CHERISH Report no.
CH/RCAHMW-AU 01

Dinas Dinlle Coastal Hillfort

Interim Report. Assessment of exposed cliff-face features and core transect, 3-7 June 2019.

CHERISH
Newid Hinsawdd a Threftadaeth yr Arfordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

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Dinas Dinlle Coastal Hillfort. Assessment of exposed cliff-face features and core transect, Interim Report

County:	Gwynedd
Community:	Llandwrog
NGR:	SH43705635
NPRN:	95309
Scheduled Monument No:	CN048
Report No.	CH/RCAHMW-AU 01
Report Authors:	Daniel Hunt (RCAHMW), Louise Barker (RCAHMW), Patrick Robson (AU) and Helen Roberts (AU)
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Date of Investigation:	3-7 June 2019
Date of Report:	10th February 2020

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Front Cover: Patrick Robson (Aberystwyth University) and Louise Barker (RCAHMW) from the CHERISH team investigating cliff-face deposits at Dinas Dinlle.

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1. SUMMARY

Between the 3-7 June 2019 the EU-funded CHERISH Ireland-Wales project undertook cliff-face investigations of archaeological and glacial deposits visible along the top of the eroding cliff-face of Dinas Dinlle hillfort, and a core transect across its southern defences. These investigations form part of wider archaeological and palaeoenvironmental investigations at Dinas Dinlle undertaken since 2017 by the CHERISH project.

The following report forms the interim, and outlines the methodologies used and some of the preliminary results. Cliff-face investigation was undertaken in two areas. Area A was centred on NGR SH 436 563, the hillfort interior, and focused on three individual features of potential archaeological interest. Following light cleaning no further recording was undertaken due to the features being identified as natural in origin. Area B was centred on NGR SH 436 562, the inner south ditch of the hillfort that was exposed following a significant collapse of the cliff-face in early 2019. The cleaning of the section revealed the clear cut of a ditch and a fill comprising 11 distinct layers that relate to a number of depositional regimes. The presence of water-lain sediments in the lowest fill suggests that the ditch initially formed as a post-glacial palaeo-channel that incised the surface of the glacial gravels. As no artefacts or charcoal were recovered in the section, the ditch fill deposits will be dated through OSL. In all 5 samples were taken, and will be critical to understanding when and how the layers were deposited and how they relate to the likely occupation of the fort.

The investigations in Areas A and B also enabled more detailed analysis of erosion affecting the site. These comprise a variety of pressures including exposure to strong winds and rain from the sea which erode the softer sand sediments and leave behind a scoured 'shelf' or surface at the junction with the harder glacial sediments. Removal of the sand, which is also exacerbated by avian and mammalian activity, then cause the overlying turf to slump and degrade. Rain also exacerbates erosion, infiltrating the surface of the fort interior where it passes easily through the sand units but is restricted by the dense nature of the underlying glacial sediments. When saturated, the water emerges from the cliff-face at the interface between the soft and hard sediments which promotes gravitational slumping and degradation of the softer sediments.

In addition to the cliff-face assessment, a core transect was undertaken at 8 locations across the southern defences of the hillfort, 30-45m away from the eroding edge. Core depths varied from 30cm to 200cm and the initial impression is that the stratigraphy broadly reflects that observed in the cliff-face section, principally layers of sand.

Results to come from the analysis of cores and luminescence dating of samples are expected during Spring/Summer 2020, at which point the final report will be produced.

2. CHERISH PROJECT BACKGROUND

CHERISH (Climate, Heritage and Environments of Reefs, Islands and Headlands) is a European-funded project led by the Royal Commission on the Ancient and Historical Monuments of Wales, in partnership with the Discovery Programme: Centre for Archaeology and Innovation Ireland, Aberystwyth University: Department of Geography and Earth Sciences and Geological Survey, Ireland.

The project commenced 1st January 2017 and will run for 6 years to December 2022; it will receive more than €4.9 million of European Union (EU) funds through the Ireland – Wales Co-operation Programme 2014-2020, Priority Axis 2 – Adaptation of the Irish Sea and Coastal Communities to Climate Change.

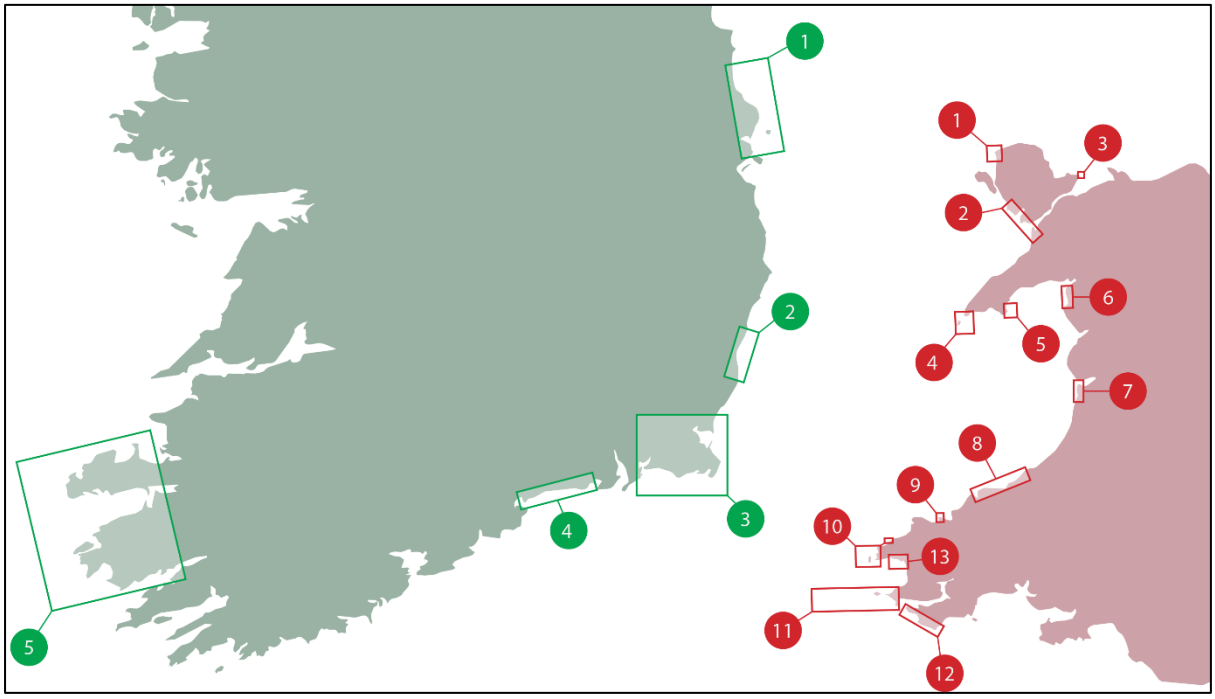

Figure 1: Map of Ireland and Wales showing the 17 principle project areas in both nations. Dinas Dinlle is located in Wales, Area 2. Crown Copyright: CHERISH Project.

The key objective of CHERISH is to increase knowledge and understanding of the impacts (past, present and near-future) of climate change, increased storminess and extreme weather events on the cultural heritage of reefs, islands and headlands of Wales and Ireland. The project seeks to fill gaps in both data and knowledge for the coastal regions of Ireland and Wales, to develop a greater understanding of climate change impacts on fragile coastal heritage sites and to establish new metrical precision for the rural, coastal landscapes under study.

3. INTRODUCTION

As part of ongoing investigations at Dinas Dinlle coastal hillfort, Gwynedd (NGR SH 4370 5635, Figure 4) the EU-funded CHERISH Ireland-Wales project undertook cliff-face investigations of archaeological deposits visible along the top of the eroding cliff-face of the hillfort and a core transect across its southern defences (Figure 2). This work took place between the 3-7 June 2019 with full permission from the landowner, the National Trust, and with Scheduled Monument and Site of Special Scientific Interest (SSSI) consent from Cadw and Natural Resources Wales (NRW) respectively.

The investigation of the cliff-face was carried out at two locations (Areas A and B; Figure 2) where potential archaeological features were identified during preceding CHERISH surveys. Where features were successfully accessed by ropes, they were lightly cleaned and investigated by hand. Features investigated within Area A were found to be natural in origin, but in Area B where the inner ditch of the hillfort was exposed full detailed recording was undertaken to record soils, cuts features and deposits. Here the section of cliff-face was recorded digitally using UAV photography which was used to create a photogrammetric orthomosaic (Figure 12). This was subsequently used to produce a digital section drawing (Figure 13). Context sheets were completed on-site to record the composition of visible deposits and a standardised Munsell soil colour chart was used when describing colours. No artefacts were recovered but samples were taken from 5 deposits visible in section for Optically Stimulated Luminescence (OSL) dating to provide a chronology of likely dates of deposition.

As part of the core transect across the southern defences, eight locations were identified 30 to 45m from the eroding edge. These were extracted along a transect running from the fort interior, through the internal bank, ditch and to the crest of the outer bank (Figures 2 and 18). The location of each core was recorded using GNSS and cores retained at Aberystwyth University for further analysis. As these cores were extracted away from erosion and slumping it is hoped that they will represent, in part, *in situ* stratigraphy relating to the construction, composition and height/depth of the southern defences.

The work was carried out by CHERISH personnel from the Royal Commission on the Ancient and Historical Monument of Wales (RCAHMW) and Aberystwyth University: Department for Earth Sciences. Supervision was provided by Plas y Brenin outdoor centre to ensure all activities carried out by CHERISH personnel adhered to European Union and United Kingdom rope safety and rescue training standards. All personnel involved participated in a two-day safe working at height course provided by Rescue 3 International at Plas y Brenin prior to this work.

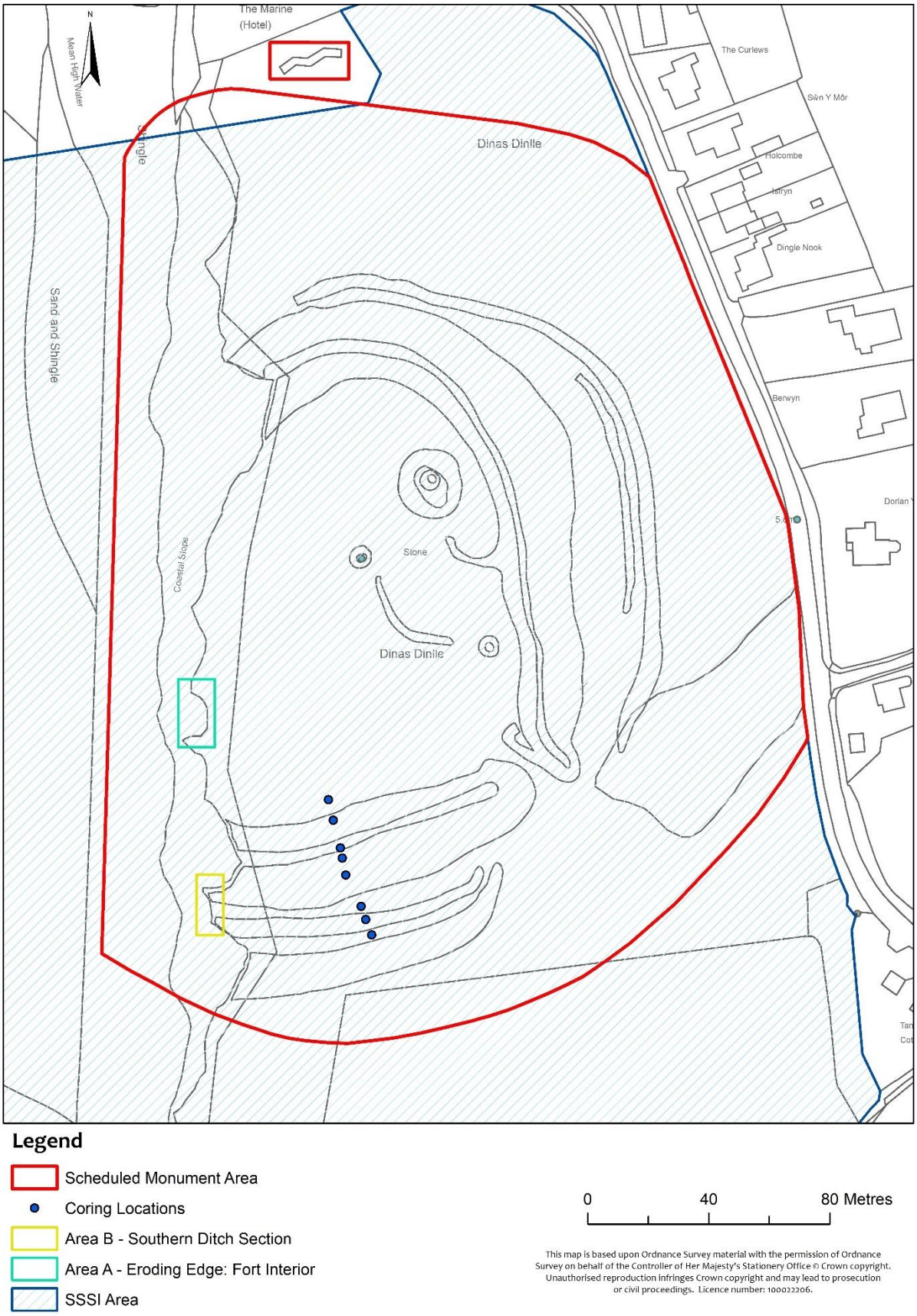

Figure 2: Map showing the location of the cliff-face investigation and the core transect work. The limits of the Scheduled Monument and Special Site of Scientific Interest areas are also shown.

3.1 Fieldwork Aims and Objectives

The key aim of this phase of investigation and survey at Dinas Dinlle was to:

- Investigate and characterise visible archaeology along the eroding cliff-face and assess the southern defences through coring.

The main objectives were to:

- Characterise and record any archaeological remains identified and assess their potential for understanding the historical development of the area, in conjunction with the known archaeological record;
- Where possible, date identified features that are immediately at risk from coastal and terrestrial erosion through the use of radiocarbon or Optically Stimulated Luminescence (OSL) dating;
- Test if percussion coring is a suitable technique to reliably characterise sediments and soils from an archaeological context where traditional excavation techniques might be impractical or could exacerbate erosion;
- To place the results in context, in relation to other work undertaken on the hillfort and with reference to *A Research Framework for the Archaeology of Wales Version 03, Final Refresh Document March 2017*.

Figure 3: Dinas Dinlle Hillfort, clearly showing the erosion to the western side of the monument. Crown Copyright: RCAHMW AP_2014_0877.

3.2 Acknowledgements

CHERISH would like to thank the National Trust as landowners and Cadw and Natural Resources Wales (NRW) for providing consent for the work to take place. We are also very grateful to Ollie Davies from Plas y Brenin National Mountaineering Centre for providing all of the equipment and keeping the team safe while carrying out our cliff-face investigations.

The work was carried out by CHERISH personnel from the Royal Commission on the Ancient and Historical Monument of Wales (RCAHMW) and Aberystwyth University: Department of Geography and Earth Sciences, specifically Louise Barker (RCAHMW), Sarah Davies (AU), Hywel Griffiths (AU), Daniel Hunt (RCAHMW), Helen Roberts (AU) and Patrick Robson (AU).

Figure 4: Professor Helen Roberts taking OSL samples from the southern ditch section (Area B). Crown Copyright: CHERISH Project.

4. SITE BACKGROUND

4.1 Site Location

Dinas Dinlle coastal hillfort (NGR: SH 4370 5635) is located immediately south of the village of Dinas Dinlle, Gwynedd where it is situated at the western edge of the reclaimed wetlands of the Caernarfonshire coastal plain (Figure 5). The fort is constructed upon part of a glacial push moraine (Harries *et al* 1997), the resulting hill dominating the low-lying coastal landscape. The site is open access owned by the National Trust and under pasture, grazed by sheep. It is crossed by the Wales Coast Path and provides the backdrop to a popular beach; it is therefore widely accessible to the public.

Figure 5: Map showing the location of Dinas Dinlle hillfort within the red box.

