Celtic Interconnector

Volume 3D2

Environmental Impact Assessment Report - Appendices

June 2021

Co-financed by the European Union
Connecting Europe Facility

Tionscadal Éireann
Project Ireland
2040

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Volume 3D2 – Environmental Impact Assessment Report Appendices

Celtic Interconnector

Volume 3D2 – Appendix 5A
Construction and Environmental Management Plan

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Report for

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1 Introduction

1.1 General

This Construction Environmental Management Plan (CEMP) supports the application for development consent for the Irish offshore elements of the Celtic Interconnector Project (the 'Proposed Development'). The overall Celtic Interconnector Project is an electrical interconnection between Ireland and France to allow the exchange of electricity between the two countries. The Proposed Development in Ireland is being developed by EirGrid, who is the electricity Transmission System Operator (TSO) (hereafter the Applicant). The overall Celtic Interconnector Project is being jointly developed by EirGrid and its French counterpart, Réseau de Transport d'Électricité (RTE).

The Celtic Interconnector Project is, by its nature, multi-jurisdictional, and is being jointly developed by the two TSOs of Ireland and France. As will be specified later under Roles and Responsibilities (Section **Error! Reference source not found.**), the environmental manager d elivering the Proposed Development will coordinate regularly with the corresponding staff delivering other elements of the Celtic Interconnector Project (Ireland onshore, and in UK waters).

In addition, while not occurring within UK territory, the Celtic Interconnector Project will be located, in part, within the UK Exclusive Economic Zone (EEZ). An Environmental Impact Assessment Report (EIAR) has been prepared to accompany a Foreshore Licence application to the Department of Housing, Local Government, and Heritage (DHLGH) for the Proposed Development. A separate, though integrated, EIAR has been prepared to accompany an application for statutory approval to An Bord Pleanála (ABP) for the Ireland Onshore element of the Celtic Interconnector project.

The EIAR has been prepared having regard for relevant guidelines, including:

- The EPA Draft Guidelines 2017;
- Environmental Protection Agency (EPA) Advice Notes for Preparing Environmental Impact Statements (Draft 2015);
- Department of Housing, Planning and Local Government (2018) Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment; and
- European Commission Environmental Impact Assessment of Projects, Guidance on the preparation of the Environmental Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU), 2017.

The environmental management of the construction works for the Proposed Development shall be delivered via the implementation of this CEMP. It outlines the environmental procedures that require consideration throughout the construction process in accordance with legislative requirements and construction industry best practice guidance. It aims to ensure that the adverse effects from the construction phase of the Proposed Development, on the environment and local communities, are minimised, as per the measures prescribed in the EIAR for the Proposed Development.

The CEMP will be implemented by the Applicant and secured through the conditions of the foreshore licence application. Revisions to this CEMP may be undertaken during the determination period of the foreshore licence application in agreement with the appointed contractors and the relevant authorities.

The appointed contractor(s) shall be responsible for safeguarding the environment and for mitigating the effects of the construction works by implementing general environmental requirements of the CEMP. The Applicant will audit and oversee the contractor(s) implementation of the CEMP via contractual arrangements.

1.2 Overall Celtic Interconnector Project

The Celtic Interconnector is primarily a subsea link that will enable the exchange of electricity between the electricity transmission grids in Ireland and France. The link will have the capacity to carry up to 700 MW of electrical energy between the two systems. The connection will link an existing electricity transmission substation located in Knockraha in east Cork, Ireland, with a substation in La Martyre in Brittany, France.

The transmission grids in both Ireland and France are operated at High Voltage Alternating Current (HVAC). High Voltage Direct Current (HVDC) is used for the transmission of electrical power over large distances where HVAC is not technically or economically feasible. Converter stations are therefore required in both France and Ireland to convert the HVDC power to HVAC.

Designated as a Project of Common Interest (PCI) by the European Union, the Celtic Interconnector project responds to European challenges regarding energy transition and addresses climate change by facilitating progress towards a low-carbon electricity mix. It will contribute to more secure, more sustainable, and better priced electricity.

The main elements of the overall Celtic Interconnector project are:

- A High Voltage Direct Current (HVDC) submarine cable of approximately 500 km in length laid between the coast in Brittany France, and the Cork coast in Ireland. The submarine cable will be either buried beneath the seabed or laid on the seabed and covered for protection;
- A landfall location in Ireland and France, where the HVDC submarine circuit will come onshore and terminate at a Transition Joint Bay (TJB);
- A HVDC underground cable (UGC) in both countries between the landfall location and a converter station compound;

- A converter station in both countries to convert the electricity from HVDC to High Voltage Alternating Current (HVAC) and vice versa;
- A HVAC UGC in both countries between the converter station compound and the connection point to the National Grid;
- A connection to the National Grid; and,
- A fibre optic link, with associated power supply, will also be laid along the route for operational control, communication, and telemetry purposes.

The key elements of the project are illustrated in Figure 1.1 and Figure 1.2.

Figure 1.1 Celtic Interconnector (Project Overview)

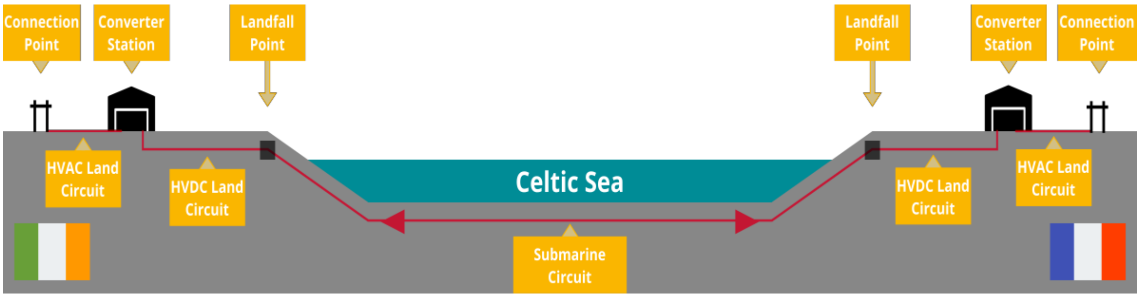
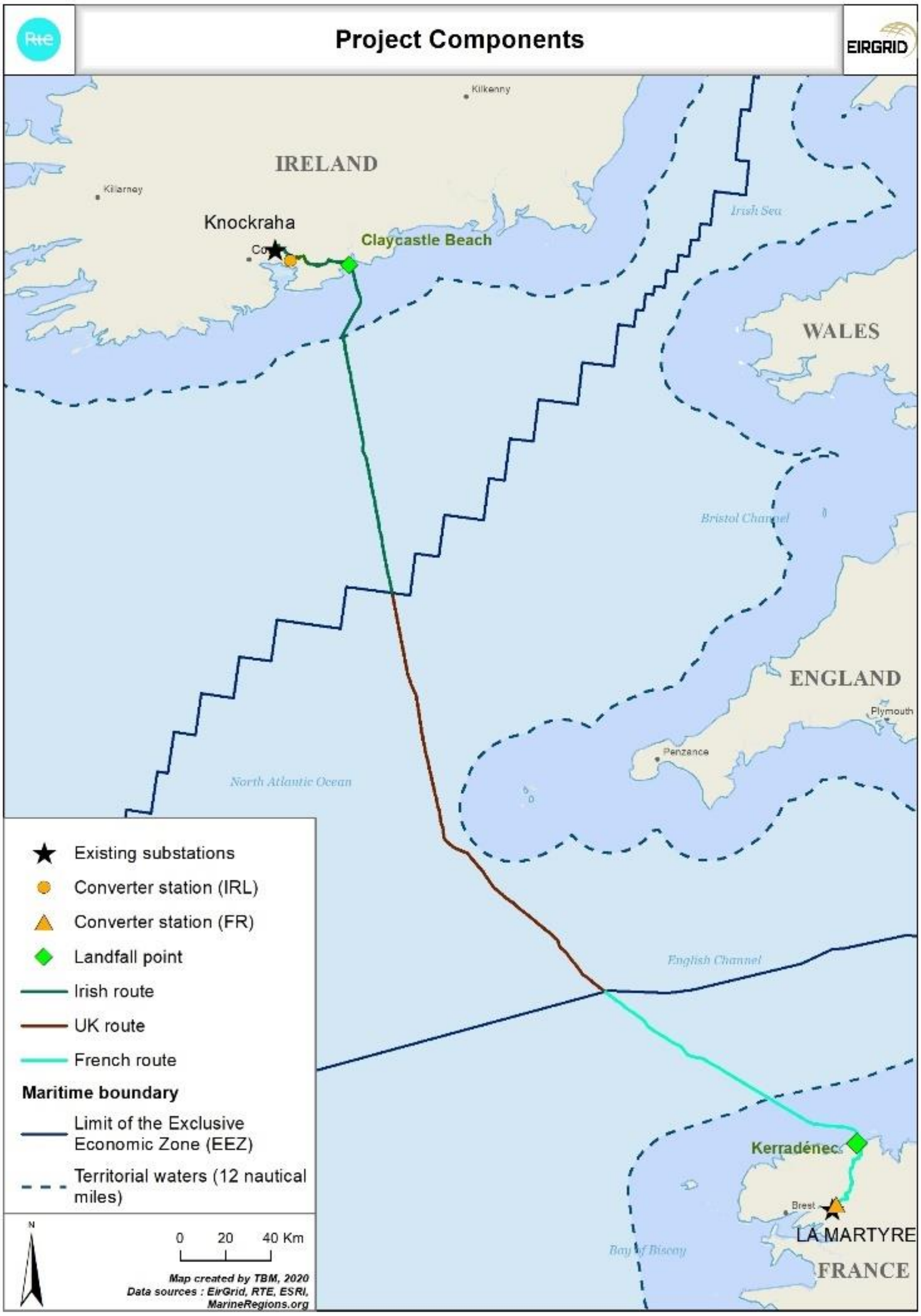


Figure 1.2 The route of the Celtic Interconnector project



1.3 Overview of Proposed Development

This CEMP relates to the Proposed Development (i.e. in Ireland Offshore), summarised in Section 2 of this CEMP.

A more detailed description of the Proposed Development is provided in Volume 3D Part 2 of the EIAR (see Chapter 5: Description of the Landfall, and Chapter 6: Description of the Offshore Cable).

1.4 Objectives of the CEMP

This CEMP provides an overarching framework for the environmental management procedure during the construction phase of the Proposed Development.

The objectives of the CEMP are as follows:

- To provide a mechanism for ensuring the delivery of environmental measures (other than those which will be secured through specific conditions of the application), to avoid, reduce or compensate for environmental effects identified in the EIAR;
- To provide an outline of the content that will be supplied in the detailed plans and schemes prior to construction of the relevant stage of works;
- To ensure compliance with legislation and identify where it will be necessary to obtain authorisation from relevant statutory bodies;
- To provide a framework for compliance auditing and inspection to ensure the agreed environmental aims are being met; and
- To ensure a prompt response to any non-compliance with legislative and EIAR. Requirements, including reporting, remediation and any additional mitigation measures required to prevent a recurrence.

1.5 Structure and content of the CEMP

The remainder of this CEMP is split into four further chapters:

- Chapter 2 describes the Proposed Development construction;
- Chapter 3 describes the roles and responsibilities of those on site;
- Chapter 4 describes the general environmental requirements that will be adopted for the Proposed Development. The general site operations cover the following elements:
  - Method Statements;
  - Audit and Inspections;
  - Competence, Training, and Awareness;
  - Communications;

  - Environmental Incident Procedure;
  - Health and Safety;
  - Construction Hours;
  - Construction Site Layout and Appearance;
  - Waste Management;
  - Security;
  - Welfare;
  - Biosecurity;
  - Unexploded Ordnance; and
  - Consents and Licences.
- Chapter 5 describes the environmental measures that will be adopted during the construction of the Proposed Development in accordance with the EIAR. The environmental measures will be implemented to avoid, reduce, or compensate for effects on receptors identified in the following environmental topics:
  - Population and Human Health;
  - Air Quality and Climate;
  - Marine Sediments Quality;
  - Marine Physical Processes;
  - Marine Water Quality;
  - Biodiversity;
  - Seascape and Landscape;
  - Archaeology and Cultural Heritage;
  - Material Assets;
  - Noise and Vibration;
  - Shipping and Navigation;
  - Commercial Fisheries; and
  - Major Accidents and Disasters.

This document is classified as a 'live document' and as such is required to be updated by the Contractor prior to the commencement of any construction related works or activities. An example CEMP Review Table is located within Appendix A of this report. Updates will take account of the following aspects:

- Changes to the design;
- Changes to external factors, including legislation;
- Unforeseen circumstances;
- Results from external audits and inspections; and
- Learning points from environmental near misses and incidents.

1.6 Conformance with the Environmental Statement

An EIAR has been undertaken for the Proposed Development. The EIAR has been prepared in accordance with the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (S.I. No. 296/2018) (the 2018 Regulations). The EIAR includes assessments of the likely significant effects on the environment that are likely to be caused during the construction and operation phases of the Proposed Development.

This CEMP has been prepared in accordance with the environmental measures identified in the EIAR (Chapters 8 - 21) and supporting documentation to avoid, reduce or compensate for the adverse effects of the Proposed Development on the environment during construction.

2 Description of the Offshore Development

2.1 Introduction

A brief overview of the Proposed Development is provided below. The detailed description of the proposed development is provided in EIAR Volume 3D Part 2 Chapter 5: Description of the Landfall, and Chapter 6: Description of the Offshore Cable.

The subsea cable will connect to its onshore element at the Transmission Joint Bay (TJB) north of the car park at Claycastle Beach near Youghal in County Cork. The HVDC subsea cables will be buried within pre-installed conduits beneath the beach and car park at Claycastle Beach. The cables will be pulled ashore through the conduits and into the TJB by a temporary winch. Once the cable is secured in the TJB, the offshore cable laying and burial process shall commence. For this, a plough / jetter shall be transferred to the beach to bury the cable seaward.

The cable landfall installation method selected for Claycastle Beach is an open cut installation method to be constructed in two phases. Phase 1 of the installation involves the installation of conduits within a trench excavated across the beach and extending across an existing car park located above the beach to the area of the TJB. Two options are proposed for these works:

1. Install the conduits almost to the Lowest Astronomical Tide (LAT) level. This minimises disruption to the beach during the high amenity season as these works can be carried out in the winter season; however they involve a significant construction effort as a causeway and extensive cofferdam piling are required. This activity is expected to take up to 10 weeks.
2. Install the conduits for a shorter distance below the beach. This significantly reduces the construction effort, as in particular there would be no requirement for a causeway and the extent of cofferdam piling would be minimal, thereby reducing associated construction noise and movements of plant and vehicles. This option would result in a short duration (2-3 days) public exclusion from a 50m corridor of the beach for the installation of each of the two cables, with pedestrian diversions on the beach during the cable installation (the works might occur in the high amenity season). However, the car park would remain fully accessible, and would facilitate the diversion around the exclusion zone.

Option 1 has the greater potential for environmental impact, and so is the basis for assessment in the Ireland Offshore EIAR (Volume 3D Part 2 – Technical Chapters).

Phase 2 of the installation sequence involves pull-in of the submarine cables through the pre-installed conduits and into the TJB using a cable winch. The specific location of the receiver pit will vary between Option 1 and Option 2; however, all other activities are similar between the two options.

Temporary laydown areas and a construction compound will be required along the beach, in the car park, and on the section of grass which separates the car park from the year-round holiday park for the installation of the onshore trench, the TJB and the winch platform.

The offshore cable route through the Irish Territorial Waters is approximately 35km and a further 116km is within the Irish EEZ. The offshore works involve a number of vessels (survey vessels, cable lay vessels and support vessels). The installation of the submarine cable will follow the general sequence below:

- Contractor survey, route engineering and finalisation;
- Unexploded Ordnance (UXO) intervention campaign;
- Boulder clearance;
- Pre-lay grapnel runs;
- Construction of infrastructure crossings;
- Pre-lay route survey;
- Cable lay;
- Post-lay survey;
- Cable burial;
- External / Secondary protection; and
- Post-burial survey.

2.2 Proposed Construction Schedule and Timing of Works

Subject to the grant of statutory approvals, it is programmed that installation of the offshore route will commence in 2024, for it to become fully operational by 2027.

The offshore works involve a number of vessels and activities as discussed in EIAR Volume 3D Part 2 Chapter 6: Description of the Offshore Cable. The first activity of the offshore works will be the pre-lay survey expected to last 28 days in Irish waters and performed well in advance of the main construction activity.

The preparatory works shall be carried out in advance of cable lay for approximately 30 days in Irish TW and EEZ.

Offshore Cable installation is envisaged using standard burial tools (plough or a mechanical trenching tool). There is approximately 33km of the marine route in the Irish EEZ (Kilometre Point (KP) 57.5 to KP 90.7) that has more challenging strata, consisting of underling chalk. Sections of this route may pose a challenge to cable burial using standard burial tools and may require the use of specialist rock cutting tools for trenching. The overall schedule for cable lay and burial in Irish Territorial Waters and EEZ excluding weather or mechanical damage stand by is 60 days.

A rock placement vessel, only if required in the Irish EEZ, will follow cable installation, and be required in Irish TW and EEZ for up to 16 days.

The durations of the works provided are indicative only and based on 24/7 operations, and will be subject to relevant approvals, safety requirements for the installation operations / procedures, and weather conditions.

3 Project Team

3.1 Roles and Responsibilities

Establishing roles and responsibilities on site is important to ensure the successful construction of the Proposed Development, including the implementation of the CEMP.

3.1.1 Contractors

The contractors will be responsible for implementing the CEMP through contractual agreements with the Applicant.

Prior to each stage of construction commencing, the contractors will prepare or update the management plans required within the CEMP.

The contractors will prepare and update the site Safety Health and Environment (SHE) Plan, which details relevant safety, health and environmental information relating to all land within the construction site.

The contractors will prepare a list of Contractors Proposals, which will detail all of the environmental mitigation measures for each stage of the works that will be implemented. The Contractors Proposals will be in accordance with the CEMP.

The plans will be made available to all persons working on the Proposed Development.

Environmental issues that arise during the construction of the Proposed Development will be reviewed at the inaugural and subsequent regular meetings held by the contractors. Daily toolbox talks will be held by the contractors to inform the construction staff of any environmental issues and any changes to the CEMP, Contractors Proposals, and/or the SHE Plan.

The Applicant and the contractors will ensure that all staff, including sub-contractors are trained and competent in the management of environmental impacts to a level that is appropriate to their role.

3.1.2 Contractor Project Director

It is to be the responsibility of the Contractor Project Director (CPD) to ensure that adequate resources are made available to the Project Team so that the environmental policy is effectively implemented during the construction phase. The CPD will sign the Policy Statement confirming the commitment of the Project Team to ensure that all environmental aspects are managed in accordance with relevant legislative and contractual requirements, and environmental commitments detailed in the CEMP.

3.1.3 Contractor Environmental Manager

The Contractor Environmental Manager (CEM) is responsible for ensuring all environmental standards and commitments are adhered to throughout the construction design, implementation, maintenance, and monitoring periods of the scheme.

The CEM will also be responsible for the following:

- Developing and reviewing the CEMP and specialist procedures;
- Leading the appointment and management of environmental specialists at the construction stage;
- Facilitating environmental training and inductions to the workforce, as required;
- Communicate sustainability good practice, innovation and targets to the project team and supply chain;
- Keep a record of key performance indicators ('KPIs');
- Monitoring compliance of construction activities with the CEMP / environmental legislation and licences;
- Acting as the focal point of contact for all environmental issues on site;
- Convening and chairing environmental team meetings and meetings of external consultees;
- Providing such advice as is required by the CPD on environmental issues; and
- Coordinating regularly with the Environmental Clerk of Works (EnCoW) implementing the CEMP for the onshore Irish elements of the Celtic Interconnector Project, and the corresponding CEM delivering the CEMP in UK waters. Unless otherwise agreed between the EnCoW, CEMs the competent authorities, or other relevant stakeholders, coordination will be required at least weekly (but daily where onshore and offshore works are concurrent at the landfall, or Irish and UK offshore works are being undertaken concurrently). The CEM will be available to attend joint meetings with EnCoW and/or other CEM(s), if requested by competent authorities, or other stakeholders relevant to timely and effective delivery of the CEMP.

The CEM will also record and report on all environmental activities on the project. They will monitor and supervise construction activities where appropriate, maintain auditable environmental records and conduct audits as required by the CEMP and offer full time presence on site throughout the construction period.

3.1.4 Environmental Clerk of Works

The EnCoW will be responsible for taking the scheme through the environmental aspects of the statutory process and aid the development of the CEMP in liaison with the specialist advisors. The EnCoW will provide advice and assistance as necessary throughout the construction process.

3.1.5 Environmental Specialists

A team of experts will be employed and utilised to support the Project Team on specific issues as and when required. They will undertake pre-construction surveys and watching briefs, and oversee implementation, maintenance, and monitoring throughout the contract period.

Marine mammal observers (MMOs) will be present on the geophysical survey vessels in Irish waters. Throughout all works, suitably qualified MMOs will follow the DAHG (2014) guidelines established by the NPWS, recording continuously as appropriate.

The role of an MMO is to monitor for the presence of marine mammals, and where noise-generating works are being completed (for example geophysical surveys), that direct and indirect impact risks (mortality, hearing loss and/or disturbance) are mitigated and operations are controlled when animals come within close proximity prior to the sound source being generated e.g. 500-1,000m.

This 500-1000m ZoI relates to typical mitigation zones, as per the DAHG (2014) guidance. DAHG (2014) guidance indicates that piling and geophysical acoustic surveys (not seismic) should not commence if marine mammals are detected within 1,000m (piling) and 500m (geo acoustic survey, not seismic), unless a distance modification has been agreed with the Regulatory Authority.

Whilst focusing on marine mammals, the survey methodology dictates that surveyors are also instructed to record any sightings of marine reptiles.

3.1.6 Engineering Manager

The Engineering Manager is responsible for ensuring the environmental issues and constraints are included in individual designs, in accordance with environmental design procedures.

3.1.7 Community and Stakeholder Liaison Officer

The primary role of the Community and Stakeholder Liaison Officer is conducting all public liaison associated with the construction phase of the Proposed Development.

The responsibilities and duties of the Community and Stakeholder Liaison Officer include the following:

- Disseminating the construction programme to all relevant parties, including, for example, any work generating high levels of noise;
- Acting as first point of contact for members of the public;
- Ensure that all local residents and stakeholders are kept informed of progress and key issues;

- Maintaining a register of queries and complaints from the public which will inform the day-to-day construction activities;
- Responding to queries, responding to complaints, and resolving concerns in addition to informing the project manager as and when complaints are received; and
- Production of newsletters / bulletins / social media upon a regular basis to raise awareness of current issues both within the project team and throughout the local community.

3.1.8 Site Health and Safety Advisor

The Site Health and Safety Advisor's main aim is to prevent accident, injuries, and work-related illnesses on site. They shall implement health and safety policies in accordance with the latest legislation, guidance, and codes of practice.

They will be responsible for the following tasks and responsibilities:

- Take overall responsibility for compliance with all health and safety requirements at the site and for achieving the required levels of health and safety performance;
- Take responsibility for implementation and management of emergency response procedures, while ensuring health and safety roles are being enacted in accordance with the requirements of these procedures, and in line with best industry practice;
- Ensure health and safety roles are provided with suitable environmental awareness training and provision of any specialist environmental training required generally to carry out their roles;
- Ensuring work is undertaken in a safe manner and machinery is used in accordance with manufactures guidance;
- Ensuring that the contractor and their associated employees work in accordance with approved risk assessments;
- Undertake regular (e.g. daily) checks to ensure that the site is tidy and secure;
- Provide health and safety toolbox talks to site employees upon a regular basis (e.g. weekly);
- Reviewing implemented health and safety procedures and where appropriate amending procedures. These reviews will be recorded; and
- Reporting and recording any incidents or near misses.

4 General Environmental Requirements

4.1 Introduction

This chapter of the CEMP provides an overview of the general environmental requirements that will be implemented during the construction of the Proposed Development to avoid, reduce, or compensate for adverse effects.

The CEMP can be updated to provide full details of environmental measures as identified by the contracted environmental specialists primarily having regard to any conditions of the relevant consents.

The relevant Contractor will ensure that all sub-contractors adhere to the environmental good practice guidelines for implementation during work activities.

4.2 Method Statements

The implementation of Method Statements for the different activities of the Proposed Development works shall be completed within the relevant contractor(s) by trained staff or other appropriate experienced personnel, in consultation with specialists as required. Their production shall include a review of the environmental / health and safety risks and commitments, so that appropriate control measures are developed and included within the construction process.

Method Statements will be reviewed by the Contractor’s Project Manager and, where necessary, by an appropriate environmental specialist. Where appropriate, and if required or necessary, Method Statements will be submitted to the relevant regulatory authorities.

Method Statements must contain as a minimum:

- Location and duration of the activity;
- Work to be undertaken and methods of construction;
- Plant and materials to be used;
- Labour and supervision requirements;
- Health, safety, and environmental considerations (including relevant control measures); and
- Permit or consent requirements.

Deviation from approved Method Statements (where this is a statutory requirement) will be permitted only with prior approval from relevant parties. This will be facilitated by formal review before any deviation is undertaken.

4.3 Audit and Inspections

The Contractor's CEM shall be responsible for updating the CEMP on a regular basis as required.

The CEM will undertake daily inspections, which will include monitoring conformance with the CEMP. Daily assessment forms will be completed by the CEM during the daily checks. Checks on equipment will be undertaken to reduce the risk of incidents occurring (for example oil leaks). As a minimum, unless otherwise agreed with the Foreshore Unit or other relevant stakeholders, the following equipment will be inspected:

- Waste storage facilities;
- Sediment management;
- Oil separators;
- Chemical storage facilities;
- Storage vessels (i.e. pumps, gauges, pipework, and hoses);
- Secondary containment (i.e., secondary skins for oil tanks);
- Spill response materials; and
- Equipment with potential to leak oils and other liquids, for example, compressors and transformers.

Regular external audits will be undertaken by the Applicant to ensure the mitigation in the EIAR is implemented correctly.

The external audits will also include:

- Reviewing the daily risk assessment forms;
- Ensuring that faults and defects are identified and rectified; and
- Providing data for performance monitoring.

Environmental performance data will be collected and collated into the SHE Plan.

The Contractor's CEM will be delegated sufficient powers under the construction contract so that she / he will be able to instruct the Contractor to stop works and to direct the carrying out of emergency mitigation / clean-up operations.

The Applicant will also have stop works authority, in the event of a non-conformance identified during an external audit.

4.4 Reporting

The Contractor's CEM will be responsible for carrying out regular monitoring of the Contractors CEMP and will report monitoring findings as required by the planning consent. The Contractor's CEM will also report monitoring findings in writing to the Applicant on a regular basis (at least weekly, but immediately in the case of incidents or accidents). Contractors shall be responsible for investigating and addressing any non- conformances raised by the CEM within an agreed time frame. The CEM will document in written reports, where additional corrective or preventative actions to those in the EIAR have been implemented

The CEM monitoring reports (and Applicant’s audit reports of same) will be made available to statutory and non-statutory bodies on request. Where specific environmental management and reporting is required, it will be set out in the relevant management plans.

Document control shall be in accordance with a Quality Management System and copies of all environmental audit reports, consents and licences shall be maintained by the Contractor’s Environmental Manager.

5 Competence, Training, and Awareness

Contractors shall identify the training needs of their employees and subcontractors so that they can implement the requirements of this CEMP (and any agreed updates to same) into briefings and construction method statements.

All personnel will be aware of their general environmental management responsibilities, and for those whose work may cause, or have the potential to cause, a significant impact on the environment, to receive specific environmental awareness briefings. Environmental awareness will be reinforced through information, such as poster campaigns, environmental / sustainability performance indicator reports and environmental alerts.

All contractors are responsible for ensuring the competency of their environmental staff. Where environmental training is needed for staff, a contractor is responsible for ensuring this requirement is fulfilled. Any environmental training provided to members of the project team will be logged by the CEM and any certification documents will be produced by the relevant members of staff as evidence that they hold the required competencies.

5.1.1 Toolbox Talks

To provide ongoing reinforcement and awareness training, the below topics, along with any other environmental issues which arise, will be discussed at regular toolbox talks provided by the CEM, or relevant specialists. Where applicable to the works the following topics will be included in the induction:

- Waste management;
- Pollution prevention and control;
- Biosecurity;
- Measures for marine mammals, including the role of Marine Mammal Observer
- Archaeology; and
- Emergency response procedures

Additional toolbox talks shall be added by the CEM or relevant specialists as required based on circumstances such as unforeseen risks, repeated observation of bad practices, or perceived lack of awareness.

Records of all toolbox talks and their attendees shall be maintained and recorded.

5.2 Communications

5.2.1 Internal Communication

Communication on environmental issues within the project team will take place through face-to-face conversations, e-mails, and telephone calls / virtual meetings. The Contractor's

Project Manager will be made aware of all environmental issues at the earliest possible opportunity. Communication on environmental matters will be maintained through construction meetings chaired by the Environmental Advisor / Manager or a senior manager.

Environmental issues identified by any member of the project team will be communicated to the relevant personnel to ensure any required actions are carried out. Dissemination of information will take place in several forms, as appropriate, including meetings to discuss project issues, method statements, task/activity briefings, toolbox talks, inductions, environmental notices, and environmental alerts. Records that these have been carried out and who received them will be recorded. The Environmental Advisor / Manager will notify Supervisors of any legislation changes which may affect working practices.

Any unexpected finds / occurrences by project staff can be reported to their supervisors, which will then give notification to the relevant member of the Environmental Team who will advise on the course of action to be taken.

5.2.2 External Communication

Contractors will liaise regularly with the Applicant and their representatives regarding the programme of works, nature of the operations, and methods to be employed to minimise adverse environmental impacts. This will include progress meetings as well as the production and submission of progress reports which will cover environmental / sustainability issues. Contractors will also supply all relevant supporting information and documentation to the Applicant for matters concerning consents and the environment in accordance with the appropriate timescales.

In the event of stakeholder liaison being required with local authorities or other stakeholders, the Contractors will identify the requirement and seek authorisation from the Applicant to undertake the task. Where consultation is required, a representative from the Applicant will be invited to attend alongside the relevant Contractor personnel.

Project staff will keep an archive of any e-mail correspondence between themselves and statutory authorities and other stakeholders concerning the activities taking place. Where any complaints are received, a log of correspondence and complaints will be kept up to date by the relevant Contractor.

The Contractor will appoint a Community and Stakeholder Liaison Officer to carry out liaison duties with the public and others and will develop the Communications Plan for the Proposed Development. The responsibilities of the Community and Stakeholder Liaison Officer are outlined in section 3.1.

Contact details of the Community and Stakeholder Liaison Officer will be made publicly available and advertised clearly.

Contact details will be detailed and displayed on the site notice board. A template for the Emergency Contact List is provided in Appendix C.

5.2.3 Community and Stakeholder Relations

It is good practice to inform interested parties when works are due to commence. Contractors will not communicate with residents unless approval has been granted by the Applicant. A Community and Stakeholder Liaison Officer role will be appointed by the Contractor, as described above.

The Contractor's Community and Stakeholder Liaison Officer will interface with the Applicant's Community Liaison Officer.

Stakeholder meetings will be held as required.

Any letters issued to interested parties will be drafted and issued by the Applicant, with inputs from the Community and Stakeholder Liaison Officer.

5.2.4 Complaints Procedure

The Community and Stakeholder Liaison Officer will be responsible for dealing with any complaints and will have the appropriate authority to resolve any issues that may occur. Should it be required, an 'out of hours' telephone number will be available. The Community and Stakeholder Liaison Officer will also communicate complaints on environmental matters communicated to the Applicant's Planning and Environmental Unit, based centrally in EirGrid's Dublin office.

The Environmental Manager / Advisor will maintain a close liaison with the relevant Local Authority Environmental Health Officer ('EHO'), and offshore regulatory body at all times, and should any complaints regarding environmental nuisance (e.g. dust or noise) be received by the Community and Stakeholder Liaison Officer the details will be passed to the relevant persons for verification purposes.

5.3 Environmental Incident Procedure

All incidents associated with the construction of the Proposed Development, including environmental incidents and non-conformance with the CEMP, will be reported, and investigated.

The formal procedure for handling Environmental Incidents will be developed and agreed by the Contractor / Construction Manager and communicated through the CEMP, however it is envisaged that it will be similar to that detailed below:

- Environmental Incidents are to be reported to the Construction Manager;
- The Construction Manager (or nominated representative) will record full details of the Environmental Incident and ensure that they are responded to as soon as reasonably practicable (preferably within one hour but always within 24 hours); and
- The Construction Manager (or nominated representative) will undertake an investigation to assess what corrective and preventative action, or further investigation is necessary to avoid recurrence of the Environmental Incident.

5.3.1 Pollution Incident Control Plan

A Marine Pollution Contingency Plan will be developed for the Proposed Development, post-consent. The production of this document is a requirement of the Foreshore Licence and will be submitted to the licencing authority for approval prior to construction.

The final response procedure will be presented in the Marine Pollution Contingency Plan, which will be produced post consent.

Each vessel utilised on the project will have an effective spill response process in place, i.e. a Ship Oil Pollution Emergency Plan (‘SOPEP’), or equivalent.

SOPEP is a MARPOL 73/78 requirement under Annex I. All ships with 400 GT and above must carry an oil prevention plan as per the norms and guidelines laid down by IMO under Marine Environmental Protection Committee (‘MEPC’) Act.

The Master of the ship has overall charge of the SOPEP of the ship, along with the chief officer as subordinate in charge for implementation of SOPEP on board. SOPEP also describes the plan for the master, officer, and the crew of the ship to tackle various oil spill scenario that can occur on a ship.

All vessels will carry spill kits, suitable individuals will be available to provide 24 hr spill response (where 24 hr working is planned). Individuals will have been trained by the CEM, or relevant specialists, in the use of spill kits and procedures so that any response is carried out immediately and efficiently.

In addition, Contractors will work with local authorities to provide support in event of any incident occurring where pollution of the marine environment occurs.

Emergency Response Plans and Emergency Notification Flowchart will be produced by the contractor. This will include project specific emergency contact details, notification requirements, and classifications for an environmental incident.

5.3.2 Dropped Objects

Dropped objects will be reported in line with the requirements set out in the Foreshore Licence.

5.4 Health and Safety

The Applicant is and Contractor are required to ensuring the health and safety of persons working on projects and the protection of the environment is maintained in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013, as amended[1] (the 2013 Regulations) and the principles and philosophy behind them.

[1] Safety, Health and Welfare at Work (Construction) Regulations 2013. Available [online] at: https://www.hsa.ie/eng/Legislation/New_Legislation/SI_291_2013.pdf (Accessed 08/06/2021).

In accordance with health and safety legislation[2], the contractors will prepare a Construction Phase SHE Plan prior to construction works commencing.

A SHE Plan will be prepared by the contractors for each element of the Proposed Development, including construction work. The Plan will ensure that adequate arrangements and welfare facilities are in place to cover:

- The safety of construction staff;
- The safety of all other people working at or visiting the construction site;
- Overall compliance with health and safety legislation, approved codes of practice and industry best practice;
- Emergency procedures being defined and adopted; and
- Appropriate training and information being provided to personnel.

The contractors' Construction Phase SHE Plan will be reviewed by the Applicant to ensure it meets the 2013 Regulations prior to construction commencing. As described at Section 2.1, the SHE Plan will be managed, implemented, and updated as necessary through the duration of the project by the Contractor Project Manager.

All staff, site visitors and delivery drivers will receive a relevant project induction by the contractors to ensure they are aware of site hazards and health, safety, and environmental management requirements. Site staff will be briefed daily by the contractors prior to work commencing. Site-specific risk assessments will be carried out to ensure the risk remains relevant. The contractors will be required to carry out audits and inspections throughout the proposed development in accordance with Section 2.1 of this CEMP.

5.5 Construction Hours

Proposed timings of the Proposed Development are outlined in the EIAR and in Chapter 2, subject to approval by the DHLGH prior to the commencement of the works.

5.6 Construction Site Layout and Appearance

The layout, appearance and operation of the construction site, site offices / compounds, and vessels will be detailed prior to construction commencing and will comply with the commitments in this CEMP.

2 Safety, Health and Welfare at Work Act 2005

5.7 Waste Management

The Applicant and the contractors are responsible for managing waste arising from all activities in order to prevent pollution and to meet or exceed legal requirements[3, 4, 5, 6, 7].

The contractor will prepare a Waste Management Plan (WMP) to include matters related to any conditions of the Foreshore Licence and any other post consent related matters, including in respect of detailed design and scope activities and confirmatory survey works.

The contractor's WMP will include waste stream management procedures that include protocols for the correct handling, segregation, and disposal of waste in accordance with the Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects, Department of the Environment (DECC, 2006), as well as in accordance with Annexes IV and V of the International Convention for the Prevention of Pollution from Ships (the MARPOL Convention).

In line with the revised 2011 EU (Waste Directive) Regulations 2011 [S.I. No. 126/20011], waste will be managed in accordance with the waste hierarchy as defined by the EU Directive 2008/98/EC on Waste. This means that waste will be reduced, reused, recovered, and recycled as far as reasonably practicable.

The contractor will operate control measures in accordance with industry best practice to ensure:

- No unauthorised keeping, deposit, or disposal of materials;
- No unauthorised treatment of material;
- No escape / release of waste material, either while the material is awaiting transportation or during transportation;
- Material is only transported by an authorised person / company who holds the correct Waste Carriers / Broker Licence; and
- A Waste Transfer Note is used with a written description of the material.

Temporary facilities for installation works will be provided in the hard standing car park area at the foreshore, including chemical toilets and additional wastewater holding capacity. These will be regularly serviced by a licensed wastewater treatment contractor, with effluents removed for discharge to a sewage treatment plant. The nearest wastewater treatment plant to the landfall site at Claycastle Beach is located less than 5km away, to the north of

3 European Union (Environmental Impact Assessment) (Waste) Regulations 2020. SI 505 of 2020.

4 European Union (Ship Recycling) (Waste) Regulations 2019 S.I. No. 13 of 2019.

5 Waste Management Act, 1996 No 10 of 1996

6 Protection of the Environment Act 2003 No 27 of 2003

7 Waste Framework Directive 2006/12/EC

Youghal. Having been upgraded in 2018 (Irish Water, 2020), the Youghal wastewater treatment plant is anticipated to have the necessary equipment and capacity for treating wastewater from site.

Vessels will manage on-board waste streams including wastewater and sewage in line with international agreements such as the International Convention for the Prevention of Pollution from Ships (the MARPOL convention), with Annex IV relating specifically to sewage management and Annex V relating to solid waste streams such as garbage.

Waste produced offshore will be stored in designated containers and returned to port by the EPC contractor. Onshore, waste will be segregated into designated containers that are made of materials appropriate to the content. Waste will be collected and disposed of by a licensed waste contractor.

Hazardous wastes arising from the works generated on board the vessels will be segregated based on its classification as (potentially) hazardous or non-hazardous. Under MARPOL 73/78 the following waste types are distinguished and on board the vessels, segregation takes places accordingly:

- Operational waste (general and recycling); and
- Hazardous wastes (which are expected to include waste oils, oil / fuel contaminated materials, and will not be mixed with non-hazardous or inert materials.

5.8 Security

The construction site and vessels will be controlled in accordance with the statutory duty[2] to prevent unauthorised access to the site. Site-specific assessments of the security and trespass risk will be undertaken at the site and appropriate control measures implemented. The control measures are likely to include:

- Consultation with An Garda Siochana on security proposals for the site and vessels with regular liaison to review security effectiveness and response to incidents; and
- Immobilisation of plant and vessel out of hours, removing or securing hazardous materials from site and compounds, and securing fuel storage containers.

5.9 Welfare

No living accommodation will be permitted on the onshore construction compound for the foreshore works. Onsite and on vessel welfare facilities will be provided for all site workers and visitors. Welfare facilities will be kept clean and tidy, in accordance with section 2.7 of this CEMP.

5.10 Biosecurity

The risk of Invasive Non-Native Species (INNS) will be reduced by the contractor in agreement with the Applicant by carrying out a Biosecurity Risk Assessment and implementing INNS Management Plan, drawing on the findings of the EIAR, including appropriate mitigation as outlined within Volume 3D2 Part 2 – Technical Chapters, Chapter 14 - Biodiversity. This will be done in relation to all marine operation activities associated to the Proposed Development. The risk assessment and management plan will include consideration of all activities, vehicles and equipment used as well as how the risk will be minimised through appropriate mitigation and adherence to best practice guidance and management measures. The risk assessment will include a review of all the available data in relation to the presence of marine INNS where applicable to the Proposed Development, and the potential risks associated to each species identified.

5.11 Unexploded Ordnance

Risk assessments will be undertaken prior to each stage of construction commencing for the possibility of unexploded ordnance being found within construction areas. These will be used to specify safe working requirements, which may include advance magnetometer surveys at piling locations and appropriate training for site operatives. An unexploded ordnance specialist will be available on-call for any works in high-risk areas. An Emergency Response Plan for unexploded ordnance will be prepared by the contractors and will be followed to respond to the discovery of unexploded ordnance. This will include notifications to the relevant local authorities, emergency services, and businesses.

5.12 Consents and Licences

A number of sections of this CEMP reference consents, permits, and licences that will be required during construction. The EIAR contains details of the consents and licences the Applicant currently believes will be required to construct the Proposed Development that will be obtained outside of the application process. A Consents Register will be maintained by the CEM which will document all existing consent conditions, record all new applications made and the status of the applications.

A Register of Legal and Other Requirements will be maintained in the CEMP. This will include information relevant to the Proposed Development. A draft Register of Legal and Other Requirements can be located in Appendix B.

6 Environmental Control Measures

6.1 Introduction

This chapter of the CEMP provides an overview of the environmental control measures that will be implemented during the construction of the Proposed Development to avoid, reduce, or compensate for adverse effects as identified in the EIAR chapters.

Any updated CEMP will provide full details of environmental control measures as identified by the contracted environmental specialists.

The Project Promoters will ensure that all sub-contractors adhere to the environmental good practice guidelines for implementation during work activities.

Table 5.1 provides a summary of the mitigation and monitoring measures, unless otherwise agreed with the NPWS and/or the Foreshore Unit, required to avoid, reduce, and minimise potential impacts which may arise from the Proposed Development during construction, and which have been committed to by the Project Promoters in the EIAR.

Table 5.1 Environmental Control Measures to be incorporated for the Construction Phase

Environmental Topic	Potential Impacts	Monitoring and Mitigation
Population and Human Health	• Impact on beach users due to reduced width of the beach and temporarily reduced parking capacity and access during landfall works. • Impact on participants of water sport and angling due to reduced parking affecting the transport of equipment to the beach, and due to limitations on access in offshore areas during installation.	• Installation activities are planned to take place over short periods, avoiding as far as possible the peak tourist season and to avoid specific events. The approach to design of the construction plan includes flexibility to allow for circumstances such as the combination of a fixed date for an event, a weather window, and restrictions on vessel deployment schedules. • Public information will be provided about the works including signage at and near the site; information at tourist information points; and timely distribution of information to civic authorities and local organisations. There will be identification of and engagement with organisations assessed as likely to be particularly concerned or affected.

Environmental Topic	Potential Impacts	Monitoring and Mitigation
		• Regular physical monitoring of the site and additional monitoring of the construction site as appropriate before, during and after natural events, organised events (such as festivals) or other circumstances in which any aspect of works, barriers or associated safety equipment and procedures may be detrimentally affected.
Air Quality and Climate	• No potential impacts are identified which require monitoring or mitigation.	• N/A
Marine Sediment Quality	• Disturbance of surficial sediments at Claycastle Beach and along the marine cable route during installation causing increased turbidity and sediment plumes. • Potential release / remobilisation of contaminants held within the sediment when the seabed is disturbed during installation. • Installation of cable protection has the potential to impact marine water quality via the release of hazardous substances through loss of	• During the pre-construction engineering and design phase, a detailed analysis of the seabed along the route of the interconnector will be undertaken. From this, the most appropriate installation techniques will be established, as determined by seabed type, to minimise sediment disturbance and hence minimise effects on marine water quality. • Vessels used for installation will be compliant with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations. These regulations cover the prevention of pollution from accidents and routine operations. • During installation, measures will be taken to minimise the risk of collision between installation vessels and other vessels, including issue of appropriate notifications via official channels. • All vessels used during installation will have Shipboard Oil Pollution Emergency Plans (SOPEP) in operation.

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	chemicals / fuels from installation vessels.	• Throughout the Proposed Development's lifespan, periodic monitoring of the cable route will be undertaken; should such monitoring identify significant changes in the bathymetry or seabed features (i.e. sediment type) in the vicinity of the cable route, appropriate measures will be taken, including replacement or addition of further external cable protection, as necessary.
Marine Physical Processes	• Disturbance to, and loss of, seabed features during cable installation. • Disturbance to, and loss of, seabed features during installation of cable protection. • Changes to coastal erosion patterns due to installation works at the cable landfall.	• During the pre-construction engineering and design phase, detailed sub-bottom profiling, and accompanying analysis of the seabed along the route of the interconnector will be undertaken. From this, the most appropriate installation techniques will be established to minimise sediment disturbance. • Where the need for external rock protection is identified, this will be designed according to the receiving environment, based on seabed type, and the need to reduce seabed disturbance.
Marine Water Quality	• Disturbance of the seabed along the route through release of contaminants held in surficial sediments.	• When the trench is excavated at Claycastle Beach spoil will be stored within the compound on the hard standing to allow the site to be restored to its previous conditions following the installation of the conduits. • Stored spoil shall be adequately covered to prevent exposure to the elements and leaching of sediment. • During the pre-construction engineering and design phase, a detailed analysis of the seabed along the route of the Celtic Interconnector will be undertaken. From this,

Environmental Topic	Potential Impacts	Monitoring and Mitigation
		the most appropriate installation techniques will be established, as determined by seabed type, to minimise sediment disturbance and hence minimise effects on marine water quality. • Where the need for external rock protection is identified, this will be designed according to the receiving environment, based on seabed type, and the need to reduce seabed disturbance. Cable protection will be designed to minimise scour, and hence resuspension of sediments. • Vessels used for any monitoring or maintenance activities during the operation phase of the Proposed Development will be expected to be compliant with MARPOL regulations. These regulations cover the prevention of pollution from accidents and routine operations. • Throughout the Proposed Development's lifespan, periodic monitoring of the cable route will be undertaken; should such monitoring identify significant changes in the bathymetry or seabed features (i.e. sediment type) in the vicinity of the cable route, appropriate measures will be taken, including replacement or addition of further external cable protection, as necessary.
Biodiversity	• Potential for loss of chemicals, fuels, or other pollutants as a result of accidental spills from installation vessels and other	• Project-related vessels to be operated in line with IMO Guidelines for the reduction of underwater noise to address adverse impacts on marine life; • Operations in the Irish marine environment to be undertaken in line with the 'Guidance to manage the risk to marine mammals from

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	associated heavy plant affecting biodiversity. • Underwater noise and disturbance effects on marine mammals in the intertidal zone (seals) and subtidal zone (all groups) during the installation phase particularly as a result of piling causing potential disturbance, hearing loss / injury and/or direct mortality, subsea survey and monitoring equipment (causing potential disturbance, hearing loss/injury, and / or direct mortality) and increased vessel movements (causing seal injury from ducted propellers). • Disturbance to seabirds due to installation works including temporary habitat loss from installation works including due to increases in suspended sediment and pollution events reducing habitat quality or having direct toxic effects.	man-made sound sources in Irish waters', as published by DAHG (2014). This guidance recommends the use of MMOs for pre-start monitoring, ramp up procedure, breaks (>30 mins) in sound output and reporting; • For the Proposed Development, different development activities have been assessed, including piling, geophysical acoustic surveys (not seismic), high frequency (>200kHz) bathymetric surveys, using multibeam and single beam echosounders, cable laying and cable protection. From these, and to be in line with this assessment and guidance (i.e. mitigation required >180dB and a ramp up procedure >170dB), an MMO (dedicated) is only required for piling and the geophysical acoustic surveys (not seismic), and not for cable laying and cable protection. High frequency (>200kHz) bathymetric surveys, using multibeam and single beam echosounders, are above the low-mid hearing frequency ranges of marine mammals, basking shark, marine turtles and fish. Cable laying and cable protection have been assessed as being below level that would require mitigation (<180dB). Also, the sound pressure levels are expected to be in the same range, as those from the installation vessels; • DAHG (2014) guidance outlines operational requirements concerning MMOs. These requirements require MMOs to be familiar with the Irish regulatory procedures, be provided with full details of all licence/consent conditions, be dedicated to and engaged solely in monitoring development activities and conducting

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	• Installation of the cofferdam will result in the loss of any trapped fish and shellfish not displaced by site disruption and noise.	survey effort for marine mammals in accordance with the guidance. The use of a crew member or team member with other responsibilities is not considered to be satisfactory. A sufficient number of MMO personnel must be assigned to ensure that the role is performed effectively and to avoid observer fatigue. General conditions for effective visual monitoring by MMOs are: (1) during daylight hours; (2) in good visibility extending 1km or more beyond the limits of the assigned Monitored Zone (1,000m for piling and 500m for geophysical acoustic surveys, not seismic); and (3) sea conditions WMO Sea State 4 (*Beaufort Force 4*) or less. Efficacy in the visual detection of marine mammal species improves considerably below Sea State 3 (*Beaufort Force 3*); • Unless otherwise agreed with the NPWS and/or the Foreshore Unit, MMOs must be located on an appropriate elevated platform from which the entire Monitored Zone (1,000m for piling and 500m for geophysical acoustic surveys, not seismic) can be effectively covered without any obstruction of view. For geophysical acoustic surveys and other moving platforms from which sound-producing activity is taking place, MMOs must be located on the source vessel; • DAHG (2014) guidance also recommends that, in some cases involving the persistent significant risk of injury to marine mammals in Ireland, the supplementary use of passive acoustic monitoring (PAM) may be recommended, or required, as part of the licence/consent conditions, in order to

Environmental Topic	Potential Impacts	Monitoring and Mitigation
		optimise marine mammal detection around the site of a plan or project. It is also indicated that PAM has/should not be regarded as the primary or sole monitoring approach for risk management purpose. It was identified that for PAM be effective, animals are required to vocalise, and their detection depends on the range capability of the technology. It should also be recognised that this was related to the method/technology that was available back in 2014; • Use of noise-attenuation fencing, solid hoarding or other acoustic barriers to reduce in-air noise propagation and to conceal human activity. The barrier material shall have a mass per unit area exceeding 7kg/m^2 in accordance with the recommendations of BS 5228 Part 1:2009+A1:2014 Part B.4; • Use of piling types and techniques that limit noise propagation: namely vibratory sheet piling installation and piling at low tide; • Use of ramp up/soft start procedures for piling and geo acoustic survey techniques to prevent receptors from being startled e.g. birds, marine mammals, marine turtles and fish (inc. basking shark); • Project-related vessels will adhere to international best practise regarding pollution control, including the MARPOL convention; and • Ensure appropriate burial depths and heat shielding from cable burial and rock placement (where applicable). This will indirectly reduce effects from heat emissions and electro-magnetic fields (EMF).

Environmental Topic	Potential Impacts	Monitoring and Mitigation
		• Seek to avoid noisiest works in January and February as these months typically coincide with peaks in bird numbers as reported on in the wintering and monthly bird surveys undertaken in 2019 and 2020, and as recorded at high and low tide at the landfall point, and elevated sensitivity due to heightened food scarcity and winter climatic conditions. •
Seascape and Landscape	• Changes to landscape / seascape character at the landfall site (up to mean high water mark (MHWM)) during the operational phase. • Changes to visual receptors' views close to the landfall site (up to MHWM) during the operational phase.	• Following completion of the installation works across Claycastle Beach to MHWM, the installation corridor (incorporating the cofferdam and raised causeway) would be reinstated using native materials previously excavated from the beach to original beach levels and gradients.
Archaeology and Cultural Heritage	• Near-shore peat deposits would be directly disturbed by the installation of the cable trench through the intertidal zone. • Disturbance and removal of remains of geoarchaeological interest and through the disruption of a single stratigraphic sequence.	• Implementation of an agreed scheme of archaeological work aimed at identifying and recording deposits of archaeological interest, retrieving, and analysing archaeological material would allow for these deposits to be adequately understood. • An agreed programme of further archaeological investigation and recordings combined with analysis of archaeological material already recovered and appropriate publication / dissemination of the results. • Archaeological exclusion zones will be established round the sites of known and

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	• Offshore deposits of geoarchaeological interest would be directly disturbed during the insertion of the marine cable where the cable is installed by jetting or ploughing. • Disturbance of archaeologically significant deposits.	potential wrecks along the cable route. These exclusion zones would be 100m from the recorded location of a wreck or location of any high potential sites, and 50m from the location of any medium potential sites.
Material Assets	• Risk of damage to existing subsea cables at cable crossings intersected by the Proposed Development. • Proposed Development intersecting with concept or early planning area for an offshore windfarm.	• Consultation with existing cable operators, use of crossing-specific cable protection specifications, and approval of Cable Crossing Agreements prior to works. • Consultation with windfarm developers to determine the likelihood of the offshore windfarm proceeding in this location, the level of risk associated with the cable location and the cable installation methods including cable protection.
Noise and Vibration	• Noise and noise from vessel movement during installation.	• Vessels used by the Proposed Development will be operated and maintained in line with IMO Guidelines for the reduction of underwater noise from commercial shipping.
Shipping and Navigation	• Temporary presence of work vessels with limited ability to manoeuvre during the construction phase and potentially an	• Compliance by both work and passing vessels with the COLREGS for vessel safety during installation. This will be encouraged and facilitated by keeping all sea users fully informed of plans and progress regarding the cable installation and procedures in

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	associated temporary exclusion zone. • Presence of rock armour above the previous seabed level, resulting in localised reduction in water depth available for navigation. • Presence of cables within anchor burial depth of the seabed, imposing restrictions on where vessels may anchor. • Installation of the cable landfall at Claycastle Beach will involve construction of a temporary cofferdam and causeway down the beach causing a temporary restriction on use of part of the beach which may affect users of beach-launched craft, such as personal watercraft, kite surf boards, or other water sports.	place to ensure their safety when navigating in the vicinity. • Supply of information to appropriate authorities to enable marine charts and sailing directions to be updated to show the cable route.
Commercial Fisheries	• Displacement of fishing activity by cable installation activities. Structures on the seabed represent	• A Fisheries Liaison Officer (FLO) will be maintained throughout the Proposed Development, to facilitate ongoing communication with fisheries representatives and organisations

Environmental Topic	Potential Impacts	Monitoring and Mitigation
	potential snagging points for fishing gear and could lead to damage to, or loss of, fishing gear. • Seabed obstructions from cables on the seabed and from cable protection.	throughout construction and installation in accordance with good practice. • Application for and use of 500m (radius) mobile safety zones around all maintenance operations. • Advanced warning and accurate location details of construction operation and associated mobile safety zones. Safety zones to be brought to the attention of mariners with as much advance warning as possible via frequent notification and other means e.g. the Kingfisher Bulletin, VHF radio broadcasts. and through direct communications via the FLO. • Bathymetric survey to be undertaken following completion of installation or repair works to ensure that the cables have been buried or protected and sediment is able to move over any installed cable protection.
Major Accidents and Disasters	• Vessel collision with potential for loss of property, injury, or loss of life. • Accidental leak or spill of fuel or lubricants during use of plant and machinery. • Accident involving plant or machinery and Hazardous offshore working conditions.	• Impacts managed through installation planning, adherence to navigational best practice, issue of Notice to Mariners, and use navigational markers. • Construction and site management good practice including preparation of a CEMP, and adherence to the International Convention for the Prevention of Pollution from Ships (MARPOL). These will limit the likelihood and size of leaks or spills and provide measures to contain accidental releases such that they cannot discharge into the environment.

Environmental Topic	Potential Impacts	Monitoring and Mitigation
		• Offshore works will not typically be undertaken in storm conditions above sea state 3. • Safety measures onboard vessels and the adequate training of crew will minimize risk to personnel.

Appendix A.

CEMP Review Table

Proposed Review Period	Due Date of Review	Actual Date of Review	Sections Amended	CEMP Issue Number	Reviewed by		
					Project Manager / Supervisor	Contractor's Project Director	Contractor's Environmental Manager

Appendix B.

Draft Register of Consents and Legal Responsibilities

Environmental Topic	Consent Licence / Permit Type	Description	Consent Granting Body	Responsibility	Date Required	Programme Risk	Additional Comments

Appendix C.

Emergency Contact Details Template

Name	Company	Person	Contact Number(s)	Contact Address
Project Hotline				
Employer				
Contractor				
Contractor's Project Manager / Supervisor				
Environmental Manager				
Environmental Co-ordinator				
Waste Management Contractor				
Fire Service				
Environmental Protection Agency				

Celtic Interconnector

Volume 3D2 – Appendix 11A

UXO Assessment

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Table of Contents

1 Introduction

1.1 Objective

The purpose of this report is to present an assessment of the potential effects that may arise as a result of the *in situ* detonation of an unexploded ordnance (UXO) target within the immediate route of the marine route of the Celtic Interconnector. This assessment is desk-based in nature, drawing on a number of key resources, including:

- EirGrid and RTE (2021) Celtic Interconnector Environmental Impact Assessment. Volume 3D – Ireland Offshore (primarily Chapter 13: Biodiversity and Chapter 17: Noise and Vibration);
- Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (Department of Arts, Heritage and the Gaeltacht, 2014); and
- Greenlink Marine Environmental Impact Assessment Report – Ireland. Appendix C: Underwater Sound Modelling Greenlink (2019).

Additional references are included within footnotes throughout report, as required.

1.2 Risk of encountering UXO within Irish waters

As presented in Chapter 6 of Volume 3D Part 1 of the EIAR, it is anticipated that UXO clearance and/or detonation will not be necessary within Irish Territorial Waters or the Irish Exclusive Economic Zone (EEZ). Magnetometer surveys completed in 2015 and 2018 have not identified a high potential for UXO targets along the cable route within either Irish Territorial Waters or the Irish EEZ; however, this will be confirmed during pre-installation confirmatory surveys along the cable route.

In the unlikely event that UXO targets are found, they will be either avoided (the preferred approach for any targets identified), removed and detonated or detonated *in situ* under appropriate licencing, held by the Engineering, Procurement and Construction (EPC) contractor. A full UXO survey campaign will be performed prior to cable installation.

This assessment has been prepared to inform licencing conditions for the Celtic Interconnector, enabling detonation of a single UXO target, if identified along the cable route.

1.3 Approach to assessment

For the purposes of this assessment, an assumption has been made regarding the possible scale of the UXO target considered. The UXO targets that have potential to occur in Irish waters include a range of sizes and types, with sea mines typically containing the largest volumes of explosives. The Greenlink EIAR (Greenlink, 2019) was informed by a desk-based assessment that reported on the UXO size classes that have potential to occur. It concluded that British sea mines were a worst-case and based its assumptions on the presence of an “M Mark III” mine, containing 794kg of explosive material. To allow for greater conservatism and flexibility within the Celtic Interconnector Project, should a UXO target be identified, the assessment presented here has been based on a target containing up to 1,000kg of explosive material. It has also been assumed that the target will be detonated *in situ*, rather than being transported elsewhere for disarmament or detonation.

Additional information on the methodology applied to determine the potential zones of influence (ZOI) for such a detonation is provided in **Section 1.4**.

1.4 Underwater noise

1.4.1 Prediction of underwater sound source levels due to UXO detonation

Detonation of explosives at the seabed generates high levels of sound at the location of the explosives. The prediction of source sound levels due to the detonation carries a high level of uncertainty. This is due to the fact that the source sound levels are a function of a number of parameters (e.g. charge weight of the explosives, the condition and specification of the explosives, or the amount of sediment covering the explosives). Given that the majority of these parameters are unknown at the impact assessment stage, a worst-case scenario will be considered, where the explosives are assumed to be at the surface of the seabed, and in full working order. As such, the estimation of the sound level generated at the source of the UXO will be defined within this assessment only by its charge weight.

The method used in this assessment to predict the source sound levels due to the detonation of UXO follows the methodology presented by Arons (1954)[1], recently revalidated by Soloway and Dahl (2014)[2]. According to this methodology, the peak pressure due to the initial positive-going shock wave (P_{peak} in Pascals) due to a charge weight W (in kg of TNT equivalent) at a distance R (in meters) from the source is given as:

$$P_{peak} = K_p \left(\frac{R}{W^{1/3}}\right)^a$$

where $K_p = 52.4 \times 10^6$ is the shock coefficient, and $a = -1.13$ is the pressure coefficient. The equivalent sound pressure level is given as:

$$SPL_{peak} = 20 \log(P_{peak}/P_0)$$

The predicted sound pressure levels from the detonation of typical UXO are presented in **Table 1-1**. In this table, the charge weights are also compared to those used in the Greenlink Interconnector (GI) assessment[3], where a different formula was used. From **Table 1-1**, it can be seen that the approach in this assessment is more conservative, predicting a sound level of 3dB above that used in the GI assessment.

1 Arons, A. B. (1954). Underwater explosion shock wave parameters at large distances from the charge. The Journal of the Acoustical Society of America, 26(3), 1948–1951.

2 Soloway, A. G., & Dahl, P. H. (2014). Peak sound pressure and sound exposure level from underwater explosions in shallow water. The Journal of the Acoustical Society of America, 136(3).

Table 1-1 Typical UXO charge weights and predicted sound pressure levels

Charge weight, W (kg)	SPL dB re 1μPa @ 1m	SPL dB re 1μPa @ 1m [GI[3]]
55	287	284
120	290	287
250	292	289
500	295	291
770	296	293
794*	296	293
1,000	297	294

***Value proposed in the Greenlink Interconnector EIA[3].

In this assessment, a charge weight of up to 1,000kg will be assumed, as previously described, leading to a predicted sound pressure level of 297 dB (re 1μPa).

1.4.2 Prediction of propagation of underwater sound

As sound propagates through the water, it tends to attenuate with distance. Most often, this is accounted for in calculations in terms of spherical spreading (inverse relationship of sound pressure with range) for continuous noise sources. However, as described by Cheong et al (2020)[4], the reduction of the peak sound pressure with range is not equivalent to spherical spreading because of the non-linear nature of the wave.

It is also common in the literature to account for other propagation characteristics, such as frequency-dependent loss coefficients that take into account the increased attenuation of sound at different frequencies. Other factors that tend to affect the attenuation of underwater sound with distance are the variable bathymetry, the seabed type, the salinity of the water etc.

In this assessment, the model used to predict the ranges of impact will be similar to that used by Mason and Braham (2018)[5], which is based on the principles of Soloway and Dahl (2015) as presented above. Mason and Braham (2018) also accounted for an attenuation correction to the absorption over long ranges (R>1km). Due to the lack of equivalent data in the vicinity of the Celtic Interconnector cable route, this is discounted in the present assessment, leading to a conservative approximation of the impact ranges.

[3] Greenlink Interconnector. (2019). Marine environmental impact assessment report - Ireland.

[4] Cheong, S.-H., Wang, L., Lepper, P., & Robinson, S. (2020). Characterisation of acoustic fields generated by UXO removal - Phase 2. In NPL REPORT AC 19.

[5] Mason, T., & Barham, R. (2018). Estimated ranges of impact for various UXO detonations, Norfolk Vanguard.

2 Key environmental receptors and sensitivity to underwater noise

2.1 Marine mammals

Marine mammals (cetaceans and pinnipeds) are dependent on sound for almost every aspect of their lives, including prey-location, communication, detection of potential hazards, navigation and general communication (Weilgart, 2007[6]). As a result, they can be sensitive to anthropogenic changes in underwater sound pressure or noise levels. Effects of changes to underwater noise levels can vary between species, but can include behavioural changes (such as altered swimming patterns, foraging behaviour, or avoidance of an area) and physiological changes (including changes in respiration rates, hearing damage, and stranding, potentially leading to mortality).

As with the following subsections, effects can be considered in terms of permanent threshold shift (PTS) and temporary threshold shift (TTS), referring to changes in the auditory range of the species being considered. These changes can ultimately, with PTS, result in permanent hearing loss or death as a worst-case.

For the purposes of this assessment, cetaceans have been divided into three categories: low-frequency, mid-frequency, and high-frequency, based on the thresholds for the onset of PTS and TTS, and their levels of functional hearing (Southall et al 2019[7]). Examples of species within each group include[3]:

- Low-frequency cetaceans: Minke whale (*Balaenoptera acutorostrata*); humpback whale (*Megaptera novaeangliae*); fin whale (*B. physalus*). Hearing range of 7-35kHz.
- Mid-frequency cetaceans: Short-beaked common dolphin (*Delphinus delphis*); bottlenose dolphin (*Tursiops truncatus*); Risso’s dolphin (*Grampus griseus*); Atlantic white-sided dolphin (*Lagenorhynchus acutus*); white-beaked dolphin (*L. albirostris*); killer whale (*Orca orca*); long-finned pilot whale (*Globicephala melas*). Hearing range of 150-160kHz.
- High-frequency cetaceans: Harbour porpoise. Hearing range of 275Hz to 160kHz.

The hearing capacity of European otter (*Lutra lutra*) and pinnipeds (seals, including grey seal [*Halichoerus grypus*) and common seal [*Phoca vitulina]*) have also been considered within this assessment, focusing on their hearing abilities within water, with hearing ranges of 60Hz to 39kHz and 50Hz to 86kHz, respectively. However, it is noted that otters are mainly coastal in distribution, and unlikely to be found along the main cable route of the

[6] Weilgart, L. (2007) A brief review of known effects of noise on marine mammals. International Journal of Comparative Psychology, Vol. 20, 2.

[7] Southall, E. B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., Ellison, W. T.

Nowacek, D. P., Tyack, P. L. (2019). Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2).

Celtic Interconnector. Therefore, on this basis, they have been scoped out of the remainder of this assessment.

Within this assessment, and based on previous, comparable studies, the threshold for behavioural disturbance for marine mammals is determined to be 160 dB rms (SEL for impulsive sound), and 120 dB rms (SEL, for continuous sound)[3].

2.2 Sea turtles

Although sea turtles' use of underwater noise is not as understood as for some other species groups, they are known to be able to detect and respond to noise, and may use this for navigation, foraging and general communication in the same way as marine mammals do.

Popper et al. (2014)[8] sought to establish sound exposure guidelines for sea turtle species, defined by the way they detect sound. Due to the limited information available, data has been extrapolated from other, similar species, as appropriate, concluding that sea turtles are more aligned with fish than mammals, in terms of the functioning of their ears, and thus hearing ability.

For key species, the following hearing ranges have been established[3]:

- Green turtle (*Chelonia mydas*): 50-1,600Hz.
- Loggerhead turtle (*Caretta caretta*): 50-800Hz.

2.3 Fish

As with sea turtles above, the key resource for understanding hearing in fish species is Popper et al. (2014)[8]. Due to the variability in fish behaviour, ecology and physiology, there is also wide variation in species' ability to detect and use sounds, and the potential effects which may arise due to anthropogenic changes in underwater noise levels.

The key driver in fish species' relationship with underwater noise, and their hearing capability, is the presence or absence of a swimbladder, and where it is present, its physiological connection with the rest of the body. An underwater explosion, as predicted from the detonation of a UXO target produces a pressure wave, which may result in rapid volume changes of gas within organs, including the swimbladder in fish, and other body cavities. This is the focus of potential impacts on fish, with limited information available on how such pressure waves affect hearing or behaviour. For consideration of potential impacts, the hearing range considered for fish is 100-400Hz.

For an *in situ* UXO detonation, it is likely that any fish in the immediate vicinity of the explosion will be injured or killed due to these pressure changes.

[8] Popper, A.N. et al. (2014) Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

2.4 Crustaceans

There is limited information on how crustacean species respond to increases in anthropogenically-generated underwater noise; they do not have an internal air-filled chamber, therefore are unlikely to be affected in the same way as fish species. Further, studies with airguns were not conclusive in terms of behavioural responses, although reduced mobility and burrowing may be an effect.

It is noted that there is no threshold for the assessment of sound exposure for crustaceans (Tidau and Briffa 2016)[9], therefore a detailed assessment of potential effects, in terms of a ZOI, is not possible, and they have been scoped out of the remainder of this assessment.

2.5 Zooplankton

As with crustaceans, there is limited evidence as to the effects on zooplankton of underwater noise, although some experimentation has been undertaken in relation to airgun noise, which showed increased mortality within a range of up to 1.2km from the noise source[3].

It is noted that there is no threshold for the assessment of sound exposure for zooplankton (Solan et al. 2016[10], McCauley et al. 2017[11]), therefore a detailed assessment of potential effects, in terms of a ZOI, is not possible, and they have been scoped out of the remainder of this assessment.

2.6 Summary of TTS and PTS onset criteria

Table 2-1 presents a summary of the injury thresholds for each of the species groups being considered within this assessment, as calculated for the *in situ* detonation of a UXO target containing up to 1,000kg of explosives.

Table 2-1 Summary of injury thresholds for identified environmental receptors from impulsive (SPL, unweighted) sound[3]

Species	Temporary injury (TTS) Threshold (dB)	Permanent injury (PTS) Threshold (dB)
Low-frequency cetaceans	213	219
Mid-frequency cetaceans	224	230
High-frequency cetaceans	196	202
Seals in water (PCW)	212	218

[9] Tidau, S., & Briffa, M. (2016). Review on behavioral impacts of aquatic noise on crustaceans. Proceedings of Meetings on Acoustics, 27(1). https://doi.org/10.1121/2.0000302

[10] Solan, M., Hauton, C., Godbold, J. A., Wood, C. L., Leighton, T. G., & White, P. (2016). Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Scientific Reports, 6.

[11] McCauley, R. D., Day, R. D., Swadling, K. M., Fitzgibbon, Q. P., Watson, R. A., & Semmens, J. M. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution, 1(7).

Species	Temporary injury (TTS) Threshold (dB)	Permanent injury (PTS) Threshold (dB)
Otters in water (OCW)	226	232
All fish species	229	-
Sea turtles	234	-

3 Impact assessment

As described above, targeted magnetometer surveys along the route of the Celtic Interconnector in 2015 and 2018 identified no potential UXO targets, and a low potential for such targets to be identified during the planned pre-installation UXO survey campaign. This will be confirmed prior to installation of the subsea cable.

However, for the purposes of this assessment, a worst-case scenario of the identification of a UXO target with a maximum charge weight of 1,000kg has been assumed, to identify potential zones of influence that may arise from an *in situ* detonation. These ZOI are presented in **Table 3.1**.

Table 3.1 Zones of influence used in impact assessment for impulsive sound arising from in situ detonation of a UXO target of 1,000kg explosive charge

Species	Temporary injury (TTS) (km)	Permanent injury (PTS) (km)
Low-frequency cetaceans	5.2	2.8
Mid-frequency cetaceans	1.7	0.9
High-frequency cetaceans	29.4	16.0
Seals in water	5.8	3.1
Sea turtles	0.6	-
All fish species	1.0	-
Zooplankton	-	-
Crustaceans	-	-

3.1 Marine mammals

From **Table 3.1**, it can be seen that the greatest potential impact arising from the modelled detonation is on cetaceans classified as 'high-frequency' based on their hearing capacity. As outlined above, this group primarily contains harbour porpoise, one of the most frequently-recorded cetacean species in Irish waters. For harbour porpoise, there is the potential for TTS within 29.4km of the detonation, and PTS within 16km.

It is noted that the use of a hypothetical UXO target containing 1,000kg is highly conservative, and such targets are unlikely to be encountered along the route of the Celtic Interconnector. However, there is still the potential for permanent injury or mortality to occur in the unlikely event that an UXO is identified and requires detonation. It is proposed that any detonation, regardless of scale, will be undertaken in compliance with the marine mammal mitigation outlined in the *Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters* (Department of Arts, Heritage and the Gaeltacht, 2014). This would include the deployment of Marine Mammal Observers (MMO) and the use of Passive Acoustic Monitoring (PAM), as required, and agreed in conjunction with the regulators and their key advisors. This will allow the clearance of an appropriate area (to be agreed with the Foreshore Unit prior to works taking place) before the detonation is undertaken, following an agreed method statement, as established by a suitably-qualified and experience contractor.

The employment of MMO / PAM will reduce the potential for PTS / TTS to affect marine mammals within all frequency groups. MMOs may also provide mitigation for seal and sea turtle species, if they are present at the surface whilst the pre-detonation watches are underway. On this basis, effects are considered to be low.

3.2 Sea turtles

Sea turtles have been identified as being at risk of TTS within 0.6km of an in-situ detonation of an UXO target of 1,000kg explosive charge. While sea turtles do occur in the Atlantic Ocean, their distribution in Irish Territorial Waters and the Irish EEZ is understood to be sparse (see Volume 3D Part 2, Chapter 3: Biodiversity for further detail). Sea turtles are not characteristically inquisitive and do not tend to be attracted to vessel activity. They will tend to dive away from perceived threats and are therefore the likelihood of sea turtles being present in the vicinity of any vessels involved in the UXO survey campaign is low. The MMO operating on-board the UXO survey campaign vessels to mitigate potential impacts to marine mammals would keep a watching brief for sea turtles but it is accepted that sea turtles are difficult to identify at the sea surface due to their relatively small size and that they typically remain partially submerged. It is not possible to identify sea turtles beneath the surface using PAM. Therefore, there remains a low risk of injury to sea turtle species as a result of UXO detonation.

3.3 Fish

The TTS injury threshold for all fish species has been identified as 1km from of an in-situ detonation of a worst-case 1,000kg UXO target. Use of standard mitigation measures, including the presence of MMO / PAM operators, is not effective for fish. Therefore, the risk of TTS is likely to occur over an area of approximately 0.79km^2. Although this has the potential to cause harm to fish within the zone of influence, this is a small area in comparison to the area over which fish populations will be spread, and it is considered that there is a low risk of injury to fish species as a result of UXO detonation.

4 Conclusions

Although initial magnetometer surveys along the route of the Celtic Interconnector have identified a low risk of encountering UXO targets along the cable route, this assessment has been undertaken to assess the potential effects which may arise should there be the need for such a detonation.

This assessment determined a zone of influence which may arise as a result of the *in situ* detonation of a UXO target containing up to 1,000kg of explosives.

This assessment has concluded that there is the potential for effects to arise for marine mammals, sea turtles and fish in the vicinity of the detonation activity, including the potential for both PTS and TTS affects. However, with standard mitigation measures in place, including the use of MMO and PAM, combined with the low risk of encountering UXO targets along the cable route, the likely effects will be low.

