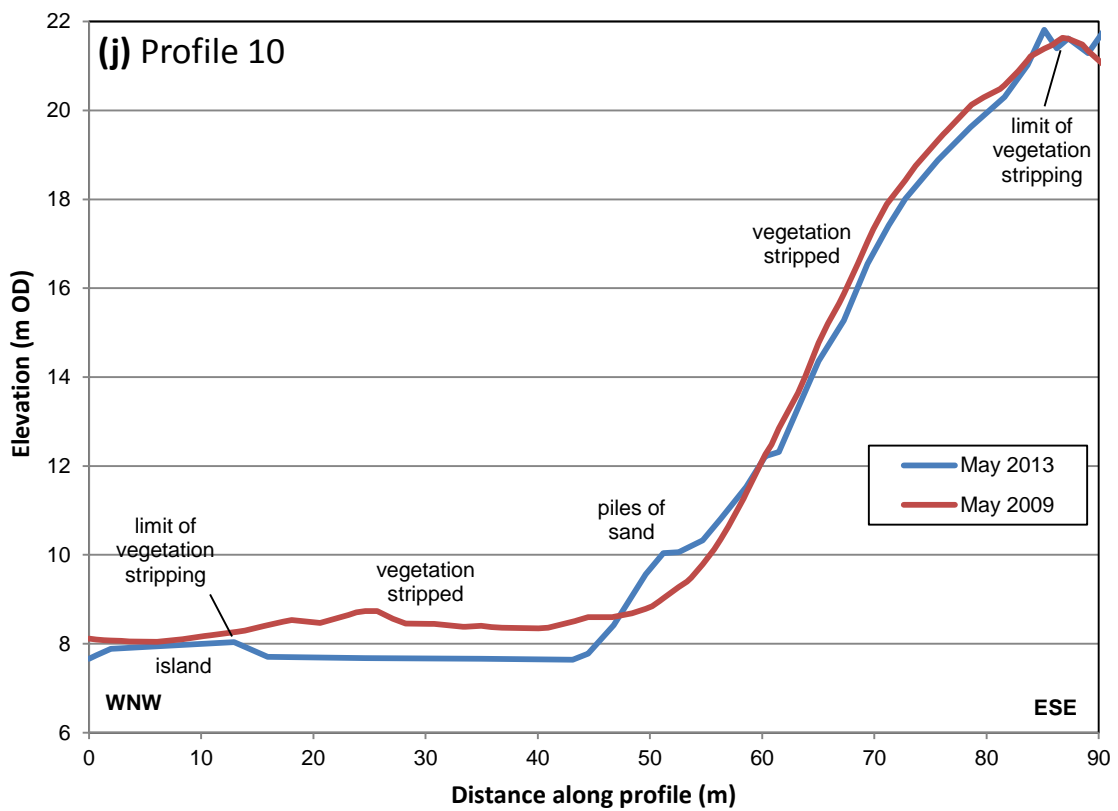
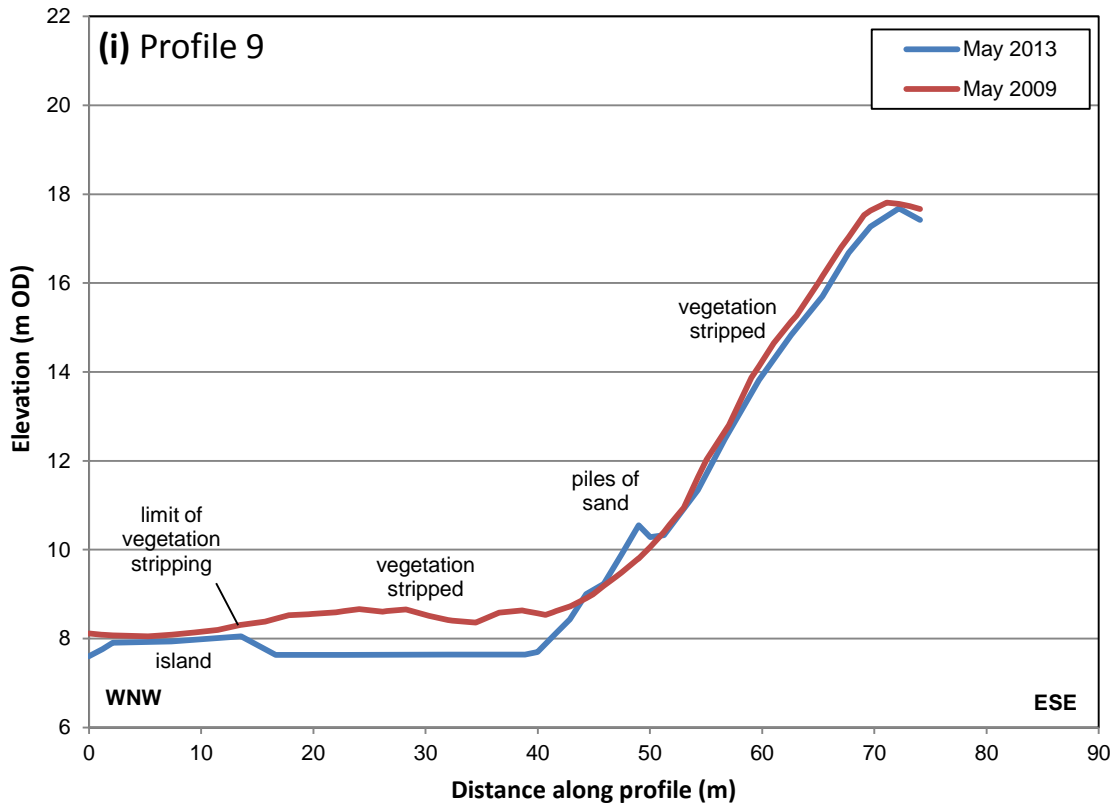


Figure 5. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

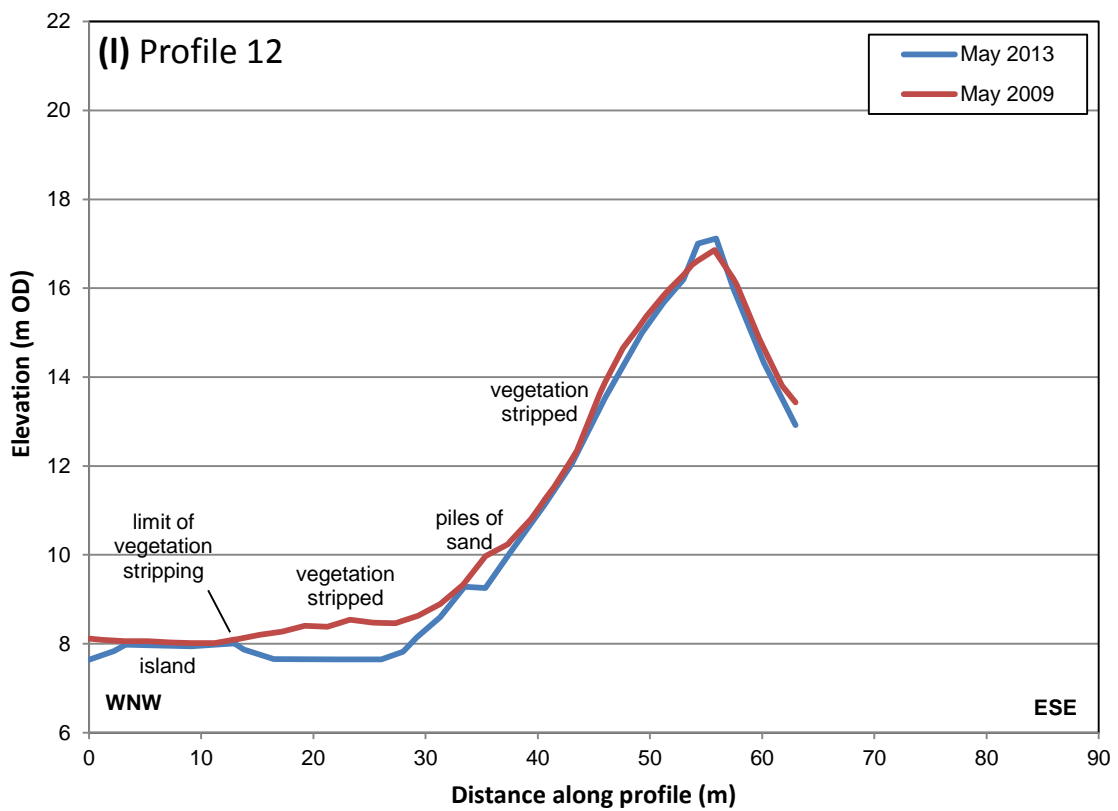
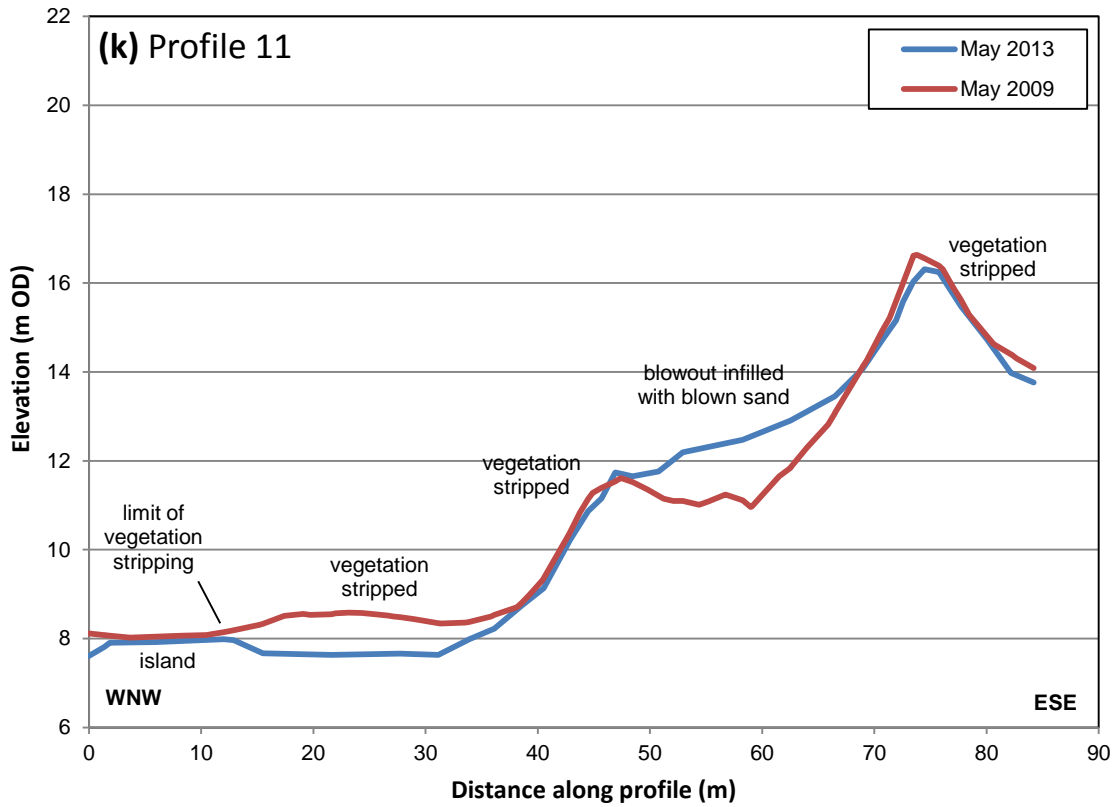


Figure 5. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

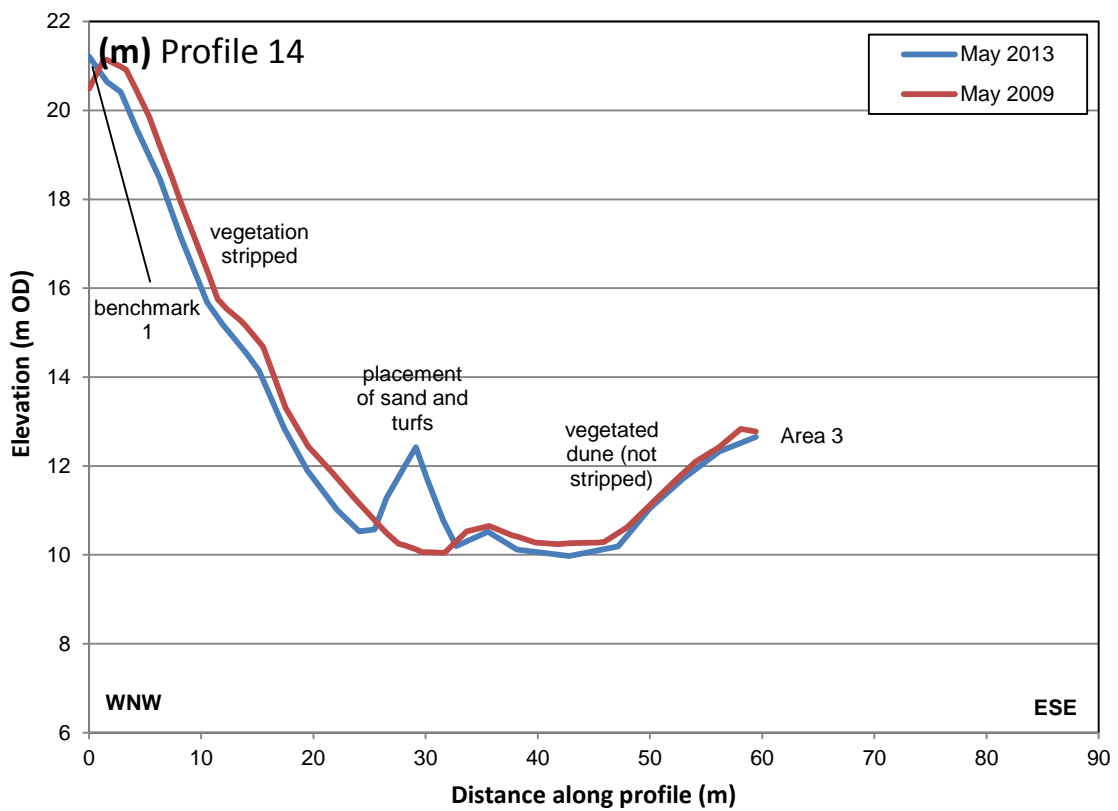
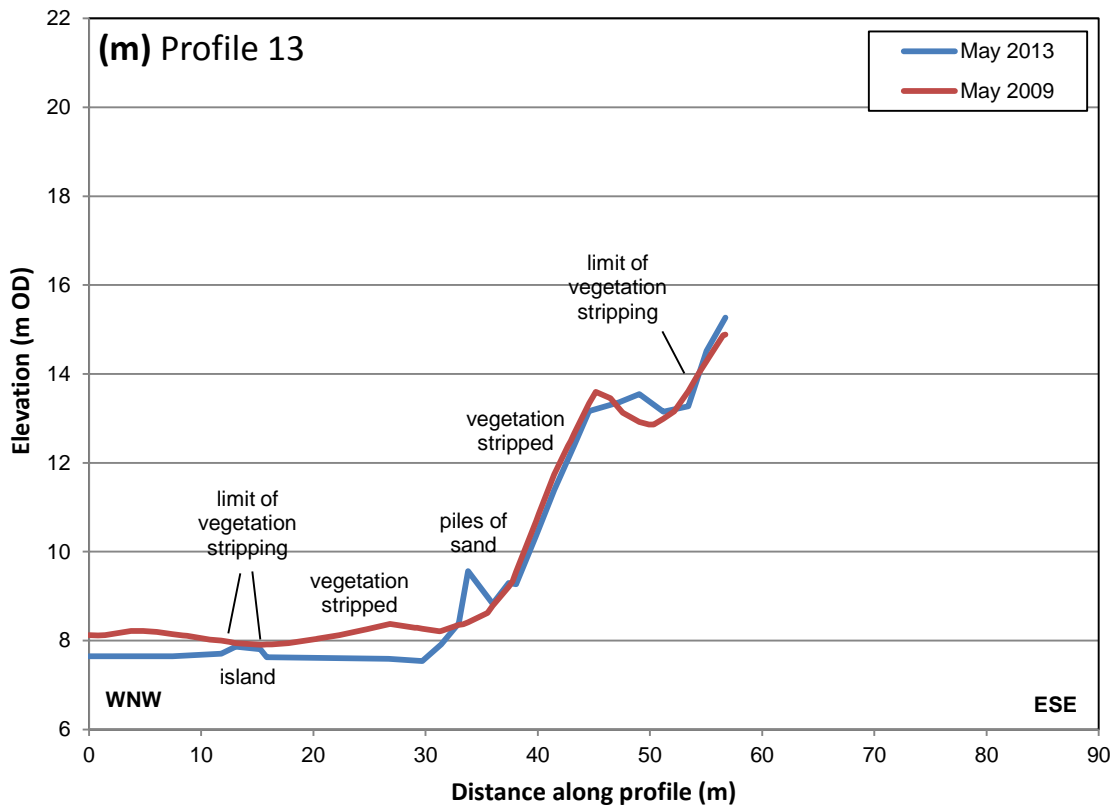