4.2 Archaeological context

Dinas Dinlle coastal hillfort (SM: CN048; SSI ID: 616) (NPRN: 95309; PRN: 1570) encloses the crest of a glacial deposit, defined through a series of banks and ditches that exploit the feature's natural topography. Based on its morphology, a fort of this type would conventionally date from the Late Bronze or Iron Age (c. 1200BC – AD 43) while stray Roman finds found within the fort and on the beach, together with a prominence in early medieval Welsh literature and folklore, suggest a longer potential history. This history stretches to the modern day with the hillfort incorporated into a golf course during the early decades of the twentieth century, and later during the Second World War, defences for the protection of the nearby RAF Llandwrog were constructed into the foot of the fort's northern slopes.

The hillfort defences are largely regarded as bivallate with an entrance in the south-east, typical to that of similar hillforts in this part of Wales such as Dinas Dinorwig, Llanddeiniolen and Craig-y-Dinas, Llanllyfni (Riley & Smith 1993), however, a CHERISH earthwork survey carried out in 2017 postulates a second entrance in the north-east. Within the interior of the fort earthworks are visible including a distinct mound in the north east corner and several banks and hollows. Geophysical survey (Hopewell 2018) together with GPR survey (Udyrysz-Kraweć & Wajzer 2020) and evaluation excavation (Lynes *et al* 2019) has also identified sub-surface remains including several roundhouses.

Due to large-scale terrestrial and coastal erosion only the northern, eastern and southern sides of the fortifications remain today (Figure 3).

4.3 Geomorphological Context

Beyond the hillfort and glacial hill is a varied landscape consisting of a range of different environmental types. To the west is a long shingle beach which defines the zone between Dinas Dinlle and the Irish Sea. Surrounding the landward sides of the fort are the marshes of the Caernarfonshire plains which have been subject to huge amounts of reclamation work since the post-medieval period. Work has recently been undertaken by CHERISH in an area of scrub woodland about 600m to the east of the hillfort where a sediment core was taken to assess its potential for pollen and diatom analysis. Three samples have also been submitted for radiocarbon dating to provide a chronology that could possibly span the past 3,000 years. It is hoped that this analysis may provide important information relating to the hydrology and vegetation history of the land surrounding Dinas Dinlle. Work is on-going and preliminary results are anticipated to be ready in early 2020.

To the north, at the mouth of the Menai Strait, is the extensive sand and gravel spit of Morfa Dinlle and behind it to the east a large estuary served by two rivers; Afon Rhyd and Afon Gwyrfai. A Ground Penetrating Radar (GPR) study coupled with some preliminary

Optically Stimulated Luminescence (OSL) dating conducted 10 years ago suggested beach ridge formation was initiated around 2100 years ago (Bristow, 2011; Duller, 2011). This would suggest that the landscape of Morfa Dinlle may have developed concurrently, at least in part, with occupational phases of Dinas Dinlle.

The GPR evidence suggests that alternating sequences of sand and beach gravels were formed by coastal processes developing in a westward direction. The older ridges are aligned along a north-east to south-west bearing, but latterly their orientation has altered to a north-northeast alignment. Superimposed on the ridges is a large, stable sand dune complex also on a north-northeast alignment. In October 2019, the CHERISH Project excavated 12 trenches through the beach-ridge system to confirm their composition and took samples for OSL dating to provide a robust chronology of their formation. The processing of OSL dates is a lengthy procedure, and consequently the results for Morfa Dinlle are not expected before the summer of 2020. The formation of these features undeniably had a huge influence on the changing environmental conditions in and around Dinas Dinlle. Understanding this environmental change is essential to understanding how the landscape would have appeared during the lifespan of the fort and how humans adapted to an extremely dynamic and challenging landscape.

4.4 Previous Work

The investigations which form the focus of this report form part of a wider programme of work being undertaken by the CHERISH project within the fort and its wider environs. All work carried out prior to and by CHERISH thus far is summarised in Appendix 1. This includes several non-invasive evaluations such as analytical earthwork survey, geophysical survey, UAV and laser scan surveys. Invasive work has comprised small-scale watching briefs during the installation of new fencing within the hillfort and a larger CHERISH funded community evaluation excavation undertaken in August 2019 within the interior of the hillfort and the field immediately to the south.

4.5 Designations and Scheduling

Dinas Dinlle is a site of national importance designated not only for its archaeological potential but also for its geological significance as a complex of glacial deposits containing a wide range of sediment types and glaciotectonic structures. Because of this, the site is protected by various pieces of protective legislation, all of which were considered in advance of investigations. The following designations and scheduling are active at Dinas Dinlle (Figure 2):

Designated Scheduled Monument – CN048 Dinas Dinlle

Dinas Dinlle hillfort is designated for its national importance and significant archaeological potential. This site has the potential to further our knowledge of monuments of this type. The following statement has been taken from the Cadw scheduled monument report:

"The monument is of national importance for its potential to enhance our knowledge of prehistoric and Romano British settlement and defence. It retains significant archaeological potential, with a strong probability of the presence of associated archaeological features and deposits. The structures themselves may be expected to contain archaeological information concerning chronology and building techniques." (Cadw 2018).

There is also a second scheduled monument within the National Trust site boundary CN396: Dinas Dinlle Seagull Trench. This monument is situated immediately to the north of the scheduled fort and is scheduled due to "*its potential to enhance our knowledge of World War II defence practices".*

Site of Special Scientific Interest – SSSI ID 616 Dinas Dinlle

The underlying geology at the site is also of national importance for its unique sequence of glacial deposits, readily visible in western eroding cliff-face. According to Natural Resources Wales's (NRW) statement on designation Dinas Dinlle has one 'special feature':

- Pleistocene/Quaternary landform assemblage and associated subsurface.

The following is NRW's summarised reasoning statement for SSSI protection:

"The 900m-long section of coastal cliffs at this site is of special scientific interest because it provides a profile through a nationally important sequence of sediments deposited during the last Ice Age. These deposits comprise a complex series of Irish Sea and Welsh tills with associated sands and gravels, which have been extensively folded and faulted. The two drift mounds at Dinas Dinlle are also important features in their own right and provide important evidence on how the sediments may have accumulated."

Consent for working on the Scheduled Monument and Special Site of Scientific Interest was **granted** by Cadw and NRW (Appendix 2).

5. CLIFF-FACE INVESTIGATION

The aim of this work was to locate, record and characterise potential archaeological features and deposits eroding from the cliff-face identified during a CHERISH UAV monitoring survey in February 2019. These included potential pits and/or ditch features within the interior of the hillfort and the earthworks of the southern defences. The following two areas were identified for investigation (Figure 2):

- **Site A** – NGR SH 436 563 – 60m band across the interior of the fort
- **Site B** – NGR SH 436 562 – 13m band across the exposed southern ditch section

5.1 Area A – Eroding Edge: Fort Interior

This area was centred on NGR SH 436 563, within one of the concave inlets along the cliff-face that represents an increased zone of weakness. Three individual features were investigated within this area at SH 43642 56329, SH 43646 56325 and SH 43643 56316. These had provisionally been identified as archaeological features and thought to represent pits and/or ditch features within the interior of the hillfort (Figure 6)

Figure 6: Potential archaeological features- pits and/or ditch features - identified during a CHERISH UAV monitoring survey in February 2019. The left-hand image shows the features standing out as darker (wetter) deposits with feature SH 43642 56329 on the left and SH 43646 56325 in the middle. The right-hand image shows feature SH 43643 56316. Crown Copyright: CHERISH Project.

Methodology and results

The three individual features investigated were lightly cleaned by hand (Figure 7) and photographed using a UAV (Figures 8 and 9). No further recording was undertaken due to the features being identified as natural in origin, formed through sedimentary changes in the geological substrate. This substrate was topped by a heavily eroded loose, pale brown wind-blown sand, around 0.3m in depth that supports the c. 0.2m thick turf layer vegetating the site.

Figure 7: UAV image showing Louise Barker and Patrick Robson investigating a possible archaeological feature at SH 43643 56316 within the interior of the fort (see Figure 7 below). Crown Copyright: CHERISH Project.

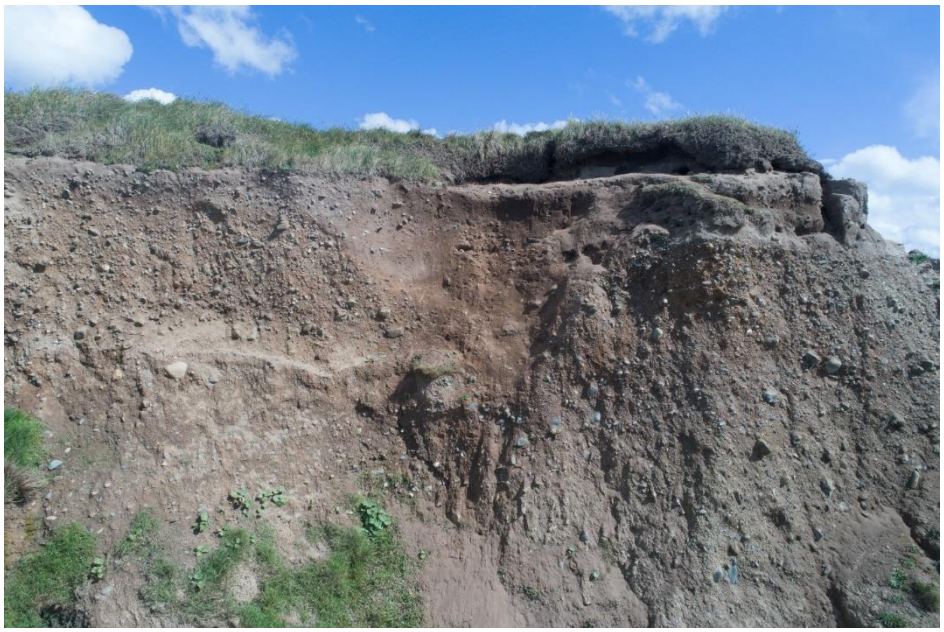

Figure 8: UAV image of feature SH 43643 56316 following cleaning. Excavation found this to be a natural formation within the upper geological substrate. Crown Copyright: CHERISH Project.

Whilst no archaeology was recovered, this work allowed for a detailed assessment of the erosion taking place at this location and which generally reflects that affecting the whole monument. Two distinct forms of erosion were identified:

1. The upper sand unit is being predominantly eroded by exposure to the wind and rain, undercutting the upper turf layer, and leaving behind a scoured 'shelf' or surface at the junction with the harder sediments. The weight of the overburdening turf is also causing slumping and degradation, clearly seen on the surface. These two processes are exacerbated by avian and mammalian activity exploiting the softer sand units for burrows and nest sites (Figures 8 and 9)

2. Rain water infiltrating the surface of the fort interior passes easily through the sand units but is restricted by the dense nature of the underlying glacial sediments. When saturated, the water emerges from the cliff-face at the interface between the soft and hard sediments which promotes gravitational slumping and degradation of the softer sediments. Surface run-off during intense rainfall events also incise and erode the sediments, this is exacerbated locally by topographic features and faunal activity. If the predictions of increased rainfall intensity associated with near future impacts of climatic change are realised, it is likely that erosional pressures at Dinas Dinlle will increase. It is apparent from CHERISH observations over the past 3 years that the intensity of rainfall is having a significant direct impact on the erosion of the hillfort, effectively 'pushing off' the soft sediments from the cliff face.

Figure 9: UAV image of showing the entirety of Area A post investigation. Clearly visible is the heavy erosion caused by prevailing winds. This erosion has undercut the upper turf layer and left behind a scoured 'shelf' of more resilient sediments. Crown Copyright: CHERISH Project.

5.2 Area B – Southern Ditch Section

This area was centred on NGR SH 436 562 and involved the investigation of the heavily eroding southern defences, specifically the inner southern ditch. During a CHERISH monitoring visit on the 14th February 2019, a significant collapse of the upper sediments of the ditch section was observed to have very recently occurred (Figure 10). Surface fissures and cracks had been observed in the area on previous visits and the collapse occurred during or immediately after period of intense rainfall. This area therefore had significant archaeological and geological study potential.

Figure 10: UAV images showing the cliff-face before (upper image, dated 11 June 2018) and after the collapse in early 2019 (lower image, dated 14 February 2019). The collapse revealed what appeared to be the clear edge / cut of the inner ditch and a previously unreported fill of sand. Crown Copyright: CHERISH Project

Methodology

The investigation area was located towards the top of the cliff and comprised a 13m wide and maximum 4m deep section of vertical cliff-face (approximately 40m^{sq}). The section was cleaned by hand and prepared for recording and interpretation by both archaeologists and geographers (Figure 11). Only a portion of the working area could be sufficiently examined due to issues with accessibility, the presence of slumped material and the inability to use certain tools safely at height while supported by ropes. The upper contexts 001 and 002, which had been exposed prior to the 2019 collapse were also heavily eroded and unstable, the sand of context 002 has been eroded by exposure to wind and rain as well as avian and mammalian activity, all leading to the overhanging turf of context 001. For these reasons only limited work was undertaken at the uppermost level.

Figure 11: Investigation of the inner ditch showing Patrick Robson, Dan Hunt and Louise Barker cleaning the exposed section. Crown Copyright: CHERISH Project.

All deposits encountered within the ditch were recorded using RCAHMW context record sheets, Munsell soil colour chart and UAV digital photography captured in RAW format. Overlapping UAV imagery was captured to produce a Structure from Motion (SfM) 3D reconstruction and orthomosaic of the site for archiving (Figure 13). Ground Control Points (GCPs) located on the section were surveyed in using Leica GNSS (Leica GS16 & CS20) and Leica reflectorless total station (Leica TCR 1205) to georeference and scale the

3D data captured. Hand-drawn scaled section drawings were not produced due to the difficulties posed by working at height. Instead, a sketch section was drawn on site and subsequently a digital section drawing was transcribed from the orthomosaic created from the SfM imagery (Figure 13). For further details on the UAV survey see the *CHERISH UAV Monitoring Event Report* (Appendix 3).

Five samples were taken through the profile of the ditch from contexts 011, 010, 007, 005 and 003 for Optically Stimulated Luminescence (OSL) dating (Figures 4 and 12). These were taken by Professor Helen Roberts from the freshly-cleaned cliff-face using opaque black plastic pipe approximately 5cm in diameter and 25cm in length driven horizontally into the exposure using a hammer. Each sample was well-packed with non-absorbent materials to prevent sediments from being mixed within the sample tube and sealed for transport to the Aberystwyth Luminescence Research Laboratory. Once each sample had been removed from the section, an additional small sample of material was taken from the deepest part of the sample hole and carefully wrapped to preserve the moisture content at the time of sampling; this, along with other assessments, will help to inform the final value of water content used for age calculation. Each sample hole was slightly enlarged and deepened using a specially modified short-auger designed for use in cramped conditions, to facilitate *in situ* field measurements of the gamma dose rate at the point where the OSL sample was taken. Assessments of the gamma dose rate were made using a digiDART™ portable gamma spectrometer equipped with a sodium iodide crystal. The locations of samples are indicated in the section drawing (Figure 14), and the sample holes are also visible in the orthomosaic of the ditch section created from the SfM imagery (Figure 13).