Celtic Interconnector

Volume 3D2 – Appendix 15A
Marine archaeology and cultural heritage technical report

June 2021

Co-financed by the European Union
Connecting Europe Facility

Tionscadal Éireann
Project Ireland
2040

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Cotswold Archaeology marine

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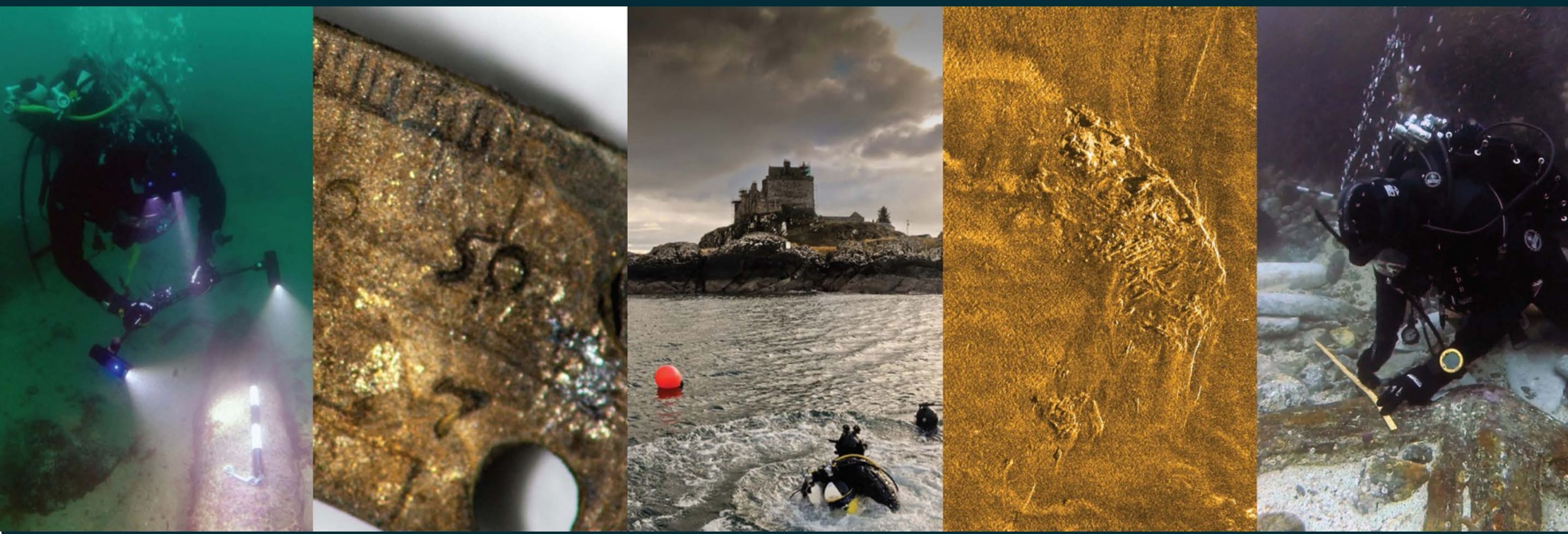
Celtic Interconnector Project

Marine archaeology and cultural heritage technical report



for

EirGrid plc

CA Project: 770617

CA Report: 770617_01

July 2019

Celtic Interconnector Project

Marine archaeology and cultural heritage technical report

CA project: 770617

CA report: 770617_01

prepared by	Michael Walsh, Senior Marine Consultant Rebecca Ferreira, Marine Archaeologist
date	May 2019
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date	July 2019
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date	July 2019
issue	1.0

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SUMMARY

Project name: Celtic Interconnector project

Cotswold Archaeology (CA) was commissioned by EirGrid plc in 2017 to provide marine archaeological support for the Celtic Interconnector project. The proposed project involves the installation of a submarine cable between Ireland and France. This report summarises all the previous archaeological assessments relating to the current proposed routes in Irish, English and French waters including those produced by Headland Archaeology (2014; 2015) and by Wessex Archaeology (2016).

These include archaeological desk-based assessments (DBAs) (Cotswold Archaeology 2017; Headland Archaeology 2014) foreshore and inter-tidal archaeological surveys, including walkover, metal detector and geophysical surveys (Cotswold Archaeology 2018a; Headland Archaeology 2015), archaeological assessments of marine geophysical survey data (Headland Archaeology 2015; Cotswold Archaeology 2018a), an underwater archaeology impact assessment (Cotswold Archaeology 2018b), a watching brief during foreshore geotechnical investigations (IAC Archaeology 2018), archaeological assessments of geotechnical data collected along the proposed route corridors (Cotswold Archaeology 2019a; Wessex Archaeology 2016); a hand auger survey at Claycastle beach to investigate exposed peats in the inter-tidal zone, and a geoarchaeological assessment of the results (Cotswold Archaeology 2019b;). These reports include assessments of archaeological potential in proximity to the cable study corridor (CSC).

An initial route, with two potential landfall locations in Ireland, at Ballycroneen beach and Ballinwilling Strand, was assessed by Headland Archaeology (2014; 2015). The route in Irish territorial waters (12 nautical miles (nm)) was subsequently revised and included two new potential landfall locations, at Claycastle and Redbarn beaches, in addition to Ballinwilling Strand. The route in the Irish exclusive economic zone (EEZ) beyond the 12nm limit has not changed substantially. Cotswold Archaeology was commissioned in 2017 to undertake archaeological assessments along these revised routes and at the two new landfall locations (Redbarn beach and Claycastle beach) as well as a reassessment of Ballinwilling Strand.

This technical report incorporates relevant information from all the archaeological assessments that have been completed to date. This report therefore summarises our current knowledge of the archaeology and the archaeological potential along the

route and at the preferred landfall locations of the Celtic Interconnector project. Wherever possible, data from redundant route and landfall options has been removed.

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1. INTRODUCTION

Outline

1.1. Cotswold Archaeology (CA) was commissioned by EirGrid plc in 2017 to provide marine archaeological support for the Celtic Interconnector project. The proposed project involves the installation of a submarine cable between Ireland and France. This technical report collates all previous archaeological reports for the project into one overarching assessment. This report comprises the results of the desk-based assessments (Cotswold Archaeology 2017; Headland Archaeology 2014), and the archaeological assessment of marine and foreshore surveys (Cotswold Archaeology 2018a; 2019a; 2019b; Headland Archaeology 2014; 2015; Wessex Archaeology 2016; IAC Archaeology 2018). Where possible, any information relating to routes that are no longer under consideration has been removed.

Proposed development

1.2. The project aims to install a 700+ MW HVDC interconnector, which will include two HVDC converter stations, subsea cabling, and onshore lines/cables as appropriate. The cable route, including revisions, runs for c. 600km between Ireland and France passing to the west of the Isles of Scilly, just beyond UK territorial limits. Three landfall options are currently under consideration in Co. Cork (Ballinwilling Strand, Claycastle beach and Redbarn beach) and two options on the coast of Brittany (Pontusval and Moguériec) (Fig. 1, Fig. 2 and Fig. 3).

1.3. Initially the route included two options within Irish territorial waters (12 nautical miles (nm)), with proposed landfalls at Ballycroneen beach or at Ballinwilling Strand. These route options and landfall locations were assessed by Headland Archaeology (2014; 2015). Subsequent route revisions in Irish territorial waters have included two new potential landfall locations, at Redbarn and Claycastle beaches, as well as one previously considered location (Ballinwilling Strand), and two revised routes and a spur in Irish territorial waters; These revised routes/landfalls were assessed by Cotswold Archaeology (2017; 2018a; 2018b). The route beyond Irish territorial waters has not altered substantively since the initial assessments.

Project background

1.4. In 2013, two national electricity transmission system operators, EirGrid plc in Ireland and Réseau de Transport d'Electricité (RTE) in France, signed a Memorandum of Understanding. The agreement was to commission further preliminary studies on the feasibility of installing a submarine electricity interconnector between the south coast of Ireland and the north-west coast of France, a distance of some 600km. EirGrid and RTE then conducted studies which indicated that an interconnector between Ireland and France could be beneficial for electricity customers in both countries.

1.5. EirGrid holds licences as independent electricity Transmission System Operator (TSO) and Market Operator (MO) in the wholesale trading system in Ireland and is the owner of the System Operator Northern Ireland (SONI Ltd), the licensed TSO and MO in Northern Ireland. The EirGrid Group includes EirGrid plc, SEMO JV, EirGrid Interconnector Ltd, and EirGrid Telecoms Ltd.

1.6. RTE, an independent subsidiary of EDF, is a public service company responsible for operating, maintaining and developing the high and extra high voltage network in France. It guarantees the reliability and proper operation of the power network.

1.7. In 2013, EirGrid and RTE undertook the exploratory phase of this interconnector project with initial studies focused on desk-based analysis of the seabed to identify potential route corridors. Between 2014 and 2015 EirGrid completed a feasibility study of the potential marine routes between Ireland and France, including geophysical and geotechnical / environmental marine surveys along the corridor between East Cork in Ireland and Brittany in France as well as investigations at two potential landfall sites in Ireland.

Archaeological assessments

1.8. Archaeological assessments of the entire route were undertaken by Headland Archaeology (2014; 2015) including a DBA, and assessment of marine geophysical survey data for the entire route and the two landfall locations in Ireland. A geoarchaeological assessment of vibrocore logs was also conducted (Wessex Archaeology 2016). These assessments include sectors of the route that are no longer under consideration so, wherever possible, the information from these redundant routes has been removed from this report.

Current assessments

1.9. CA was commissioned by EirGrid plc in 2017 to undertake further archaeological assessments on the new / revised routes. These included a DBA, assessment of marine geophysical survey data, non-intrusive foreshore surveys including walkover, hand-held metal detector, and geophysical (electrical conductivity) surveys at two new locations (Claycastle & Redbarn), and a walkover survey at Ballinwilling Strand that had been assessed previously (Headland Archaeology 2015). The aim was to assess and to map the extent of archaeological remains at these three potential landfall locations.

1.10. The archaeological assessment of marine geophysical data for the revised routes in Irish territorial waters was undertaken for Cotswold by Coastal and Offshore Archaeological Research Services (COARS), University of Southampton in 2018. The aim was to identify, locate and characterise features with possible archaeological potential, and to assess the sub-bottom profiler (SBP) data in order to establish the archaeological and palaeo-environmental potential of the sub-surface sediments that may be encountered (Cotswold Archaeology 2018a).

1.11. In advance of geotechnical site investigations, which used intrusive techniques such as vibrocores, boreholes and test pits, an underwater archaeology impact assessment was undertaken at the landfall locations. This mapped features of archaeological potential at each of the landfall locations, including the exposed peat deposits at Claycastle beach, highlighting their palaeo-environmental potential. It then suggested mitigation in the form of archaeological exclusion zones to avoid any impact to these sites (Cotswold Archaeology 2018b). The impact assessment has not been included in this report as the details contained therein are addressed in other assessments.

In addition to the original site investigations along the original proposed cable route (Wessex Archaeology 2016), further site investigations were undertaken in 2018 along the revised routes in Irish territorial waters. These comprised test pits and boreholes on the landfall and nearshore locations, and vibrocores in deeper water (Cotswold Archaeology 2019a). A watching brief (or ‘archaeological monitoring’) was conducted during the site investigations on the foreshore and in the intertidal zone (IAC Archaeology 2018).

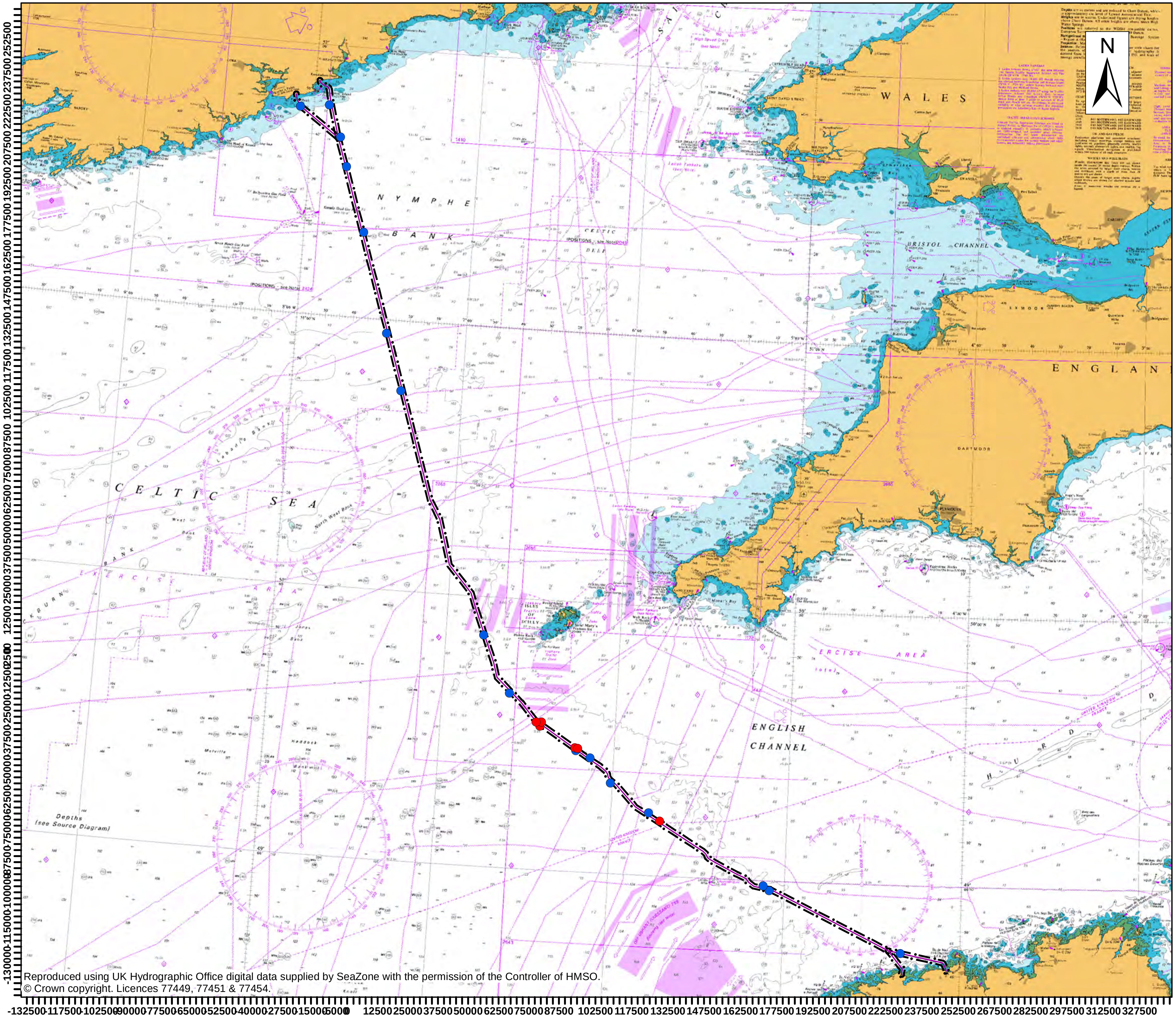
1.12. The peat deposits found exposed in the inter-tidal zone at Claycastle beach were further investigated using a hand auger and hand-dug test pits. A geoarchaeological assessment was then undertaken of the results of these investigations. This assessment was undertaken to understand the nature and extent of the buried peat deposits, to recover any material which might be of archaeological significance, and to enhance our understanding of the nature of the deposit (Cotswold Archaeology 2019).

Aims and objectives

1.13. The aim of this technical report is to present our current understanding of the marine archaeology and cultural heritage in the vicinity of the proposed development.

1.14. The objectives of this report are:

- To synthesise all the project-specific archaeological assessments that have been completed to date; and
- To include only information relevant to the current proposed development. All other information relating to routes that are no longer under consideration has been removed.



HEADLAND ARCHAEOLOGY

Key

- Obstruction
- Wreck
- Marine Survey Route
- Inner Search Area

Kilometers

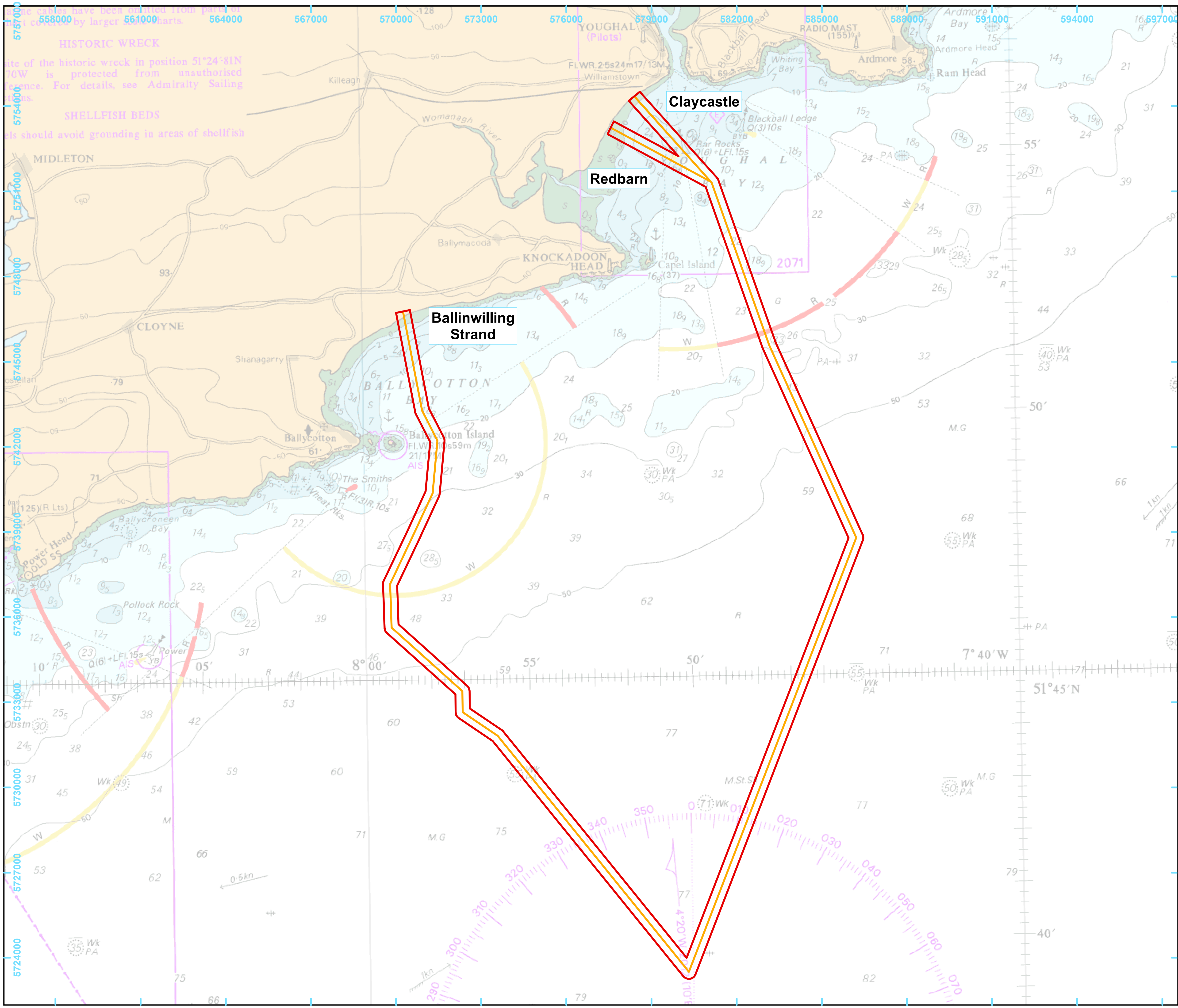
0 50

1:1,550,000

Ireland-France Celtic Interconnector [EIFI13]

DRAFT

Figure 1: Overview of the cable study corridors (CSCs) for the entire route of the Celtic Interconnector



Legend

N

500m wide CSC

Cable Route

0 5km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Close up of the CSC in Irish territorial waters

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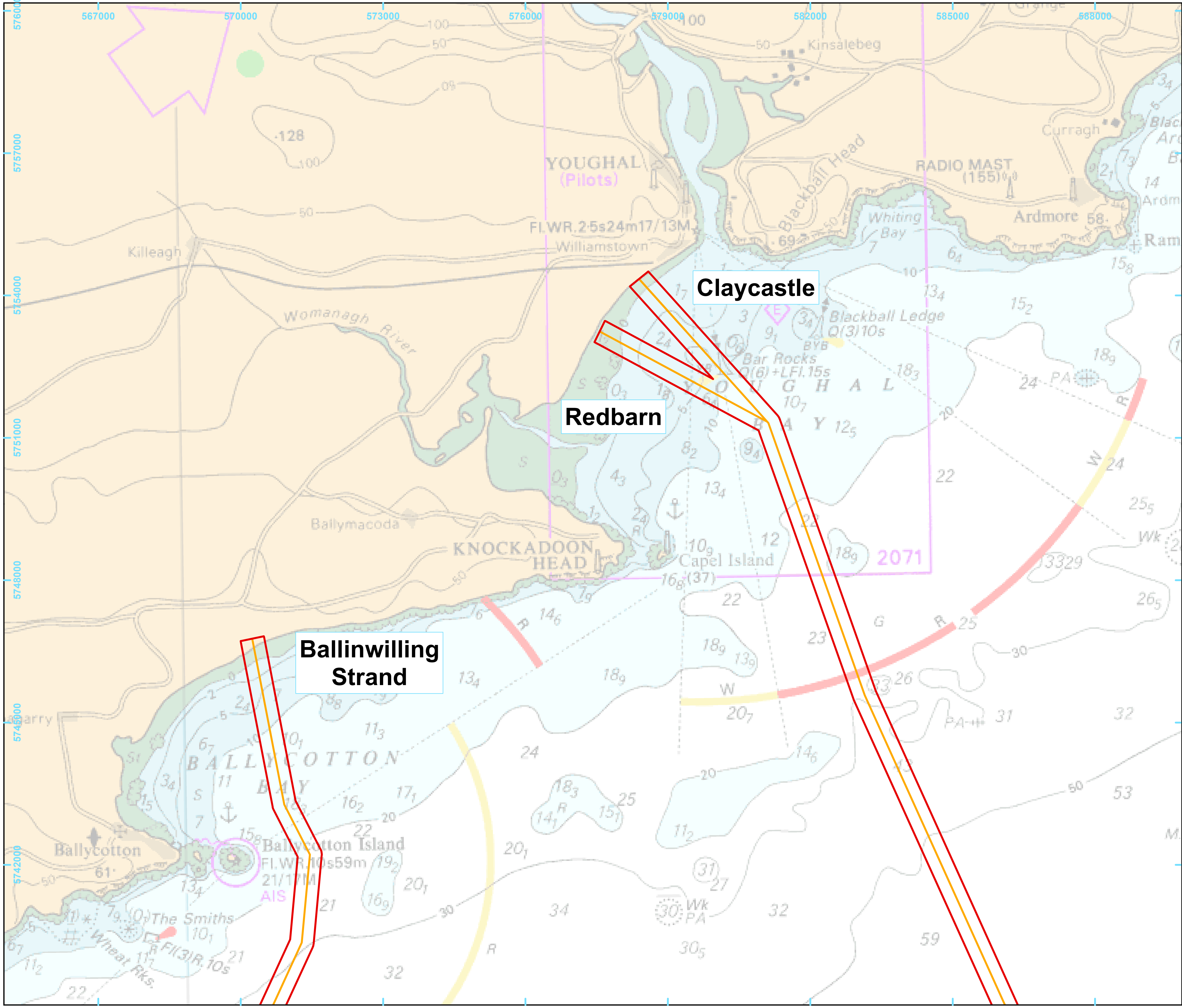

Legend

N

500m wide CSC

Cable Route

0 3.25km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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PROJECT TITLE
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FIGURE TITLE
Revised proposed landfall locations for the Celtic Interconnector in Irish territorial waters

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2. LEGISLATIVE FRAMEWORK AND GUIDANCE

2.1. As the project is located within Irish and French territorial waters and within the continental shelves of Ireland, France and the UK (adjacent to England within the UK Exclusive Economic Zone (EEZ)), all assessments considered the following national and international legislative procedures and guidelines:

Republic of Ireland

- National Monuments Acts (1930-2004);
- Heritage Act (Ireland, 1995); and
- Framework and Principles for the Protection of the Archaeological Heritage (Department of Culture, Heritage and the Gaeltacht 1999).

France

- *Code du Patrimoine* (France, 2004).

UK

- Protection of Wrecks Act 1973;
- Protection of Military Remains Act 1986;
- Merchant Shipping Act 1995; and
- Burial Act 1857.

General

- European Convention on the Protection of the Archaeological Heritage (Valetta) 1992;
- UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001);
- International Council of Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage (1996) (the Sofia Charter); and

- United Nations Convention on the Law of the Sea (UNCLOS) 1982.

2.2. All assessments have been compiled in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. These include:

Republic of Ireland

- Institute of Archaeologists of Ireland code of conduct for archaeological assessment excavation (2006).

UK

- Chartered Institute for Archaeologists (CIfA) guidelines: Standard & guidance for archaeological desk-based assessment (2014);
- Joint Nautical Archaeology Policy Committee (JNAPC) code of practice for seabed development (2008);
- COWRIE Historic environment guidance for the offshore renewable energy sector (2007);
- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy (2008);
- COWRIE Guidance for offshore geotechnical investigations and historic environment analysis: guidance for the renewable energy sector (2011);
- The Crown Estate (2014). Offshore renewables protocol for archaeological discoveries; and
- The Crown Estate (2010). Round 3 offshore renewables projects model clauses for archaeological written schemes of investigation.

General

- EIA Directive 85/337/EEC as amended by 97/11/EC and 2003/35/EC.

3. METHODS AND DATA SOURCES

3.1. The following section sets out the methods used for the assessment of the proposed CSC, including the sources used for collation of data and the relevant legislative framework and guidance.

Desk-based assessment methodology

3.2. The DBA consisted of a documentary and cartographic search, utilising a variety of sources, in order to locate all known cultural heritage assets and to identify the archaeological potential within the CSC (Cotswold Archaeology 2017).

3.3. Sources consulted for this assessment include, where relevant:

Republic of Ireland

- Information held by the Underwater Archaeology Unit (UAU) of the Department of Culture, Heritage and the Gaeltacht (DCHG);
- Information held by Heritage Ireland on protected wrecks;
- Information held by Integrated Mapping for the Sustainable Development of Ireland's Marine Resources (INFOMAR);
- National Museum of Ireland archives;
- National Library of Ireland (for historic charts and maps only); and
- Geological Survey Ireland.

France

- Information held by *Le Département des Recherches Archéologiques Subaquatiques et Sous-Marines* (DRASSM);
- Information held by *Le Service Régional de l'Archéologie* (Brittany); and
- Service *Hydrographique et Océanographique de la Marine* (SHOM), - the French hydrographic office, for records of wrecks.

UK

- Information held by Historic England on designated wrecks and the National Monuments record (NMR – maritime section);

- United Kingdom Hydrographic Office (UKHO) Wrecks and Obstructions Database (SeaZone);
- UKHO review of cartography, historic charts and sailing directions;
- Ministry of Defence (military remains only);
- Receiver of Wreck (RoW);
- Records held with the Archaeology Data Service (ADS); and
- Marine Environment Data Information Network (MEDIN).

General

- Readily accessible published sources and grey literature (e.g. results from previous studies);
- Relevant external marine historic environment specialists;
- British Geological Survey regional guide and previous work in the area;
- Relevant dive groups and local interest groups;
- Relevant external marine historic environment specialists (eg palaeo-environmental); and
- Relevant Strategic Environmental Assessment (SEA) reports (eg UK Continental Shelf SEA archaeological baseline) and Coastal Survey Assessment reports.

Consultation with statutory bodies

3.4. For this assessment, the following statutory bodies and stakeholders were consulted, including:

- Underwater Archaeology Unit (UAU) of the National Monuments Service, Department of Culture, Heritage and the Gaeltacht (DCHG); and
- INFOMAR.

3.5. In addition, the following statutory bodies and stakeholders were consulted as part of the assessment produced by Headland Archaeology in 2014:

- Heritage Ireland;
- Historic England;
- Ministry of Defence (military remains only);
- Receiver of Wreck (UK Maritime Coastguard Agency); and
- *Centre départemental d'archéologie Conseil General de Finistere*.

Limitations of data

3.6. One of the greatest limitations when researching known and potential offshore cultural heritage is the difficulty of locating recorded maritime losses. For many losses the location of the sinking of the vessel can be in the form of a general area description, as in 'SW and W from southern Ireland' or '30 miles north of Ushant', which is not useful practically for accurate assessment, except to show the potential exists to encounter lost cultural remains (Cotswold Archaeology 2017).

3.7. Many wrecks have been identified through sonar survey, but this too presents difficulties as many of these wrecks have been located using GPS, which until relatively recently was only accurate to 100m (Baird 2009; see also Satchell 2012); or by DECCA which can give locations accurate to only one kilometre. In addition, recorded maritime losses are heavily biased towards the 19th and 20th centuries when more comprehensive records of losses began to be compiled by the UKHO.

3.8. To prevent a large error range in sonar measurements due to tidal range varying across bays and coastlines during the recent INFOMAR surveys, onshore and offshore tidal gauges were installed to ensure accurate tide height data.

3.9. The details for specific offshore cultural heritage assets within this study area were acquired from the three main sources cited above. Other sources, also cited above, were consulted by Headland Archaeology for the feasibility phase of this project in 2014. All these databases are each derived, in turn, from a variety of sources including various published lists of marine losses and marine surveys. Consequently, there are considerable overlaps and discrepancies between the datasets.

3.10. Wrecks discussed below are generally referred to as either 'live', 'dead' or 'lifted'. 'Live' wrecks are those for which there is a known location which has been verified by recent surveys. 'Dead' refers to sites or reports of incidents that have been recorded in a certain location, but which have not been detected by repeated or the most recent surveys. Whilst there is no recorded evidence of any lifted wrecks within the study areas, this refers to wrecks that have been removed from the seabed.

3.11. Where a live wreck has been identified this information is provided in Tables 2 and 3; a wreck in a known location that has not been identified is referred to as unidentified. Where the status of a wreck is given as 'unknown', this means that it is not recorded whether the wreck is live, dead or lifted.

3.12. The assets listed in this report relate to the current route options and cover all UAU, INFOMAR, UKHO entries (as held by SeaZone), DRASSM and *Le Service Régional de l'Archéologie* within the study areas including dead entries. Dead entries are included because although wrecks may not have been detected in recent surveys the recorded locations may still contain remains of cultural heritage interest. Given locational discrepancies (Satchell 2012) the possibility that wrecks lie outside previous search areas cannot be discounted.

3.13. All relevant data held by the UAU, INFOMAR, UKHO / SeaZone, DRASSM and *Le Service Régional de l'Archéologie* – the primary historic data repositories for this assessment - were considered, and for completeness, listed and cross-referenced. The data supplied by the UAU appears to include multiple entries which refer to the same site, such as an unidentified wreck recorded in the same position, or same place of loss (i.e. latitude and longitude). Whilst the data has been recorded as individual entries by the UAU, and usually relates to separate UKHO entries, in this report multiple entries recorded in the same location have been listed as one wreck. These sites have been indicated in Tables 2 & 3 with the addition of an asterisk (i.e. CA1*). Each wreck is discussed in more detail below (Cotswold Archaeology 2017).

Foreshore survey methodology

3.14. The landfall surveys, conducted on the foreshore and in the inter-tidal zone, comprised walkover, hand-held metal detector, and geophysical (electro-magnetic conductivity) surveys. The aim of the surveys was to assess and map the extent of any archaeological remains within the proposed development (Cotswold Archaeology 2018a).

3.15. The surveys were conducted in during Spring tides to achieve full overlap with the offshore marine surveys. All surveys were positioned using the geodetic datum WGS 1984, with projection in the Universal Transverse Mercator Zone 29 North (UTM 29N).

Walkover survey

3.16. A walkover survey was undertaken at all potential landfall locations which entailed the identification of physical features relating to the historic environment. The locations of identified features were recorded using a hand-held Garmin GPS unit, and were recorded photographically together with a brief descriptive record.

Metal detector

3.17. Hand-held metal detectors were used to conduct surveys at all potential landfall sites. The survey followed 5m wide traverses in accordance with the geophysical surveys. The detector was set to detect all metal and the sensitivity was adjusted to compensate for the high salt content of the beach sand.

3.18. As this was a non-intrusive survey, where possible the numeric values displayed on the detector were recorded to assist potentially in the identification of the type of metal detected. A higher value is more likely to indicate a non-ferrous metal (Minelab 2017:11); no finds spots were excavated. All finds spots were recorded using a hand-held Garmin GPS and were plotted using ArcGIS.

Geophysics

3.19. The most recent foreshore geophysical surveys used a Geonics EM31 electromagnetic conductivity meter to perform a terrain electrical conductivity survey, similar to those conducted previously. The instrument is a non-intrusive frequency-domain electrical conductivity measuring device that records the spatial variations of apparent ground conductivity of the earth in units of milliSiemens/metre (mS/m). The ‘siemen’ is the international (SI) unit of measurement for volume electrical conductance and is the equivalent to an ampere/volt. Differences in deposits, principally variations in thickness between deposits with different conductivities, can produce spatial variations in conductivity readings.

3.20. The system provides two measurements, quadrature (apparent conductivity) and in-phase (metallic response) data. The system has, subject to the vagaries of differing soil conditions, an effective operation depth of approx. 6m.

3.21. The instrument has various environmental applications and its data can be used to map landfills, to locate buried metal objects, to detect shallow groundwater contamination and to measure soil thicknesses.

3.22. A survey grid was set out at the required locations and subdivided into 5m transects, using a GPS system utilising the Irish Transverse Mercator Grid (UTM) with an accuracy of 0.5m or greater.

3.23. The primary focus of the survey was to identify buried metal objects on the beach that might relate to heritage assets. In addition, some success was gained at mapping variations in silting patterns within the foreshore area. Variations in response might occur where timber structures have influenced the deposition of sediments and could therefore be used to identify the presence of wooden material which could be indicative of wreck material or other wooden structures buried in the sand.

3.24. In addition, as ground conductivity is influenced by soil moisture content, an electromagnetic conductivity survey can be used to differentiate between areas of solid substrata and sand. This could help to define the former physical topography of the survey area by identifying former channels or basins in the sub-strata. Identification of these features could help to define areas of archaeological potential within the survey area.

3.25. The data was digitally recorded and periodically downloaded to a field computer for quality assurance and preliminary interpretation.

3.26. At the end of the survey, the Geonics EM31 data was interpreted and mapped using Terrasurveyor V3.0.32.4 software (DWConsulting), a surface mapping software that allows topographic data to be contoured and presented in a manner that allows for the interpretation of sub-surface features (Cotswold Archaeology 2018a).

Marine geophysical survey methodology

Irish territorial waters

Bathymetric and geophysical survey specification and data acquisition

3.27. The bathymetric and marine geophysical surveys in Irish territorial waters were conducted by Next GeoSolutions in 2017. The archaeological assessment of this survey data was undertaken for Cotswold Archaeology by Dr Michael Grant of COARS (Cotswold Archaeology 2018a).

3.28. Bathymetric data were acquired using a dual head R2Sonic 2024 (200-400 kHz) multibeam echo sounder (MBES).

3.29. Side scan sonar (SSS) survey was undertaken using an Edgetech 2200 Series dual frequency (410 and 125 kHz), set to 50m range to provide a total swath of 100m. The magnetometer survey was conducted using a Geometrics G882 magnetometer.

3.30. The SBP seismic data were acquired by means of a combined SSS/SBP Edgetech 2200 Series with a SBP DW216 operating at 2-12 kHz at 20ms with a 4Hz ping rate.

3.31. The Sparker data were acquired by means of a Multi-tip Sparker System Geo Marine Survey Systems Geo-Source / Geo-Spark 200. Positioning was acquired using a Teledyne PDS2000/ PosMv system.

Geodetic and projection parameters and vertical datum

3.32. Vertical datum was referred to the required vertical reference level, lowest astronomical tide (LAT), referred to Ordnance Survey Ireland (OSi) datum in the nearshore sector, and Vertical Offshore Reference Frames (VORF) vertical reference for the Irish offshore sector.

Assessment methodology

3.33. Geophysical assessment was undertaken using the programs Coda Octopus Survey Engine 4.3 and ArcGIS 10.5. SBP data were analysed using the former with the positions of sub-surface anomalies exported in shapefiles to be uploaded into ArcGIS 10.5 alongside processed magnetometer data provided by Next

GeoSolutions, following the professional guidelines of Plets *et al*. (2013). The geophysical data was assessed for archaeological potential, based on the presence of multiple lines of evidence (confirming datasets) (Cotswold Archaeology 2018a).

Irish territorial limit out to the Irish / UK median line

Assessment methodology

3.34. The bathymetric and marine geophysical surveys from Irish territorial limit out to the Irish / UK median line were conducted by Osiris Projects in 2015 (Osiris 2015). The archaeological assessment of the marine survey data was undertaken by Headland Archaeology by (2015).

3.35. Bathymetric data were acquired using a multibeam echo sounder (MBES). The data were visualized using the Fledermaus 7.3.3 suite; DMagic was used to produce a digital terrain model (DTM) gridded at 1 m and shadow and geographic information objects were then assembled. These were exported for interpretation into Fledermaus with a 32 step colour map overlaid to aid interpretation and later into ArcGIS 10.2.1.

3.36. Side scan sonar (SSS) survey data, from Irish territorial limits out to the Irish / UK median line, were received as navigation-corrected and post-processed .cod files which were associated with accompanying CODA Octopus software projects; coverage was provided in Coda Octopus SurveyEngine 4.2 format.

3.37. The SBP seismic data were provided by Osiris Projects as CODA SurveyEngine 4.2 projects for all cable route sections.

3.38. Magnetic data were reviewed using the Geometrics MagPick. The raw xyz profile files were imported and individually assessed. Correlation between magnetic targets and other datasets was based on a 50m buffer owing to the problems inherent in accurately positioning magnetic targets by their detectable magnetic field. Concentrated clusters of magnetic anomalies are usually associated with coherent ferrous structure of post-medieval and later origin. Isolated features may correspond to debris, anchorage material, or unexploded ordnance. All such features are cross-referenced with the available geophysical data and are graded in terms of archaeological potential where possible. These anomalies may be subject to archaeological exclusion zones where high magnetic returns (> 100nT) are consistent across multiple records.

Geotechnical investigations methodology

Marine and foreshore geotechnical investigations

Irish territorial waters and landfall options

3.39. A total of 85 geotechnical site investigations were undertaken in Irish territorial waters in 2018, ranging in elevation height from 11m to -83m LAT (Fig. 4).

3.40. Archaeological monitoring was undertaken on the foreshore at Ballinwilling Strand, Redbarn beach and Claycastle beach at the 12 locations where geotechnical investigations, comprising boreholes and test pits, were conducted (IAC Archaeology 2018) (Table 1).

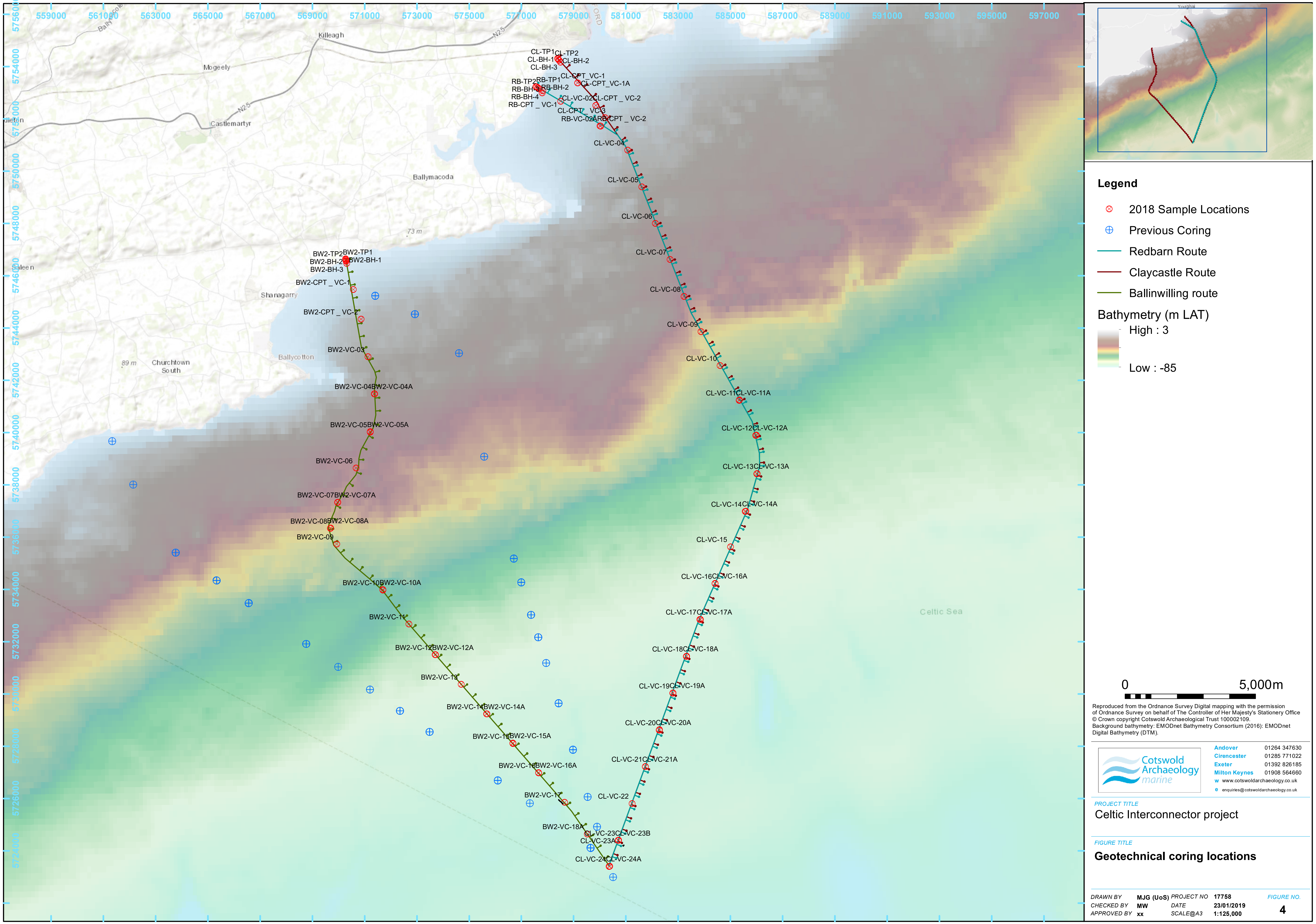
3.41. Following excavation, the test pits were backfilled using only native materials while the boreholes were backfilled using pellet bentonite (compactonite).

3.42. The equipment used included:

- Borehole – PSM-8G hydraulic drilling rig
- Test Pit – 21 tonne tracked excavator
- Metal detector – Garret EuroAce

3.43. Marine and foreshore geotechnical samples were collected to inform the engineering design, with recording and laboratory-testing undertaken by Next GeoSolutions. All samples were split longitudinally and photographed prior to recording of the deposits by the geotechnical specialists, prior to sub-sampling with respect to both the stratigraphy encountered and the testing scheduled. The destructive laboratory testing included:

- Moisture content – at least 50g (fine grained soil), 3kg (coarse grained);
- Atterberg Limits – at least 600g passing 425µm sieve;
- Particle size distribution – at least 500g (for samples with grain sizes <10mm), 35kg (for samples with grain sizes <50mm);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5740000
5738000
5734000
5732000
Killeagh
Mogeely
Castlemartyr
Ballymacoda
Shanagarry
Ballycotton
Churchtown South
89 m
73 m
Celtic Sea
Youghal
CL-TP1
CL-TP2
CL-BH-1
CL-BH-2
CL-BH-3
CL-CPT_VC-1
CL-CPT_VC-1A
RB-TP2
RB-TP1
RB-BH-3
RB-BH-2
RB-BH-4
RB-CPT _ VC-1
CL-VC-02
CL-CPT _ VC-2
CL-CPT _ VC-3
RB-VC-02A
RB-CPT _ VC-2
CL-VC-04
CL-VC-05
CL-VC-06
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BW2-VC-12
BW2-VC-12A
BW2-VC-13
BW2-VC-14
BW2-VC-14A
BW2-VC-15
BW2-VC-15A
BW2-VC-16
BW2-VC-16A
BW2-VC-17
BW2-VC-18A
Legend
2018 Sample Locations
Previous Coring
Redbarn Route
Claycastle Route
Ballinwilling route
Bathymetry (m LAT)
High : 3
Low : -85
0
5,000m
Reproduced from the Ordnance Survey Digital mapping with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office
© Crown copyright Cotswold Archaeological Trust 100002109.
Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).
Cotswold Archaeology marine
Andover 01264 347630
Cirencester 01285 771022
Exeter 01392 826185
Milton Keynes 01908 564660
w www.cotswoldarchaeology.co.uk
e enquiries@cotswoldarchaeology.co.uk
PROJECT TITLE
Celtic Interconnector project
FIGURE TITLE
Geotechnical coring locations
DRAWN BY MJG (UoS)
CHECKED BY MW
APPROVED BY xx
PROJECT NO 17758
DATE 23/01/2019
SCALE@A3 1:125,000
FIGURE NO.
4

- Minimum/maximum density – at least 6kg (sand), 16kg (gravelly soil);
- Oedometer – undisturbed sample at least 1 x diameter in length;
- Unconsolidated undrained triaxial – undisturbed sample at least 2 x diameter in length; and
- Consolidated triaxial – undisturbed sample at least 2 x diameter in length.

3.44. Core sections not subjected to destructive testing were retained by Next GeoSolutions and were made available to Cotswold Archaeology. Core photographs and descriptions were provided to enable Cotswold to undertake an assessment of the geo-archaeological potential of the samples.

Geoarchaeological recording method

3.45. The geoarchaeological assessment followed Historic England (2015) guidelines, with descriptions according to Hodgson (1997) including sediment type, depositional structure, texture and colour. Interpretations regarding mode of deposition, formation processes, likely environments represented, and potential for palaeo-environmental analysis were also noted. As all the samples had been sub-sampled, there was little information available regarding sedimentary structures (bedding, laminations, etc) or stratigraphic boundaries. A photographic record of the samples, including key stratigraphic features, was made to supplement the sedimentary descriptions.

Table 1 Borehole and test pits monitored at Ballinwilling Strand, Redbarn beach and Claycastle beach

SI Code	Location	ITM Eastings	ITM Northings	Max. Width	Max. Length	Max. Depth
BW2-BH1	Ballinwilling	570265	**5746647**	165mm	165mm	21m
BW2-BH2	Ballinwilling	570282	**5746588**	165mm	165mm	20m
BW2-TP1	Ballinwilling	570276	**5746622**	3m	5.5m	2m
BW2-TP2	Ballinwilling	570308	**5746478**	3.5m	4.5m	1.9m
RB-BH1	Redbarn	**577581**	**5753228**	165mm	165mm	20m
RB-BH2	Redbarn	**577683**	**5753162**	165mm	165mm	20m

SI Code	Location	ITM Eastings	ITM Northings	Max. Width	Max. Length	Max. Depth
RB-TP1	Redbarn	**577557**	**5753240**	2m	5m	3m
RB-TP2	Redbarn	**577621**	**5753202**	2m	5m	3m
CL-BH1	Claycastle	578396	5754300	165mm	165mm	20m
CL-BH2	Claycastle	578440	5754248	165mm	165mm	20m
CL-TP1	Claycastle	578387	5754308	2.5m	5m	3m
CL-TP2	Claycastle	578432	5754258	2m	5m	3.6m

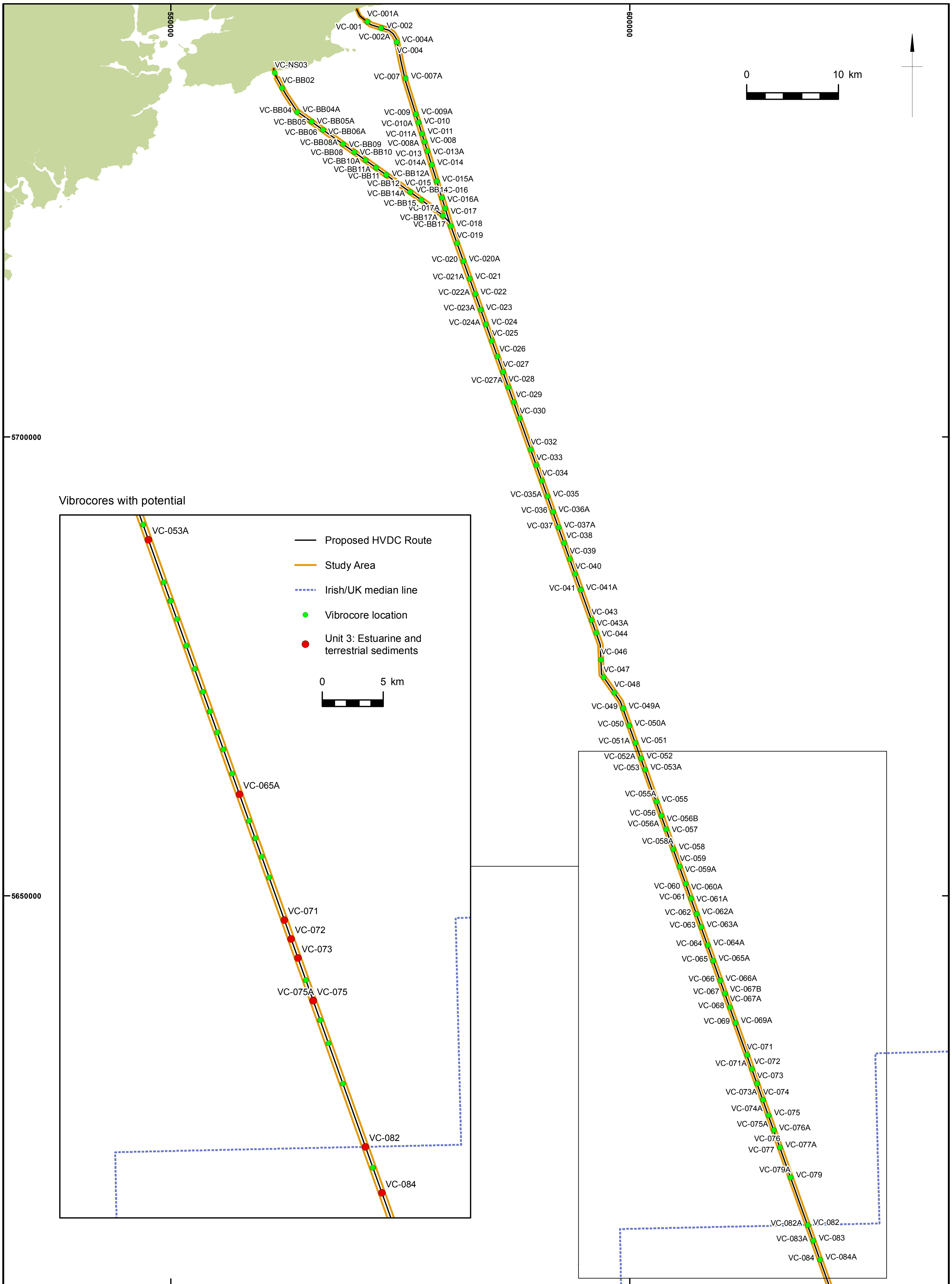
Irish territorial limits out to Irish / UK median line

3.46. The logs of 148 vibrocores acquired by Osiris in 2015 out to the Irish / UK median line (Osiris 2015) were reviewed by Wessex Archaeology (2016) (see Fig. 5). However, 48 of these cores relate to redundant routes in Irish territorial waters and have therefore been removed and will not be considered further; only the 100 logs that are located from the Irish territorial limit out to the Irish / UK median line will be discussed. The vibrocore logs were sampled along the route to 3m below the mudline with retests performed where recovery or penetration was less than 2m (Osiris 2015).

3.47. Two vessels were utilised for the geotechnical survey, owing to the variable water depth along the route. RRS Ernest Shackleton was employed for the offshore section, while SV Bibby Tethra was used nearshore. Both vessels were equipped with marine piezocone cone penetrometer (CPT) and vibrocoring systems. The vibrocore locations up to the Irish/UK median line were all recorded in WGS84 UTM29N.

3.48. Each log has been reviewed and interpreted based on comparison with each other and to the known sequence recorded by BGS (Evans et al 1990; Tappin et al 1994). Data from the logs were input manually into Rockworks 17™ software creating a geospatial database including coordinates, vibrocore identification number, depth, recovery and date acquired.

3.49. The lithologies have been grouped with regard given to geoarchaeological and palaeo-environmental deposits of interest to derive an overall stratigraphic interpretation of the logs.



Company Name: Wessex Archaeology
Client Name: EirGrid plc
Project: Celtic Interconnector - Feasibility Study
Drawing Title: Location of vibrocores
Drawing Number: 112110_Fig02.mxd

Proposed HVDC Route
Study Area
Irish/UK median line
Vibrocore location

Date:	17/02/2016	Revision Number:	1
Scale:	1:400,000 & 1:300,000 (A3)	Illustrator:	KJF
Path:	X:\PROJECTS\112110\GIS\FigsMXD\Geoarch\2016_02_04		

Figure 5 Original map of the location of vibrocores provided by Wessex Archaeology (2016). No alterations have been made regarding route revisions.

3.50. The SBP data were assessed at targeted locations where palaeo-channels had been identified in a previous archaeological assessment (Headland Archaeology 2015). The geophysical data were also re-assessed over the locations of a selection of logs in which organic remains were identified. SBP data were processed using Coda Seismic+ software.

Foreshore geotechnical investigations at Claycastle beach

3.51. 20 locations (four locations along five transects running landward to seaward) were proposed for a hand auger survey (Cotswold Archaeology 2018a). Owing to the specific nature of the intertidal zone (very loose sand / gravel sediments), the proposed auger locations had to be adapted in order to obtain suitable locations for the survey.

3.52. To establish the extent of the peat deposits, 20 additional test pits (TPs) were dug in randomly-chosen locations between the previously proposed transects. Most of the TPs were situated c. 10m to the north-west of the area of exposed peat to establish the presence of the peat deposits under the beach sand (Cotswold Archaeology 2019b). The auger and test pit locations are illustrated in Figure 6.

The auger survey was conducted using a standard hand-operated Dutch auger with 1m long extension rods. Hand auguring was conducted in eight locations (**CL4001**, **CL4002**, **CL4003**, **CL4005**, **CL4007**, **CL4011**, **CL4012**, and **CL4024**). Unsuccessful attempts were made in numerous other locations but were aborted owing to the instability of the sand. The sediment recovered was laid out and recorded following standard procedures (Cotswold Archaeology 2017; Munsell 2018; Tucker 2011).

3.53. Augers **CL4002**, **CL4003** and **CL4011** were drilled in areas where the peat was exposed in order to provide a full sedimentary sequence. Three environmental bulk samples were taken from the top, middle and bottom of the peat in each of these auger cores (nine samples in total). All samples were placed inside sealable plastic bags and labelled using CA's standard procedures (Cotswold Archaeology 2017).

3.54. 31 small TPs (**CL4004**, **CL4006**, **CL4007** to **CL4010**, **CL4013**, **CL4014**, **CL4016** to **CL4023**, and **CL4025** to **CL4040**) were dug by hand in locations where unstable sediments prevented the use of the hand auger. The TPs were recorded following standard procedures as above. All TPs were backfilled as soon as recording had been completed.

3.55. At the time of the survey, the local authority (Cork County Council) was undertaking groundworks just to the front of the boardwalk on the beach. The opportunity was therefore taken to examine the excavation. This TP was mechanically excavated through drier sand to a depth of c. 2.7m.

Legend

N

- Auger
- Test pit
- Test pit and auger
- Machine test pit
- Youghal Strand Core 2002
- Exposed peat
- Cable Route
- 500m wide CSC

0 0.05km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine
Andover 01264 347630
Cirencester 01285 771022
Exeter 01392 826185
Milton Keynes 01908 564660
Suffolk 01449 900120
www.cotswoldarchaeology.co.uk
enquiries@cotswoldarchaeology.co.uk

PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Auger and test pit locations

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4. RESULTS

Desk-based assessment

Baseline environment

4.1. The aim of this section is to provide a brief assessment of the palaeo-environmental potential of sediments potentially impacted by the proposed cable routes and three potential landfall locations. This assessment will provide data that will assist in identifying potential sediments of palaeo-environmental and archaeological interest. The specific objectives of this palaeo-environmental assessment are to review available data in respect of seabed and sub-seabed deposits to identify those likely to be of palaeo-environmental and archaeological interest.

4.2. A number of radiocarbon dates are referred to in the text below. The uncalibrated dates are conventional radiocarbon ages. The radiocarbon ages were calibrated using the University of Oxford Radiocarbon Accelerator Unit calibration programme OxCal v4.3.2 (2017) (Bronk Ramsey 2009) using the IntCal13 curve (Reimer *et al* 2013). All radiocarbon dates in this report are to 95.4% probability.

4.3. This baseline environmental assessment considers previous work done in the areas of the proposed revised cable routes in order to place project-specific investigations into the wider context of the palaeo-environment of the three areas potentially affected.

Ballinwilling Strand, Redbarn Beach and Claycastle Beach, Co. Cork, Ireland

4.4. There is a paucity of relative sea-level (RSL) information for the south of Ireland; research that has been undertaken has been documented by Brooks and Edwards (2006) and provides a key insight into the impact of RSL change at both national and regional levels.

4.5. Although there are no RSL studies specifically relating to Ballinwilling Strand, Redbarn beach and Claycastle Beach, RSL data are available for the southwest of Ireland and in particular for Co. Cork. These can be used to interpret how RSL has changed in this area since the last glacial period. RSL index points from areas closest to the proposed landfall sites have been generated from Dungarvan Bay, Co. Waterford (Sinnott 1999), *c.* 25km northeast of Claycastle Beach, and from Ballycotton Bay, Co. Cork (Carter *et al* 1989), *c.* 3km south of Ballinwilling Strand.

4.6. A conjectural RSL curve was produced for the southwest of Ireland by Taylor *et al* (1986), which suggested that RSL in this area stood at *c.* 5m below ordnance datum (OD) at 15,000 years before present (BP) and fell to 10m below OD around 9,500 BP. RSL than began to rise steeply to attain its current level at approximately 3,500 BP. The curve produced by Taylor *et al* (1986) suggests that submerged landscapes of Mesolithic and Neolithic date may be present around the coast of southwest Ireland.

4.7. These models have been updated by Brooks *et al* (2008) suggesting that for the areas of east Cork, west Cork and south Wexford, RSL rose sharply from *c.* 80m below OD to *c.* 50m below OD (west Cork) and to *c*. 40m below OD (south Wexford) between 15,000 to 14,000 BP before the rate of rise slowed down to *c.* 40m below OD to *c.* 35m below OD by 11,500 BP. Following this more gradual rate of rise, RSL rose steeply once more to reach *c.* 1m below OD by c. 6,000 BP before slowly rising to its current level. The new models by Brooks *et al* (2008) concur with those proposed by Taylor *et al* (1986) in the potential for submerged landscapes to be present from the Mesolithic to at least the Neolithic period.

4.8. These submerged landscapes have also been signalled by intertidal peats which have been recorded in the area just south of Ballinwilling Strand at Ballycotton Bay, where it has been estimated that land has receded by *c.* 6-6.5m per year since 1840 (Carter *et al* 1989). Not all land recession along this coastline, however, is due to sea level rise. At Youghal, for example, *c.* 2km northeast of Claycastle beach, dredging for marine aggregates in the 19th century led to major coastal changes. An estimated 270,000m^3 yr^{-1} of gravel was removed from inshore shoals over the period 1850 to 1900, leading to beach lowering and shoreline recession (Carter *et al* 1989).

4.9. Remains of submerged forest (remnant woodland) have been recorded in the peats at Ballycotton Bay, with pollen analysis indicating that this woodland may have consisted of oak (*Quercus sp.*), hazel (*Corylus avellana*) and alder (*Alnus glutinosa*), which was later replaced by sedge (*Carex sp.*) and reed (*Phragmites australis*) swamp (Carter *et al* 1989). The woodland is estimated to have been present at around 5,000 BP, indicating a Mesolithic date (Carter *et al* 1989). Intertidal peats, containing wood and monocotyledon fragments (indicating good preservation of organic material), have also been recorded at 0.5 to 0.8m below OD at Lakeland Strand, Cork Harbour (Devoy 1984). These peats were radiocarbon dated and seem to have accumulated between 2350±45 BP (736–239 cal BC; Q-2382) and 1810±40 BP (87–332 cal AD; Q-2381), when they were replaced by saltmarsh, which indicates that terrestrial surfaces were present until the Iron Age (Carter *et al* 1989).

4.10. Beyond Co. Cork intertidal peats have been located at other locations along the southern Irish coastline (predominantly in estuarine locations) (e.g. Devoy *et al* 2006; Timpany 2008; Brooks & Edwards 2006) which further indicate the potential for these deposits to occur. For example, in Dungarvan Bay carr peats were identified at Killingongford and Ballinacourty by Sinnott (1999). At the former a basal reedswamp peat, dated 4205±70 (2922–2577 cal BC; Q-2876), is overlain by a carr peat straddling modern data dated between 3470±70 (1964–1620 cal BC; Q-2875) and 780±50 (1157–1295 cal AD; Q-2874). At Ballinacourty the carr peat, below modern datum, accumulated between 3515±70 (2029–1665 cal BC; Q-2873) and 2630±70 (972–541 cal BC; Q-2872).

4.11. In addition to intertidal peats, offshore peats have also been recorded in marine waters outside Cork harbour, such as at Curlane Bank (W794633). Here a wood and monocotyledon peat containing remains of oak, hazel, pine (Pinus sp.), common reed (*Phragmites australis*) and sedges (*Cyperaceae*) signals the presence of previous fen woodland in the area. The formation of this peat sequence has been dated between 8200±75 BP (7455–7057; Q-2379) and 7840±75 BP (7028–6503 cal BC; Q-2378) indicating terrestrial woodland was in existence during the Mesolithic period (Carter *et al* 1989).

4.12. From these studies it seems most likely that at the three potential landfall sites, RSL rose gradually from the early Mesolithic, peaking sometime in the Iron Age. There is, therefore, the potential for previously terrestrial deposits (e.g. peats) and cultural materials from the early Mesolithic to the Iron Age to be present in submerged and intertidal areas around these locations.

4.13. In addition to the Holocene-age deposits associated with bays and estuaries, there have also been older Pleistocene deposits encountered, such as the Pleistocene interglacial estuarine deposits found at depth beneath glacial diamicton in Cork Harbour (Dowling *et al* 1998). Although the age of these deposits is unclear, with contradicting dates from marine isotope stage (MIS) 9 to 5e, they do demonstrate that evidence of earlier Pleistocene warm periods can be found along the coastline.

4.14. The first arrival of humans in Ireland has been traditionally suggested as being soon after 10,000 BP (Woodman 2012; 2015), although recent evidence from Co. Clare has suggested that Ireland might have been populated as early as 12,500 BP during the late Upper Palaeolithic (Dowd & Carden 2016). Evidence for the presence of early Mesolithic peoples in the Cork area prior to 8,000 BP, is confirmed by the presence of lithic finds and radiocarbon dating (Woodman 1985), with later Mesolithic materials having also been recorded (Andersen 1993). This suggests habitation of this area throughout the Mesolithic.

4.15. Proxy-evidence for the presence of Mesolithic peoples in the southwest of Ireland has also been recovered from pollen evidence taken from peatlands (e.g. Mitchell 1990; Mighall *et al* 2008; Mitchell *et al* 2013). This indicates that people were mobile and impacting the landscape during this period, which further highlights the information that may be attained from intertidal and submerged peats. Co. Cork has a rich archaeological heritage; in addition to Mesolithic cultural materials there is evidence of settlement and activity from the Neolithic onwards (e.g. Twohig & Ronayne 1993) which indicates the potential for archaeological finds from the Mesolithic onwards. Evidence of such activity is supported by the isolated find of a retouched flint blade (leaf shaped, abrupt retouch on both lateral edges and butt-trimmed - a so-called ‘Bann’ flake), dating from *c.* 3,000BC. The retouched flint blade was found in 1967 (NMI acc. no. 1972: 354; **CA25**), in a *fulacht fiadh*, on the edge of Ballycrenane beach (see Fig. 7) (Cotswold Archaeology 2017).

Pontusval & Moguériec, Brittany, France

4.16. In comparison to the UK there is relatively little information on Holocene RSL changes for this part of the North Atlantic coast (Leorri *et al*. 2012; Goslin *et al*. 2013) and there are no studies available specific to the sites of Pontusval and Moguériec. In order to interpret potential RSL change for this area, therefore, studies around Brittany have been considered together with palaeo-geographic models and other RSL studies from locations along the North Atlantic coast.

4.17. Studies of RSL change in the Atlantic coastal area of France (e.g. Ters 1986) have suggested that at around 20,000 to 18,000 BP, RSL was approximately 100m below present levels, with a main period of RSL rise occurring between 15,000 and 6,000 BP. Following this period of rise RSL change then stabilized near to its present level (Lambeck 1997). Palaeogeographic models of RSL change produced by Lambeck (1997) indicate that in the region of Ploudalmézeau, close to Brest and to the two sites of Pontusval and Moguériec, RSL change appears to follow this general trend.

4.18. The predicted RSL curve constructed by Lambeck (1997) shows that RSL in this area rose steadily from 95m below OD to 85m below OD between 18,000 and 14,000 BP. There is then a sharp rise in sea-level with RSL rising to 10m below OD by around 6,000 BP. Following this period of rapid change, RSL continued to rise to its present level but at a more gradual rate. Similar changes in RSL during the Holocene have been recorded in the Bay of Biscay (Leorri *et al*. 2012) and Audierne Bay (Vliet-Lanoë *et al*. 2014) to the south, comparing well to those at Brittany (Lambeck 1997) and further strengthening this model.

4.19. From these studies it seems most likely that at Pontusval and Moguériec, RSL rose sharply from the end of the last glacial period c. 14,000 BP to 6,000 BP and then more gradually to its present level. There is, therefore, a potential for submerged terrestrial deposits from the early Mesolithic onwardsin the offshore area. This potential has also been shown in the palaeogeographic maps produced by Lambeck (1997) and by Sturt *et al*. (2013) who have shown that the palaeo-shoreline of this area of France has changed considerably over the last 18,000 years and that it would have extended seaward, particularly during the Mesolithic period.

4.20. At a number of sites along the Atlantic coast of France (e.g. Ters 1986; Mariette 1971; Delibras & Guillier 1971; Frouin *et al*. 2007, 2009; Vliet-Lanoë *et al.* 2014a, 2014b) submerged and terrestrial peat deposits have been utilised to provide sea level index points (SLIPS) to reconstruct RSL change through the Holocene. Early peat deposits have been found at depths of up to26.7m below OD at La Havre and 26.4m below OD at Becquet Bay, dating from as early as 9,900±300 BP (GIF-744) and 9,880±230 BP (GIFF-1023), respectively (Delibras & Guillier 1971).

4.21. The dates for the peats respect the RSL curve produced by Lambeck (1997) for the region of Ploudalmézeau with the age of the peat generally decreasing with increasing OD height for those peats dating to approximately 5,000 BP or more. Peats with dates from c. 5,000 to 600 BP show greater variation in OD height in relation to age and suggest that oscillations in RSL change occurred during this time. These oscillations have been confirmed, by recent studies in western Brittany and in the Bay of Biscay, as occurring between c. 7,000 to 3,000 BP (Allard *et al*.

2008; Goslin *et al*. 2013) indicating that RSL changed at different rates on a more regional scale than shown in the models by Lambeck (1997) and Leorri *et al*. (2012).

4.22. There is therefore good potential for buried peats to be present in the estuarine areas of Pontusval and Moguériec, which would provide information on RSL change, landscape change and human activity from the Mesolithic to the Iron Age periods. The palaeo-environmental potential of such deposits has been realised from other estuarine sites in France such as at the Dives estuary, Normandy (Lespez *et al*. 2010).

4.23. The anaerobic nature of these sediments also indicates that they have good potential to contain cultural material such as wooden objects and structures. This potential is increased when taking into consideration the rich coastal and island archaeological heritage of Brittany, which includes fish traps of multiple periods, megalithic monuments, tombs and settlement sites (Scarre 2002; Daire 2009, Shi *et al*. 2012). Fish traps in particular have been recorded within the two areas under consideration here (Langouët & Daire 2009).

4.24. Palaeo-environmental and palaeo-climate information along the French coastline has also come from offshore cores (e.g. Naughton *et al*. 2007) indicating that there is potential for sediments in maritime locations to contain valuable palaeo-environmental and archaeological information.

Sites of cultural heritage interest within or in proximity to the CSC

4.25. The datasets used in the compilation of the various baseline assessments (Headland Archaeology 2014; Cotswold Archaeology 2017) have been amalgamated with duplicate entries removed.

4.26. DBAs have been conducted over the entire route from the Irish to the French coasts (Headland Archaeology 2014), and more recently to address route revisions in Irish territorial waters (Cotswold Archaeology 2017). These assessments included a wider study area (WSA) of c. 5km which has now been refined to the current proposed CSC of c. 0.5km.

Irish territorial waters

4.27. Two unidentified wrecks (**CA1 & CA8**; Table 2; Fig. 7), and one findspot on the foreshore of Ballinwilling Strand (**CA25**; Table 3; Fig. 7), were recorded within (the findspot) or in proximity (the two wrecks) to the CSC (Fig. 7) in Irish territorial waters. As neither wreck has been identified they are protected under Section 3 of the National Monuments (Amendment) Act, 1987) until they have been assessed further; this protection is not an indication of archaeological potential.

4.28. An unidentified live wreck (**CA1**) includes two entries in the same location which are presumed to relate to the same site. The wreck was detected by sonar at a depth of 74.6m, *c.* 91.4m (300ft) by 7.3m (24ft) in height.

4.29. The second unidentified wreck, (**CA8**), is recorded at a depth of 72.98m.

Table 2 Wrecks and obstructions in proximity to the CSC in Irish territorial waters (* = wrecks with multiple data entries)

CA no.	Name	Type	Date	Status	Latitude	Longitude	Source
CA1*	Unidentified	Wreck	Unknown	Live	51.72033	-7.92567	UKHO UAU
CA8	Unidentified	Wreck	Unknown	Unknown	51.661445	-7.827655	UKHO INFOMAR UAU

4.30. A retouched flint blade (leaf shaped, abrupt retouch on both lateral edges and butt-trimmed - a so-called 'Bann' flake), dating from *c.* 3,000BC, was found in 1967, in a *fulacht fiadh*, on the edge of Ballycrenane beach (NMI acc. no. 1972:354; **CA25**).

Table 3 DBA assets within the CSC

CA no.	Name	Type	Date	Status	Latitude	Longitude	Source
CA25	'Bann' flake	Retouched flint blade	c. 3000BC	Stored in National Museum of Ireland (NMI)	51.865834	-7.979895	NMI acc. no. 1972:354

4.31. The UAU has records of a number of wrecks that ran ashore in Ballycotton Bay (Cotswold Archaeology 2017: Table 3), mostly dating from the 18th and 19th centuries. No spatial data is recorded, but the project-specific geophysical survey (Cotswold Archaeology 2018a) did not detect any unknown wrecks so these will not be considered further.

Irish territorial limit to the French coast

4.32. Twenty wrecks, obstructions or sites were recorded in the CSC beyond Irish territorial waters (**HA1-HA5, HA7, HA9-HA22**; Table 4; Figs 8-11; Headland Archaeology 2014), including:

- Fourteen wrecks (**HA1-HA5, HA7, HA9-HA16**), ten of which are live and four of which are dead; and
- Six obstructions (**HA17-HA22**), one of which is live and five of which are dead.

4.33. Wreck sites **HA1, HA2, HA5 & HA11** will not be considered further as no corresponding anomalies were detected by the project-specific geophysical surveys, so their locations remain unknown.

4.34. The Alit (**HA3**; Fig. 11) was a French merchant ship which sank close to the French coast on 22 October 1916, but details such as ship type and cause of sinking are not known. The location of this wreck has not been confirmed and therefore cannot be removed as there is no corresponding geophysical data to confirm or deny its existence as it lies beyond the Irish / UK median line.

4.35. The *Auguste Marie* (**HA4**; Fig. 11) was a French steam vessel sunk on 28 November 1916 by U-18 commanded by Claus Lafrenz. The wreck lies *c.* 48km north of Ushant.

4.36. HMS *Woodpecker* (**HA9**; Fig. 10) was a Royal Navy sloop of the Black Swan class which was torpedoed on 20 February 1944 by U-256 whilst on convoy duty. The explosion removed the stern of the ship and she sank seven days later whilst under tow. This is one of two possible locations for the wreck. Although the locations have not been confirmed they cannot be removed as there is no corresponding geophysical data to confirm or deny their existence as it lies beyond the Irish / UK median line.

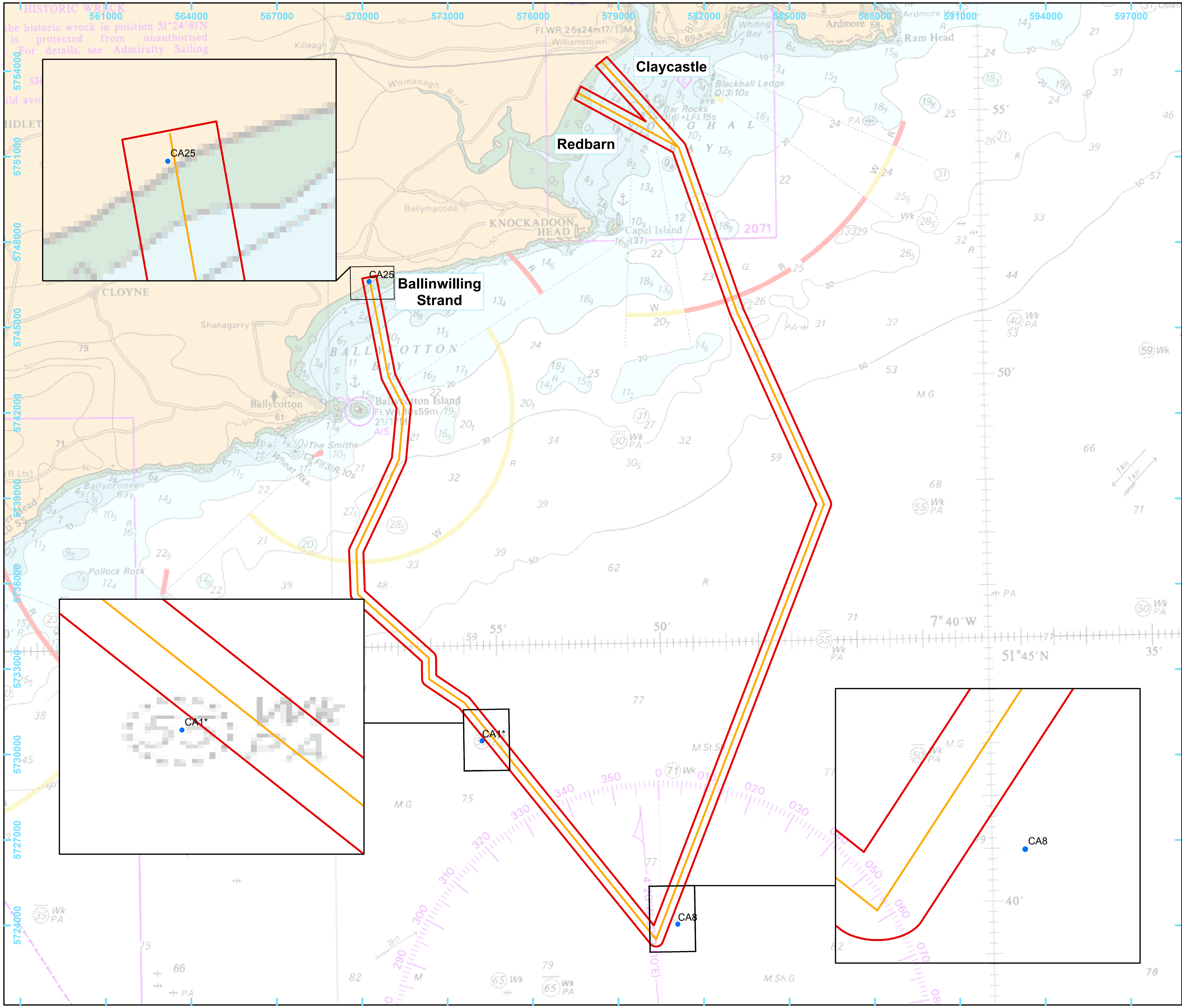
4.37. The *Zane Spray* (**HA10**; Fig. 8) was a leisure yacht which sank on 4 July 1995 whose location has been confirmed.