Figure 5. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

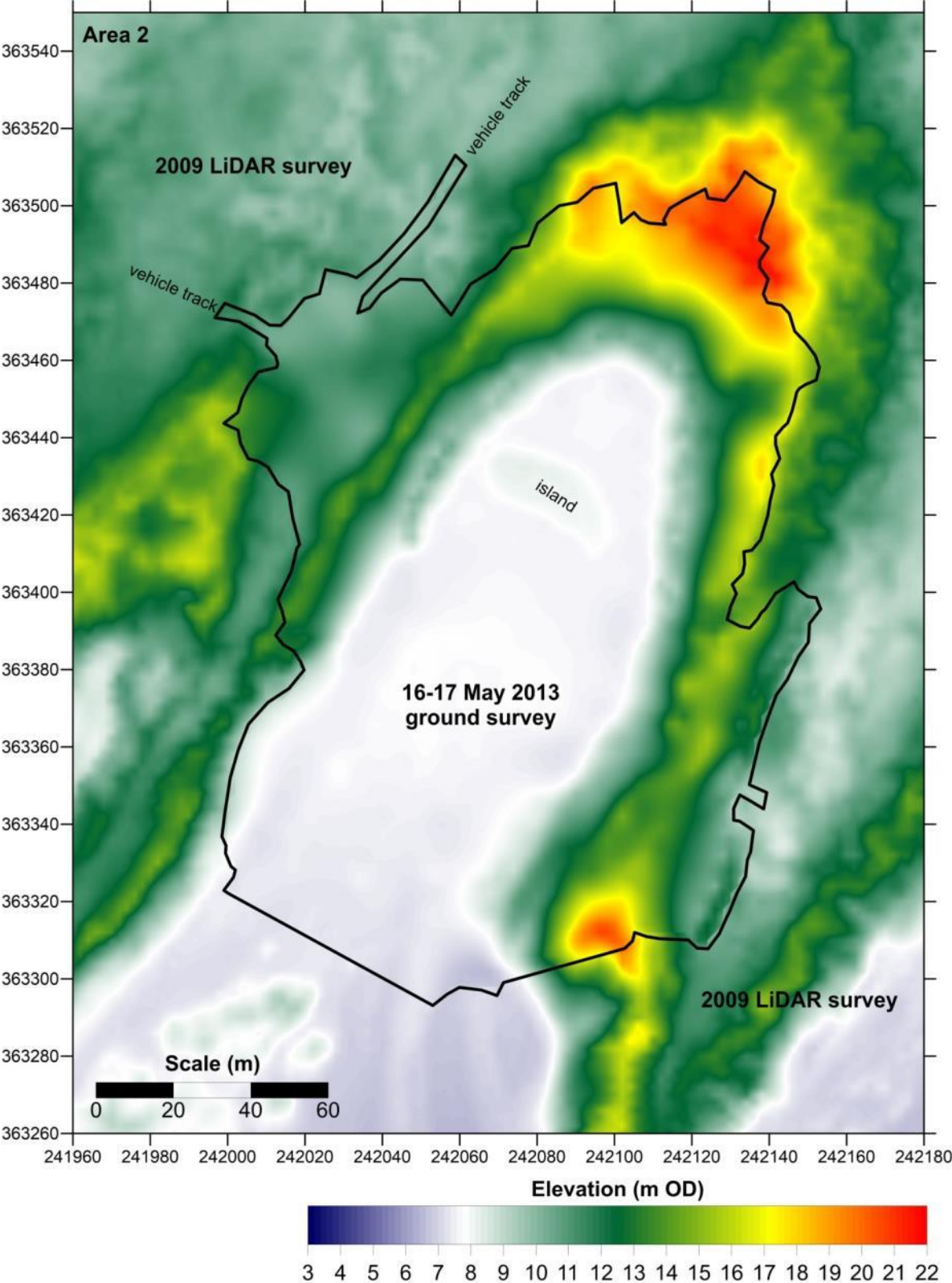


Figure 6. Digital elevation model of the Area 2 restoration works site surveyed on 16-17 May 2013, with the black line indicating the limit of the survey. The areas outside the black line are taken from the LiDAR survey flown in May 2009.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

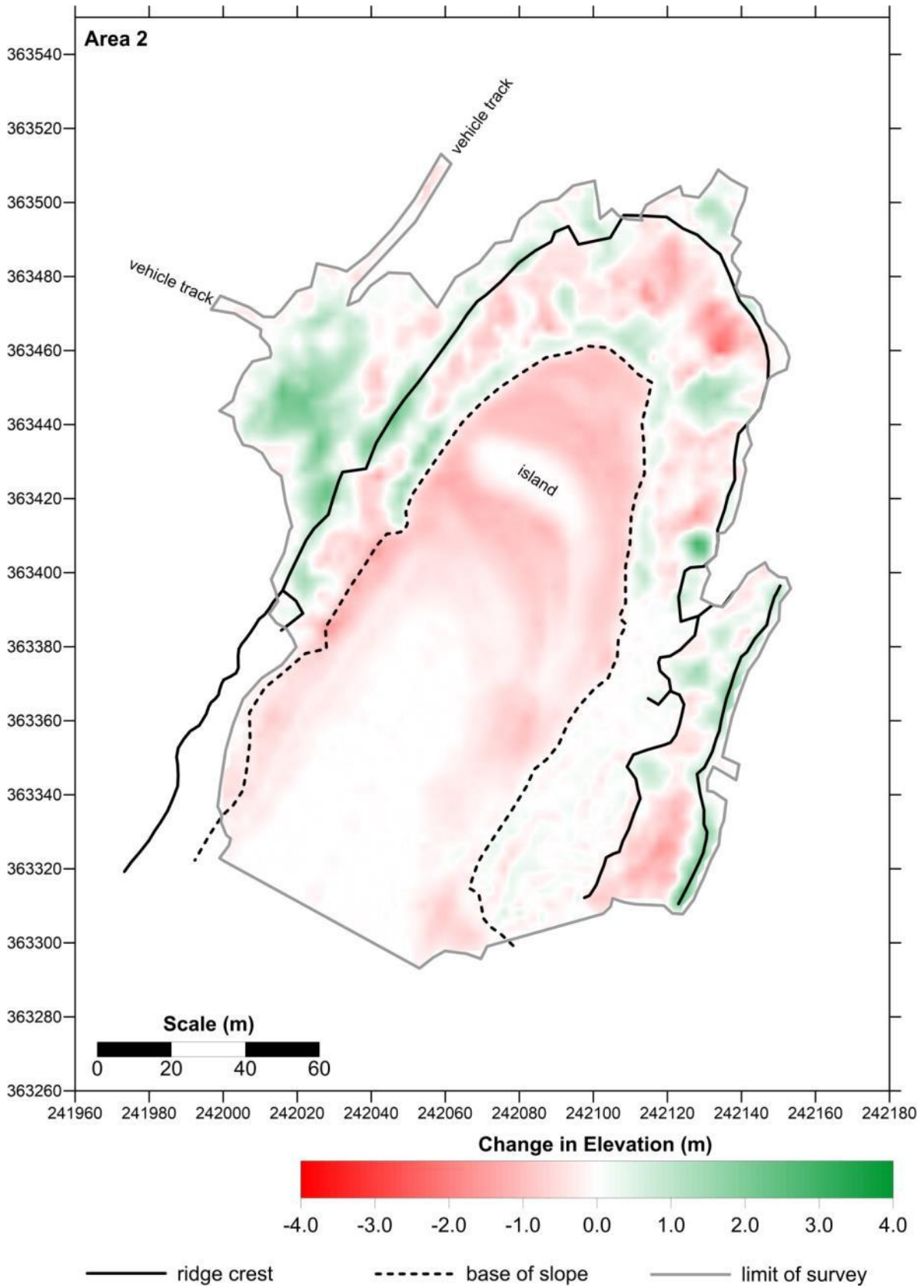


Figure 7. Change in elevation between the LiDAR survey flown in May 2009, and the ground survey of the restoration works site on 16-17 May 2013, in Area 2.

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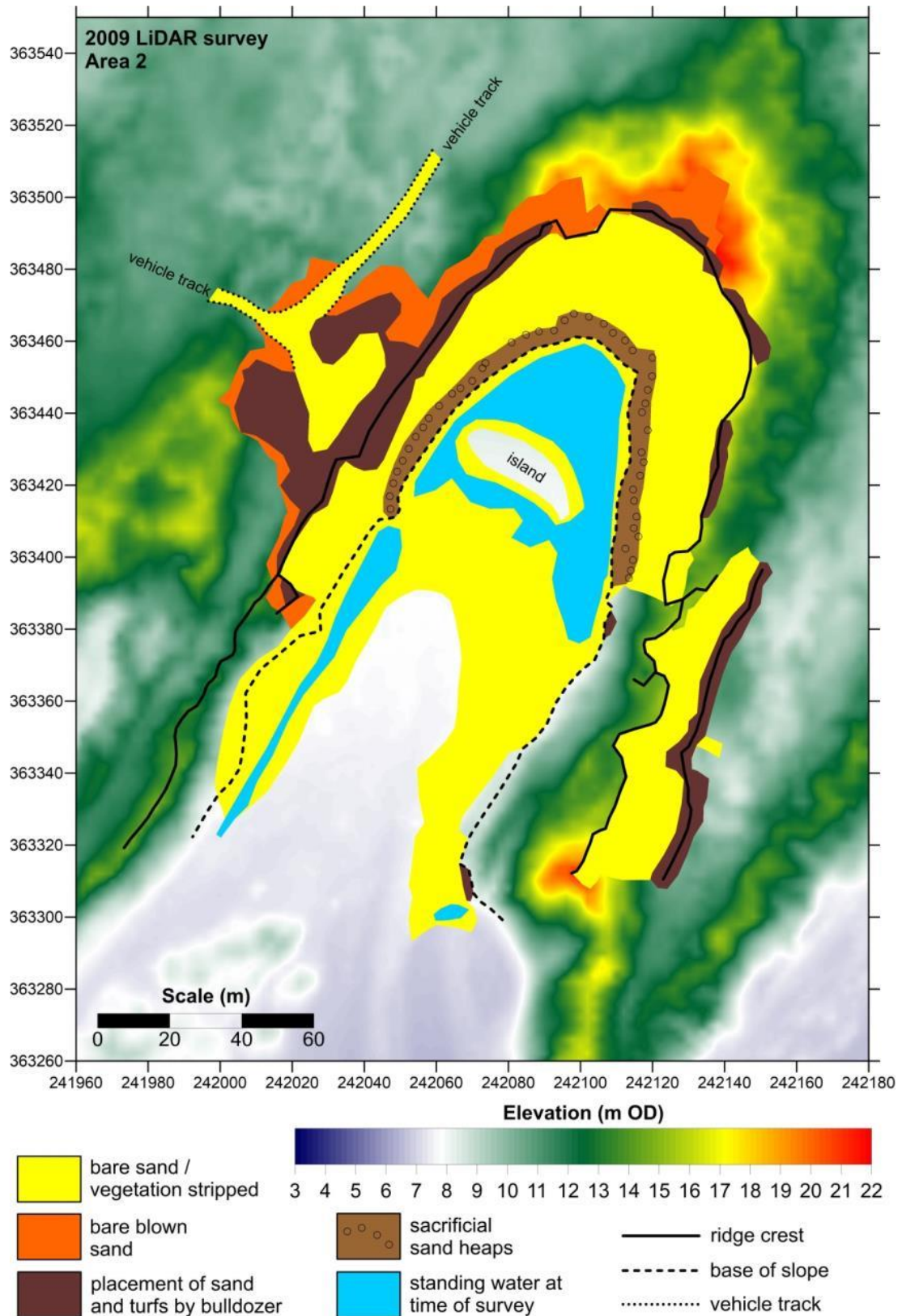


Figure 8. Features mapped in the field, overlaid on LiDAR DEM flown in May 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

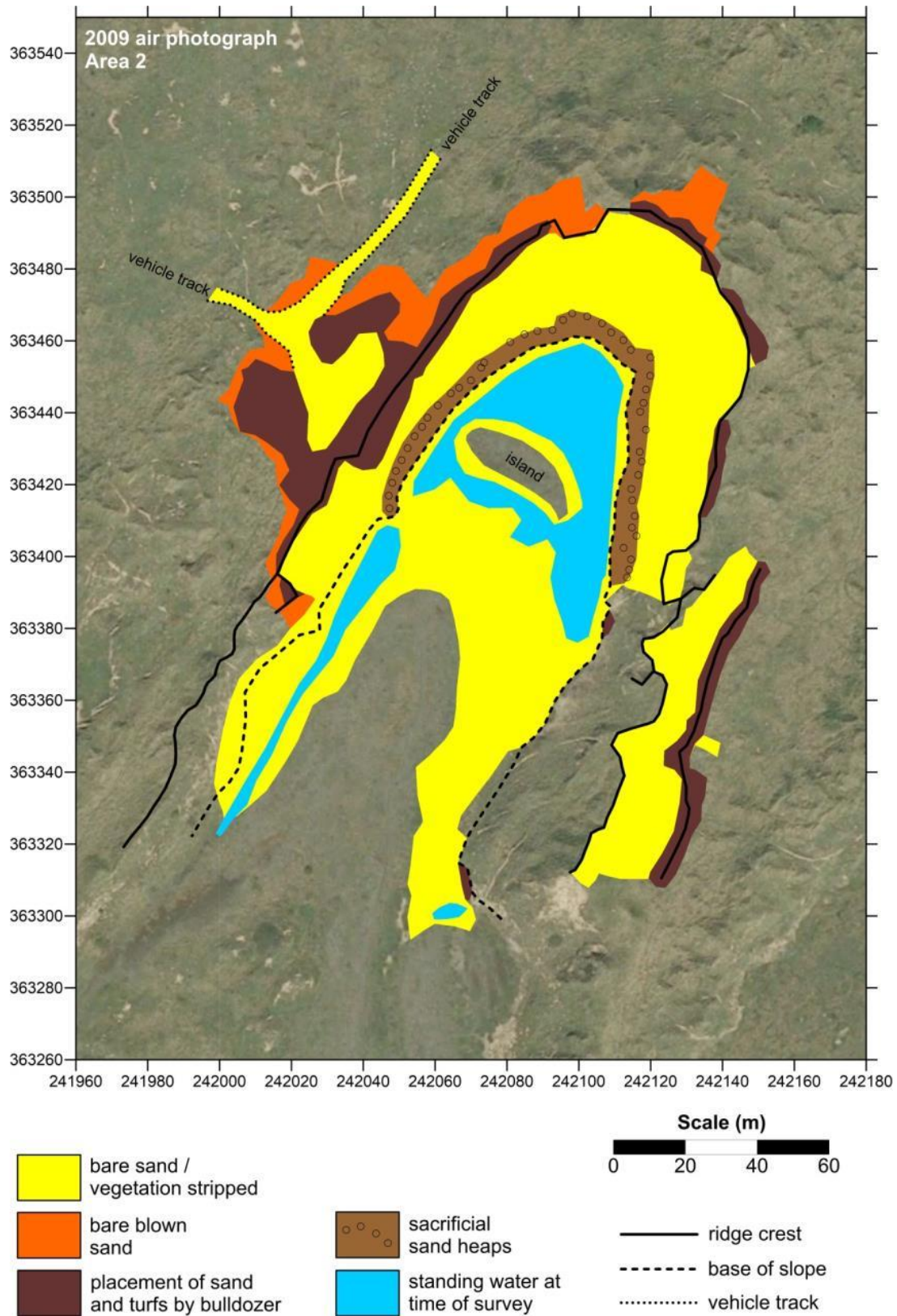


Figure 9. Features mapped in the field, overlaid on air photographs flown in Sep 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

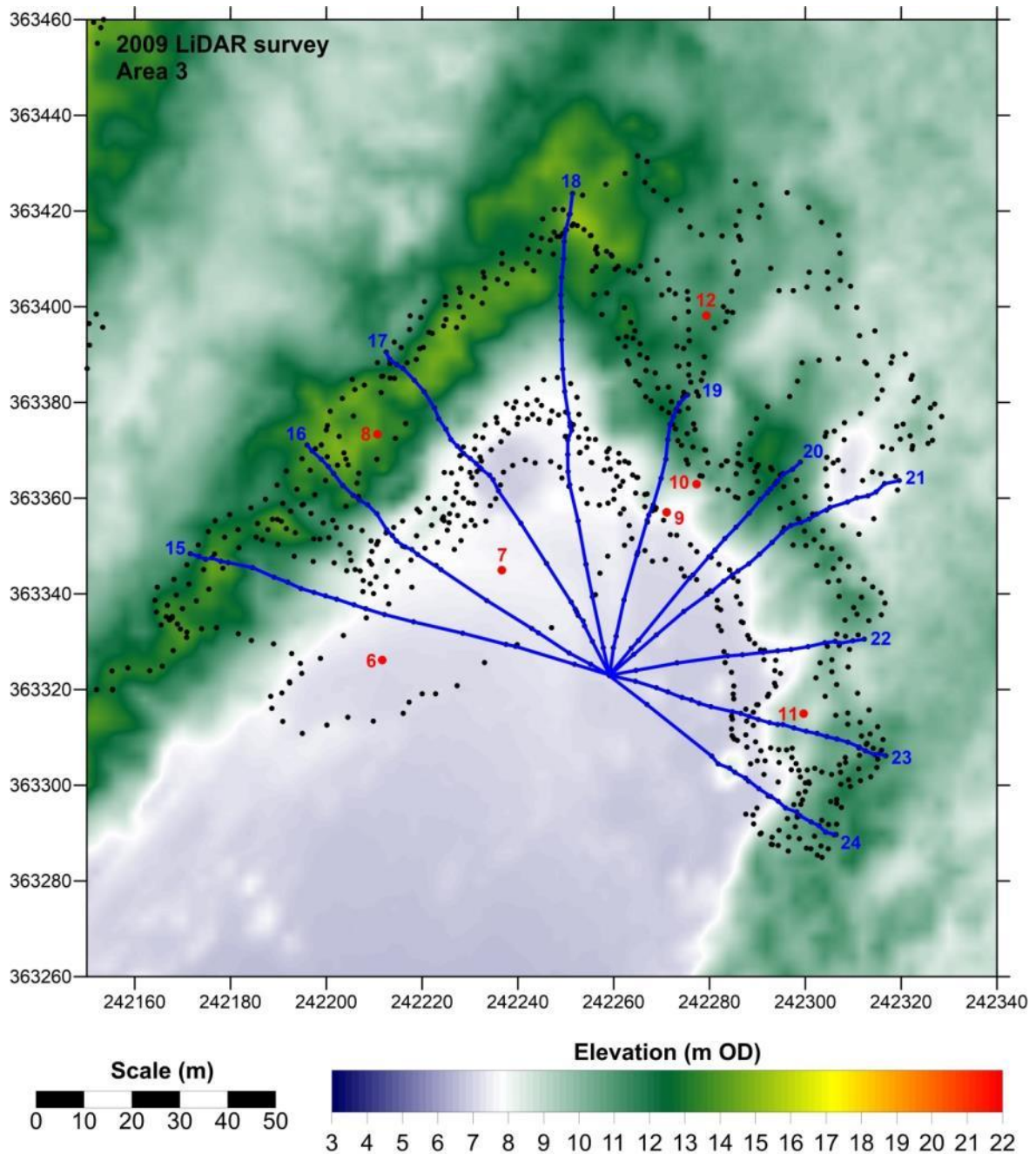


Figure 10. Locations of data points (black dots), sediment samples (red dots) and cross-profiles (blue lines), overlaid on 2009 LiDAR DEM, in Area 3