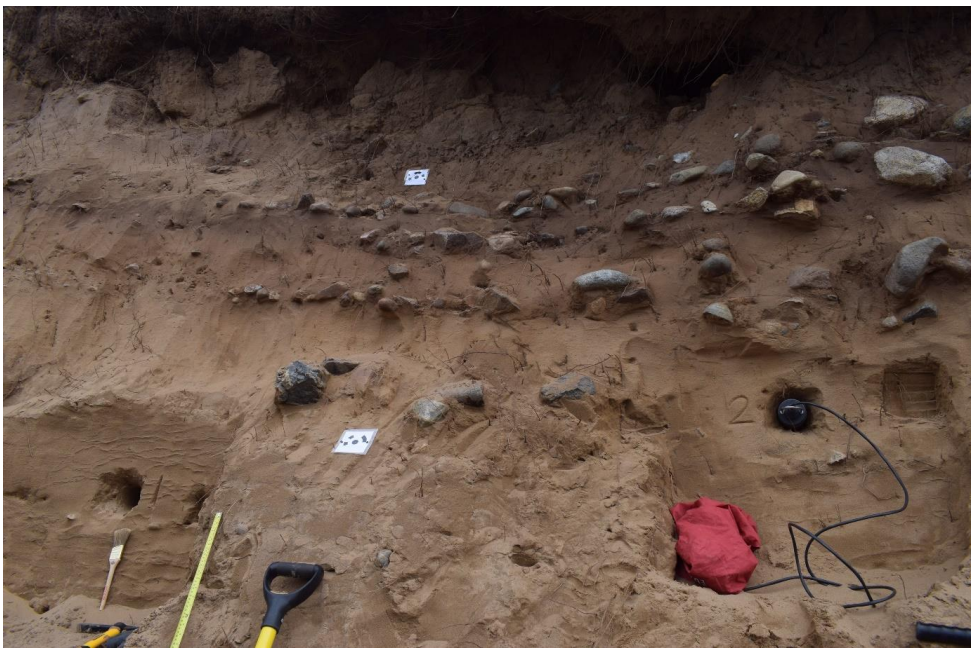

Figure 12: OSL sample location 1 (left-side of image, above paintbrush for scale) and 2 (right-side of image, with gamma spectrometer deployed in the sample hole created by taking the OSL tube-sample). Crown Copyright: CHERISH Project.

Results

The collapse of the cliff-face in early 2019 exposed a clear section across the inner ditch of the hillfort, with subsequent UAV photography revealing what appeared to be the clear edge / cut of the ditch and a previously unreported fill of sand. This had clear archaeological, geomorphological, climate and weather history significance and was therefore a priority for investigation. Its exposure also provided the opportunity for the least destructive method of excavating hillfort defences when compared with a traditional trench excavation.

The cleaning of the section revealed the clear cut of a ditch and that the sand fill was not a single depositional unit, but a series of distinct layers, 11 in total (contexts 001 to 011) relating to a number of depositional regimes. A detailed drawing of the section is presented in Figure 14 and full context description as Table 1. No finds were recovered.

Figure 13: Orthomosaic of the southern ditch section created from overlapping SfM UAV imagery in Agisoft Metashape. Ground Control Points(white targets) were used to georectify and scale the image. The series of layers within the ditch can be seen along with the circular holes where OSL samples were taken. Crown Copyright: CHERISH Project

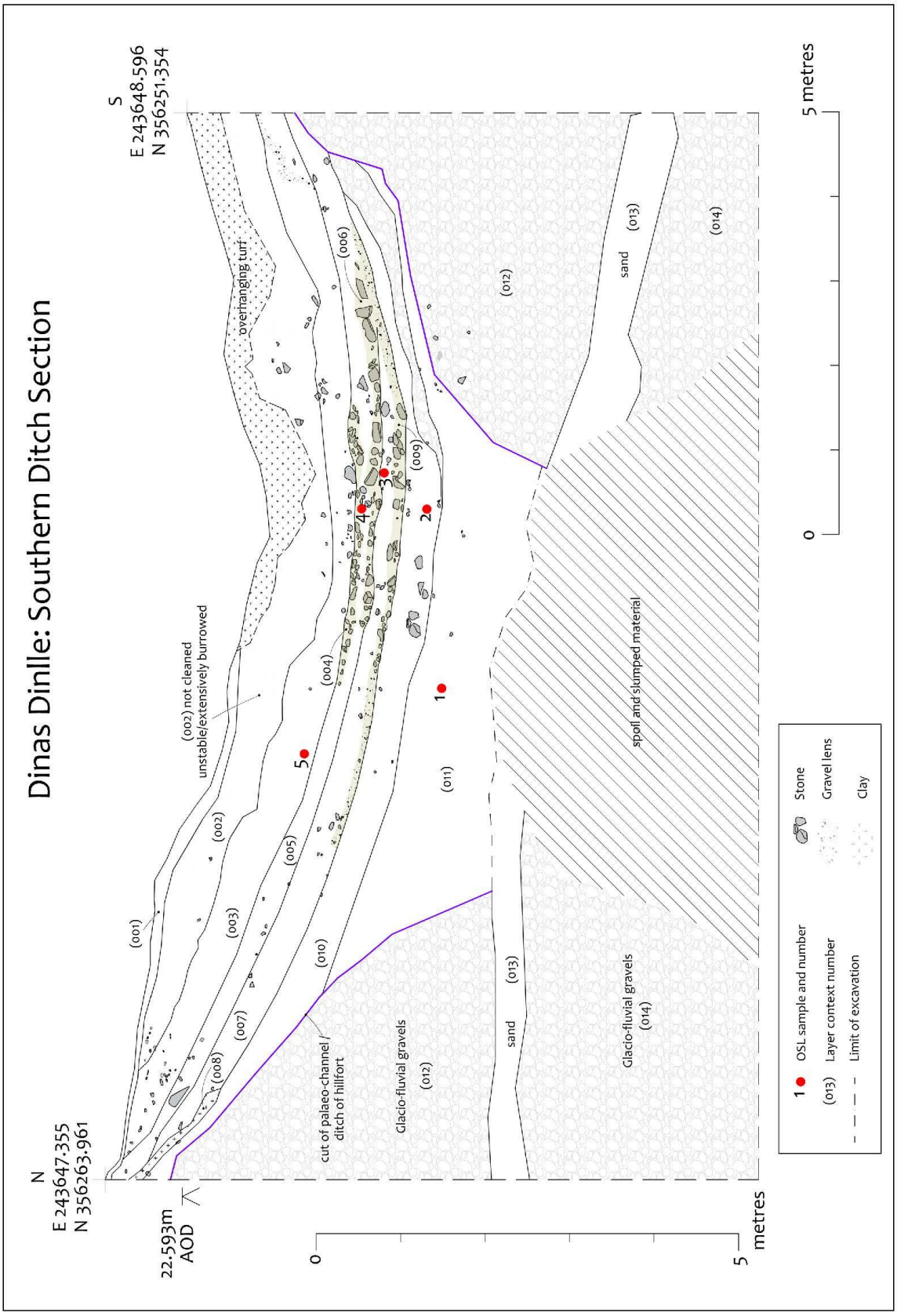

Figure 14: Section drawing of Area B – Southern Ditch Section. All units and features seen here were transcribed from the created orthophoto shown in Figure 13. The drawing also shows the locations of the OSL samples extracted (shown in red). Crown Copyright: CHERISH Project.

Table 1: Area B – Southern Ditch Section, context description

Context No.	Description	Compaction	Colour (Munsell)	Composition	Inclusions	Extent and Thickness
001	Turf and topsoil. Overhanging in places.	Loose	Brown	Sandy	None	Across whole section, max 20cm thickness.
002	Sand -wind-blown? Modified by biological activity, physical and chemical weathering processes	Loose	Very pale brown	95% fine sand – well sorted	Very occasional small-medium stones – max 10cm. More on south side of section with gravel.	Across whole section, 40cm – 80cm thickness.
003	Sand. Some modification by biological activity, physical and chemical weathering processes.	Loose	Light yellowish brown	85% fine sand – well sorted	Frequent small gravel inclusions – max 5mm diameter with gravel band on north and south sides of section. Very occasional small-medium stones max 18cm.	Across whole section 25 – 73cm thickness.
004	Spread of stones in middle of section, set within top of (005)	N/A	N/A	100% cobbles 2cm – 20cm in diameter. Range between angular and rounded	N/A	3.3m spread, max 15cm thickness.

005	Sand	Loose	Brown	95% medium sand - well sorted	Very occasional angular stone inclusions max 3cm. Very occasional gravel.	Across whole section, even 20cm thickness.
006	Spread of stones across southern half of section, set within bottom of (005).	N/A	N/A	100% Cobbles 4cm – 25cm in diameter. Range between angular and rounded.	N/A	4.3m spread, max 14cm thickness.
007	Sand	Loose	Brownish Yellow	95% fine sand – well sorted	Very occasional rounded stones 1cm – 6cm in diameter	Set between (008) to (009), max 40cm thickness.
008	Silty clay lens at north end of section.	Stiff	Brownish orange	75% silts and clays	Very frequent gravels and stones 1cm – 3cm diameter	1.4m extent, max 14cm thickness.
009	Spread of gravel and stones in southern half of section, set within bottom of (007)	N/A	Brownish yellow	100% Cobbles 4cm – 19cm in diameter. Range between angular and rounded. Peters out to gravels at either end.	N/A	7.5m extend, max 14cm thickness.
010	Sand	Loose	Light yellowish brown	95% medium sand – well sorted.	Very occasional rounded stones mainly in middle of section between 6cm – 15cm diameter	Runs from (012) on south side of section. Thinner at either end of section, reaching max thickness of

						45cm in middle.
011	Sand with lenses of silts and clays	Firm	Light yellowish brown	80% medium sand	Very occasional rounded pebbles 1cm – 5cm diameter	1.5m thickness but not fully excavated.
012	Glacio-fluvial gravels	Stiff	Brownish orange	Coarse, clast-rich	Gravel to cobbles	
013	Sand	Firm	Light yellowish brown	tbc	tbc	Band between (012) and (013) 50cm thickness.
014	Glacio-fluvial gravels	Stiff	Brownish orange	Coarse, clast-rich	Gravel to boulder Size clasts	

A comprehensive geomorphological and GPR study of the glacial sediments at Dinas Dinlle by Harries *et al.* (1997) recorded a large unit of gravel in this particular section of the moraine and classified it as glacio-fluvial outwash, with a thick sequence of sand at the base. Contexts 014 and 012 most probably relate to this glacial-fluvial outwash, although here it is separated by an unreported 50cm bed of sand, context 013. The glacial-fluvial gravels of context 012 appears to have been cut into a broad v-shaped ditch and subsequently infilled with sediment units of contexts 002 – 011 which have been capped by the turf and topsoil of context 001. The limits of the excavation meant that neither the full width or depth of the ditch was revealed, and it is unclear how far the cut continues down through the sand of context 013 and glacial-fluvial gravels of context 014. In the section excavated the ditch measures a maximum width of 12.62m and depth of 4m.

Within the ditch, the lowest fill excavated was context 011, cleaned to a maximum depth of 1.6m, though not fully excavated. This comprised a medium sand with clear lenses (ripples) of silts and clays throughout and very occasional horizontally-bedded pebbles between 1cm and 5cm in width (Figure 15). This type of sediment structure is strongly indicative of fluvial deposition with a variable flow regime. The presence of water-lain sediments therefore suggests that the glacio-fluvial gravels of context 012 was cut by fluvial activity and thus the ditch is natural in origin and represents a palaeo-channel, rather than entirely human in origin and dug during the construction of the hillfort.

Figure 15: A close-up of the fluvial ripples revealed with a soft brush within context 011. The unit comprises medium sand, rippled with silts and clays and occasional horizontally-bedded pebbles. OSL sample 1 taken from the middle of this unit is indicated by the circular depression in the centre of the image. Crown Copyright: CHERISH Project.

Above context 011, the depositional regime of ditch fill, contexts 003 to 010, is less certain. It could result from fluvial, aeolian, gravitational processes or anthropogenic activity, or indeed a combination of processes. OSL dating of these contexts is therefore critical to understanding when and how they were deposited and the relationship between them and the occupation of the site. These contexts comprised three broad groups:

- Contexts 010, 007, 005 and 003 were all well sorted loose sand units running across the full width of the ditch/section, from which samples were taken for OSL dating (Figure 16).
- context 008 was an isolated 14cm thick silty clay lens at the northern end of the section between sand units 010 and 007.
- contexts 009, 006 and 004 were spreads of stones (cobbles and gravels) concentrated towards the southern side of the ditch (Figure 17).

Above these contexts was the heavily disturbed and eroded context 002, a band of likely wind-blown sand between 0.4 and 0.8m thick on top of which the turf and topsoil layer

context 001, provided a capping and evidence of stability to what is otherwise a very dynamic and highly erodible ditch fill sequence.

Figure 16: Image showing the central section of the ditch, the fills of sand and stone spreads. The fluvial ripples of context 011 can be seen below the scale whilst the darker brown sand of context 005 is near the top. Crown Copyright: CHERISH Project.

Figure 17: Image of the stone spreads (contexts 009, 006 and 004) within the ditch fill. The circular holes in the section relate to OSL sample locations 2, 3 and 4. Crown Copyright: CHERISH Project.

6. CORE TRANSECT SURVEY

6.1 Methodology

Recording and analysis of the visible stratigraphy of *in situ* deposits is crucial to understanding the possible function of the site, its formation, construction and abandonment. A coring transect across the southern ramparts was carried out in order to investigate the nature of the southern defences without the need for excavation, which would have been logistically challenging, destructive and time consuming. With the exception of the inner ditch section described above, the exposed rampart section at the cliff edge was deemed too difficult and dangerous to be properly cleaned for recording - it was far too heavily eroded and had an uneven stepped profile.

The rationale for the coring at Dinas Dinlle was to:

- Investigate the sediment stratigraphy of the site without breaking ground with traditional trenches;
- Determine if it is possible that archaeological horizons could be identified in core sections;
- Compare sediment stratigraphy across the site and to the exposed cliff section.

The firm dry sediments of Dinas Dinlle are too compacted to be sampled with a hand-driven Russian or Livingstone corer, therefore an Atlas Copco Cobra percussion corer was employed. The Cobra uses a petrol driven engine to produce compressed air to hammer a 1m core barrel with 4cm internal diameter into the ground (Figure 18). The core is retrieved using a manual jacking system.

Figure 18: Hywel Griffiths and Sarah Davies coring through the southern outer rampart. Crown Copyright: CHERISH Project.

A series of 8 locations were cored running in a transect from the hillfort interior over the inner bank, inner ditch and up onto the crest of the outer bank. The transect was located 30-45m away from the eroding cliff edge (Figure 19). Core depths varied from 30cm to 200cm, and depths at each sampling point are detailed in Table 2. Since their extraction the cores have been stored below 5°C at Aberystwyth University.

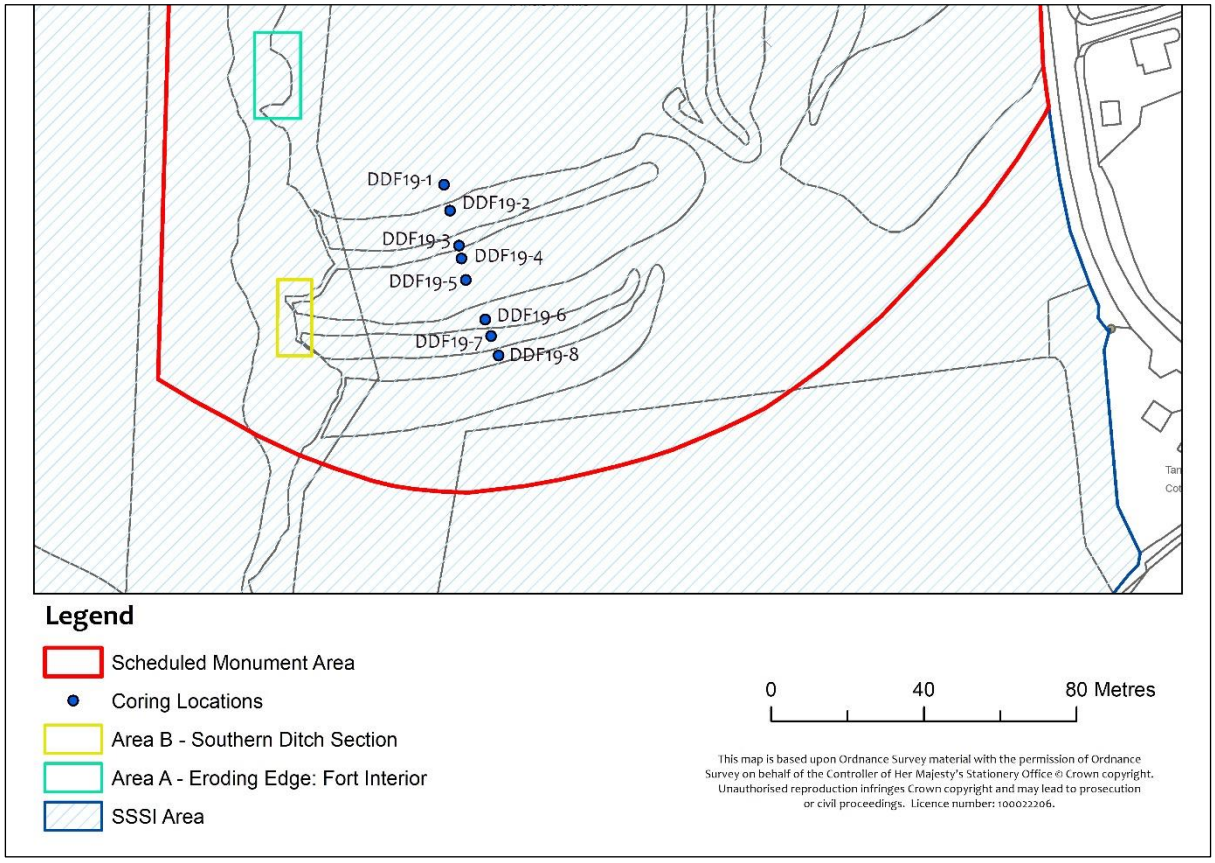

Figure 19: Map showing location and ID of core transect. Crown Copyright: CHERISH Project.