4.38. There are five further unidentified wrecks (**HA12-16**; Figs 8-11) whose locations are known. **HA16** was classified as a rock (obstruction) by UKHO but has recently been identified (by UAU) as a demasted brig of unknown date and origin and is therefore protected.

4.39. A further six assets are recorded as 'obstructions' (**HA17-22**), only one of which is live (**HA17**; Fig. 10), identified though a sonar contact as lying at 107m depth. The remaining five obstructions (**HA18-22**) are dead, so will not be considered further.

Table 4 Wrecks and obstructions in proximity to the CSC from then Irish territorial limit out to the French coast

HA no.	Name	Type	Date	Status	Latitude	Longitude	Source
3	*Atlit*	Wreck	22/10/1916	Live	48.74908	-4.3346	UKHO
4	*Auguste Marie*	Wreck	28/11/1916	Live	48.96567	-5.08483	UKHO
9	*HMS Woodpecker* (poss)	Wreck	27/02/1944	Live	49.85782	-6.78308	UKHO
10	*Zane Spray*	Wreck	04/07/1995	Live	51.31717	-7.64567	UKHO
11	*Honeydew*	Wreck	11/01/2007	Live	50.95	-7.46667	UKHO
12	Unknown	Wreck	Unknown	Live	48.98233	-5.11983	UKHO
13	Unknown	Wreck	Unknown	Live	51.6625	-7.82817	UKHO
14	Unknown	Wreck	Unknown	Live	49.33703	-6.01112	UKHO
15	Unknown	Wreck	Unknown	Live	49.23425	-5.78732	UKHO
16	Unknown	Wreck	Unknown	Live	50.74167	-7.35833	UKHO
17	Foul	Obstruction	Unknown	Live	49.53314	-6.43117	UKHO



N

Legend

Wrecks and obstructions

500m wide CSC

Cable Route

0 5km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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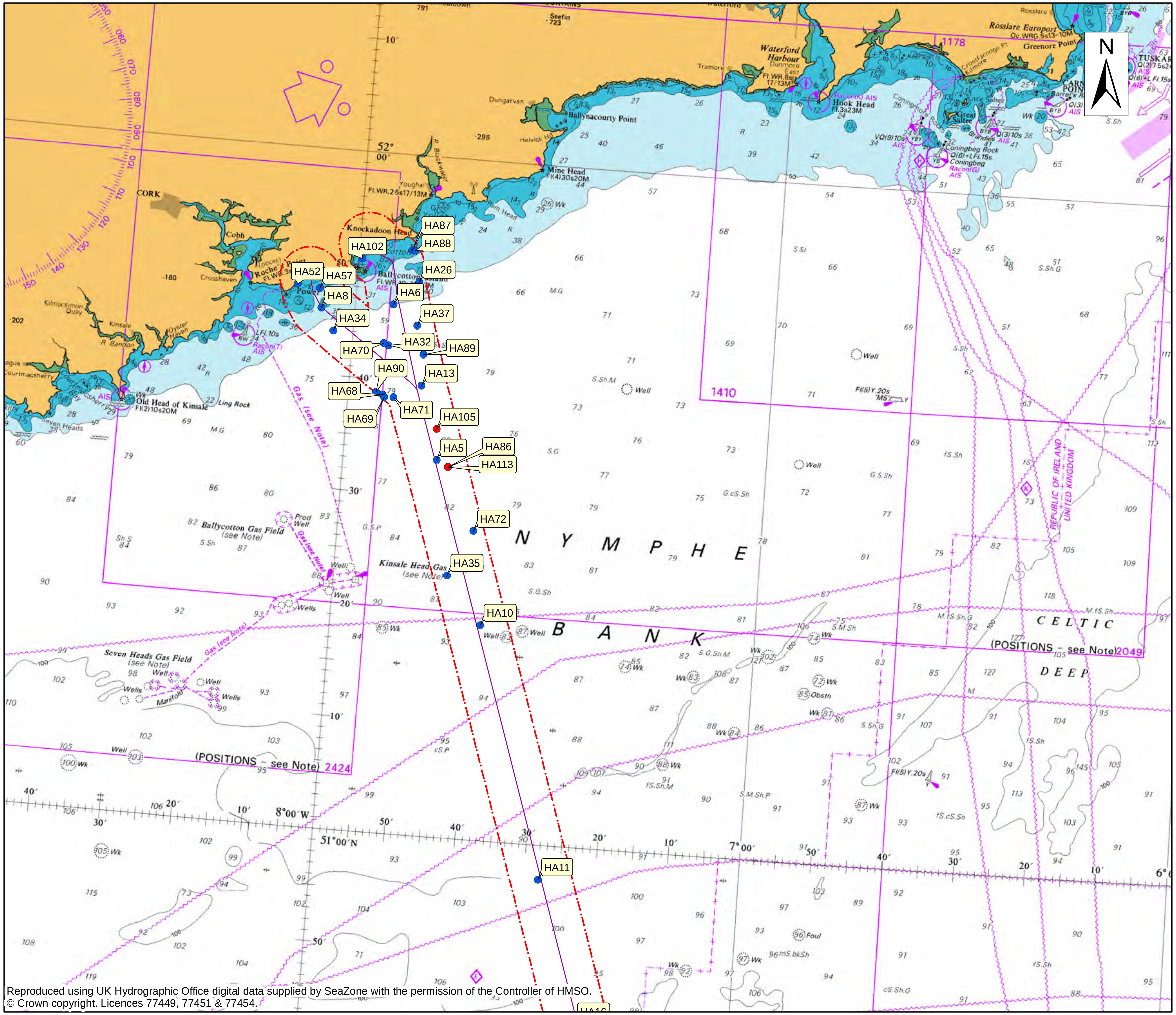
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Wrecks, obstructions and findspots within or in proximity to the CSC in Irish territorial waters

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	16/05/2019	7
APPROVED BY	MTW	SCALE@A3	1:125,000	



HEADLAND ARCHAEOLOGY

Key

- Obstrn
- Wreck
- Marine Survey Route
- 5km Search Area

Kilometers

0 20

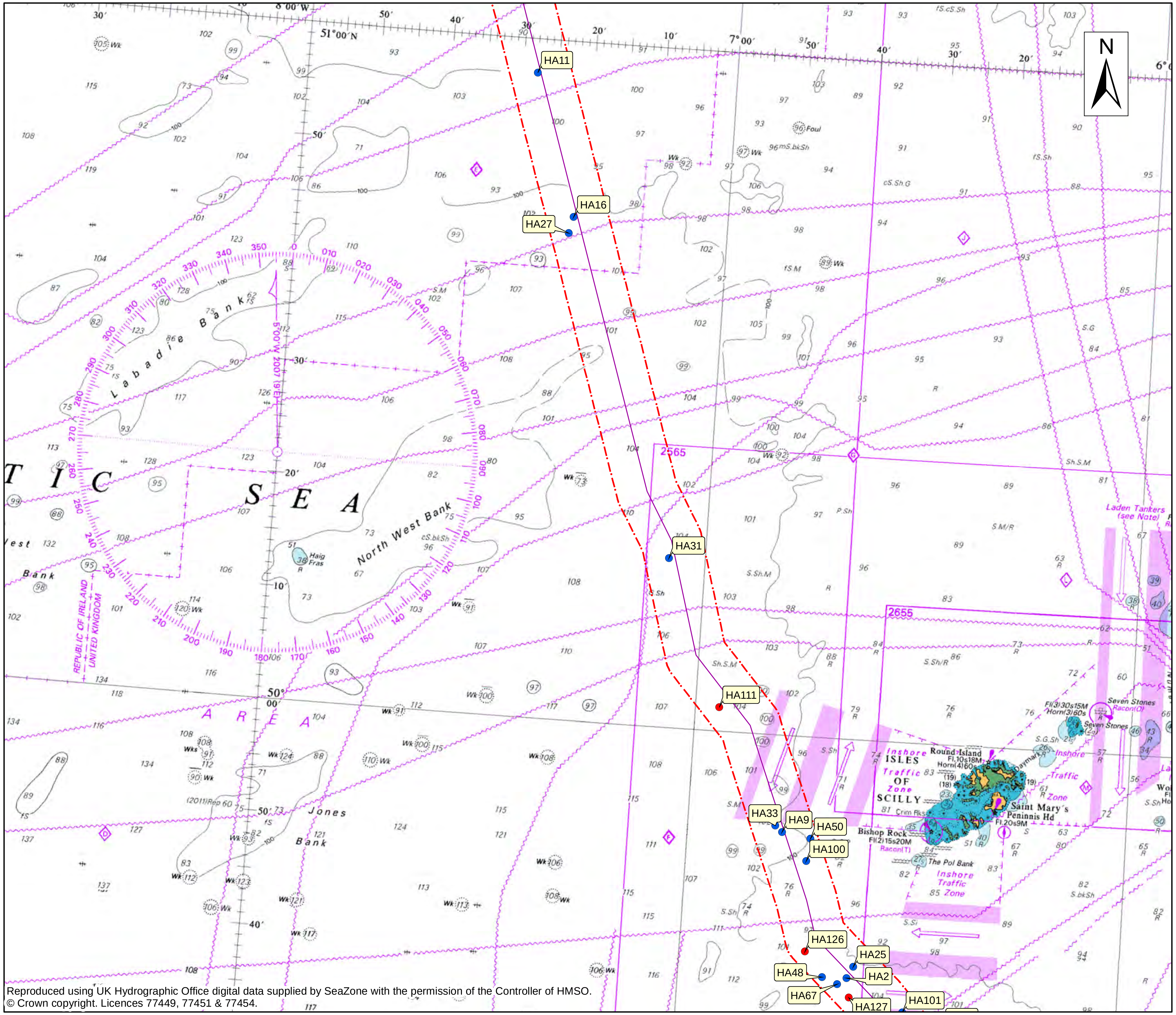
1:625,000

Ireland-France Celtic Interconnector [EIFI13]

DRAFT

EIFI13

Figure 8 Original map of wrecks and obstructions within the CSC and WSA in Irish waters, provided by Headland Archaeology (2015). No alterations have been made regarding revised routes and redundant sites.



HEADLAND ARCHAEOLOGY

Key

- Obstrn
- Wreck
- Marine Survey Route
- 5km Search Area

Kilometers

0 20

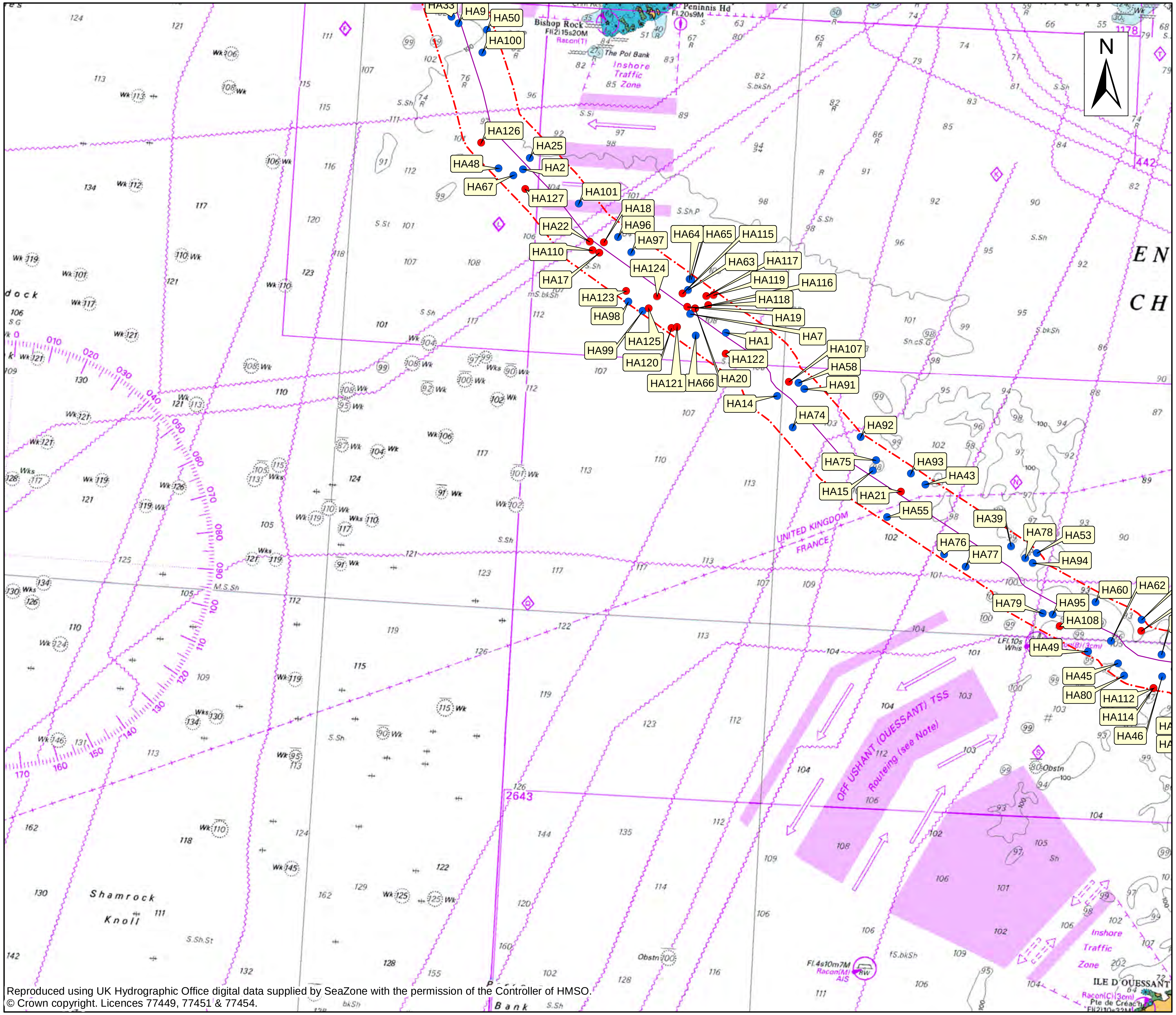
1:625,000

Ireland-France Celtic Interconnector [EIFI13]

DRAFT

EIFI13

Figure 9 Original map of wrecks and obstructions within the CSC and WSA from Irish / UK median line to French waters, provided by Headland Archaeology (2015). No alterations have been made regarding revised routes and redundant sites.



HEADLAND ARCHAEOLOGY

Key

- Obstrn
- Wreck
- Marine Survey Route
- 5km Search Area

Kilometers

0 20

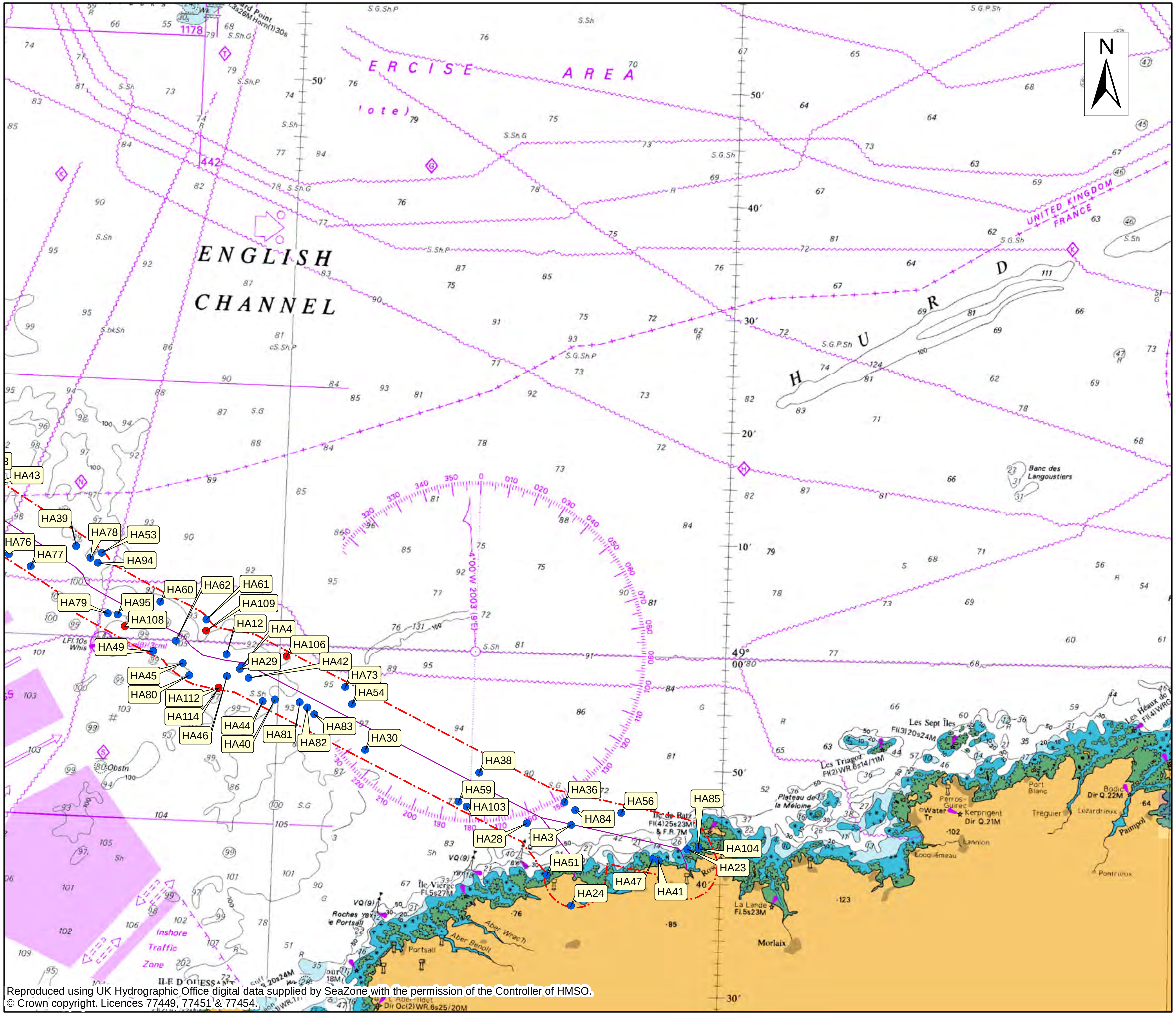
1:625,000

Ireland-France Celtic Interconnector [EIFI13]

DRAFT

EIFI13

Figure 10 Original map of wrecks and obstructions within the CSC and WSA in French waters, provided by Headland Archaeology (2015). No alterations have been made regarding revised routes and redundant sites.



HEADLAND ARCHAEOLOGY

Key

- Obstrn
- Wreck
- Marine Survey Route
- 5km Search Area

Kilometers

0 20

1:625,000

Ireland-France Celtic Interconnector [EIFI13]

DRAFT

EIFI13

Figure 11 Original map of wrecks and obstructions within the CSC and WSA in French territorial waters, provided by Headland Archaeology (2015). No alterations have been made regarding revised routes and redundant sites.

Foreshore survey results

Walkover survey

Ballinwilling Strand

4.40. A series of features relating to sea defences (Table 5) were identified during the walkover survey conducted by Headland Archaeology (2015: 5).

Table 5 Features identified at Ballinwilling Strand in 2015 walkover survey by Headland Archaeology

ID	Latitude	Longitude	Material	Description
101	51,51.982	-7,58.690	Concrete	Cut water, 0.40m wide, 4m visible extending from beach, aligned SE-NW, constructed from concrete with iron reinforcing bars.
102	51,51.949 51.51.992	-7,58.829 -7,58.636	Wooden piles/ Stone	A series of wooden piles driven into the beach, running for approximately 180m, aligned with the cliff edge and forming a retaining barrier for a deposit of large white rounded stones. The piles have worn down and some of the stones have spread down the beach.
103	51,51.560 51,51.580	-7,58.510 -7,58.460	Concrete	Concrete and stone access slipway aligned with the cliff edge. The structure provides access to the beach via a long ramp; the lower quarter has been recently damaged. The external sea face has been reinforced with wooden facing.

Claycastle beach

4.41. A series of exposed peat deposits (**CA3008-CA3011**) were observed in the inter-tidal zone in the south-west of the survey area (Table 6 and Figs 12 & 13). These peat deposits included evidence of plant remains (tree roots; **CA3002-CA3005**), as well as evidence of excavation in the form of recti-linear cuts (**CA3007**), possibly for use as *fulachtai fia*.

4.42. An eroded and heavily encrusted circular object, possibly a pot (**CA3001**) lying half exposed in the intertidal zone (Fig. 13) was also recorded. It could, possibly, be the fossilised remains of a hollowed-out trunk but this seems less likely as the other wooden remains associated with the peat do not appear fossilised.

4.43. This section of beach also included the remains of eight dilapidated wooden groynes (**CA3012-CA3018**) that were relatively evenly spaced (c. 60m apart) in the inter-tidal zone (Fig. 14).

Legend

N

- Walkover survey points
- Metal detector survey points
- End of groyne
- Exposed peat
- Cable Route
- 500m wide CSC

0 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Walkover and metal detector findspots at Claycastle beach

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.	
CHECKED BY	MTW	DATE	20/05/2019		12
APPROVED BY	MTW	SCALE@A3	1:1,750		

Table 6 Walkover survey results from Claycastle beach

CA ID	Latitude	Longitude	Material	Description
CA 3001	51.933011	-7.858793	Metal	Circular pot
CA 3002	51.932628	-7.860034	Wood	Tree stump in peat
CA 3003	51.932638	-7.859962	Wood	Tree trunk in peat
CA 3004	51.932626	-7.859938	Wood	Tree roots in peat
CA 3005	51.932729	-7.859835	Wood	Tree stump in peat
CA 3006	51.932791	-7.85976	Wood	Upstanding timbers in peat
CA 3007	51.9328	-7.85967	-	Rectangular cut in peat
CA 3008	51.931989	-7.860591	Peat	Exposed peat (c. 168 sq. m)
CA 3009	51.932187	-7.860424	Peat	Exposed peat (c. 85 sq. m)
CA 3010	51.932359	-7.860423	Peat	Exposed peat (c. 711 sq. m)
CA 3011	51.932881	-7.859492	Peat	Exposed peat (c. 1.06 sq. km)
CA 3012	51.934405 51.934581	-7.856025 -7.856265	Wood	Beach groynes
CA 3013	51.934104 51.934357	-7.856747 -7.857098	Wood	Beach groynes
CA 3014	51.933738 51.934079	-7.857387 -7.857782	Wood	Beach groynes
CA 3015	51.933384 51.933631	-7.858092 -7.858386	Wood	Beach groynes
CA 3016	51.933054 51.933166	-7.858796 -7.859009	Wood	Beach groynes
CA 3017	51.932647 51.932871	-7.859427 -7.859692	Wood	Beach groynes
CA 3018	51.93234 51.932558	-7.859944 -7.860314	Wood	Beach groynes

CA ID	Latitude	Longitude	Material	Description
CA 3019	51.932077 51.932258	-7.860412 -7.860725	Wood	Beach groynes

Figure 13 Walkover findspot examples - *left* recti-linear cut in peat (CA3007- facing north-east); *top right* - possible pot (CA3001 – facing north); *bottom right* – wood protruding from exposed peat.

Figure 14 Remains of a groyne on Claycastle beach (facing south-east). Note the exposed peat deposits in the foreground.

Redbarn beach

4.44. Two features were identified during the walkover survey (Table 7). These were relatively close to the level of MHWS and appear to be the remains of earlier sea defences (Fig. 15). The remains consist of a line of upstanding stones (**CA3042**), running E-W and standing up to 0.4m high.

4.45. The barrier restricting beach access is modern and will not be considered further. A large area of rounded stones was also observed and noted as unusual for this area of the beach.

Table 7 Walkover survey results from Redbarn beach

CA ID	Latitude	Longitude	Material	Description
CA 3042	51.925578	-7.870442	Stone	Linear stone barrier on an east-west alignment, parallel to the shore. Approx. 210m in length
Beach barrier	51.924620	-7.871691	Wood/metal	A series of wooden posts, with a metal barrier, used to restrict vehicular access to the beach. Approx. 24m in length

Figure 15 Possible beach defences (CA 3042) along the shoreline (facing north-west)

Metal detector survey results

Ballinwilling Strand

The metal detector survey at Ballinwilling Strand detected a total of 51 find spots (Fig. 16 & Appendix 1). The locations of the detected finds suggest random rather than deliberate deposition indicative of casual losses in the inter-tidal zone. None of the findspots were associated with the prehistoric find spot recorded by the NMS (NMI acc. No. 1972: 354; **CA25**; Cotswold Archaeology 2017).

Claycastle beach

4.46. 22 metal anomalies were detected during the metal detector survey at Claycastle beach (see Fig. 12 above & Appendix 1). These were located primarily in the north-east corner of the survey area, close to the high-water mark with a scattering of anomalies spread to the south and west. These were predominantly low detector value anomalies, probably indicating ferrous material.

Redbarn beach

4.47. A total of 81 metal anomalies were detected at Redbarn beach (Fig. 17 & Appendix 1). A significant number of these were concentrated along a stretch of beach 300m long and 60m wide in the centre of the inter-tidal zone. Other anomalies were found to the west, closer to high water and surrounding the beach defences, with a few scattered eastwards towards the sea.

Geophysical survey results

Ballinwilling Strand

4.48. The geophysical survey at Ballinwilling strand (Figures 18–23) indicated that the survey area consisted of a spread of bedrock at a shallower depth. From the visible outcrop in the southeast corner of the survey area it appears that these rocks have a more graduated incline than those observed on the other beach. However, the deeper responses from the 3m and 4m coil separation imply that the extent of the bedrock is equally well defined, shelving steeply beneath the sand to the south.

4.49. There is a break in the bedrock that could represent some form of earlier channel. However, in this case there is not a clearly defined causal mechanism for the break in the bedrock. The channel also shows more clearly on the electromagnetic data (in-phase). This might imply that the break is a deliberate cut, perhaps for an outfall pipe, at this location. If so, the pipe does not appear to be metal or it has been removed subsequently.

4.50. There are no clearly interpretable metallic responses as were observed elsewhere.

Claycastle beach

4.51. The dataset from Claycastle beach shows variation throughout the in-phase survey but a more homogenous background has been detected across most of the quadrature survey. This is thought to show near-surface variation in the depth and composition of the upper beach deposits and a more homogenous, conductive underlying deposit. The area of exposed peat in the south-west of the Claycastle survey area has not been detected as an isolated anomaly but is associated with a more extensive area of increased magnetic susceptibly, perhaps suggesting that the peat deposits extend beneath the beach sand. See Figure 24 and 25.

4.52. An amorphous area of negative magnetic susceptibility in the east of the survey area corresponds with an area of lower electrical conductivity in the quadrature dataset. This anomaly is caused by variation in the depth and composition of the estuarine silts and clays.

4.53. Very low in-phase and quadrature readings are recorded at the head of Claycastle beach. This is caused by the contrast between the conductive and magnetically susceptible beach deposits and those at the dune/vegetation line. No clearly interpretable metallic responses have been identified at Claycastle beach.

Redbarn beach

4.54. The survey at Redbarn beach shows variation throughout both the in-phase (magnetic susceptibility) and the quadrature (conductivity) datasets. The broad amorphous anomaly in the centre of the survey area corresponds with a slight channel in the covering sand where sea water pools temporarily as the tide retreats. This anomaly exhibits a negative magnetic susceptibility and a lower electrical conductivity than the surrounding beach material and is caused by variation in the depth and composition of the marine deposits (see Figures 26 & 27).

4.55. In the southernmost corner of the in-phase dataset the magnetic susceptibility values increase significantly although there is no variation in the quadrature data. The cause of this anomaly is not clear although it may locate the extent of the outfall of alluvial deposits from the river Blackwater, as suggested by recent satellite imagery (Ordnance Survey Ireland 2018).

4.56. As at Claycastle beach, very low in-phase and quadrature readings are recorded at the head of Redbarn beach. This is caused by the contrast between the conductive and magnetically susceptible beach deposits and those at the dune/vegetation line.

4.57. No clearly interpretable geophysical metallic responses have been identified at Redbarn beach.

Summary

Claycastle beach

4.58. The exposed peat deposits identified at Claycastle beach are of high archaeological potential. Previous investigations of a core taken at Claycastle (Delahunty 2002) radiocarbon dated the deepest peat deposit from the core to *c.* 4,555 years BP. The lowest peat deposits therefore date from the Early Neolithic and are of archaeological significance (Delahunty 2002). The results of the geophysical survey appear to suggest that the exposed peat probably represents a much larger deposit that extends beneath the sand both landward and seaward. This was investigated further with a limited hand auger survey (see below).

4.59. There appears to be little apparent patterning or correlation between the anomalies detected during the metal detector survey on Claycastle beach. These seem to represent casual losses rather than being indicative of coherent archaeological sites or features and are therefore of low archaeological potential.

4.60. The series of dilapidated wooden groynes recorded in the intertidal zone appear to be relatively modern, early 20th century, coastal defences and are therefore considered to be of low archaeological potential.

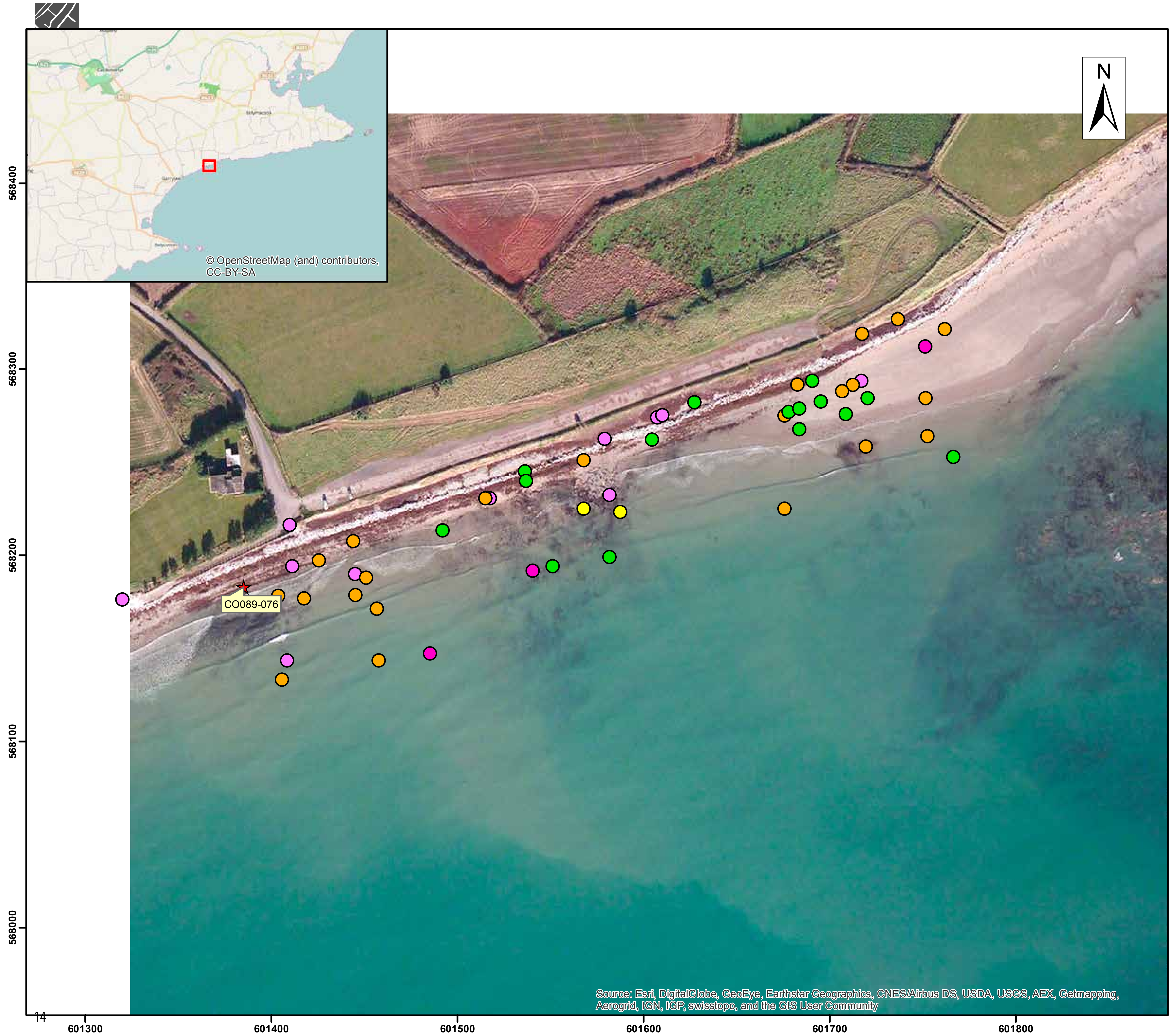
Redbarn beach

4.61. The metal detector survey at Redbarn beach appears to have detected a significant number of seemingly related anomalies, as well as a number of random, probably casual, losses. The former appears to correlate with a possible sub-surface depression identified in the geophysical survey. These occur in a relatively regular formation of three lines on a north-east to south-west alignment covering an area c. 275m by 60m. This suggests a possible site of medium archaeological potential.

The upstanding remains of possible beach defences are considered of low archaeological potential.

Ballinwilling Strand

4.62. There was little apparent patterning or correlation between the 51 anomalies detected during the metal detector survey and none appear to be associated with the prehistoric flint blade associated with the *fulacht fiadh* (**CA25**). The remains of the sea defences, concrete breakwaters and groynes along the edge of Ballinwilling Strand are all of low archaeological potential.



HEADLAND ARCHAEOLOGY

Legend

- ★ National Monument Service Record
- Copper alloy (modern coin)
- Iron (Fe)
- Aluminium (Al)
- Gold (Au) / Silver (Ag)
- Silver (Ag)

Meters

0 100

Coordinate System: IRENET95 Irish Transverse Mercator
Projection: Transverse Mercator
Datum: IRENET95
False Easting: 600,000.0000
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter

Produced by: Trevor Draeseke

Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 16

Metal detector find spots at Ballinwilling strand

N

Legend

Metal detector survey points

Beach defenses

Cable Route

500m wide CSC

0 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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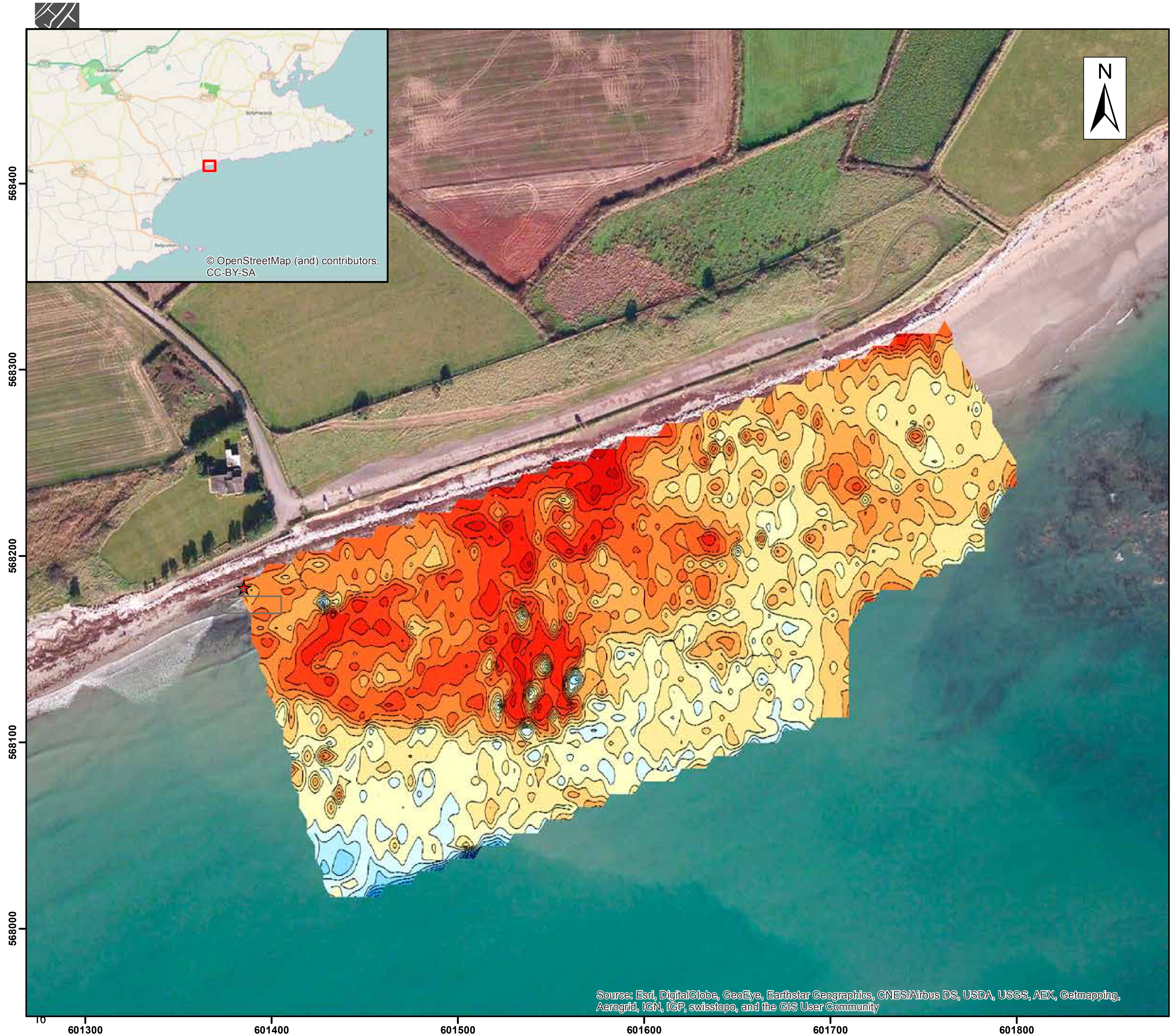
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Walkover and metal detector findspots at Redbarn beach

DRAWN BY	RLF	*PROJECT NO*	770617	*FIGURE NO.*
CHECKED BY	MTW	*DATE*	20/05/2019	17
APPROVED BY	MTW	*SCALE@A3*	1:2,000	



HEADLAND ARCHAEOLOGY

Legend

★ CA25

Meters
0 100

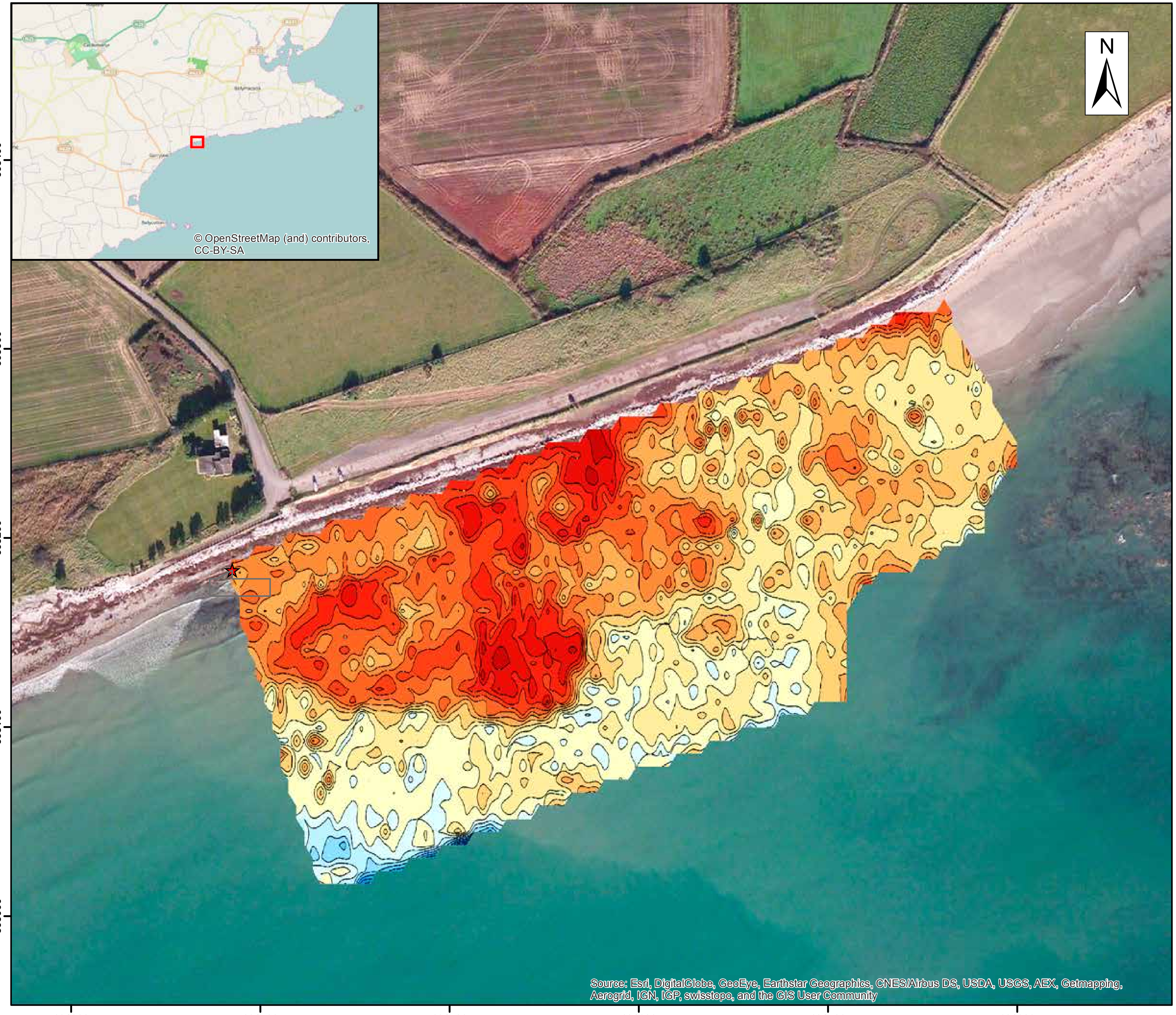
Coordinate System:
IRENET95 Irish Transverse Mercator
Projection: Transverse Mercator
Datum: IRENET95
False Easting: 600,000.0000
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 18

Electrical conductivity survey 0–0.5m Ballinwilling strand



HEADLAND ARCHAEOLOGY

Legend

★ CA25

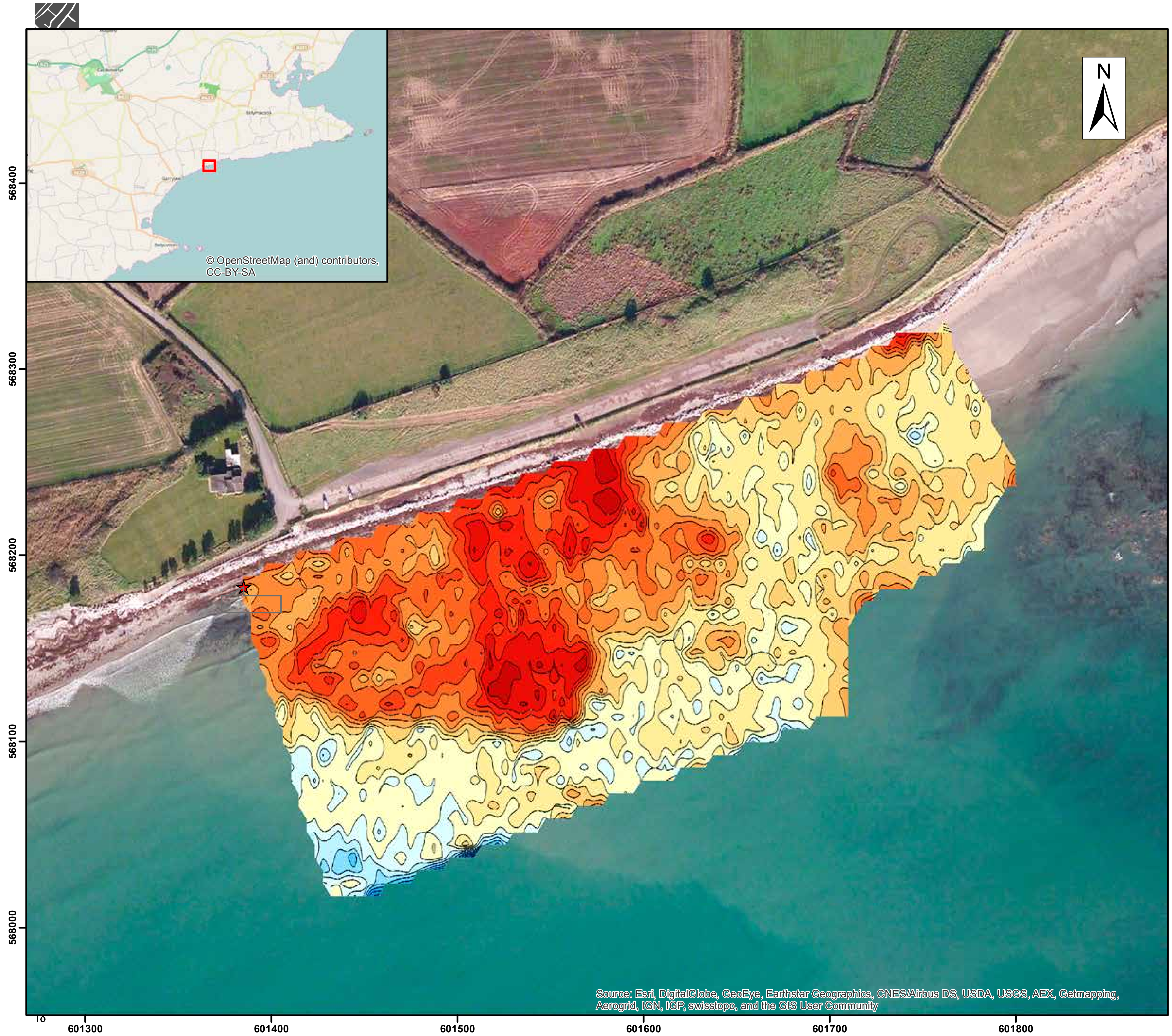
Meters
0 100

Coordinate System:
IRENET95 Irish Transverse Mercator
Projection: Transverse Mercator
Datum: IRENET95
False Easting: 600,000.0000
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 19
Electrical conductivity survey 0.5–1.0m Ballinwilling strand



HEADLAND ARCHAEOLOGY

Legend

★ CA25

Meters

0 100

Coordinate System:
IRENET95 Irish Transverse Mercator
Projection: Transverse Mercator
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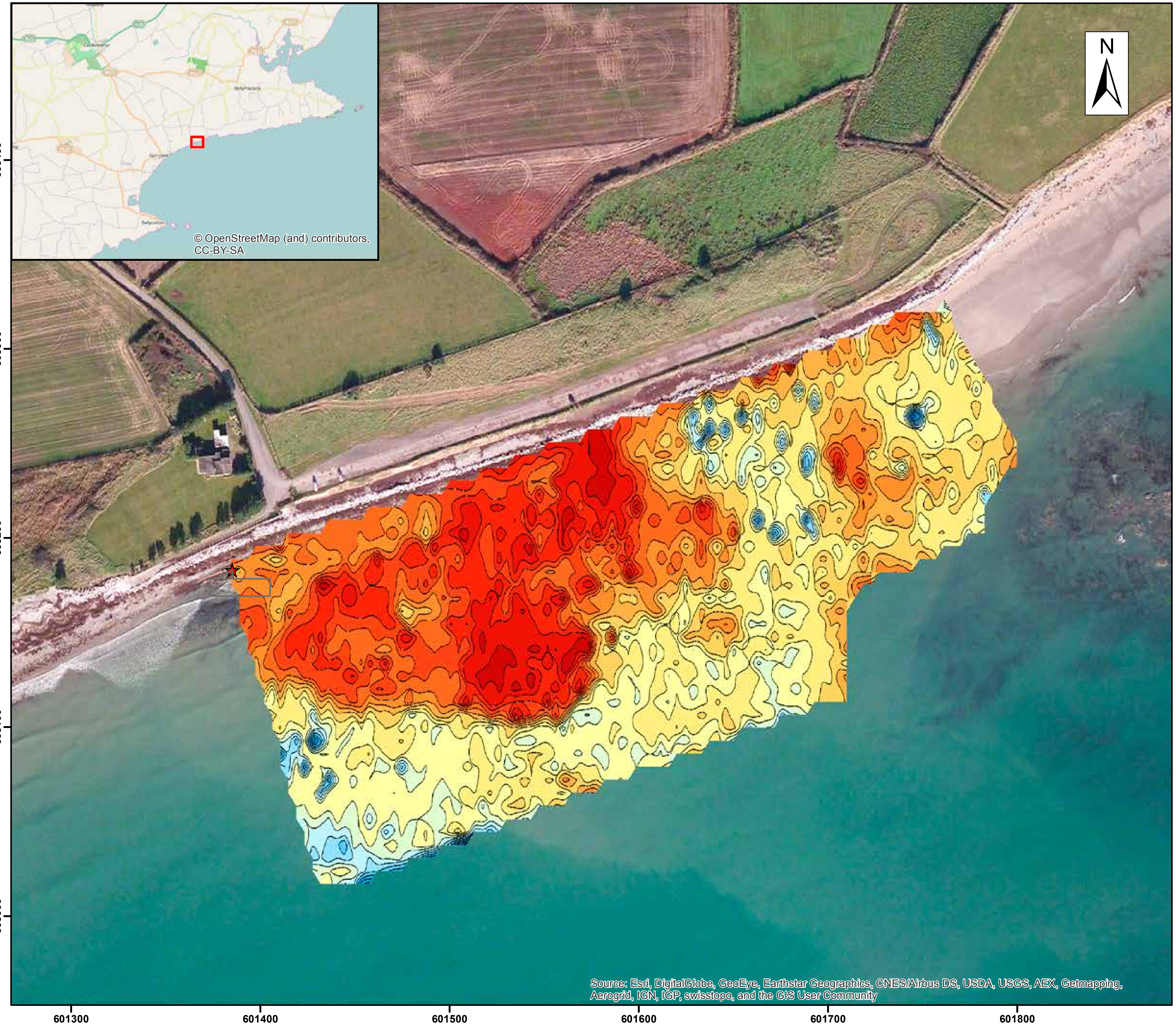
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 20

Electrical conductivity survey 1.0–1.5m Ballinwilling strand



HEADLAND ARCHAEOLOGY

Legend

★ CA25

Meters
0 100

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Projection: Transverse Mercator
Datum: IRENET95
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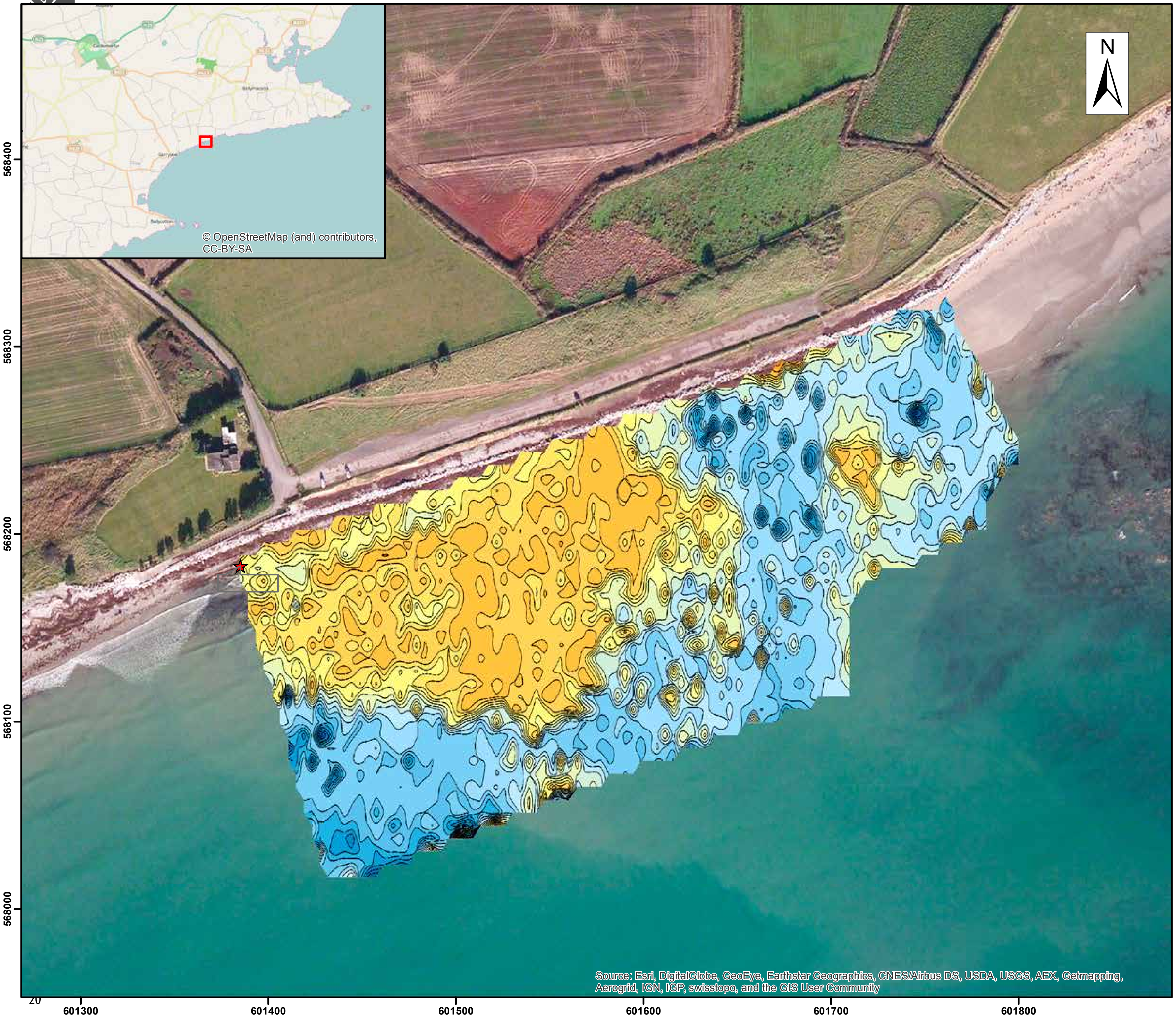
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 21
Electrical conductivity survey 1.5–2.0m Ballinwilling strand



HEADLAND ARCHAEOLOGY

Legend

★ CA25

Meters

0 100

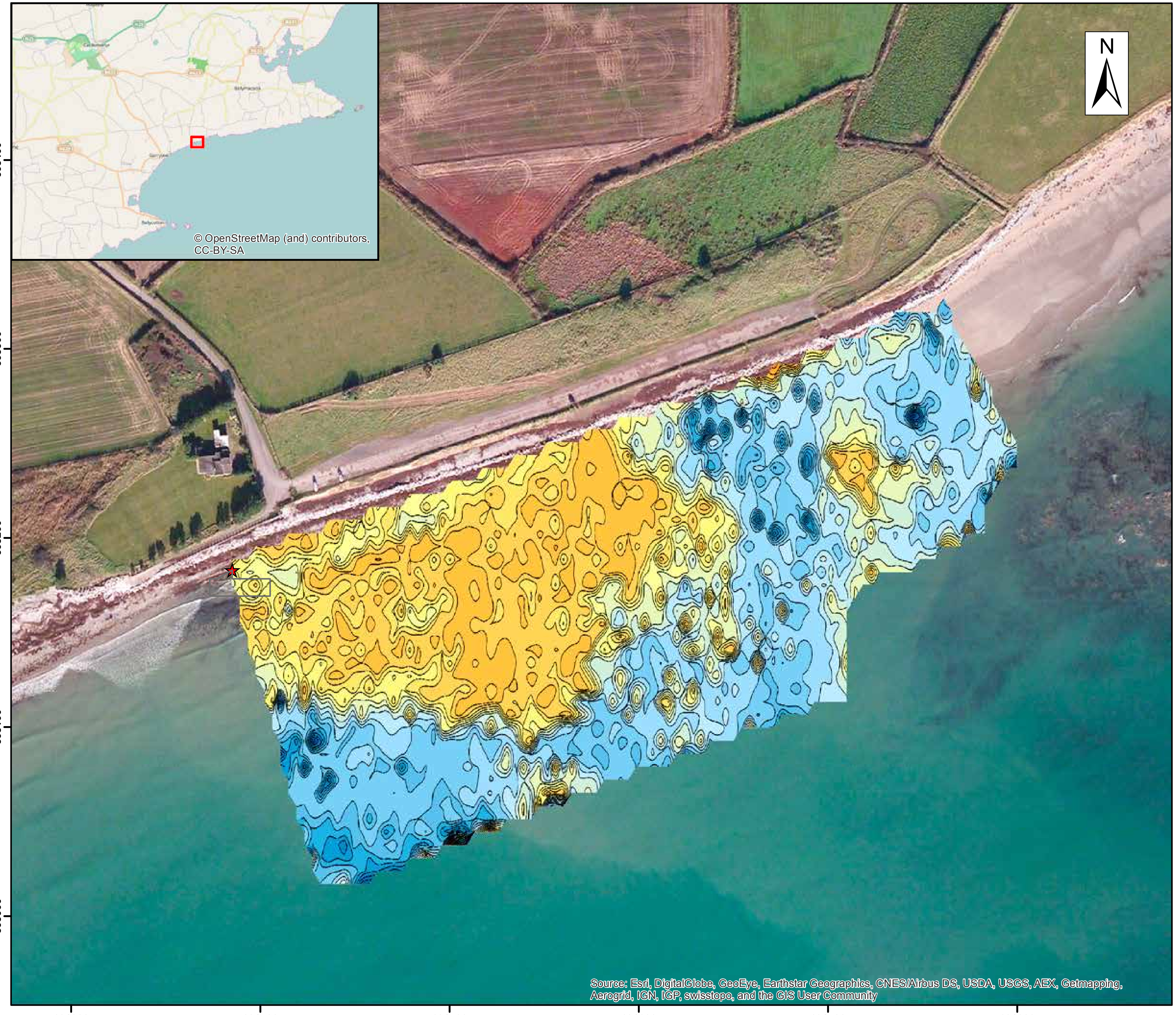
Coordinate System: IRENET95 Irish Transverse Mercator
Projection: Transverse Mercator
Datum: IRENET95
False Easting: 600,000.0000
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 22

Electrical conductivity survey 2.0–2.5m Ballinwilling strand



HEADLAND ARCHAEOLOGY

Legend

★ **CA25**

Meters
0 100

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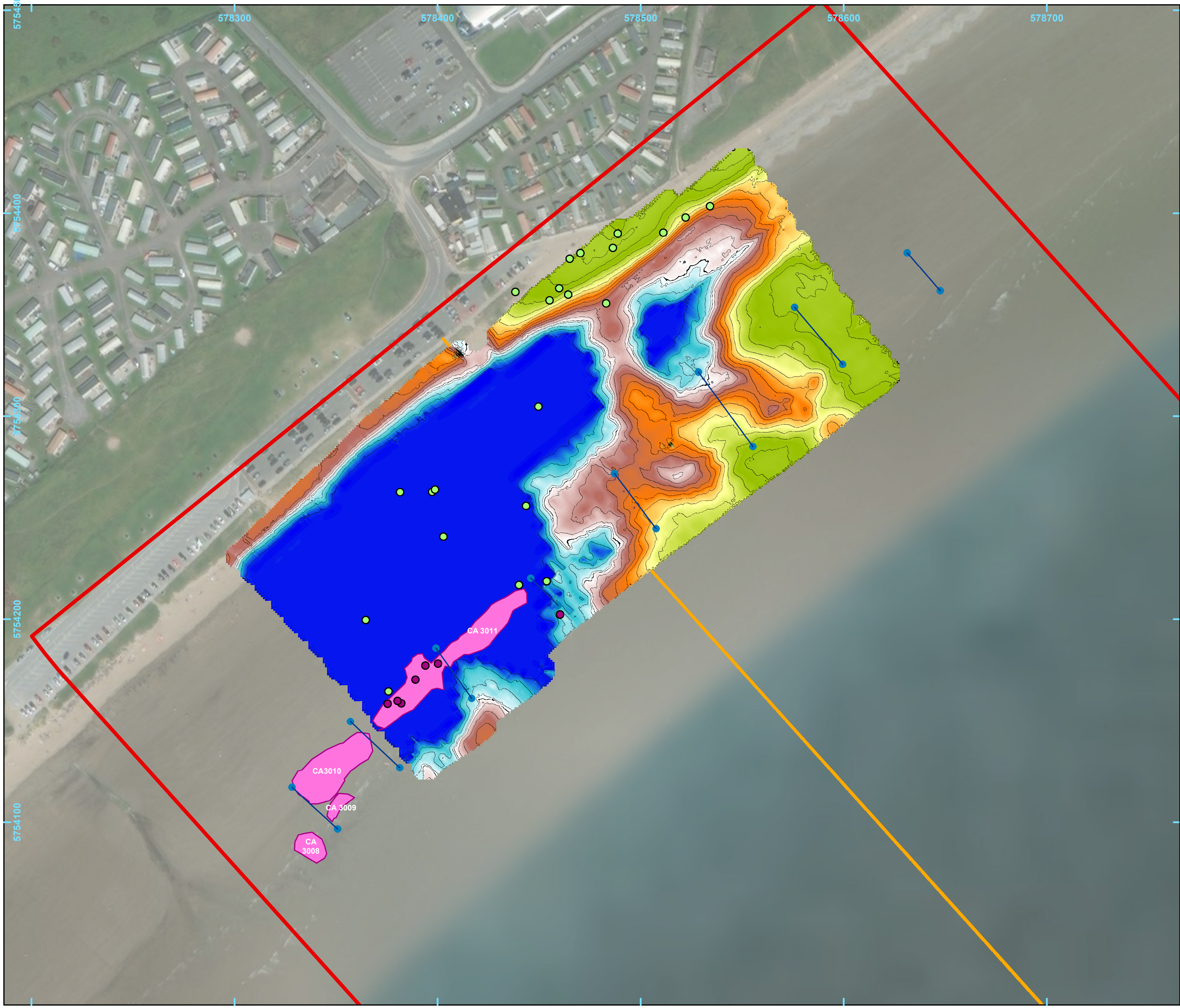
Projection: Transverse Mercator
Datum: IRENET95
False Easting: 600,000.0000
False Northing: 750,000.0000
Central Meridian: -8.0000
Scale Factor: 0.9998
Latitude Of Origin: 53.5000
Units: Meter
Produced by: Trevor Draeseke
Date: 20/03/2015

1:2,000 at A3

Celtic (Ireland-France) Interconnector

FIGURE 23
Electrical conductivity survey 2.5–3.0m Ballinwilling strand



Legend

N

- Walkover survey points
- Metal detector survey points
- End of groyne
- Exposed peat
- Cable Route
- 500m wide CSC

In-phase survey

ppt

-3.0 22.0

0 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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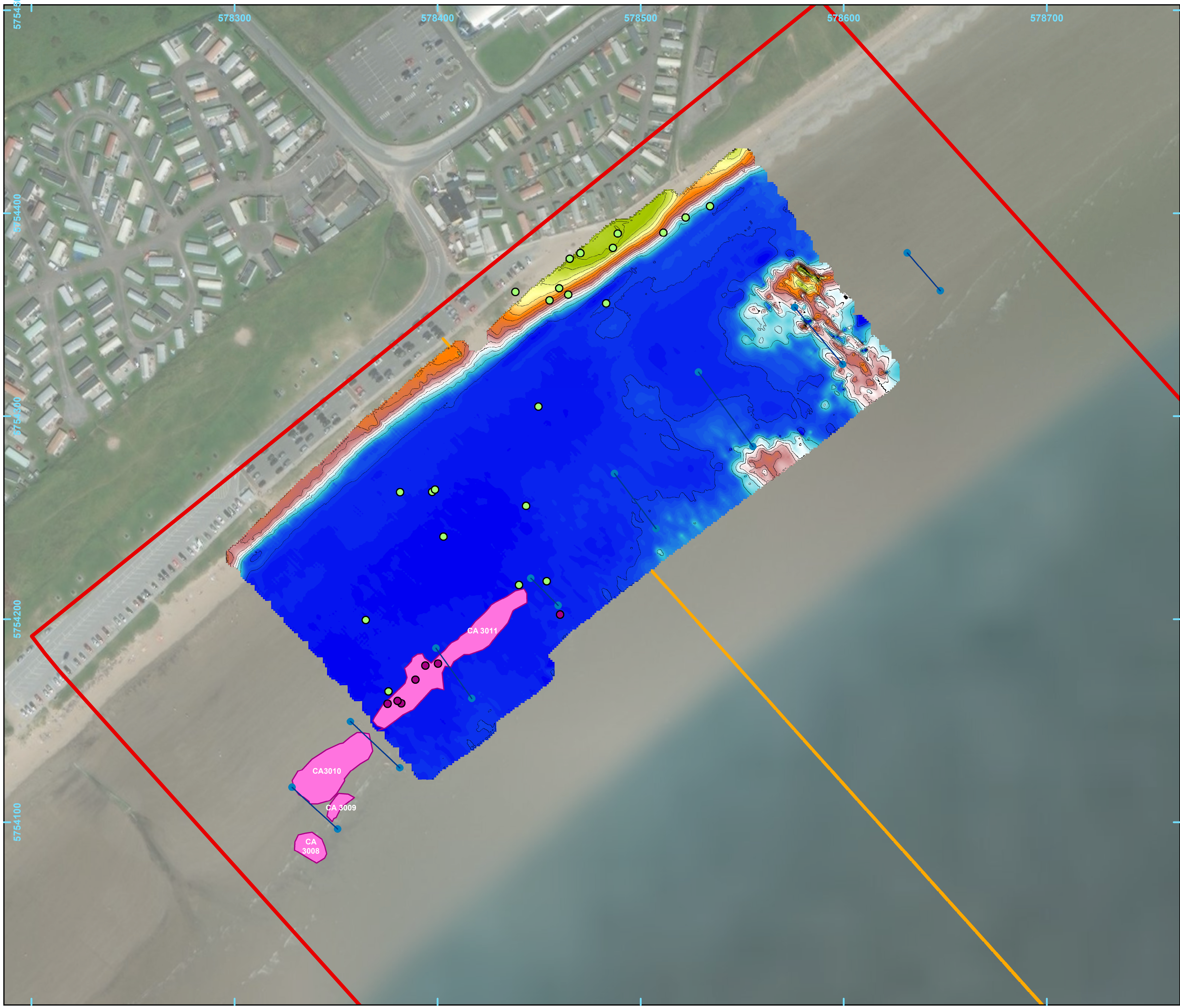
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Claycastle beach geophysics (in-phase) with metal detector results overlain

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	20/05/2019	24
APPROVED BY	MTW	SCALE@A3	1:1,750	



Legend

N

- Walkover survey points
- Metal detector survey points
- End of groyne
- Exposed peat
- Cable Route
- 500m wide CSC

Quadrature survey

ms/m

25.0 – 202.0

0 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE

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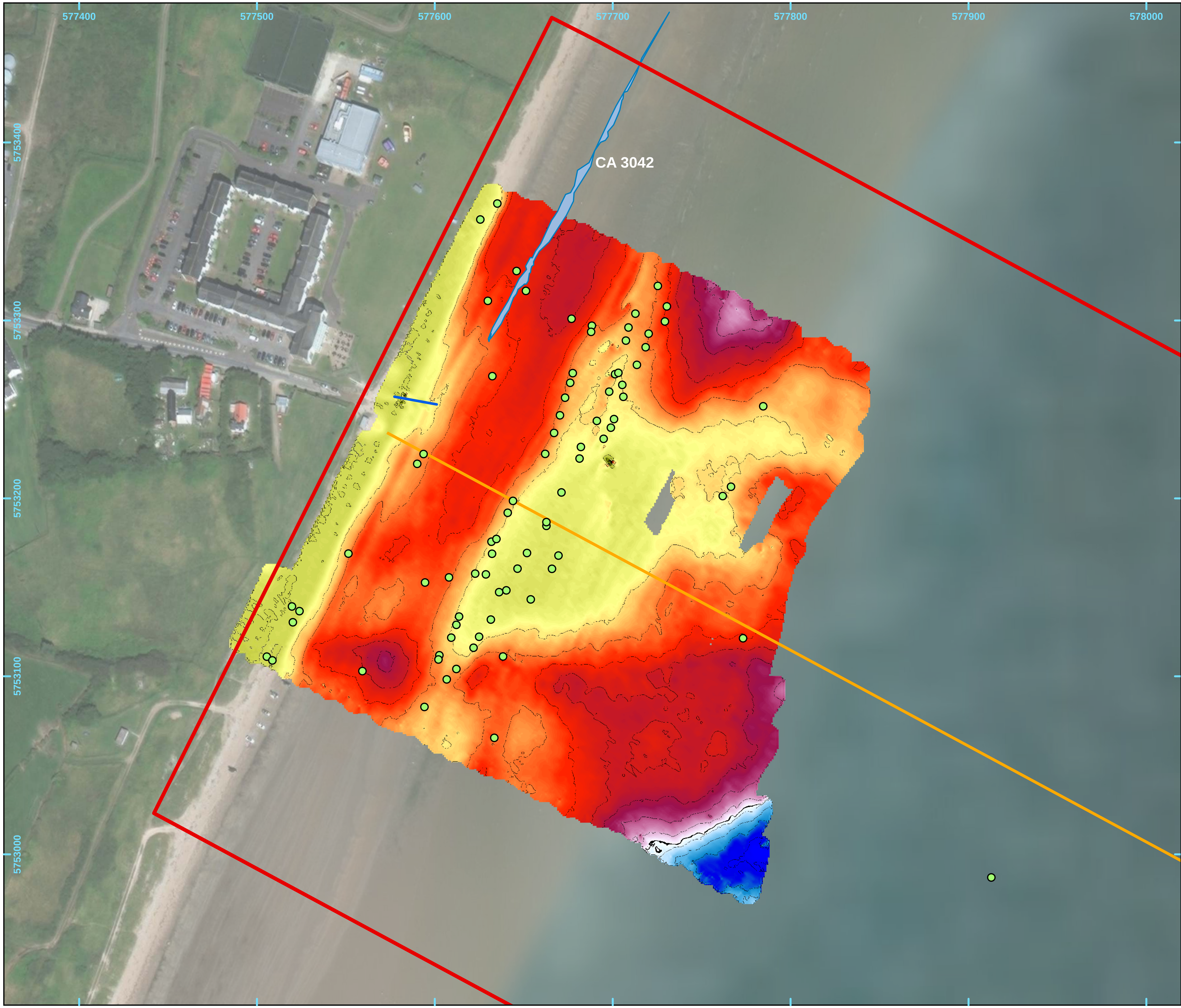
FIGURE TITLE

Claycastle beach geophysics (quadrature)with metal detector results overlain

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	20/05/2019	25
APPROVED BY	MTW	SCALE@A3	1:1,750	



Legend

N

- Metal detector survey points
- Beach defenses
- Modern beach barrier
- Cable Route
- 500m wide CSC

In-phase survey

ppt

-12.0 – 20.0

0 – 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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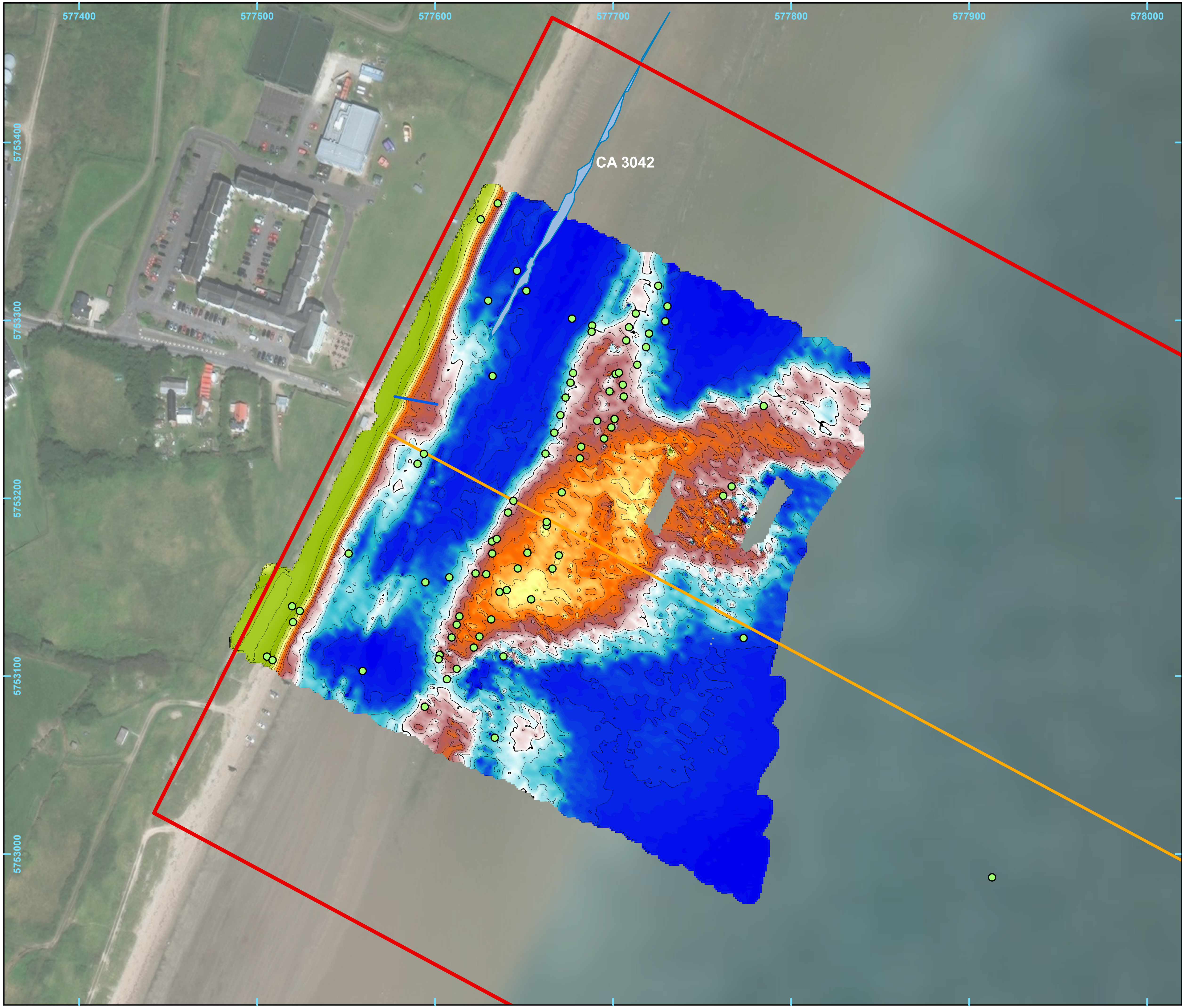
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Redbarn beach geophysics (in-phase) with metal detector results overlain

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	21/05/2019	26
APPROVED BY	MTW	SCALE@A3	1:2,000	



Legend

N

- Metal detector survey points
- Beach defenses
- Modern beach barrier
- Cable Route
- 500m wide CSC

Quadrature survey

ms/m

16.0 – 201.0

0 – 0.075km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Redbarn beach geophysics (quadrature) with metal detector results overlain

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	21/05/2019	27
APPROVED BY	MTW	SCALE@A3	1:2,000	

Marine geophysical survey results

4.63. The results of the geophysical assessment of marine geophysical survey data in Irish territorial waters (Cotswold Archaeology 2018a) and beyond Irish territorial waters (Headland Archaeology 2015) are presented below.