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

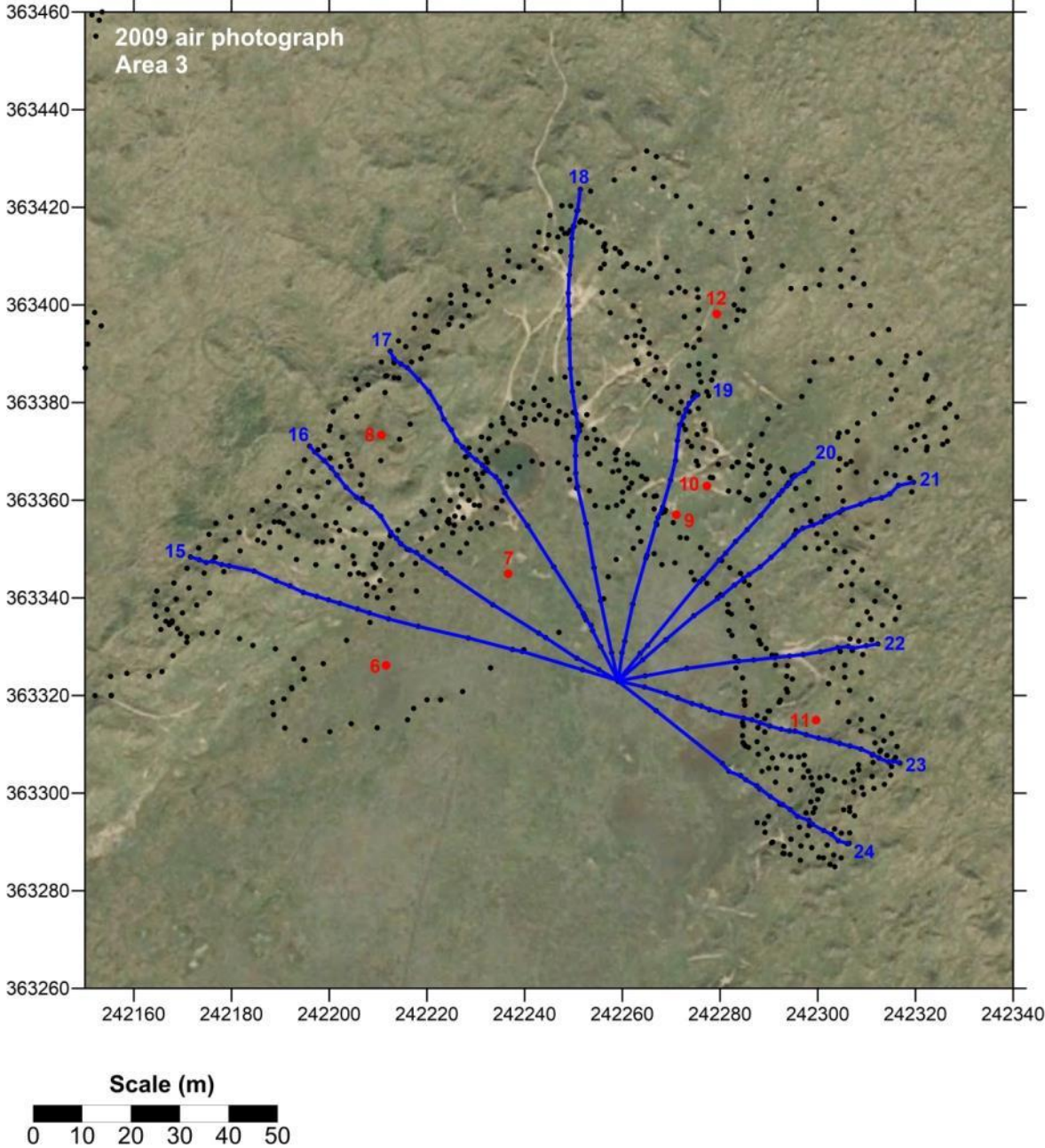


Figure 11. Locations of data points (black dots), sediment samples (red dots) and cross-profiles (blue lines), overlaid on 2009 air photographs, in Area 3

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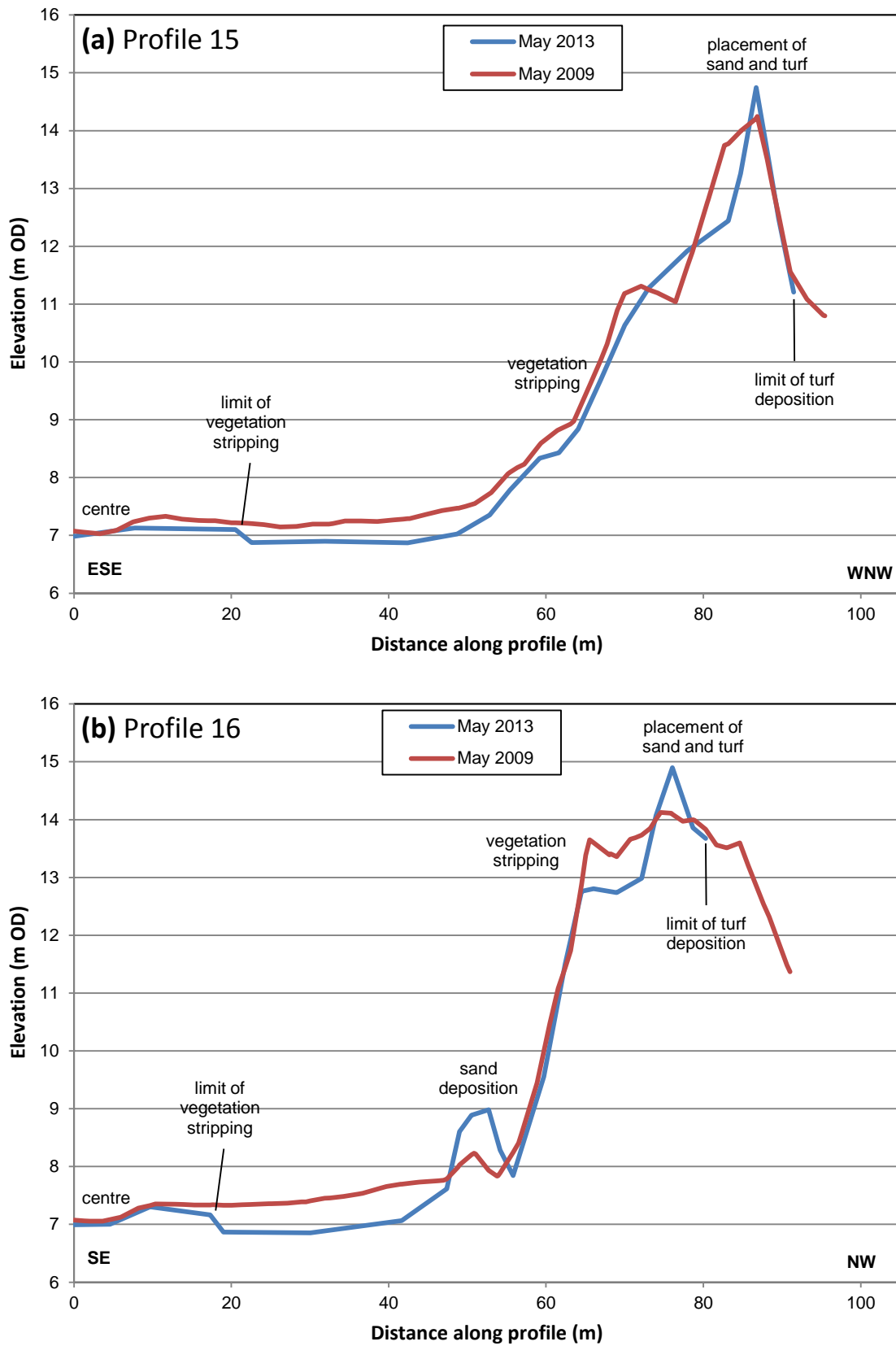


Figure 12. Cross-profiles at Area 3, at the locations indicated in Figure 8, measured from the ground survey on 16 and 17 May 2013, and LiDAR aerial survey in May 2009.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

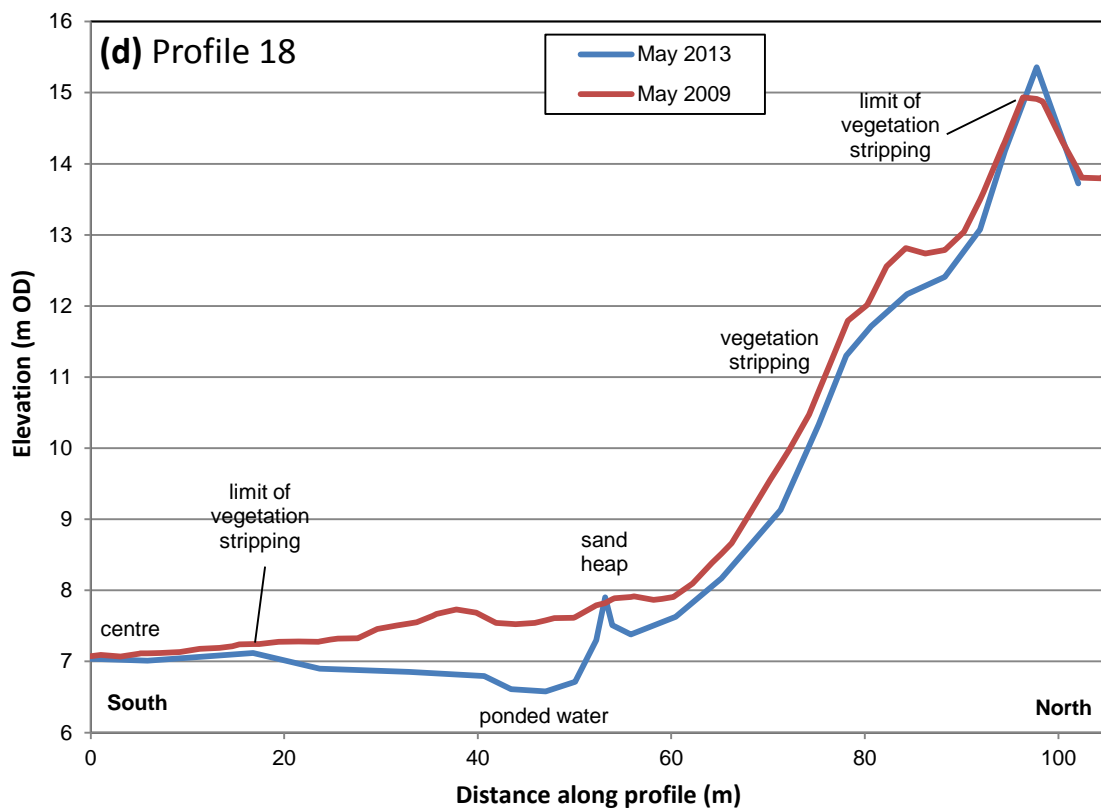
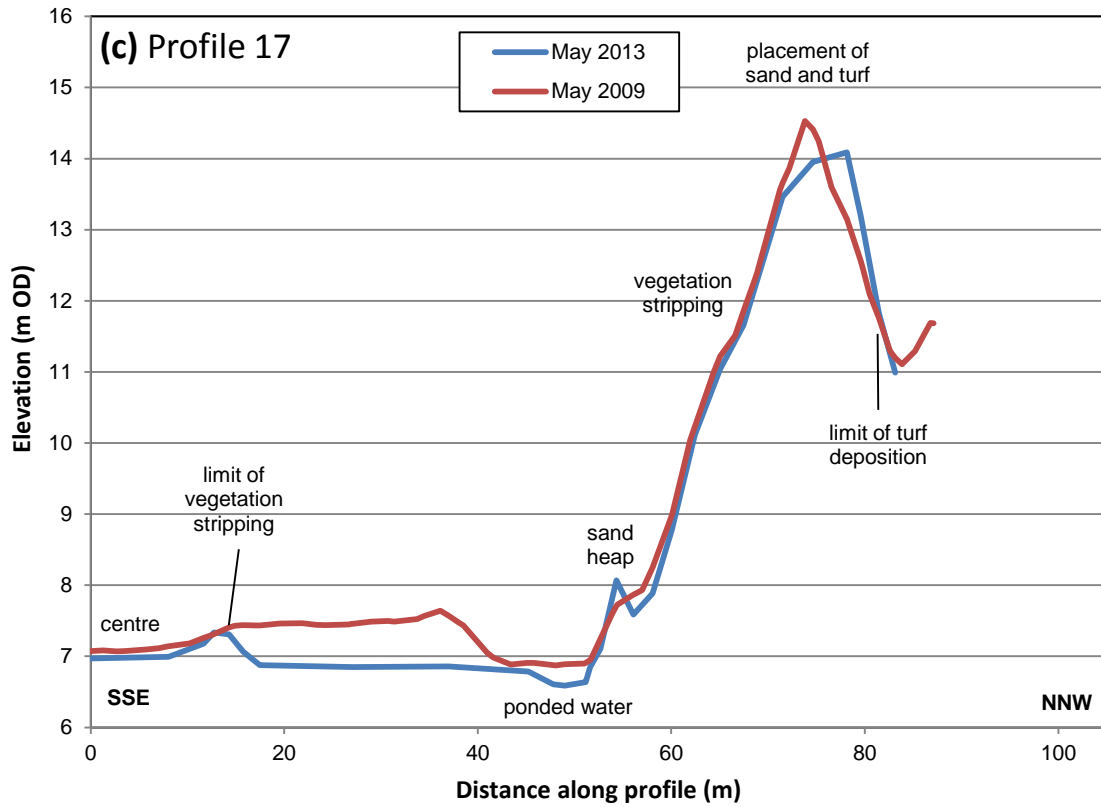


Figure 12. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

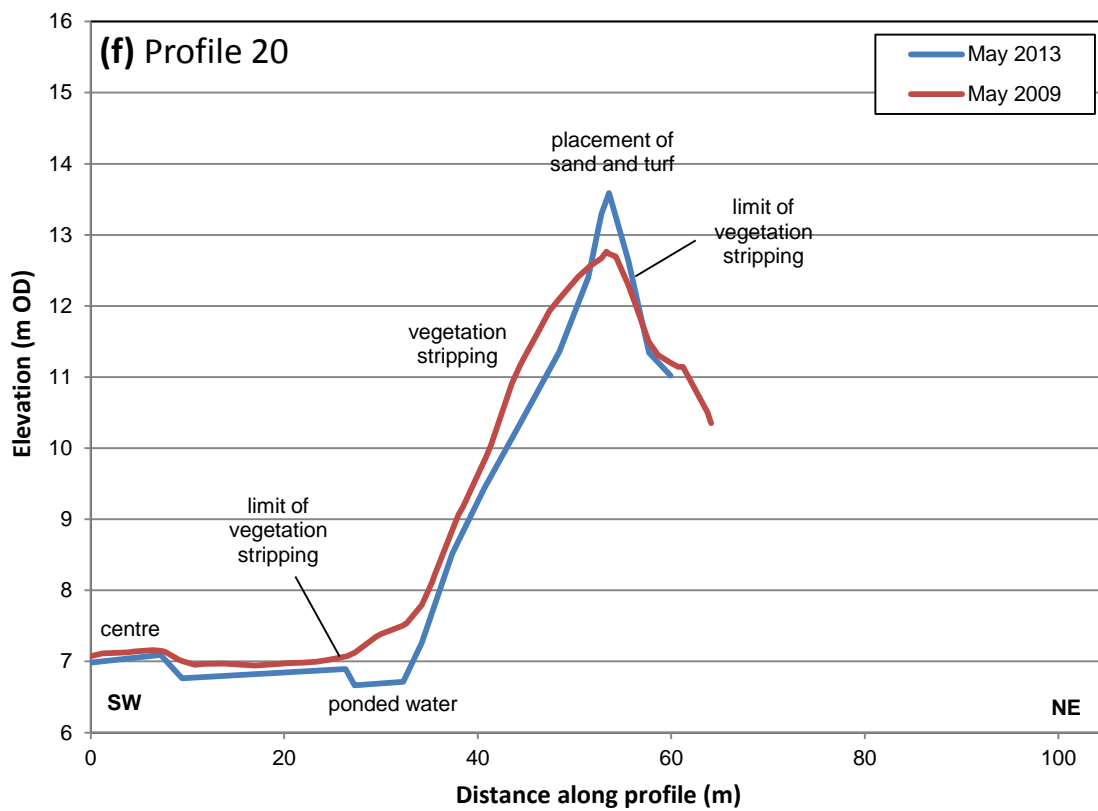
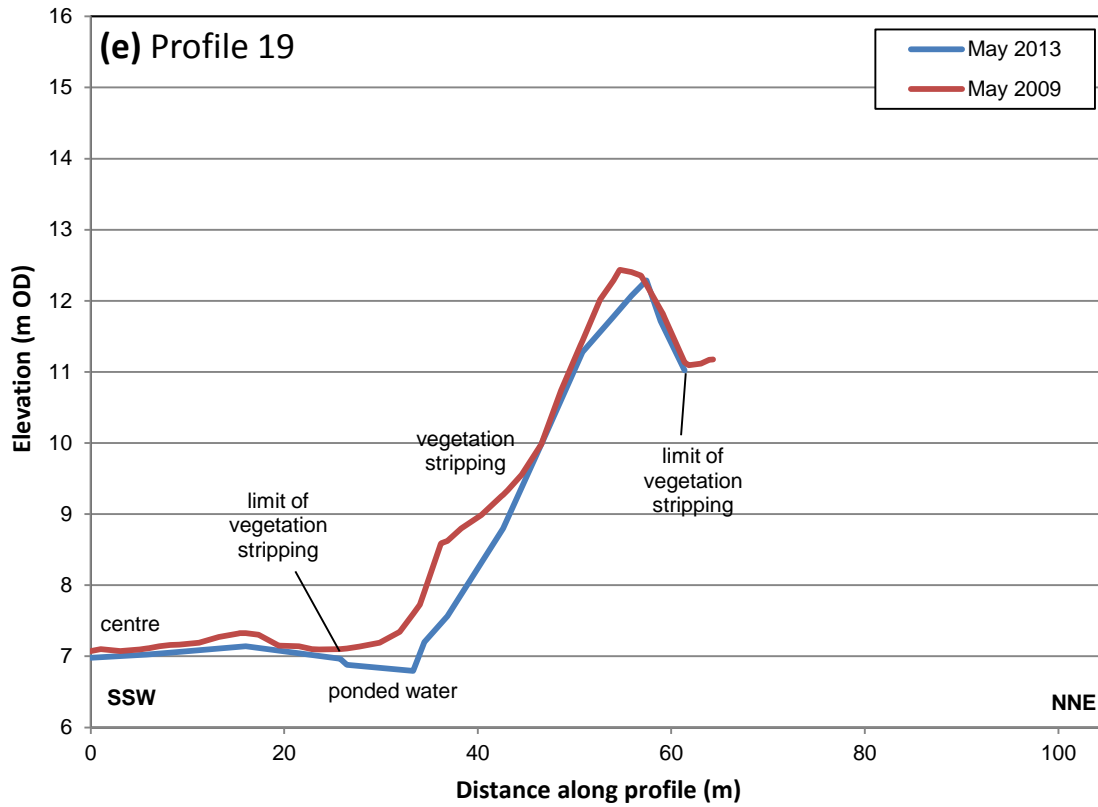