Table 2: Core ID, grid reference and descriptive location within the hillfort, and the number of sections driven at each location and depths of sections recorded on site.

Core ID	National Grid Reference	Location	Number of Sections Driven	Depth of Section
DDF19-1	SH 43685 56293	Hillfort interior	3 Sections 1A 1P 1A 2P 1B 2P	 0-50cm 50-150cm 10-110cm
DDF19-2	SH 43686 56286	Inner (north) face of inner bank	1 Section 2A 1P	 0-100cm
DDF19-3	SH 43689 56277	Top of inner bank	1 Section 3A 1P	 0-30cm

DDF19-4	SH 43689 56273	Outer (south) face of inner bank	1 Section 4A 1P	 0-30cm
DDF19-5	SH 43690 56268	Outer (south) face of inner bank	2 Sections 5A 1P 5A 2P	 0-100cm 100-200cm
DDF19-6	SH 43696 56257	Inner ditch	1 Section 6A 1P	 0-80cm
DDF19-7	SH 43697 56253	Inner (north) face of outer bank	1 Section 7A 1P	 0-100cm
DDF19-8	SH 43699 56248	Top of outer bank	2 Sections 8A 1P 8A 2P	 0-100cm 100-200cm

6.2 Results

The cores will be opened, logged and analysed in early 2020, and the results discussed in the final report. Our initial impression is that the stratigraphy broadly reflected that observed in the cliff-face section, principally layers of sand deposits. The depth of sections DDF19- 1, 5 and 6 down to what appears to be natural suggests we are likely to have hit archaeological horizons and this will be particularly interesting for cores DDF19-1 in the interior (Figure 20) and DDF19-8 which provides a section all the way through the outer bank. With the other cores large stones prevented complete retrieval of the stratigraphy, which in the case of cores DDF19-2, 3 and 4 suggest the presence of rampart walling.

Figure 20: Examining the stratigraphy of test core DDDF 1 in the interior of the hillfort, comprising 10cm of soil with roots over 70cm of uniform sand. Crown Copyright: CHERISH Project.

7. INTERIM CONCLUSIONS

The cliff-face investigations have provided an important insight into the evolution of Dinas Dinlle. From undertaking this work, we have improved our understanding of the formation of the southern inner ditch and gained a clearer understanding of some of the erosional processes affecting the site. It is also clear that the layers of sand encountered in both the ditch section and coring indicate that events leading to the deposition of substantial amounts of sand are likely to have played a large factor in the history of the site.

The investigation of the southern ditch in Area B suggests that it initially formed as a post-glacial palaeo-channel that incised the surface of the glacial gravels through fluvial processes. The channel was then likely incorporated into the defensive circuit of the hillfort as an inner ditch which is likely to have been modified by the builders during activities such as rampart construction and ditch clearance. Utilisation of natural features, such as hillslopes, cliff edges and to a lesser extent palaeo-channels in the construction of hillforts is not uncommon and raises the question as to how much of the site utilises/augments natural features, specifically further palaeo-channels.

As no artefacts or charcoal were recovered in the ditch section, dating the ditch fill deposits will be achieved through OSL and will be critical to understanding when and how they were deposited. Until this chronological time-sequence is established it is not possible to say with certainty how the formation of the channel and its subsequent in-filling coincides with the likely occupation of the fort. Interesting questions therefore remain at this point in time as to the timing and nature of events that led to the deposition of the sand in contexts 010, 007, 005 and 003, and the origin of the deposits of stone in contexts 004, 006 and 009 – are they laid through natural processes or the result of collapse/slumping of walling from the outer bank or in fact laid to keep material in the ditch. All in all, the lack of any soil horizons in the ditch section hints at either significant ditch clearance or more likely a very dynamic coastal environment.

Investigations in Areas A and B enabled more detailed analysis of the erosional pressures affecting the site. By assessing two separate areas it was clear that there are various forms of erosion taking place. Exposed sand layers are being eroded through exposure to strong winds from the sea, whilst rain water infiltrating the surface of the fort interior passes easily through the sand units but is restricted by the dense nature of the underlying glacial sediments. When saturated, the water emerges from the cliff-face at the interface between the soft and hard sediments which promotes gravitational slumping and degradation of the softer sediments. This was the clear factor in the collapse of the inner ditch section of Area B in early 2019 and along with wind erosion of the now exposed ditch fills will continue to be a weak point for future erosion.

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APPENDIX 1: SUMMARY OF PREVIOUS ARCHAEOLOGICAL WORKS AT DINAS DINLLE TO DECEMBER 2019

Summary of pre-CHERISH archaeological work

An analytical earthwork survey was carried out by The Muckle Partnership on behalf of The National Trust during the early 2000s (Figure 1). This survey recorded all visible archaeological features as well as a regressive study of past coastal erosion extending as far back as the 1880s. This plan also illustrates evidence of terrestrial erosion such as sheep scrapes. This data is held by The National Trust.

Gwynedd Archaeological Trust (GAT) have carried out several studies of the site which have not only looked at the archaeological potential of the fort but provided an insight into how erosional processes have, and continue to, affect the monument. As part of the wider Coastal Zone Assessment for Wales the trust carried out a study in 1993 that indicated early concerns surrounding the amount of the monument that has been lost to erosion. The report also suggests work that should be carried out in advance of further loss (Riley & Smith 1993) and progress was made with GAT undertaking the first geophysical survey (gradiometer) of the monument in 2004. Beyond this, GAT have carried out two wider studies of hillforts and defended enclosures in northwest Wales on behalf of Cadw. The 2004-2005 Prehistoric Defended Enclosure Survey (Smith 2005) and the 2008 Iron Age Settlements in Wales study (Smith 2008) which contributed to furthering the understanding of the site and its environs. The Arfordir Coastal Heritage survey (Parry; et al 2012) summarised these findings and provided a short chronology of the site from known finds and features. The most recent regional synthesis to include Dinas Dinlle is by Waddington (2013).

Intrusive evaluation at the site has been limited to two small watching briefs carried out in 2009 and 2010 (Brooks & Smith 2009; Evans & Jones 2010) during work to replace the footpath and fencing, both of which had been affected by erosion. Both surveys failed to identify archaeological remains beyond modern imported deposits.

In 2011 the Royal Commission and Vizworx LTD, Bangor University, collaborated on a basic 3D animation and reconstruction of the hillfort as part of the Peoples Collection Wales development work; the short animation can still be seen on YouTube with the full version available on the PCW website.

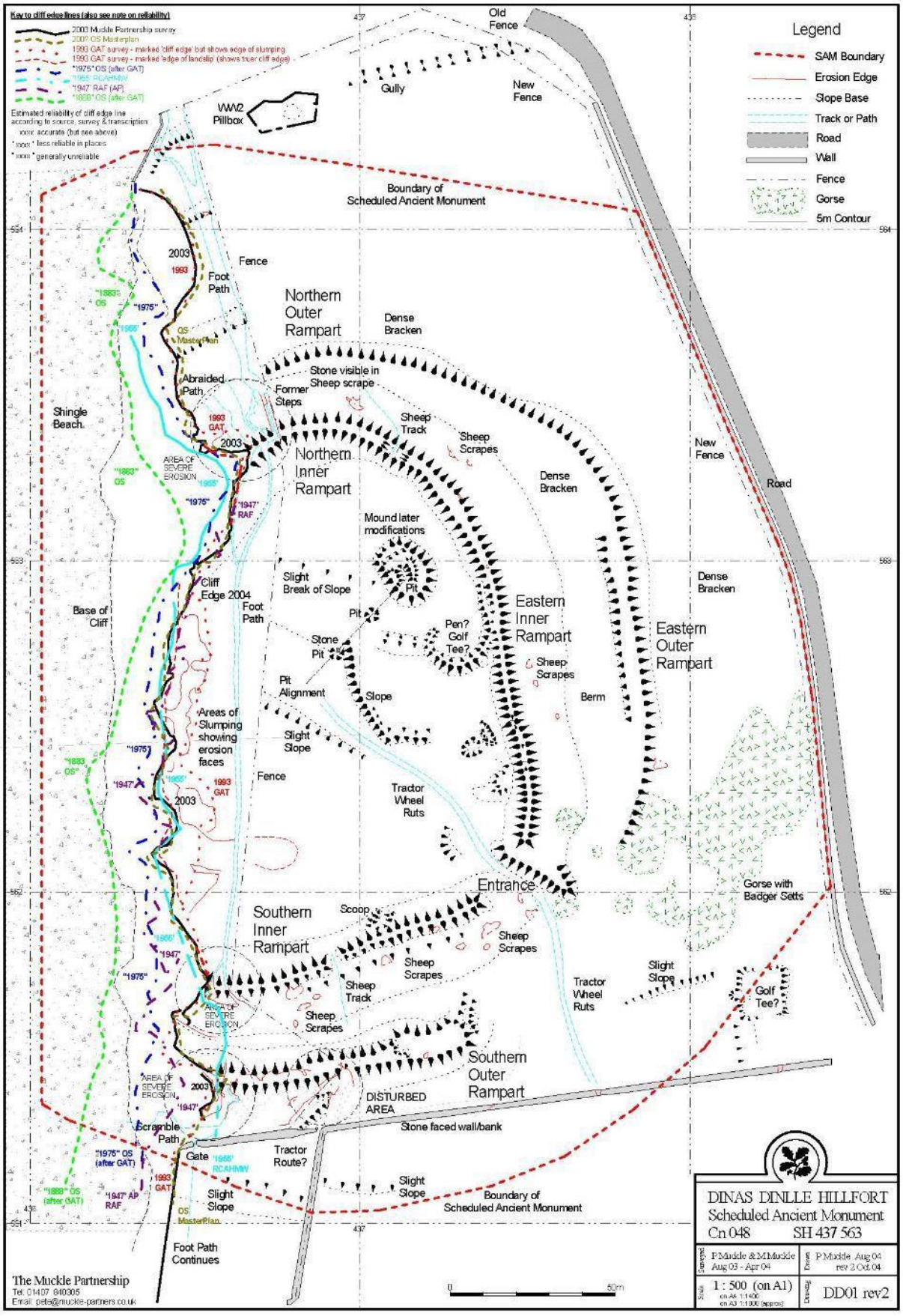

Figure 1. Analytical earthwork survey carried out by The Muckle Partnership of behalf of The National Trust in 2003 and 2004 (after Parry; et al 2011: 47).

Summary of CHERISH project work at Dinas Dinlle

Aligning with the key themes and objectives of the CHERISH project Dinas Dinlle was chosen as one of the priority areas of study due to its national importance and the substantial risk posed to the site from coastal and terrestrial erosion. Since the start of the project in January 2016 several phases of work have been undertaken to record the archaeological remains and provide accurate baseline datasets to be used to quantify erosional processes happening at the site over the course of the project and beyond. The following provides an overview of the work carried out by CHERISH staff from RCAHMW and Aberystwyth University. This summary also includes work commissioned and funded by the project:

Aerial Reconnaissance

Dinas Dinlle has comprehensive historic aerial photographic cover which includes low-level RAF coastal oblique sorties dating from 29/05/1951 and 26/05/1961 providing a valuable record of the front face of the eroding cliff, together with catalogued RAF vertical air photographs from 10/05/1946, 20/01/1947 and 11/01/1957 showing the eroding cliff edge in plan. In recent decades the fort has been recorded during observer-directed oblique aerial reconnaissance by the Gwynedd Archaeological Trust (1970s onwards) and the Royal Commission (1986 onwards with CHERISH since 2017); the earliest catalogued Royal Commission obliques date from 1990. Aerial cover of note includes a low-light sortie from 10/12/2012 by the Royal Commission which revealed very low earthworks within the interior (published in Archaeology in Wales 52, 168-9) and more intensive aerial survey for the CHERISH Project in 2017 to obtain initial structure from motion imagery alongside monitoring during the Summer drought of 2018.

New Analytical Earthwork Survey – Winter 2017

The first stage of ground-based work completed at the site was a new earthwork survey carried out with the intention of building and improving on the Muckle survey. This work was carried out by CHERISH staff from RCAHMW using a Global Navigation Satellite System (GNSS). All visible archaeological features along with evidence of terrestrial erosion were surveyed. The eroding coastal edge was not surveyed on this occasion due to health and safety concerns. This data was obtained through subsequent Unmanned Aerial Vehicle (UAV) and laser scan surveys. All raw data has been downloaded and the hachuring of the plan is currently in progress.

Initial results from the earthwork survey suggest a more complex arrangement of the defences defining the northern side of the fort, suggesting a third line of defence or an annex alongside an additional entranceway. Additional Archival research has also revealed more information about the early 20th century golf courses which ran across the fort and into fields to the south. A plan of the course by Eurwyn Lloyd Evans (2009)

provided the rough locations of its various features and using this plan alongside the recent earthwork survey, it has been possible to trace surviving elements of the course on the ground. Figure 2 shows an interpretive plan of the possible layout of the course which has been created as part of the CHERISH project.