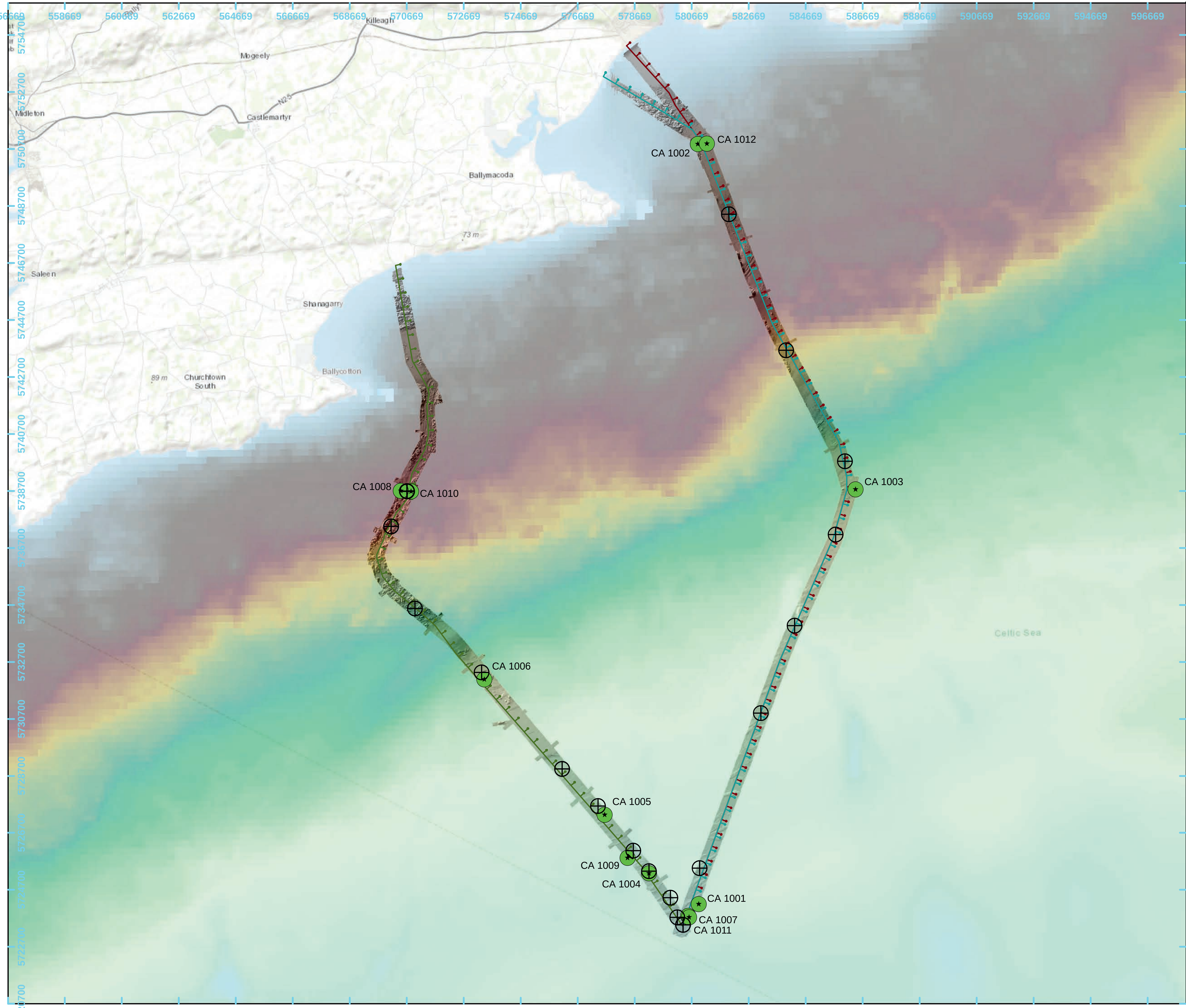
Geophysical anomalies in Irish territorial waters

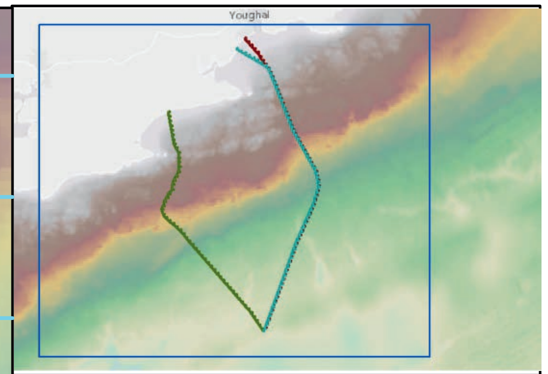
4.64. Archaeological assessment of the marine geophysical datasets from Irish territorial waters identified 12 anomalies with archaeological potential (see Figure 28 and Table 8; each anomaly location is illustrated in Appendix 2). Other geophysical anomalies identified in the survey data, notably the SSS, consisted of small (<2m) boulders, sometimes with associated scour, in areas where bedrock was not exposed on the surface. These anomalies had no associated magnetic signal so are interpreted as natural in origin.

4.65. Of the 12 anomalies identified, only one potential wreck site (**CA1001**) was identified within the CSC. This comprised a large bathymetric high, with associated features visible in the SSS, and a cluster of magnetic anomalies measuring up to 7,682 nanotesla (nT). This anomaly is located on the eastern margin of the Claycastle / Redbarn route close to KP33.

4.66. This anomaly was recorded as an unknown wreck in the INFOMAR surveys, measuring c. 91.4m long by 7.3m high at a depth of c. 73m (listed as **CA8** in the DBA (Cotswold Archaeology 2017; see above)). Thus, **CA8** equates to anomaly **CA1001** and is a site of high archaeological potential within the CSC.

4.67. Nine anomalies were identified as having medium archaeological potential (**CA1002** to **CA1009**, and **CA1011**). These consist of magnetic anomalies exceeding 25nT sometimes with associated bathymetric or SSS anomalies. These might suggest metallic objects lying on, or just under, the seabed. No corresponding anomalies were identified in the neighbouring SBP surveys, although survey lines rarely coincided directly with the position of these anomalies visible in the surface datasets. Two anomalies (**CA1010** and **CA1012**) were identified as having low archaeological potential.





Legend

N

- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Bathymetry (m LAT)

Value

1.26

-81.9

0 5km

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE

Celtic Interconnector

FIGURE TITLE

Distribution of geophysical anomalies offshore

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	RP	DATE	30/01/2018	28
APPROVED BY	MW	SCALE@A3	1:125,000	

Table 8 Description of geophysical anomalies identified with archaeological potential

Anomaly	Easting	Northing	Description	Potential
CA1001	580911	5724197	Located on the eastern edge of the survey corridor. Bathymetry shows an elevated feature, 3m in height, with build-up of sediment on its western margin. SSS has partial coverage of the western edge of the anomaly, showing a curved shape and a series of linear features that may relate to infrastructure / rigging. There is an area of enhanced magnetic intensity around the feature, with the highest value recorded as 7682 nT (IRE_MAG_15) suggesting the presence of a large metallic object on the seabed. This is probably a wreck	High
CA1002	580878	5750872	Magnetic anomaly measuring 110nT (IRE_MAG_47). No associated feature in the bathymetry or SSS data, and the position coincides with an area of exposed rock. May be metallic debris located between cracks in the rock	Medium
CA1003	586418	5738751	Magnetic anomaly measuring 53nT (IRE_MAG_13). Bathymetry shows an area of slightly raised seabed but with no features exposed on the surface. SSS shows a small rounded dark reflector, measuring c. 1.5 x 1.5m	Medium
CA1004	579159	5725278	Magnetic anomaly measuring 51nT (IRE_MAG_27). Bathymetry shows a small depression, measuring 9 x 8m containing a SSS dark reflector measuring 2.2 x 0.8 x 0.4m.	Medium
CA1005	580536	5723787	Bathymetric high measuring 23 x 18m. Coincides with two magnetic anomalies within 10m of its edge, measuring 48nT and 21nT (IRE_MAG_32)	Medium
CA1006	573380	5732081	Cluster of magnetic anomalies, measuring up to 45nT (IRE_MAG_21). No anomalies visible in bathymetry or SSS	Medium
CA1007	577604	5727330	Single magnetic anomaly measuring 39nT (IRE_MAG_84), located on the southern edge of a wide area of deepened seabed bathymetry. There are no anomalies visible in the SSS data. Located 68m NW of CA_0011	Medium
CA1008	570816	5738681	Single magnetic anomaly measuring 37nT (IRE_MAG_14), located in an area of fairly smooth seabed (maximum variation of 0.2m). The southern edge of a wide area of deepened seabed bathymetry. There are no anomalies visible in the SSS data	Medium
CA1009	578410	5725821	Single magnetic anomaly measuring 36nT (IRE_MAG_14), located in an area of smooth seabed with no bedrock protrusions. A small dark reflector, measuring 0.8 x 0.7m, is present in the SSS data	Medium

Anomaly	Easting	Northing	Description	Potential
CA1010	570453	5738698	Cluster of magnetic anomalies, the largest measuring 28nT (IRE_MAG_14). Bathymetry shows an area of smooth seabed north of a bedrock exposure, with small boulder-shape anomalies visible in the local area in both the bathymetry and SSS data	Low
CA1011	580567	5723726	Single magnetic anomaly measuring 25nT (IRE_MAG_12), located in an area of elevated seabed with no bedrock protrusions. A small dark reflector, measuring 2.4 x 1.3 x 0.6m is present in the SSS data. Located 68m SE of CA_0007	Medium
CA1012	581200	5750884	Single magnetic anomaly measuring 23nT (IRE_MAG_10), in close proximity to an area of slightly rough seabed as indicated in the bathymetry. No anomalies are visible in the SSS data at this location	Low

Submerged palaeo-landscapes in Irish territorial waters

4.68. A review of the SBP seismic survey data in Irish territorial waters has identified 21 areas where features with archaeological potential are present (Figure 29). Illustrations of each area, including corresponding SBP seismic lines, are provided in Appendix 3.

4.69. Previous project-specific surveys of adjacent routes (Headland Archaeology 2015) have identified palaeo-channels in close proximity to the southern sector of the Ballinwilling Strand route. Coring associated with these previous route options has identified the nature of the sedimentary sequence in these channels (Wessex Archaeology 2016; see below). Typically, the upper 1-2m of these channel areas contain glacio-marine sediments overlain by surface seabed sediments.

CA2001

4.70. The SBP survey shows a palaeo-channel that splits in the centre of the survey corridor. Both channels show an undulating rock surface. The northern channel base deepens along its northern edge, while the southern channel shows a greater depth, up to 18m below the seabed, and a more symmetrical cross-section. No clear internal reflectors were identified within the channel suggesting a fairly homogenous sediment type. A second facies is visible in the top of each channel immediately underlying the seabed at c. 2m depth.

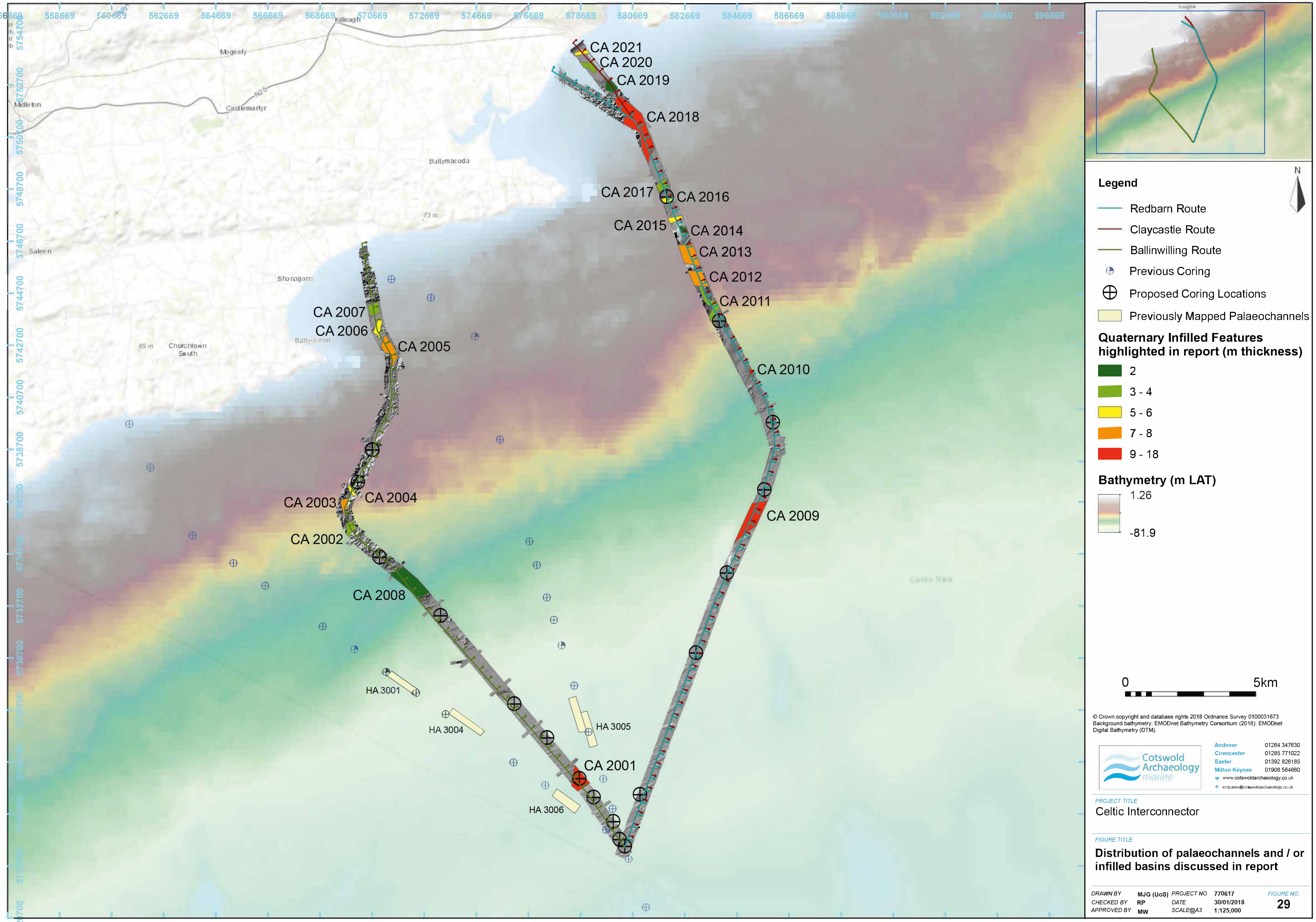
4.71. The channel aligns with palaeo-channels identified in surveys undertaken for previous route options on the Celtic Interconnector immediately north and south of the current survey, recorded as HA3005 and HA3006 (Headland Archaeology 2015). Coring of HA3005 identified a sedimentary sequence in cores VC-015 and VC15A consisting of up to 1m of glacio-marine deposits in the upper part of this channel. These cores suggest that this channel contains pre-Holocene sediments and is therefore of low archaeological potential.

CA2002

4.72. This feature lies between exposed bedrock, visible on the surface of the seabed. A probable palaeo-channel with a smooth basal profile has been identified in the centre of this area of smooth seabed. A second facies is present near the seabed showing 1-2m of sediment above the palaeo-channel filling this depression between the exposed bedrock. The smooth profile of the exposed rock margins along the southern edge of **CA 2002** also suggest a possible submerged channel.

CA2003

4.73. This feature also lies between exposed bedrock visible on the surface of the seabed. A single palaeo-channel is visible in the north-eastern corner of the feature, with two channels visible in the centre of the area suggesting bifurcation around the exposed bedrock visible on the seabed. The southernmost channel can be traced passing through the gap visible in the bedrock, whereas the northernmost channel may run westwards through the gap in the bedrock west of **CA 2003**. The northern channel appears to have internal reflectors suggesting some banding of coarser grained sediments, while the southern channel appears to have some basal gravel deposits built up along the southern margin. Overlying these channels is a veneer of sediment filling most of the space between the exposed bedrock up to 2m in depth. These have an undulating surface and appear to have eroded the upper surface of the underlying channel deposits.


CA 2021
CA 2020
CA 2019
CA 2018
CA 2017
CA 2016
CA 2015
CA 2014
CA 2013
CA 2012
CA 2011
CA 2010
CA 2009
CA 2008
CA 2007
CA 2006
CA 2005
CA 2004
CA 2003
CA 2002
CA 2001
HA 3001
HA 3004
HA 3005
HA 3006
Killeagh
Mogeely
Midleton
Castlemartyr
Ballymacoda
Saleen
Shanagarry
Ballycotton
Churchtown South
73 m
89 m
Legend
Redbarn Route
Claycastle Route
Ballinwilling Route
Previous Coring
Proposed Coring Locations
Previously Mapped Palaeochannels
Quaternary Infilled Features highlighted in report (m thickness)
2
3 - 4
5 - 6
7 - 8
9 - 18
Bathymetry (m LAT)
1.26
-81.9
N
0
5km
© Crown copyright and database rights 2018 Ordnance Survey 0100031673
Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).
Cotswold Archaeology marine
Andover 01264 347630
Cirencester 01285 771022
Exeter 01392 826185
Milton Keynes 01908 564660
w www.cotswoldarchaeology.co.uk
e enquiries@cotswoldarchaeology.co.uk
PROJECT TITLE
Celtic Interconnector
FIGURE TITLE
Distribution of palaeochannels and / or infilled basins discussed in report
DRAWN BY MJG (UoS)
CHECKED BY RP
APPROVED BY MW
PROJECT NO 770617
DATE 30/01/2018
SCALE@A3 1:125,000
FIGURE NO. 29

CA2004

4.74. This feature is aligned north-west to south-east and contains a palaeo-channel following the gap between bedrock exposed on the seabed. The channel fill has some internal reflectors suggesting some banding of coarser grained sediments. Overlying the channel fill is a wider veneer of sediments covering the entire space between exposed bedrock between 1 and 2m deep.

CA2005

4.75. This feature shows an area where near-surface sediments exceed 2m, with a clearly defined basal seismic reflector up to 8m below the seabed. The survey lines show the bedrock close to the seabed surface in the northern part of the area resulting in a series of shallower fills, with no exposure of bedrock at the seabed surface.

CA2006 & CA2007

4.76. Two distinct depressions aligned north-south (**CA 2006**) and east-west (**CA 2007**) are visible, divided by a sub-seabed bedrock ridge. Both contain an undulating rock base with no internal reflectors in the depression fills. The relationship of **CA 2006** to **CA 2005** is unclear from the available datasets.

CA2008

4.77. The presence of a near-parallel, probably planar, surface beneath seabed sediments, up to 3m in thickness. There are some reflectors in the near-seabed deposits that might suggest some stratification within these sediments, with deeper deposits possibly being glacially-derived earlier Pleistocene.

CA2009

4.78. An intermittent deep reflector was observed in all neighbouring survey lines. This suggested a possible channel up to 13m deep possibly orientated north-east to south-west. Where a seismic reflector could be identified, it suggests an undulating basal profile. It was not possible to distinguish the nature of the overlying sediments within the available seismic data, or if any higher separate facies were present.

CA2010

4.79. An intermittent seismic reflector was only visible in a survey line from the eastern side of this corridor. This suggests a possible depression, up to 8m deep, and could represent a laterally more extensive feature similar to **CA 2009**. It was not possible to distinguish either the nature of the overlying sediments in the available seismic data, or any higher separate facies.

CA 2011 & CA 2012

4.80. **CA 2011** shows a meandering palaeo-channel that originates on the southern edge of **CA 2012** and passes south between exposed bedrock, before turning eastwards and then southwest. The channel profile suggests a channel base gradient southward, reaching up to 4m below the seabed. An upper seismic reflector is visible showing a laterally persistent seismic impedance zone.

4.81. **CA 2012** is a laterally more extensive depression which may be part of a wider channel area. Similar to **CA 2011** it has two facies visible in the seismic data, though this depression reaches depths of up to 7m.

CA 2013

4.82. This contains a wide east-west orientated area of multiple seismic reflectors between areas of bedrock exposed on the seabed. The profile suggests a possible channel with a build-up of probable sand / gravel on the margins, possibly indicating a prograding channel system. In the centre of the area a later phase of channelization might also be evident, possibly implying basal Pleistocene deposits with later, probably early Holocene, channel incision.

CA 2014

4.83. A pair of depressions is visible in the seismic survey, up to 3m deep, beneath an area of raised seabed. These features are not present in the western side of the survey corridor where the seabed is c. 2-3m lower. This might be interpreted as earlier bedforms buried beneath the present seabed surface, which consists of east-west aligned ripple bedforms in north-south aligned longitudinal ribbons. Alternatively, shallow, wide channel areas might be preserved here beneath the area containing raised bedforms, but these may have been eroded where the seabed is lower to the west. The seismic profiles show sands overlying what is likely to be finer-grained sediments in the depressions themselves. The base of the depressions appears to be smooth with poor reflectance, probably indicating that this is not a bedrock surface.

CA 2015

4.84. A clearly defined east-west palaeo-channel is visible, which deepens along its southern edge.

CA 2016

4.85. A clearly defined east-west palaeo-channel is visible, with a flat basal profile, a curved boundary on its southern edge and a more gradual profile on the northern side. Some parallel reflectors are visible within the channel fill.

CA 2017

4.86. This feature is poorly defined within the seismic data but shows a zone of sub-surface features that may be dunes or other elongated bedforms, as currently exposed on the seabed between **CA 2017** and **CA 2016**. The area is covered by east-west orientated ripples in an area of elevated seabed.

CA 2018

4.87. This area is characterised by a series of deep incisions, up to 13m, of the bedrock surface. Internal reflectors suggest zones of coarser-grained sediments, particularly in the northern sector of this area. There appears to be an erosive upper surface below the seabed. A series of sinuous erosion features are present in the adjacent exposed bedrock, which suggests channels flow into **CA 2018**, implying that this is possibly part of a more extensive channel complex that may extend up to **CA 2021**.

CA 2019

4.88. This feature is located north of **CA 2018** and shows a series of northward-dipping reflectors. These may indicate a pro-grading channel system of sands and gravels, with the main channel present in the centre of the area.

CA 2020

4.89. This feature is located north of **CA 2020** and may also represent a continuation of the channel system found in **CA 2018** and **CA 2019**. A pair of dipping reflectors appear to show the margins of a channel, up to 6m deep, in the centre of this area.

CA 2021

4.90. This area contains a south-dipping seismic reflector that probably marks the northern limit of the system visible in **CA 2018** to **CA 2020**.

Geophysical anomalies from the Irish territorial limit out to the Irish/UK median line

4.91. Analysis of the marine geophysical datasets from the Irish territorial limit out to the Irish/UK median line identified 156 anomalies with archaeological potential (Headland Archaeology 2015). Other geophysical anomalies identified in the survey data consisted of isolated boulders that were assessed by the survey contractor as having no archaeological potential (Osiris 2014).

4.92. Of the 156 anomalies identified, no features of high archaeological potential were identified.

4.93. Five anomalies were identified as having medium archaeological potential (**HA2041, HA2051, HA2052, HA2067 & HA2082**; Fig. 30). Three of these medium anomalies were represented only in the SSS data (**HA2052, HA2067 & HA2082**), whilst **HA2041** consisted of a SSS anomaly that corresponded with magnetic anomaly **HA5049** (Fig.31), and **HA2051** consisted of a SSS anomaly that corresponded with bathymetric anomaly **HA4000** (Fig. 32).

HA2041

4.94. An irregularly shaped raised reflector with an associated high magnetic signal of 1,617.26nT (**HA5049**). It measures 7.09 x 1.80m and stands up to 1.05m above the surrounding seabed. It is located 232m east of the proposed cable centre. The feature may be representative of the partially exposed hull of a wreck and is therefore assigned medium archaeological potential.

HA2051

4.95. Large area of raised seabed, 35m long and up to 15m wide, with a maximum height of 1.51m above the surrounding seabed. The feature exhibits some evidence of complex structure at the perimeters, is clearly visible in the 2m binned bathymetry (**HA4001**) and, despite lacking a magnetic return, may represent a wreck site. The feature is situated 220m west of the proposed cable centre. Another feature exhibiting complex morphology is located 28m to the north and maybe associated (**HA2052**).

HA2052

4.96. A small area of complex reflectors and shadow in the vicinity of a possible wreck (**HA2051**). The largest element is 0.74 x 0.37m and stands 0.29m above the surrounding seabed. It is situated 28m to the north of **HA2051**, a possible wreck. There are no magnetic anomalies associated with this feature.

HA2067

4.97. A significant distribution of hard reflectors, shadows and scour over a 20m x 12m area. The feature contrasts with the numerous and common rock outcrops seen across the study area, and may represent a concentration of anthropogenic material, possibly wreck. The feature is 124m west of the proposed cable route centre.

HA2082

4.98. A complex, discrete area of reflectors and shadows over a 10 x 7m distance, contrasting with the morphology of rock heads and boulder clusters seen elsewhere in the study area. The feature is interpreted as being likely to represent a concentration of anthropogenic material that will require further investigation to understand in more detail and is therefore ascribed medium archaeological potential. **HA2082** is located 32m west of the proposed cable centre line.

4.99. The remaining 151 geophysical anomalies from the Irish territorial limit out to the Irish/UK median line were identified as having low archaeological potential and are not discussed further.

Submerged palaeo-landscapes from the Irish territorial limit out to the Irish/UK median line

4.100. A review of the SBP seismic survey data has identified seven areas (**HA3001-HA3007**; Fig. 33) where features with archaeological potential are present along the Irish EEZ out to the Irish/UK median line.

HA3001-HA3002

These two features have been cut into the bedrock. The data suggest that they are in-filled with marine sediment. However, it is possible that pre-inundation units associated with the relict fluvial channel could survive but they have not been resolved by the geophysical survey.

HA3003-HA3006

4.101. These features are likely to be representative of the same two channel features extending across both legs of the inshore cable route options, based on their similar morphology and positions. They exhibit a more complex sequence of channel cuts and fills within a larger and deeply incised channels, with **HA3006** being approximately 300m in diameter.

HA3007

4.102. This feature is a deep channel approximately 4.7km in width and is infilled with a main sedimentary unit above the channel base which is at a depth of up to 30m. This unit is overlain by gravels and then marine sands, which are continuous across the remaining extent of this part of the study area. Within the deep channel feature these upper units vary in depths, with some nested channels reaching up to 10m below seabed.

Summary

4.103. To summarise, the analysis of the marine geophysical survey data identified 12 geophysical anomalies in Irish territorial waters (Cotswold Archaeology 2018a), only one of which is a probable wreck (**CA1001**) of high archaeological potential. Of the remaining eleven anomalies, nine are considered of medium potential (**CA1002-9**, **CA1011**) and the remaining two are considered of low potential (**CA1010 & CA1012**).

4.104. 156 geophysical anomalies were identified from the Irish territorial limit out to the Irish / UK median line, none of which are considered to be of high potential. Five of the anomalies are considered to be of medium potential (**HA2041, HA2051, HA2052, HA2067 & HA2082**), while 151 are considered of low archaeological potential.

4.105. A review of the SBP seismic survey data in Irish territorial waters identified 21 areas with features of archaeological potential. Eight palaeo-channels are located along the Ballinwilling Strand corridor, and ten are located along the Claycastle / Redbarn corridor. Along the Claycastle route there is high potential for a nearshore submerged channel system that may contain deposits with archaeological potential. These are likely to comprise submerged peats or estuarine deposits, which would correspond with the inter-tidal submerged forest peat deposits found at the Claycastle landfall site.

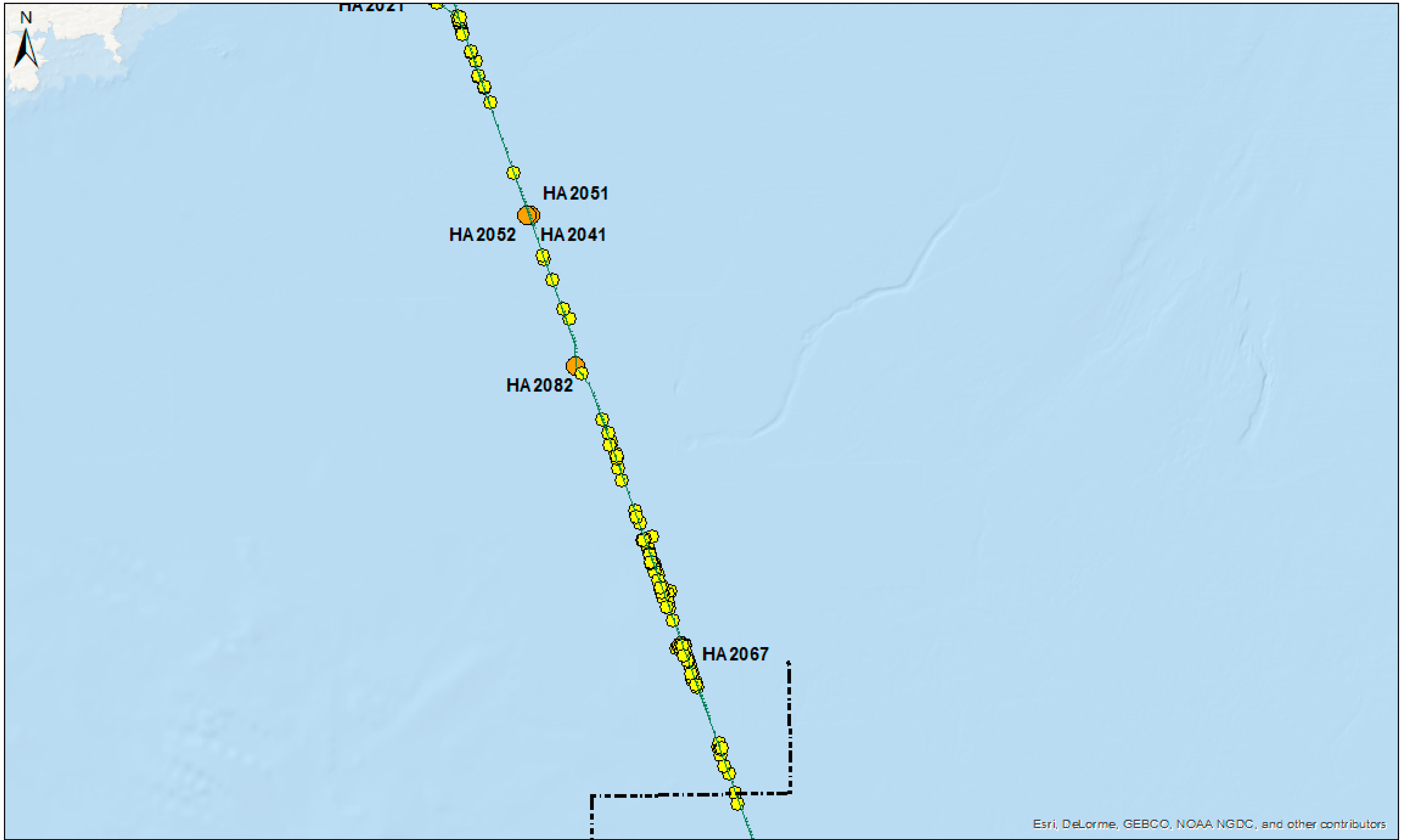
4.106. Previous assessments of glacio-marine deposits associated with some of the offshore palaeo-channels have suggested that the deposits are pre-Holocene and are therefore of low archaeological potential. The cores taken from palaeo-channels identified previously indicate that these channels are of low archaeological potential.

4.107. A review of the SBP seismic survey data from the Irish territorial limit out to the Irish / UK median line identified seven areas with features of archaeological potential. All seven areas have been interpreted as palaeo-channels that intersect the CSC in several locations and extend beyond the data area.

4.108. Relative to the length of the route in Irish territorial waters, the density of geophysical anomalies identified along it is sparse, so the potential to encounter unknown archaeological sites and features is considered low.

4.109. The potential to encounter unknown archaeological sites from the Irish territorial limit out to the Irish / UK median line is also considered low. Although there was a density of geophysical anomalies along this part of the route, they mostly represented featured of low archaeological potential. Furthermore, no wrecks were confirmed in the geophysics.

APPENDIX VI OFFSHORE TARGETS AS THEY RELATE TO PROPOSED BOREHOLES



Legend

Side scan sonar anomalies

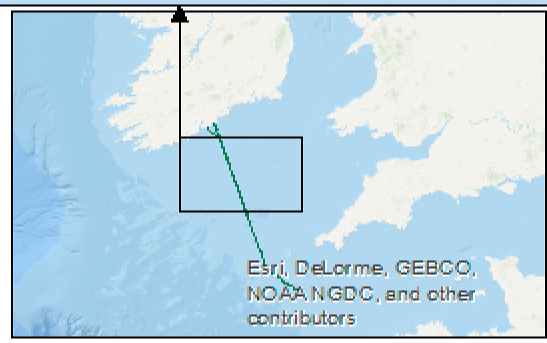
- Low
- Medium
- Planned cable route
- UK/Irish Median

Ireland France Interconnector

0 13,000 26,000 52,000 Meters

0 5 10 20 Nautical Miles

Scale: 1:650,000



Maritime Archaeology 2015
National Oceanography Centre
Room W1/95
Southampton. SO14 3ZH.

HEADLAND ARCHAEOLOGY
Headland Archaeology 2015
13 Jane Street
Edinburgh
EH6 5HE

Date: 26/03/2015
Chart produced by: MA Ltd.
Ref: 1863_19

FIGURE 30
Side scan sonar anomalies from Irish territorial limit out to the Irish / UK median

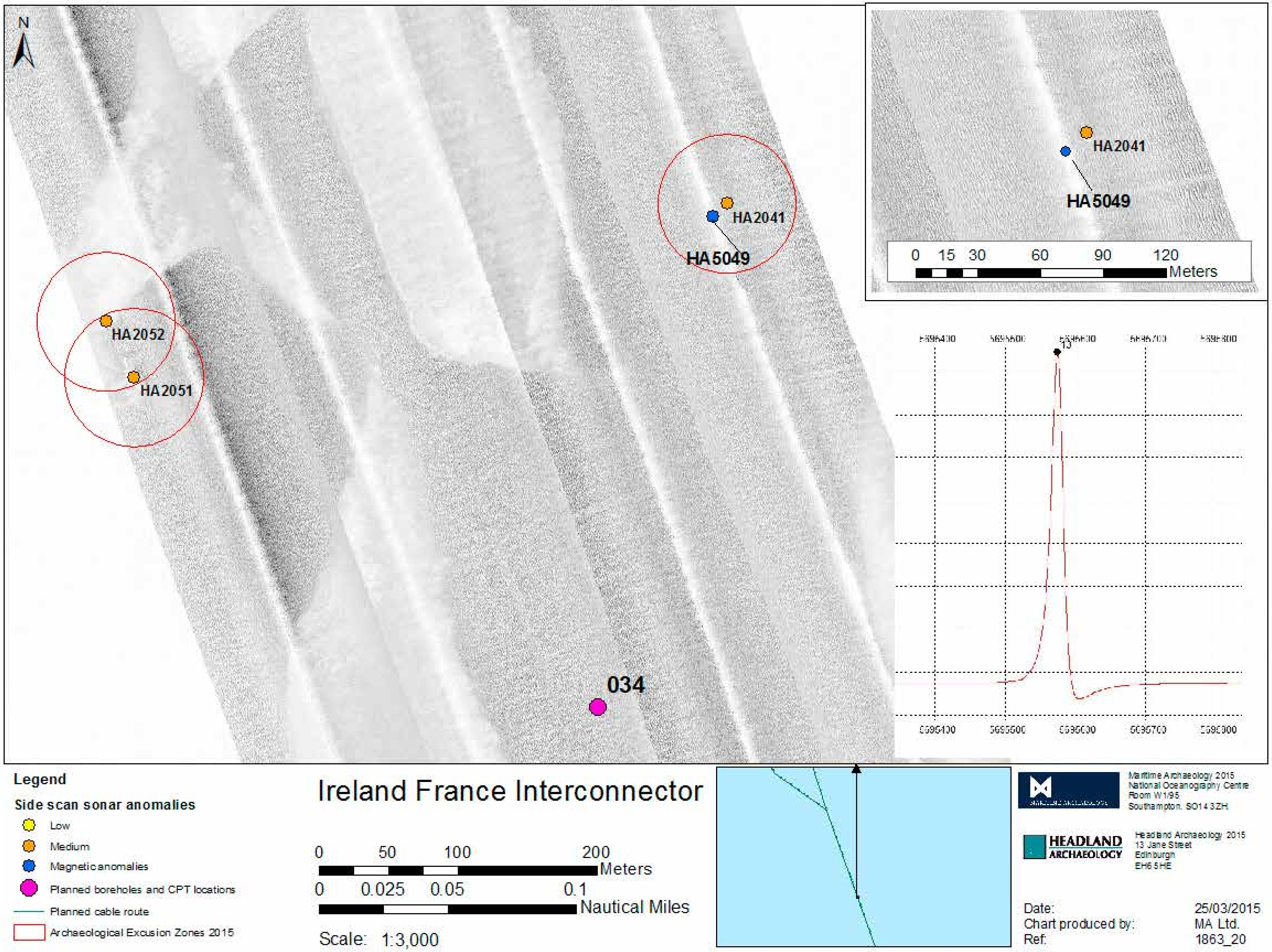
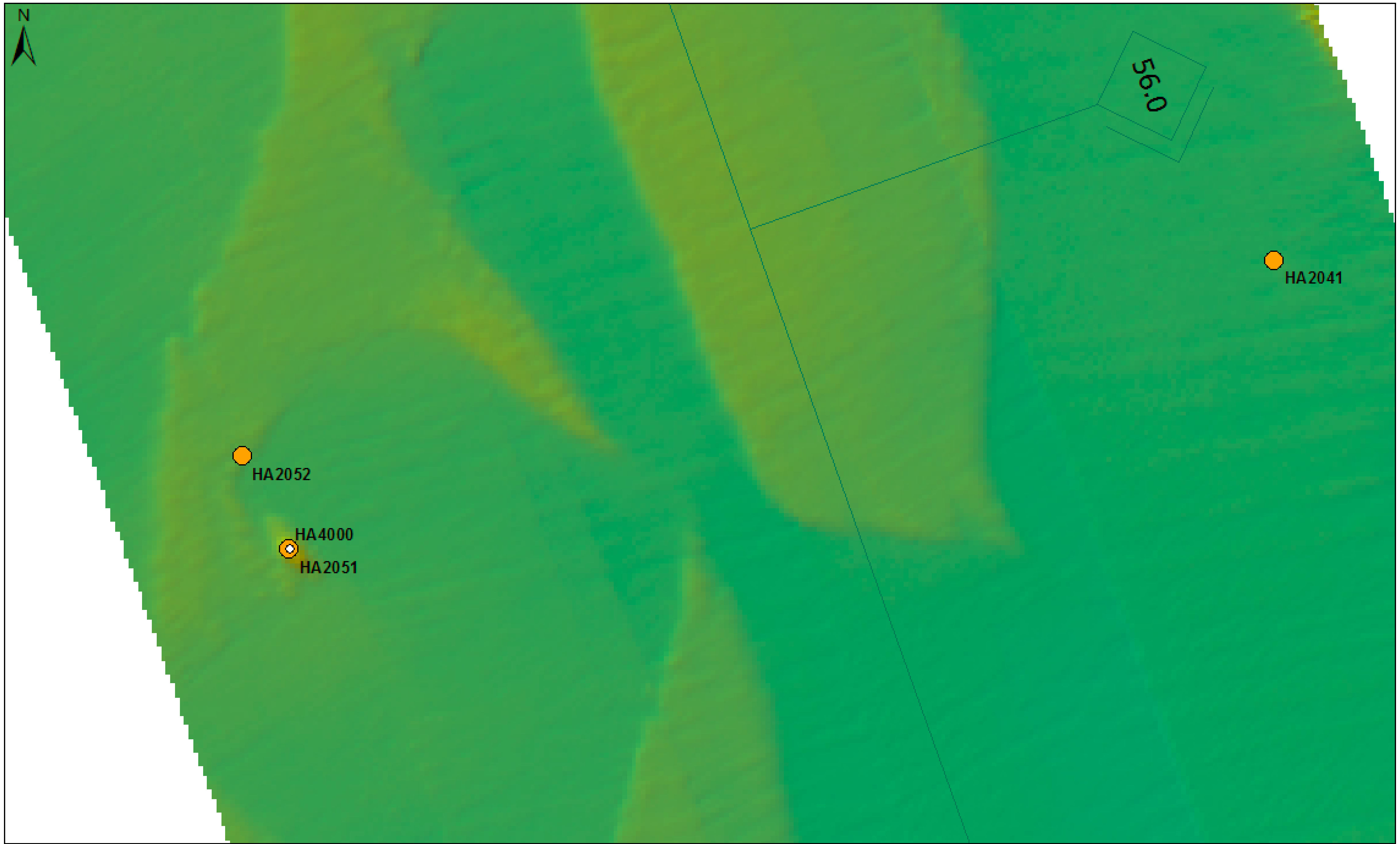


FIGURE 31
Magnetic anomaly HA5049 with a high amplitude of 1,617nT, and which correlates with side scan anomaly HA2041



Legend

- Bathymetry anomalies

Side scan sonar anomalies

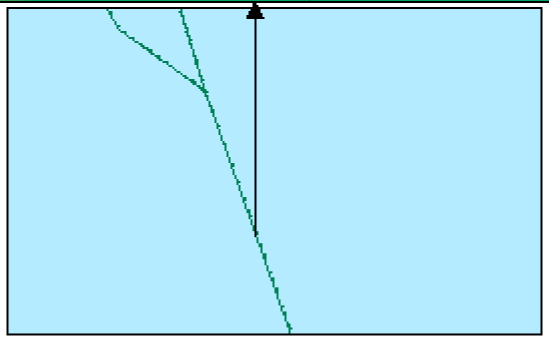
- Low
- Medium
- Planned cable route

Ireland France Interconnector

0 40 80 160 Meters

0 0.0175 0.035 0.07 Nautical Miles

Scale: 1:2,000



Maritime Archaeology 2015
National Oceanography Centre
Room W1/95
Southampton. SO14 3ZH.

HEADLAND ARCHAEOLOGY

Headland Archaeology 2015
13 Jane Street
Edinburgh
EH6 5HE

Date: 26/03/2015
Chart produced by: MA Ltd.
Ref: 1863_23

FIGURE 32

HA4000, a discrete raised feature that correlates with HA2051 and is interpreted as medium archaeological potential

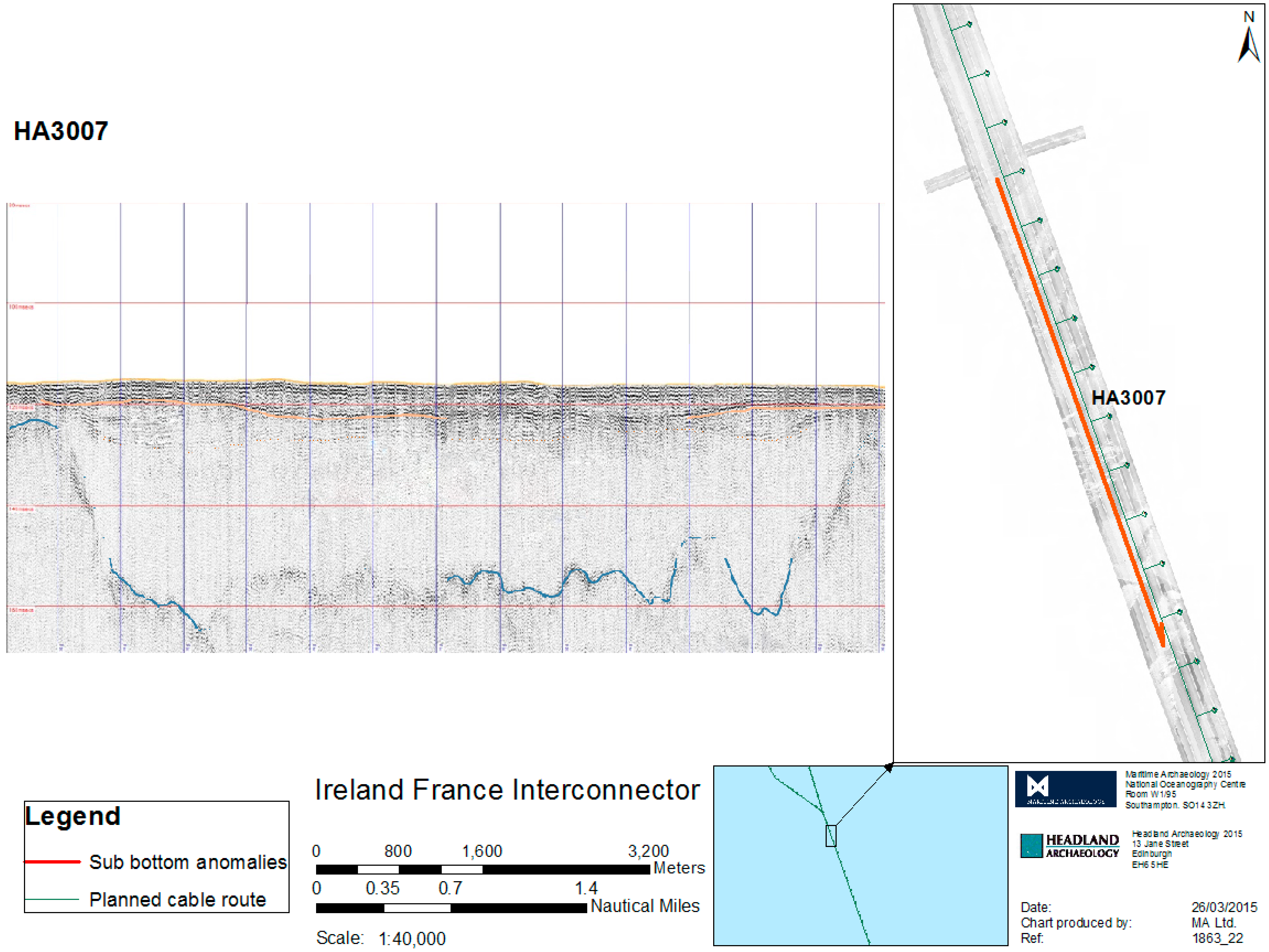


FIGURE 33

Cross-section of feature HA3007, comprising a 4.7km wide channel identified just beyond Irish territorial waters

Geotechnical investigation results

4.110. Archaeological assessment has been undertaken of three geotechnical investigations, including Irish territorial waters and the proposed landfall locations (Cotswold Archaeology 2019a), a hand auger survey of peat deposits at Claycastle beach (Cotswold Archaeology 2019b), and from the Irish territorial limit out to the Irish / UK median (Wessex 2016).

Irish territorial waters

4.111. A total of 85 nearshore and foreshore investigations were undertaken, ranging in elevation height from 11m to -83m LAT, in Irish territorial waters and at the proposed landfall locations (refer back to Fig. 4 & Fig. 34; Table 13) (Cotswold Archaeology 2019a). 12 of the 85 investigations were undertaken at the three landfall locations (Ballinwilling Strand, Redbarn beach and Claycastle beach) monitored by IAC Archaeology (2018; Table 13).

4.112. The assessment of the marine vibrocore logs from the 2018 geotechnical investigations (Cotswold Archaeology 2019a) identified the following broad stratigraphic units within the cores:

- Marine sand with shell;
- Gravels and sand; and
- Compacted, probably over-consolidated, glacially-derived deposits including diamictons, clays and sub-glacial/outwash sand horizons.

4.113. No peats or possible palaeosol horizons were identified in either the marine vibrocores or the core photos and were not alluded to in the sediment logs. The predominance of marine and glacial deposits suggests that these cores have low geo-archaeological potential and would therefore not require any geo-archaeological recording to assess palaeo-environmental potential.

Table 9 Site investigation locations 2018

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-BH-1 *	570265	5746647	6.73
BW2-BH-2 *	570282	5746588	-0.37
BW2-BH-3	570308	5746478	0.47

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-CPT _ VC-1	570565	5745468	-7.67
BW2-CPT _ VC-2	570861	5744335	-15.21
BW2-TP1 *	570276	5746622	0.67
BW2-TP2 *	5701291	5746565	-0.87
BW2-VC-03	571125	5742899	-22
BW2-VC-04	571384	5741478	-30
BW2-VC-04A	571370	5741484	-30
BW2-VC-05	571216	5740019	-37
BW2-VC-05A	571212	5740030	-37
BW2-VC-06	570672	6738649	-43
BW2-VC-07	569960	5737329	-44
BW2-VC-07A	569976	5737337	-45
BW2-VC-08	569690	5736341	-51
BW2-VC-08A	569697	5736346	-51
BW2-VC-09	569934	5735736	-56
BW2-VC-10	571694	5733975	-63
BW2-VC-10A	571696	5733990	-64
BW2-VC-11	572695	5732677	-67
BW2-VC-12	573710	5731495	-72
BW2-VC-12A	573696	5731498	-72
BW2-VC-13	574690	5730363	-76
BW2-VC-14	575680	5729235	-80
BW2-VC-14A	575667	5729236	-79
BW2-VC-15	576671	5728105	-80
BW2-VC-15A	576672	5728122	-81
BW2-VC-16	577661	5726978	-79
BW2-VC-16A	577661	5726991	-80
BW2-VC-17	578648	5725853	-80
BW2-VC-18A	579520	5724639	-83
CL-BH-1 *	578387	5754308	3.33
CL-BH-2 *	578432	5754258	0.57

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
CL-BH-3	578496	5754176	-0.37
CL-CPT _ VC-2	579848	5752527	-6.97
CL-CPT _ VC-3	580198	5752043	-9.99
CL-CPT_VC-1	579150	5753381	-2.41
CL-CPT_VC-1A	549145	5753381	-2.41
CL-TP1 *	578396	5754300	2.19
CL-TP2 *	578440	5754248	0.73
CL-VC-02	579850	5752523	-7
CL-VC-04	581068	5750805	-19
CL-VC-05	581605	5749403	-28
CL-VC-06	582128	5748005	-31
CL-VC-07	582686	5746622	-34
CL-VC-08	583224	5745213	-38
CL-VC-09	583876	5743864	-47
CL-VC-10	584605	5742559	-55
CL-VC-11	585334	5741240	-62
CL-VC-11A	585338	5741252	-62
CL-VC-12	585963	5739899	-70
CL-VC-12A	585985	5739902	-70
CL-VC-13	586010	5738424	-70
CL-VC-13A	586017	5738432	-70
CL-VC-14	585566	5736988	-71
CL-VC-14A	585582	5736997	-71
CL-VC-15	584999	5735629	-74
CL-VC-16	584413	5734225	-77
CL-VC-16A	584411	5734234	-77
CL-VC-17	583827	5732859	-75
CL-VC-17A	583849	5732857	-75
CL-VC-18	583306	5731435	-78
CL-VC-18A	583317	5731444	-79
CL-VC-19	582793	5730032	-80

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
CL-VC-19A	582807	5730041	-80
CL-VC-20	582268	5728624	-80
CL-VC-20A	582280	5728632	-80
CL-VC-21	581747	5727218	-80
CL-VC-21A	581739	5727227	-80
CL-VC-22	581231	5725809	-80
CL-VC-23	580710	5724399	-82
CL-VC-23A	580722	5724409	-82
CL-VC-23B	580709	5724399	-82
CL-VC-24	580359	5723405	-82
CL-VC-24A	580374	5723413	-83
RB-BH-1 *	577557	5753240	4.2
RB-BH-2 *	577621	5753202	-0.05
RB-BH-3	577819	5753080	-0.53
RB-BH-4	577795	5753003	-0.07
RB-CPT _ VC-1	578504	5752678	3.1
RB-CPT _ VC-2	580009	5751736	11.03
RB-TP1 *	577581	5753228	1.61
RB-TP2 *	577683	5753162	-1.56
RB-VC-02A	580027	5751726	-15

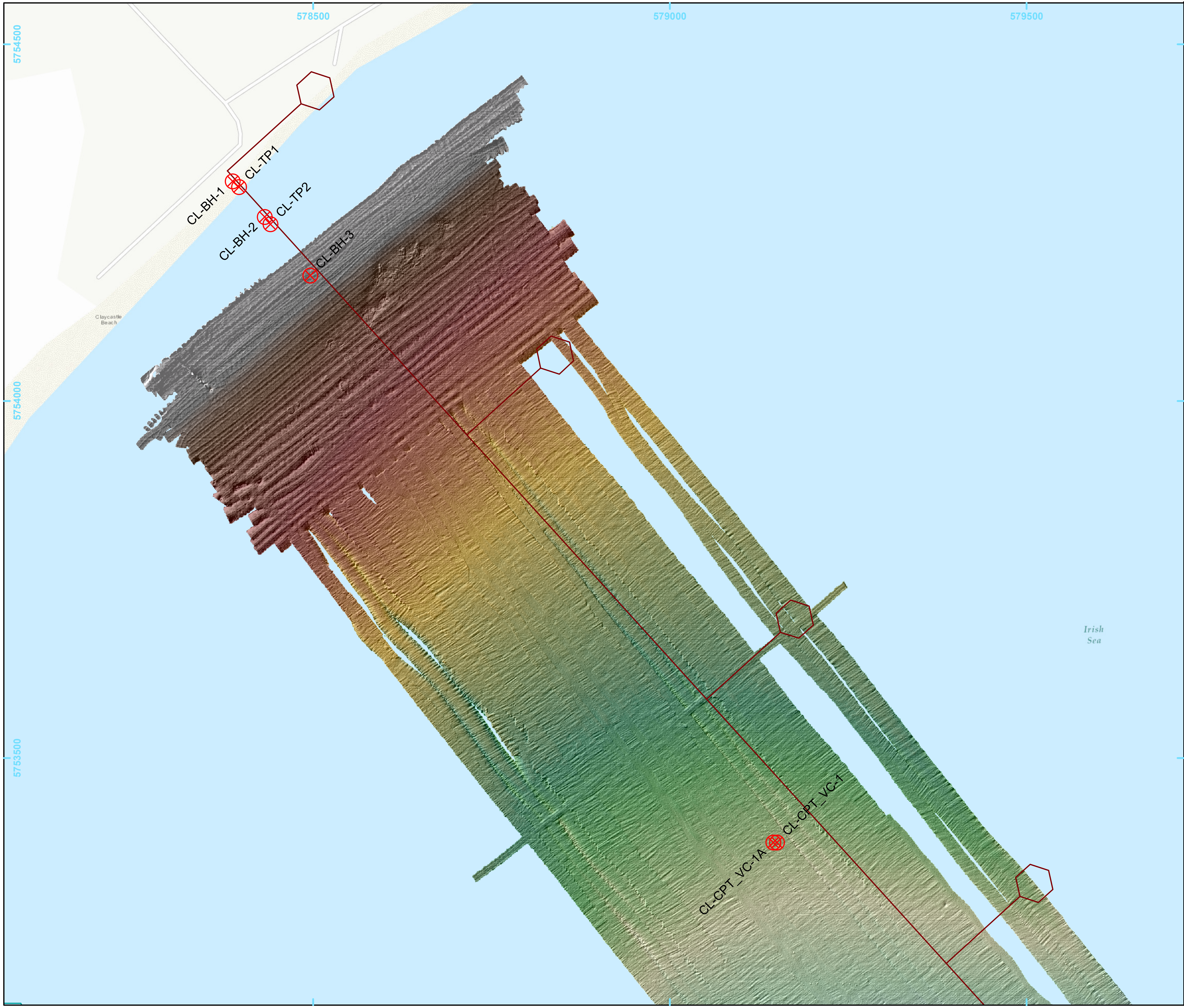
* monitored by IAC Archaeology

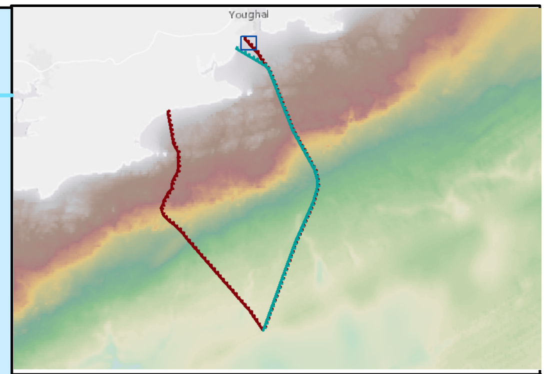
4.114. The nearshore / foreshore cores were identified as having higher geo-archaeological potential. These demonstrated the presence of similar stratigraphic units as those identified in the marine cores, along with the presence of:

- Peat horizons (including the submerged forests identified at Claycastle (Cotswold Archaeology 2017)); and
- Estuarine clay.

4.115. The following cores were identified as having potential from the three landfall / nearshore sites:

- **BW2-BH3**
- **RB-CPT_VC-1**
- **CL-BH1**
- **CL-BH3**
- **CL-CPT_VC-1A**





Legend

- 2018 Sample Locations
- Redbarn Route
- Claycastle Route
- Ballinwilling route

Bathymetry (m LAT)
High : 1.41
Low : -3.12083

0 200m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

Cotswold Archaeology marine
Andover 01264 347630
Cirencester 01285 771022
Exeter 01392 826185
Milton Keynes 01908 564660
w www.cotswoldarchaeology.co.uk
e enquiries@cotswoldarchaeology.co.uk

PROJECT TITLE
Celtic Interconnector project

FIGURE TITLE
Geotechnical Site Investigations Claycastle

DRAWN BY	MJG (UoS)	PROJECT NO	17758	FIGURE NO.
CHECKED BY	MW	DATE	25/01/2019	34
APPROVED BY	xx	SCALE@A3	1:5,000	

Ballinwilling Strand

BW2-BH3

4.116. At 1.5 - 2.0m (-2.0 to -2.5m LAT) the geology is described (by Next GeoSolutions) as a 'red (2.5Y 4/8) CLAY with frequent plant remains (wood) and pockets of gravel. Plant remains are intact. Gravel is fine to medium, rounded'. This deposit may be comparable to the deposit recorded by IAC Archaeology (2018: 3.2.1; Plate 1) in BW2-BH1 where a 'very loose brown slightly clayey silty fine to medium sand with occasional medium to coarse sub-rounded gravel and occasional stains of organic matter' was encountered at 5.5-10.9m (1.23 to -4.17m LAT). Although this deposit was noted in the field it was, unfortunately, not recovered in the borehole and therefore no physical samples were retained to permit geo-archaeological assessment (Fig. 35).

Figure 35 Samples from BW2-BH3 (from Next GeoSolutions)

Redbarn beach

RB-CPT_VC-1

4.117. The geological description noted the presence of a thin peat recorded at 3.3 - 3.5m (-6.4 to -6.6m LAT) overlying probable Till. The core photographs, however, do not show the presence of a peat horizon. Next GeoSolutions account for this discrepancy by stating that the only organic matter encountered was related to smears of clayey organic matter on the walls of the SPT sampler (Fig. 36). The core was therefore deemed to have no geo-archaeological potential.

Figure 36 Samples from RB-CPT-VC-1 (from Next GeoSolutions)

Claycastle beach

CL-BH1

4.118. At 4.5 - 6.0m the geological description (supplied by Next GeoSolutions) was of a 'dense dark brown (7.5YR 3/4) to black (10 YR 2/1) slightly gravelly, slightly sandy PEAT with frequent decayed plant material'. This peat deposit is part of the submerged forest located on the foreshore (Cotswold Archaeology 2018b) and was monitored by IAC Archaeology (2018; 3.4.1).

4.119. All the material from 4.5 - 5.0m in Shelby tube P4 was used for geotechnical testing purposes; the only retained sample from 5.0 - 5.45m consisted of a deposit described as sands with organic matter within SPT4. There was no sample recovery at 5.5 - 6.0m, but the next sample recovered, at 6.0m, contained no evidence of peat, thus providing a maximum potential depth for the base of the peat (of 6m) and a thickness of up to 1.5m (Fig. 37).

CL-BH2

4.120. This core was taken adjacent to the known exposure of the submerged forest and was also encountered in CL-TP2 (see IAC Archaeology 2018). The recorded sequence was:

- 0.00 - 0.90m: Loose brown (10YR 5/3) gravelly slightly silty fine to medium SAND. Gravel is fine to coarse and sub-angular to sub-rounded of various lithologies;

- 0.90 - 1.50m: Grey silty sand with pockets of silt with rare spongy pseudo-fibrous peat and pseudo-fibrous spongy plant and wood remains. Intense organic odour;

- 1.50 - 3.40m: Very loose grey (2.5Y 5/1) to olive brown (2.5Y 4/4), slightly silty fine to coarse organic SAND with amorphous and fibrous peat;

- 3.40 - 6.50m: Very soft grey (2.5Y 5/1) to greenish grey (GLEY1 5/1) slightly sandy silty CLAY. Between 4.50 - 5.00m a band of slightly gravelly slightly sandy clayey silt, and at 6.00m a light grey (10YR 7/2) slightly gravelly very sandy very silty CLAY. Gravel is fine to coarse, sub-rounded to sub-angular of mudstone.

Figure 37 Samples from CL-BH1 (from Next GeoSolutions)

4.121. The adjacent core (**CL-TP2)** confirmed that the peat deposit was between 0.25m and 1.80m, overlying sand with shell fragments. This could indicate that the peat represents an extension of the peat over previous riverine / marine sand deposits and could therefore potentially provide a useful Late Holocene sea level index point (SLIP). There was no sample retention of the peat deposits suitable for geo-archaeological recording.

CL-BH3

4.122. A further extension of the submerged forest was recorded, with a possible basal palaeosol preserved at the base of the sequence. The geological description (supplied by Next GeoSolutions) for the section of interest, 8.3 - 9.1m (-7.9 to -8.7m LAT), was:

- 8.30 - 8.50m: Black (10YR 2/1) spongy clayey fibrous PEAT;
- 8.50 - 8.80m: Firm grey (2.5 5/1) soft (12 kPa) very gravelly very sandy CLAY with blocks of pseudo-fibrous spongy plant remains;
- 8.80 - 9.10m: Reddish brown (2.5YR 4/3) slightly silty slightly clayey very gravelly fine to medium SAND. Gravel is fine to coarse, sub-rounded to rounded meta-sandstone (low grade) quartz and flint.

4.123. The samples from this core that were available for the depths of interest were limited to 8.20 - 8.50m and 8.80 - 9.00m (Fig. 38); the remainder were either destructively tested or not retained. The core photos do not show a distinct peat horizon; Next GeoSolutions confirmed that the only rare evidence of spongy clayey fibrous peat was encountered at about 8.3m.

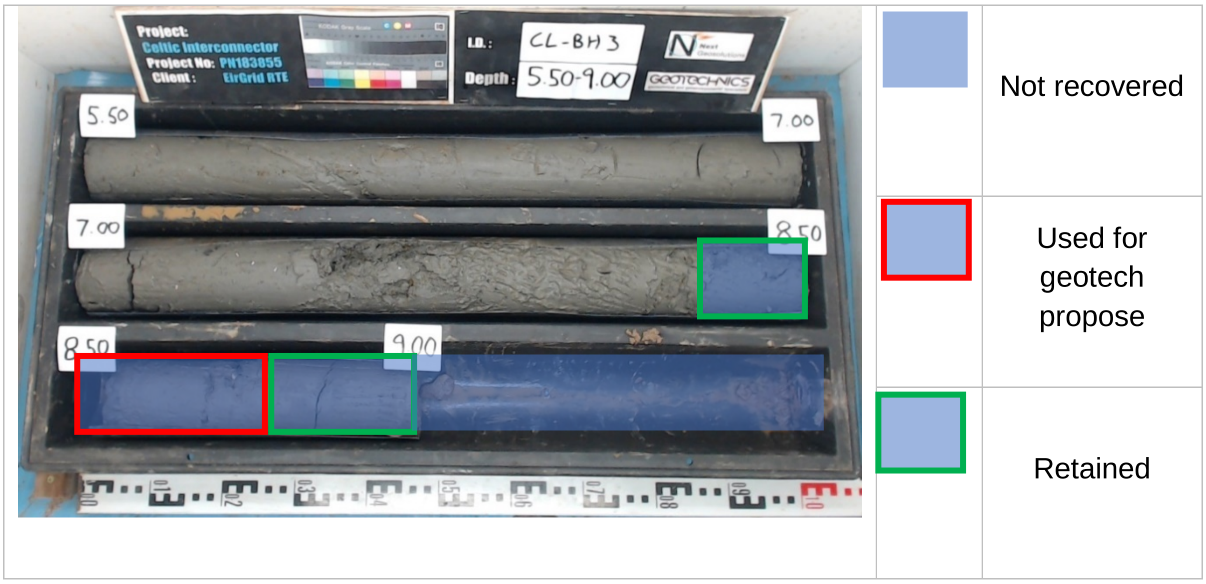


Figure 38 Samples from CL-BH3 (from Next GeoSolutions)

CL-CPT_VC-1A

4.124. The geological logs recorded clays with shells and occasional organic matter at 1.6 - 5.5m (-4.0 to -7.9m LAT). Next GeoSolutions confirmed that there was no evidence of peat present and only occasional evidence of amorphous organic matter was highlighted. This core appears to contain a series of clays representing estuarine deposits (Fig. 39). Core **CL-CPT_VC-1**, immediately adjacent to this vibrocore, contained a similar sedimentary sequence.

4.125. The DBA and updated descriptions from Next GeoSolutions, resulted in the identification of four core sections from Claycastle beach where sediment was retained that might hold palaeo-environmental potential:

- CL-BH1: 5.00-5.45m;
- CL-BH3: 8.20-9.00m;
- CL-CPT-VC1A 1.6-2.5m; and 3.50-4.50m

4.126. These cores sections were sent to CA for geo-archaeological recording. The results have been tabulated and are presented below (Tables 10, 11 & 12)

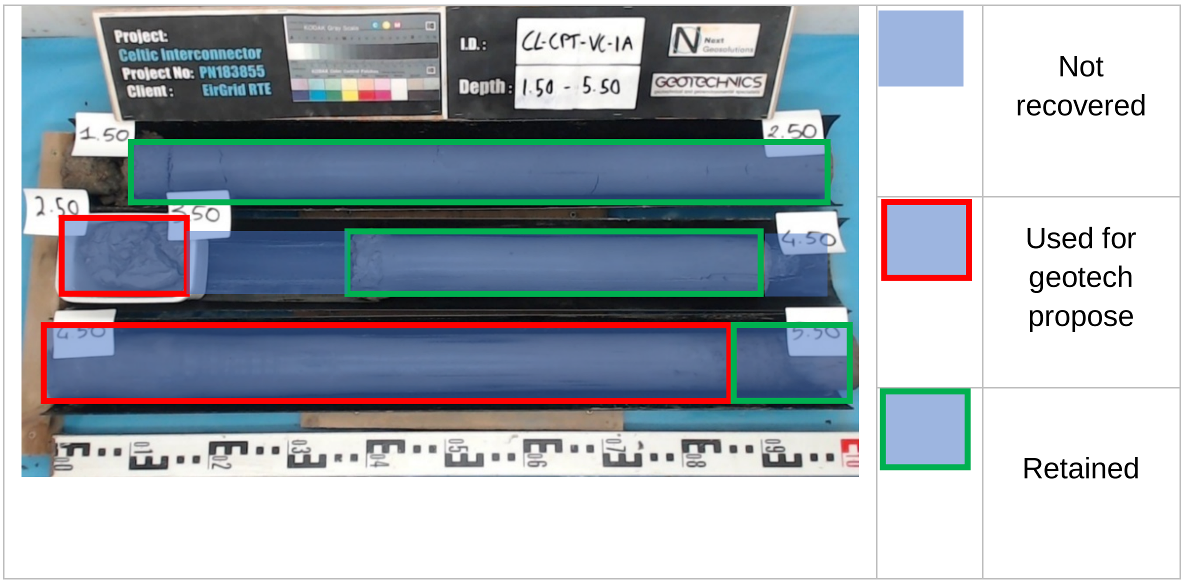


Figure 39 Samples from CL-CPT_VC-1A (from Next GeoSolutions)

Geoarchaeological recording results

4.127. Geoarchaeological descriptions of the samples from each of the three core samples are provided below.

CL-BH1: 5.00 - 5.45m

4.128. A single bulk sample was obtained and confirmed the presence of a woody peat. The elevation of the peat suggests it is probably an onshore extension of the submerged forest deposits encountered on the foreshore and observed in CL-BH2 and CL-TP2 (see IAC Archaeology 2018). The sample may be suitable for an assessment of the waterlogged plant remains but would be of little use for other techniques such as pollen as the sample only represents a single bulk sample.

Table 10 Geoarchaeological description of CL-BH1

Depth in core	Depth (m LAT)	Description	Interpretation
5.00 - 5.45m	-1.67 to - 2.12m	10YR 1/1 peat, some fibrous ?root remains and also small wooden ?twigs.	Peat

CL-BH3: 8.20 - 9.00m

4.129. The core sections available represent an estuarine deposit overlying a probable Late Pleistocene Glacial Till. The estuarine deposit was only sampled between 8.20 - 8.50m but contained distinct laminations which may relate to rhythmite deposition within a saltmarsh or mudflat environment. Broken shell could point towards the nearby presence of a channel with higher flow rates leading to the deposition of broken shell during periods of flooding. The base of the sequence, which could indicate a transgressive surface, was not sampled. The core, however, might have palaeo-environmental potential for understanding the environment of deposition associated with the deposits at 8.20 - 8.50m, especially if the organic material within the core is suitable for radiocarbon dating.

Table 11 Geoarchaeological description of CL-BH3

Depth in core	Depth (m LAT)	Description	Interpretation
8.20 - 8.50m	-5.57 to - 8.87m	10YR 7/3 No mottles silty clay, finely laminated, stoneless, broken shell at 8.28 and 8.43m, 1-2%, organics, slightly laminated but not full core width, at 8.28, 8.33, 8.37, 8.43, 8.46, 8.51 and 8.57m. Base not reached	Estuarine deposit
8.50 - 8.80m	-8.87 to - 9.17	GAP	
8.80 - 9.00m	-9.17 to - 9.37	10YR 5/4 1-2% fine mottle, very dense (?over consolidated) 10YR 6/6 clay, finely laminated, sub-rounded to rounded / tabular stones, 10-40mm, very slightly stony, no shell, no organics, base not reached	Possible Glacial Till

CL-CPT-VC1A 1.60 - 2.50m and 3.50 - 4.50m

4.130. The top and base of the 1.60 - 2.50m section was not marked, so it is assumed that the coarser sand-rich horizon is the top of this core section. This is supported by the fact that the underlying Shelby sample is composed of clay with no sand inclusions.

4.131. The core contained a long estuarine sequence, although the base of this sequence was not reached. The coarsening of the grain size in the core suggests a transition towards a higher energy environment and the proximity of channels and / or the littoral zone. The basal clays are likely to represent intertidal environments.

4.132. The presence of intact bivalve molluscs in this deposit suggests a low energy environment and could also be diagnostic, relating to establishing the indicative elevation of this deposit, as well as providing good potential for radiocarbon dating.

4.133. Overlying organics are likely to reflect saltmarsh or reedbed deposits. Some organics could be dated if deemed appropriate taphonomically (i.e. not roots). This core provides the potential to date the change in estuarine conditions which might provide a palaeo-landscape context for the onshore submerged forest.

4.134. If dating is successful, this core could also provide a sea level record if coupled with foraminifera, diatom and pollen assessments.

Table 12 Geoarchaeological description of CL-CPT-VC1A

Depth in core	Depth (m LAT)	Description	Interpretation
1.60 - 1.625m	-4.01 to - 4.035m	10YR2/1 No mottles, sandy silt loam, stoneless, small shell (<5mm), 1-2%, no visible organics, Abrupt boundary to:	Estuarine deposit
1.625 - 1.685m	-4.035 to - 4.095m	10YR4/1 No mottles, sandy clay, rounded tabular stones, slightly stoney, up to 15mm, bivalve shell (up to 8mm), 2%, no visible organics. Sharp boundary to:	Estuarine deposit
1.825 - 2.50m	-4.095 to - 4.91m	10YR4/1 No mottles, silt loam, stoneless (very rare), broken bivalve shell, 1.75, 2.26 and 2.38m. fine organics present at 2.14, 2.20m, with vertical rooting between 2.33-2.42m. Base not reached	Estuarine deposit
2.50 - 3.50m	-4.91 to - 5.91m	GAP	

Depth in core	Depth (m LAT)	Description	Interpretation
3.50 - 4.50m	-5.91 to - 6.91m	10YR 5/1 no mottles, clay, stoneless, intact bivalves up to 25mm, both horizontal and vertical orientation, but not articulated, 3.60-3.66 and 3.77m, 1% small organic at 3.52 and 3.75m. Base not reached	Estuarine deposit

Palaeo-environmental potential

4.135. The three cores subjected to geo-archaeological recording display good potential for understanding the Holocene palaeo-landscape of the Claycastle area. Onshore and offshore cores confirm the presence of estuarine deposits, which correlate with the channel area identified previously in the assessment of the marine geophysical survey data. The submerged forest deposits appear to extend from their intertidal exposures up to the location of **CL-BH1** and may be up to 1.6m in thickness (see Table 10).

4.136. Both the peat and estuarine deposits have the potential to provide material suitable for radiocarbon dating. Coupled with assessments of waterlogged plant remains, molluscs, pollen, diatoms and foraminifera, these cores could provide an important insight into the timing of marine transgression and regression in this area of southeast Ireland.

4.137. The geotechnical samples from **CL-CPT-VC1A** and **CL-BH3** provide sufficient material for an assessment of the changing sedimentary sequence. The sample from **CL-BH1** (coupled with **CL-BH2**) demonstrate the extent of the submerged forest but provide insufficient material for palaeo-environmental assessment.

Foreshore geotechnical investigations at Claycastle beach

4.138. A hand auger survey was conducted at Claycastle beach (Fig. 28; Cotswold Archaeology 2019b) to investigate further the exposed peat deposits (Cotswold Archaeology 2018a).