Figure 12. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

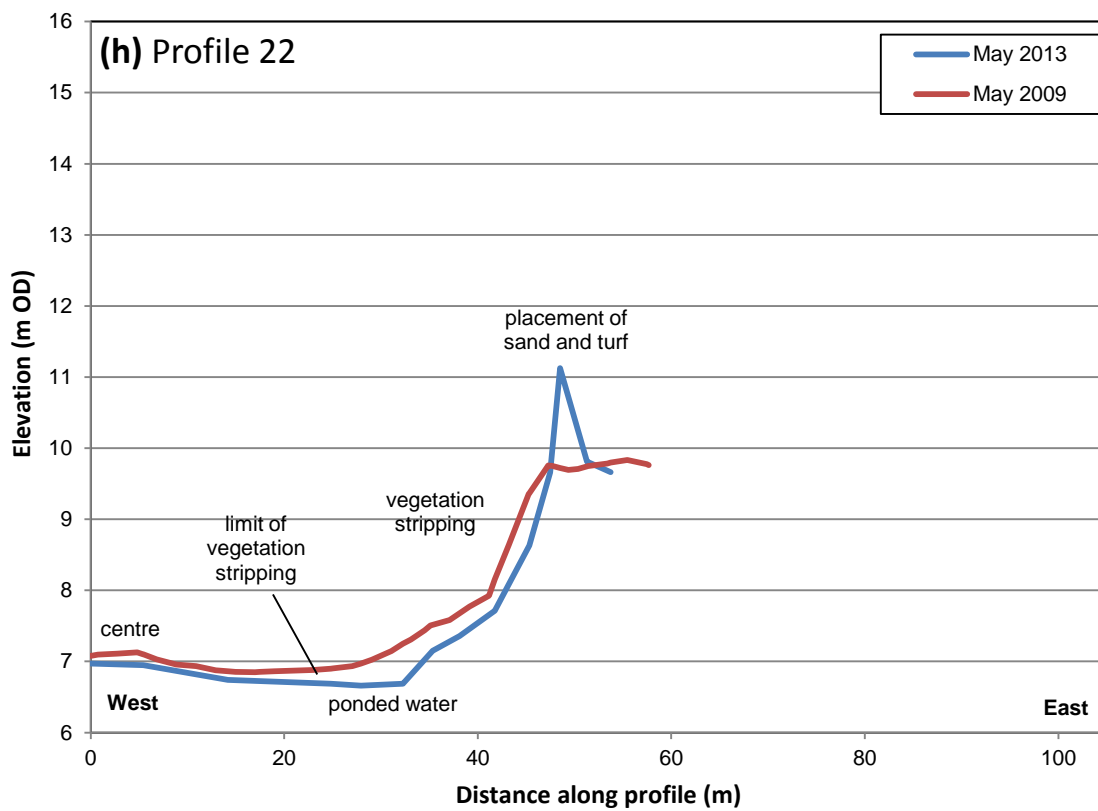
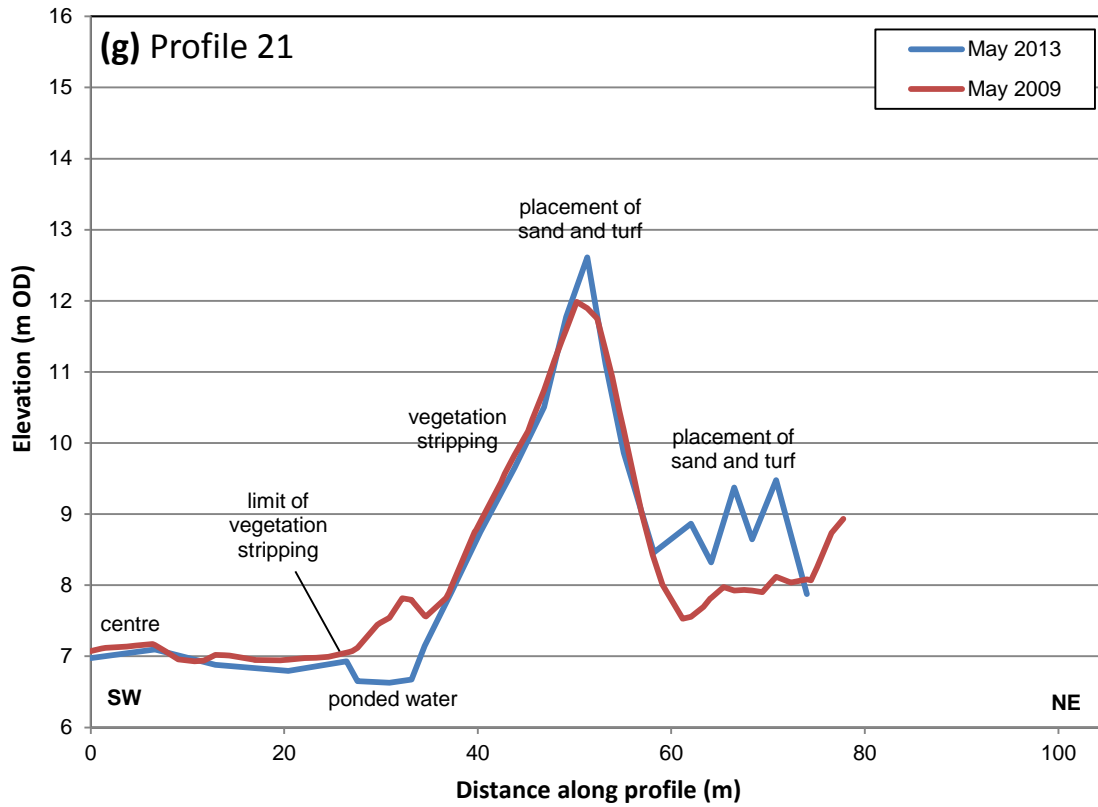


Figure 12. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

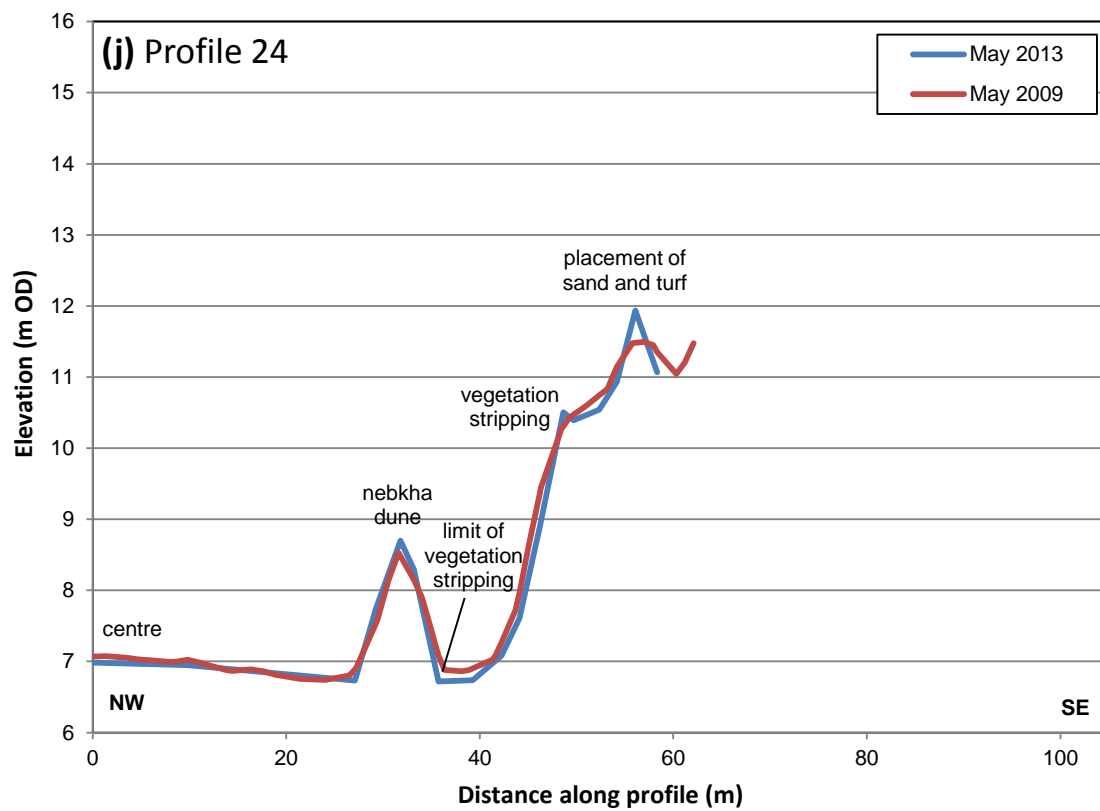
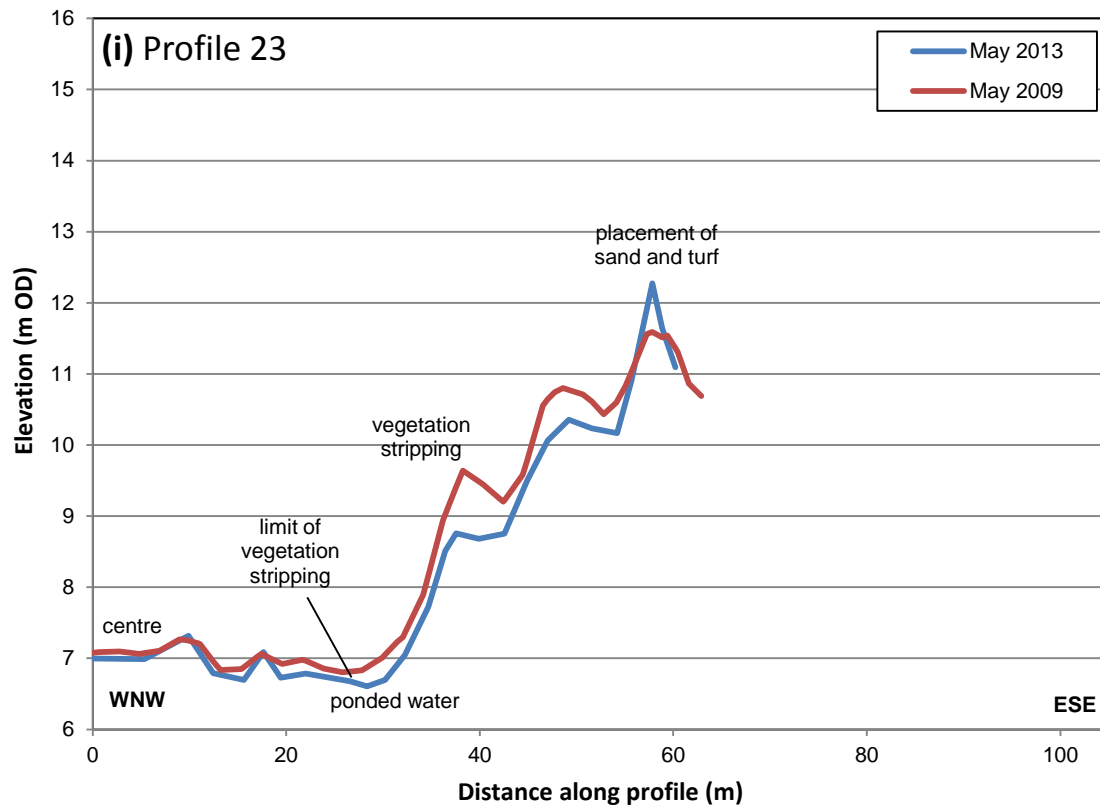


Figure 12. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

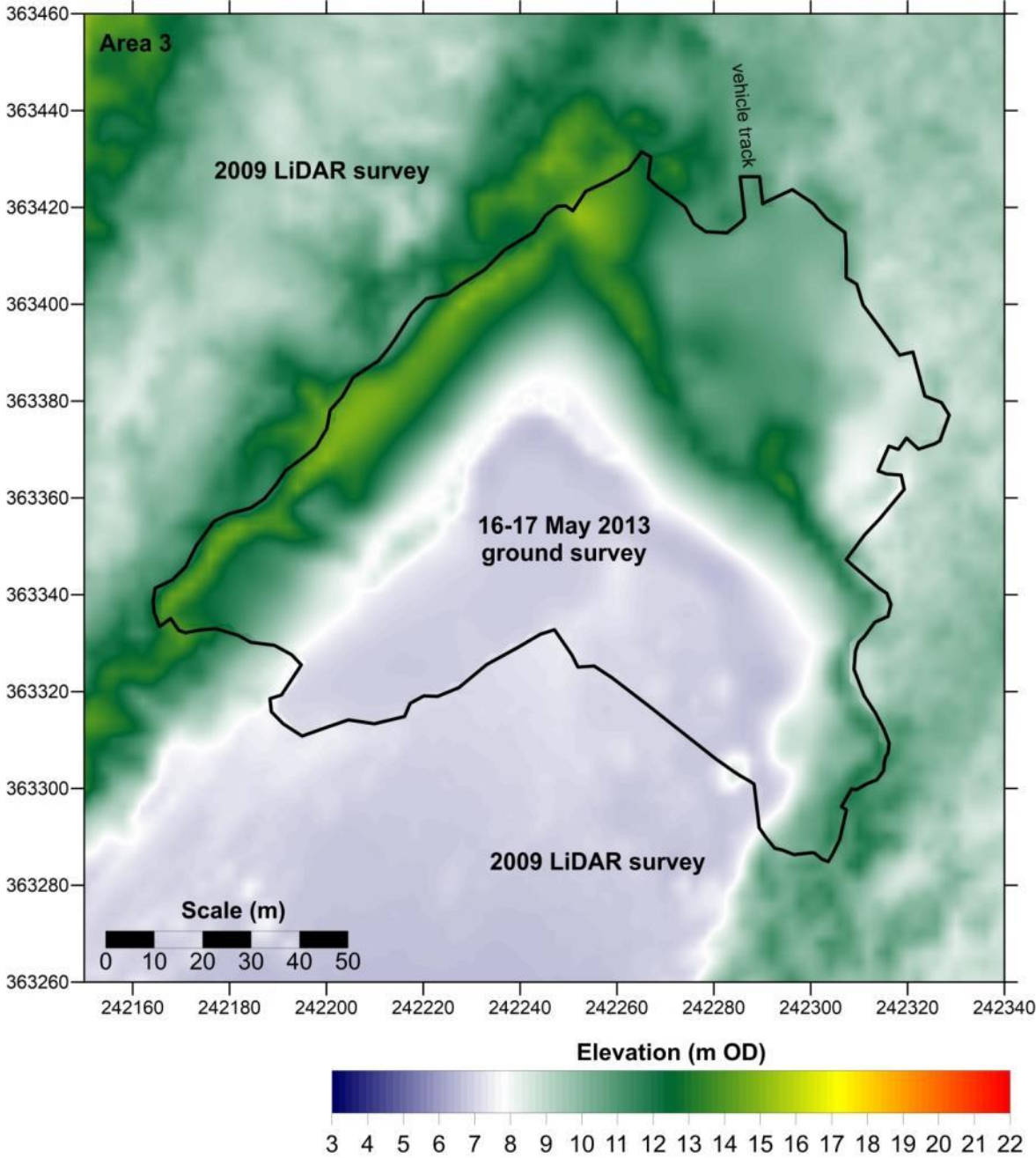


Figure 13. Digital elevation model of the Area 3 restoration works site surveyed on 16-17 May 2013, with the black line indicating the limit of the survey. The areas outside the black line are taken from the LiDAR survey flown in May 2009.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