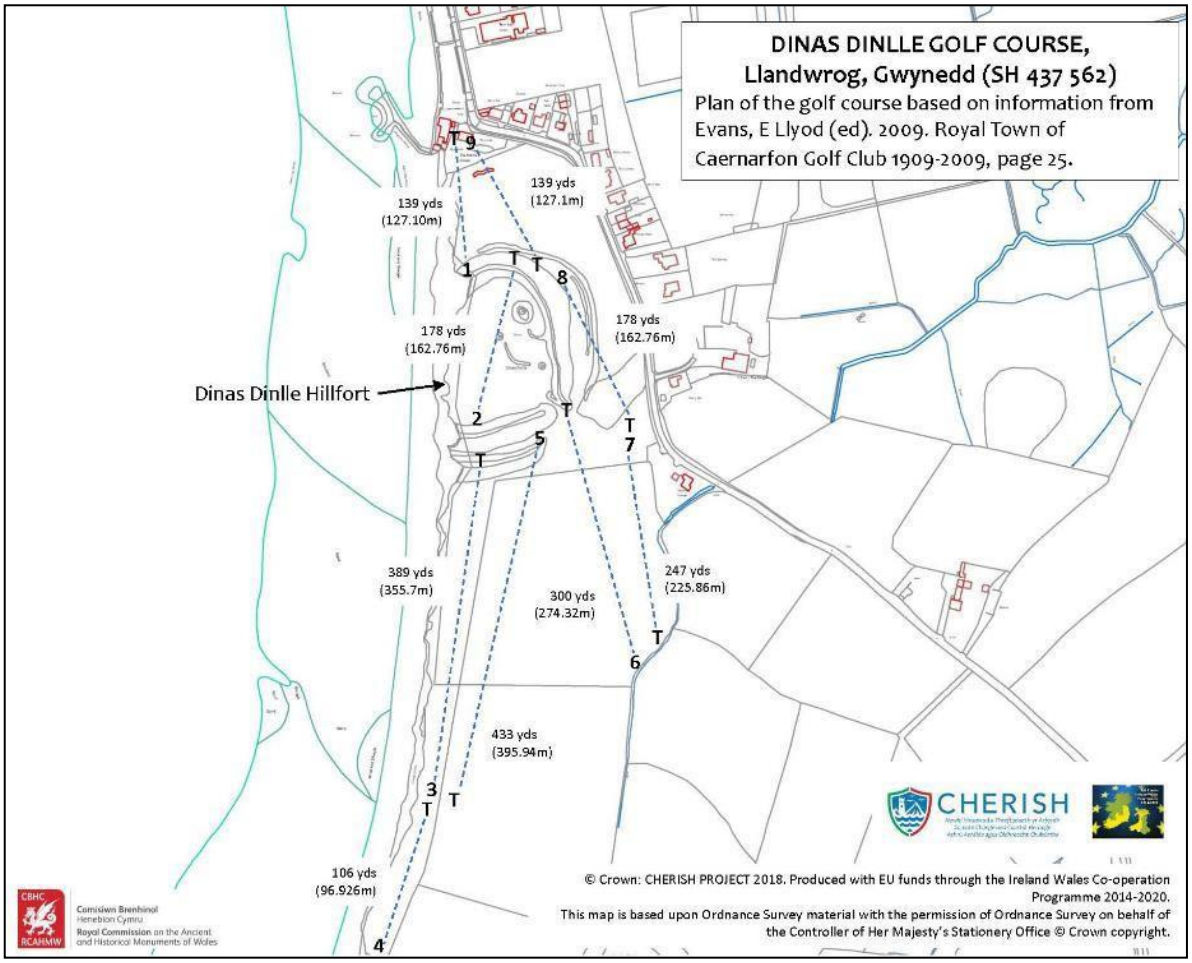

Figure 2: Plan showing the possible layout of the early 20th century Dinas Dinlle golf club (© Crown copyright: CHERISH project 2018).

Geophysical Survey (GAT commissioned by CHERISH) – November 2017 & May 2018

A geophysical survey (gradiometer) was carried out by GAT on behalf of CHERISH over two phases; November 2017 and May 2018 (Hopewell 2018) (Figures 3 and 4), improving on the previous survey carried out in 2004 (mentioned above). The first phase comprised a high- resolution survey (0.5m x 0.125m) of the interior of the fort which was limited to the western fence line and the feet of the inner rampart banks. The second phase comprised a standard resolution survey (1.0m x 0.25m) of the National Trust owned field immediately to the south of the fort and outside of the scheduled area. Both surveys greatly increased our understanding of the archaeological remains and potential at the site. The buried remains are likely to extend from prehistory to the post medieval period.

Numerous possible roundhouses and other anomalies were identified within the interior of the fort, several of which are situated very close to the eroding clifftop. Further possible prehistoric features, along with post medieval field boundaries, were identified in the southern field. This work has been completed through to final report where all findings and interpretations are delineated.

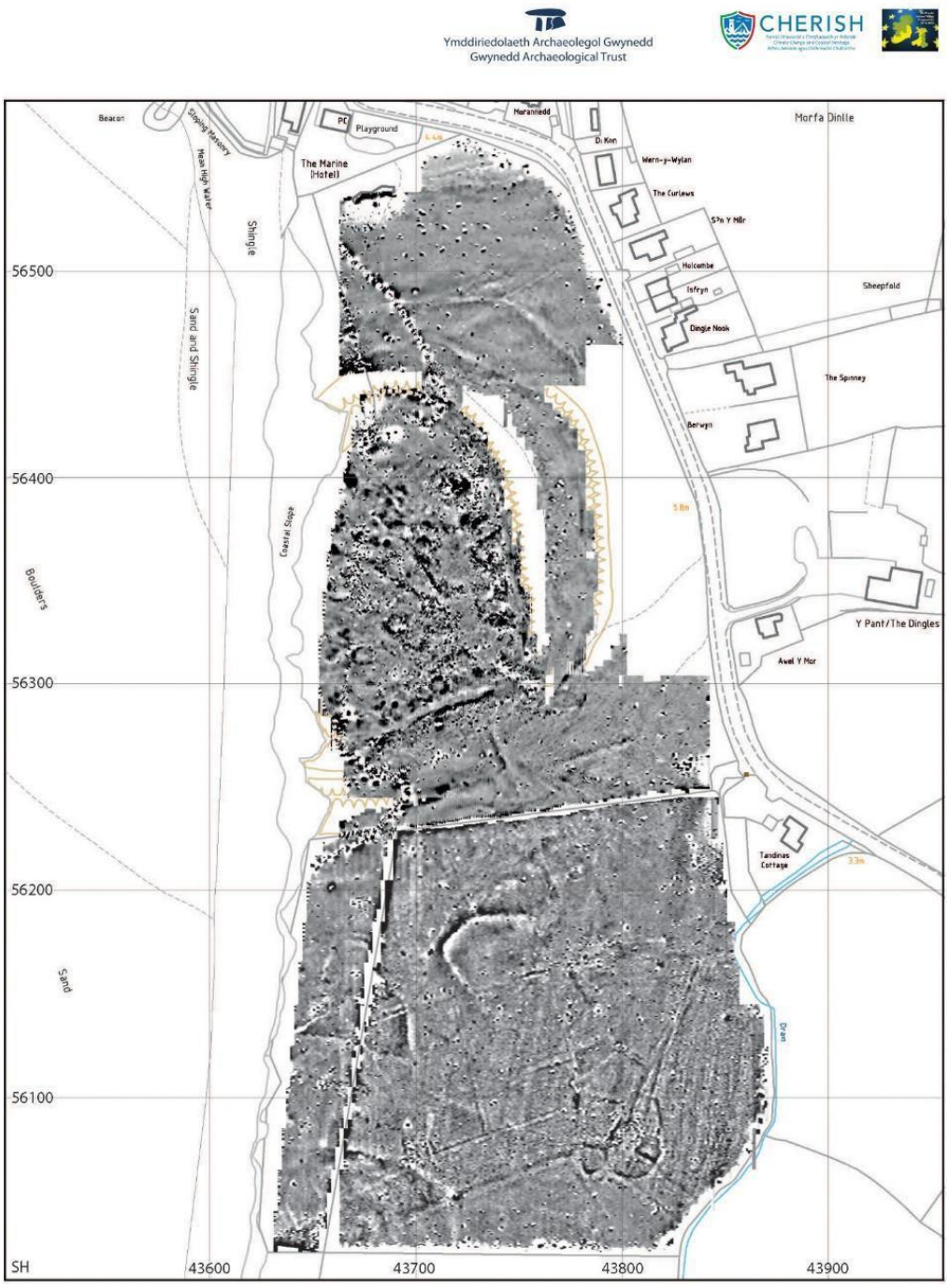

Figure 3: Result of GAT's 2017 & 2018 geophysical surveys of Dinas Dinlle coastal fort and environs (after Hopewell 2018: 8).

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

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Figure 4: Interpretation plot of anomalies identified during the 2017 & 2018 geophysical surveys of Dinas Dinlle coastal fort (after Hopewell 2018: 9).

Paleoenvironmental sampling of the wider landscape – May 2018 & February 2019

CHERISH staff from Aberystwyth University's Department of Geography and Earth Sciences have carried out some prospective paleoenvironmental work within the environs of the site. In May 2018, a 1.3m core retrieved (with a Russian corer) from NGR SH 44454 56573 was taken to test environmental potential within the surrounding wetlands. The basal date from this core was 2770 14C years BP. XRF elemental data was also collected from this core allowing for a rough pollen profile to be produced. However, it is thought that this may not produce a very reliable result due to poor preservation in the area.

In February 2019, a 2.25m sediment core was recovered from an area of scrub woodland about 600m to the east of Dinas Dinlle with the kind permission of Llyr Ellis. This core is currently under investigation to assess its potential for pollen and diatom analysis. Three samples have also been submitted for radiocarbon dating to provide a chronology that we are hopeful may span the past 3,000 years.

It is hoped that the full analysis of the cores will provide important information relating to the hydrology and vegetation history of the land surrounding Dinas Dinlle. Work is on-going and preliminary results are anticipated to be ready in early 2020.

UAV Photogrammetric Survey – June 2018

An aerial photogrammetric survey was carried out to provide a complete metric dataset of the whole monument, including the eroding cliff face. Photographic data was captured using a Phantom 4 Advanced UAV fitted with an integrated gimbal and camera with 1-inch 20-megapixel sensor. Ground control was derived from intersections in field boundaries resulting in a maximum absolute error of 30cm in the geographical positioning of model. Photographs were processed using Agisoft Photoscan Professional up to dense point-cloud level and several products have been produced, including: A new Digital Elevation Model (DEM); scaled 3D model and orthophoto (Figure 5). The resolution of the DEM is approximately 17cm, superseding previously collected 50cm resolution LiDAR data held by Welsh Government.

Figure 5: Meshed 3d model of Dinas Dinlle created by photogrammetry (© Crown copyrught: CHERISH project 2018).

Laser Scanning of eroding coastal edge – June 2018

A new laser scan survey of the eroding cliff face was undertaken in June to establish a highly accurate and precise baseline dataset to be used in future monitoring. The survey was carried out using a Faro Focus 3D laser scanner, with 49 scans being collected in total. Scans were registered using universal spheres and the data fixed to National Grid Coordinates through georeferencing spheres at the northern, southern and central extents of the survey area with GNSS. The scans have been registered to within a mean distance error of 1.4mm, mean horizontal error of 0.8mm and a mean vertical error of 1.0mm. The registered scans are currently in the process of being cleaned up and processed ready for further interrogation (Figure 6).

During scanning, the CHERISH team also noted and recorded a small area of exposed peat deposits in the intertidal zone to the west of the fort [SH 4352 5623] that helps provide us with a greater understanding of the environment prior to the construction of the hillfort. The peat deposits are thought to date from around 2000BC and confirm that a brackish-freshwater deltaic environment existed here at the time, with the sea around 1km west of its present-day position. The location of the peat also provides us with a maximum extent of the glacial hill/mound upon which the hillfort is situated.

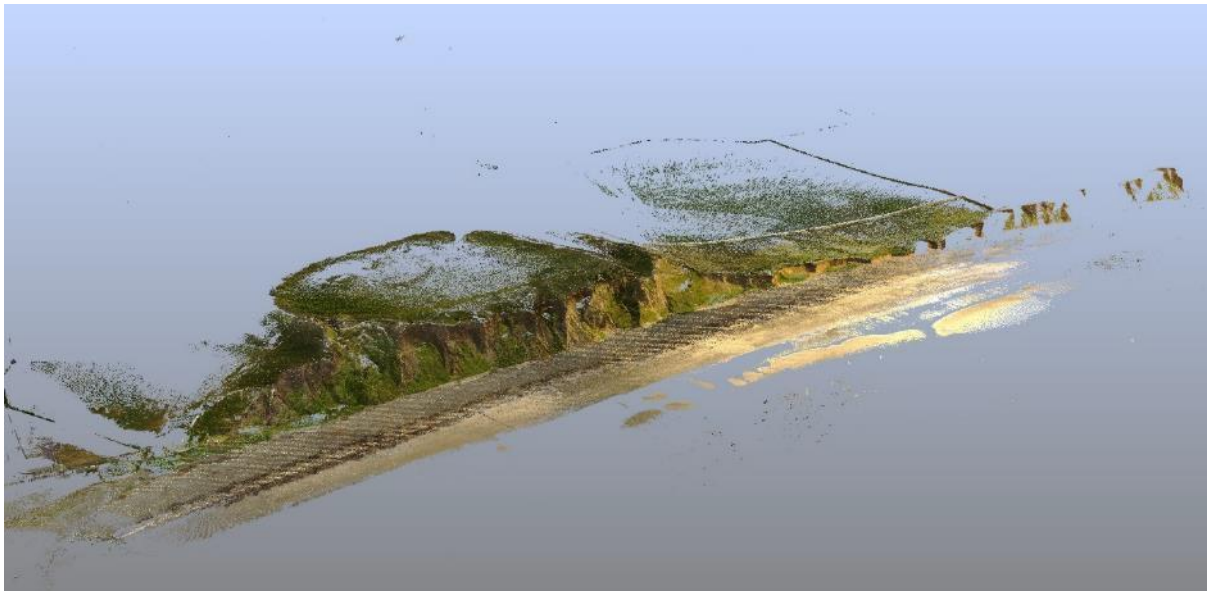

Figure 6: Raw point cloud of the cliff face derived from laser scanning survey (© Crown copyright: CHERISH project 2018).

UAV Photogrammetric Survey – February 2019

An aerial photogrammetric survey was carried out to provide a comparable dataset to June 2018 and record significant collapse to the cliff face in early 2019. This data will be used to assess erosion that occurred between the two surveys. Photographic data was captured using a Phantom 4 Advanced UAV fitted with an integrated gimbal and camera with 1-inch 20-megapixel sensor. Ground control was established using fixed targets that

were subsequently surveyed using survey-grade GNSS equipment which has provided a maximum absolute error of 10cm in the geographical positioning of model. Photographs were processed using Agisoft Metashape Professional up to dense point-cloud level.

Rope Access Excavation and Core Transect – June 2019

The investigation of the cliff-face comprised 2 areas along the eroding cliff-face of the fort (Area A: SH 436 563, fort interior and Area B: SH 436 562, southern ditch section) undertaken in accordance with Safe Working at Height legislation and fully supervised by staff from Plas y Brenin National Outdoor Centre. Exposed sections were lightly cleaned and investigated by hand with full detailed recording of visible features, soils and deposits of areas of Area B. Here the ditch section was recorded digitally using UAV photography and photogrammetry used to create a scaled and georeferenced orthomosaic able to be transcribed during the post-excavation stage (Figure 7). Due to a lack of artefacts Optical Stimulated Luminescence (OSL) samples were taken from a selection of the ditch deposits to provide chronology and likely dates of deposition.

A transect of eight cores were also extracted across the southern defences of the hillfort, in an area directly adjacent to the collapsed and slumped defences. Core locations were recorded using GNSS and were retained for further analysis and to ascertain potential for radiocarbon and luminescence dating, and geochemical analysis.

Analysis of the cores and processing of OSL samples will be completed during Spring 2020.