Previous research on Claycastle beach

4.139. Previous environmental research, conducted in 2001 by Delahunty (2002), investigated the peat deposits at Claycastle beach. Two core samples were taken from Ballyvergan Marsh and from Youghal Strand in order to investigate historical changes in local vegetation. The Youghal Strand Core (SC) was extracted in the area of interest, at 51° 56.020 N; 07° 51.545 W. The SC revealed almost two metres of peat deposit above sediments consisting of grey silt. The peat deposit was radiocarbon (^{14}C) dated and the deepest peat from the core was dated to c. 4,555 years before present (BP) (3488-3242 BC OxCal). Dates obtained from the SC were calibrated by using the OxCal 4.3 program with 95% probability (OxCal 2019; Table 13).

Table 13 Strand core (SC) 14C data (Delahunty 2002 fig. 3, appendix B).

Depth	Date C14 BP / ID	Date OxCal. 95%	Period
12cm	1920±35 N45297	2-210 AD	Iron Age
86cm	3115±35 N45298	1488-1281 BC	Middle Bronze Age
120cm	3870±34 N45296	2768-2210 BC	Early Bronze Age
180cm	4555±35 N45295	3488-3241 BC	Early Neolithic

4.140. The pollen diagram for the SC suggests that at Youghal the landscape was covered by woodland that formed more than 5,000 years ago amid a freshwater ecosystem inland of the Atlantic Ocean. The changing climate had a significant impact on the woodland cover; around the first century A.D., the landscape was possibly affected by flooding. Consequently, the local woodlands were submerged, and a brackish environment was created northward into the low-lying land (Delahunty 2002, 88).

Legend

N

- Auger
- Test pit
- Test pit and auger
- Machine test pit
- Youghal Strand Core 2002
- Exposed peat
- In phase peat extent (indicative)
- Quadrature peat extent (indicative)
- Auger survey peat extent (indicative)
- Cable Route
- 500m wide CSC

0 0.05km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Possible peat extents on Claycastle beach

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	22/05/2019	40
APPROVED BY	MTW	SCALE@A3	1:1,600	

Auger and test pits logs from Claycastle beach

4.141. The auger logs from **CL4002**, **CL4003** and **CL4011** provide a full sedimentary sequence (Table 14). The lowermost unit comprised grey (2.5Y 5/1) loose fine silt to medium sand deposit (the GREY SAND) with occasional bivalve shell fragments. This unit was overlain by a reddish-black (2.5Y 2.5/1) spongy fibrous silty peat deposit containing identifiable plant material. The well-preserved wood fragments and herbaceous plant remains indicate the presence of woodland and / or reed swamp communities in the past (see Delahunty 2002). The PEAT deposits recorded in these auger cores range in thickness from 0.85m to 1.20m. Overlying the PEAT was a brown (10YR 5/3) to yellowish brown (10YR 5/4) fine to coarse sand (the SAND) with occasional rounded gravel and cobbles of different lithology. See Figure 34 for a map of the potential extent of the peat on Claycastle beach. The extents of the peat are not conclusive: they are indicative points based on the presence of peat in the augers/test pits and on the geophysical results.

4.142. The majority of the TPs show that the SAND tends to become more coarse and gravelly lower down in the deposit. The SAND coverage in the areas of exposed peat, has probably been eroded by tidal action. Across the entire surveyed area, the SAND ranged in thickness from 0.05m to c. 2.70m. Nine bulk samples were taken from the three auger cores for possible palaeo-environmental analysis. No remains suggesting prehistoric human activity were encountered in the areas of exposed peat.

4.143. It is worth noting that the depth of SAND coverage increased in the landward TPs and auger holes. In test pit **CL4041**, the SAND deposit was c. 2.70m deep (Fig. 3), and no peat was recorded. It corresponds with data obtained from the trial pit log **CL-TP1** and borehole log **CL-BH2**, where the PEAT deposit was covered by c. 0.90m to c. 2.50m of the SAND sediments respectively. In borehole **CL-BH1**, situated next to the car park, the peat was recorded under 4.50m deep deposits of beach sand (IAC Archaeology 2018).

Summary

4.144. To summarise, with the exception of the exposed deposits, the peat is overlain by a fine to coarse sand which becomes more gravelly with depth (ranging from 0.05m to 2.70m). The peat deposit recorded in the auger cores range in thickness from 0.85m to 1.20m. However, according to the watching brief report by IAC

Archaeology 2018 the thickness of the peat across the site varies from 0.40m (**CL-TP1**) to 1.45m (**CL-TP2**).

4.145. The peat was recorded primarily in the area west of the proposed cable but was not encountered to the north-east of the CSC. This does not indicate that the peat is necessarily absent from these areas of the beach but may be buried deeper under the overlying sand.

Table 14 Auger and test pit logs

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4001	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Very few very coarse gravel (30 to 60mm).		Auger. End at 0.90m due to side collapse.
	0.40-0.70	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded).		
	0.70-0.90	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarser than unit above. Common cobbles (60 to 200mm) and few (<3%) bivalves shell fragments.		
CL4002	0-1.20	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. From c. 0.75m more humified, pseudo fibrous plant material, less wood visible. More compact at the bottom. Intense organic odour.	<1> 0-0.20; <2> 0.70-0.80; <3>1.00-1.20	Auger
	1.20-1.30	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose. Very few wood fragments (possibly contamination form above).		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4003	0-0.05	SAND	10YR 5/3 Brown	Fine to coarse loose sand.	<4> 0-0.15; <5> 0.60-0.70; <6>0.80-.90	Auger
	0.05-0.90	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. From c. 0.80m more humified, pseudo fibrous plant material. More reddish (2.5R 2.5/4 dark red) in colour and more compact towards the bottom. Intense organic odour.		
	0.90-1.00	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose. Few (<4%) bivalve shell fragments.		
CL4004	0-0.70	SAND	10YR 5/3 Brown	Fine to coarse loose sand. More gravelly towards bottom. Well rounded pebbles and cobbles (20-180mm).		Test pitted to c. 050m and augered to 0.90m. Abandoned due to sides collapsing.
CL4005	0-1.00	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Very few gravel, well rounded (20 to 60mm). More gravelly with depth.		Auger. End at 1.10m due to side collapse and gravel hard to drill.
CL4006	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pitted to c. 030m and augered to 0.60m. Abandoned due to sides collapsing.
	0.20-0.60	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded).		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4007	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. More gravelly towards bottom. Well rounded pebbles and cobbles (20-180mm).		Test pit to c. 0.50m and auger. Stopped at 1.20 due to sides collapse.
	0.40-1.10	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Few (<4%) bivalve shell fragments.		
	1.10-1.20	SAND	10YR 5/4 Yellowish brown	Fine to coarse loose sand. Few very coarse gravel (30 to 60mm).		
CL4008	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pit to c. 0.50m and auger. Stopped at 0.50 due to obstruction (possibly a large cobble).
	0.20-0.50	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
CL4009	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pit to c. 0.60m and auger. Stopped at 0.70 due to sides collapse.
	0.40-0.70	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
	0.70-0.72	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4009a	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit to c. 0.30m and auger. Stopped at 1.10 due to obstruction.
	0.30-1.10	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4010	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Auger location abandoned due to high tide.
CL4011	0-1.30	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.	<7> 0-0.30; <8> 0.50-0.60; <9> 1.10-1.30	Auger
	1.30-1.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4012	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Auger. Stopped at 0.50 due to sides collapse.
	0.20-0.50	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4013	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Common well rounded pebbles and cobbles (20-180mm).		Test pit.
CL4014	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0-0.60	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
CL4015	0-0.80	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Very few shell fragments (<2%). Loose.		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4016	0-0.25	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.25-0.60	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		
CL4017	0-0.10	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.10m		Line of test pits dug by hand to establish presence of the peat towards North. Line started c. 10m from the peat exposure zone. Due to loose sediments and water, no augering was possible.
	0.10+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4018	0-0.25	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.25m		
	0.25+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4019	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.40m		
	0.40+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4020	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. NO Peat **NO** recorded under 0.60m		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4021	0-0.65	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.65m		
	0.65+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4022	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.20-0.60	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		
CL4023	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Stopped due to loose sediments and sides collapse.
	0.30-0.35	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4024	0-0.07	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit and auger. Taken to test the peat presence. Stopped due to sides collapse.
	0.07-0.75	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4025	0-0.13	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.13m		Line of test pits dug by hand to establish presence of the peat. Due to loose sediments and water, location CL4024 was selected for augering.
	0.13+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4026	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.30m		
	0.30+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4027	0-0.45	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.45m		
	0.45+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4028	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.60m		
	0.60+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4029	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
CL4030	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.50-0.52	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4031	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm).		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4032	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.30-0.33	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4033	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
CL4034	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
CL4035	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
	0.30-0.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4036	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel and cobbles (20 to 100mm).		Test pit and auger. Loose sediments and sides collapse.
	0.60-0.65	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4037	0-0.40	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4038	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.60-0.65	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4039	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.20-0.30	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4040	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.30-0.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4041	0-2.70	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Pebbles and cobbles more common with depth (20-180mm, rounded, <7%).		Machine trial pit

Irish territorial limit to the Irish / UK median

4.146. 100 vibrocore logs from the Irish territorial waters out to the Irish / UK median line were acquired by Osiris in 2015 (Osiris 2015) and reviewed by Wessex Archaeology (2016) (see Fig. 5; Table 15 & Appendix 4).

4.147. A targeted assessment of SBP data was conducted where palaeo-channels had been identified in the nearshore area of the cable route in an archaeological review of geophysical survey data undertaken by Headland Archaeology (2015). The geophysical data were also re-assessed in locations where logs were found to contain organic remains.

4.148. The vibrocore geoarchaeological data were classified using four sedimentary sequences:

- Unit 1, Bedrock;
- Unit 2, Quaternary glacial/glacio-marine sediments;
- Unit 3, Estuarine and terrestrial sediments; and
- Unit 4, Seabed sediments (Wessex Archaeology 2016).

Unit 1: Bedrock deposits

4.149. The Upper Cretaceous chalk bedrock unit was identified in 20 vibrocores and concentrated in the centre of the CSC between **VC-025** and **VC-049A**. The unit was recorded in water depths between 81m below LAT in **VC-025** and 93.87m below LAT in **VC-049A** (Appendix 4). The deposit was not fully penetrated in any of the vibrocores; a maximum thickness of 1.72m was recorded in vibrocore **VC-048**. The bedrock is visible in the cores as a structureless chalk comprising stiff to very stiff friable light grey and off-white, slightly sandy, slightly gravelly clay.

This chalk bedrock is described in the solid geology maps and BGS interpretation (Tappin et al 1994) as a widespread deposition of chalk deposited in the Late Cretaceous period due to a combination of high sea levels and regional subsidence. It has been identified in a concentrated area offshore overlain by a thin cover of Quaternary sediments. No vibrocores penetrated deeply into this unit.

Unit 2: Quaternary glacial/glacio-marine sediments

4.150. These Quaternary glacial / glacio-marine sediments units were identified in 95 vibrocores across the majority of the CSC (see Appendix 4), with seven of these units directly overlying bedrock (**VC-030, VC-035A, VC-037A, VC- 039, VC-041, VC-044 & VC-NS03**). The differentiation between Unit 2 and Unit 4 (Seabed sediments) is based on the composition of vibrocores, with denser silts and clay sediments observed in the Unit 2 cores as well as sands and gravels.

4.151. There is a large and diverse range of sediments grouped into this one unit due to the scale of the project. Owing to the limited depth of recovery a range of Quaternary units dating to a range of glacial stages within the Pleistocene, that are extant within the CSC, cannot be clearly separated presently.

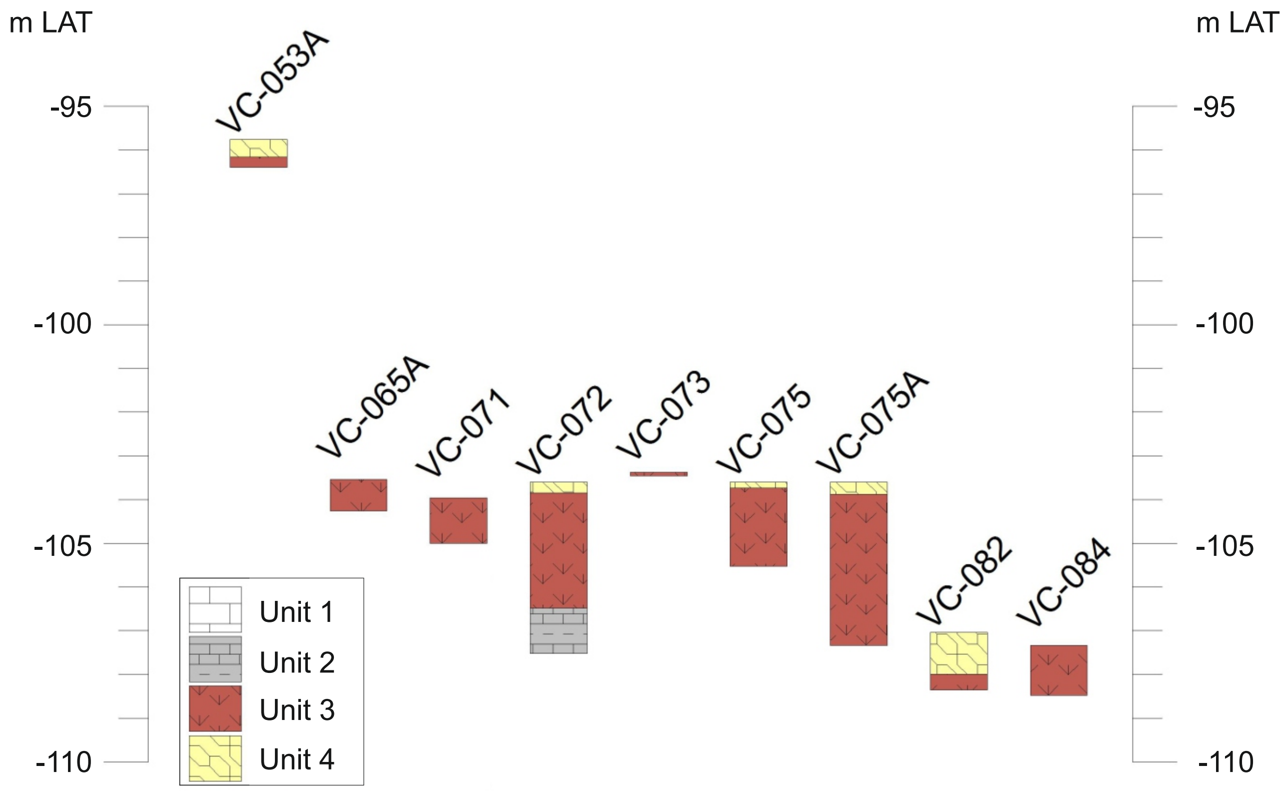
4.152. The principal sediments mapped across the site are thin layers of the Lower Unstratified member (LU); this is part of the Caernarfon Bay Formation attributed to the Middle Pleistocene (Tappin et al 1994). BGS borehole evidence has identified this deposit as olive-grey till comprising hard diamicton of matrix-supported, gravelly muddy sand with broken shells and abundant chalk and lignite fragments. This large expanse of deposit has probably been penetrated across the CSC, although it is difficult to identify this unit irrefutably.

4.153. Expanses of Bedded member (BE) also of the Caernarfon Bay Formation are present across the CSC, which is cited to either overlie the LU deposit or grade laterally into it. A BGS borehole that penetrated this unit (although poorly recovered) identified sand with occasional clay beds and scattered pebbles with shell debris (Tippen *et al* 1994). This type of deposit has been identified across the CSC.

4.154. The Western Irish Sea Formation (WIS) attributed to the Upper Pleistocene is present across the CSC. It is described in the BGS as both localised incision infill deposits up to 200m thick and overlying, more-widespread, tabular-stratified deposits that are generally less than 10m thick. This is made up of five different facies some of which correspond to glacio-marine events. This unit typically overlies a marked erosion surface (Tappin *et al* 1994).

Unit 3: Estuarine and terrestrial sediments

4.155. Nine vibrocores containing peat were identified across the CSC (**VC-053A, VC-065A, VC-071, VC-072, VC-073, VC-075, VC-075A, VC-082 & VC-084**) (Fig. 42 & Table 16). The deposits have been recovered from cores located between 96.19m



Company Name: Wessex Archaeology
Client Name: EirGrid plc
Project: Celtic Interconnector - Feasibility Study
Drawing Title: Log section of vibrocores containing Unit 3: Estuarine and terrestrial sediments
Drawing Number: 112110_Fig03.cdr

Date:	08/02/2016	Revision Number:	0
Scale:	see above	Illustrator:	KJF
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Figure 41 Log section of vibrocores containing Unit 3: Estuarine and terrestrial sediments

below LAT (**VC-053A**) and 104.8m below LAT (**VC-082**) and all are visible in the upper layers of Unit 2.

4.156. **VC-073** contained the shortest sequence of peat measuring 0.06m; the deposit is present in slightly sandy, slightly gravelly clay with occasional small black organic / peaty pockets up to 6mm. The largest organic sequence was recorded in core **VC-075A** which contains 2.52m of black organic and peaty deposits; between 1.60m to 2.10m the deposits are clearly visible as organic and peaty laminae.

4.157. In a number of vibrocores an organic odour was recorded, although no *in situ* organic sediments were observed in the corresponding sample photographs to suggest further analysis (i.e. Unit 3).

Unit 4: Seabed sediments

4.158. This unit primarily relates to the modern seabed. It was observed in the majority of the vibrocores and generally comprised unconsolidated sands and gravels with frequent bivalve and gastropod shell. This deposit was seen across the entire length of the CSC with the largest sequence, 2.53m in thickness at 83.3m below LAT, recovered at **VC-023A**. These sediments may form part of the large sand waves and ridges over which the CSC crosses in this area.

Table 15 Vibrocore stratigraphy interpretation (after Wessex Archaeology 2016)

Vibrocore ID	Depth from (m downcore)	Depth to (m downcore)	Stratigraphic Interpretation
VC-018	0	1.87	Unit 4
	1.87	2.25	Unit 2
VC-019	0	2.1	Unit 4
VC-020	0	0.24	Unit 4
	0.24	0.65	Unit 2
VC-020A	0	0.44	Unit 2
VC-021	0	1.13	Unit 4
VC-021A	0	1.5	Unit 4
VC-022	0	1.4	Unit 4
VC-022A	0	2.5	Unit 4
VC-023	0	1.18	Unit 4
VC-023A	0	2.53	Unit 4
VC-024	0	0.38	Unit 2
VC-024A	0	0.2	Unit 2
	0	0.42	Unit 4
VC-025	0	0.3	Unit 4
	0.3	0.6	Unit 1

Vibrocore ID	Depth from (m downcore)	Depth to (m downcore)	Stratigraphic Interpretation
VC-026	0	0.84	Unit 4
VC-027	0	0.2	Unit 4
	0.2	1.2	Unit 2
VC-027A	0	0.2	Unit 4
	0.2	1.25	Unit 1
VC-028	0	0.25	Unit 4
	0.25	0.44	Unit 1
VC-029	0	0.28	Unit 4
	0.28	0.5	Unit 1
VC-030	0	0.3	Unit 2
	0.3	0.81	Unit 1
VC-032	0	0.3	Unit 4
	0.3	0.4	Unit 1
VC-033	0	0.28	Unit 4
	0.28	1.3	Unit 1
VC-034	0	0.32	Unit 4
	0.32	0.65	Unit 1
VC-035	0	0.1	Unit 4
VC-035A	0	0.27	Unit 2
	0.27	0.58	Unit 1
VC-036	0	0.15	Unit 4
VC-036A	0	0.15	Unit 4
VC-037	0	0.5	Unit 2
VC-037A	0	0.49	Unit 2
	0.49	0.7	Unit 1
VC-038	0	0.29	Unit 4
	0.29	0.36	Unit 1
VC-039	0	0.68	Unit 2
	0.68	0.91	Unit 1
VC-040	0	0.1	Unit 4
	0.1	0.3	Unit 1
VC-041	0	0.21	Unit 2
	0.21	1.51	Unit 1
VC-041A	0	0.22	Unit 4
	0.22	1	Unit 1
VC-043	0	1.68	Unit 4
VC-043A	0	1.5	Unit 4
VC-044	0	0.4	Unit 2
	0.4	3	Unit 1
VC-046	0	0.4	Unit 4
	0.4	1.3	Unit 1
	0	2.37	Unit 4

Vibrocore ID	Depth from (m downcore)	Depth to (m downcore)	Stratigraphic Interpretation
VC-047	2.37	3	Unit 1
VC-048	0	0.23	Unit 4
	0.23	1.95	Unit 1
VC-049	0	1.4	Unit 4
VC-049A	0	0.87	Unit 4
	0.87	1.04	Unit 1
VC-050	0	1.72	Unit 4
VC-050A	0	0.59	Unit 2
VC-051	0	0.65	Unit 2
VC-051A	0	0.85	Unit 4
VC-052	0	0.9	Unit 4
VC-052A	0	1.68	Unit 4
VC-053	0	0.8	Unit 2
VC-053A	0	0.29	Unit 4
	0.29	0.46	Unit 3
VC-055	0	0.4	Unit 2
VC-055A	0	0.03	Unit 4
VC-056	0	0.08	Unit 4
VC-056A	0	1.56	Unit 4
VC-056B	0	1.95	Unit 4
	1.95	2.18	Unit 2
VC-057	0	2	Unit 4
VC-058	0	1.38	Unit 4
VC-058A	0	0.81	Unit 4
VC-059	0	1.38	Unit 2
VC-059A	0	0.31	Unit 4
	0.31	1.87	Unit 2
VC-060	0	1.08	Unit 4
VC-060A	0	2.25	Unit 4
VC-061	0.3	0.9	Unit 2
VC-061A	0	1.2	Unit 2
VC-062	0	0.85	Unit 2
VC-062A	0	0.82	Unit 2
VC-063	0	0.82	Unit 2
VC-063A	0	0.8	Unit 2
VC-064	0	1.54	Unit 2
VC-064A	0	0.24	Unit 4
VC-065	0	0.05	Unit 4
VC-065A	0	1.08	Unit 2
	0.56	1.08	Unit 3
VC-066	0	1.75	Unit 4
VC-066A	0	1.95	Unit 2

Vibrocore ID	Depth from (m downcore)	Depth to (m downcore)	Stratigraphic Interpretation
VC-067B	0	0.4	Unit 2
VC-068	0	1.3	Unit 4
	1.3	2	Unit 2
VC-069A	0	0.92	Unit 2
VC-071	0	1.12	Unit 2
	0.36	1.12	Unit 3
VC-071A	0	0.25	Unit 2
VC-072	0	0.18	Unit 4
	0.18	2.1	Unit 3
	2.1	2.85	Unit 2
VC-073	0	0.3	Unit 2
	0.24	0.3	Unit 3
VC-073A	0	0.69	Unit 4
VC-074	0	0.07	Unit 4
VC-074A	0	1.33	Unit 2
VC-075	0	0.1	Unit 4
	0.1	1.4	Unit 3
VC-075A	0	0.2	Unit 4
	0.2	2.72	Unit 3
VC-076	0	1.15	Unit 2
VC-076A	0	0.2	Unit 4
	0.2	0.67	Unit 2
VC-077	0	1.9	Unit 2
VC-077A	0	1.01	Unit 2
VC-079	0	0.53	Unit 2
VC-079A	0	0.07	Unit 4
	0.07	1.13	Unit 2
VC-082	0	0.7	Unit 4
	0.7	0.96	Unit 3
VC-082A	0	0.36	Unit 2
VC-083	0	0.7	Unit 2
VC-083A	0	1.65	Unit 2
VC-084	0	1.25	Unit 4
	0.42	1.25	Unit 3
VC-084A	0	0.88	Unit 2

Submerged palaeo-channels

4.159. One palaeo-channel (**HA3007**) was detected in the Irish EEZ by Headland Archaeology (2015) during the assessment of the marine geophysical survey data.

4.160. This feature (**HA3007),** a maximum depth of 18m below the seabed, is characterised by steeply sloping sides and an uneven base (Fig. 42). The channel is likely to be a glacial feature cutting into Unit 2 possible Lower Unstratified member (LU) and filled with possible Bedded Member (BE) or Western Irish Sea Formation (WIS)) of Unit 2 Quaternary glacial or glacio-marine sediments. This is overlain by an approximately 3.8m thick deposit of possible terrestrial sediments of Unit 3 estuarine and terrestrial sediments. Overlaying this, up to 2.5m depth below the seabed, is a possible thin layer of seabed sediments (Unit 4). The Unit 3 deposits could possibly contain sediments of palaeo-environmental potential. Vibrocore **VC-021** intersects this location with a recovery depth of 1.5m; the composition of this core was interpreted to be Unit 4 seabed sediments which correlates with the sub-bottom seismic data.

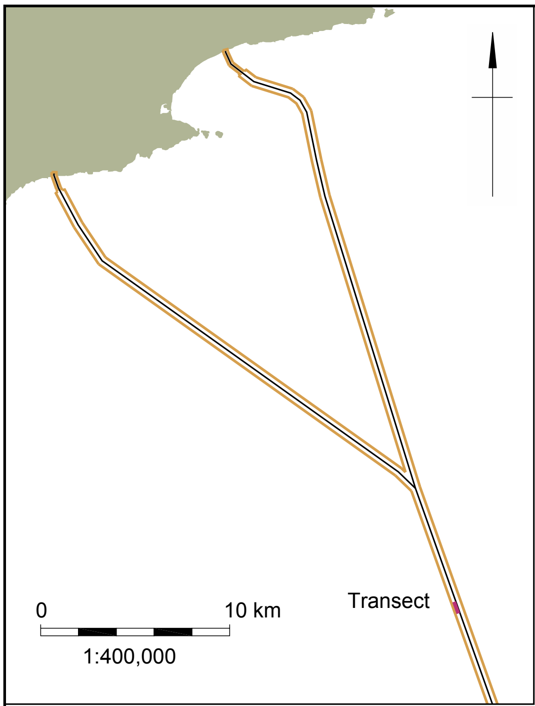
4.161. Five vibrocore locations that contained peat (**VC-53A, VC-65A, VC-71, VC-72 and VC-73)** were assessed in the SBP data for their palaeo-environmental potential. Peat was present in cores up to 2.52m below the seabed. There was no evidence in the geophysical data of peat or organic deposits; this may be owing to the loss of response in the seabed pulse.

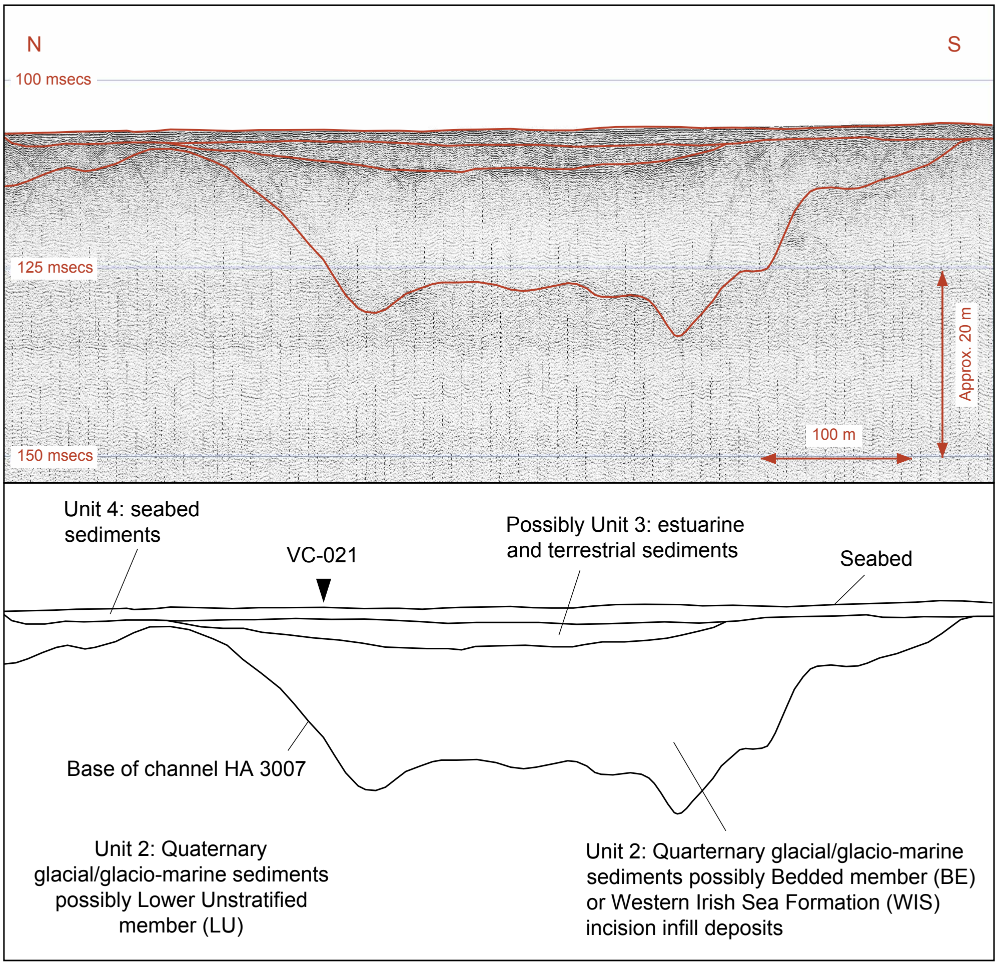
Summary

4.162. Bedrock deposits (Unit 1) are of no archaeological interest as they are too old to contain any archaeological material.

4.163. The youngest deposit of Seabed sediments (Unit 4) is similarly of little or no geoarchaeological importance but may contain reworked artefacts and material in addition to more recent archaeological material. The deposition of this unit is likely to have occurred initially during the Holocene sea level rise, so some of this sediment is probably part of marine bedforms, some of which are mobile such as sand ribbons, sand waves and sandbanks. These deposits, however, do have the potential to contain reworked prehistoric archaeological material or more recent archaeological remains such as shipwrecks.

4.164. Unit 2 is identified as a group of Quaternary glacial/glacio-marine sediments comprising finer-grained clays and silts. It is likely that these deposits relate to multiple glacial events mapped across the area (Tappin et al 1994) and may have potential for understanding the timing and influence of marine transgression and the development of geomorphology since the last glaciation. Archaeological material and artefacts are unlikely to be present in these deposits owing to the nature of their formation (glacial / glacio-marine) and their likely age. There is low potential that





Company Name: Wessex Archaeology
Client Name: EirGrid plc
Project: Celtic Interconnector - Feasibility Study
Drawing Title: Sub-bottom profiler data example (Channel HA 3007)
Drawing Number: 112110_Geotech_Fig04-8.dwg

Date:	27/04/2016	Revision Number:	0
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Figure 42 Sub-bottom profiler data example (channel HA3007)

reworked artefacts may be present in marine units transported down-river from terrestrial contexts. The archaeological record of the neighbouring coasts is presently restricted to the current post-glacial (<MIS2: Late Upper Palaeolithic and Mesolithic) (Bicket and Tizzard 2015) with some potential for MIS 8/7 Neanderthal activity near Liverpool Bay (*Pontnewydd* cave) distal from the survey area.

4.165. As Unit 3 contains repeated layers of peats in silts and clays, visible as small black organic/peaty deposits, pockets, bands and laminae, it is of archaeological interest. These deposits are concentrated mainly at the Irish/UK median line and may represent the first stages of terrestrial environmental development immediately following the last or a previous glacial period. As such these deposits have potential for providing scientifically important information on sea level minima and early post-glacial environments of archaeological interest (Bicket and Tizzard 2015).

4.166. **HA3007** is interpreted as glacial in formation with multiple phases of Unit 2 observed throughout. Possible evidence of remnants of Unit 3 is, however, observed. Unit 3 may be of palaeo-environmental interest. No evidence of peat was identified in the SBP data of the channel.

4.167. Nine vibrocores were recommended for further geoarchaeological assessment (Table 16). Since the original sampling, however, the vibrocores have been tested and no further assessment is recommended.

Table 16 Geotechnical vibrocores of archaeological potential

ID	Depth from (m downcore depth)	Depth to (m downcore depth)	Rationale	Research potential
VC-053A	0.29	0.46	Firm friable amorphous black Peat (H8)	• Palaeo-environmental interest • Sea level minima reference points
VC-065A	0.56	1.08	Occasional black organic pockets up to 7 mm	• Palaeo-environmental interest • Sea level minima reference points
VC-071	0.36	1.12	Occasional black organic pockets up to 12 mm	• Palaeo-environmental interest • Sea level minima reference points

ID	Depth from (m downcore depth)	Depth to (m downcore depth)	Rationale	Research potential
VC-072	0.18	2.1	Occasional black organic and peaty pockets up to 12 mm, between 1.6 - 2.1 m many black organic/peaty laminae	• Palaeo-environmental interest • Sea level minima reference points
VC-073	0.24	0.3	Occasional small black organic/peaty pockets up to 6 mm	• Palaeo-environmental interest • Sea level minima reference points
VC-075	0.1	1.4	Black organic/peaty pockets and laminae up top 12 mm, between 0.9 - 0.95 m black organic peaty band	• Palaeo-environmental interest • Sea level minima reference points
VC-075A	0.2	2.72	Small bands of organic/peaty pockets and laminae up to 7 mm	• Palaeo-environmental interest • Sea level minima reference points
VC-082	0.7	0.96	Dark brown/black slightly sandy Silt	• Palaeo-environmental interest • Sea level minima reference points
VC-084	0.42	1.25	Slightly peaty slightly sandy clayey Silt	• Palaeo-environmental interest • Sea level minima reference points

5. CONCLUSIONS

5.1. It is clear from this technical report that considerable efforts have gone into assessing the archaeology, the archaeological potential, and the palaeo-environmental evidence along the route through which the Celtic Interconnector cable is proposed to pass. This will ensure that the impact from this proposed development on the cultural heritage resource will be minimised.

5.2. The numbers of wrecks, obstructions and anomalies of archaeological potential identified along the route are in very low numbers and are therefore easily avoided. For example, in Irish territorial waters of 12 anomalies with archaeological potential, only one (**CA1001**), which corresponds to **CA8** recorded in the DBA) is a probable wreck of high archaeological potential.

5.3. Relative to the length of the route, the density of archaeological and geophysical anomalies identified along the route is sparse, so the potential to encounter unknown archaeological sites and features within the CSC is low.

5.4. The exposed peat deposits identified in the intertidal zone on Claycastle beach have been dated from the Early Neolithic (at the bottom) through to the Iron Age (at the top) and are therefore of considerable archaeological and palaeo-environmental significance. Investigations of these deposits (hand auguring and test pitting) has shown them to be extensive, as is common with deposits of this nature. The discovery of peat deposits in nearshore borehole **CL-BH3** suggest that the exposed peat deposits on Claycastle beach extend out to this location.

5.5. Analysis of SBP data has identified 21 areas with features of archaeological / palaeo-environmental potential. Assessments of glacio-marine deposits associated with some of the offshore palaeo-channels have suggested that the deposits are pre-Holocene and are therefore of low archaeological potential.

5.6. Should Claycastle beach be selected as the preferred landfall option, a linear development such as the Celtic Interconnector can be relatively easily mitigated through further archaeological assessment and investigation of the peat deposits. In conclusion then, nothing has yet been discovered that could not be mitigated through further archaeological site investigation.

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APPENDIX 1: METAL DETECTOR ANOMALIES

Tables A1.1 – A1.3 presents the results of the metal detector surveys at the three landfall locations (Claycastle beach, Redbarn beach and Ballinwilling Strand).

Claycastle beach

Table A1.1 Metal detector results at Claycastle beach (Cotswold Archaeology 2018a)

ID	Latitude	Longitude	Material	Detector value
CA 3020	51.934439	-7.859074	Metal	12
CA 3021	51.934453	-7.858761	Metal	24
CA 3022	51.934582	-7.858681	Metal	-4
CA 3023	51.934606	-7.858604	Metal	36
CA 3024	51.934627	-7.858371	Metal	-6
CA 3025	51.934690	-7.858334	Metal	-6
CA 3026	51.934423	-7.858696	Metal	-6
CA 3027	51.934399	-7.858831	Metal	12
CA 3028	51.934691	-7.858009	Metal	12
CA 3029	51.934805	-7.857671	Metal	34
CA 3030	51.934756	-7.857847	Metal	8
CA 3031	51.934382	-7.858426	Metal	8
CA 3032	51.933490	-7.859022	Metal	10
CA 3033	51.933560	-7.859922	Metal	8
CA 3034	51.933569	-7.859672	Metal	30
CA 3035	51.933559	-7.859693	Metal	12
CA 3036	51.933930	-7.858923	Metal	30
CA 3037	51.933141	-7.859081	Metal	2
CA 3038	51.932679	-7.860028	Metal	4
CA 3039	51.933156	-7.858883	Metal	40
CA 3040	51.933360	-7.859617	Metal	3
CA 3041	51.932997	-7.860182	Metal	4

Redbarn beach

Table A1.2 Metal detector results at Redbarn beach (Cotswold Archaeology 2018a)

ID	Latitude	Longitude	Material
CA 3043	51.922159	-7.867026	Metal
CA 3044	51.923582	-7.872708	Metal
CA 3045	51.923331	-7.872920	Metal
CA 3046	51.923311	-7.872874	Metal
CA 3047	51.923503	-7.872702	Metal
CA 3048	51.923558	-7.872646	Metal
CA 3049	51.923845	-7.872240	Metal

ID	Latitude	Longitude	Material
CA 3050	51.924293	-7.871665	Metal
CA 3051	51.924342	-7.871613	Metal
CA 3052	51.925522	-7.871119	Metal
CA 3053	51.925602	-7.870978	Metal
CA 3054	51.925111	-7.871068	Metal
CA 3055	51.925259	-7.870829	Metal
CA 3056	51.925158	-7.870755	Metal
CA 3057	51.924730	-7.871041	Metal
CA 3058	51.923251	-7.872140	Metal
CA 3059	51.923693	-7.871617	Metal
CA 3060	51.925014	-7.870385	Metal
CA 3061	51.923717	-7.871420	Metal
CA 3062	51.923734	-7.871205	Metal
CA 3063	51.923894	-7.871069	Metal
CA 3064	51.924098	-7.870888	Metal
CA 3065	51.924977	-7.870221	Metal
CA 3066	51.924946	-7.870227	Metal
CA 3067	51.924739	-7.870383	Metal
CA 3068	51.924691	-7.870405	Metal
CA 3069	51.924616	-7.870448	Metal
CA 3070	51.924527	-7.870493	Metal
CA 3071	51.924439	-7.870543	Metal
CA 3072	51.924334	-7.870619	Metal
CA 3073	51.924039	-7.870932	Metal
CA 3074	51.923907	-7.871028	Metal
CA 3075	51.923833	-7.871066	Metal
CA 3076	51.923730	-7.871119	Metal
CA 3077	51.923518	-7.871343	Metal
CA 3078	51.923477	-7.871366	Metal
CA 3079	51.923412	-7.871409	Metal
CA 3080	51.923325	-7.871509	Metal
CA 3081	51.923303	-7.871517	Metal
CA 3082	51.923064	-7.871638	Metal
CA 3083	51.923202	-7.871452	Metal
CA 3084	51.923254	-7.871371	Metal
CA 3085	51.923360	-7.871229	Metal
CA 3086	51.923415	-7.871182	Metal
CA 3087	51.923501	-7.871084	Metal
CA 3088	51.923638	-7.871012	Metal
CA 3089	51.923647	-7.870953	Metal
CA 3090	51.923756	-7.870860	Metal
CA 3091	51.923834	-7.870780	Metal

ID	Latitude	Longitude	Material
CA 3092	51.923970	-7.870618	Metal
CA 3093	51.923988	-7.870618	Metal
CA 3094	51.924137	-7.870491	Metal
CA 3095	51.924307	-7.870339	Metal
CA 3096	51.924366	-7.870326	Metal
CA 3097	51.924496	-7.870193	Metal
CA 3098	51.924643	-7.870088	Metal
CA 3099	51.924731	-7.870037	Metal
CA 3100	51.924737	-7.870010	Metal
CA 3101	51.924899	-7.869945	Metal
CA 3102	51.924966	-7.869921	Metal
CA 3103	51.925035	-7.869864	Metal
CA 3104	51.925173	-7.869677	Metal
CA 3105	51.925069	-7.869605	Metal
CA 3106	51.924993	-7.869624	Metal
CA 3107	51.924933	-7.869758	Metal
CA 3108	51.924864	-7.869784	Metal
CA 3109	51.924776	-7.869858	Metal
CA 3110	51.924676	-7.869979	Metal
CA 3111	51.924616	-7.869972	Metal
CA 3112	51.924504	-7.870051	Metal
CA 3113	51.924461	-7.870078	Metal
CA 3114	51.924405	-7.870139	Metal
CA 3115	51.923819	-7.870523	Metal
CA 3116	51.923753	-7.870577	Metal
CA 3117	51.923599	-7.870755	Metal
CA 3118	51.923313	-7.870988	Metal
CA 3119	51.922903	-7.871070	Metal
CA 3120	51.924107	-7.869172	Metal
CA 3121	51.924153	-7.869103	Metal
CA 3122	51.924557	-7.868831	Metal
CA 3123	51.923387	-7.869025	Metal

Ballinwilling Strand

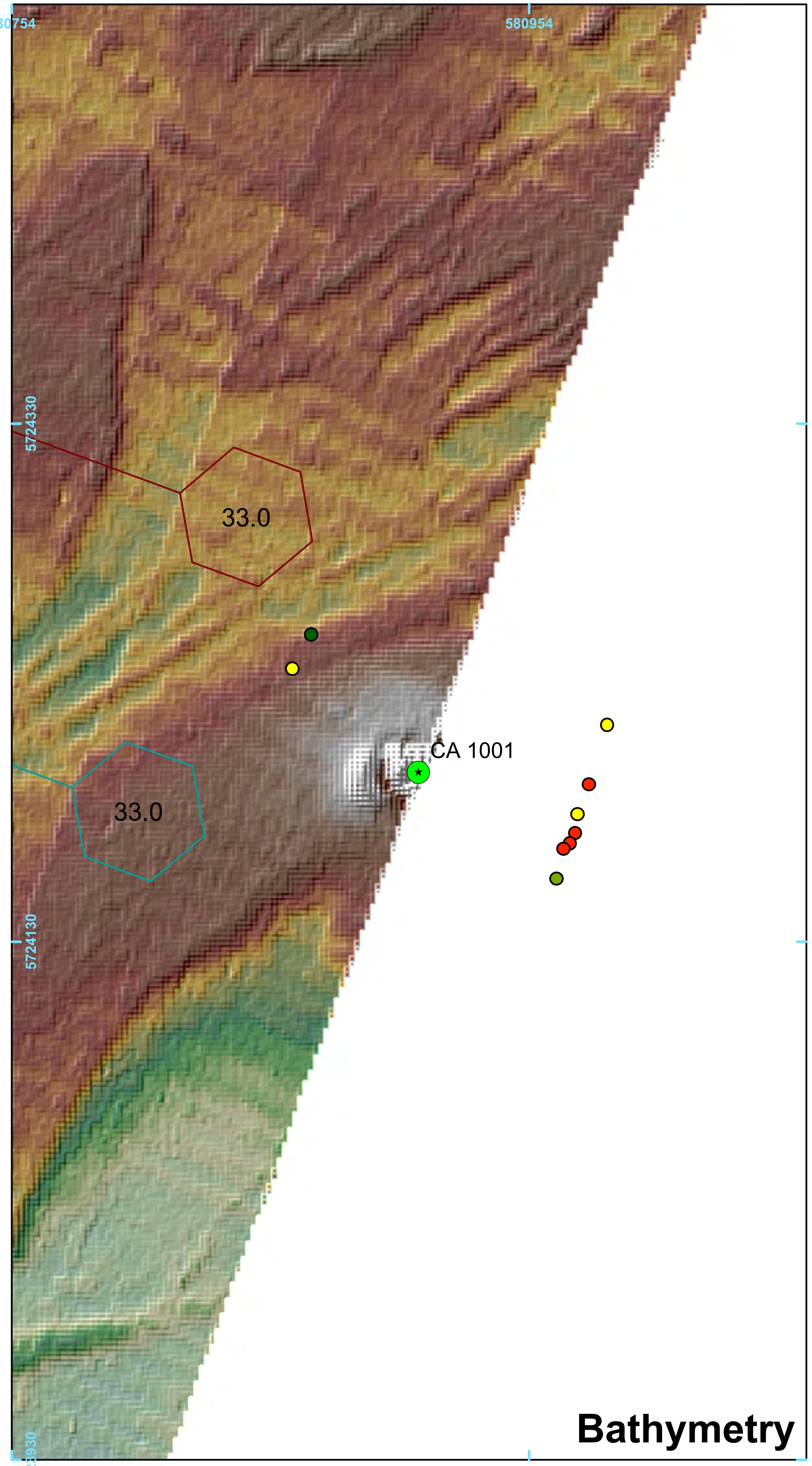
Table A1.3 Metal detector results at Ballinwilling Strand (Headland Archaeology 2015)

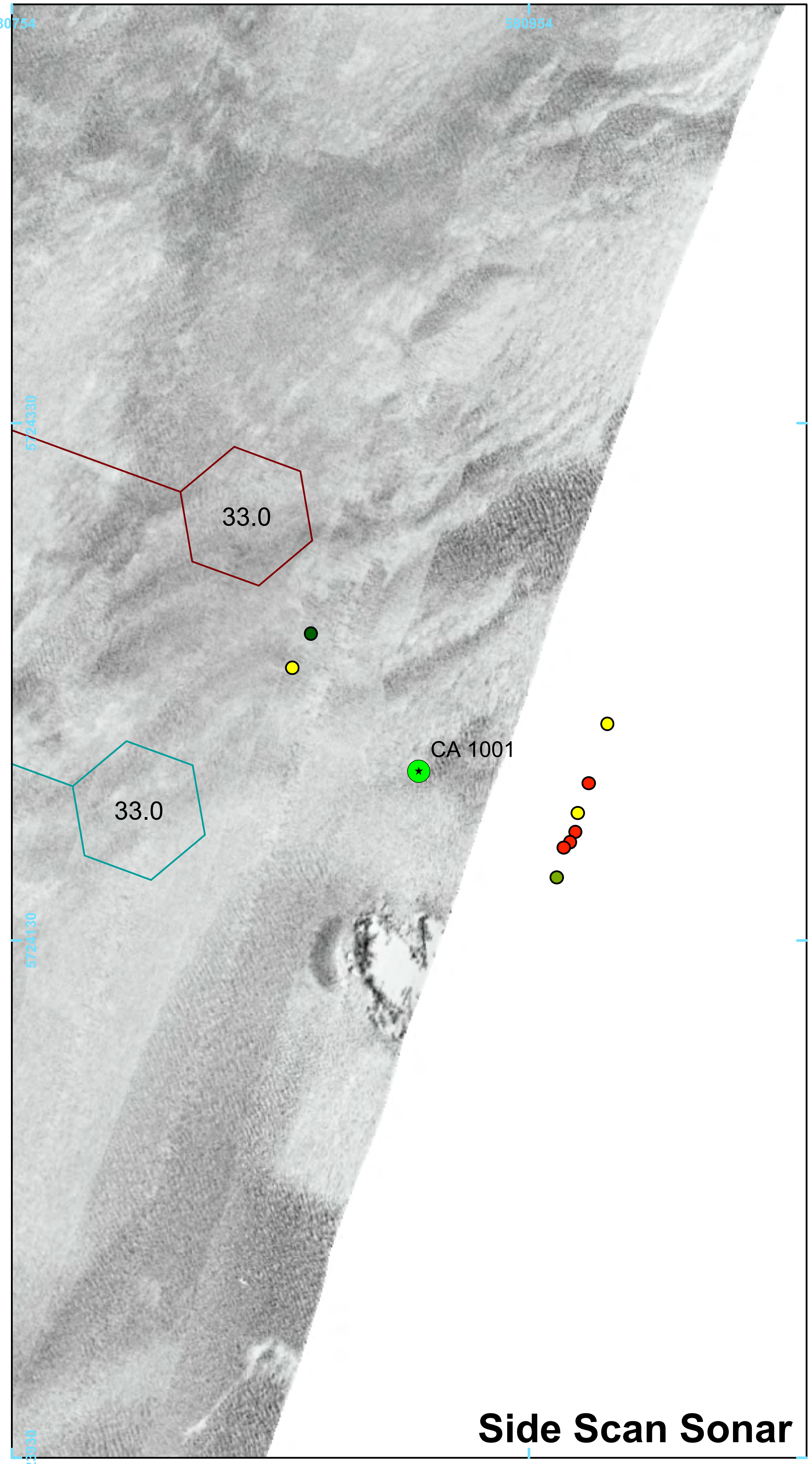
Response based on the Garrett 250 discrimination screen	Latitude	Longitude
Iron (Fe)	51,51.954	007,85.765
Aluminium (Al)	51,52.010	007,58.525
Aluminium (Al)	51,51.999	007,58.579
Iron (Fe)	51,51.990	007.58.622

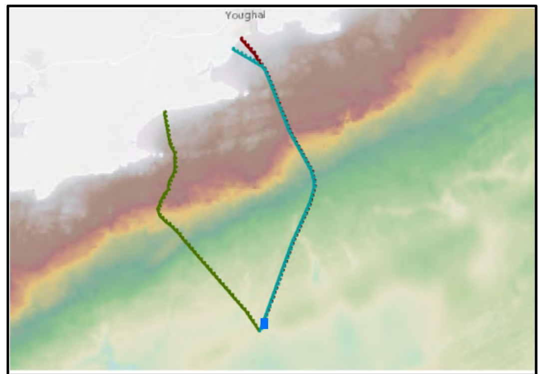
Response based on the Garrett 250 discrimination screen	Latitude	Longitude
Copper alloy (modern coin)	51.51.980	007.58.659
Aluminium (Al)	51,51.962	007,58.741
Aluminium (Al)	51,52.018	007,58.500
Copper alloy (modern coin)	51,51.000	007,51.511
Aluminium (Al)	51,51.025	007,58.483
Aluminium (Al)	51,51.996	007,58.588
Iron (Fe)	51,51.992	007,58.609
Aluminium (Al)	51,51.987	007,58.634
Iron (Fe)	51,51.978	007,58.678
Aluminium (Al)	51,51.760	007,58.757
Aluminium (Al)	51,52.025	007,58.465
Aluminium (Al)	51,51.958	007,58.758
Aluminium (Al)	51,51.976	007,58.680
Copper alloy (modern coin)	51,51.981	007,58.661
Copper alloy (modern coin)	51,51.993	007,58.602
Copper alloy (modern coin)	51,51.007	007,58.541
Aluminium (Al)	51,52.009	007,58.534
Copper alloy (modern coin)	51,52.010	007,58.527
Aluminium (Al)	51,52.020	007,58.474
Silver (Ag)	51,52.016	007,58.483
Aluminium (Al)	51,52.010	007,58.504
Aluminium (Al)	51,52.007	007,58.513
Copper alloy (modern coin)	51,52.000	007,58.540
Aluminium (Al)	51,51.973	007,58.670
Copper alloy (modern coin)	51,52.001	007,58.538
Copper alloy (modern coin)	51,52.002	007,58.533
Copper alloy (modern coin)	51,52.005	007,58.501
Aluminium (Al)	51,51.953	007,58.736
Iron (Fe)	51,51.947	007,58.765
Iron (Fe)	51,51.948	007,58.741
Copper alloy (modern coin)	51,51,996	007,58.533
Aluminium (Al)	51,52.005	007,58.474
Gold (Au) / Silver (Ag)	51,51.972	007,58.617
Aluminium (Al)	51,51.944	007,58.731
Gold (Au) / Silver (Ag)	51,51.973	007,58.634
Aluminium (Al)	51,51.991	007,58.502
Aluminium (Al)	51,51.942	007,58.730
Iron (Fe)	51,51.929	007,58.773
Iron (Fe)	51,51.936	007,58.773
Sliver	51,51.955	007,58.658
Aluminium (Al)	51,51.994	007,58.473

Response based on the Garrett 250 discrimination screen	Latitude	Longitude
Copper alloy (modern coin)	51,51.954	007,58.647
Aluminium (Al)	51,51.923	007,58.775
Copper alloy (modern coin)	51,51.959	007,58.622
Iron (Fe)	51,51.977	007,58.547
Copper alloy (modern coin)	51,51.988	007,58.461
Silver (Ag)	51,51.931	007,58.706

APPENDIX 2: OFFSHORE GEOPHYSICAL ANOMALY LOCATIONS







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-76.3

-80.4

0 50m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE
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FIGURE TITLE
Geophysical anomaly CA1001

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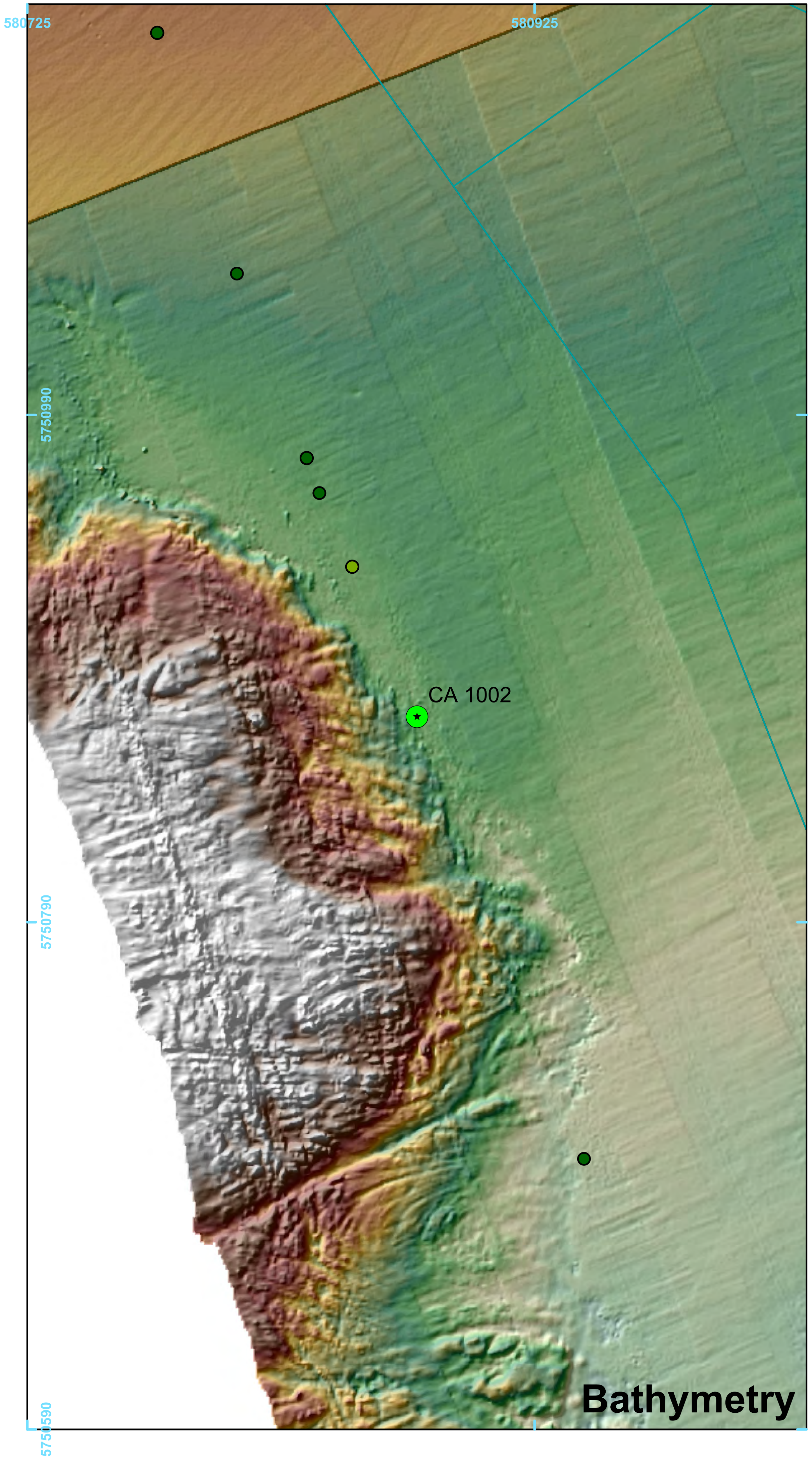

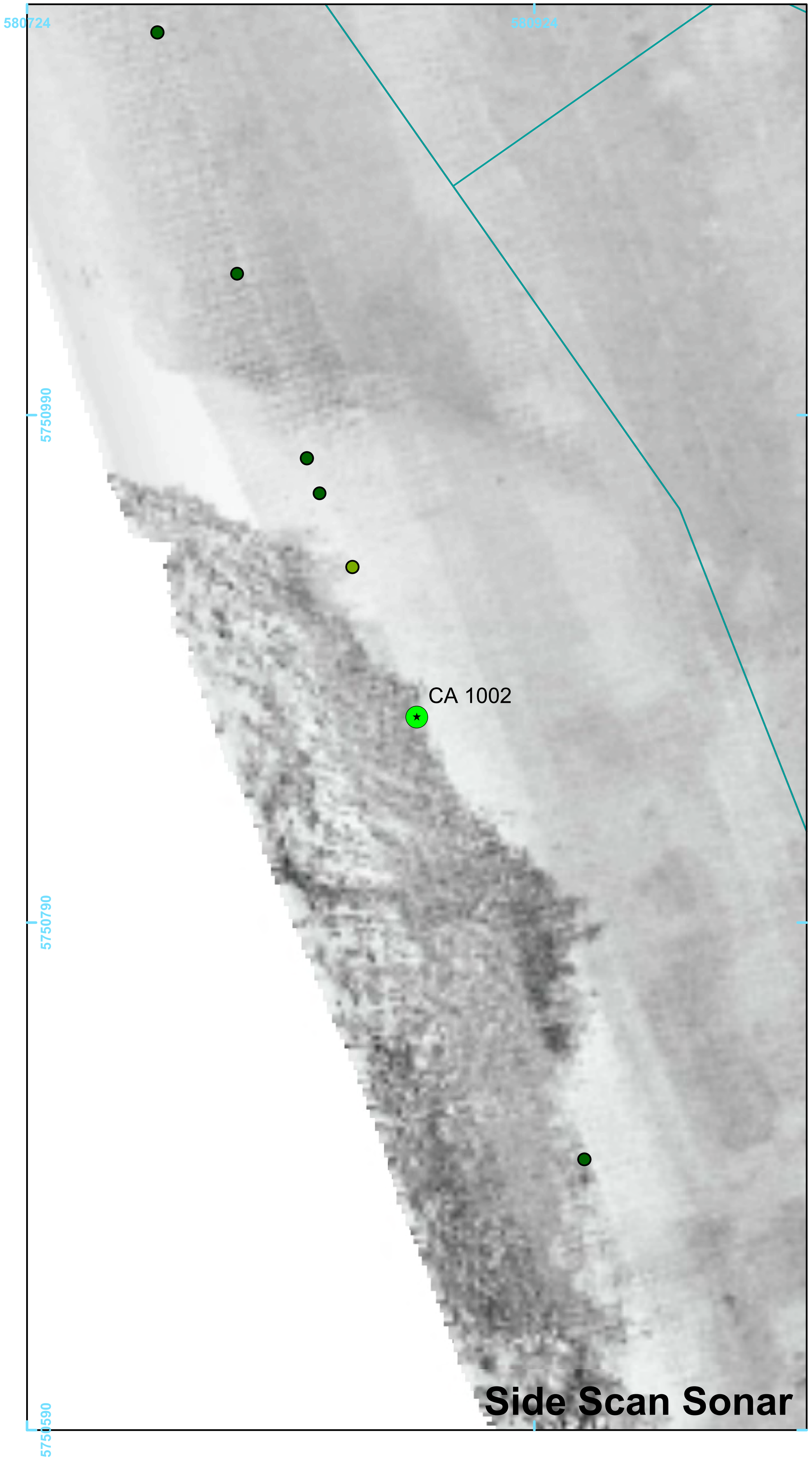

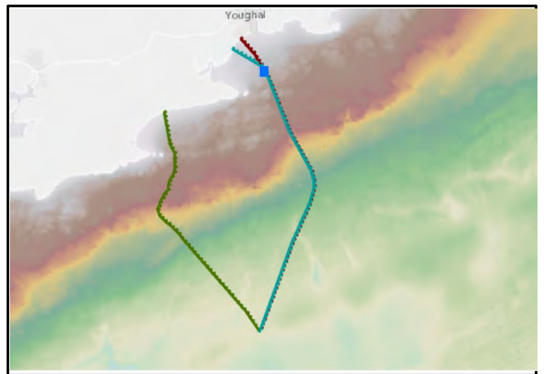

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-10.6

-17.0

0 50m

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PROJECT TITLE
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FIGURE TITLE
Geophysical anomaly CA1002

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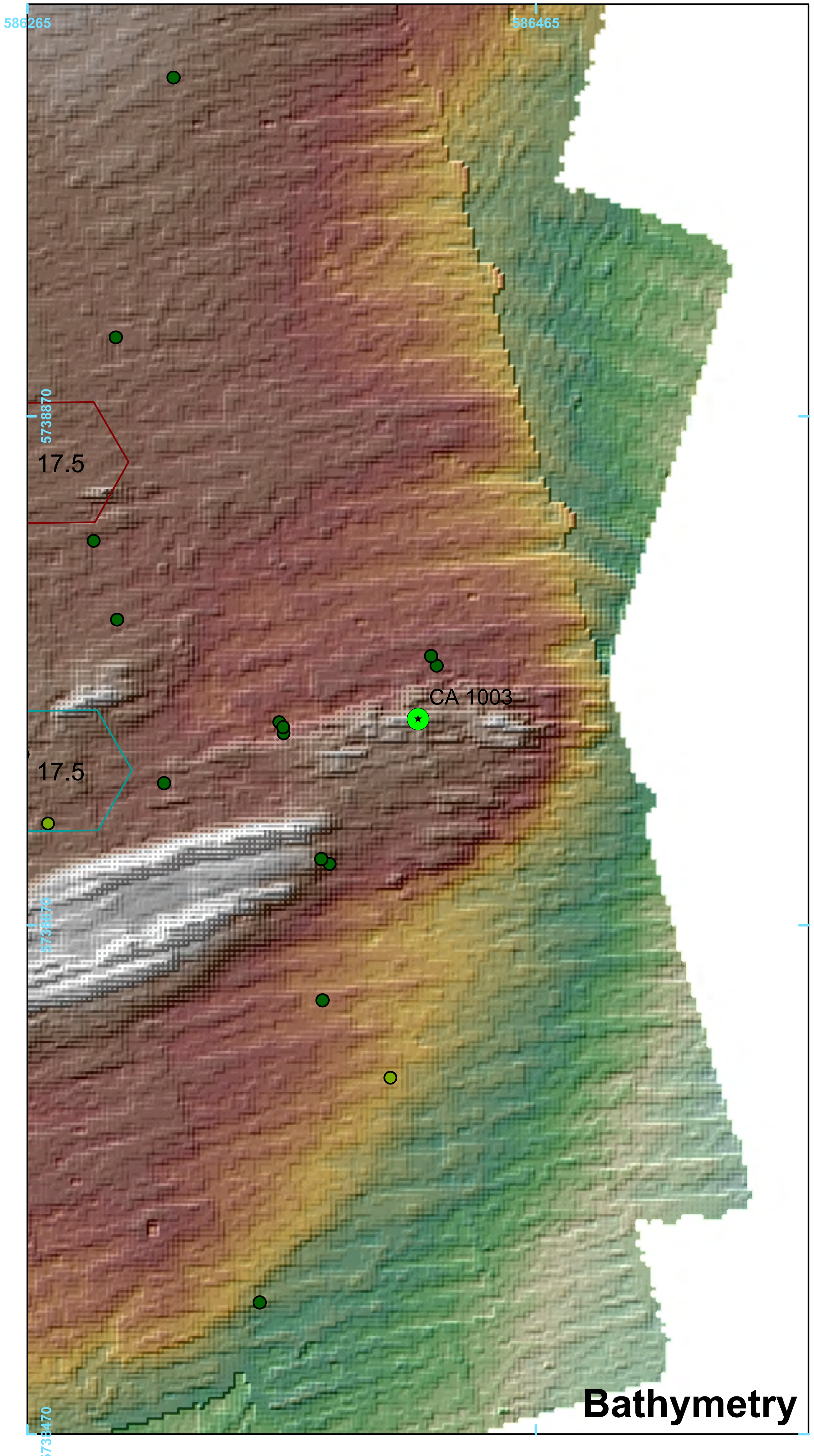

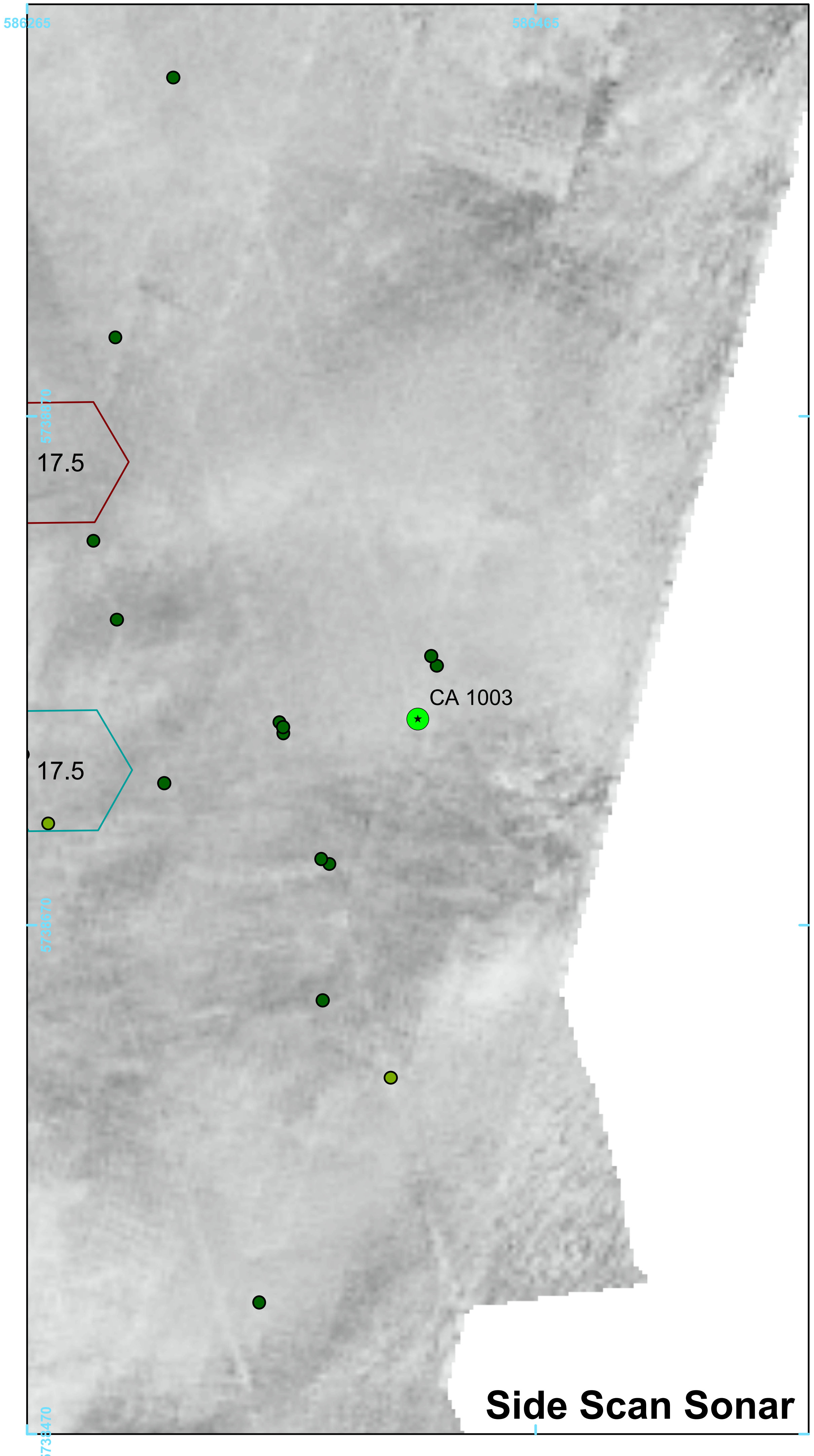

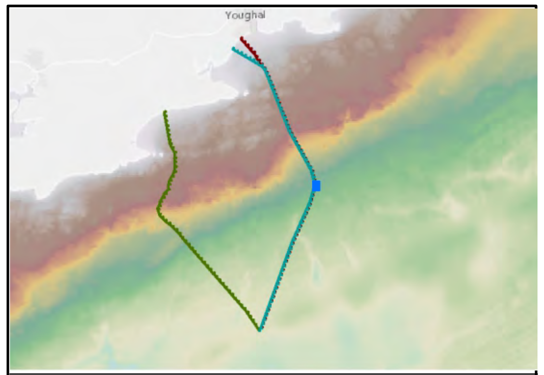

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-66.1

-67.9

0 50m

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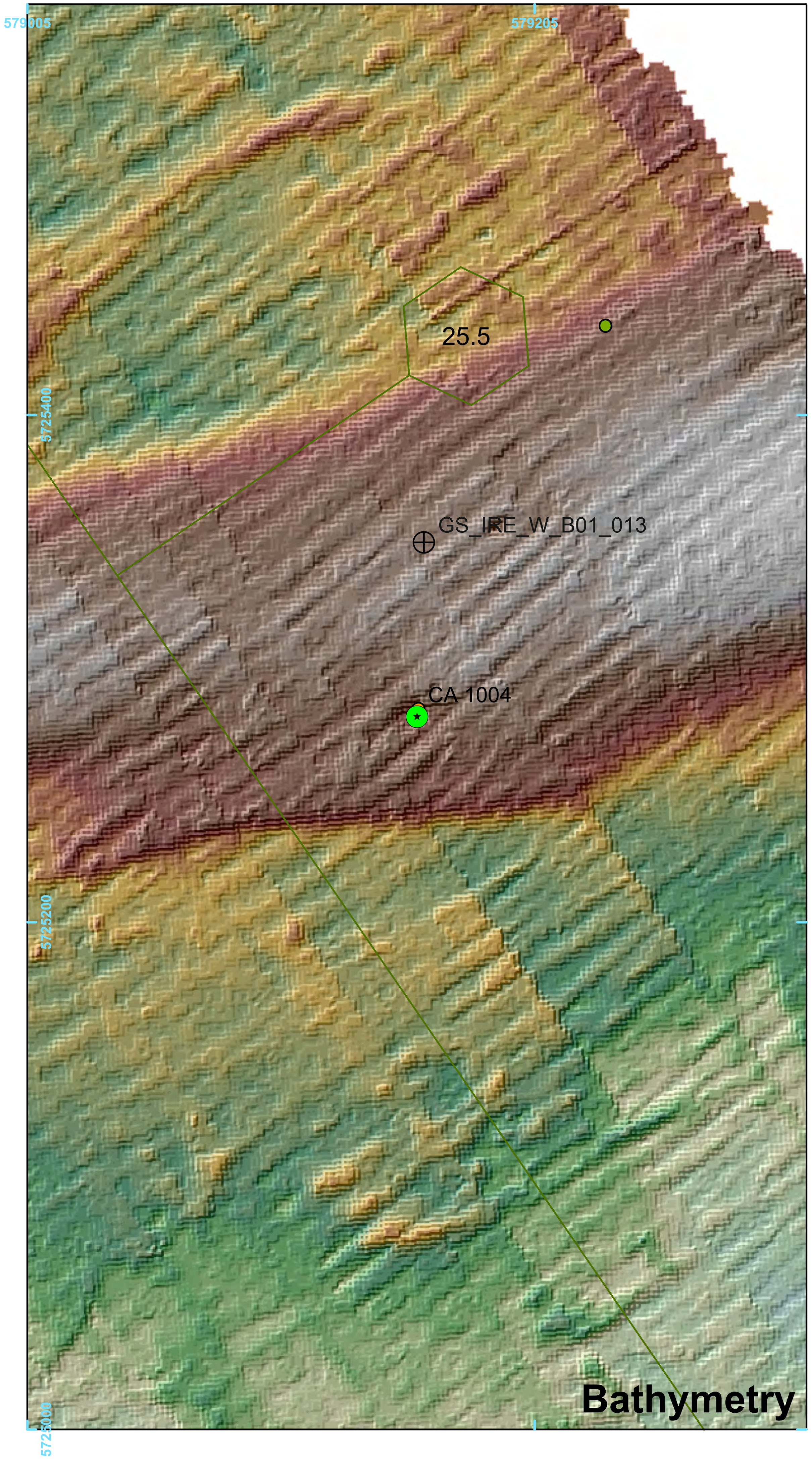
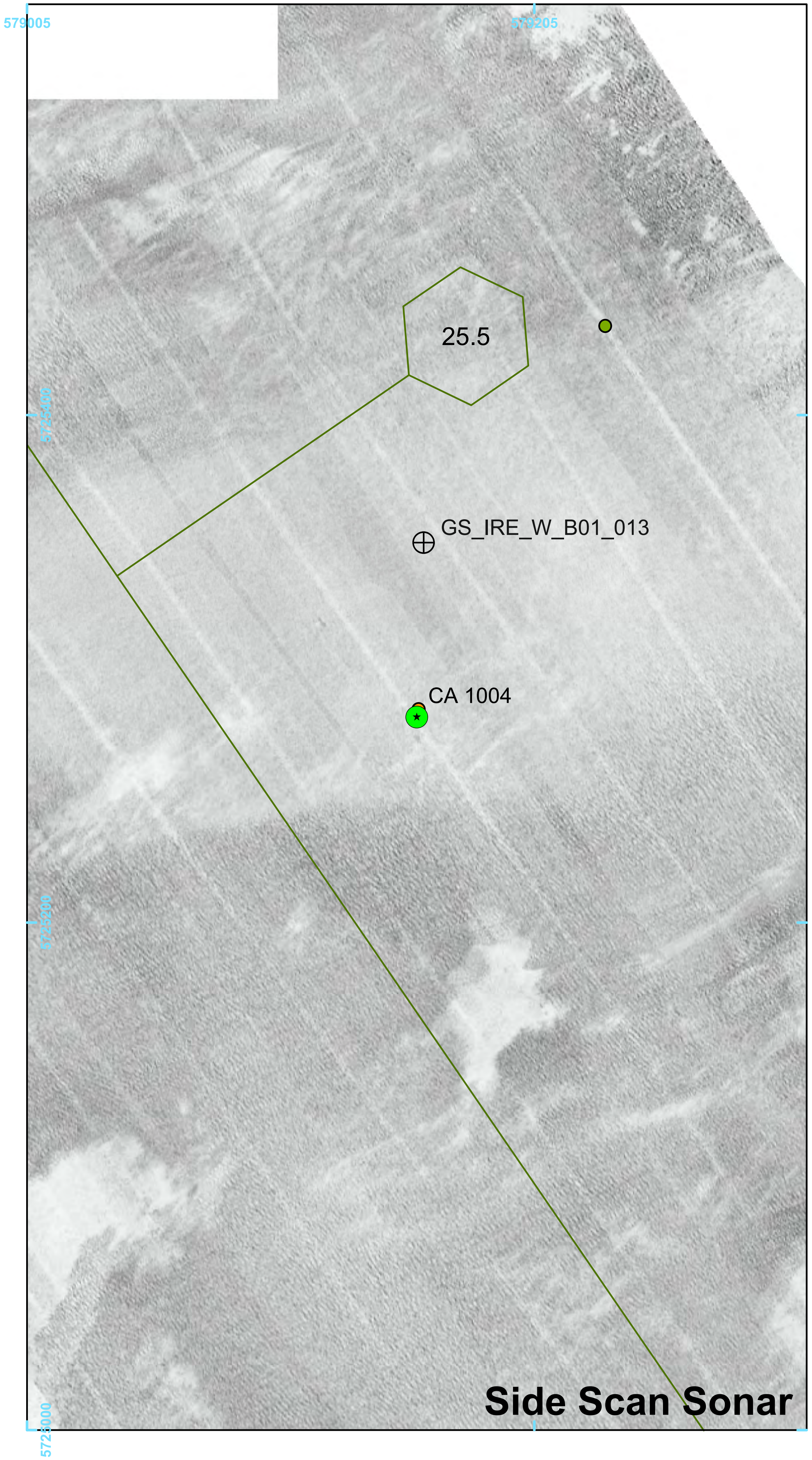
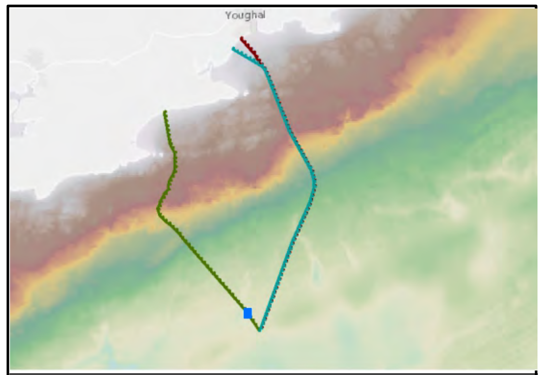
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1003