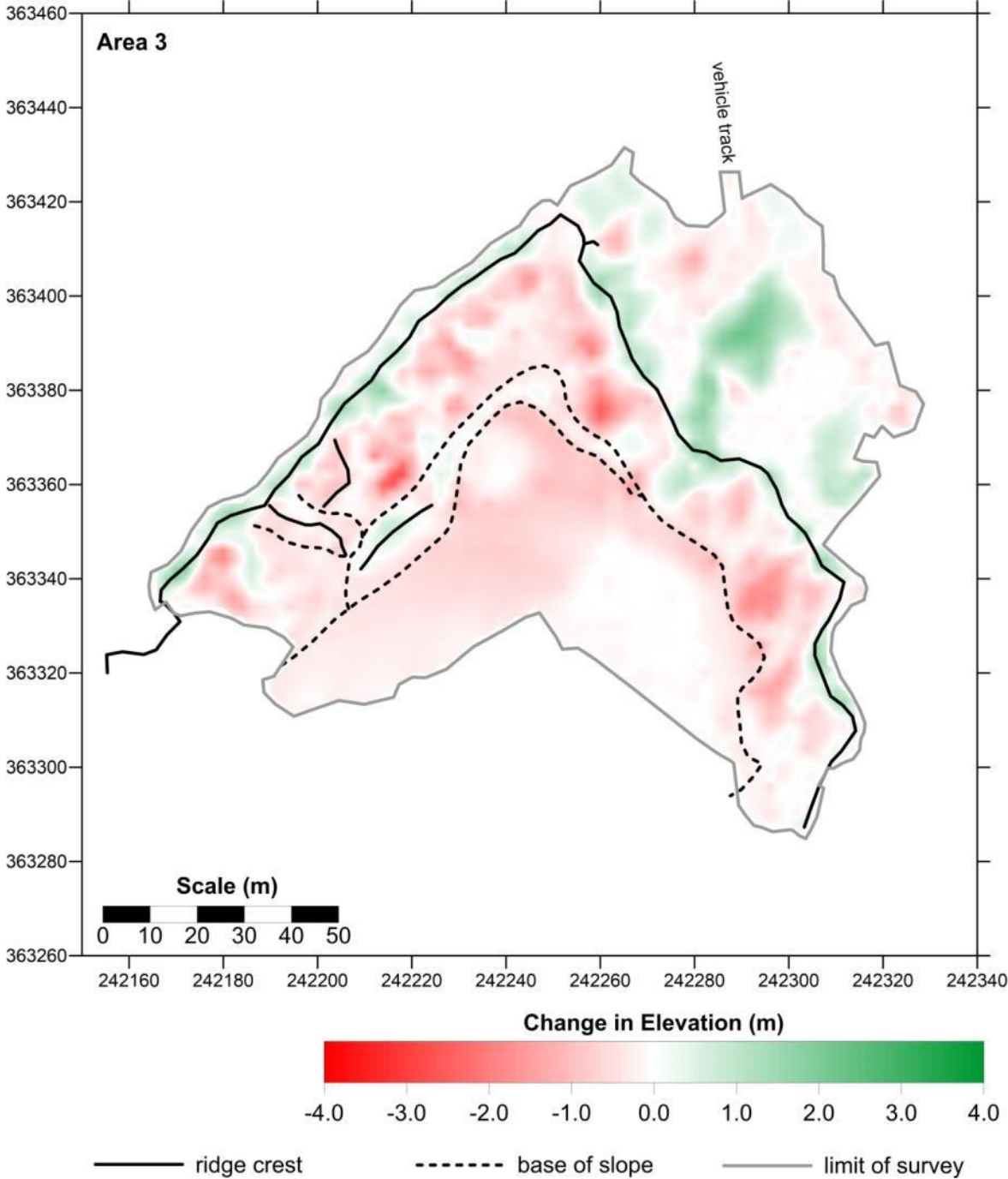


Figure 14. Change in elevation between the LiDAR survey flown in May 2009, and the ground survey of the restoration works site on 16-17 May 2013, in Area 3.

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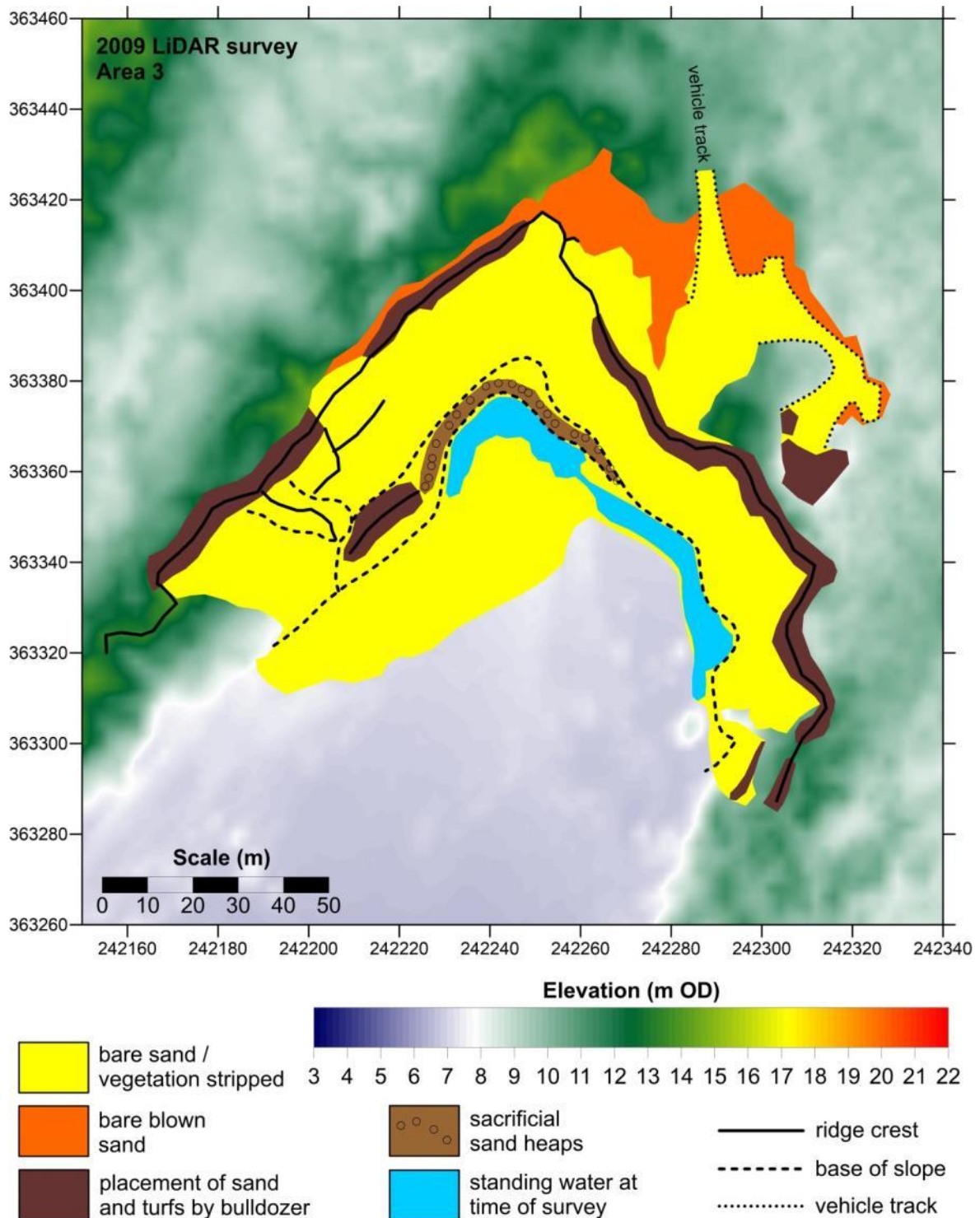


Figure 15. Features mapped in the field in Area 3, overlaid on LiDAR DEM flown in May 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

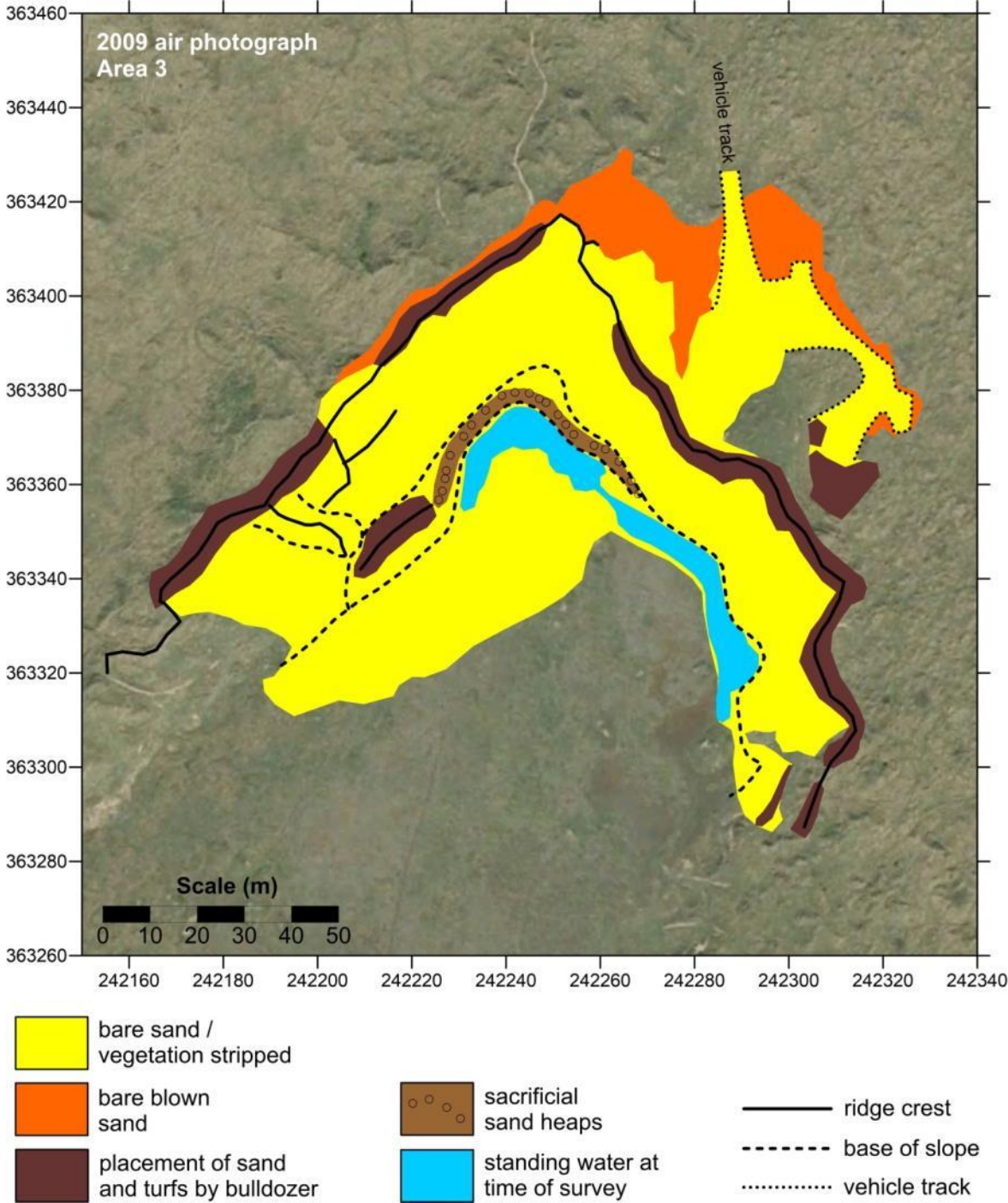


Figure 16. Features mapped in the field in Area 3, overlaid on air photographs flown in Sep 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

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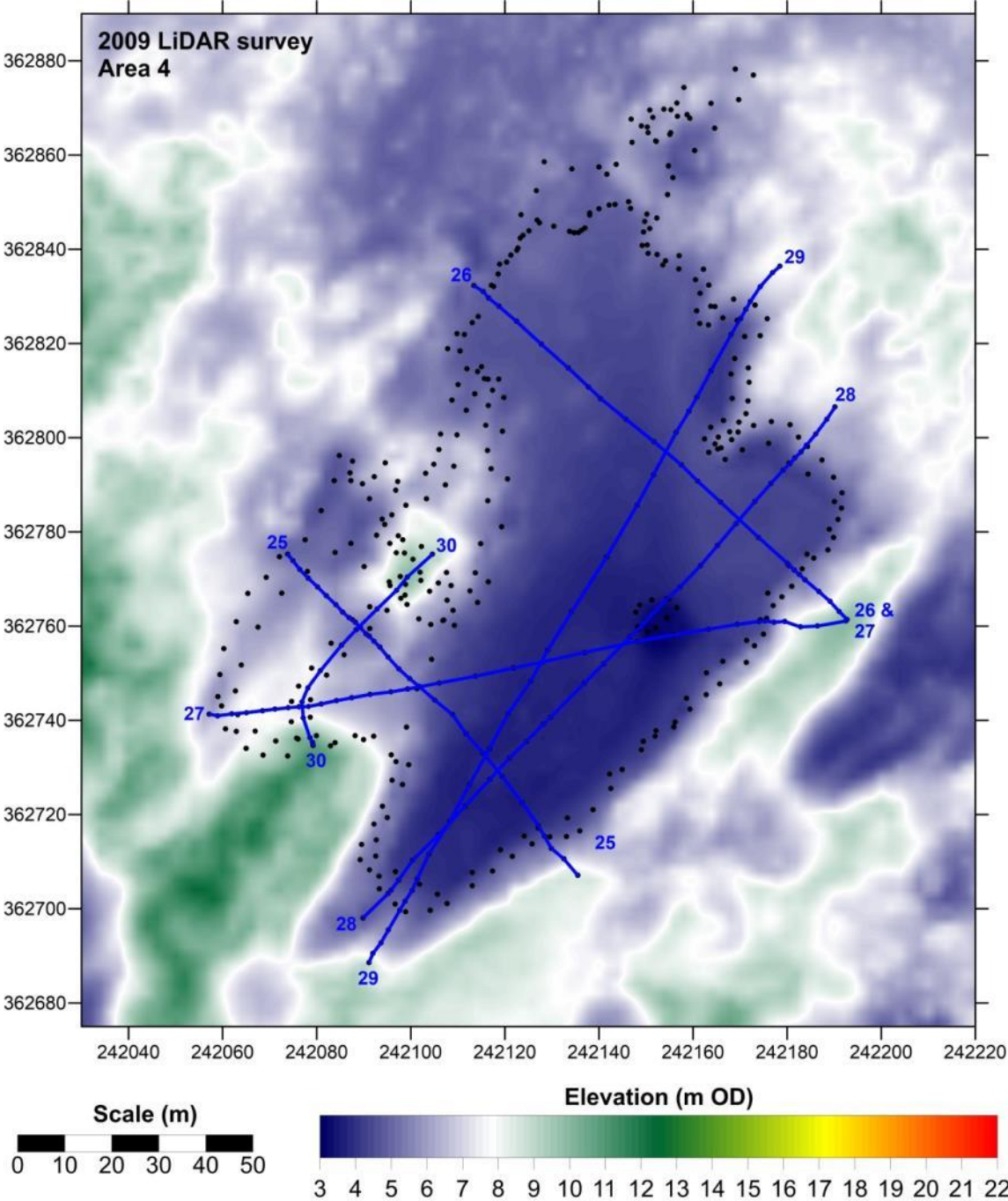


Figure 17. Locations of data points (black dots) and cross-profiles (blue lines), overlaid on 2009 LiDAR DEM, in Area 3

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

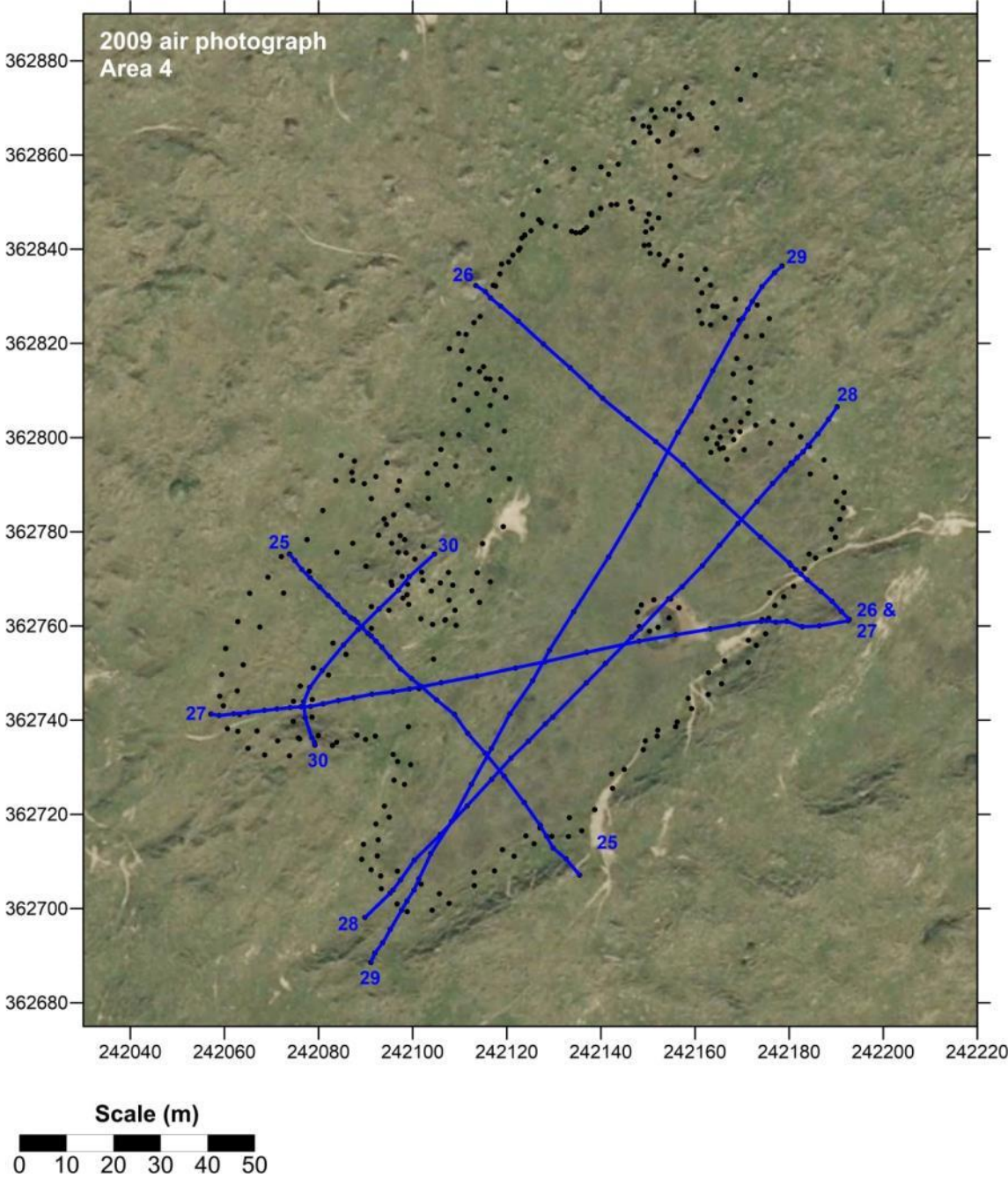


Figure 18. Locations of data points (black dots) and cross-profiles (blue lines), overlaid on 2009 air photographs, in Area 3