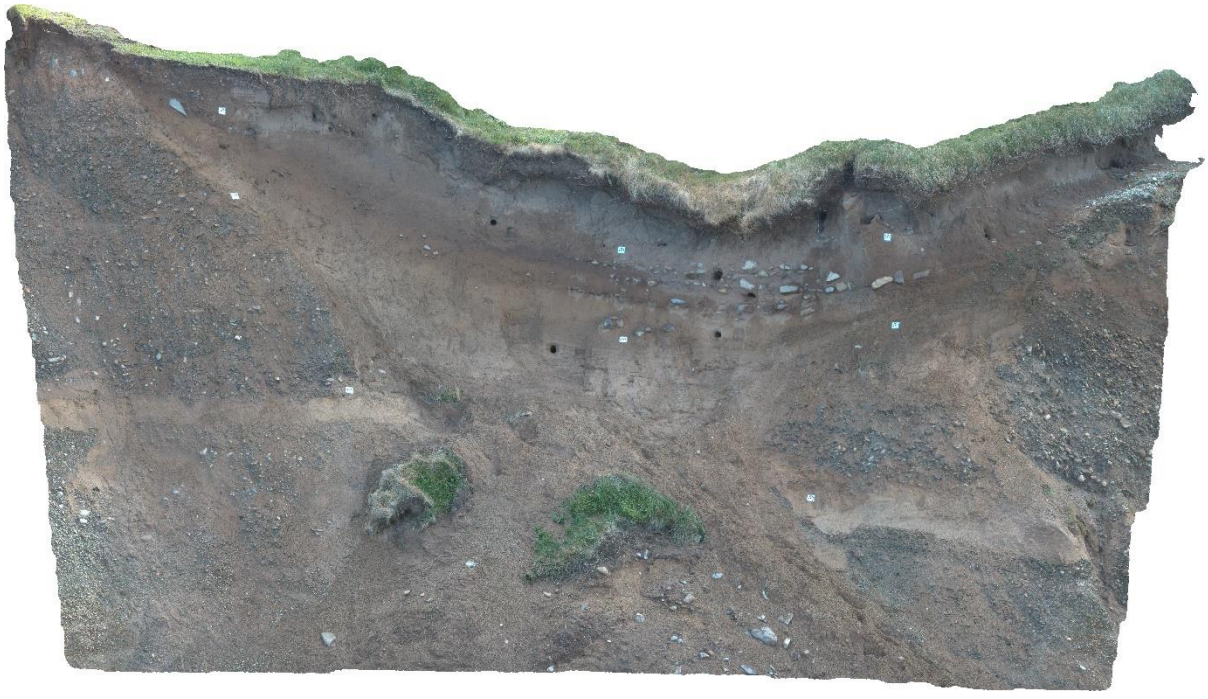

Figure7: Orthomosaic of the southern ditch section created from overlapping SfM UAV imagery in Agisoft Metashape. Ground Control Points (white targets) were used to georectify and scale the image. The series

of layers within the ditch can be seen along with the circular holes where OSL samples were taken. Crown Copyright: CHERISH Project

Evaluation Excavation and Resistivity Survey of Interior Mound (GAT commissioned by CHERISH) - August 2019

An evaluation excavation (with community involvement) was undertaken in August 2019. A total of 8 trenches were excavated, two within the fort interior and 6 within the adjacent field to the south. This evaluation excavation targeted key geophysical anomalies identified in the 2018 survey, in an attempt to date and characterise aspects of the hillfort and immediate environs. The targeted trenches confirmed the presence of substantial roundhouses within the hillfort (Figure 8), as well as later activity in the area to the south, whilst a resistivity survey across the mound in the forts interior suggested evidence of structural activity and localised disturbance. The recovery of Roman artefacts in the hillfort and elsewhere demonstrated continued occupation within this period and the identification of the abandoned post-medieval farmstead reflected more recent settlement. All trenches were characterised by thick deposits of windblown sand and the significant impact on the local landscape and archaeology was clearly evident (Figure 9). Further excavation is needed to fully characterise these results and confirm the extent of archaeological activity, particularly within the hillfort. The roundhouses were only partially excavated, and the potential is there to identify occupation layers and further structural activity, whilst the area to the south may also reveal additional activity (Lynes et al 2019).

The final excavation report will be published following post-excavation assessment and analysis of recovered artefacts and ecofacts and the results of OSL dating, expected Spring 2020.

Figure 8: The northern wall of the roundhouse uncovered in trench 1. The walls appear to have been constructed from large stones to a width of 2.4m, and indicate a diameter of some 13.2m. Crown copyright: CHERISH project.

Figure 9: Professor Helen Roberts from Aberystwyth University taking Luminescence samples through wind-blown sand deposits from the section adjacent to the southern wall of the roundhouse in trench 1. Crown copyright: CHERISH ptoject

OSL dating at Morfa Dinlle – October 2019

The beach ridges and dune system of Morfa Dinlle is also under investigation by the CHERISH team. A ground penetrating radar study coupled with some preliminary Optically Stimulated Luminescence (OSL) dating 10 years ago suggested beach ridge formation was initiated about 2100 years ago (Bristow 2011 & Duller 2011). This would suggest the landscape of Morfa Dinlle may have developed concurrently at least in part, with occupation phases of Dinas Dinlle.

At the beginning of October 2019, the CHERISH Project excavated 12 trenches through the beach-ridge system to confirm their composition and takes samples for OSL dating to provide a robust chronology of their formation. OSL dating results takes up to 6 months to process and the results for Morfa Dinlle are not expected before the summer of 2020.

Geophysical Survey: Ground Penetrating Radar (SUMO services commissioned by CHERISH) – December 2019

A Ground Penetrating Radar (GPR) survey was conducted in December 2019 over an area of approximately 11380 m^2 across the fort interior. The objective was to search for evidence of archaeological features associated with the fort. A Mala MIRA High Density Array Radar was used for the investigation.

Seven significant categories of anomalies were identified by the GPR. Three categories of

anomalies were considered to be of potential archaeological significance – geometric features, broad linear feature and linear features. The geometric anomalies have rectilinear, curvilinear, annular, circular and other more complex shapes typically associated with man-made features of an archaeological origin, such as roundhouses, building walls, foundations and enclosures amongst other features.

A broad linear to curvilinear anomaly that follows most of the western site boundary has been identified as either an infilled perimeter ditch or rampart, or a section of the modern coastal path. A number of relatively short, narrow linear anomalies scattered across the site may be associated with features such as ditches, gullies or tracks (Figure 10).

Many of the GPR anomalies displayed good correlation with the results of a previous magnetometer survey and the roundhouse walls uncovered in two trenches during the August 2019 excavation intersected annular shaped anomalies in the south-west corner of the site. (Udyrysz & Wajzer 2020)

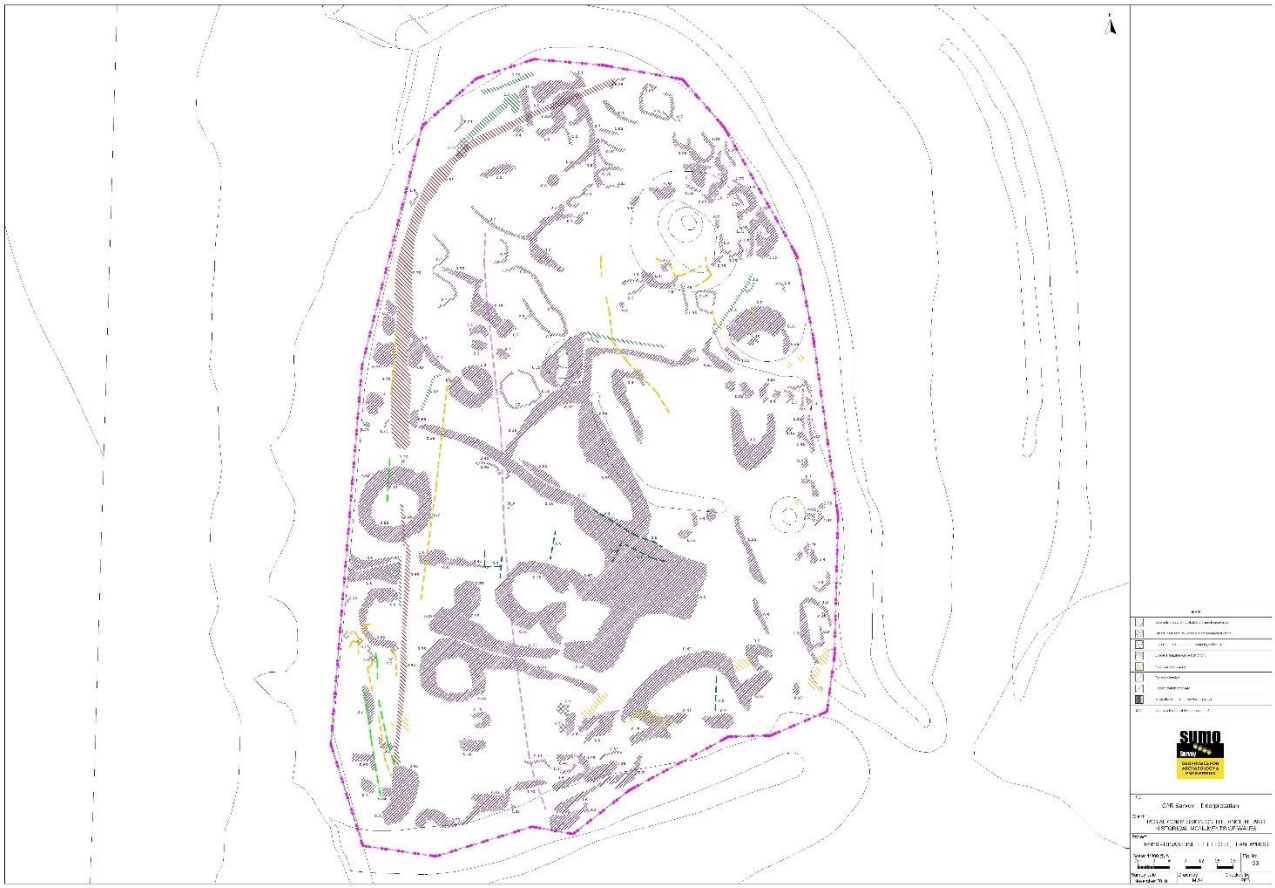

Figure 10: GPR survey interpretation plan

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APPENDIX 2: SCHEDULED MONUMENT AND SSSI CONSENT

Llywodraeth Cymru
Welsh Government

Plas Carew, Uned 5/7 Cefn Coed
Parc Nantgarw, Caerdydd CF15 7QQ
Ffôn 0300 025 6000
ebost cadw@llyw.cymru
www.cadw.gov.wales

Plas Carew, Unit 5/7 Cefn Coed
Parc Nantgarw, Cardiff CF15 7QQ
Tel 0300 025 6000
email cadw@gov.wales
www.cadw.gov.wales

Louise Baker
Royal Commission on the Ancient and Historical Monuments of wales

By email: louise.barker@rcahmw.gov.uk

Eich cyfeirnod Your reference	CN048
Ein cyfeirnod Our reference	
Dyddiad Date	11 April 2019
Llinell uniongyrchol Direct line	0300 0256007
Ebost Email:	amadminplanning@gov.wales

Dear Louise Baker,

Ancient Monuments and Archaeological Areas Act 1979
Section 2 and Schedule 1
Application for Scheduled Monument Consent
Proposed works at: Dinas Dinlle (CN048)

I refer to your application of 27 March 2019 for scheduled monument consent to carry out a programme of investigation and excavation works at the above scheduled monument. The programme of investigation and excavation forms of the CHERISH (Climate Change and Coastal Heritage) project.

You declined the opportunity of appearing before, and being heard by, a person appointed for that purpose, afforded to you in the letter of 5 April 2019. Nor have you submitted any further representations in support of your case.

The proposed works can be carried out without detriment to the historic or archaeological integrity of the monument. The works accord with the sustainable development principle and contribute towards the well-being goals defined in the Wellbeing of Future Generations (Wales) Act 2015.

Accordingly, the Welsh Ministers hereby grant scheduled monument consent for the works described at paragraph 4 of the application of 27 March 2019, subject to the following conditions.

Conditions

1. That you shall provide notice to the Welsh Ministers in writing of the start date for the excavation (notice via email is acceptable);

2. That you shall afford access at all reasonable times to any Cadw official to monitor progress of the works;

3. That the works shall be carried out in accordance with the following approved plans and documents listed below and submitted to Cadw on 27 March 2019.

No variations from these plans and documents are permitted unless they have been authorised in advance by the Welsh Ministers;

No.	Document / plan
1	SMC application form
2	Figure 1: Dinas Dinlle (CN048). Location of proposed works
3	Figure 2: Dinas Dinlle (CN048). Location of proposed works overlain on 2017/18 geophysical survey interpretation plan
4	Figure 3: Dinas Dinlle Erosion 1889 to 2017
5	Report for Site Visit at Hillfort Dinas Dinlle
6	Risk Assessment and Control Template

4. No works including site clearance shall commence until the Welsh Ministers has received and approved a **written scheme of investigation** for the excavation and evaluation work;

5. That the Welsh Ministers shall be provided with regular updates on the progress of the site works, throughout the course of the project;

6. Should significant archaeological features or deposits be exposed they shall be retained *in-situ* and reported to the Welsh Ministers within two working days. Works shall be halted in that area/part of the site affected until provision has been made for retention and/or recording of the feature in accordance with details submitted to and approved in writing in advance by the Welsh Ministers;

7. A digital copy of the excavation report shall be submitted to the Welsh Ministers for approval within 3 months of the project being completed[1]; and

8. That you shall notify the Welsh Ministers (via email) upon completion of the works.

Section 2(6) of the 1979 Act provides that non-compliance with a condition attached to a grant of scheduled monument consent shall be an offence.

By virtue of Section 4 of the 1979 Act if no works to which this consent relates are executed or started within 5 years from the date of this letter, the consent shall cease to have effect at the end of that period (unless it is revoked in the meantime).

This letter does not convey any approval or consent required under any enactment, bylaw, order or regulation other than Section 2 of the Ancient Monuments and

---

[1] *Cadw will retain a copy of the historic building survey report for our records and will deposit a digital copy with the regional Historic Environment Record and National Monuments Record of Wales.*

Archaeological Areas Act 1979. It is the responsibility of the applicant to obtain any such approval or consent where necessary.

Your attention is drawn to the provisions of Section 55 of the 1979 Act under which, if you are aggrieved by the decision given in this letter, you may challenge its validity by an application made to the High Court within six weeks from the date when the decision is given. The grounds on which an application may be made to the court are:

a) that a decision is not within the powers of the Act (that is, the Welsh Government has exceeded its powers);
b) that any of the relevant requirements have not been complied with and the applicant's interest has been substantially prejudiced by the failure to comply.

"The relevant requirements" are defined in Section 55 of the 1979 Act and you are advised to seek legal action before taking any action.

Yours sincerely,

Nichola Davies
Policy and Protection
under authority of the Deputy Minister for Culture, Sport and Tourism, one of the Welsh Ministers

Cyfoeth Naturiol Cymru
Natural Resources Wales

The National Trust
Ysbyty Estate Office
Dinas
Betws-y-Coed
GWYNEDD
LL24 0HF

Consent Ref No: 2297350
Our Ref: SH 45.1/PMH
12 April 2019

Dear Sir/Madam

CONSENT BY THE NATURAL RESOURCES BODY FOR WALES ("NATURAL RESOURCES WALES") TO CARRY OUT OPERATIONS IDENTIFIED IN A NOTICE DATED 1 APRIL 2019 UNDER SECTION 28E OF THE WILDLIFE AND COUNTRYSIDE ACT 1981 (AS SUBSTITUTED)

DESIGNATED SITE(S):
DINAS DINLLE - SITE OF SPECIAL SCIENTIFIC INTEREST

Please find enclosed a consent to carry out specified work affecting the above-named site(s). This consent allows you to carry out, cause or permit to be carried out the operation(s) in the way described, and fulfils the legal requirement. You must give written notice if you intend to alter the(se) operation(s) in any way or wish to carry out any further work.

Should you disagree with any part of this consent you may appeal. Details of how to appeal are shown at the end of the attached consent.

Note that this consent only relates to the above-mentioned legislation – other authorisations may be required.

Yours faithfully

Philip Oliver
Arbenigwr Technegol (Cadwraeth) / Technical Specialist (Conservation)

Ffôn /Tel: 0300 065 3000
Ebost/Email philip.harper@cyfoethnaturiolcymru.gov.uk
www.cyfoethnaturiolcymru.gov.uk www.naturalresourceswales.gov.uk

Maes y Ffynnon Penrhosgarnedd , Bangor , GWYNEDD LL57 2DW

CYFOETH NATURIOL CYMRU
NATURAL RESOURCES WALES

Consent ref no: 2297350
Our ref: SH 45.1

CONSENT TO CARRY OUT OPERATIONS ON LAND AFFECTING THE FOLLOWING SITE(S): DINAS DINLLE - SITE OF SPECIAL SCIENTIFIC INTEREST UNDER SECTION 28E OF THE WILDLIFE AND COUNTRYSIDE ACT 1981 (AS SUBSTITUTED)

The Natural Resources Body for Wales ("Natural Resources Wales") hereby agrees that,

The National Trust
Ysbyty Estate Office
Dinas
Betws-y-Coed
GWYNEDD
LL24 0HF

as owner/occupier of land affecting the above site(s), may carry out, cause or permit to be carried out the operation(s) specified below in the manner prescribed.