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A2.3
APPROVED BY	xx	SCALE@A3	1:2,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

- -78.0
- -78.9

0 50m

Cotswold Archaeology marine
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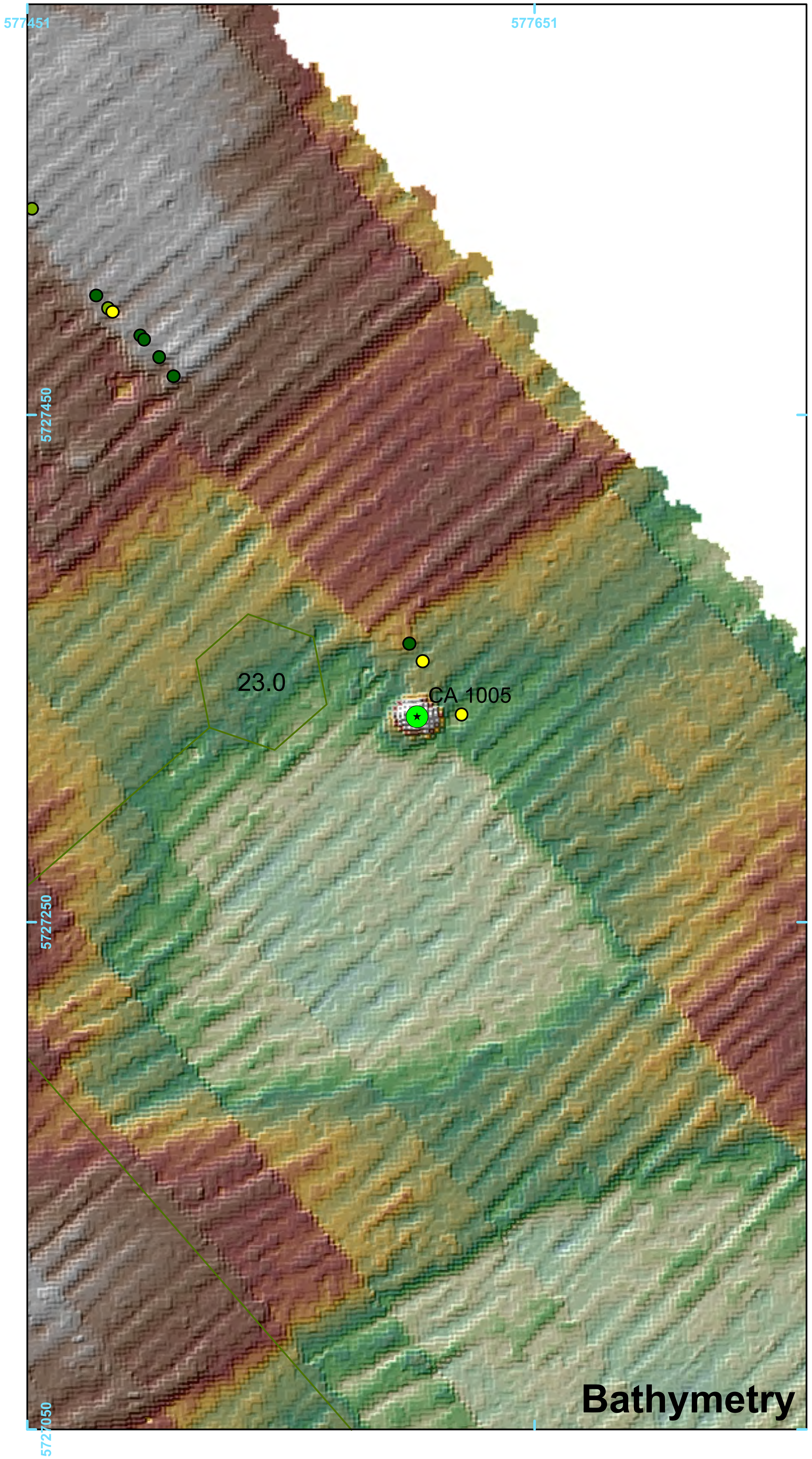
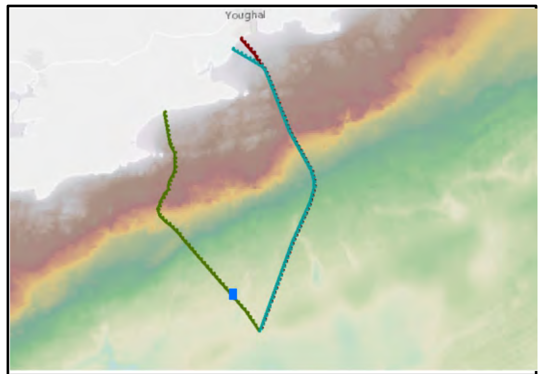
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1004

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	
APPROVED BY	xx	SCALE@A3	1:2,000	A2.4





Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-75.3

-77.1

0 50m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

Cotswold Archaeology marine

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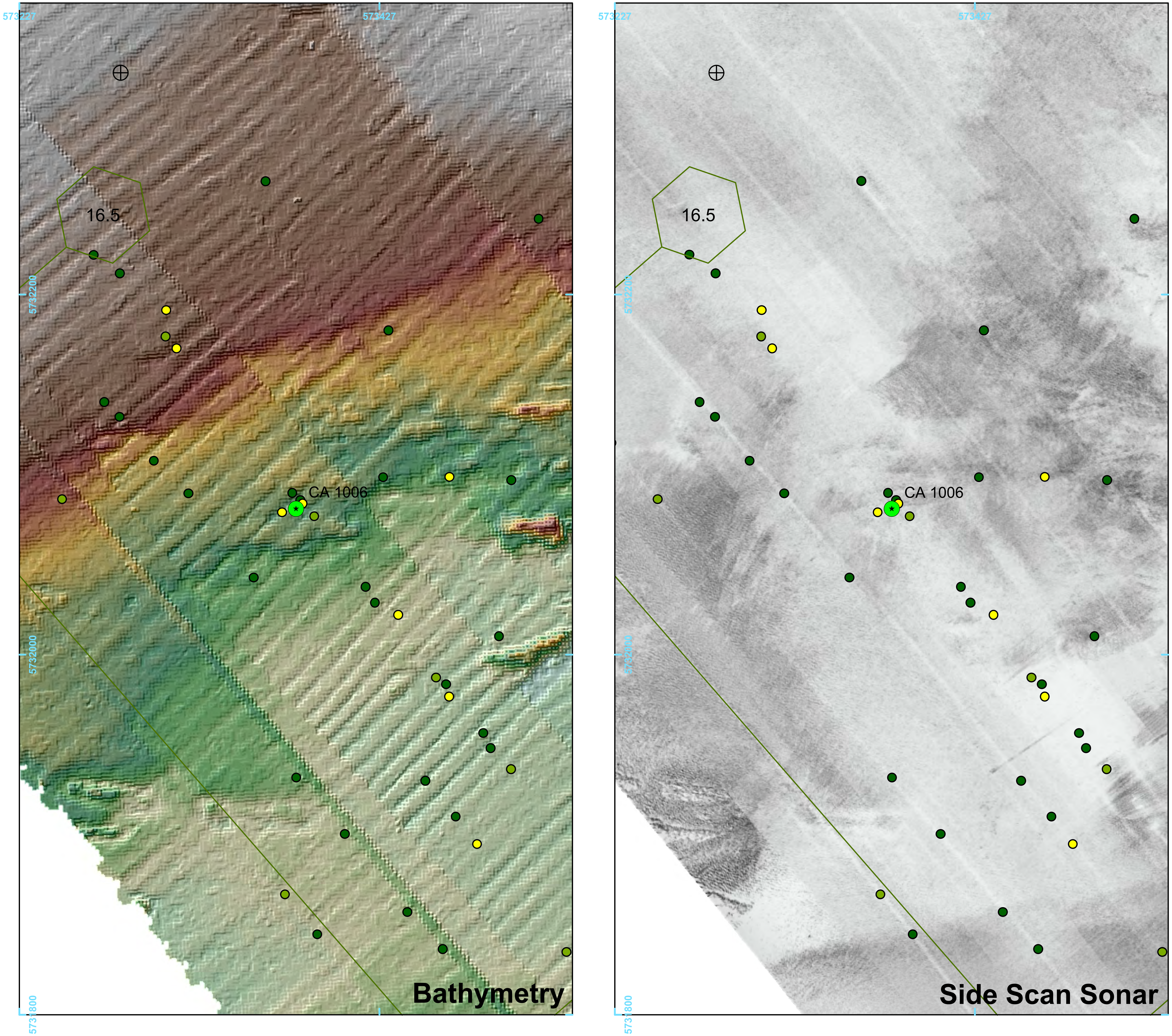
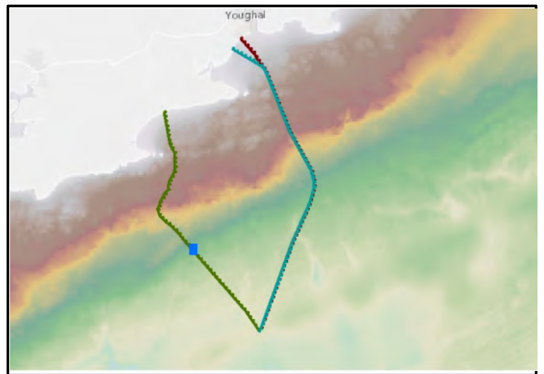
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1005

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	
APPROVED BY	xx	SCALE@A3	1:2,000	A2.5





Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-67.6

-69.0

0 50m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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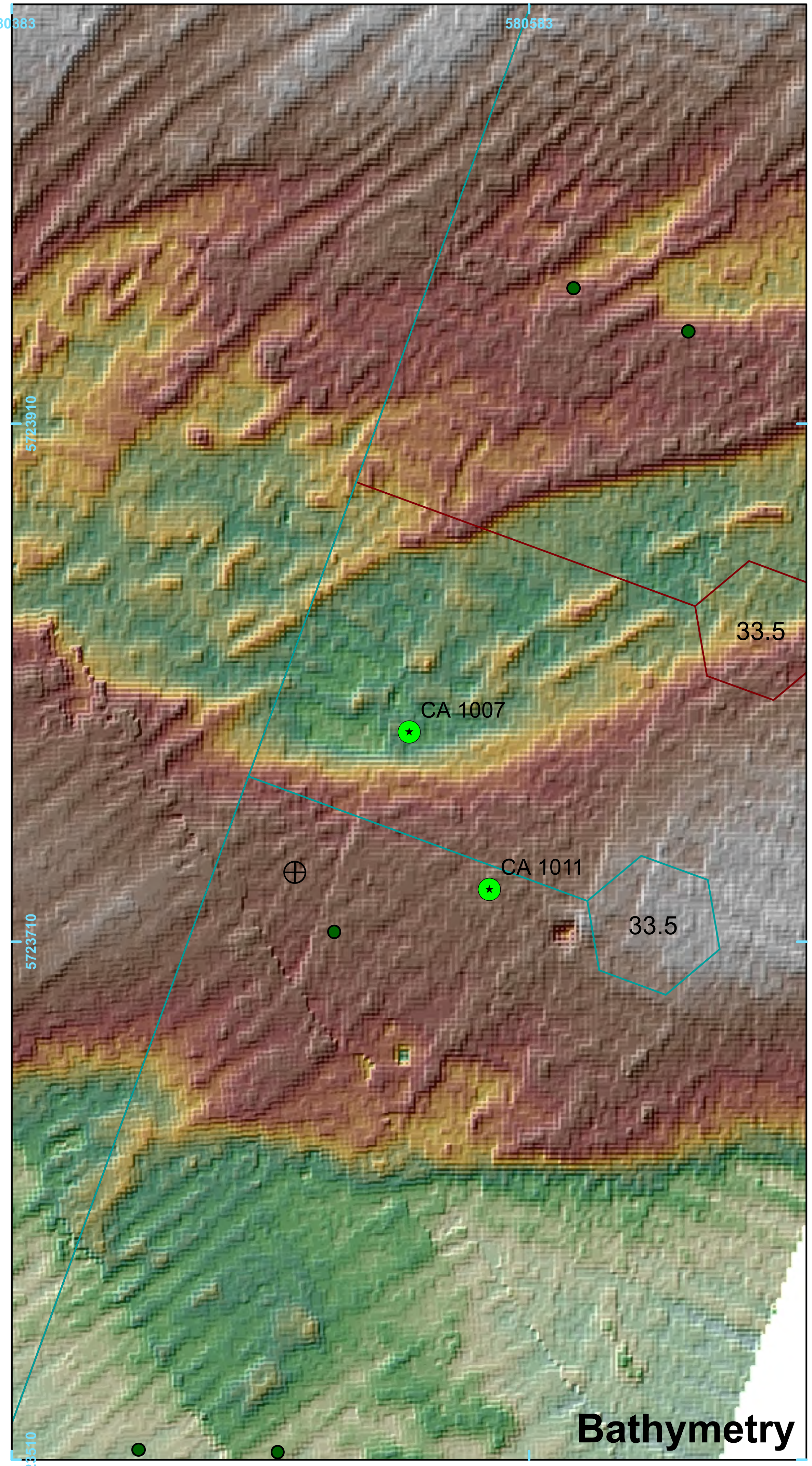
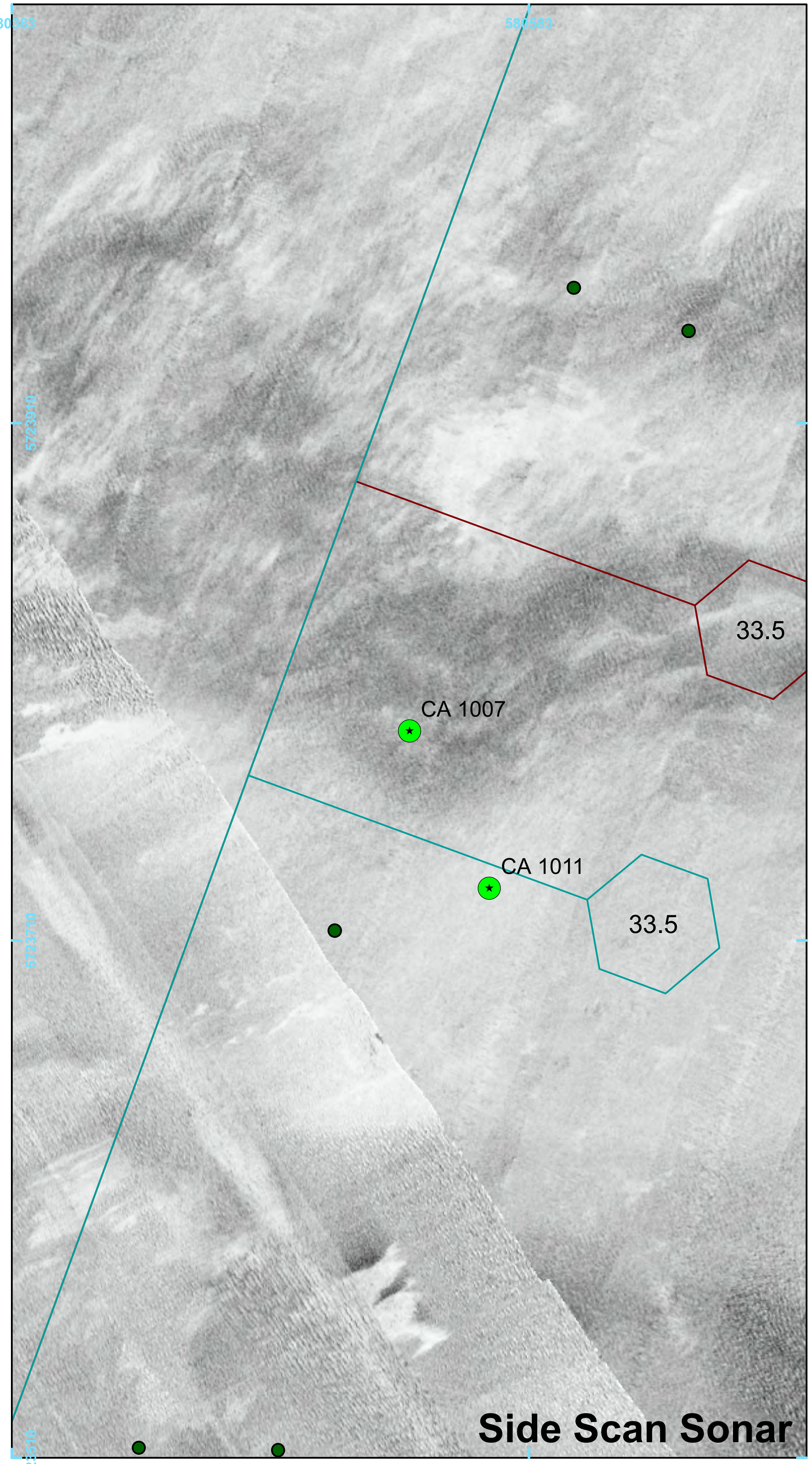
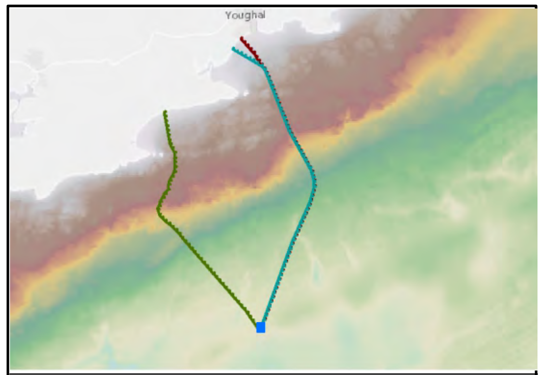
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1006

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	
APPROVED BY	xx	SCALE@A3	1:2,000	A2.6







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-79.9

-80.7

0 50m

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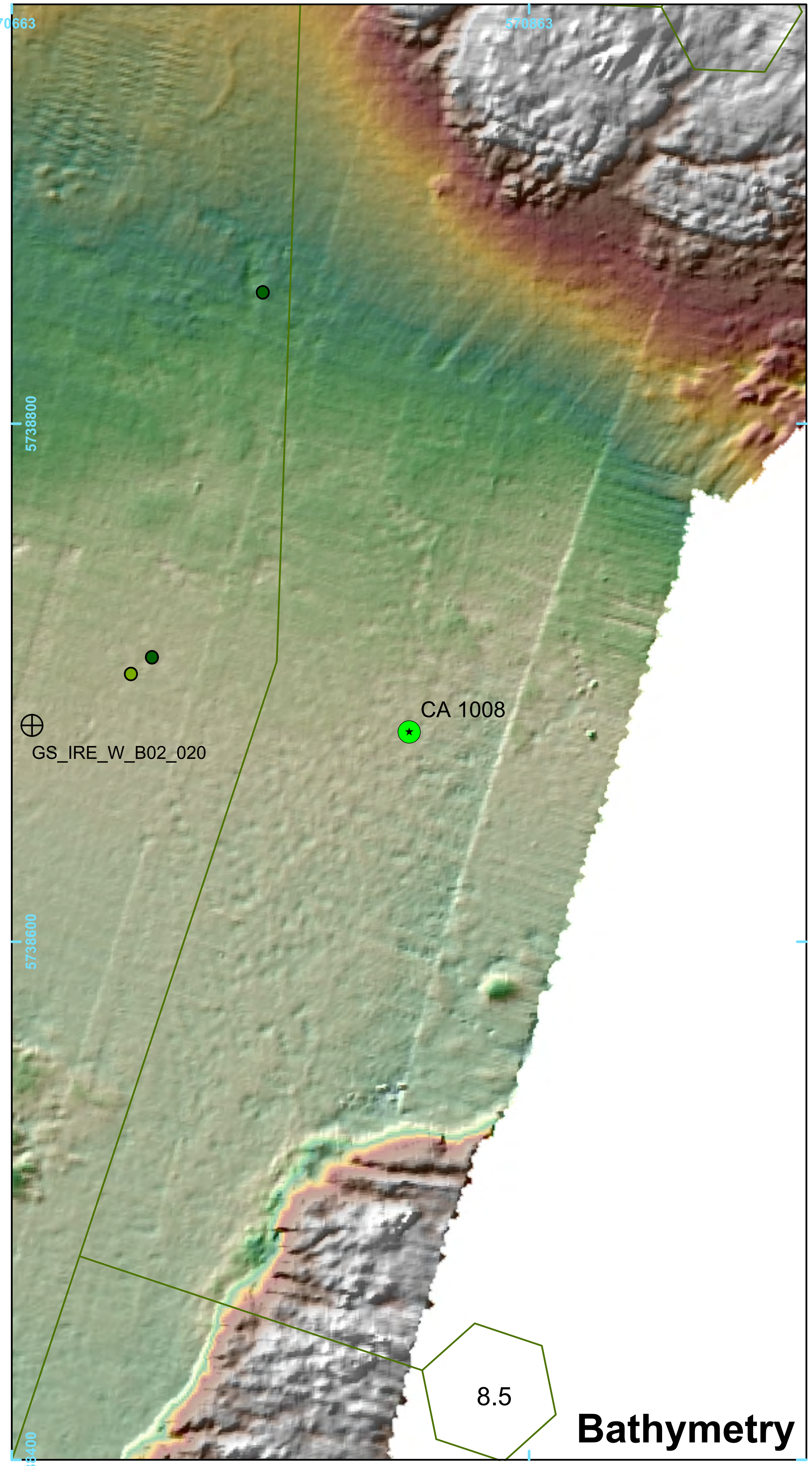
PROJECT TITLE

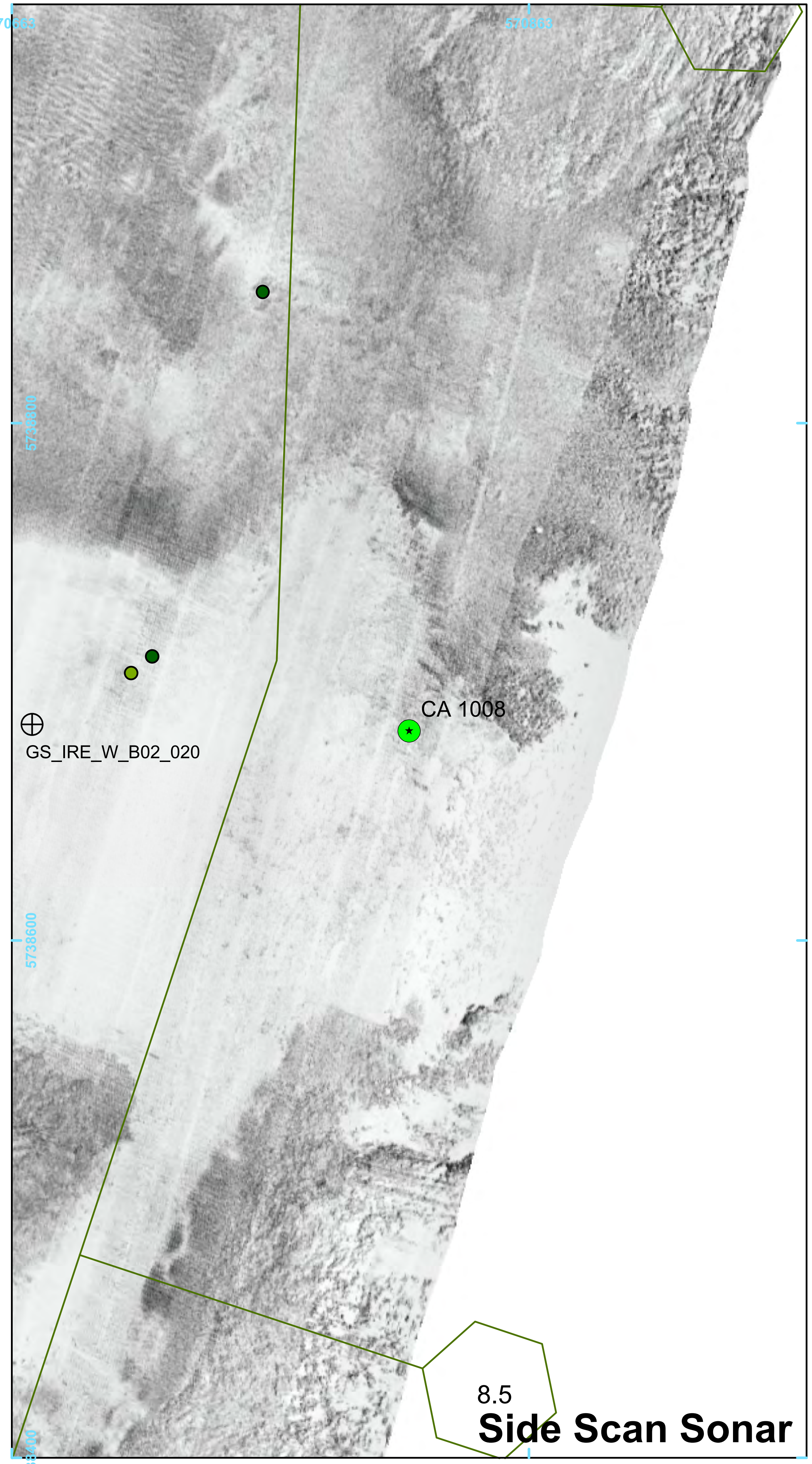
Celtic Interconnector

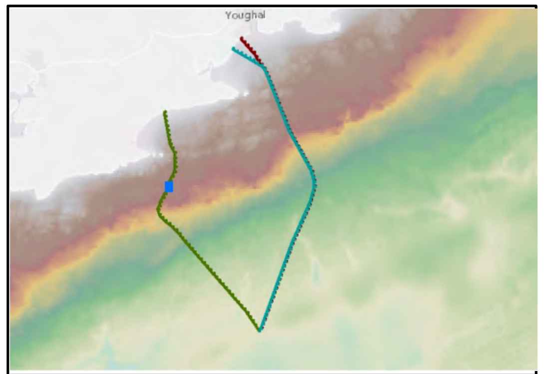
FIGURE TITLE

Geophysical anomaly CA1007

DRAWN BY	MJG (UoS)	*PROJECT NO*	770617	*FIGURE NO.*
CHECKED BY	MW	*DATE*	30/01/2018	A2.7
APPROVED BY	xx	*SCALE@A3*	1:2,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-32.4

-38.1

0 50m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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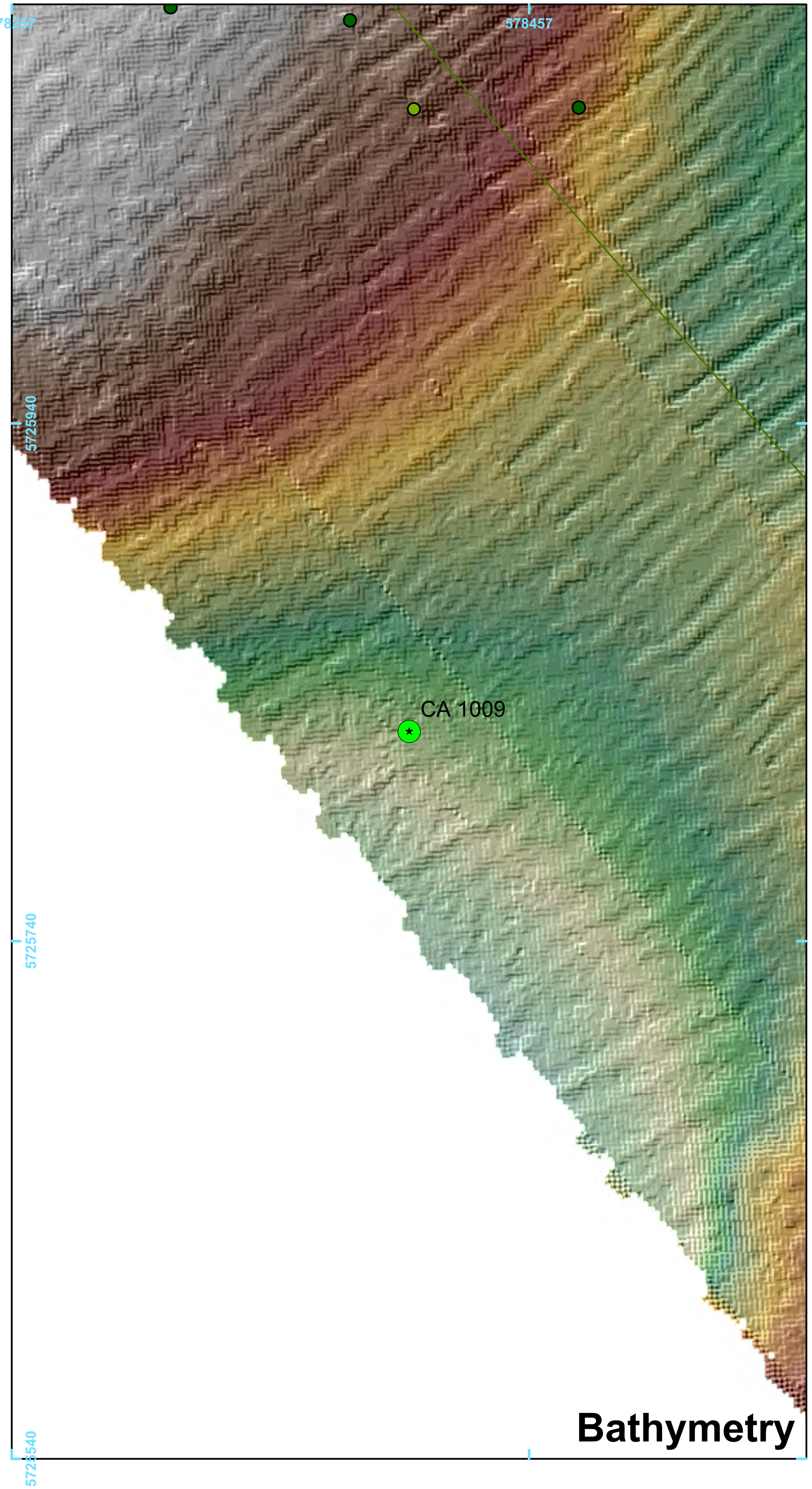
PROJECT TITLE

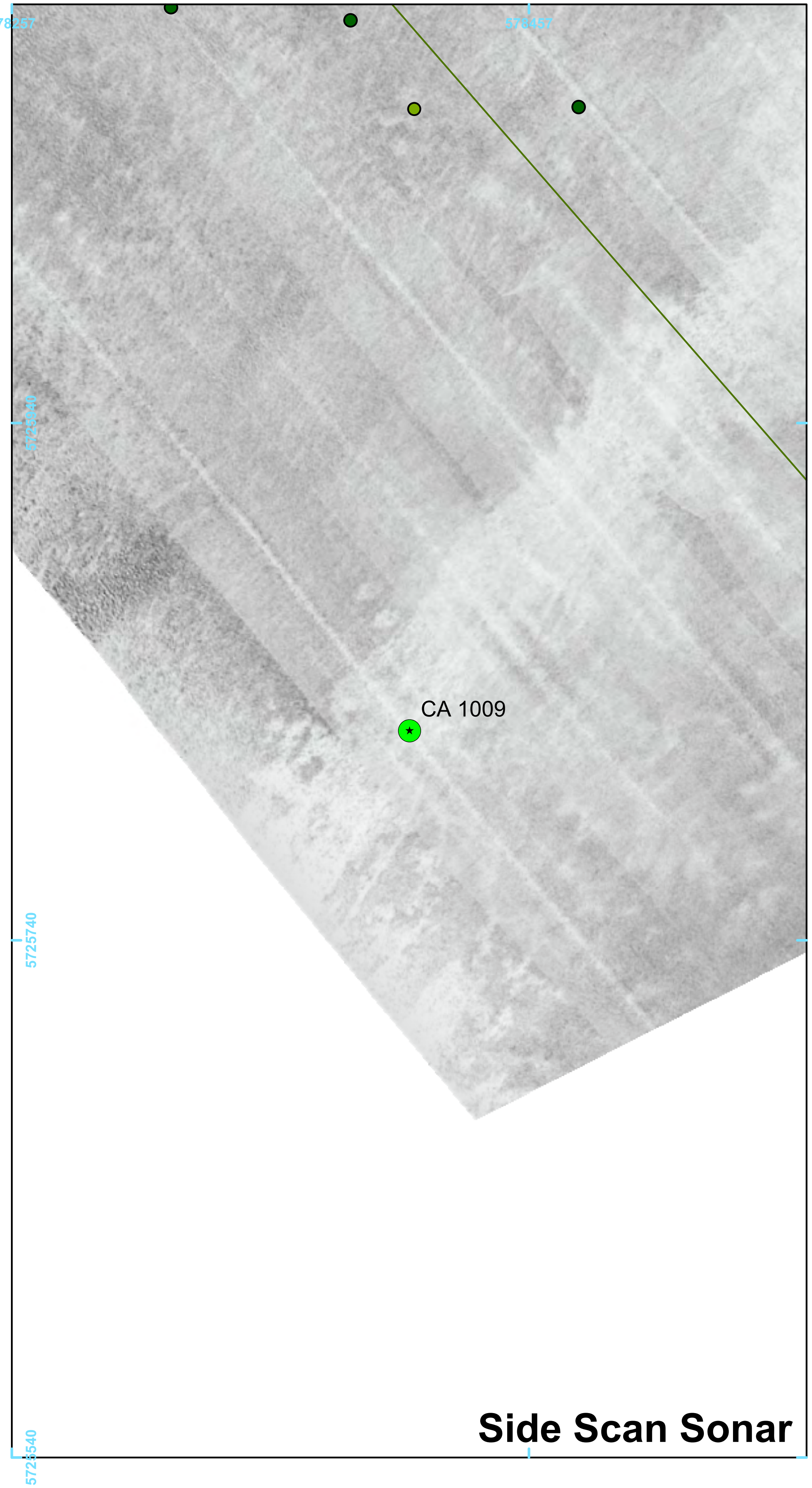
Celtic Interconnector

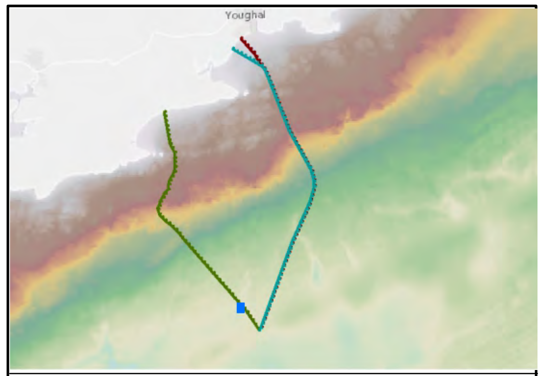
FIGURE TITLE

Geophysical anomaly CA1008

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	**A2.8**
APPROVED BY	xx	SCALE@A3	1:2,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-78.3

-80.3

0 50m

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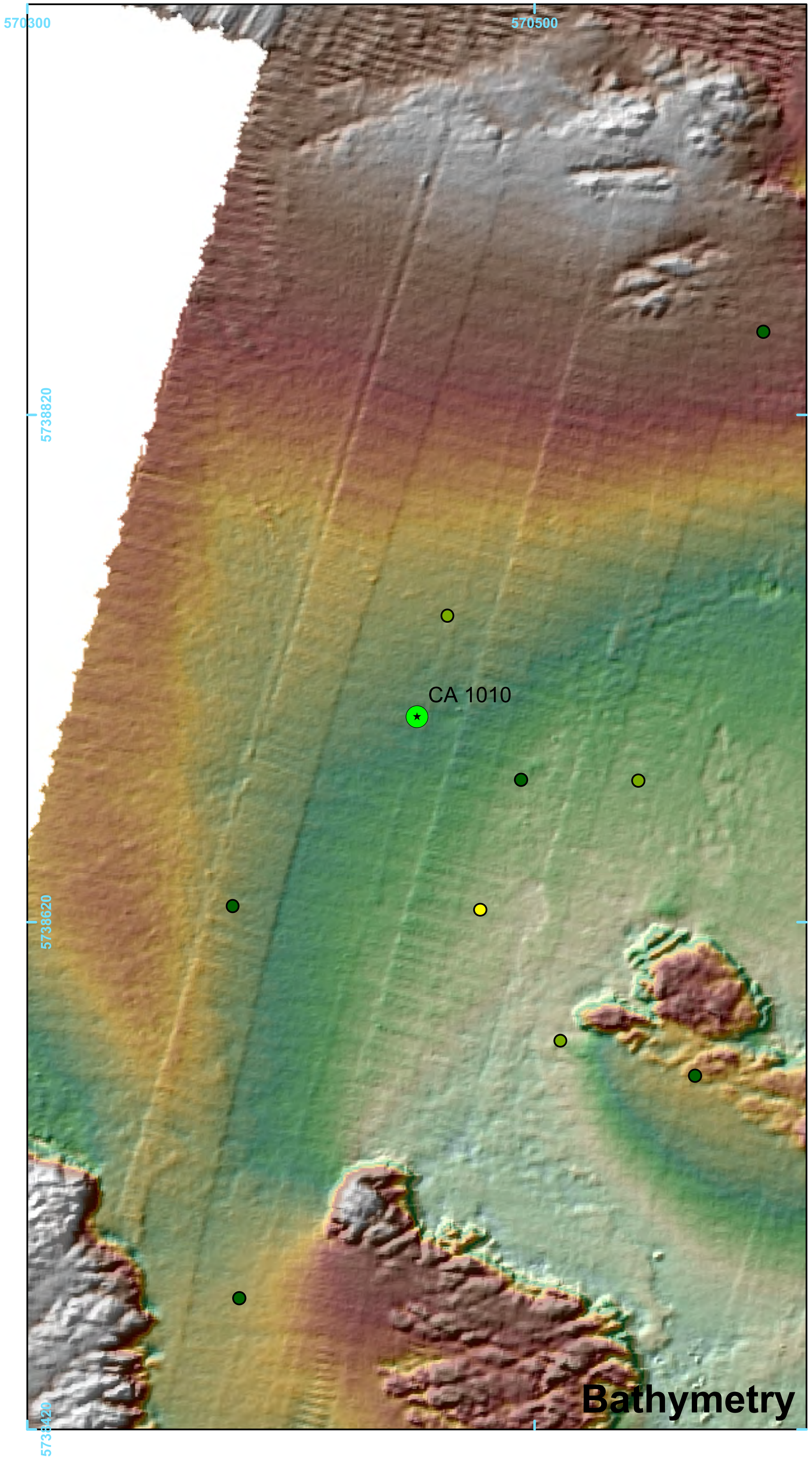
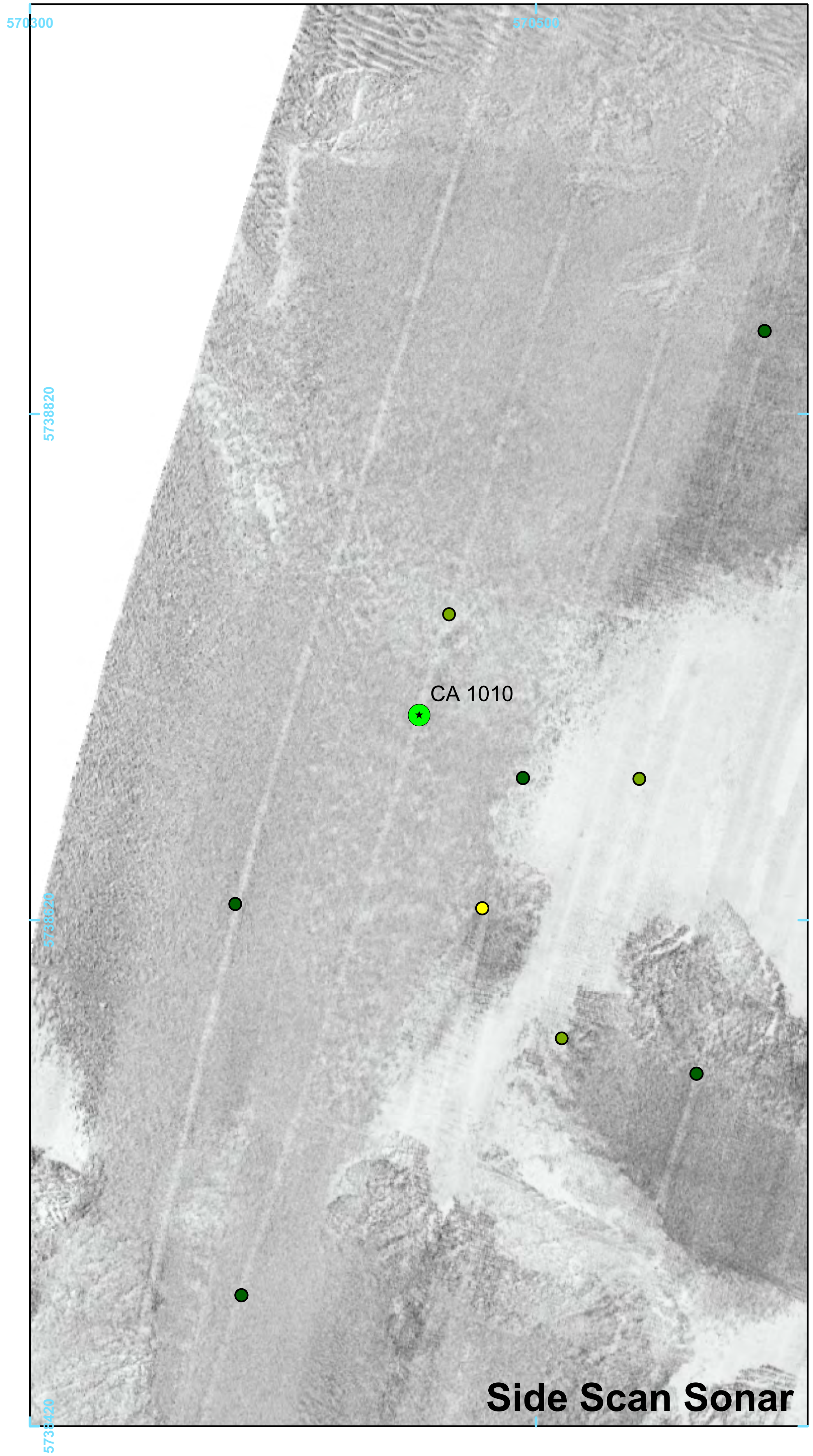
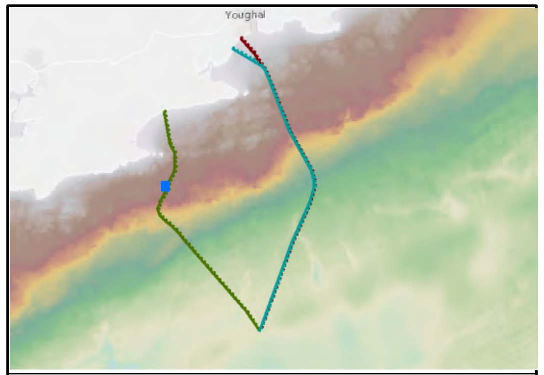
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1009

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A2.9
APPROVED BY	xx	SCALE@A3	1:2,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-34.7

-38.0

0 50m

Cotswold Archaeology marine

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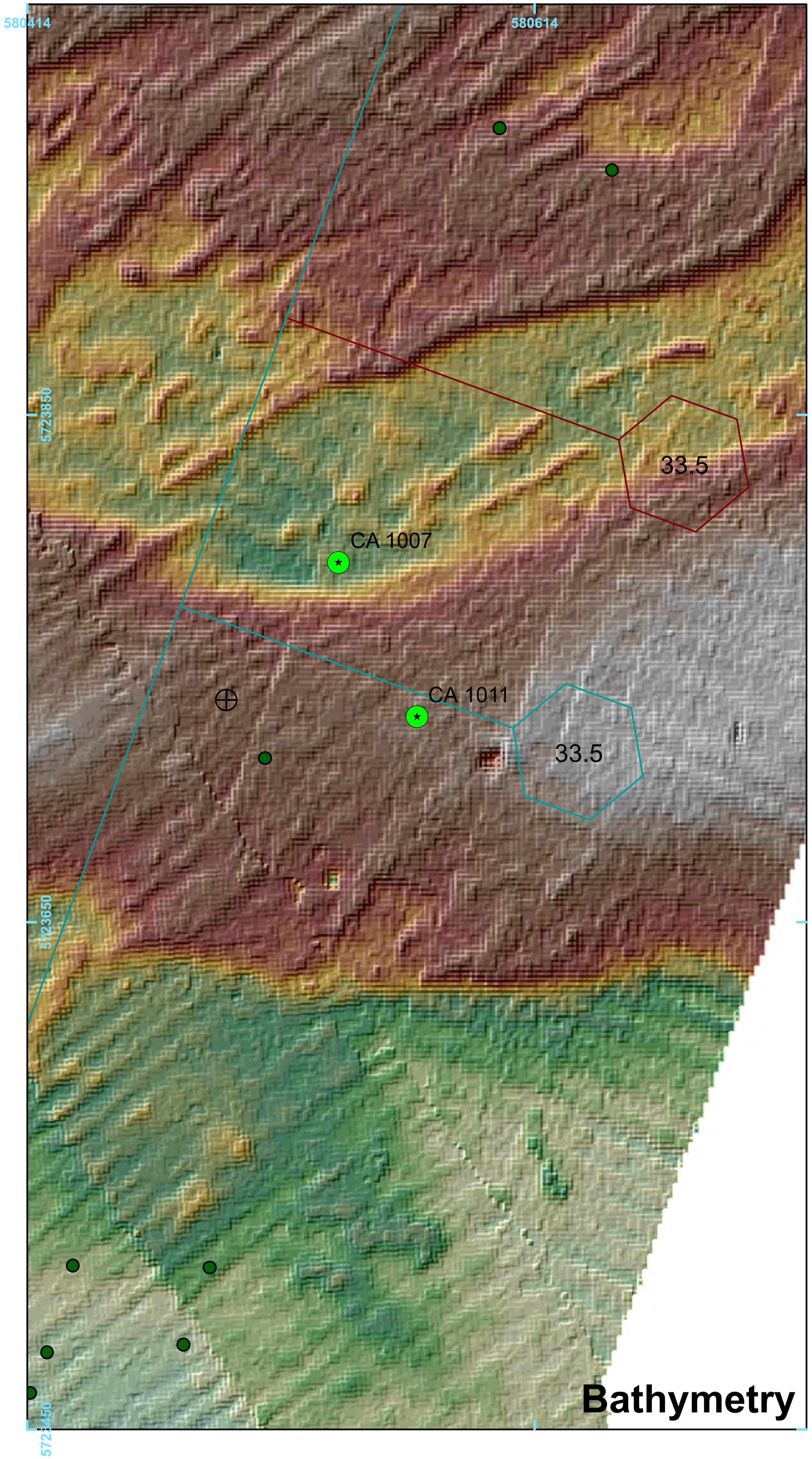
PROJECT TITLE

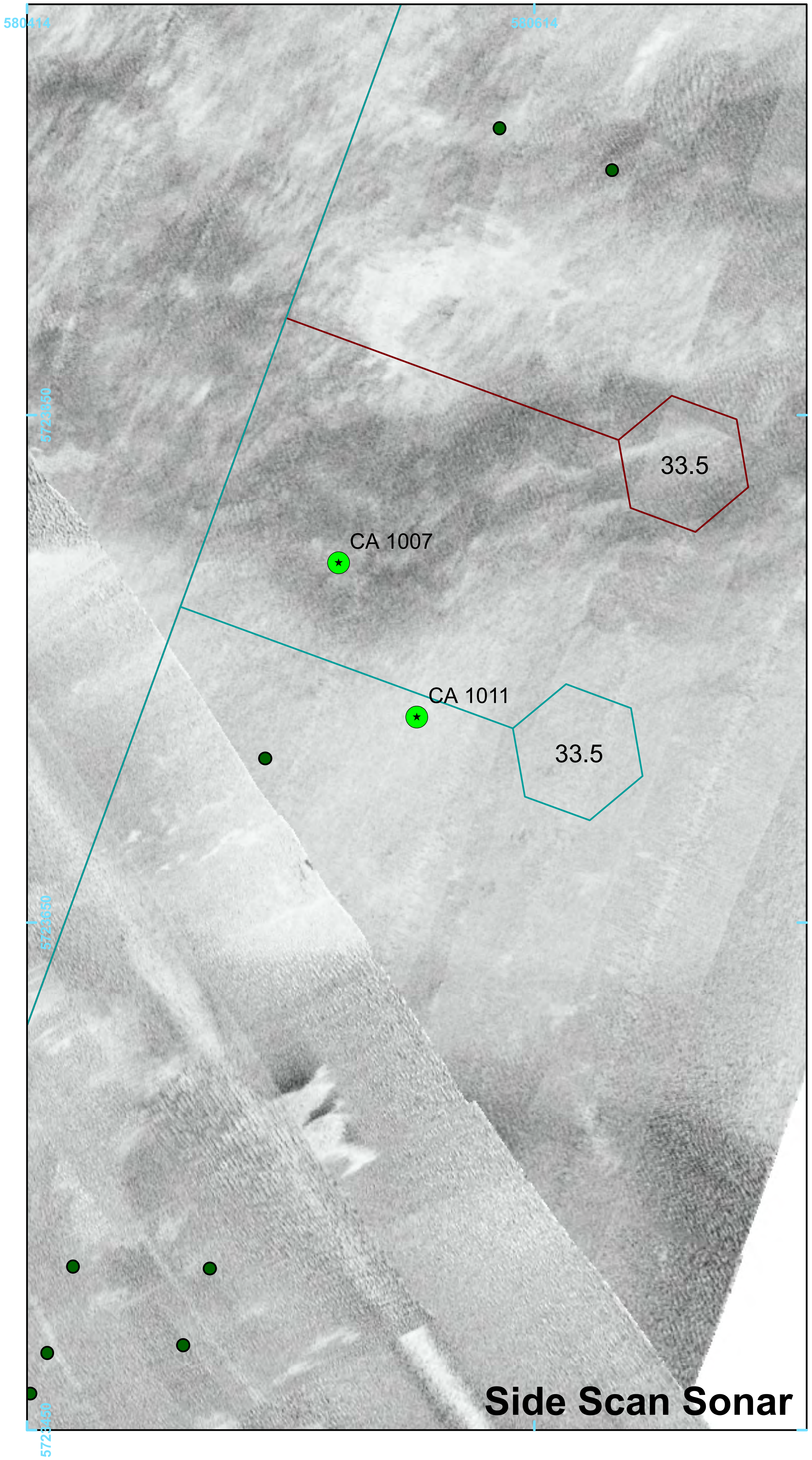
Celtic Interconnector

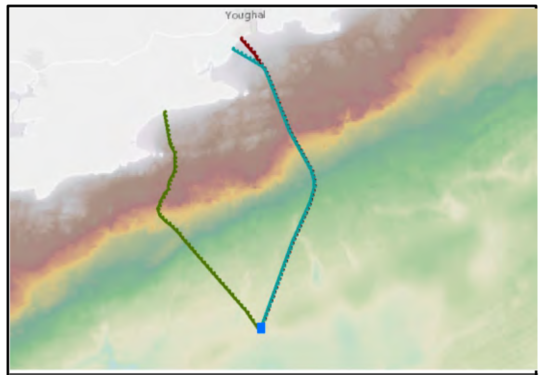
FIGURE TITLE

Geophysical anomaly CA1010

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	**A2.10**
APPROVED BY	xx	SCALE@A3	1:2,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

- -79.9
- -80.7

0 50m

Cotswold Archaeology marine

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Geophysical anomaly CA1011

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A2.11
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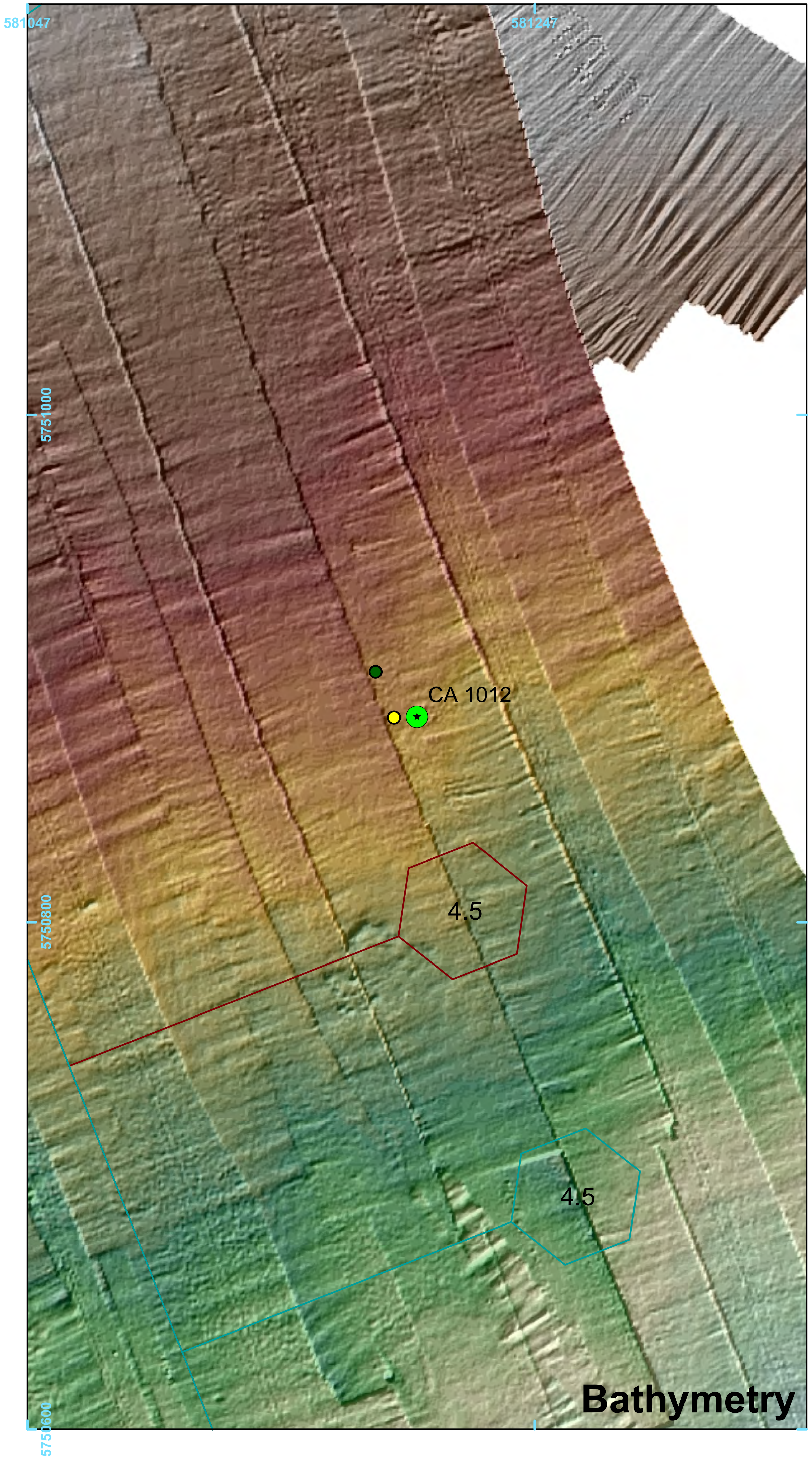

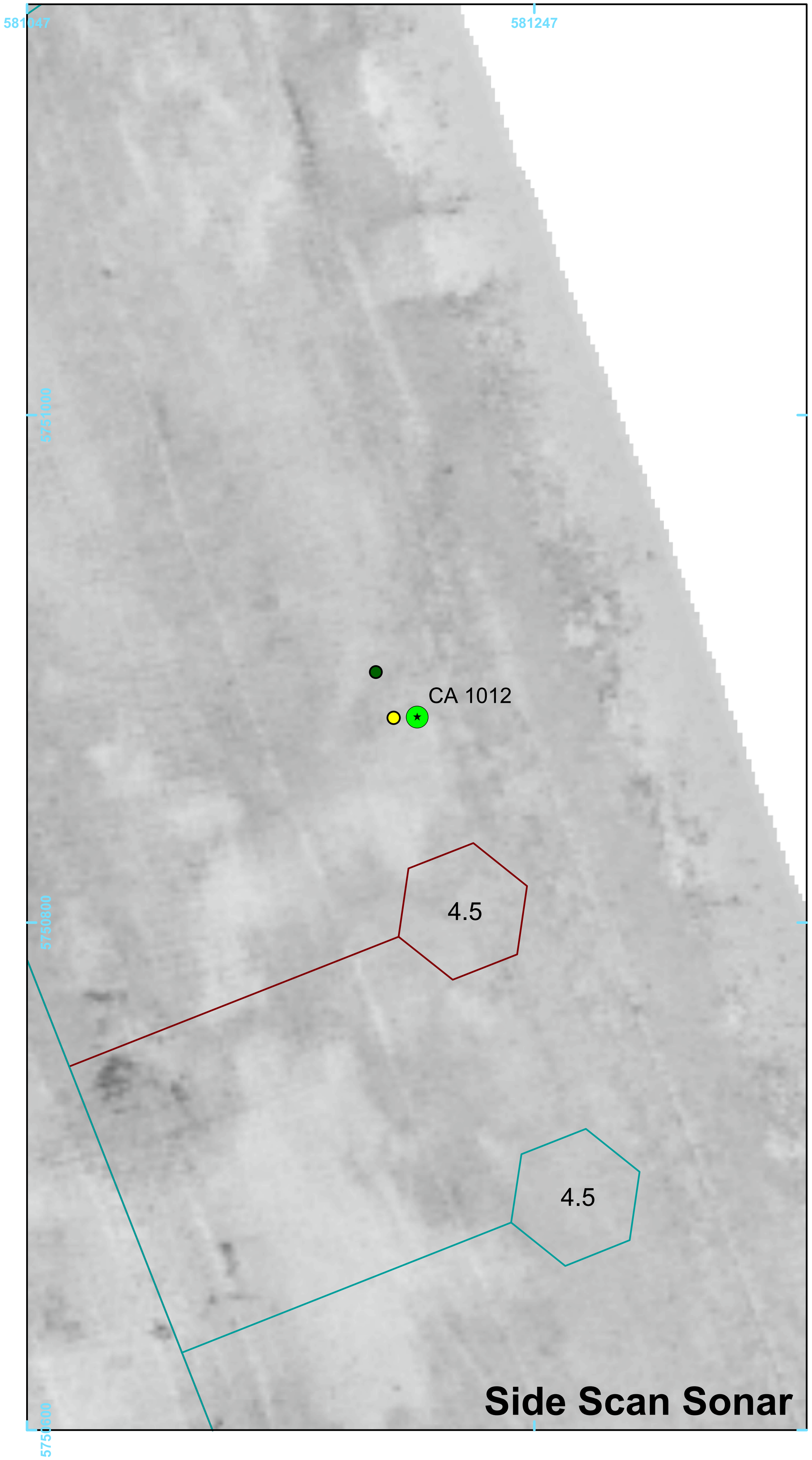

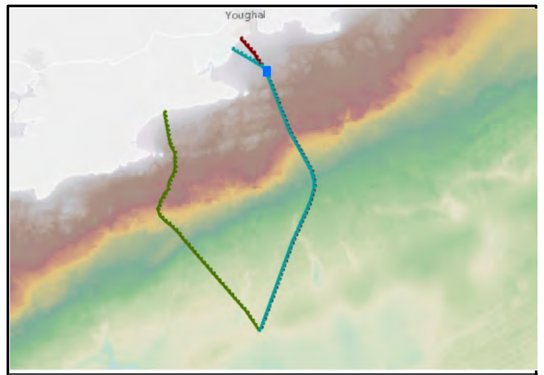

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100

Bathymetry (m LAT)

-15.1

-17.3

0 50m

Cotswold Archaeology marine

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PROJECT TITLE

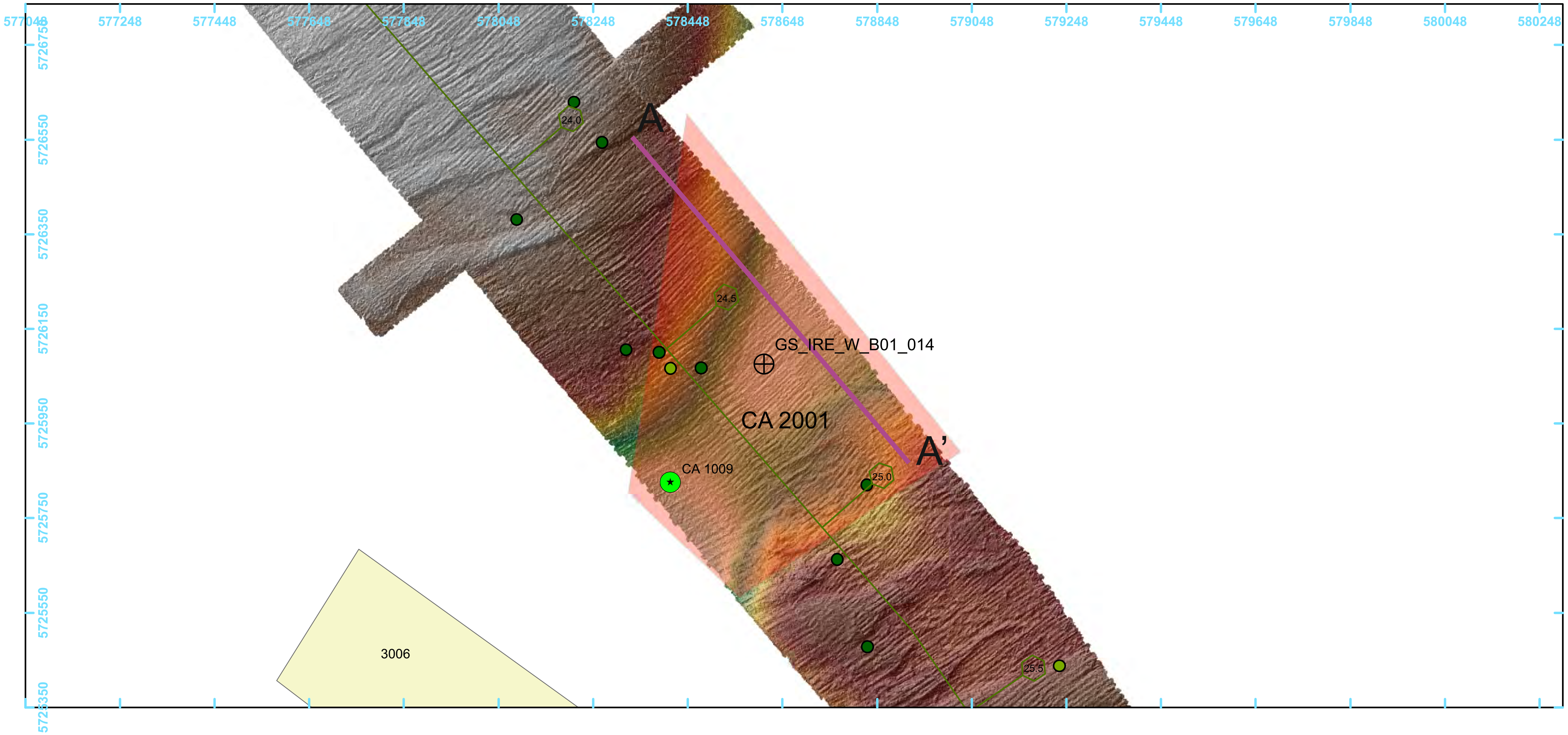
Celtic Interconnector

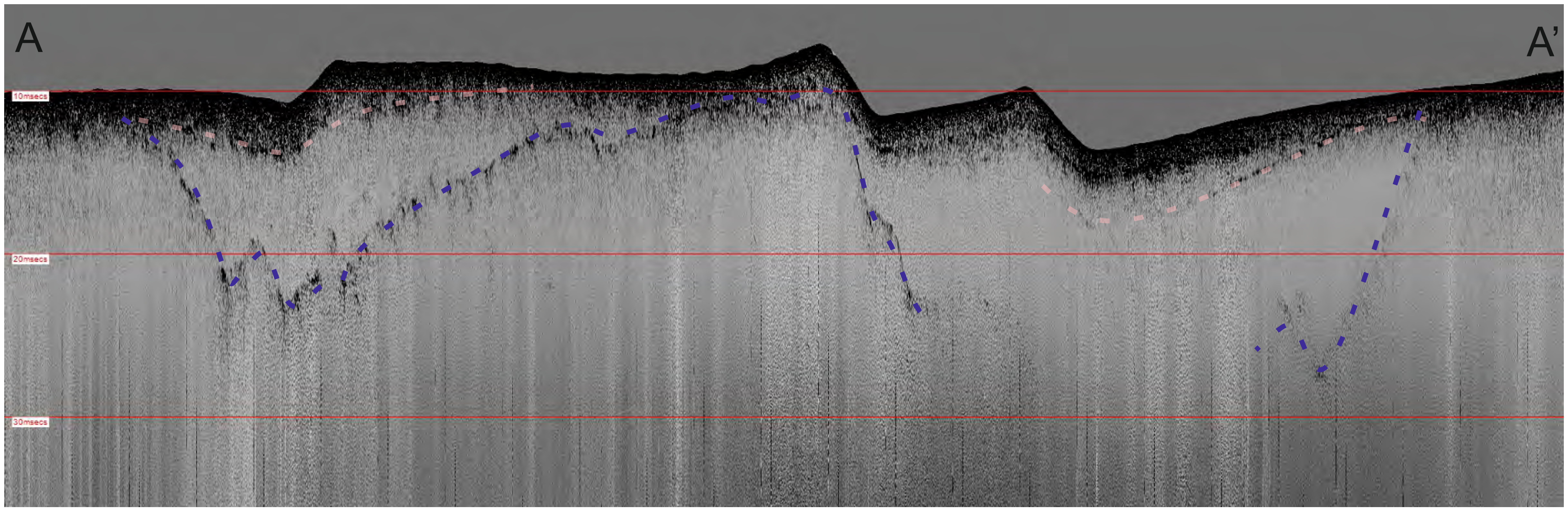
FIGURE TITLE

Geophysical anomaly CA1012

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A2.12
APPROVED BY	xx	SCALE@A3	1:2,000	

APPENDIX 3: SUB-BOTTOM FEATURES WITHIN THE CSC IN IRISH TERRITORIAL WATERS





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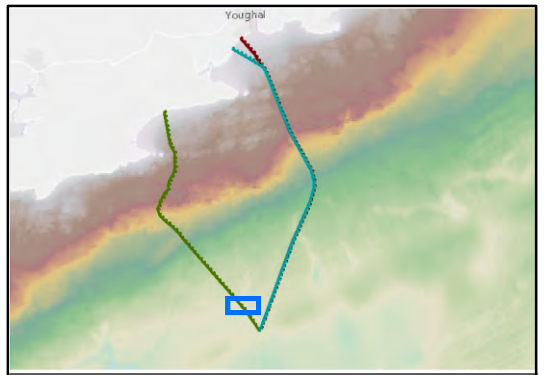

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-77.0

-80.3

0 400m

Cotswold Archaeology marine

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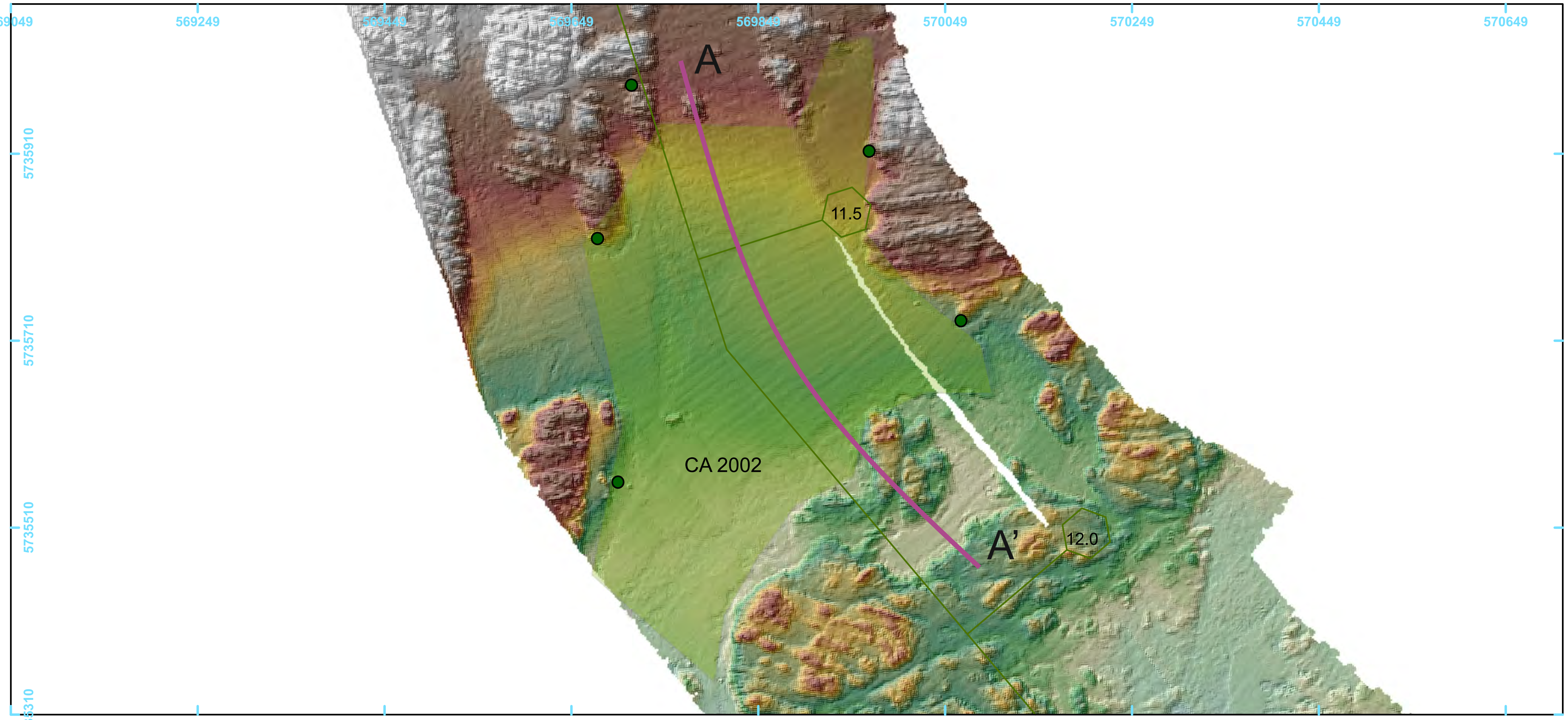
PROJECT TITLE

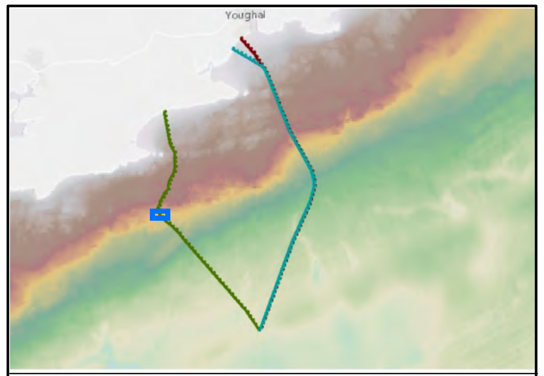
Celtic Interconnector

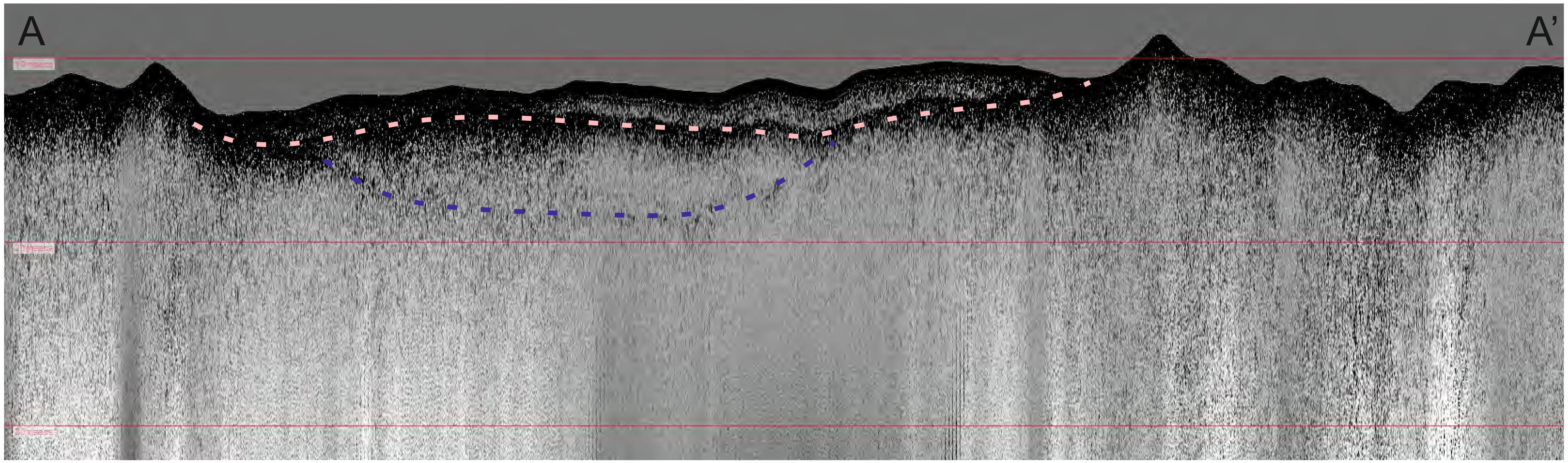
FIGURE TITLE

Sub-bottom Feature CA2001

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.1
APPROVED BY	xx	SCALE@A3	1:10,000	