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

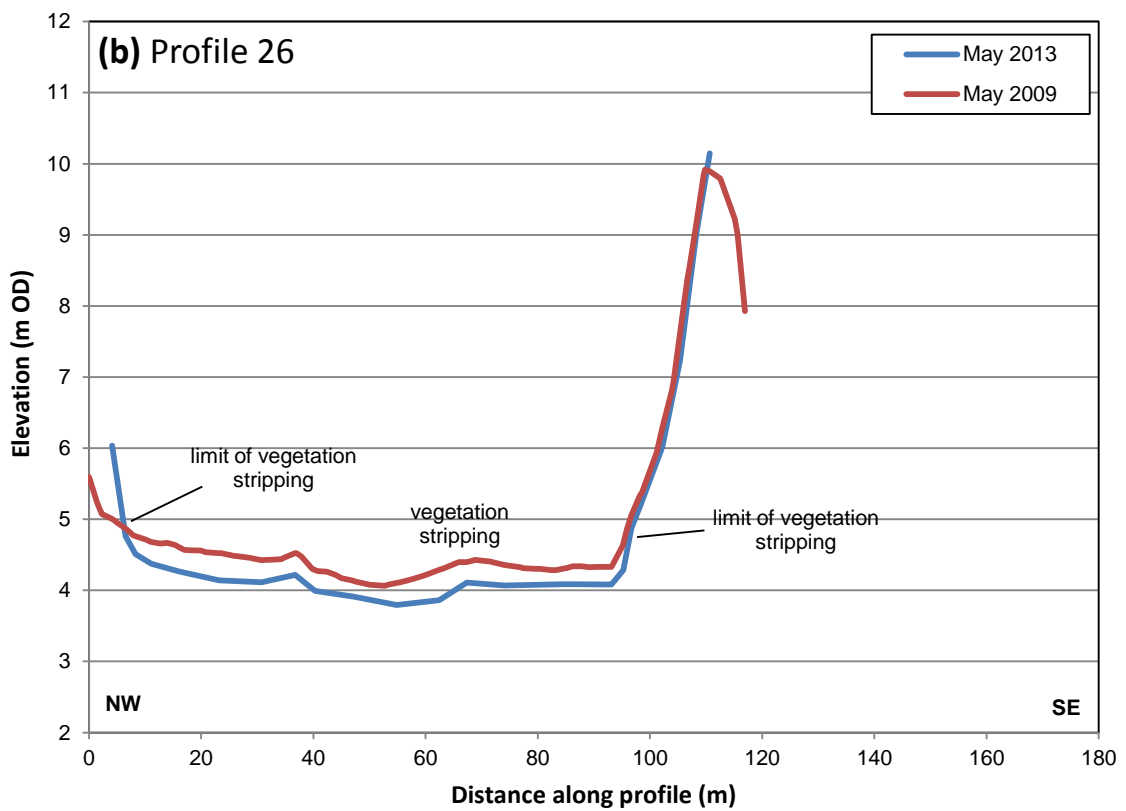
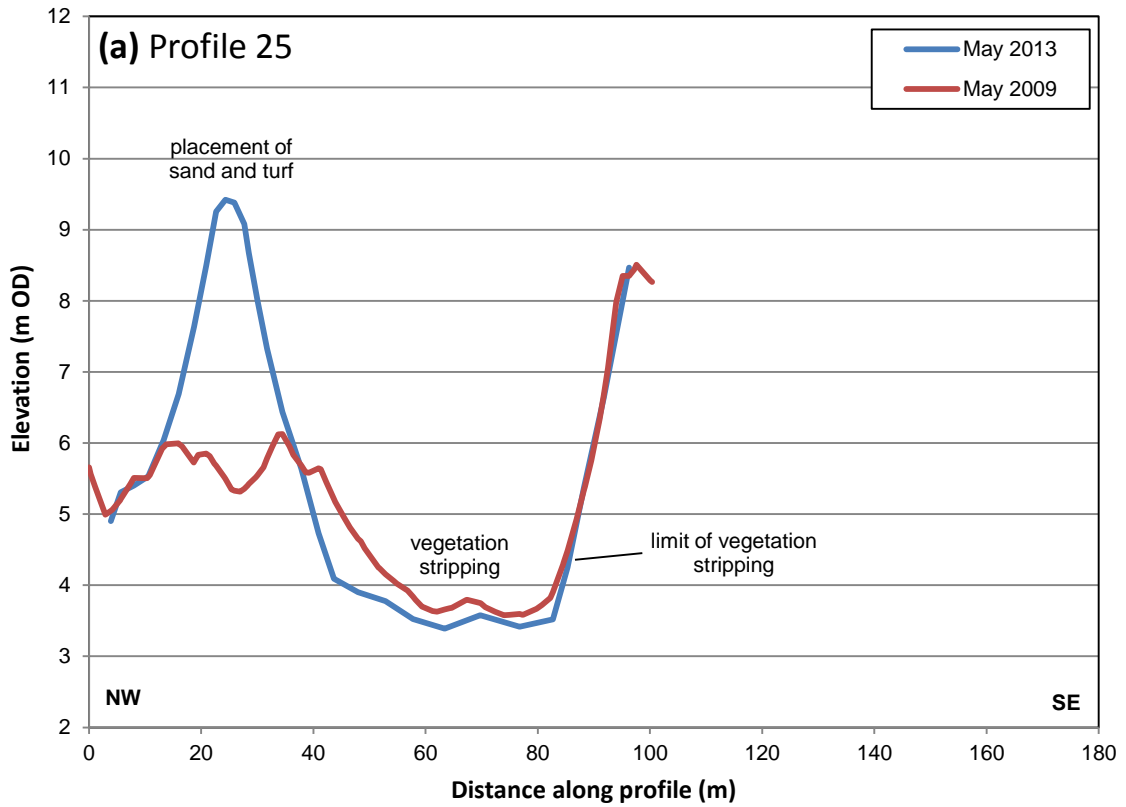


Figure 19. Cross-profiles at Area 4, at the locations indicated in Figure 13, measured from the ground survey on 16 and 17 May 2013, and LiDAR aerial survey in May 2009.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

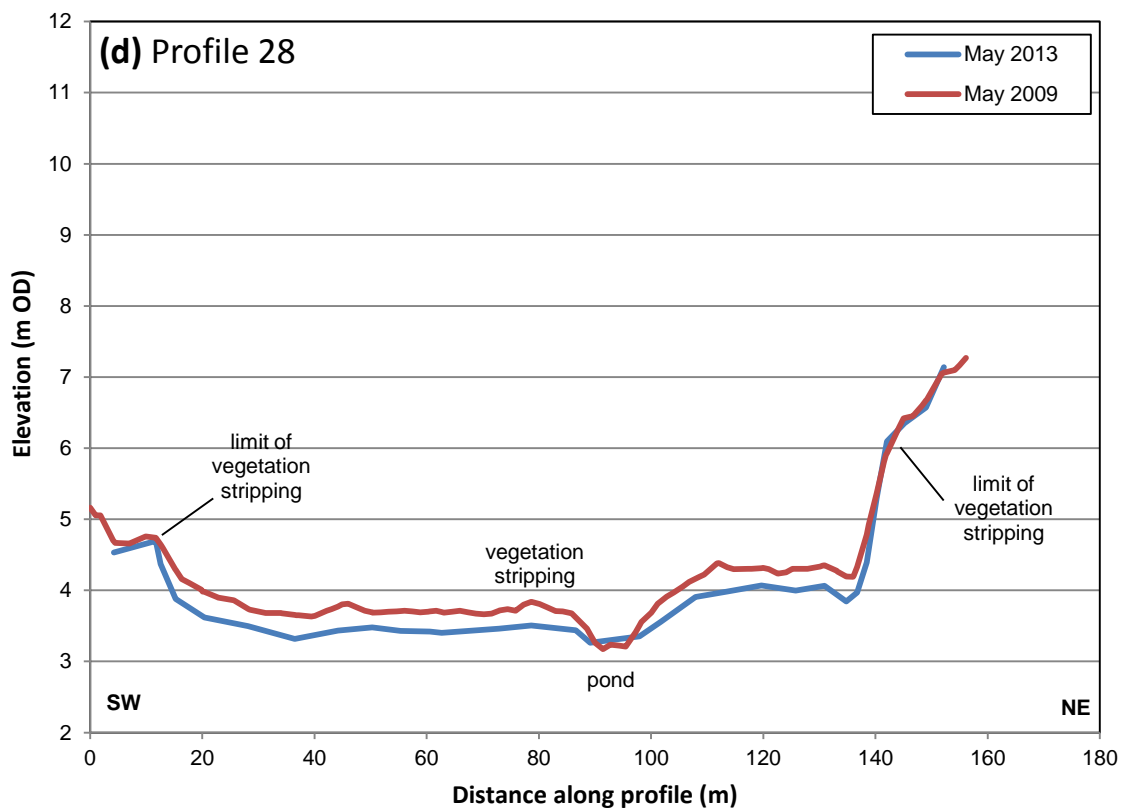
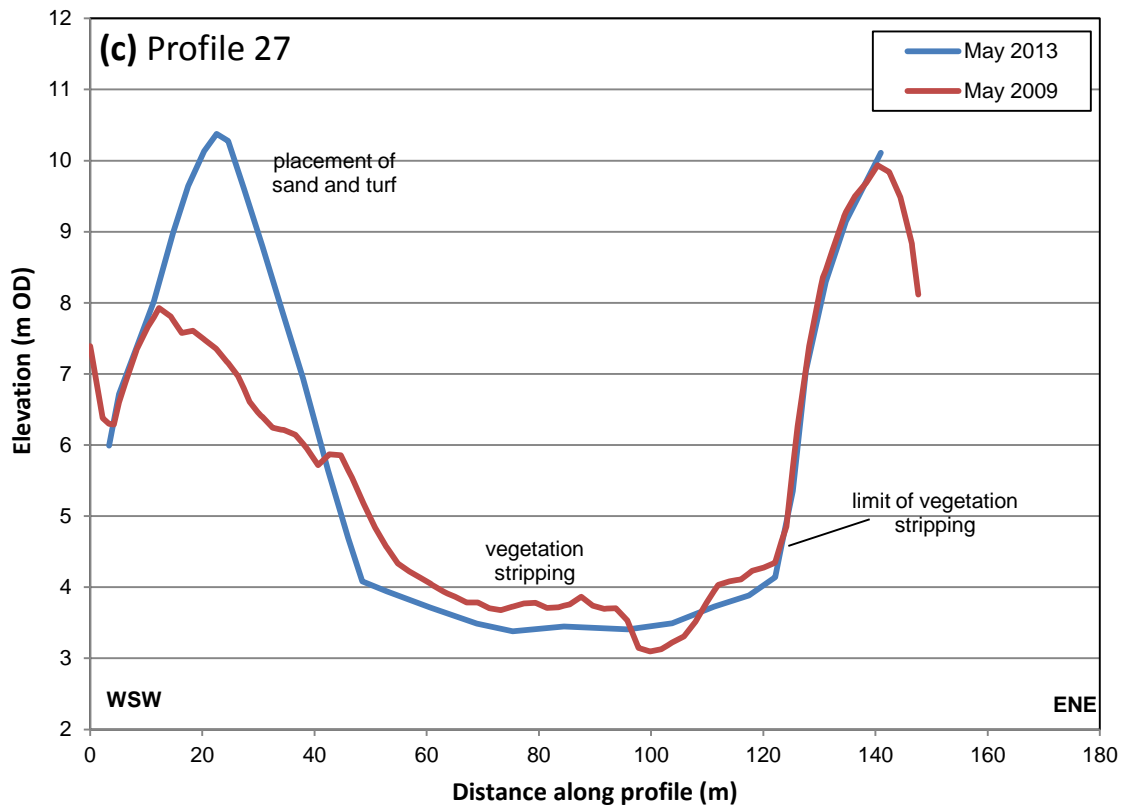


Figure 19. continued.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

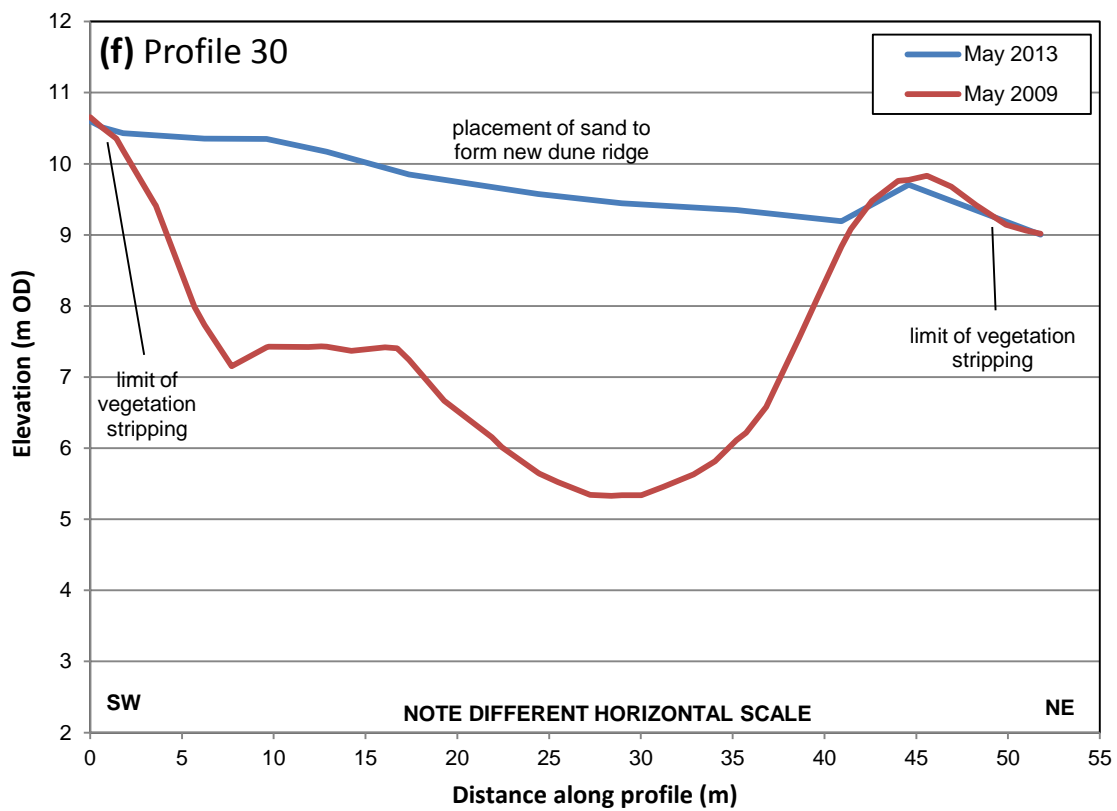
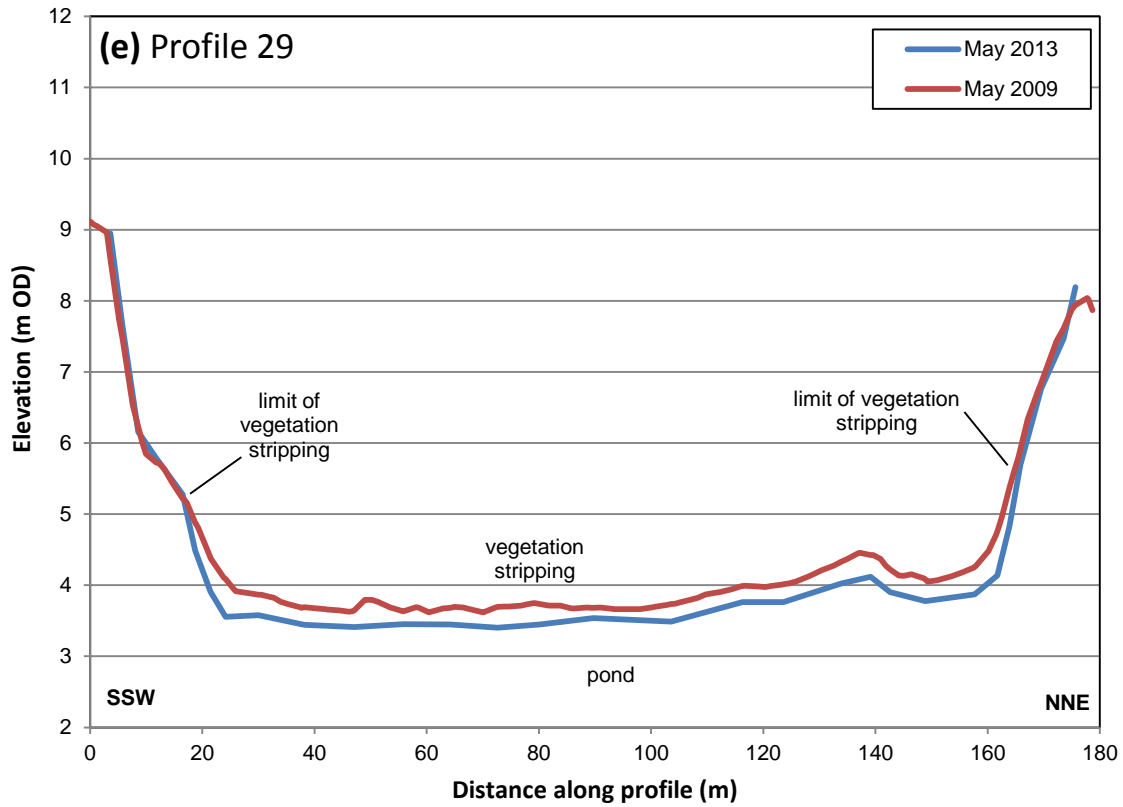


Figure 19. continued. Note different horizontal scale in (f).