Cliff investigation, coring and invasive excavation at Dinas Dinlle to increase understanding of the hillfort an its environment. See Appendix for operational details.

THE ABOVE OPERATION(S) CAN ONLY BE CARRIED OUT UNDER THE FOLLOWING CONDITION(S)

Condition:
This consent is valid until 1st April 2020

Reason(s):
To allow sufficient time for completion of the operations, and end date the consent

This consent only relates to the above-mentioned legislation. It does not release you from any obligations to obtain approval under other legislation or the General Law. If proposed works involve development, you must also apply for planning permission to the Local Authorit. Some proposals may require the landowner's permission or other authorisations.

Date: 12 April 2019

Signed:

Philip Oliver
Arbenigwr Technegol (Cadwraeth) / Technical Specialist (Conservation)

APPENDIX 3: CHERISH UAV MONITORING EVENT REPORT 6 JUNE 2019 (DATA ARCHIVE ACCESSION NUMBER RCCS11)

CHERISH UAV Survey Report No.
CH/RCAHMW 04

DINAS DINLLE PREHISTORIC COASTAL FORT, GWYNEDD

CHERISH UAV MONITORING EVENT REPORT: 06/06/2019

CHERISH
Newid Hinsawdd a Threftadaeth yr Arfordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

EU Funds Ireland Wales Programme 2014-2020

CBHC RCAHMW

Comisiwn Brenhinol
Henebion Cymru
Royal Commission on the Ancient and Historical Monuments of Wales

CHERISH
Newid Hinsawdd a Threftadaeth yr Arfordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

Dinas Dinlle – UAV Survey Event Report

County:	Gwynedd
Community:	Llandwrog
NGR:	SH43705635
NPRN:	95309
SM No:	CN048
Surveyed by:	Daniel Hunt (Pilot in Charge)
Date of Survey:	06/06/2018
Report Number:	CH/RCAHMW 04
Report Author:	Daniel Hunt
Illustrations:	Daniel Hunt
Date of Report:	29/10/2019

Comments or queries regarding the content of the report should be made to the author:

RCAHMW, Ffordd Penglais, Aberystwyth, Ceredigion, SY23 3BU

Tel: 01970 621200

World Wide Web: http://www.rcahmw.gov.uk/ http://www.cherishproject.eu/

Description of Survey

UAV Survey

A UAV survey was carried out at Dinas Dinlle prehistoric coastal fort on 6th June 2019 by the CHERISH project to record the eroding southern defences being affected by coastal and terrestrial erosion. This survey was carried out as part of a programme of excavation and sampling. The primary purpose of this survey was to record the exposed ditch section and produce a high-resolution and scaled orthophoto after manual cleaning, recording and sampling had been undertaken by CHERISH via rope-access.

Carrying out a photogrammetric UAV survey is time and cost-effective and provides highly detailed three-dimensional datasets capable of being used for archaeological prospection, erosion monitoring and the creation of outreach tools such as three-dimensional models (digital and physical). The UAV was used to capture photogrammetric images of the cleaned ditch section and georeferenced using ground control points (GCPs) surveyed in using a Leica TCR 1205 total station set up over an established point. The imagery was processed using Structure from Motion (SfM) software Agisoft Metashape. Processed derived data comprises an xyz pointcloud, a Digital Elevation Model (DEM) and an orthophoto. The vertical orthomosaic was the primary output from this survey and has been used to produce a digital section drawing of the feature and its associated archaeological deposits.

Site Background:

Dinas Dinlle is a monumental prehistoric coastal hillfort occupying a locally prominent glacial hillock overlooking a beach and low-lying former wetlands and saltmarsh. The hillfort would conventionally date from the Late Bronze or Iron Age (c. 1200BC – AD 43) while Roman finds from erosion features on site, together with a prominence in early medieval Welsh literature and folklore, suggest a longer potential history. In the early 20th century the monument formed part of the Dinas Dinlle golf course and a separately-scheduled Second World War 'seagull trench' (CN 396) built into the northern slopes of the fort formed part of the defence for the nearby RAF Llandwrog, now Caernarfon Airport. Today Dinas Dinlle dominates a small coastal village with a seasonal holiday trade. The hillfort is open to the public and the Wales Coast Path crosses through it.

Between its initial survey on 11/06/2018 and the survey reported here the site has suffered noticeable erosion. The southern ramparts have seen the largest amount of change with several tonnes thought to have fallen away between these two surveys.

DINAS DINLLE PREHISTORIC COASTAL FORT

UAV MONITORING EVENT REPORT: 06/06/2018

LOCATION OF SURVEY	
CHERISH AREA: Area 2 – Dinas Dinlle	
SITE NAME: Dinas Dinlle	**SCHEDULED MONUMENT:** CN048
GRID REF: SH 4370 5635	**RECORD NUMBER (NPRN):** 95309

RECORDED BY	
PILOT IN CHARGE: Daniel Hunt	**OBSERVER(S):** N/A
TIME OF SURVEY: 10:50 – 12:35	**DATE OF SURVEY:** 06/06/2019

SURVEY EQUIPMENT USED	
UAV	Phantom 4 Advanced
GNSS	Leica GS16 & CS20 operating as RTK rover linked by radio to a Leica GS10 base station unit.
TST	Leica TCR 1205

WEATHER CONDITIONS	
Wind (speed and direction)	South Westerly varying between 10-15mph
Temperature	13°c
Precipitation	Clear day, minimal clouds, no precipitation

TIDAL CONDITIONS		
Station: Fort Belan		
Hi/Lo	**Time (24hrs) BST**	**Height (m)**
High Tide	00:08	4.56
Low Tide	06:39	0.64
High Tide	12:36	4.41
Low Tide	18:55	0.82
Source: https://www.tidetimes.org.uk/fort-belan-tide-times-20190606		

On-site survey metadata

UAV Survey-level metadata	
Survey extent top right	243647.000, 356267.000
Survey extent bottom left	243642.000, 356249.000
Survey date/s	06/06/2019
Camera manufacturer	DJI
Camera model name	Phantom 4 Advanced
Camera model number	N/A
Shutter speed	8 - 1/2000 s
Aperture value	AUTO
Focal length settings	AUTO
ISO speed	VARIABLE AUTO Video: 100 - 3200 (Auto) 100 - 6400 (Manual) Photo: 100 - 3200 (Auto) 100- 12800 (Manual)
Airborne GPS model name	Phantom 4 Advanced
Airborne GPS model number	N/A
Airborne GPS base error rate	5m
Terrestrial GPS model name	Leica GS16
Terrestrial GPS serial number	3703129
Terrestrial GPS base error rate	Hz: 8mm + 0.1ppm V: 15mm + 0.5ppm
Lens calibration image file name	N/A
Lens calibration target file name	N/A
Lens calibration target information	N/A
Flight Log	Yes
Captured Image Type (JPEG or RAW)	RAW
Additional UAV survey notes	Camera native .RAW converted to .TIFF For use in Agisoft Photoscan

Ground Control Points (GCPs) – see figure 1 for location map			
point	**x**	**y**	**z**
1	243647.149	356262.359	22.593
2	243646.727	356262.164	21.499
3	~~243648.304~~	~~356257.674~~	~~20.803~~
4	243647.641	356257.208	19.653
5	243647.225	356253.776	20.978
6	243646.900	356253.649	19.846
Vertical Alignment	243647.641	356257.208	**20.653**
GCP Vertical alignment was created for the purpose of vertically aligning the projection layer for the orthomosaic. The values of **GCP 4** were duplicated, with exactly 1m added to the z value. This enabled the creation of a perfectly vertically aligned orthomosaic.			
Stored as CSV.	**Coordinates expressed as OSGB 1936 / British National Grid**		
Total Control point total RSME (mm)	**1.5378mm** across x, y and z values of control points		

Notes on GCPs	**GCP 3 was not used for the georeferencing of the orthophoto due to a large error with the GCP position.** GCPs were surveyed using a TST set up over a point established by GNSS.

Survey Parameters	
Flight Survey method (Manual or Auto)	Manual
Horizontal Overlap percentage	Approx 90%
Vertical overlap percentage	Approx 60%
Ground Sample Distance (GSD) of vertical images	**1.22 mm/pix**

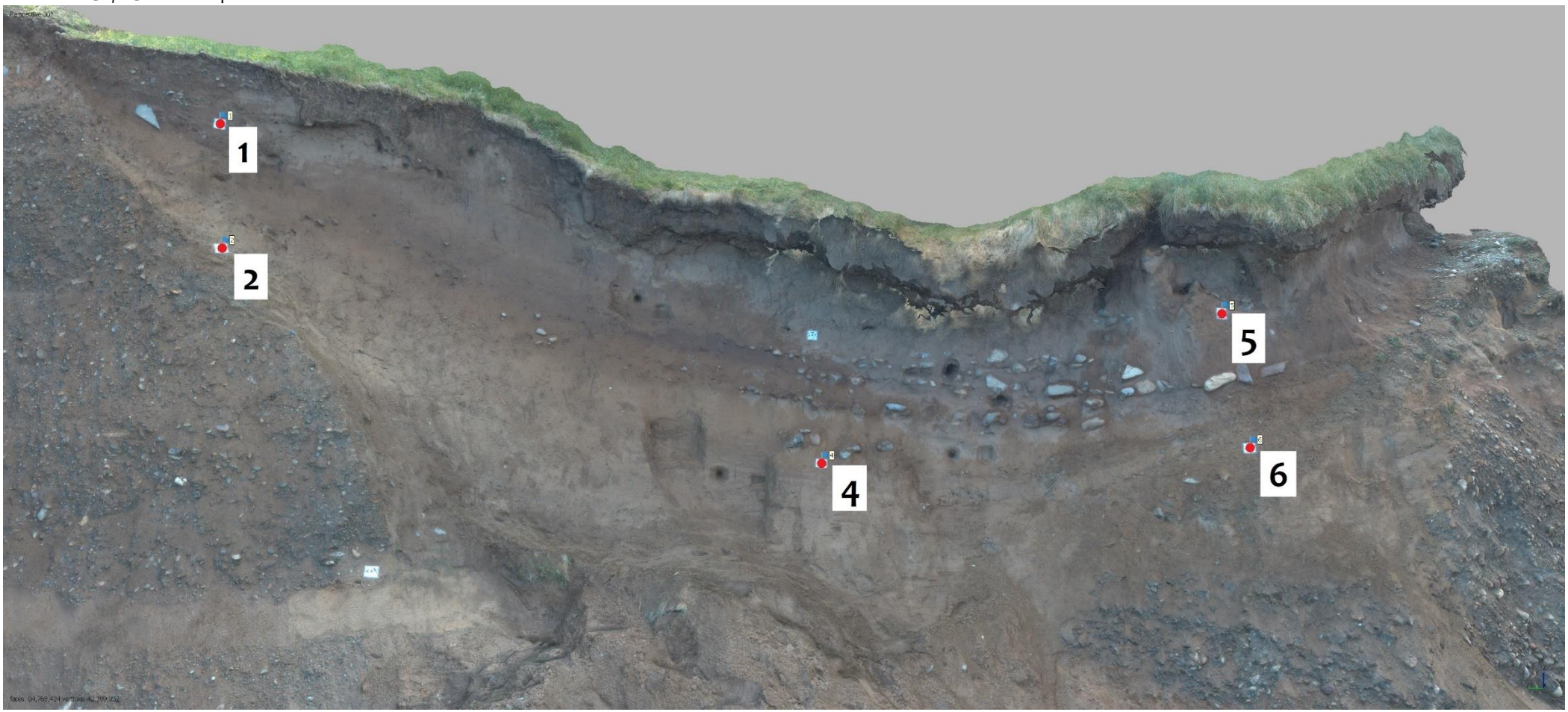
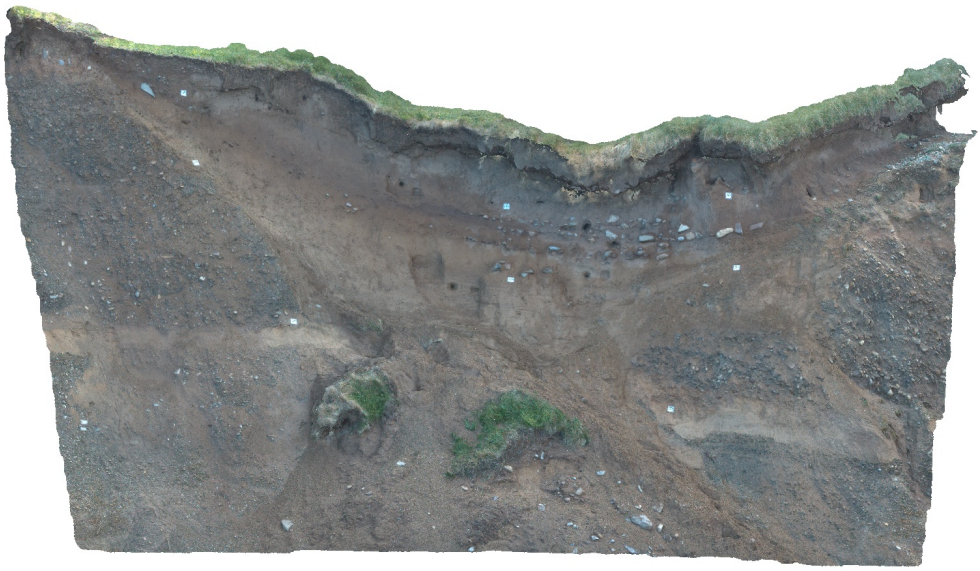


Figure 1 Location of GCPs

Dinas Dinlle Southern Ditch Section 06-06-19

UAV Processing Report

27 September 2021



Survey Data

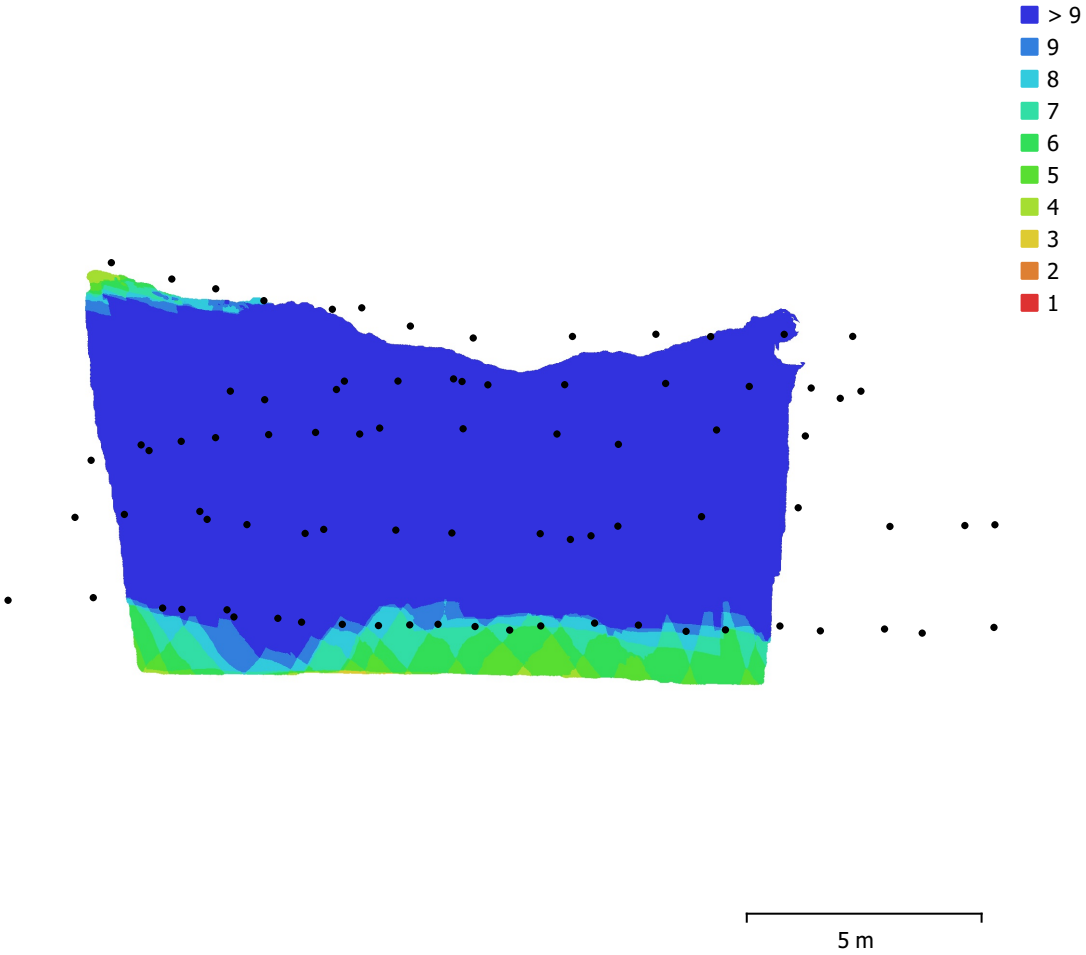


Fig. 1. Camera locations and image overlap.