Survey Line BL1_IR_W_06

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-47.0

-55.0

0 200m

Cotswold Archaeology marine

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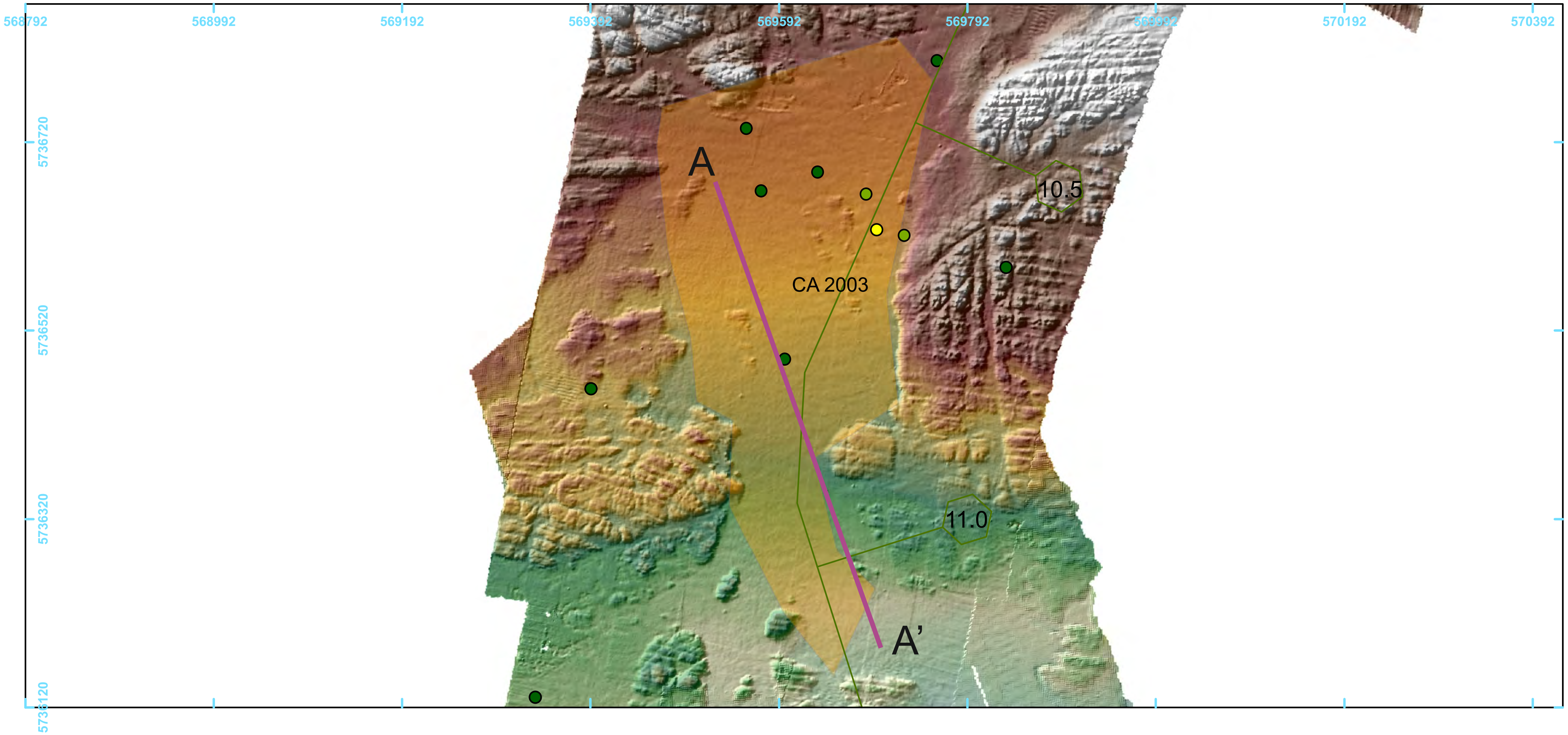
PROJECT TITLE

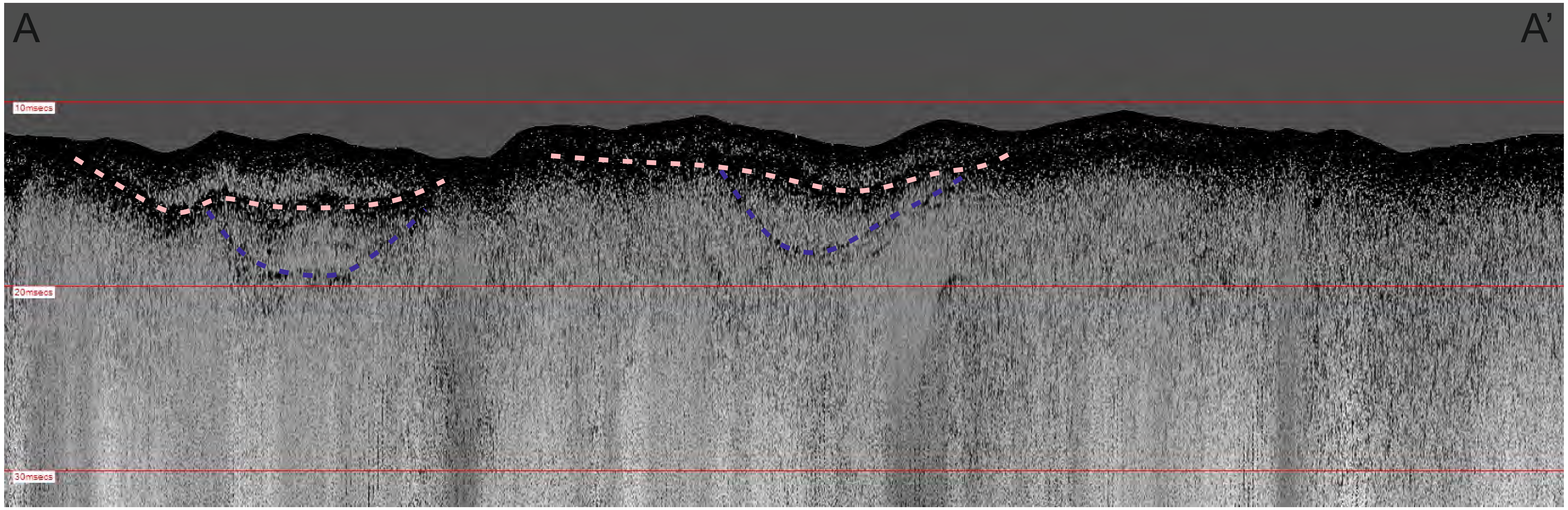
Celtic Interconnector

FIGURE TITLE

Sub-bottom Feature CA2002

DRAWN BY	MJG (UoS)	*PROJECT NO*	770617	*FIGURE NO.*
CHECKED BY	MW	*DATE*	29/01/2018	A3.2
APPROVED BY	xx	*SCALE@A3*	1:5,000	





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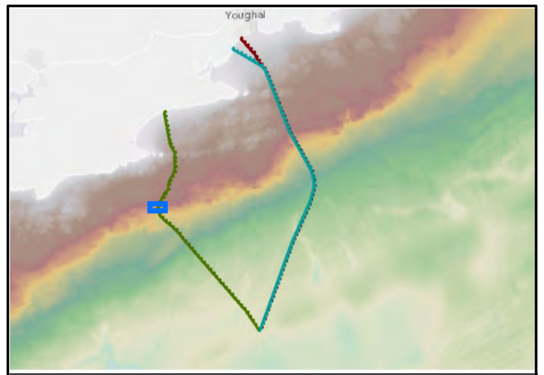

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-37.5

-50.2

0 200m

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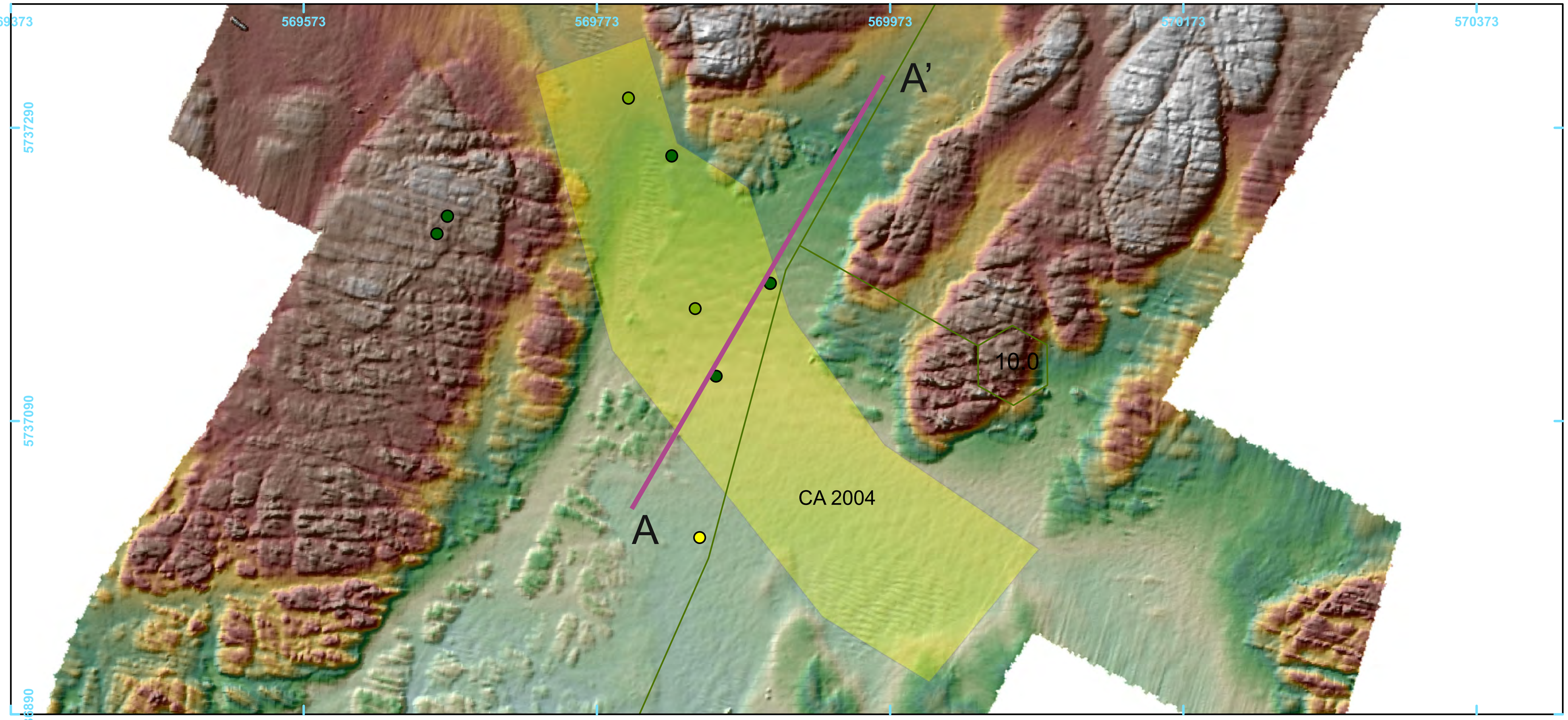
PROJECT TITLE

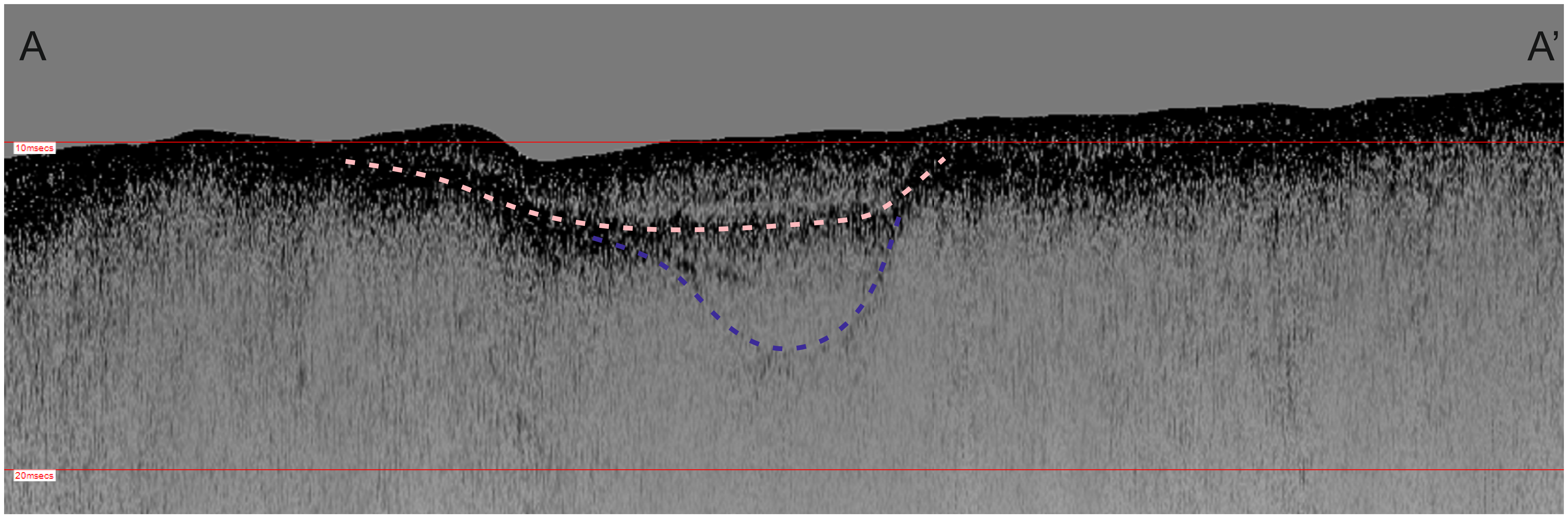
Celtic Interconnector

FIGURE TITLE

Sub-bottom Feature CA2003

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.3
APPROVED BY	xx	SCALE@A3	1:5,000	





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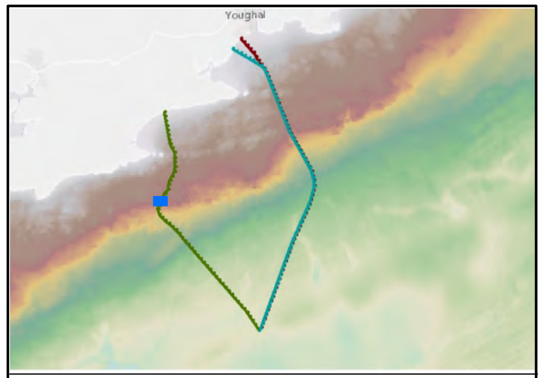

Legend

Proposed Coring Locations
Geophysical Anomaly
Redbarn Route
Claycastle Route
Ballinwilling Route

Magnetic Anomaly (nT)

2-5
5-10
10-50
50-100
>100
Previously mapped Palaeochannels

Quaternary Infilled Features (m)

2
3 - 4
5 - 6
7 - 8
9 - 18

Bathymetry (m LAT)

-29.1
-43.4

0 125m

Cotswold Archaeology marine
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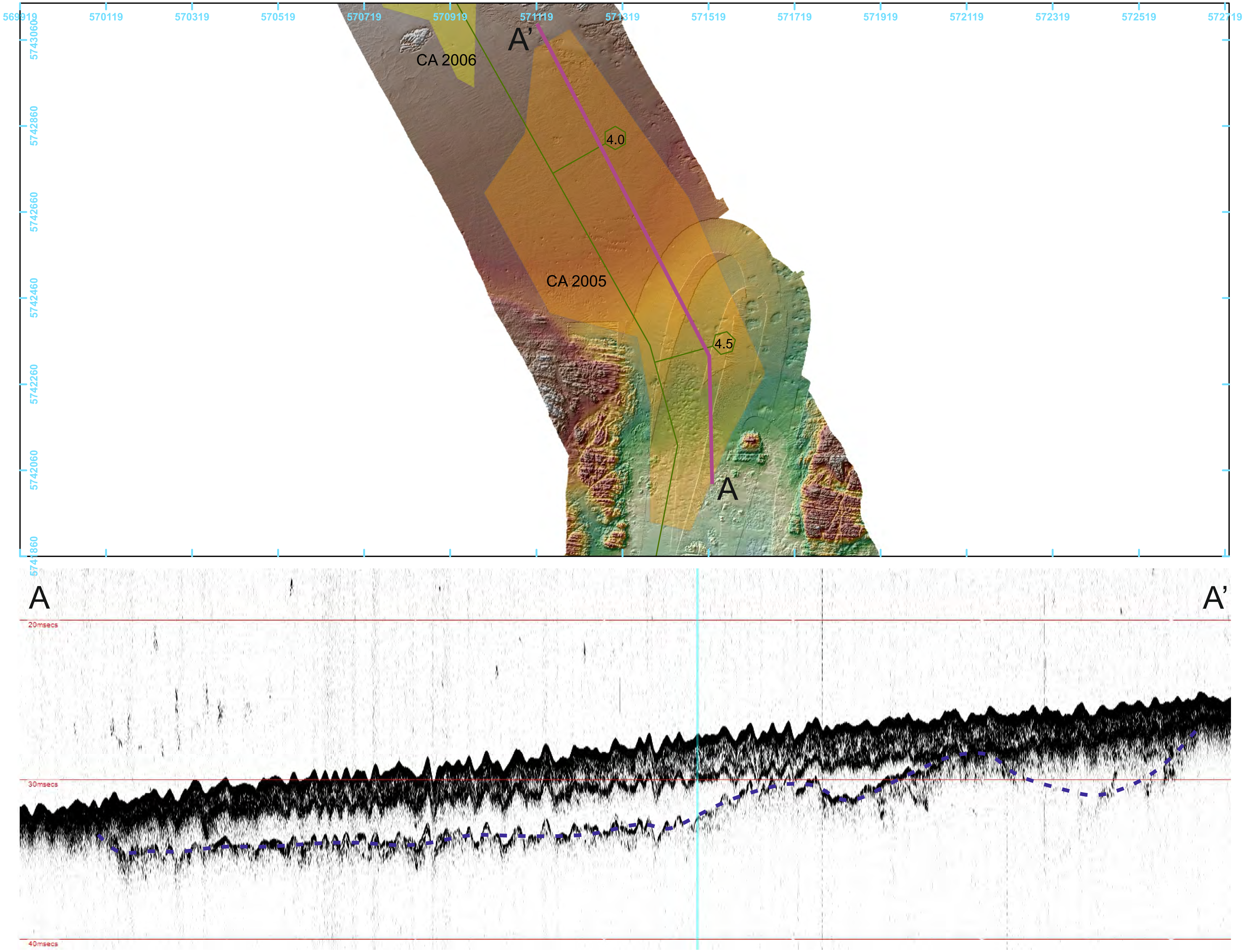
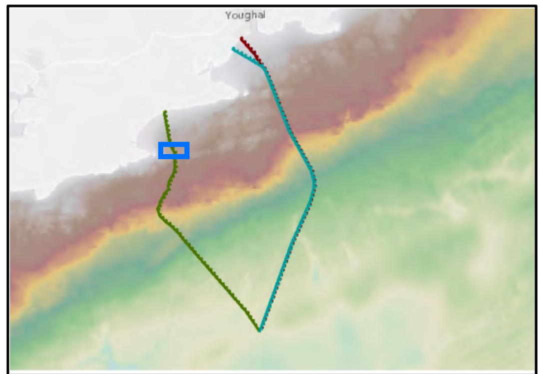
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2004

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.4
APPROVED BY	xx	SCALE@A3	1:3,250	



Survey Line Celtic_9_20171108144912_LF



Legend

Proposed Coring Locations

Geophysical Anomaly

Redbarn Route

Claycastle Route

Ballinwilling Route

Magnetic Anomaly (nT)

2-5

5-10

10-50

50-100

>100

Previously mapped Palaeochannels

Quaternary Infilled Features (m)

2

3 - 4

5 - 6

7 - 8

9 - 18

Bathymetry (m LAT)

-16.0

-25.2

0 375m

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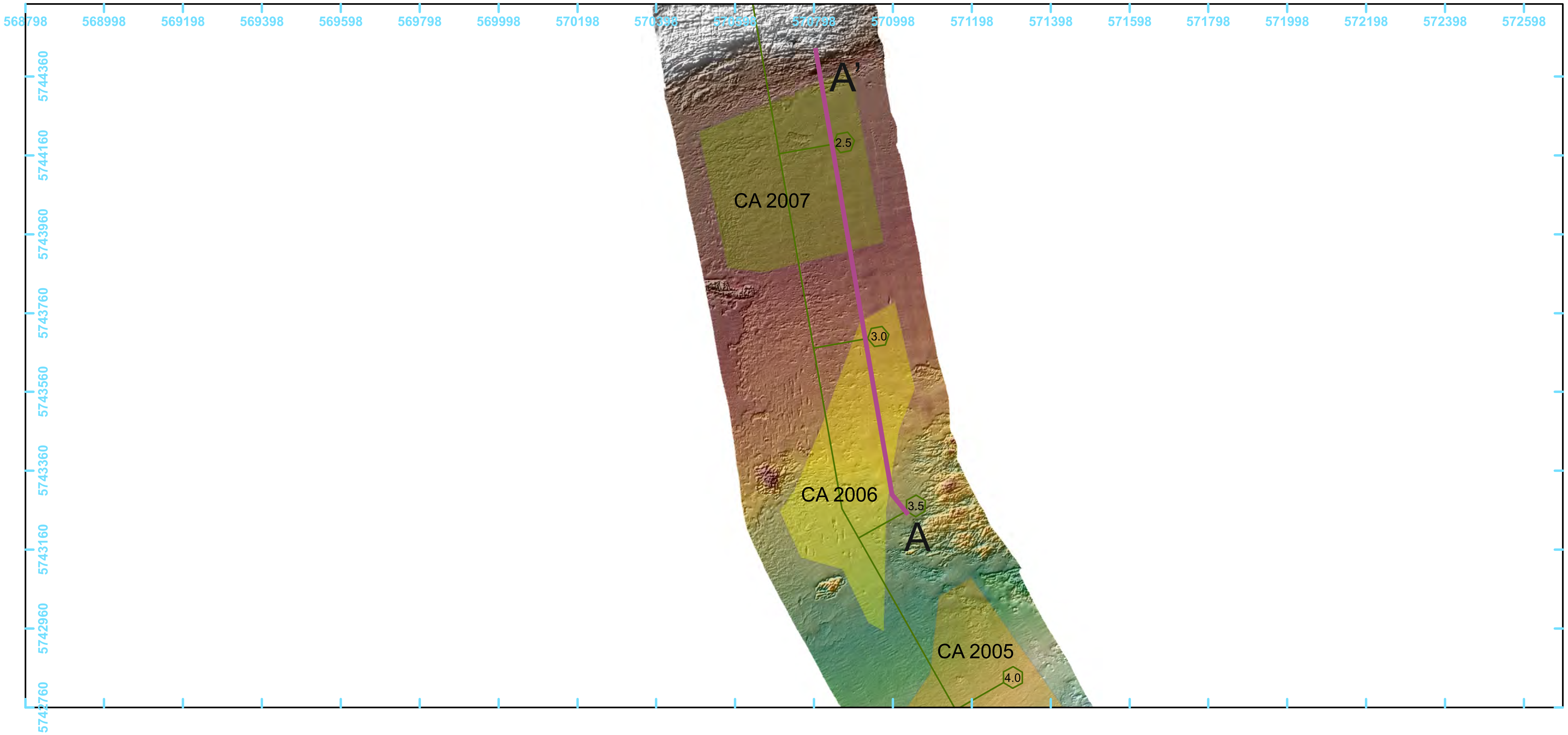
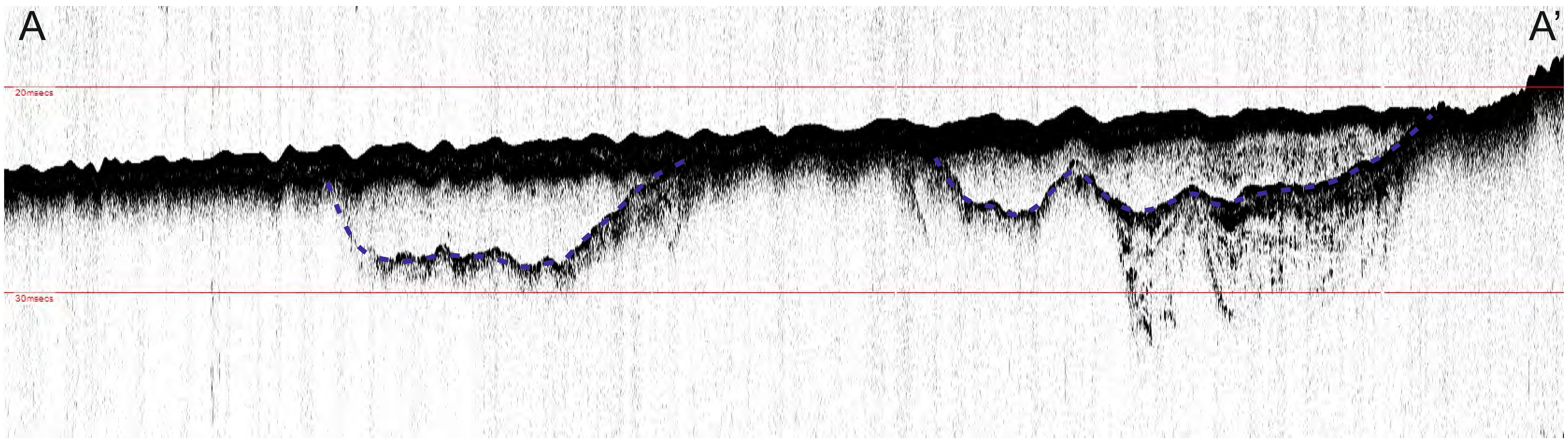
PROJECT TITLE
Celtic Interconnector

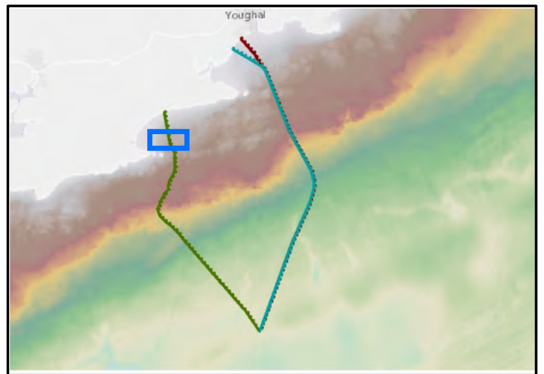
FIGURE TITLE
Sub-bottom Feature CA2005

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.5
APPROVED BY	xx	SCALE@A3	1:8,650	





Survey Line Celtic_9_20171108144912_LF



Legend

Proposed Coring Locations
Geophysical Anomaly
Redbarn Route
Claycastle Route
Ballinwilling Route

Magnetic Anomaly (nT)

2-5
5-10
10-50
50-100
>100
Previously mapped Palaeochannels

Quaternary Infilled Features (m)

2
3 - 4
5 - 6
7 - 8
9 - 18

Bathymetry (m LAT)

-10.9
-20.5

0 500m

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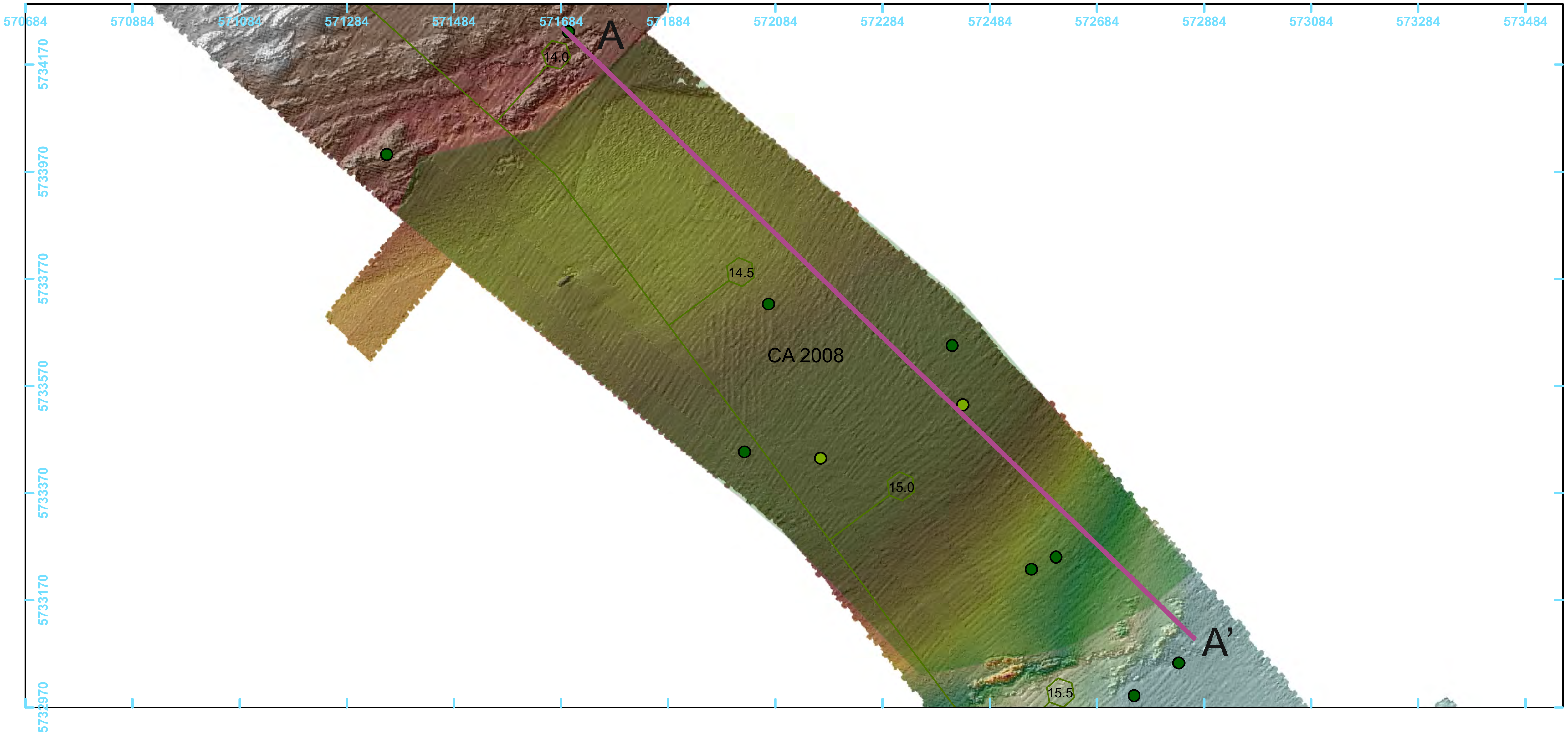
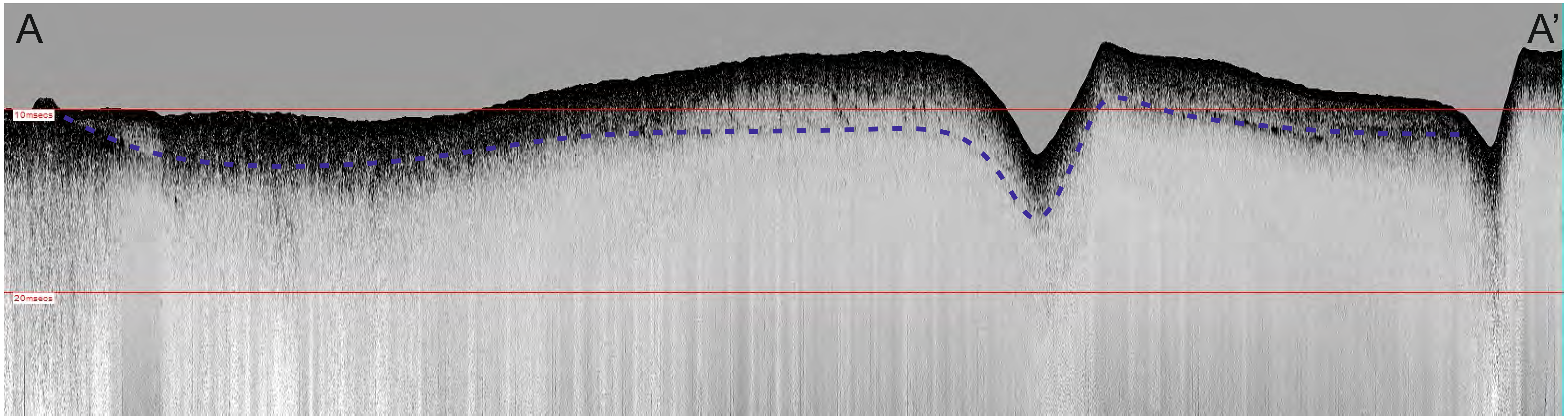
PROJECT TITLE
Celtic Interconnector

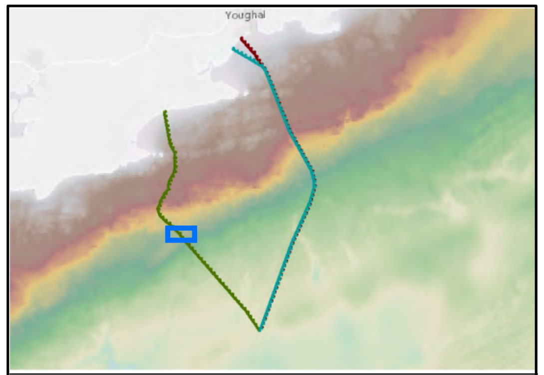
FIGURE TITLE
Sub-bottom Features CA2006 and Ca2007

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.6
APPROVED BY	xx	SCALE@A3	1:12,000	





Survey Line BL_IR_W_09



Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-56.3

-65.9

0 375m

Cotswold Archaeology marine

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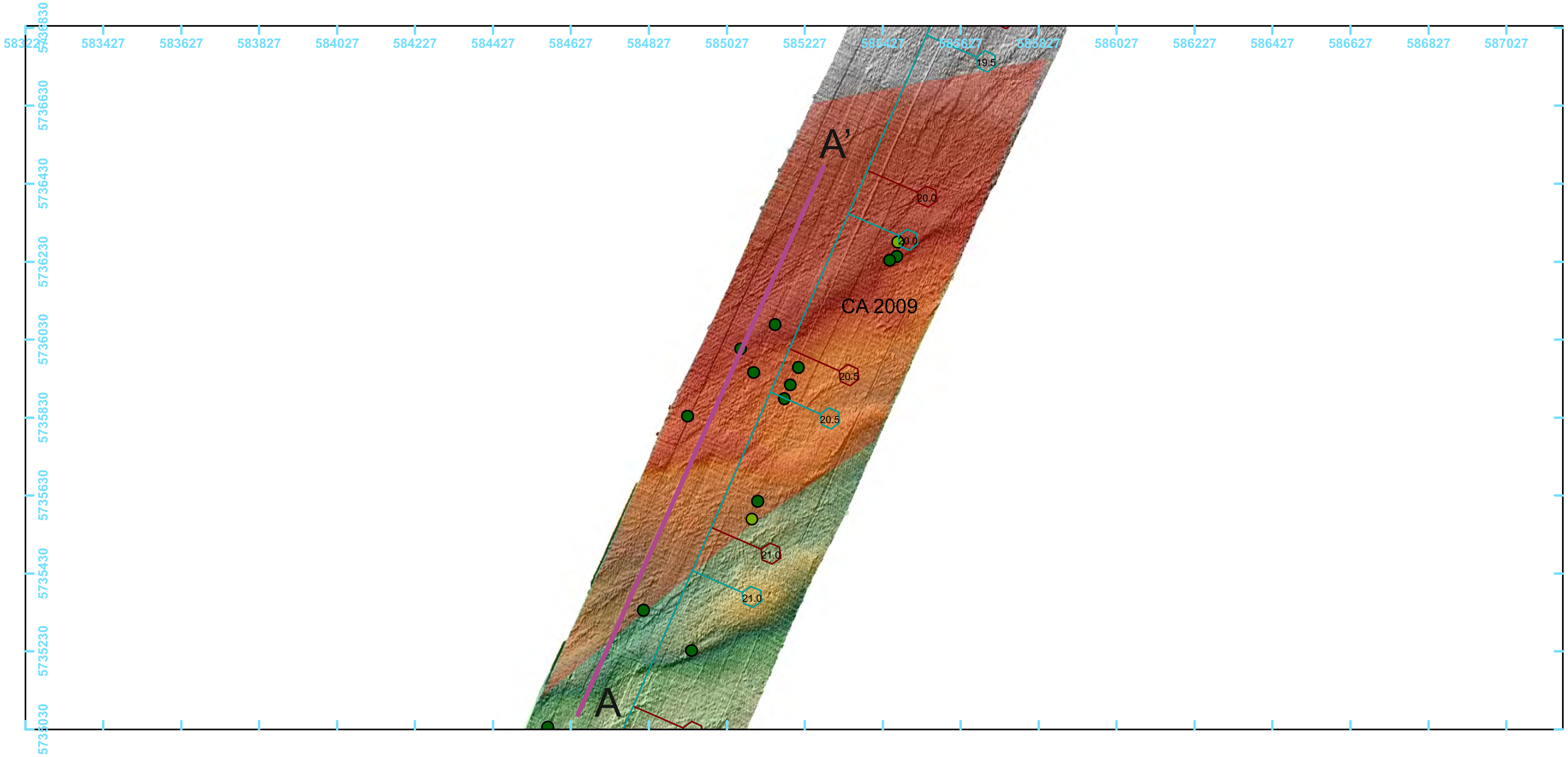
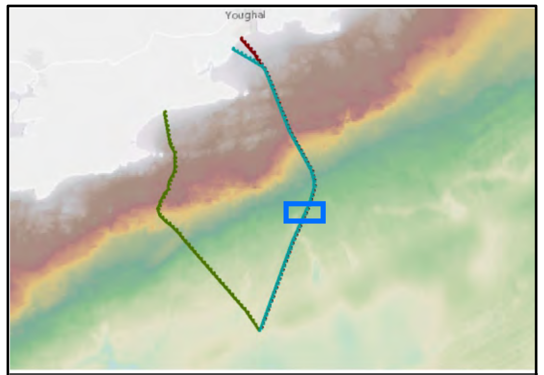
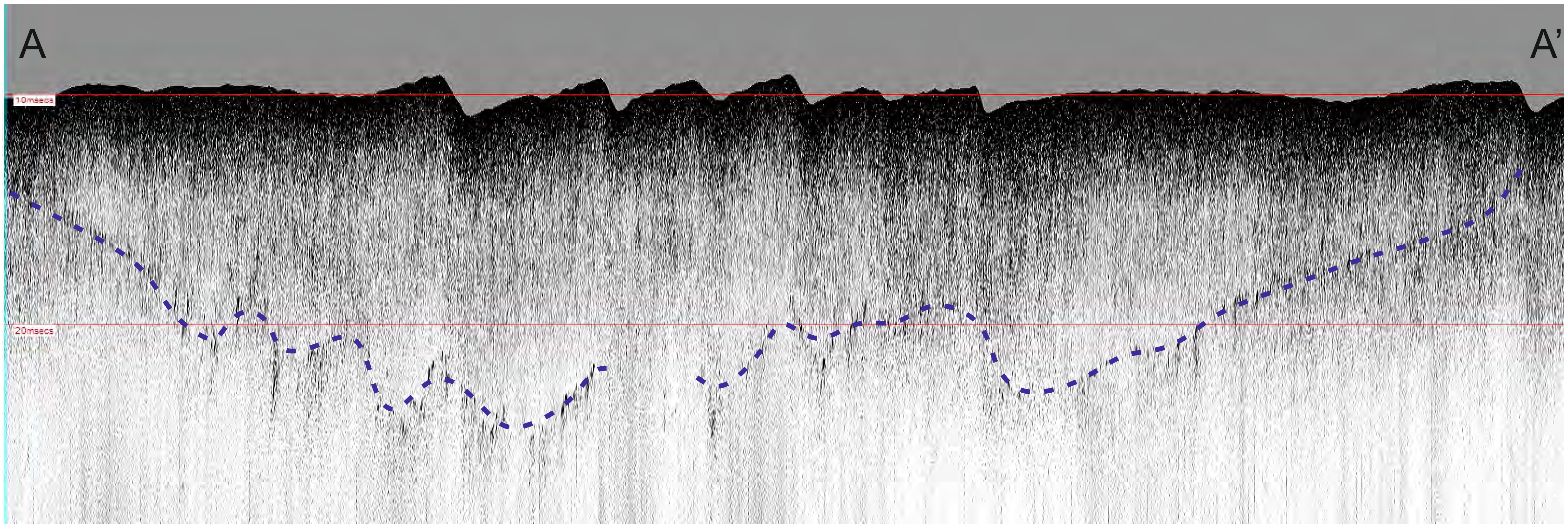
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2008

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	29/01/2018	A3.7
APPROVED BY	xx	SCALE@A3	1:8,800	







Survey Line BL1_IR_E_02

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-69.7

-73.0

0 500m

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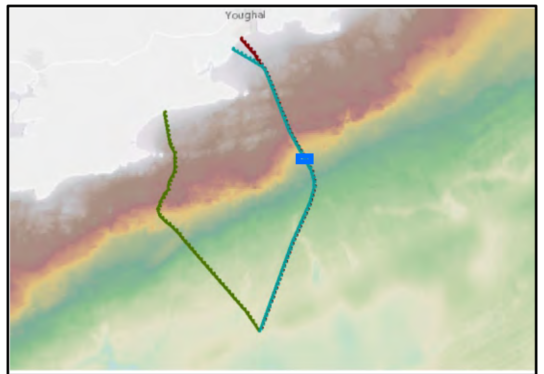
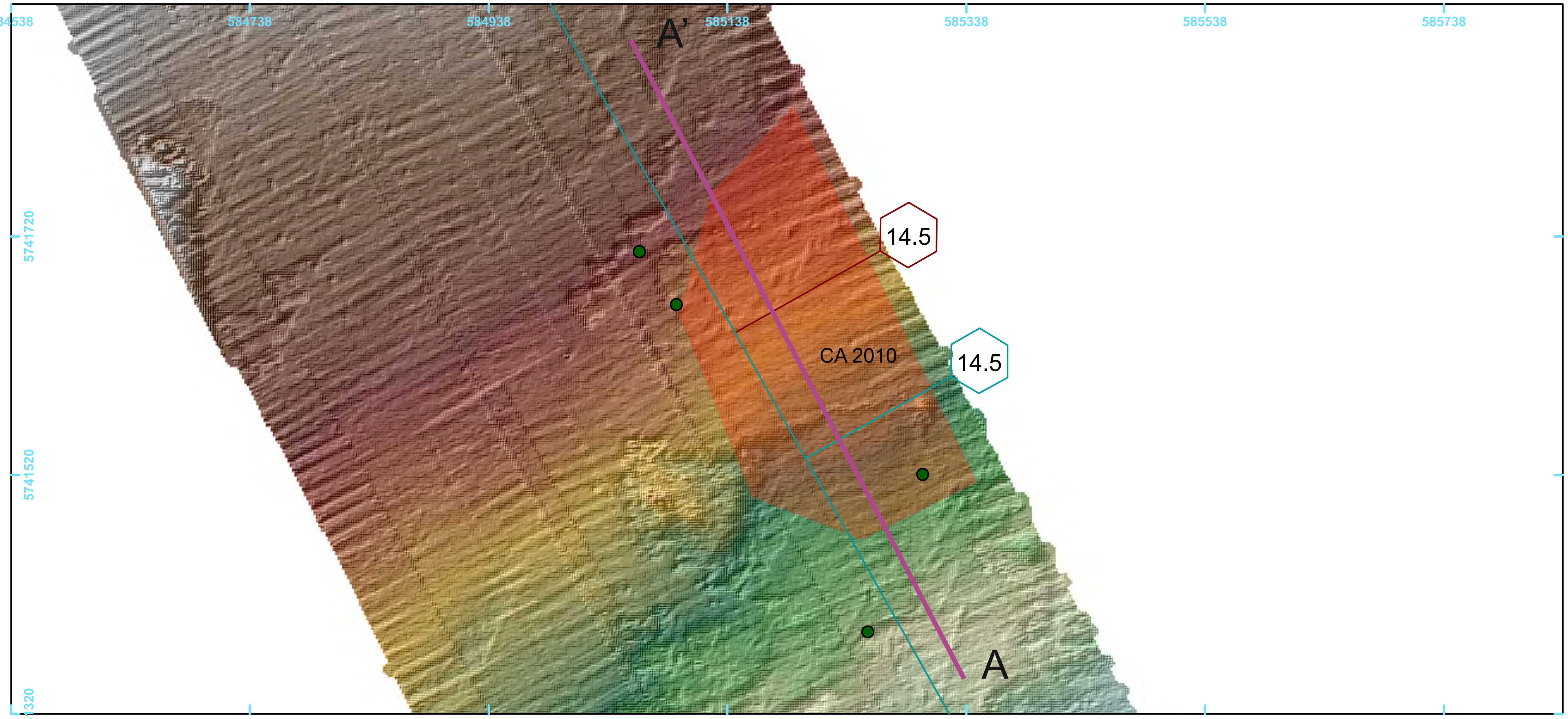
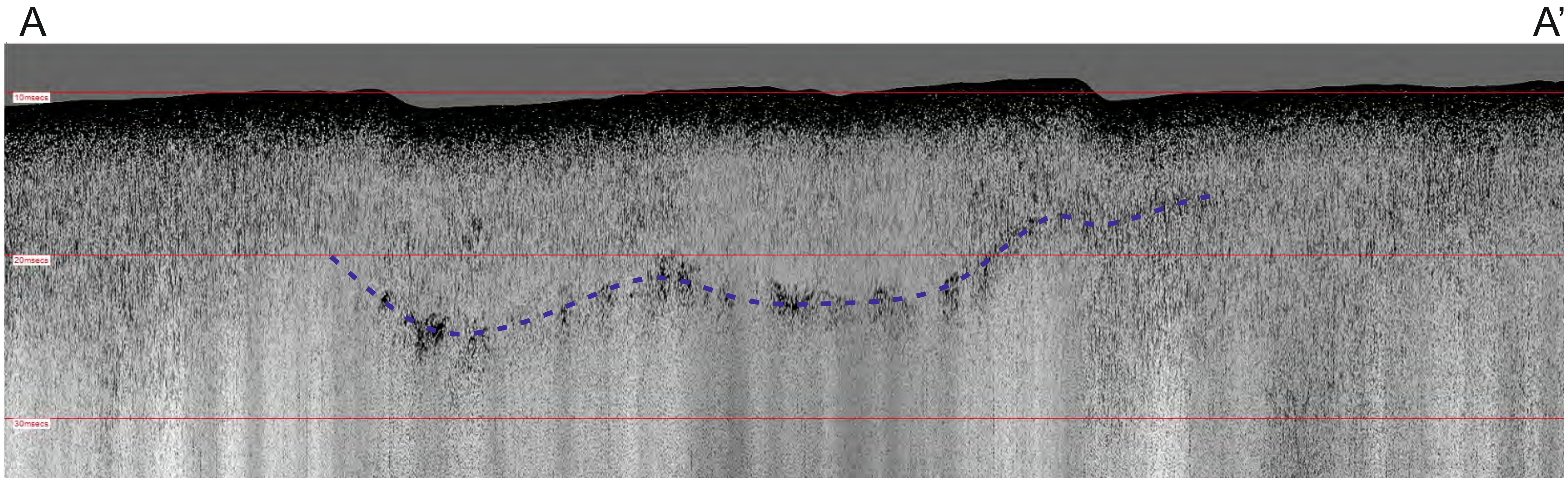
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2009

DRAWN BY	MJG (UoS)	PROJECT NO	770619	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.8
APPROVED BY	xx	SCALE@A3	1:12,100	







Survey Line BL1_IR_E_08

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-54.7

-59.4

0 150m

Cotswold Archaeology marine

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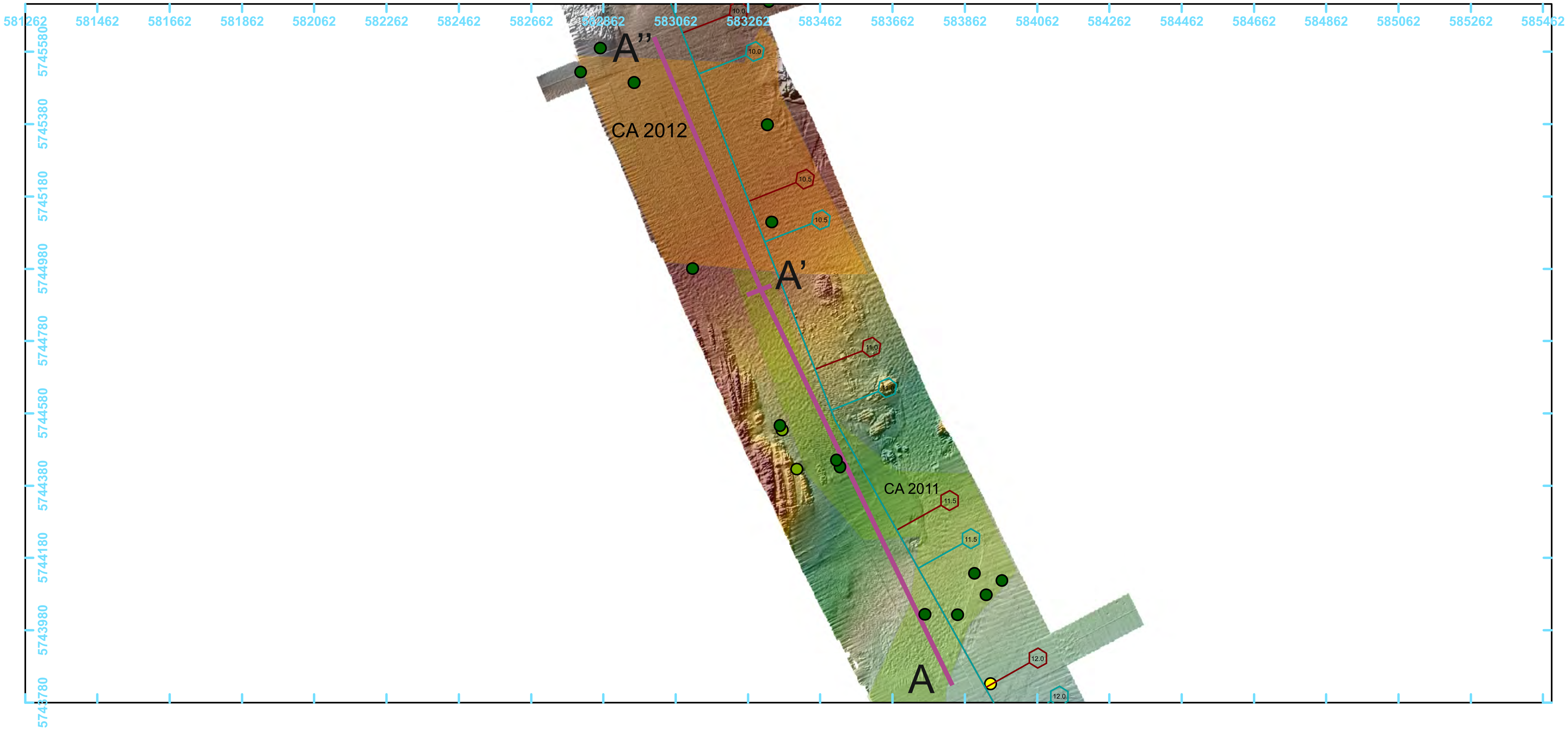
PROJECT TITLE

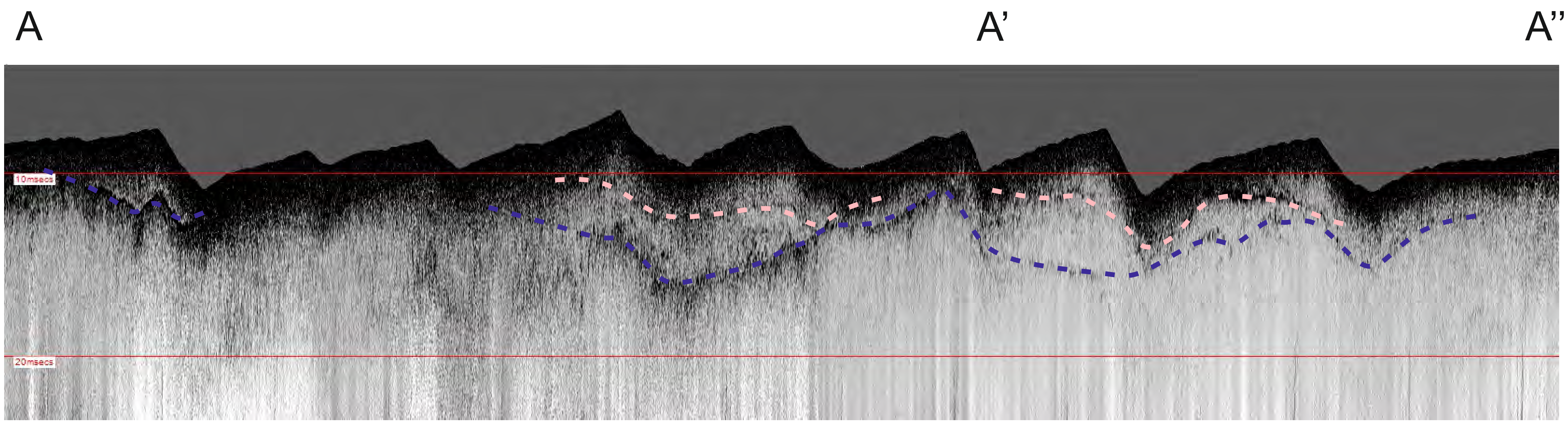
Celtic Interconnector

FIGURE TITLE

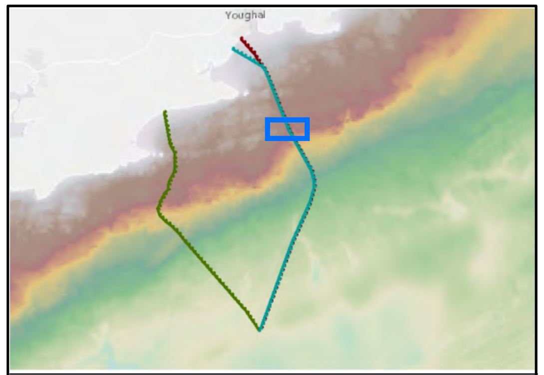
Sub-bottom Feature CA2010

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.9
APPROVED BY	xx	SCALE@A3	1:4,000	





Survey Line BL1_IR_E_04



Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-27.6

-46.7

0 550m

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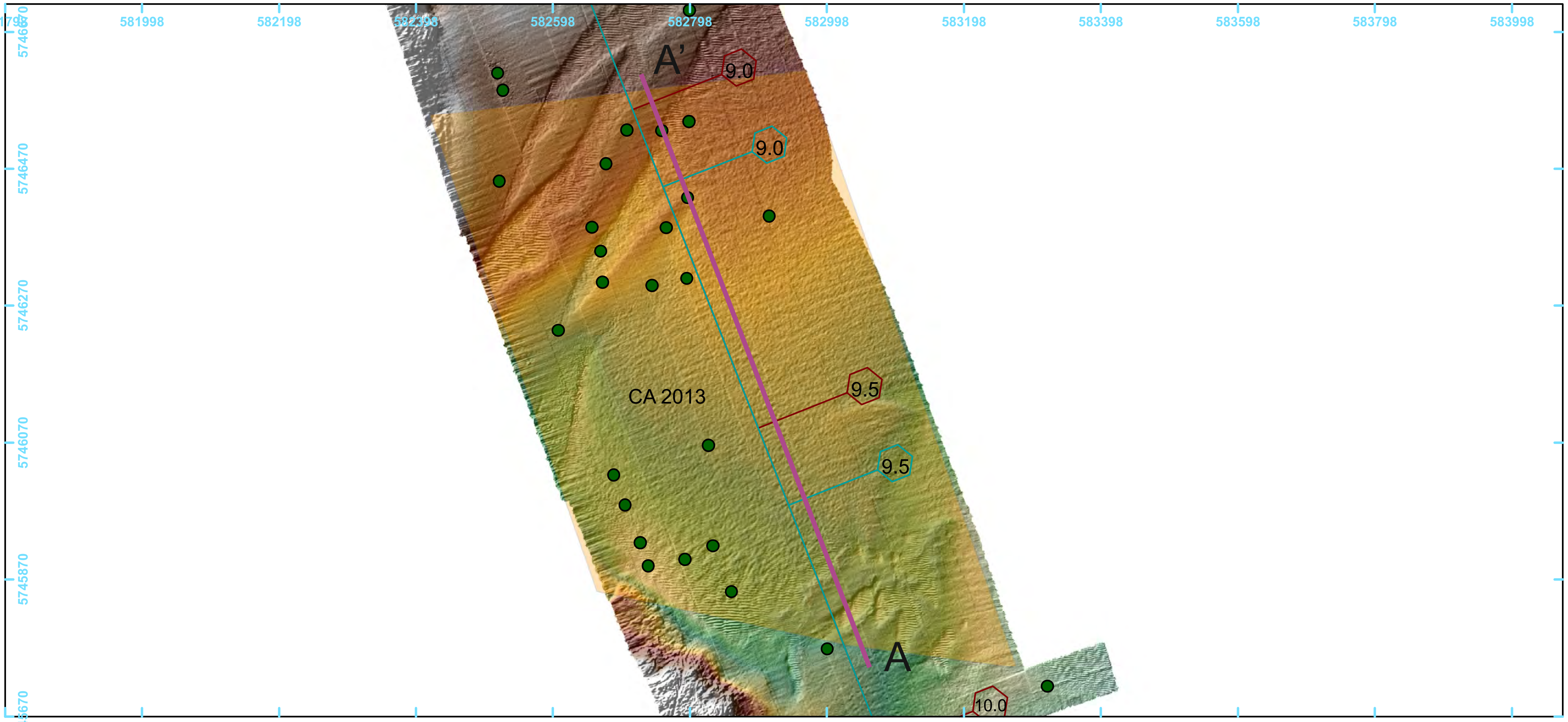
PROJECT TITLE

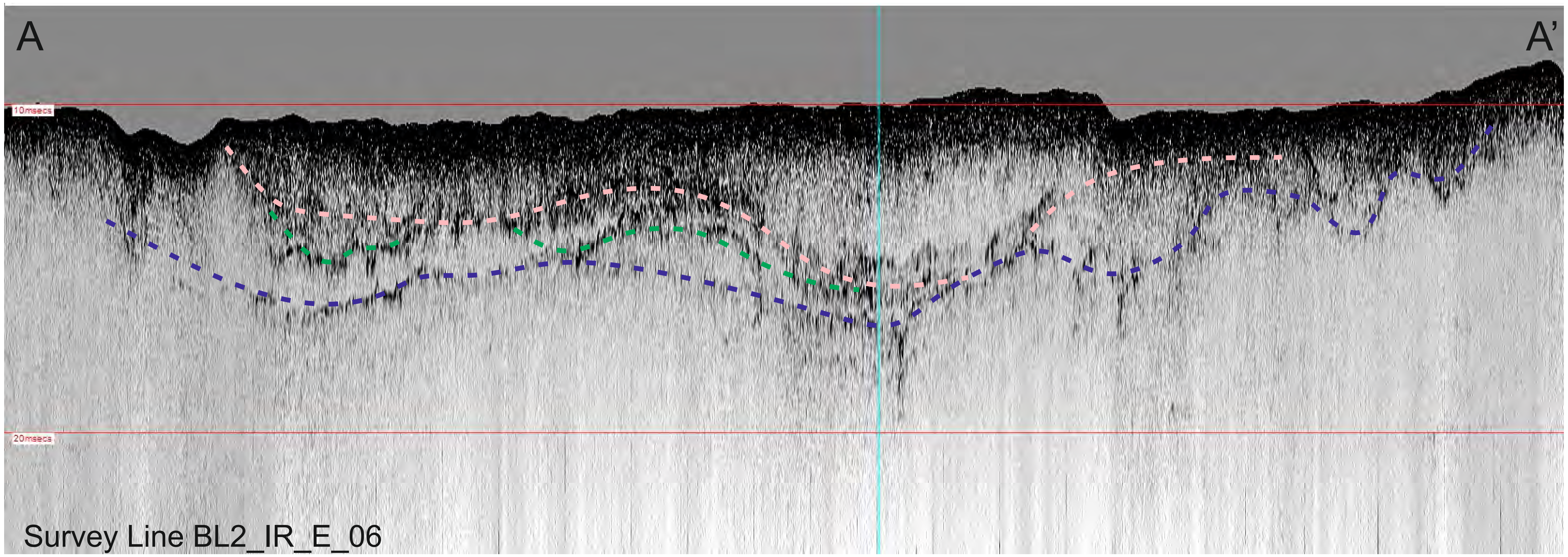
Celtic Interconnector

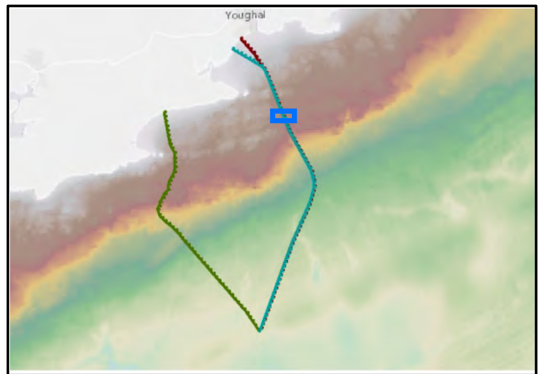
FIGURE TITLE

Sub-bottom Features CA2011 and CA2012

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	
APPROVED BY	xx	SCALE@A3	1:13,000	A3.10







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-25.8

-34.6

0 300m

Cotswold Archaeology marine

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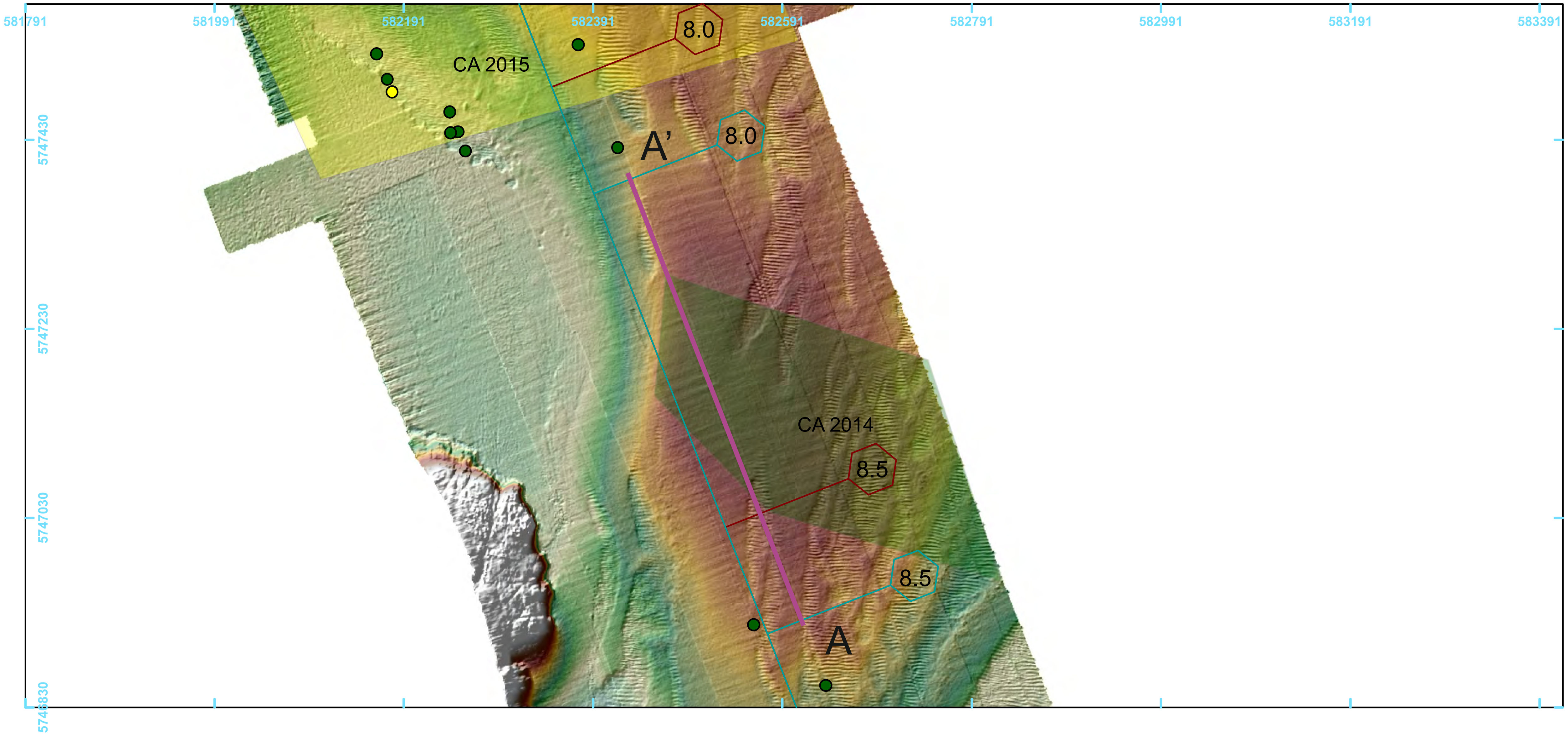
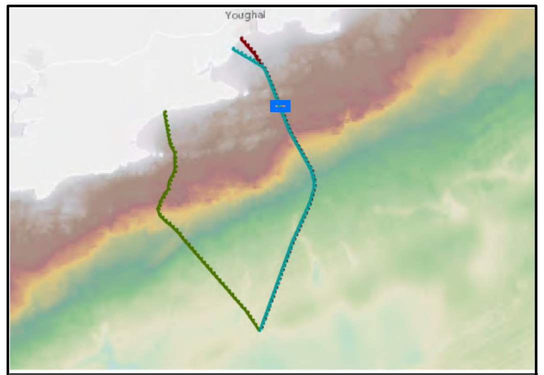
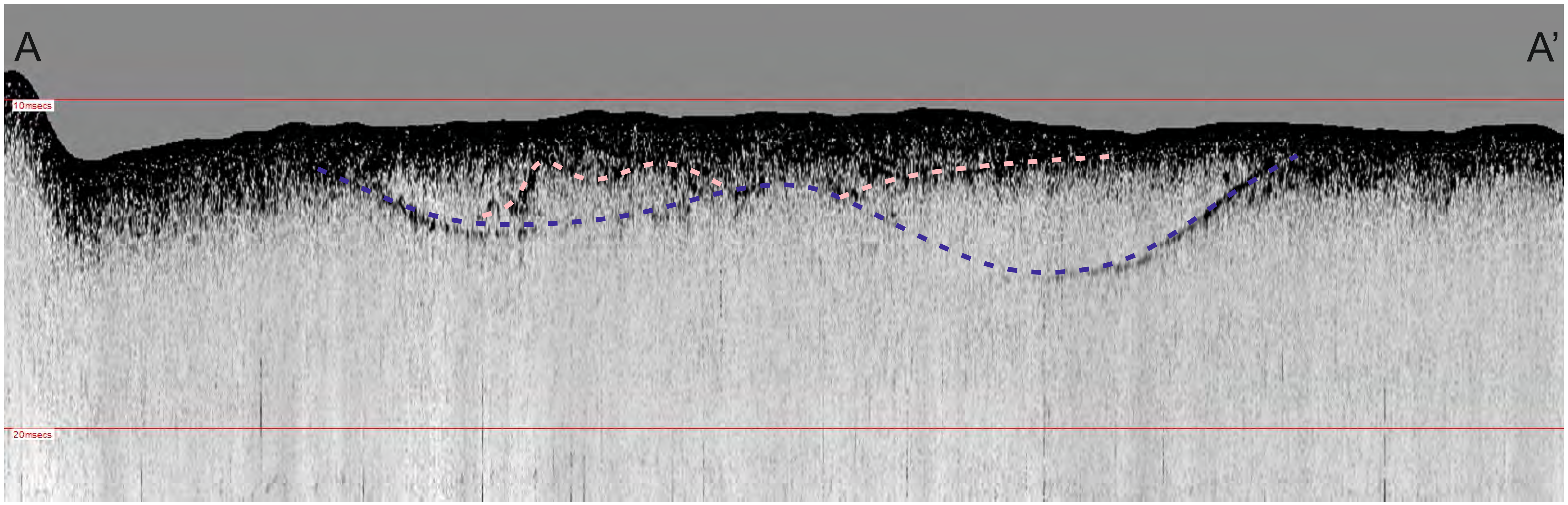
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2013

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.11
APPROVED BY	xx	SCALE@A3	1:7,000	







Survey Line BL2_IR_E_06

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-24.5

-31.1

0 200m

Cotswold Archaeology marine
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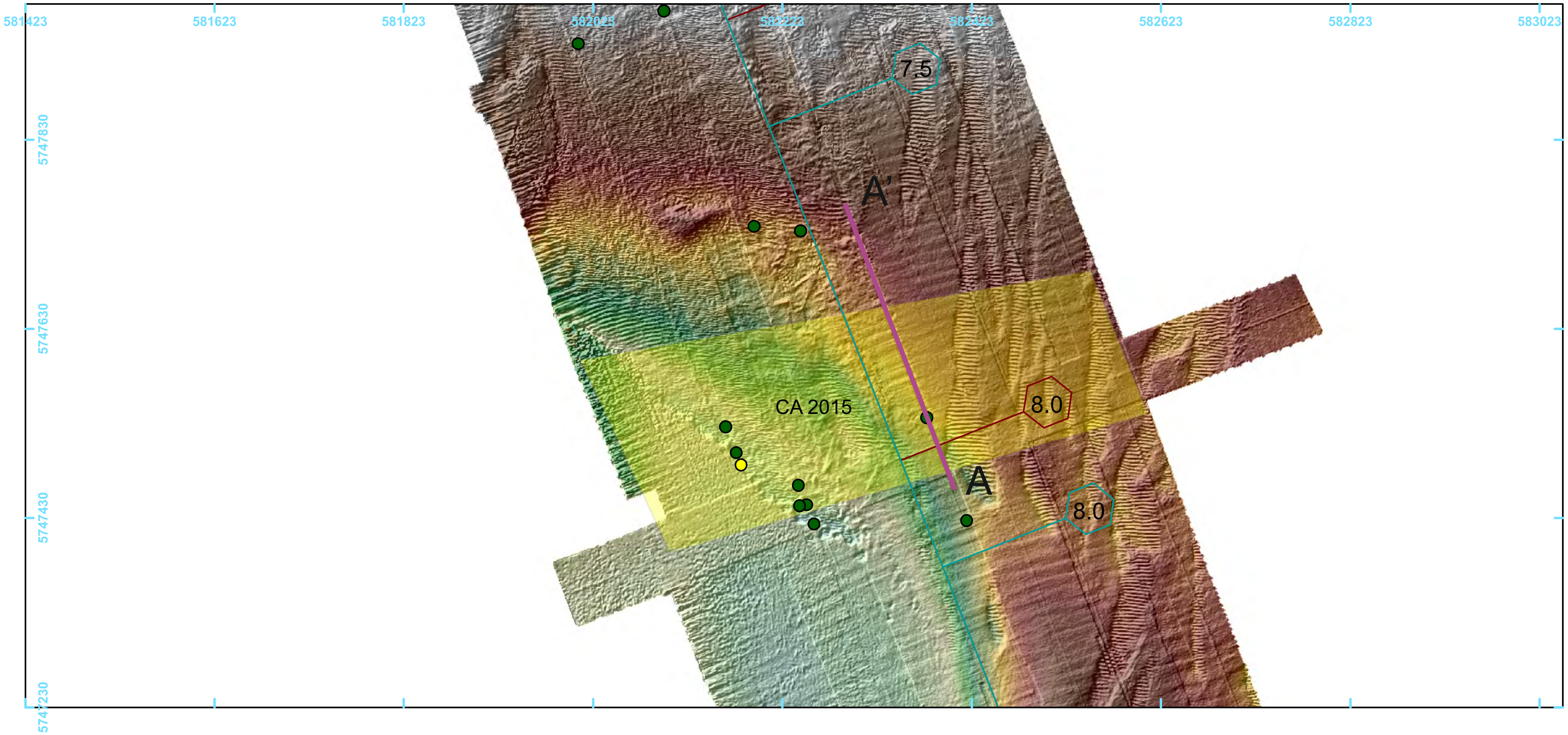
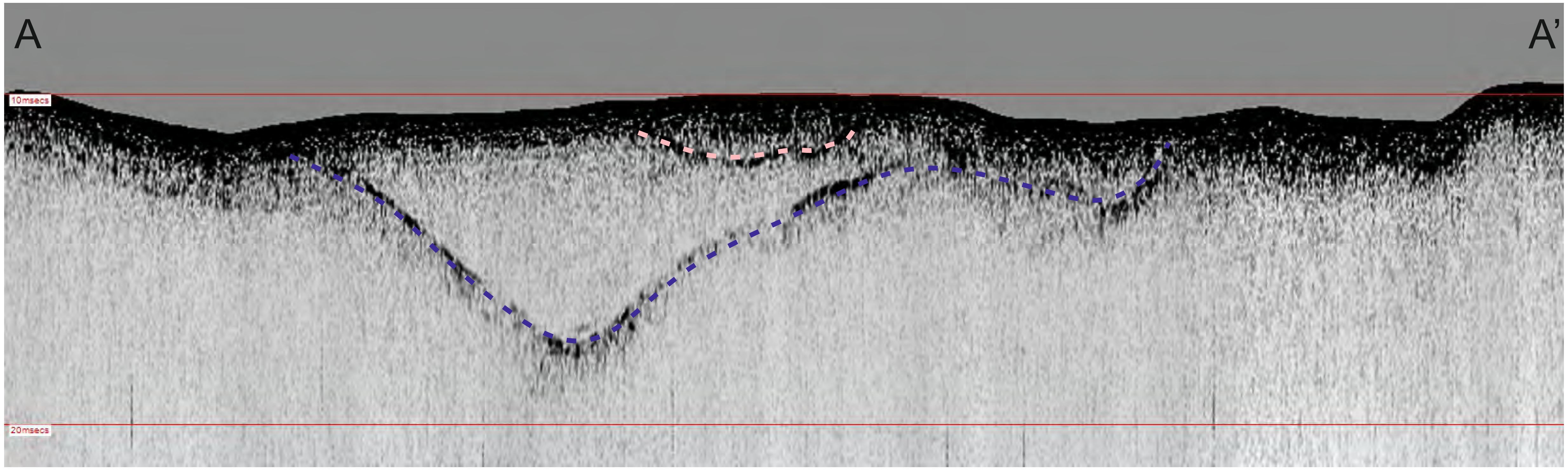
PROJECT TITLE
Celtic Interconnector