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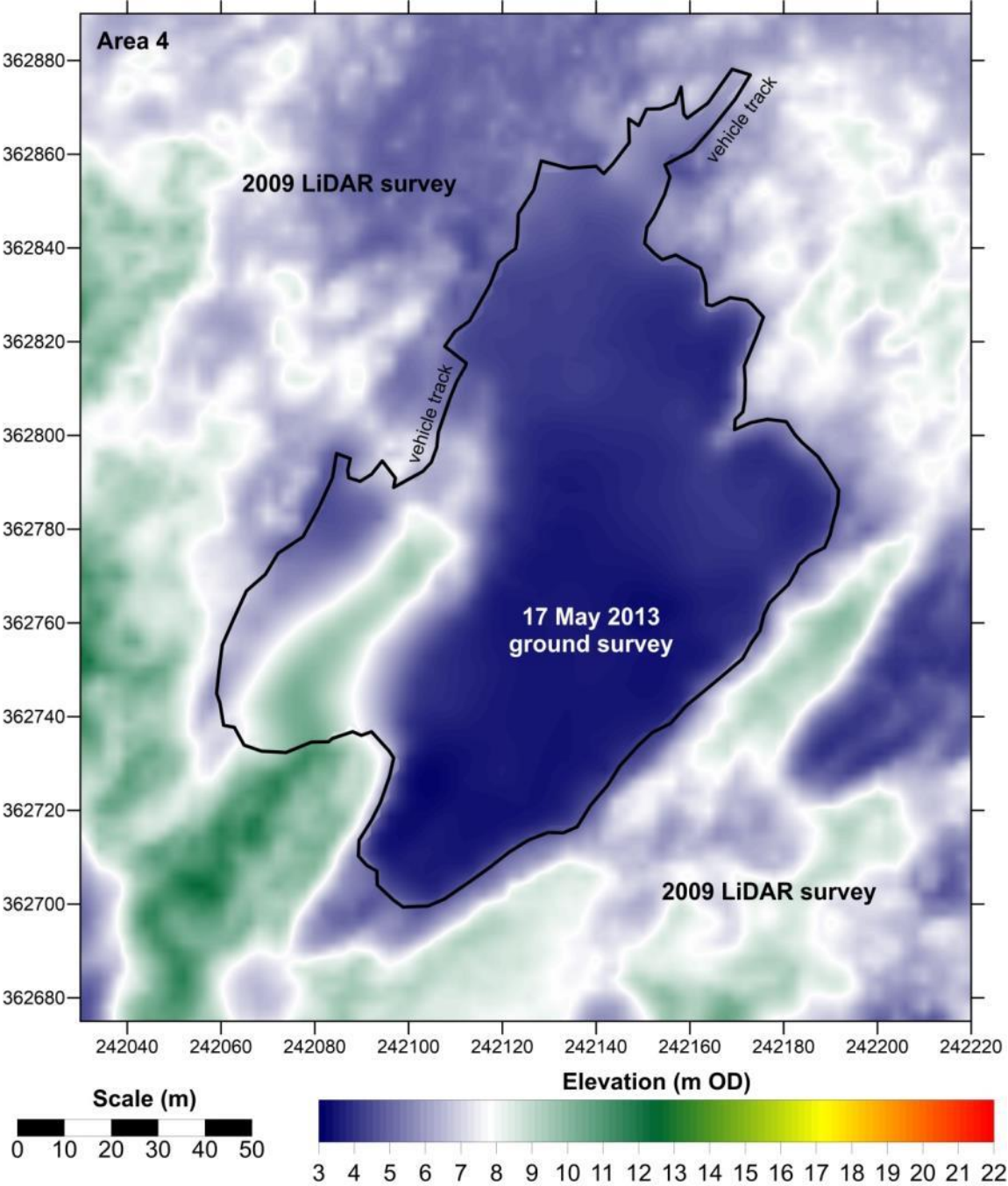


Figure 20. Digital elevation model of the Area 4 restoration works site surveyed on 17 May 2013, with the black line indicating the limit of the survey. The areas outside the black line are taken from the LiDAR survey flown in May 2009.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

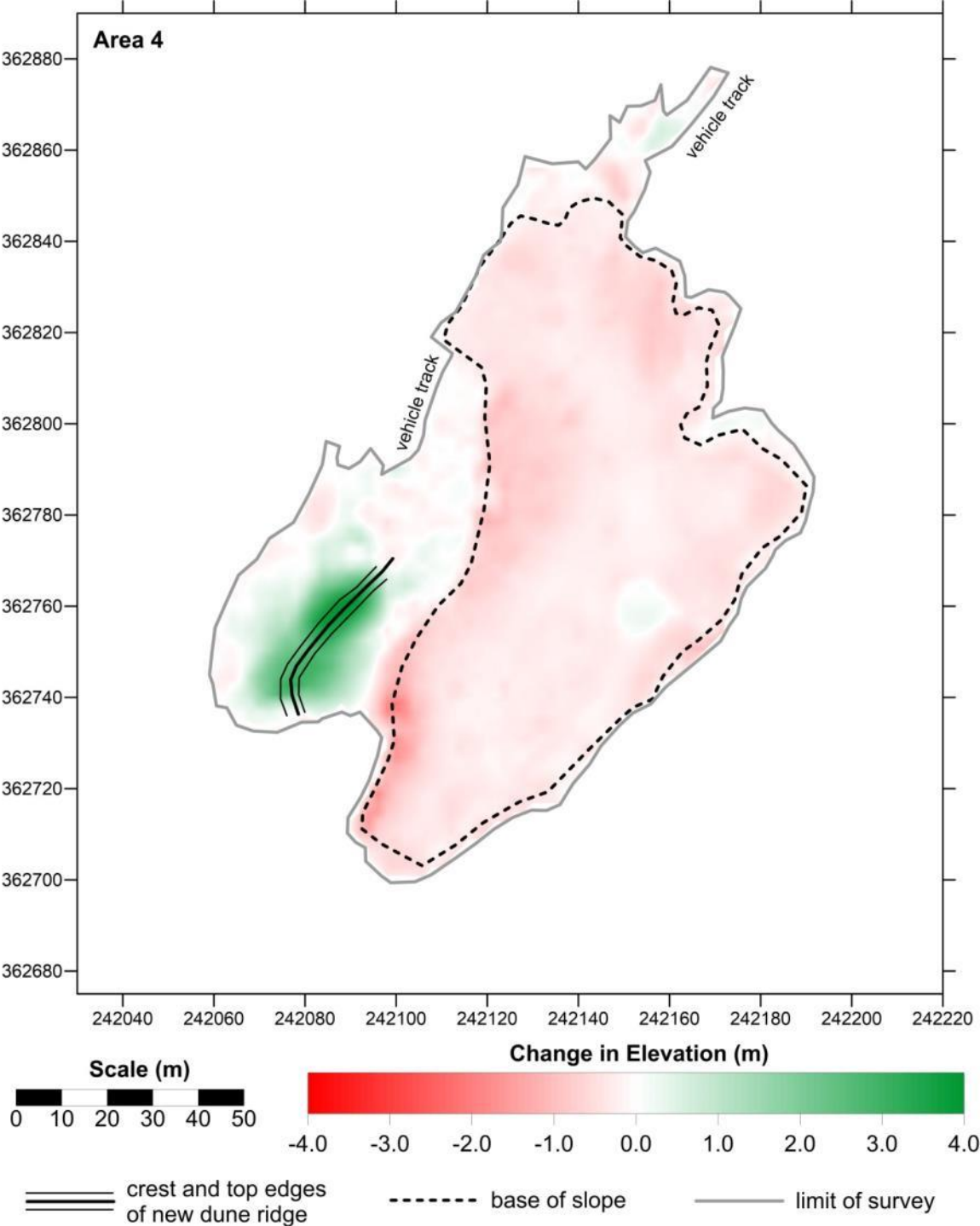


Figure 21. Change in elevation between the LiDAR survey flown in May 2009, and the ground survey of the restoration works site on 17 May 2013, in Area 4.

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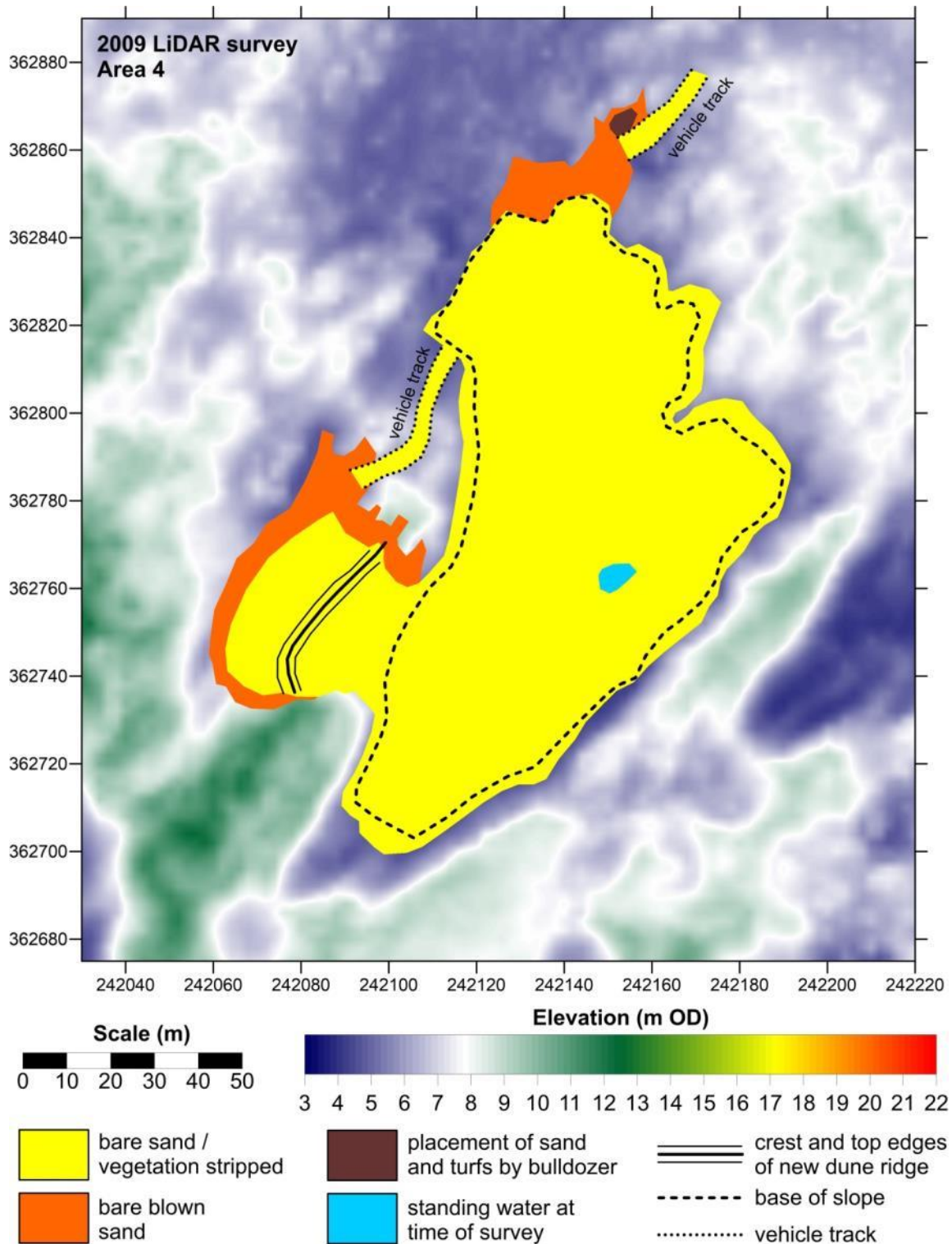


Figure 22. Features mapped in the field in Area 4, overlaid on LiDAR DEM flown in May 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

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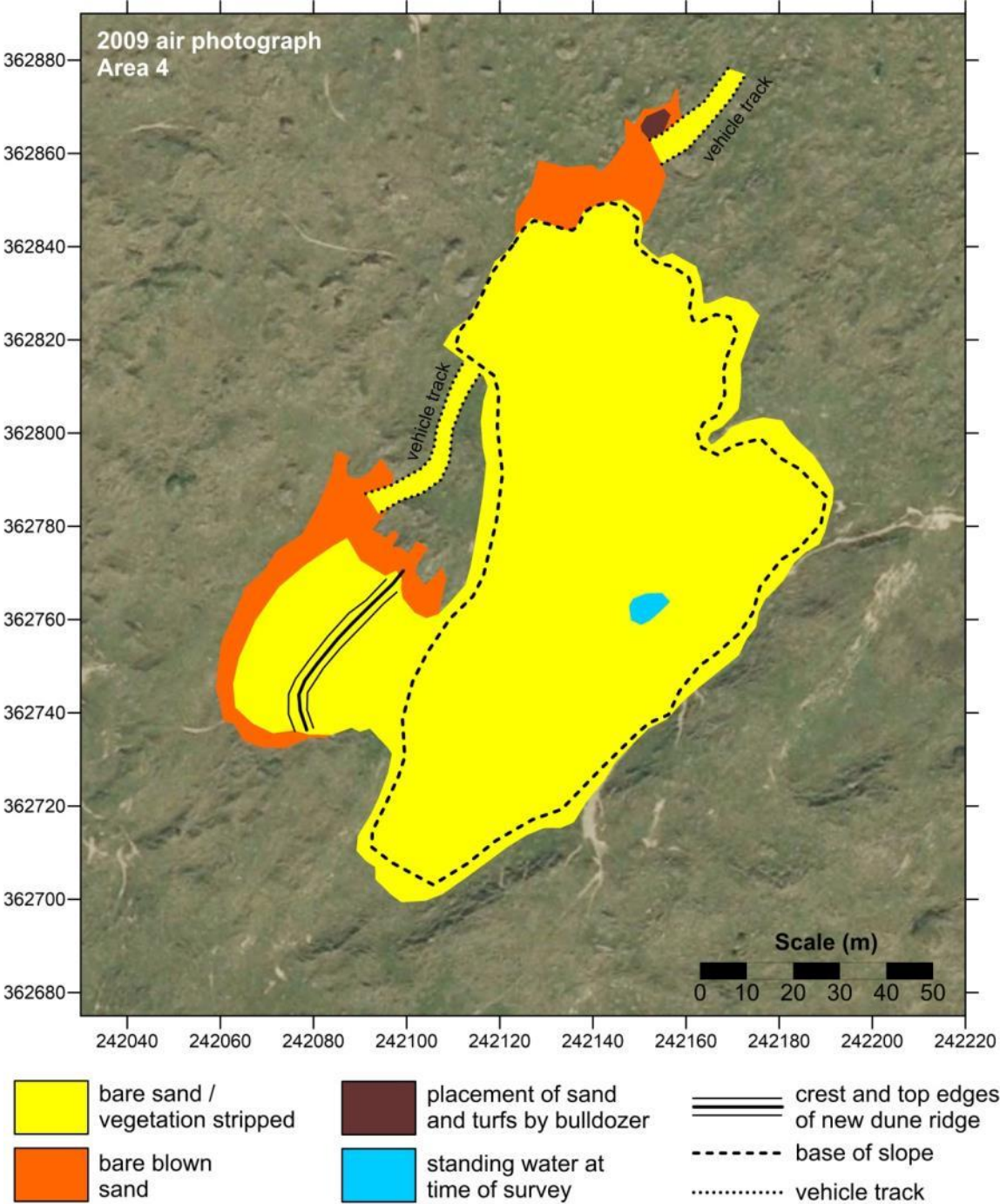


Figure 23. Features mapped in the field in Area 4, overlaid on air photographs flown in Sep 2009, showing areas of bare sand (either through vegetation stripping or wind-blown), areas where significant quantities of sand and/or turf have been placed, and standing water at the time of the survey. Solid and dashed lines indicate the crest and base of the main slopes on the site.

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Table 3. Particle size characteristics of dune samples collected at the Newborough Warren restoration works site on 17 May 2013. Statistics are calculated using GRADISTAT software (Blott & Pye, 2001), mean and sorting using the formulae of Folk & Ward (1957).