Number of images:	83	Camera stations:	83
Flying altitude:	4.72 m	Tie points:	555,954
Ground resolution:	1.2 mm/pix	Projections:	1,654,543
Coverage area:	106 m²	Reprojection error:	0.335 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6310 (8.8mm)	5464 x 3640	8.8 mm	2.42 x 2.42 µm	No

Table 1. Cameras.

Camera Calibration

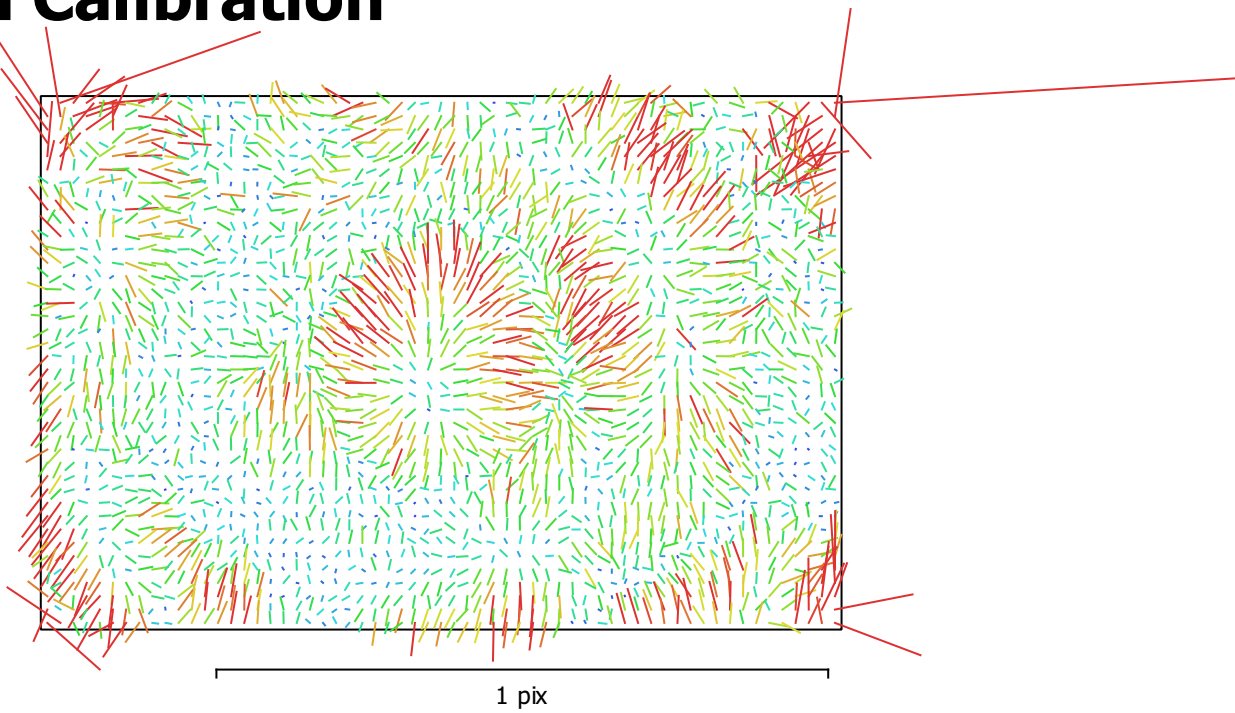


Fig. 2. Image residuals for FC6310 (8.8mm).

FC6310 (8.8mm)

83 images

Type	Resolution	Focal Length	Pixel Size
Frame	**5464 x 3640**	**8.8 mm**	**2.42 x 2.42 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2	P3
F	**3651.41**	0.039	1.00	0.01	-0.18	-0.30	0.02	-0.34	0.17	-0.13	0.11	-0.13	0.26	-0.25
Cx	**2.83656**	0.056		1.00	-0.03	-0.01	0.09	0.01	-0.01	0.01	-0.01	-0.50	0.05	-0.04
Cy	**6.92712**	0.045			1.00	-0.34	-0.09	0.09	-0.01	-0.01	0.01	0.22	-0.71	0.58
B1	**0.940075**	0.032				1.00	0.07	-0.14	0.01	0.00	-0.00	-0.07	0.33	-0.28
B2	**0.439264**	0.022					1.00	-0.02	-0.01	0.01	-0.02	-0.09	0.11	-0.08
K1	**-0.266377**	1.4e-05						1.00	-0.93	0.86	-0.80	0.07	-0.20	0.16
K2	**0.120385**	4.4e-05							1.00	-0.98	0.95	-0.01	0.04	-0.03
K3	**-0.0533182**	5.7e-05								1.00	-0.99	-0.01	-0.00	-0.00
K4	**0.012468**	2.6e-05									1.00	0.02	-0.01	0.01
P1	**-1.65531e-05**	5e-07										1.00	-0.33	0.31
P2	**0.000195532**	2.1e-06											1.00	-0.94
P3	**0.356622**	0.0089												1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

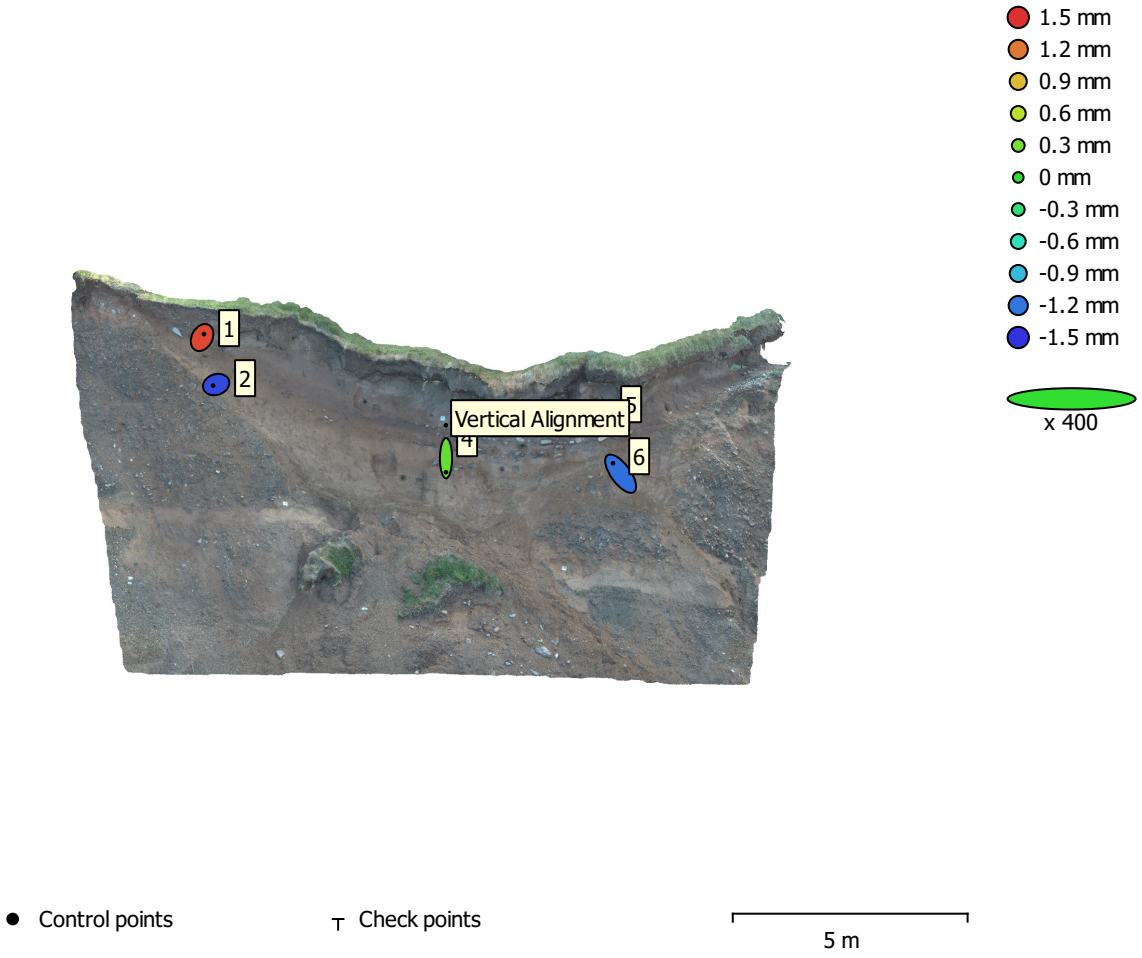


Fig. 3. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (mm)	Y error (mm)	Z error (mm)	XY error (mm)	Total (mm)
5	0.584232	0.852749	1.13855	1.03369	1.5378

Table 3. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (mm)	Y error (mm)	Z error (mm)	Total (mm)	Image (pix)
1	0.195995	0.367198	1.40377	1.46418	0.242 (21)
2	-0.320651	-0.110261	-1.39586	1.43646	0.272 (15)
4	-0.00601615	-1.49328	0.219609	1.50935	0.167 (38)
5	0.95117	0.122666	1.00284	1.38761	0.194 (27)
6	-0.8128	1.11534	-1.22825	1.8475	0.228 (25)
Vertical Alignment					
Total	**0.584232**	**0.852749**	**1.13855**	**1.5378**	**0.213**

Table 4. Control points.

X - Easting, Y - Northing, Z - Altitude.

Digital Elevation Model

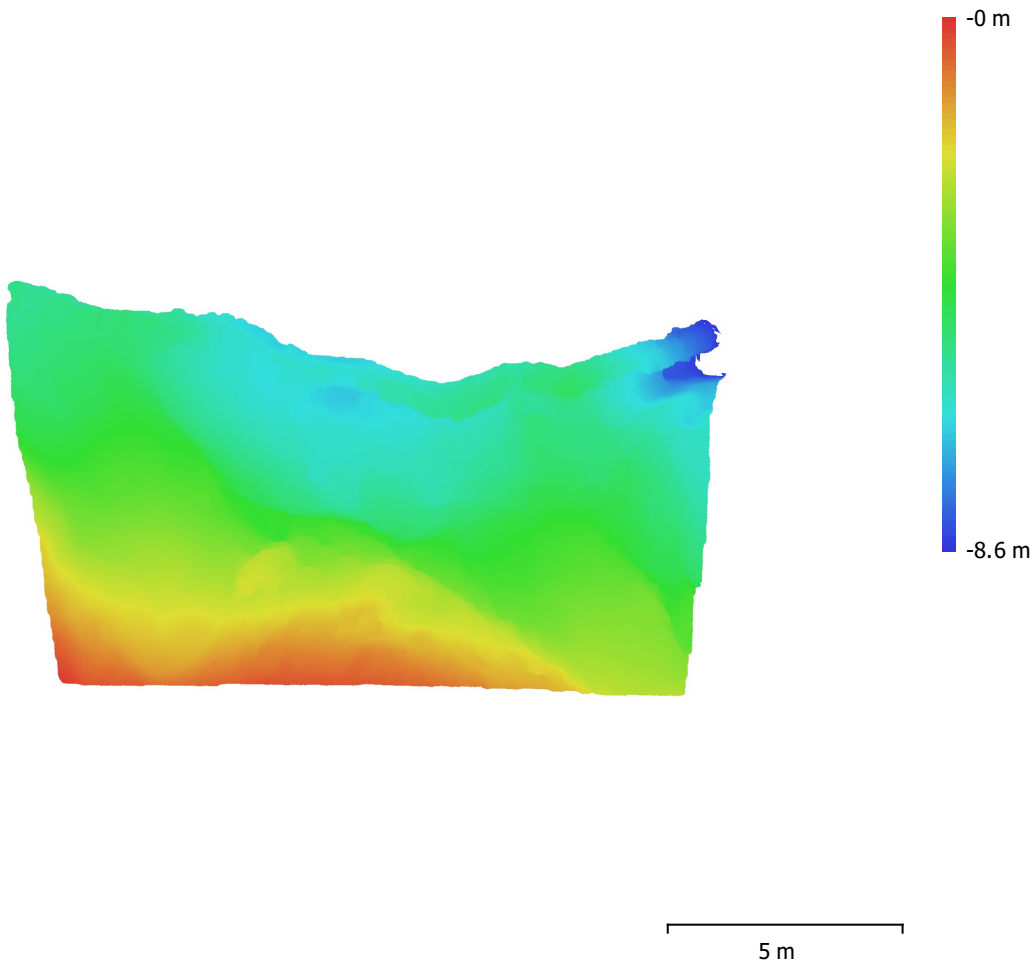


Fig. 4. Reconstructed digital elevation model.

Resolution:	2.39 mm/pix
Point density:	17.5 points/cm²

Processing Parameters

General	
Cameras	83
Aligned cameras	83
Markers	6
Coordinate system	OSGB 1936 / British National Grid (EPSG::27700)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	555,954 of 1,041,123
RMS reprojection error	0.0978315 (0.335361 pix)
Max reprojection error	0.43799 (5.85472 pix)
Mean key point size	3.13322 pix
Point colors	3 bands, uint16
Key points	No
Average tie point multiplicity	2.84867
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	No
Key point limit	900,000
Tie point limit	0
Filter points by mask	Yes
Mask tie points	Yes
Adaptive camera model fitting	Yes
Matching time	25 minutes 16 seconds
Alignment time	1 minutes 46 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k4, p1-p3
Adaptive camera model fitting	No
Optimization time	19 seconds
Software version	1.5.2.7838
File size	63.95 MB
Depth Maps	
Count	83
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	6 hours 3 minutes
Software version	1.5.2.7838
File size	431.12 MB
Dense Point Cloud	
Points	32,471,025
Point colors	3 bands, uint16
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	6 hours 3 minutes
Dense cloud generation parameters	
Max neighbors	All
Processing time	21 minutes 5 seconds
Software version	1.5.2.7838

File size	696.32 MB
Model	
Faces	84,768,434
Vertices	42,389,352
Vertex colors	3 bands, uint16
Texture	4,096 x 4,096, 4 bands, uint16
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	6 hours 3 minutes
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense cloud
Interpolation	Enabled
Strict volumetric masks	No
Processing time	21 minutes 56 seconds
Texturing parameters	
Blending mode	Mosaic
Texture size	4,096
Enable hole filling	Yes
Enable ghosting filter	Yes
UV mapping time	8 minutes 25 seconds
Blending time	40 minutes 38 seconds
Software version	1.5.2.7838
File size	3.56 GB
DEM	
Size	7,963 x 4,804
Coordinate system	OSGB 1936
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	27 seconds
Software version	1.5.2.7838
File size	146.82 MB
Orthomosaic	
Size	12,943 x 7,403
Coordinate system	OSGB 1936
Colors	3 bands, uint16
Reconstruction parameters	
Blending mode	Mosaic
Surface	Mesh
Enable hole filling	Yes
Processing time	22 minutes 27 seconds
Software version	1.5.2.7838
File size	16.83 GB
System	
Software name	Agisoft Metashape Professional
Software version	1.7.1 build 11797
OS	Windows 64 bit
RAM	63.90 GB
CPU	Intel(R) Core(TM) i7-7700K CPU @ 4.20GHz
GPU(s)	None