ID	Mean (μm & class)		D50 (μm)	Mode (μm)	Mean (phi)	Sorting (phi & description)		Gravel (%)	Sand (%)	Mud (%)
NW1	208	FS	202	196	2.27	0.26	VWS	0.0	100.0	0.0
NW2	189	FS	193	196	2.40	0.27	VWS	0.0	100.0	0.0
NW3	185	FS	192	196	2.43	0.21	VWS	0.0	100.0	0.0
NW4	184	FS	190	196	2.44	0.24	VWS	0.0	100.0	0.0
NW5	184	FS	190	196	2.44	0.24	VWS	0.0	100.0	0.0
NW6	233	FS	232	231	2.10	0.25	VWS	0.0	99.9	0.1
NW7	168	FS	166	165	2.58	0.20	VWS	0.0	100.0	0.0
NW8	174	FS	177	196	2.52	0.23	VWS	0.0	100.0	0.0
NW9	192	FS	194	196	2.38	0.23	VWS	0.0	100.0	0.0
NW10	192	FS	194	196	2.38	0.25	VWS	0.0	100.0	0.0
NW11	195	FS	196	196	2.36	0.27	VWS	0.0	100.0	0.0
NW12	188	FS	192	196	2.41	0.20	VWS	0.0	100.0	0.0

Mean Size Classification:

VCS (very coarse sand)
 CS (coarse sand)
 MS (medium sand)
 FS (fine sand)
 VFS (very fine sand)

Sorting Descriptions:

VWS (very well sorted)
 WS (well sorted)
 MWS (moderately well sorted)
 MS (moderately sorted)
 PS (poorly sorted)
 VPS (very poorly sorted)

Blott, S.J. & Pye, K. (2001) GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. *Earth Surface Processes and Landforms*, 26, 1237-1248.

Folk, R.L. & Ward, W.C. (1957) Brazos River bar: a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, 27, 3-26.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

Table 4. Sediment textural classifications, according to Folk (1954) and Blott & Pye (2012), from the samples collected on 17 May 2013.

ID	Folk (1954)	Blott and Pye (2012)
NW1	Sand	Sand
NW2	Sand	Sand
NW3	Sand	Sand
NW4	Sand	Sand
NW5	Sand	Sand
NW6	Sand	Sand
NW7	Sand	Sand
NW8	Sand	Sand
NW9	Sand	Sand
NW10	Sand	Sand
NW11	Sand	Sand
NW12	Sand	Sand

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *Journal of Geology*, 62, 344-359.

Blott, S.J. & Pye, K. (2012) Particle size scales and classification of sediment types based on particle size distributions: review and recommended procedures. *Sedimentology*, 59, 2071-2096.

Newborough Phase 1 Dune Rejuvenation Works: Topographic Survey, May 2013

Table 5. Particle size distribution of samples collected on 17 May 2013: percentage dry weight retained on sieves spaced at notional 'half phi' intervals.

Size (µm)	Sediment retained on sieve (%)											
	NW1	NW2	NW3	NW4	NW5	NW6	NW7	NW8	NW9	NW10	NW11	NW12
1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
850	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
710	0.0	0.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
600	0.0	0.5	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
500	0.3	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0
425	0.2	0.2	0.0	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.2	0.0
355	0.6	0.2	0.0	0.4	0.0	0.9	0.0	0.0	0.2	0.4	0.3	0.0
300	2.1	0.5	0.0	0.7	0.7	3.8	0.0	0.0	0.4	0.5	0.9	0.0
250	9.3	2.5	0.9	1.8	2.2	14.3	0.8	0.3	3.1	3.6	5.0	0.6
212	20.4	9.8	6.1	6.1	9.7	48.3	2.8	3.3	16.0	13.8	18.5	11.3
180	45.9	41.6	69.6	38.3	43.0	9.6	15.1	29.1	53.5	45.0	42.9	48.7
150	8.9	11.7	11.2	15.1	17.2	5.7	59.0	25.3	16.0	13.8	15.9	15.0
125	4.5	7.5	9.7	6.8	8.3	0.7	6.9	10.9	6.6	6.5	6.4	5.2
106	0.5	0.8	1.6	0.8	1.0	0.1	4.9	1.5	0.8	0.6	0.6	0.4
90	0.1	0.1	0.5	0.1	0.2	0.1	0.8	0.3	0.1	0.2	0.1	0.1
75	0.0	0.1	0.1	0.1	0.1	0.0	0.2	0.0	0.0	0.1	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
pan	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0

4. Field Photographs

Taken 16-17 May 2013

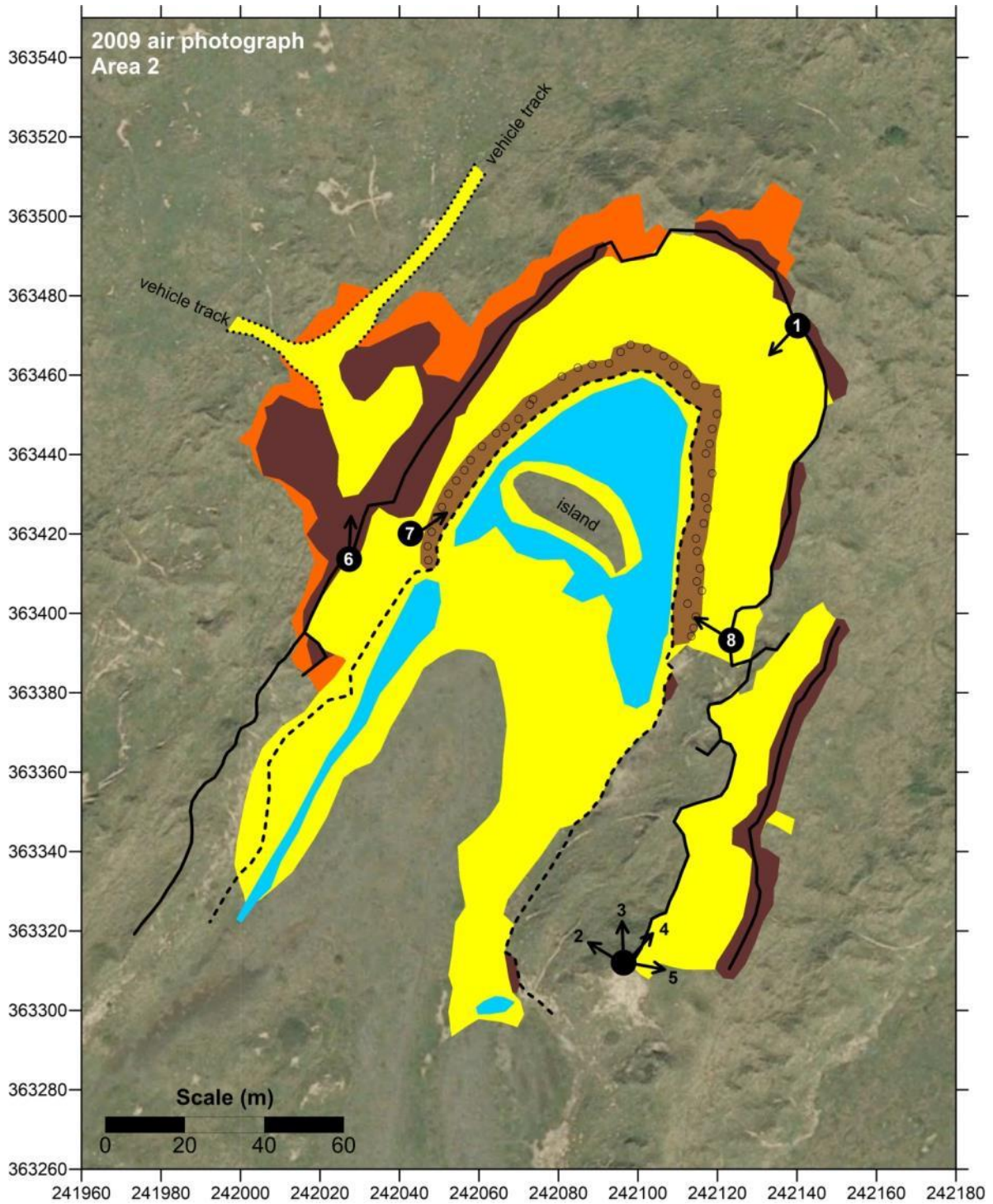


Figure 24. Locations of field photographs 1-8 taken in Area 2. Numbers indicate photograph numbers, while arrows indicate the direction of the photograph.

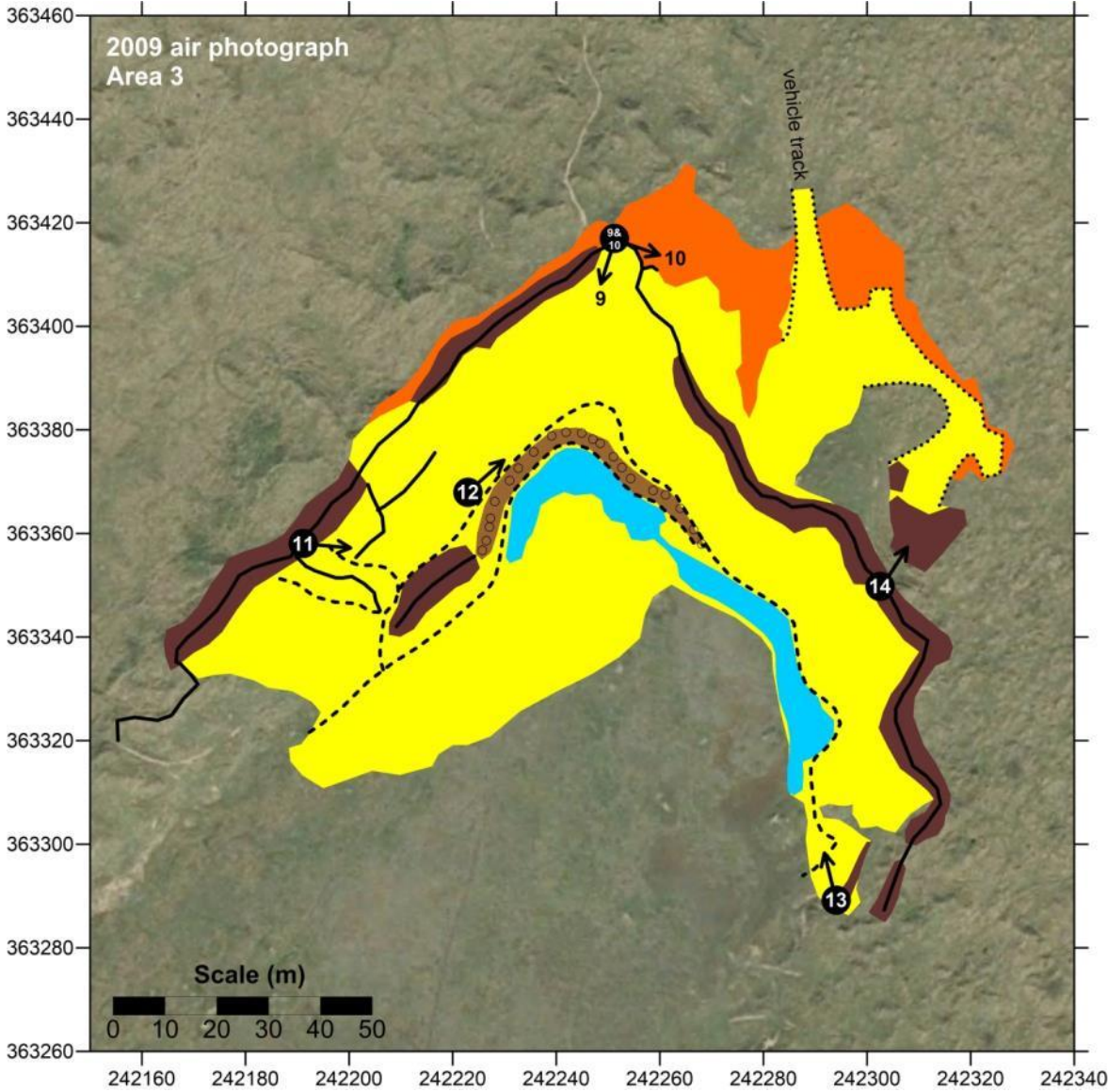


Figure 25. Locations of field photographs 9-14 taken in Area 3. Numbers indicate photograph numbers, while arrows indicate the direction of the photograph.

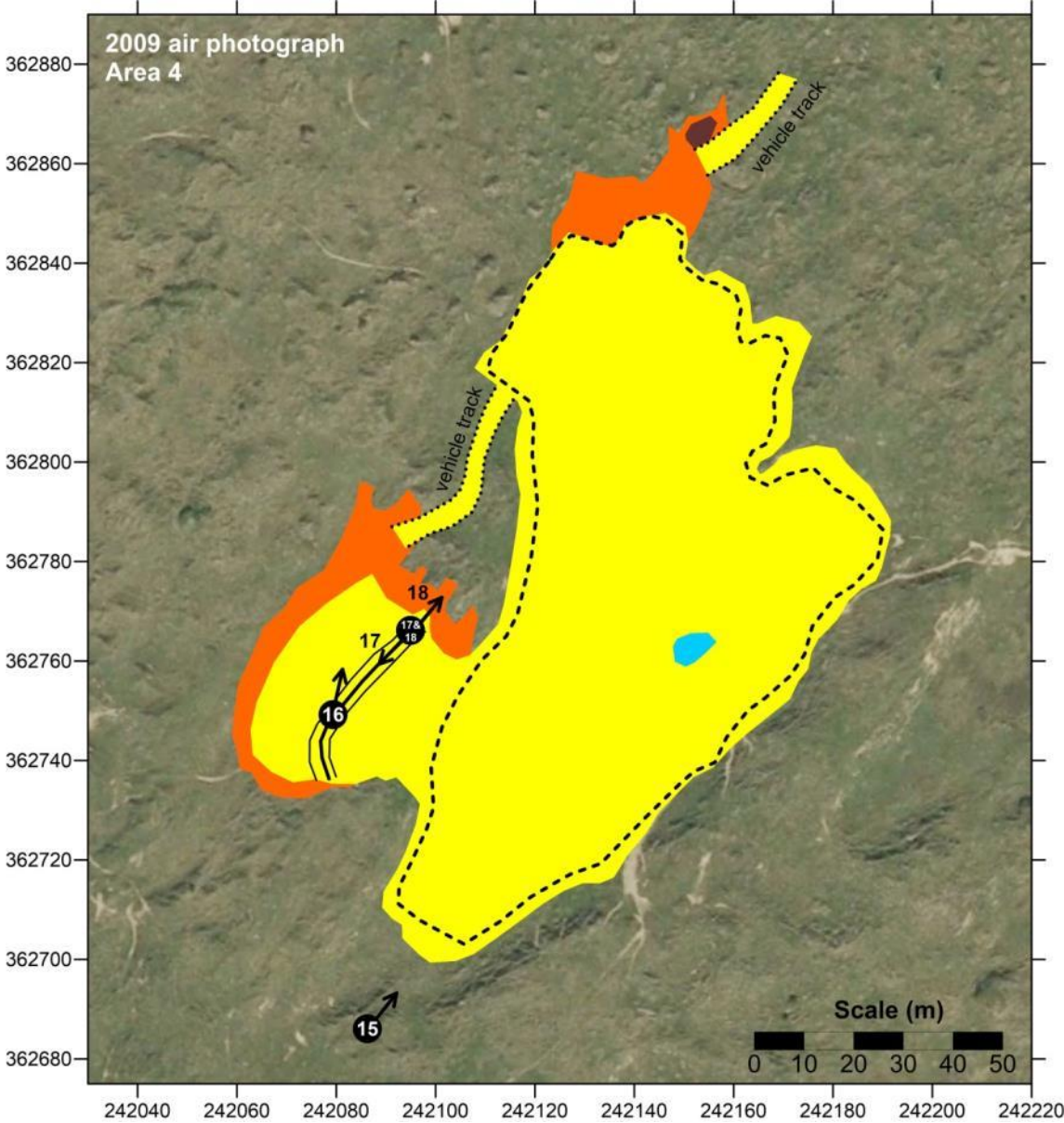


Figure 26. Locations of field photographs 15-18 taken in Area 4. Numbers indicate photograph numbers, while arrows indicate the direction of the photograph.



Photo 1. Area 2, looking SW from the head of the dune.



Photo 2. Area 2, looking NW from Benchmark 1.



Photo 3. Area 2, looking N from Benchmark 1 towards the head of the dune.



Photo 4. Area 2, looking NE from Benchmark 1. Vegetation stripping on the eastern side of the ridge can be seen in the foreground.



Photo 5. Area 2, looking W from Benchmark 1. Pile of sand and turf in the foreground, Area 3 in the background.



Photo 6. Area 2, north-western part of the site. Piles of turf in the foreground, vehicle access tracks in the centre.



Photo 7. Area 2, showing sacrificial heaps of sand placed around the base of the dune.



Photo 8. Area 2, looking NW across the site. Surface disturbance by ponies is important at this site.



Photo 9. Area 3, overview of the site, looking SSW from the head.



Photo 10. Area 3, showing vegetation stripping and deposition of turfs to the rear of the dune head.



Photo 11. Area 3, looking east from the western arm of the dune, showing transverse ridge crest in the foreground.



Photo 12. Area 3, showing sacrificial heaps of sand placed around the base of the dune.



Photo 13. Area 3, showing the SE part of the site, two nebkha dunes in the foreground.



Photo 14. Area 3, piles of sand and turf to the rear of the dune head.



Photo 15. Area 4, overview of the site, looking NE from the southern limit.



Photo 16. Area 3, vegetation stripping and blown sand areas to the north and west of the newly constructed dune ridge



Photo 17. Area 3, looking SW along the crest of the new dune ridge.



Photo 18. Area 3, looking NE from the end of the new dune ridge towards the northern part of the site.

Data Archive Appendix

Data outputs associated with this project are archived at 'Newborough Dune Rejuvenation; project 421, media 1439' 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 (Newborough Warren Survey 16-05-2013 Data.xls) of data points (x,y,z)
- [C] 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 [115840]

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