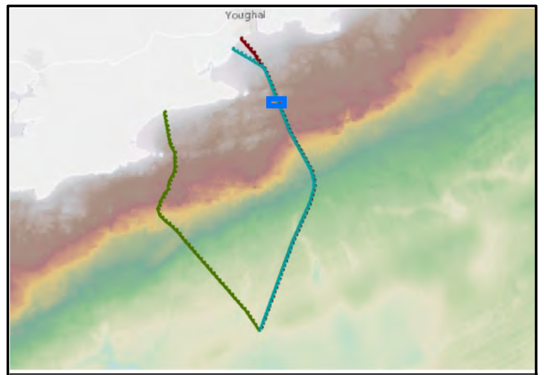
FIGURE TITLE
Sub-bottom Feature CA2014

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.12
APPROVED BY	xx	SCALE@A3	1:5,000	





Survey Line BL2_IR_E_06



Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

- -27.9
- -30.9

0 200m

Cotswold Archaeology marine

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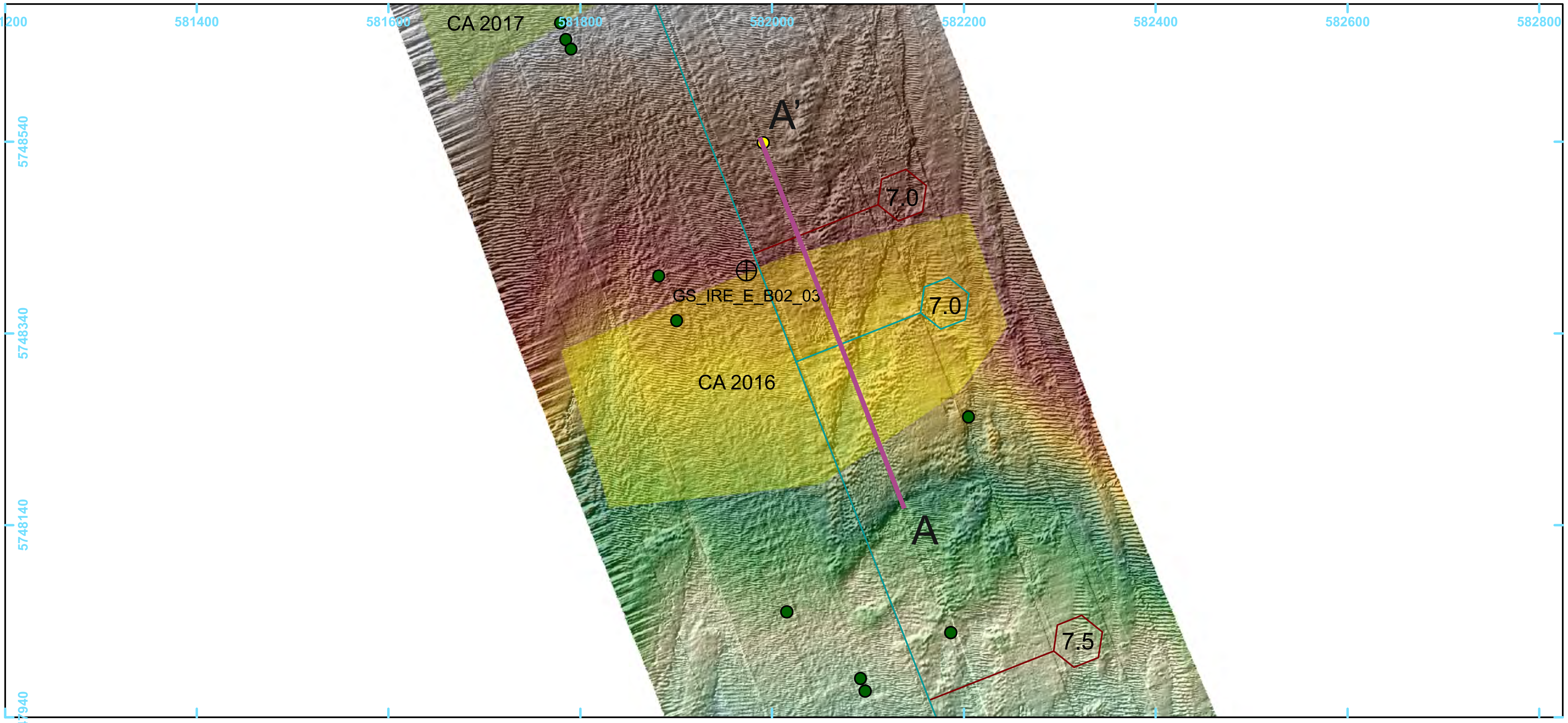
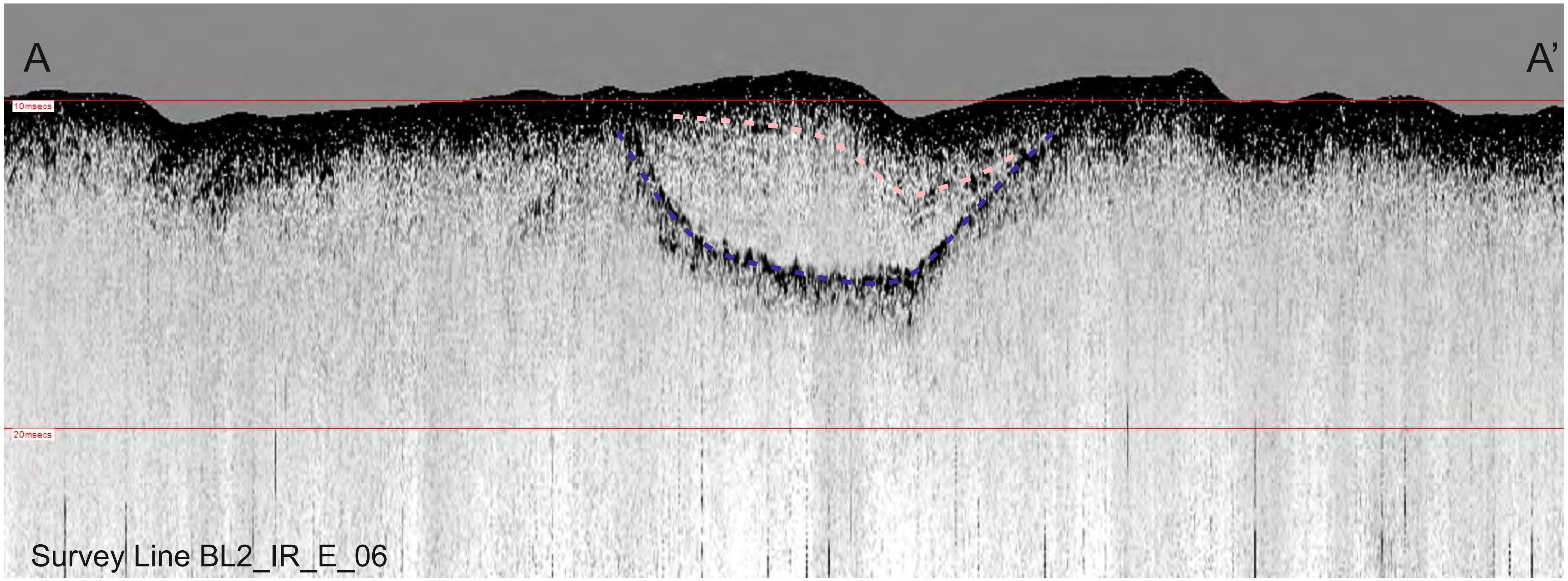
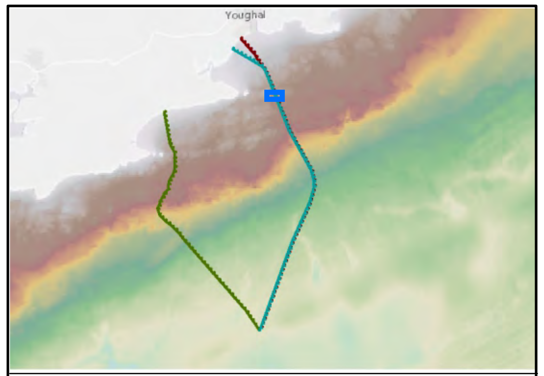
PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2015

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.13
APPROVED BY	xx	SCALE@A3	1:5,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-23.8

-28.7

0 200m

Cotswold Archaeology marine

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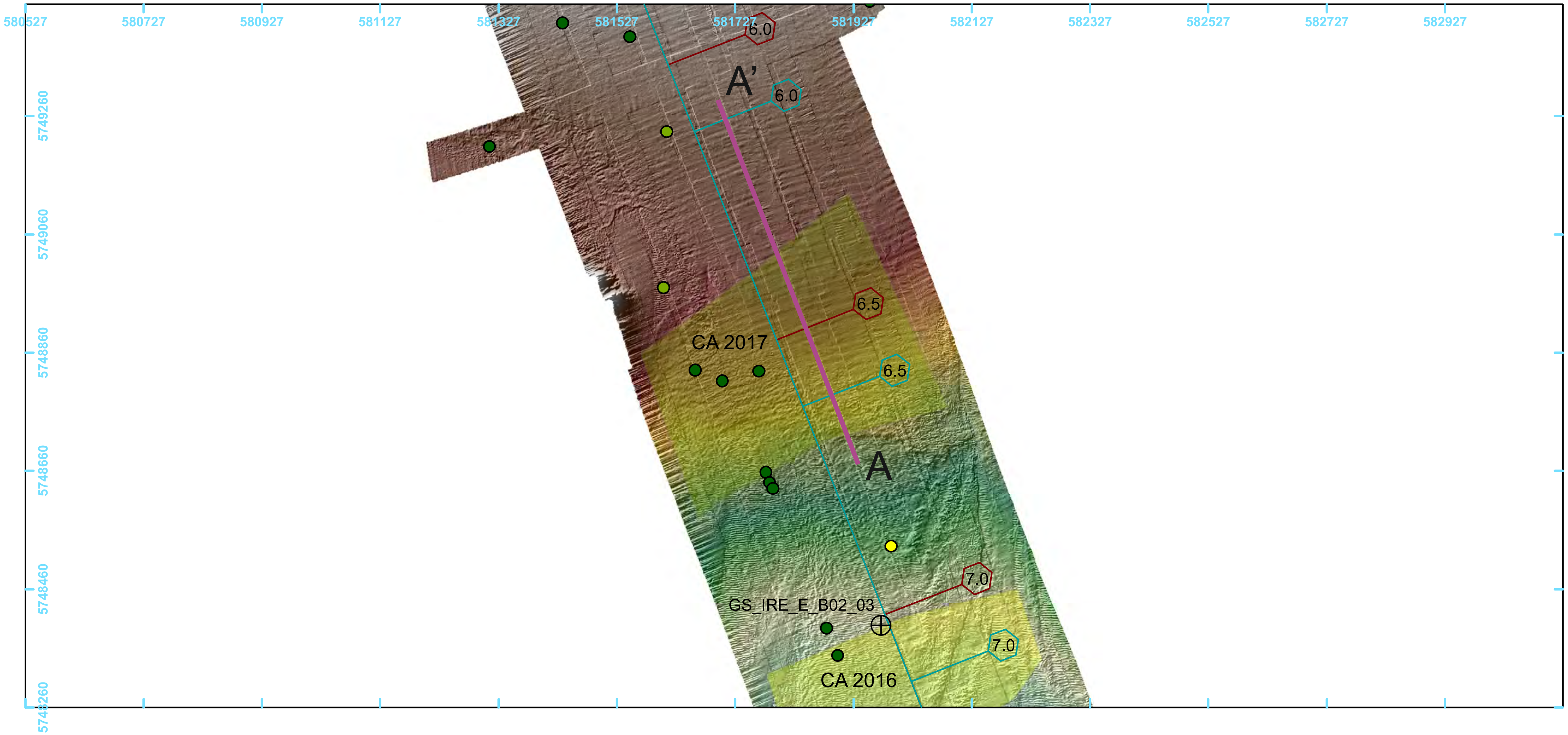
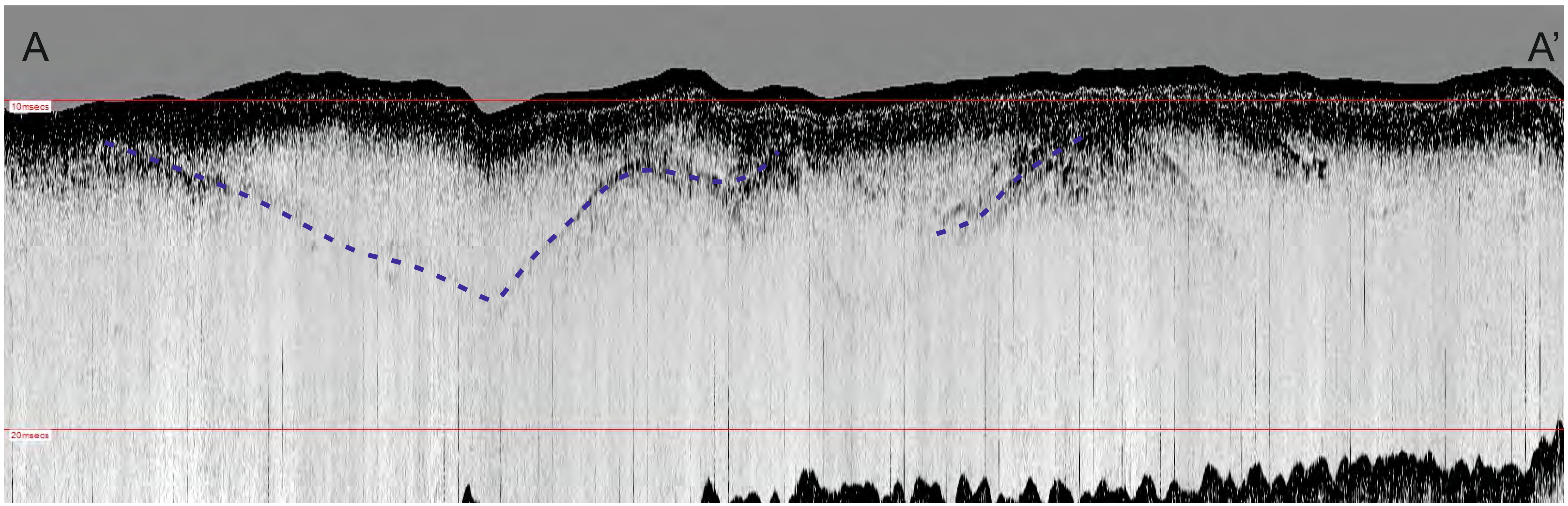
PROJECT TITLE
Celtic Interconnector

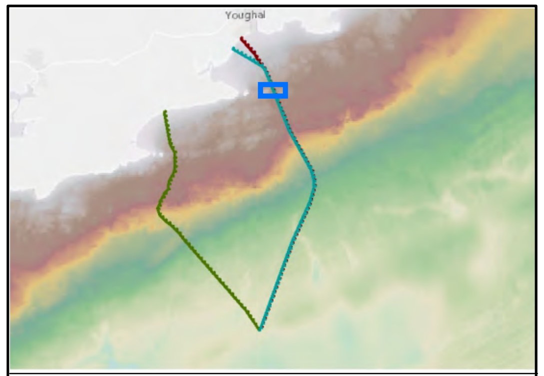
FIGURE TITLE
Sub-bottom Feature CA2016

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	
APPROVED BY	xx	SCALE@A3	1:5,000	A3.14





Survey Line BL2_IR_E_06



Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-19.2

-27.0

0 350m

Cotswold Archaeology marine

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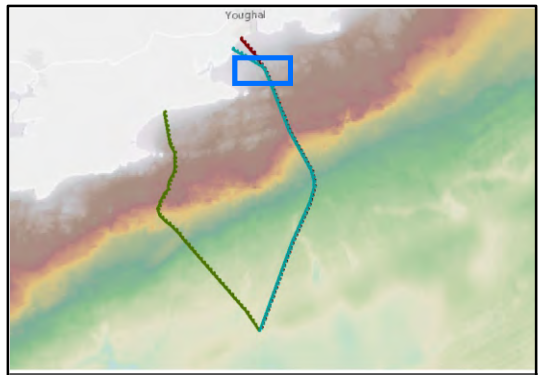
PROJECT TITLE

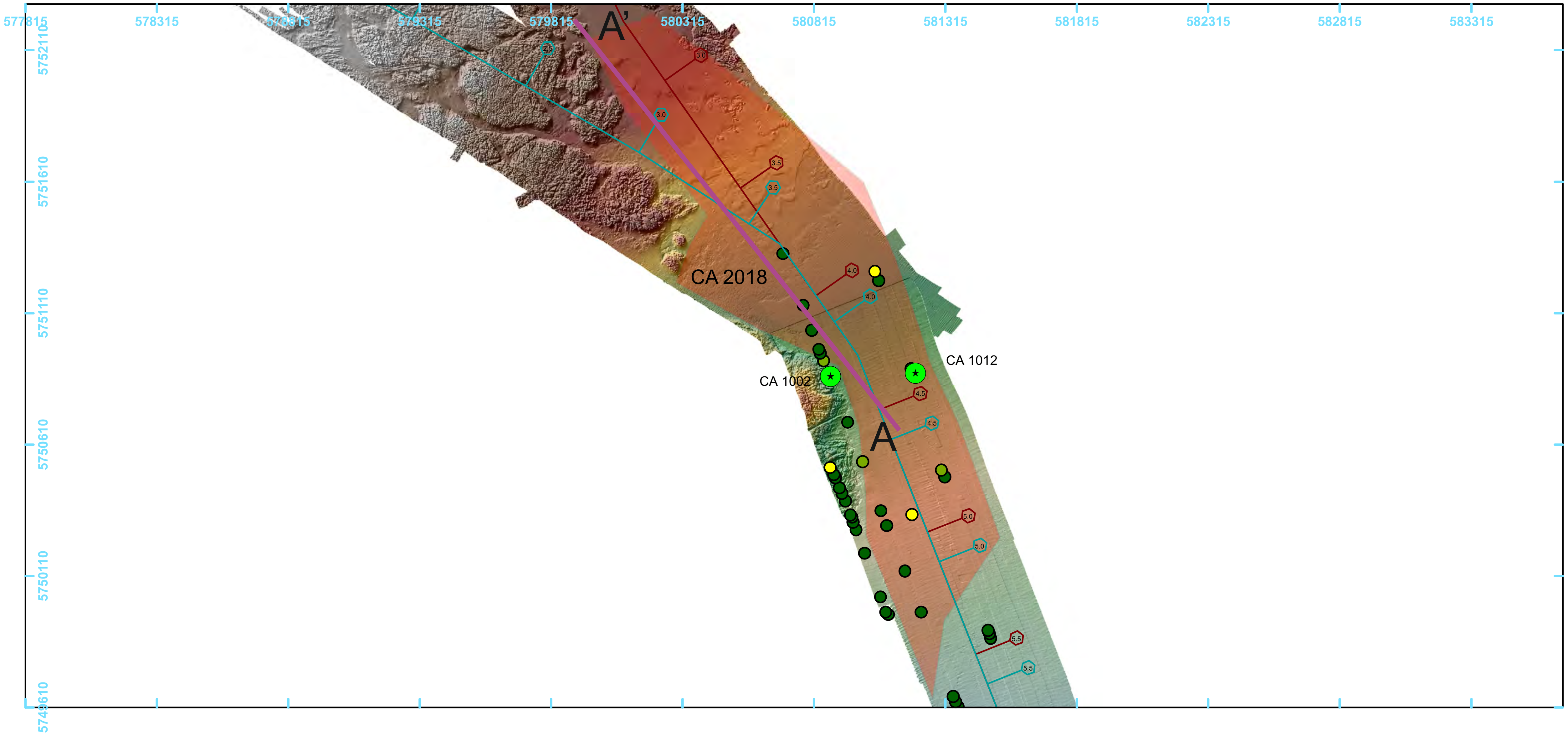
Celtic Interconnector

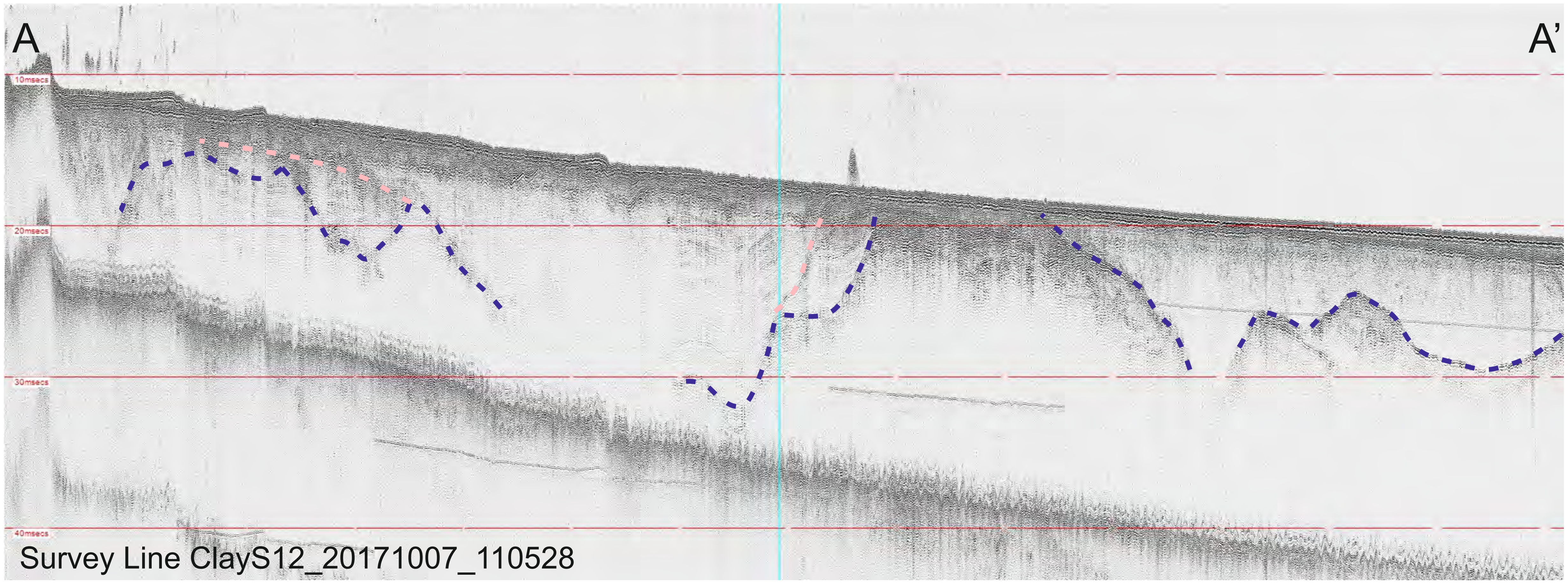
FIGURE TITLE

Sub-bottom Feature CA2017

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.15
APPROVED BY	xx	SCALE@A3	1:8,000	







Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-2.5

-20.2

0 800m

Cotswold Archaeology marine

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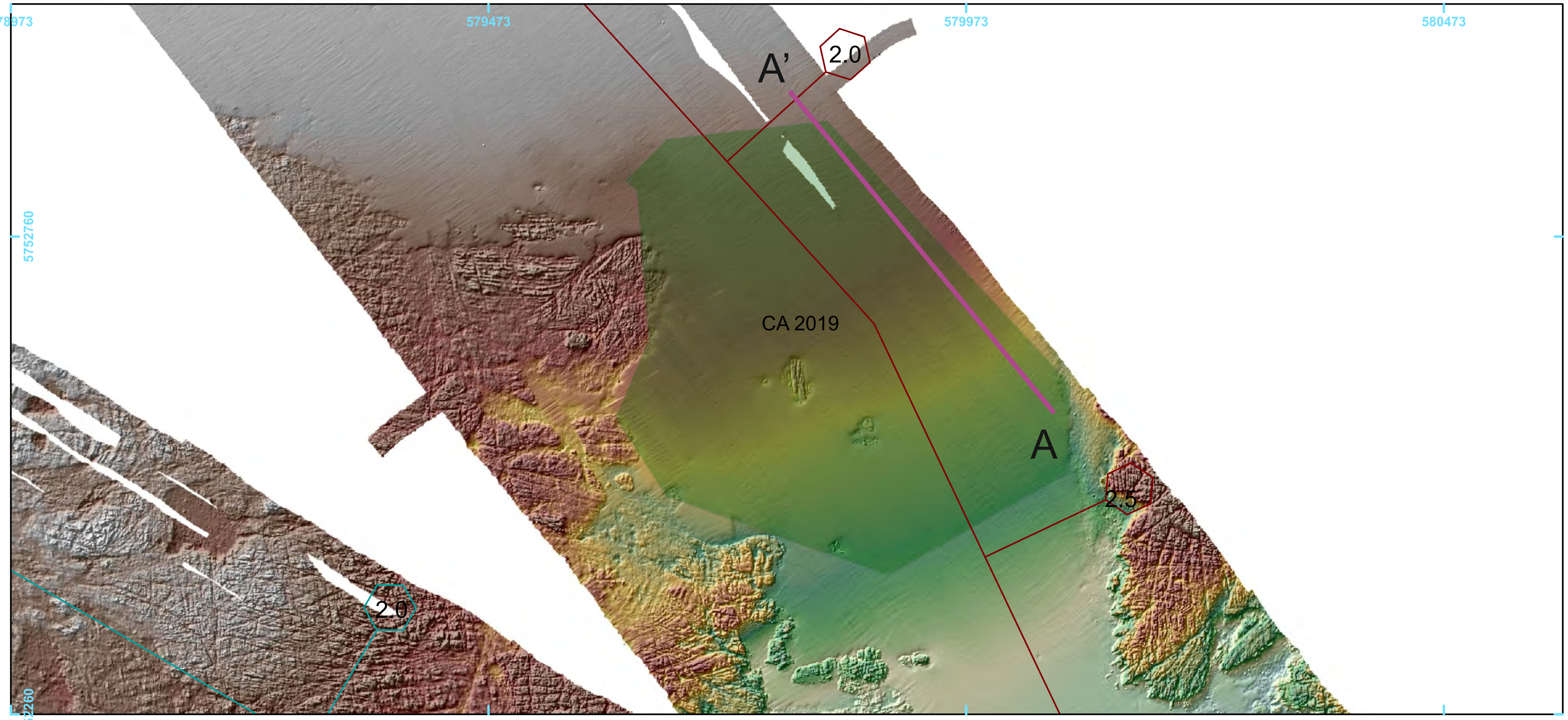
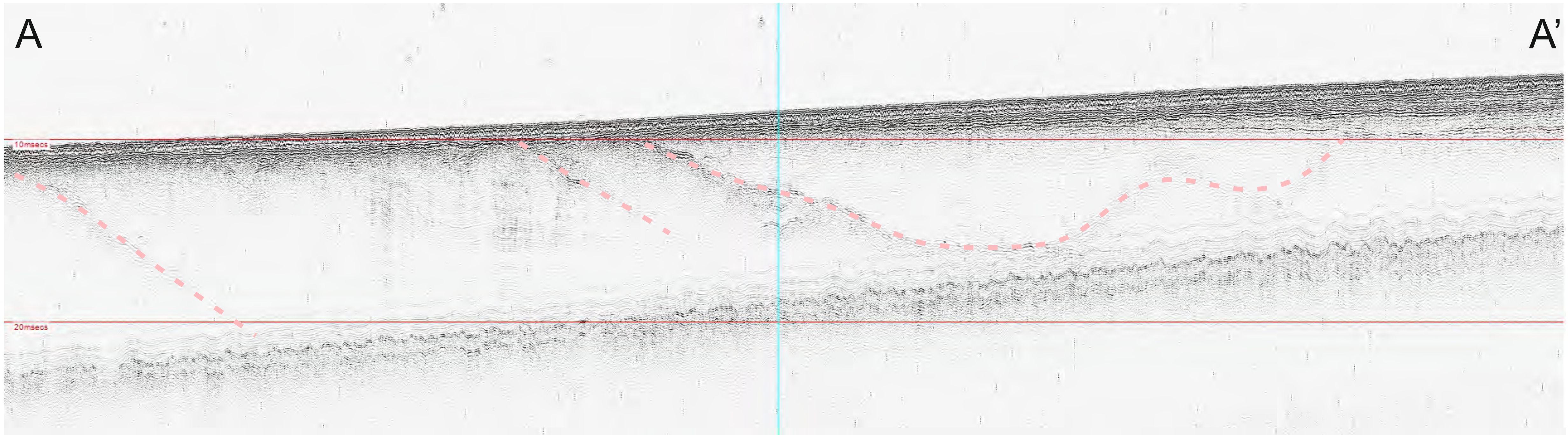
PROJECT TITLE
Celtic Interconnector

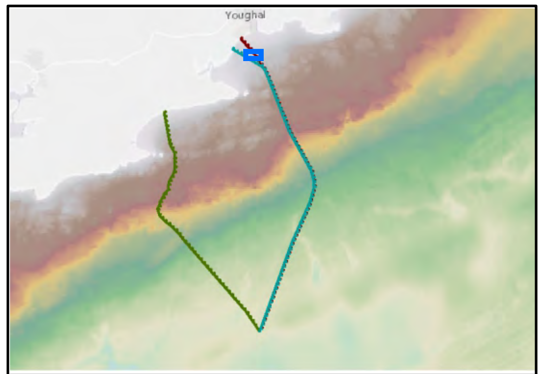
FIGURE TITLE
Sub-bottom Feature CA2018

DRAWN BY	MJG (UoS)	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MW	DATE	30/01/2018	A3.16
APPROVED BY	xx	SCALE@A3	1:18,000	





Survey Line ClayP22_20171027_130723



Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-2.95

-9.66

0 200m

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2019

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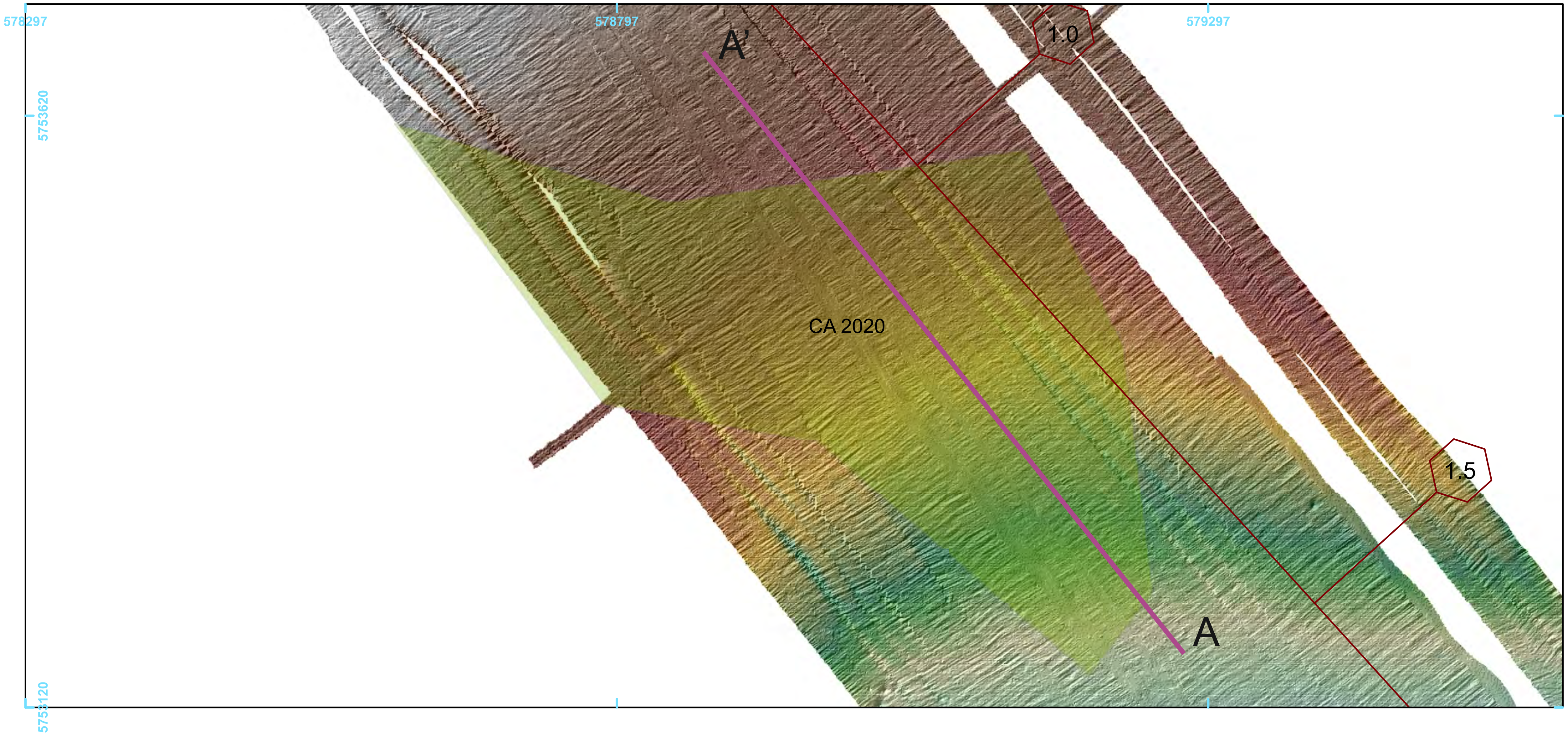

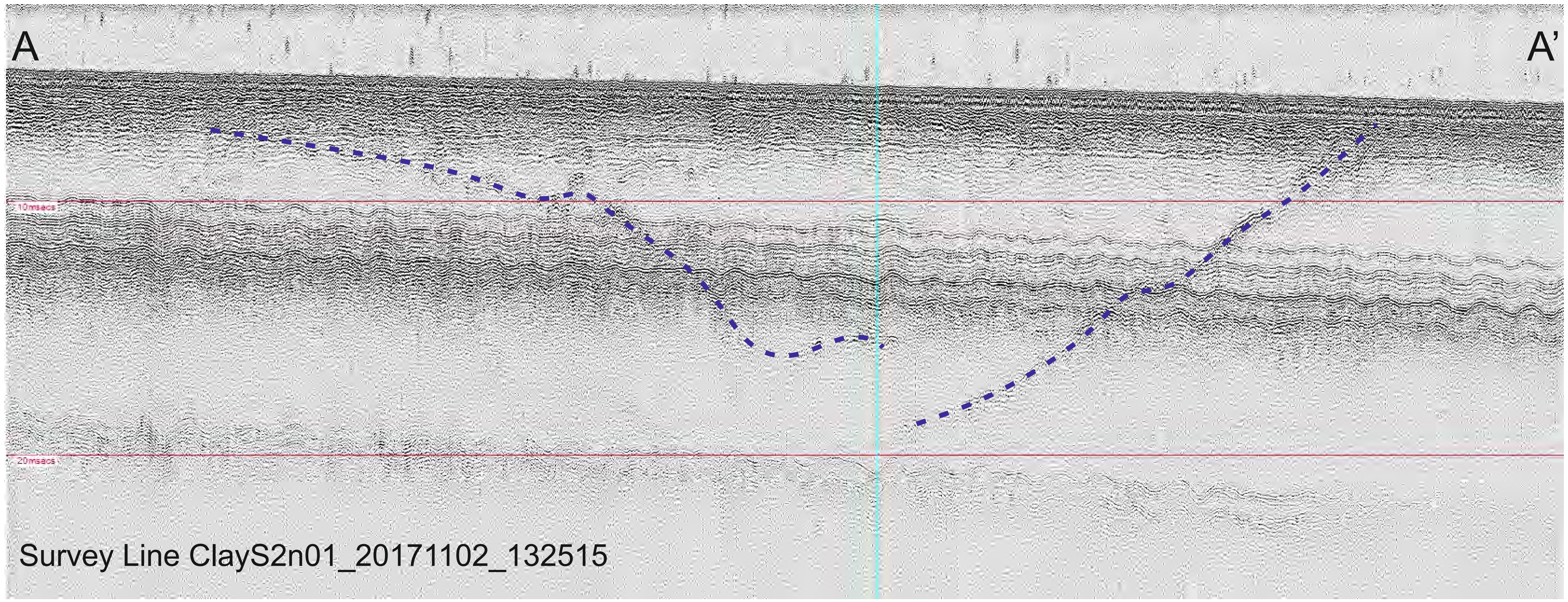

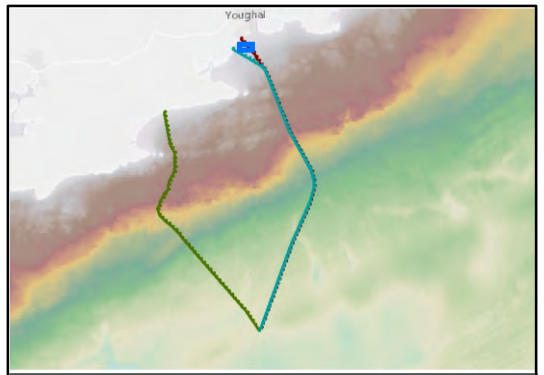

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

-1.3

-3.1

0 150m

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PROJECT TITLE

Celtic Interconnector

FIGURE TITLE

Sub-bottom Feature CA2020

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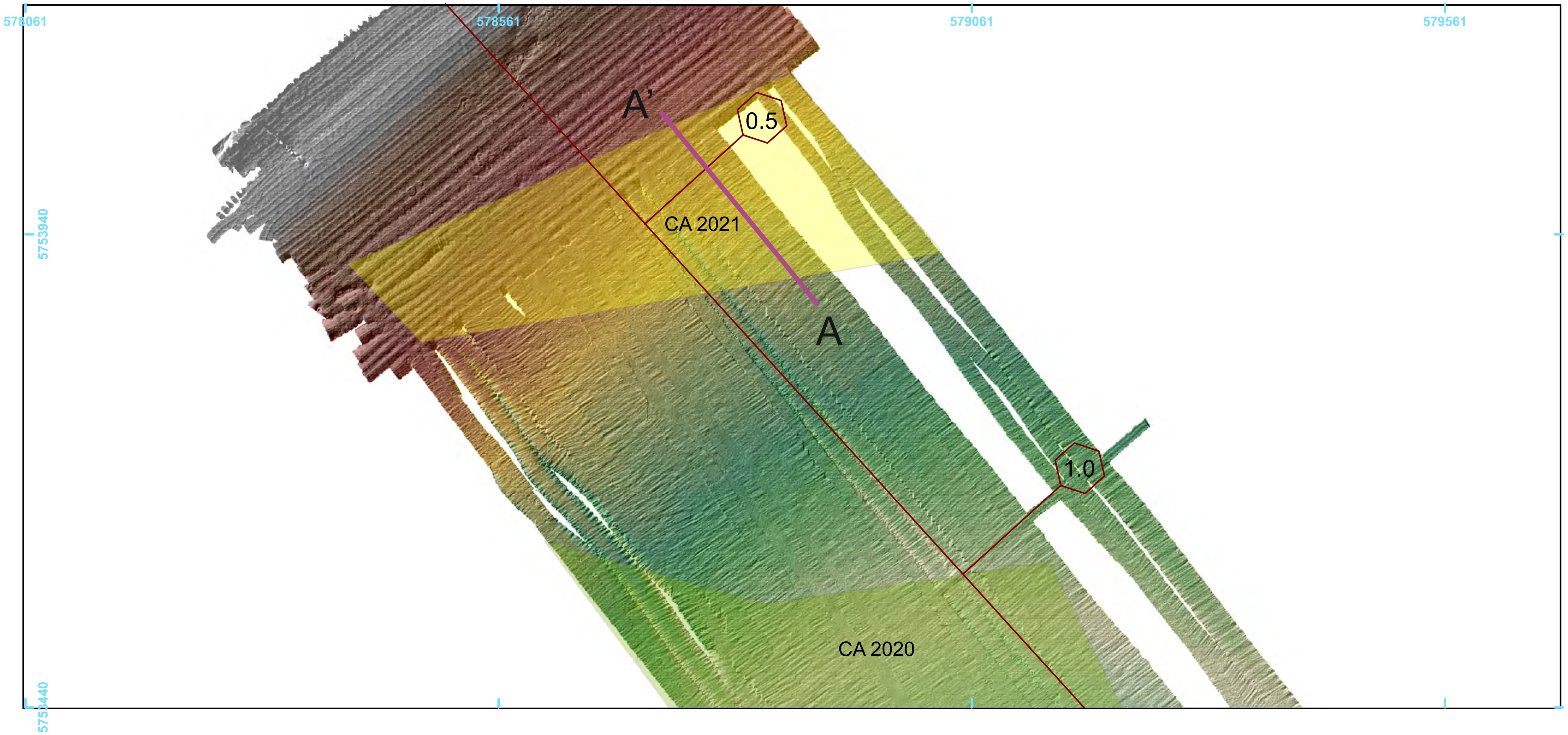

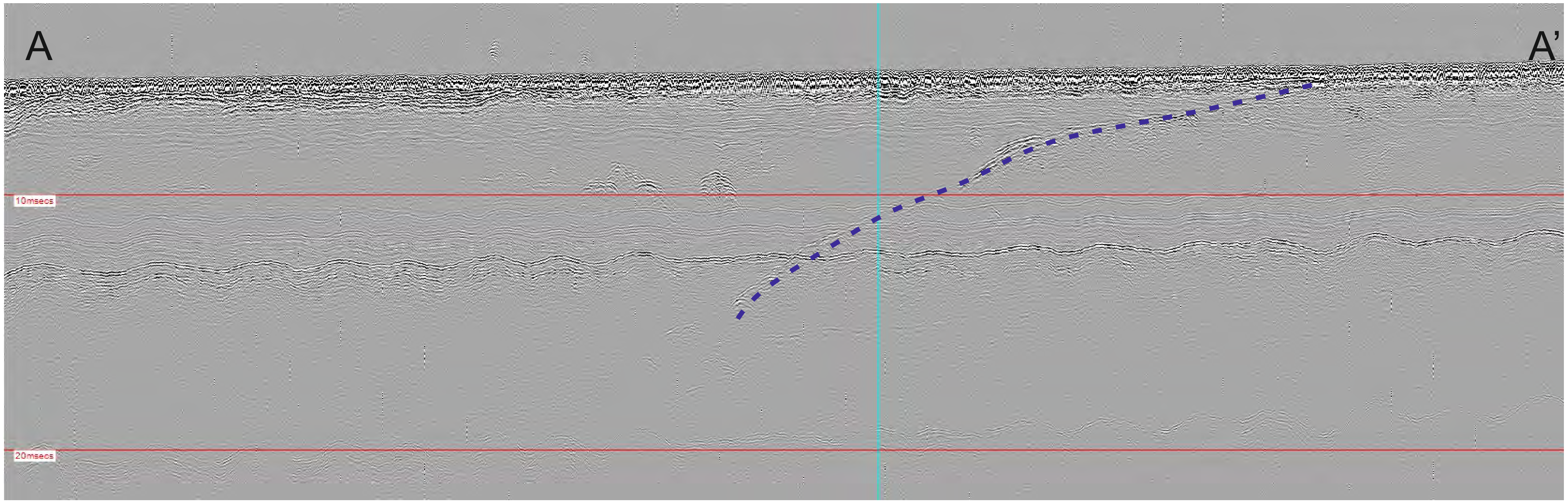

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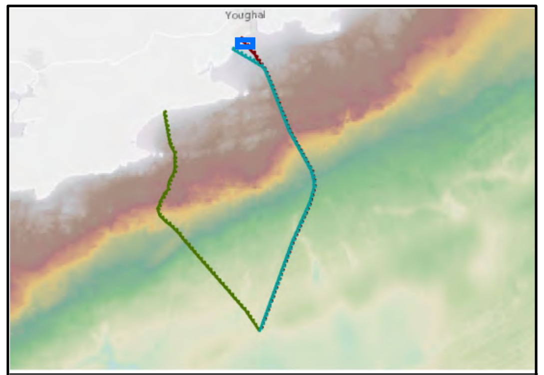

Legend

- Proposed Coring Locations
- Geophysical Anomaly
- Redbarn Route
- Claycastle Route
- Ballinwilling Route

Magnetic Anomaly (nT)

- 2-5
- 5-10
- 10-50
- 50-100
- >100
- Previously mapped Palaeochannels

Quaternary Infilled Features (m)

- 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 18

Bathymetry (m LAT)

1.4

-2.5

0 200m

Cotswold Archaeology marine

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Sub-bottom Feature CA2021

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APPROVED BY	xx	SCALE@A3	1:5,000	A3.19

APPENDIX 4: GEOTECHNICAL CORING LOCATIONS FROM THE IRISH TERRITORIAL LIMIT OUT TO THE IRISH / UK MEDIAN LINE

Table A4.1 below presents the locations of the vibrocores from the Irish territorial limit out to the Irish / UK median line. The vibrocore locations from redundant routes in Irish territorial waters has been removed, as they are not considered further.

Table A4.1 Vibrocore locations form the Irish territorial limit out to the Irish / UK median line

Vibrocore ID	Recovery (m)	m LAT	Easting	Northing
VC-018	2.25	-80.3	580507.4	5722983
VC-019	2.1	-82.1	581171.9	5721120
VC-020	0.65	-82.8	581881.2	5719142
VC-020A	0.44	-82.8	581884.3	5719134
VC-021	1.13	-83.4	582559.9	5717237
VC-021A	1.5	-83.4	582557.9	5717242
VC-022	1.4	-82.7	583156.1	5715563
VC-022A	2.5	-82.7	583154.3	5715570
VC-023	1.18	-83.3	583761.9	5713868
VC-023A	2.53	-83.3	583760.7	5713875
VC-024	0.38	-82.1	584332.9	5712267
VC-024A	0.42	-82.1	584331.1	5712274
VC-025	0.6	-80.7	584974.1	5710477
VC-026	0.84	-80.9	585581.1	5708783
VC-027	1.2	-82.5	586185.6	5707085
VC-027A	1.25	-82.4	586187.4	5707079
VC-028	0.44	-83.4	586772.8	5705440
VC-029	0.5	-83.5	587360.1	5703790
VC-030	0.81	-84.5	588001.3	5702003
VC-032	0.4	-84.3	589212.3	5698611
VC-033	1.3	-84.8	589816.6	5696916
VC-034	0.65	-85.4	590424.1	5695219
VC-035	0.1	-85.5	591027.2	5693529
VC-035A	0.58	-85.5	591024.4	5693535
VC-036	0.15	-86.2	591633.9	5691830
VC-036A	0.15	-86.2	591636.5	5691823
VC-037	0.5	-86.9	592239.1	5690136
VC-037A	0.7	-86.9	592242	5690129
VC-038	0.36	-87.2	592846.1	5688440
VC-039	1.91	-88.1	593468.6	5686699
VC-040	0.3	-88.9	594057	5685051
VC-041	1.51	-89.6	594662.1	5683356

Vibrocore ID	Recovery (m)	m LAT	Easting	Northing
VC-041A	1	-89.6	594663.9	5683348
VC-043	1.68	-90.7	595838.4	5680058
VC-043A	1.5	-90.7	595841.1	5680050
VC-044	3	-91	596341.8	5678646
VC-046	1.3	-91.8	596859.7	5675725
VC-047	2.37	-92.4	597160.2	5673805
VC-048	1.95	-92.6	598312.8	5672171
VC-049	1.4	-93	599275.7	5670436
VC-049A	1.04	-93	599278.2	5670429
VC-050	1.72	-93.6	599945.4	5668554
VC-050A	0.59	-93.6	599949.4	5668549
VC-051	0.65	-93.8	600618.3	5666671
VC-051A	0.85	-93.8	600616.7	5666676
VC-052	0.9	-94.2	601222.8	5664976
VC-052A	1.68	-94.2	601221.2	5664981
VC-053	0.8	-95.9	601660.6	5663749
VC-053A	0.46	-95.9	601662.8	5663743
VC-055	0.4	-97.6	602904.5	5660265
VC-055A	0.03	-97.7	602903.2	5660270
VC-056	0.08	-94.8	603443.4	5658759
VC-056A	1.56	-94.8	603445.6	5658754
VC-056B	2.18	-94.7	603447.8	5658748
VC-057	2	-90.6	603983.5	5657251
VC-058	1.38	-97.8	604756.8	5655087
VC-058A	0.81	-97.8	604755	5655094
VC-059	1.38	-95.9	605429.7	5653202
VC-059A	1.87	-95.9	605433.4	5653195
VC-060	1.08	-96.2	606103.6	5651320
VC-060A	2.25	-96.2	606105	5651310
VC-061	0.9	-96.9	606671.9	5649717
VC-061A	1.2	-96.9	606677	5649708
VC-062	0.85	-96.9	607275.4	5648022
VC-062A	0.82	-96.9	607280.9	5648016
VC-063	0.82	-99.3	607785.5	5646608
VC-063A	0.8	-99.4	607786.6	5646602
VC-064	1.54	-100.8	608489.3	5644632
VC-064A	0.24	-100.9	608491.7	5644626
VC-065	0.05	-101.1	609095	5642938
VC-065A	1.08	-101	609096.7	5642934
VC-066	1.75	-102.8	609869.2	5640772
VC-066A	1.95	-102.8	609872.4	5640764
VC-067	0	-101.9	610374	5639359

Vibrocore ID	Recovery (m)	m LAT	Easting	Northing
VC-067A	0	-101.9	610376.1	5639351
VC-067B	0.4	-101.9	610382.5	5639356
VC-068	2	-99.1	610909.3	5637852
VC-069	0	-101.2	611512.4	5636156
VC-069A	0.92	-101.2	611516.7	5636148
VC-071	1.12	-101.5	612759.5	5632672
VC-071A	0.25	-101.5	612762.8	5632664
VC-072	2.85	-101.6	613315.5	5631120
VC-073	0.3	-101.2	613869.8	5629565
VC-073A	0.69	-101.1	613872.1	5629556
VC-074	0.07	-102.4	614508.4	5627775
VC-074A	1.33	-102.5	614510.5	5627770
VC-075	1.4	-101.6	615115.5	5626080
VC-075A	2.72	-101.6	615114	5626071
VC-076	1.15	-103.3	615685.5	5624477
VC-076A	0.67	-103.3	615693.1	5624472
VC-077	1.9	-103.3	616356.9	5622596
VC-077A	1.01	-103.3	616363.5	5622592
VC-079	0.53	-104.6	617534.9	5619300
VC-079A	1.13	-104.6	617532.5	5619308
VC-082	0.96	-104.1	619385.5	5614121
VC-082A	0.36	-104.1	619379.7	5614129
VC-083	0.7	-103.8	619988.8	5612427
VC-083A	1.65	-103.8	619986	5612434
VC-084	1.25	-103.9	620727.7	5610355
VC-084A	0.88	-103.9	620729.7	5610361

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Celtic Interconnector

Volume 3D2 – Appendix 15B
Geoarchaeological Assessment

June 2021

Co-financed by the European Union
Connecting Europe Facility

Tionscadal Éireann
Project Ireland
2040

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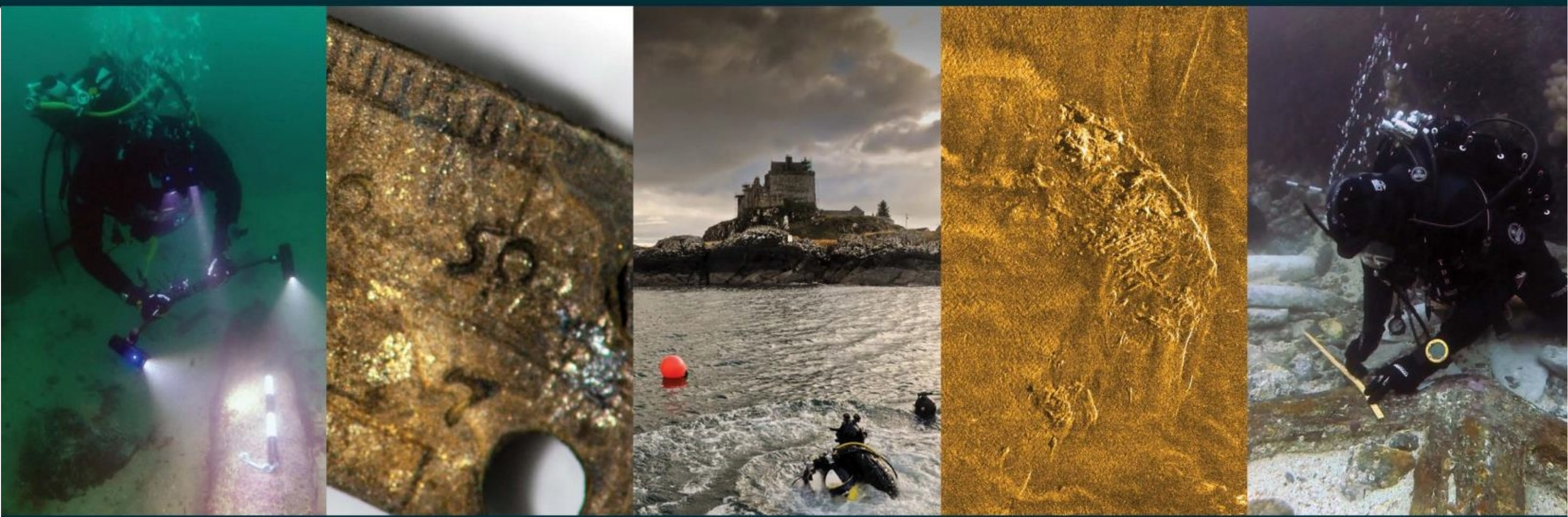
Cotswold Archaeology
marine

Celtic Interconnector Project

Geoarchaeological Assessment



for

EirGrid plc

CA Project: 770617

CA Report: 19017

January 2019

Celtic Interconnector project
Geoarchaeological Assessment

CA project: 770617
CA report: 19017

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date	January 2019
checked by	Dr Michael Walsh, Senior Heritage Consultant - Marine
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signed	
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issue	1.1

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SUMMARY

Project name: Celtic Interconnector project

Cotswold Archaeology was commissioned by EirGrid plc to undertake a geoarchaeological assessment in association with the 2018 Geotechnical Site Investigations for the Celtic Interconnector project.

Recent studies indicate that there is good potential for the presence of submerged landscapes containing archaeological evidence from the early Mesolithic through to the Iron Age, and palaeo-environmentally important deposits in and around Ballinwilling Strand, Redbarn Beach and Claycastle Beach.

In 2018, 85 separate site investigations were undertaken along the three proposed routes, comprising test pits and boreholes on the landfall and nearshore locations, and vibrocores in deeper water. The site investigations confirmed the presence of extensive Late Pleistocene glacial deposits overlain by marine deposits. At the nearshore locations, however, some estuarine deposits were also encountered, including the remains of a submerged forest at Claycastle beach. A preliminary desk-based assessment of the geotechnical survey data identified cores with geoarchaeological potential, with four cores selected for geoarchaeological recording.

An assessment of palaeoenvironmental potential was made, resulting in recommendations for a palaeoenvironmental assessment, including preliminary dating, of estuarine deposits from three cores associated with the Claycastle area.

Recommendations are also made for additional site investigations at Claycastle where the submerged forest deposits are present, should this be the chosen landfall location for the project.

CONTENTS

LIST OF ILLUSTRATIONS

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1. INTRODUCTION

Outline

1.1. Cotswold Archaeology (CA) was appointed by EirGrid plc in July 2017, under the Specialist Public Planning, Ecology and Environmental Services Framework, to prepare a marine cultural heritage assessment for the Celtic Interconnector project (Cotswold Archaeology 2017). This included an assessment of marine and coastal cultural assets, up to mean high water springs (MHWS), potentially affected by this project. The baseline environmental assessment considered previous work done in the areas of the proposed revised cable routes and indicated good palaeo-environmental potential for understanding the submerged prehistoric landscapes of south-east Ireland, including contributing to studies of past sea level change.

Project background

1.2. In 2013, two national electricity transmission system operators, EirGrid plc in Ireland and Réseau de Transport d'Electricité (RTE) in France, signed a Memorandum of Understanding. The agreement was to commission further preliminary studies on the feasibility of installing a submarine electricity interconnector between the south coast of Ireland and the north-west coast of France, a distance of some 600 kilometres. EirGrid and RTE then conducted studies which indicated that an interconnector between Ireland and France could be beneficial for electricity customers in both countries. The project would involve the procurement and installation of a 700+MW High Voltage Direct Current (HVDC) interconnector which will include two HVDC converter stations, subsea cabling, and onshore lines/cables as appropriate.

1.3. EirGrid holds licences as independent electricity Transmission System Operator (TSO) and Market Operator (MO) in the wholesale trading system in Ireland and is the owner of the System Operator Northern Ireland (SONI Ltd), the licensed TSO and market operator in Northern Ireland. The EirGrid Group includes EirGrid plc, SEMO JV, EirGrid Interconnector Ltd, and EirGrid Telecoms Ltd.

1.4. RTE, an independent subsidiary of EDF, is a public service company responsible for operating, maintaining and developing the high and extra high voltage network in France. It guarantees the reliability and proper operation of the power network.

1.5. In 2013, EirGrid and RTE undertook the exploratory phase of this interconnector project with initial studies focussed on desktop analysis of the seabed to identify potential route corridors. Between 2014 and 2015 EirGrid completed a feasibility study of the potential marine routes between Ireland and France, including geophysical and geotechnical / environmental marine surveys along the corridor between East Cork in Ireland and Brittany in France as well as investigations of two potential landfall sites. A desk-based assessment for this stage of the project was produced by Headland Archaeology (2014). An addendum was issued by Cotswold Archaeology (2017) to consider three revised/new potential cable routes within Irish territorial waters as well as three potential landfall locations; one revised and two new locations.

1.6. The revised / new cable routes run between three landfall options in Co. Cork (Ballinwilling Strand, Claycastle beach and Redbarn beach), and converge on the previously chosen route at the boundary of Irish territorial waters at 12 nautical miles (nm) (Figure 1). The revised routes were surveyed by Next Geosolutions in September to November 2017, and the data was passed to Cotswold Archaeology for a desk-based assessment in advance of the planned geotechnical site investigations.

Assessment of 2017 geophysical survey data

1.7. The 2018 geotechnical site investigations were planned to assess three potential landfall areas (Ballinwilling Strand, Claycastle beach and Redbarn beach) and the routes approaching them. In January 2018, Cotswold Archaeology commissioned Coastal and Offshore Archaeological Research Services (COARS), University of Southampton, to assess the marine geophysical survey data collected by Next Geosolutions.

1.8. The desk-based review of the geophysical data was undertaken to identify, locate and characterise features with possible archaeological potential, and to assess the sub-bottom profile data in order to establish the archaeological and palaeo-environmental potential of the sub-surface sediments that may be encountered (Cotswold Archaeology 2018a). Cotswold Archaeology (2018b) undertook an impact assessment of the landfall sites, mapping the submerged forest deposits at Claycastle and highlighting their palaeo-environmental potential, as well as identifying archaeological features at each of the foreshore locations. These reviews were undertaken in advance of site investigations which would use intrusive techniques, such as vibrocores and boreholes.

1.9. The assessment of the marine geophysical data revealed a series of palaeo-channels along all three route options. Along the Claycastle route there appears to be a series of deep fills between KP0.5 and KP5.0 where there is high potential for a nearshore submerged channel system. These may contain deposits with archaeological potential, such as submerged peats or estuarine deposits, corresponding with the onshore submerged forest peat deposits found at the Claycastle landfall site. By contrast the nearshore landfalls at Redbarn and Ballinwilling cross exposed bedrock where there is no archaeological potential for palaeo-environmental evidence unless it is located in the small channel seen meandering through the exposed bedrock. Previous coring associated with the offshore palaeo-channels has suggested that the channels may contain glacio-marine deposits at the near-surface, which would have low archaeological potential.

2. AIMS AND OBJECTIVES

2.1. The geo-archaeological assessment had the following aims:

- To undertake a desk-based assessment of the geotechnical data to identify samples with geo-archaeological potential;
- To inspect the core samples visually and describe samples identified as having geoarchaeological potential; and
- To assess the archaeological potential of the core samples and make recommendations for any further geo-archaeological investigations of these samples.

3. DESK-BASED ASSESSMENT OF GEOTECHNICAL DATA

3.1. A total of 85 interventions, ranging in elevation height from 11m to -83m lowest astronomical tide (LAT), were undertaken during the 2018 geotechnical site investigation phase (Fig. 1, Table 1). Onshore archaeological monitoring during the geotechnical investigations at Ballinwilling Strand, Redbarn beach and Claycastle beach was undertaken by IAC Archaeology (2018). This focused on 12 locations consisting of boreholes and test pits (indicated (*) in Table 1).

3.2. This assessment will consider the palaeo-environmental importance of the submerged forest deposits present at Claycastle beach that had been previously recorded during by Cotswold Archaeology (2018b; Figure 2).

3.3. Geotechnical samples were collected with the purpose of informing the engineering design, with recording and laboratory testing undertaken by Next GeoSolutions. All samples were split longitudinally and photographed prior to recording of the deposits by the geotechnical specialists, prior to sub-sampling with respect to both the stratigraphy encountered and the testing scheduled. The destructive laboratory testing included:

- Moisture content – at least 50g (fine grained soil), 3kg (coarse grained);
- Atterberg Limits – at least 600g passing 425μm sieve;
- Particle size distribution – at least 500g (for samples with grain sizes <10mm), 35kg (for samples with grain sizes <50mm);
- Minimum/maximum density – at least 6kg (sand), 16kg (gravelly soil);
- Oedometer – undisturbed sample at least 1 x diameter in length;
- Unconsolidated undrained triaxial – undisturbed sample at least 2 x diameter in length; and
- Consolidated triaxial – undisturbed sample at least 2 x diameter in length.

3.4. Core sections not subjected to destructive testing were retained by Next GeoSolutions and were made available to Cotswold Archaeology. Core photographs and descriptions were provided to enable Cotswold Archaeology to undertake a desk-based assessment of the geo-archaeological potential of the samples.

3.5. The assessment of the offshore vibrocore logs identified the following broad stratigraphic units within the cores:

- Marine sand with shell;
- Gravels and sand; and
- Compacted, probably over-consolidated, glacially-derived deposits including diamictons, clays and sub-glacial/outwash sand horizons.

Table 1 2018 Site investigation locations

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-BH-1 *	570265	5746647	6.73
BW2-BH-2 *	570282	5746588	-0.37
BW2-BH-3	570308	5746478	0.47
BW2-CPT _ VC-1	570565	5745468	-7.67
BW2-CPT _ VC-2	570861	5744335	-15.21
BW2-TP1 *	570276	5746622	0.67
BW2-TP2 *	5701291	5746565	-0.87
BW2-VC-03	571125	5742899	-22
BW2-VC-04	571384	5741478	-30
BW2-VC-04A	571370	5741484	-30
BW2-VC-05	571216	5740019	-37
BW2-VC-05A	571212	5740030	-37
BW2-VC-06	570672	6738649	-43
BW2-VC-07	569960	5737329	-44
BW2-VC-07A	569976	5737337	-45
BW2-VC-08	569690	5736341	-51
BW2-VC-08A	569697	5736346	-51
BW2-VC-09	569934	5735736	-56
BW2-VC-10	571694	5733975	-63
BW2-VC-10A	571696	5733990	-64
BW2-VC-11	572695	5732677	-67
BW2-VC-12	573710	5731495	-72
BW2-VC-12A	573696	5731498	-72
BW2-VC-13	574690	5730363	-76
BW2-VC-14	575680	5729235	-80
BW2-VC-14A	575667	5729236	-79
BW2-VC-15	576671	5728105	-80
BW2-VC-15A	576672	5728122	-81
BW2-VC-16	577661	5726978	-79

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
BW2-VC-16A	577661	5726991	-80
BW2-VC-17	578648	5725853	-80
BW2-VC-18A	579520	5724639	-83
CL-BH-1 *	578387	5754308	3.33
CL-BH-2 *	578432	5754258	0.57
CL-BH-3	578496	5754176	-0.37
CL-CPT _ VC-2	579848	5752527	-6.97
CL-CPT _ VC-3	580198	5752043	-9.99
CL-CPT_VC-1	579150	5753381	-2.41
CL-CPT_VC-1A	549145	5753381	-2.41
CL-TP1 *	578396	5754300	2.19
CL-TP2 *	578440	5754248	0.73
CL-VC-02	579850	5752523	-7
CL-VC-04	581068	5750805	-19
CL-VC-05	581605	5749403	-28
CL-VC-06	582128	5748005	-31
CL-VC-07	582686	5746622	-34
CL-VC-08	583224	5745213	-38
CL-VC-09	583876	5743864	-47
CL-VC-10	584605	5742559	-55
CL-VC-11	585334	5741240	-62
CL-VC-11A	585338	5741252	-62
CL-VC-12	585963	5739899	-70
CL-VC-12A	585985	5739902	-70
CL-VC-13	586010	5738424	-70
CL-VC-13A	586017	5738432	-70
CL-VC-14	585566	5736988	-71
CL-VC-14A	585582	5736997	-71
CL-VC-15	584999	5735629	-74
CL-VC-16	584413	5734225	-77

Core ID	Easting (UTM29N)	Northing (UTM29N)	Elevation (m LAT)
CL-VC-16A	584411	5734234	-77
CL-VC-17	583827	5732859	-75
CL-VC-17A	583849	5732857	-75
CL-VC-18	583306	5731435	-78
CL-VC-18A	583317	5731444	-79
CL-VC-19	582793	5730032	-80
CL-VC-19A	582807	5730041	-80
CL-VC-20	582268	5728624	-80
CL-VC-20A	582280	5728632	-80
CL-VC-21	581747	5727218	-80
CL-VC-21A	581739	5727227	-80
CL-VC-22	581231	5725809	-80
CL-VC-23	580710	5724399	-82
CL-VC-23A	580722	5724409	-82
CL-VC-23B	580709	5724399	-82
CL-VC-24	580359	5723405	-82
CL-VC-24A	580374	5723413	-83
RB-BH-1 *	577557	5753240	4.2
RB-BH-2 *	577621	5753202	-0.05
RB-BH-3	577819	5753080	-0.53
RB-BH-4	577795	5753003	-0.07
RB-CPT _ VC-1	578504	5752678	3.1
RB-CPT _ VC-2	580009	5751736	11.03
RB-TP1 *	577581	5753228	1.61
RB-TP2 *	577683	5753162	-1.56
RB-VC-02A	580027	5751726	-15

* monitored by IAC Archaeology

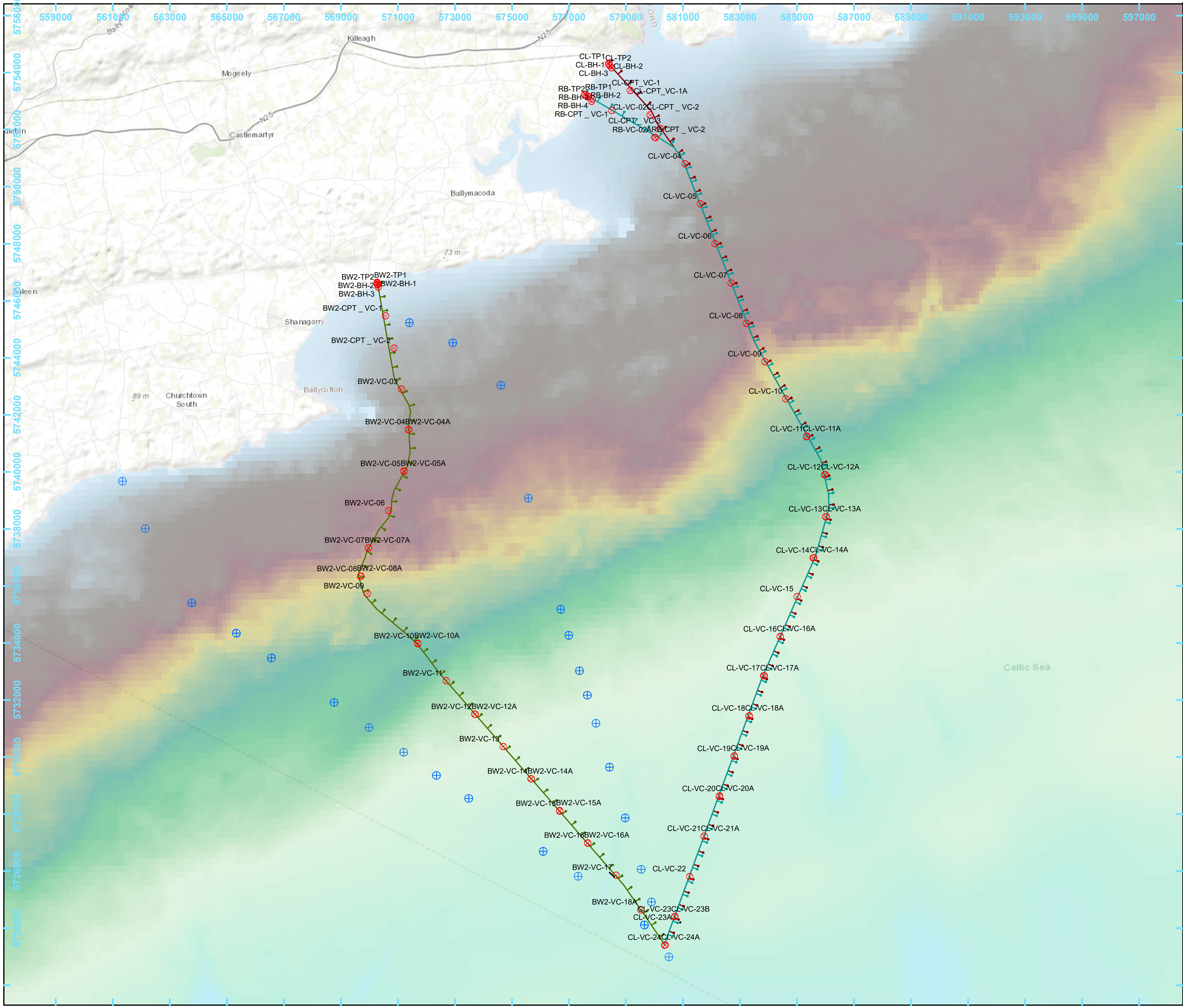
3.6. No peats or possible palaeosol horizons were identified in either the vibrocores or the core photos and were not alluded to in the sediment logs. The predominance of marine and glacial deposits suggests that these cores have low geo-archaeological potential and would therefore not require any geo-archaeological recording to assess palaeo-environmental potential.

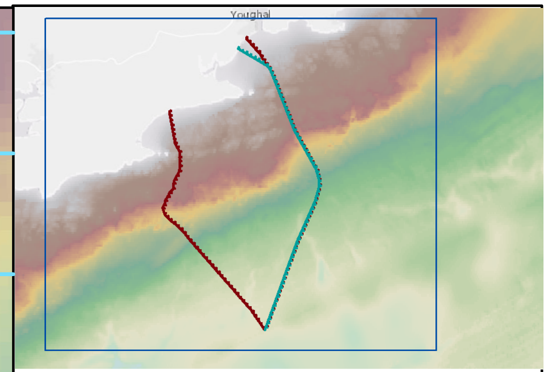
3.7. The nearshore / onshore cores were identified as having higher geo-archaeological potential. These demonstrated the presence of similar stratigraphic units as those identified in the offshore cores, along with the presence of:

- Peat horizons (including the submerged forests identified at Claycastle); and
- Estuarine clay.

3.8. The following cores were identified as having potential from the three landfall / nearshore sites:

- BW2-BH3
- RB-CPT_VC-1
- CL-BH1
- CL-BH3
- CL-CPT_VC-1A





Legend

- 2018 Sample Locations
- Previous Coring
- Redbarn Route
- Claycastle Route
- Ballinwilling route

Bathymetry (m LAT)

High : 3

Low : -85

0 5,000m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

Cotswold Archaeology marine

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e enquiries@cotswoldarchaeology.co.uk

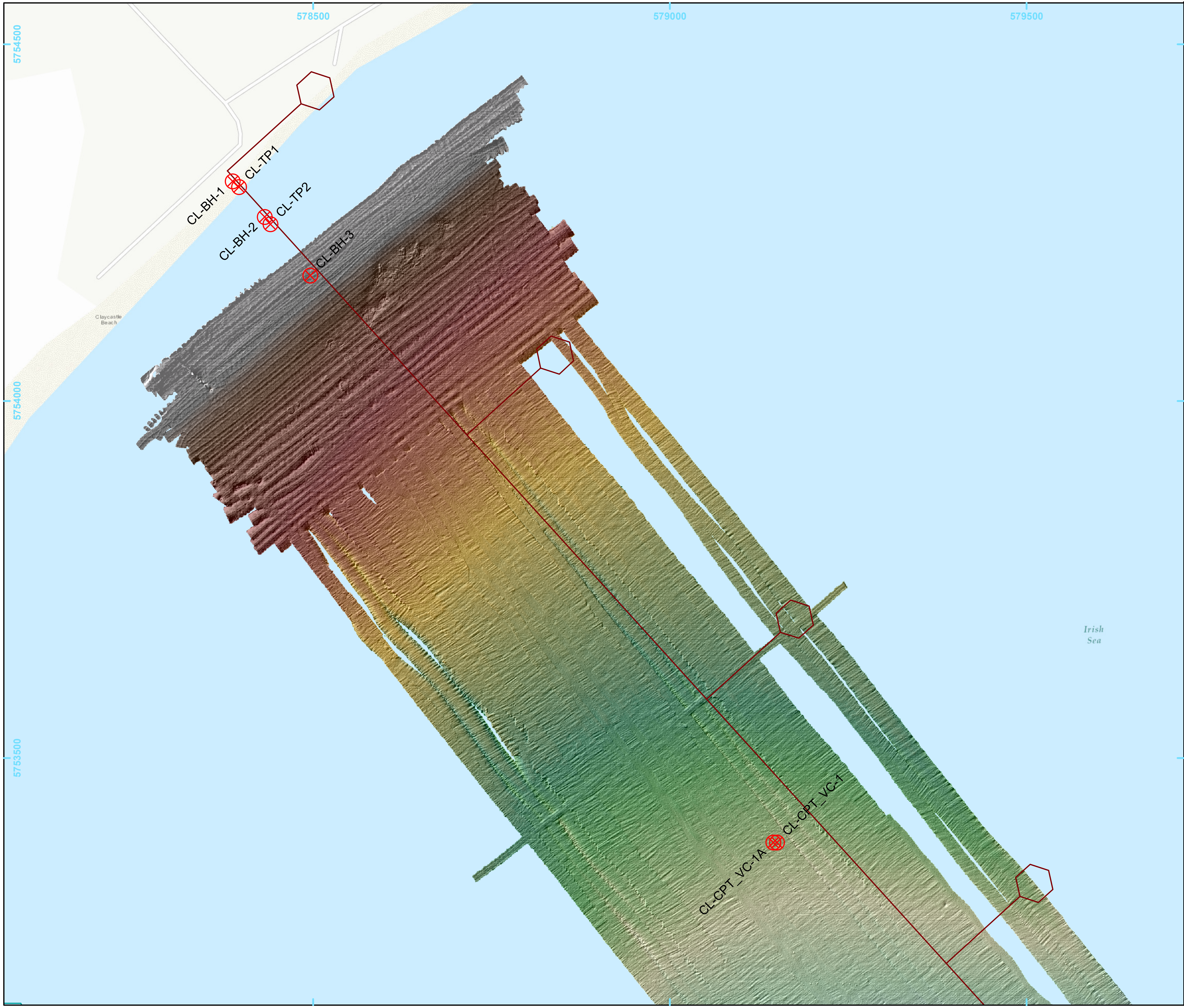
PROJECT TITLE

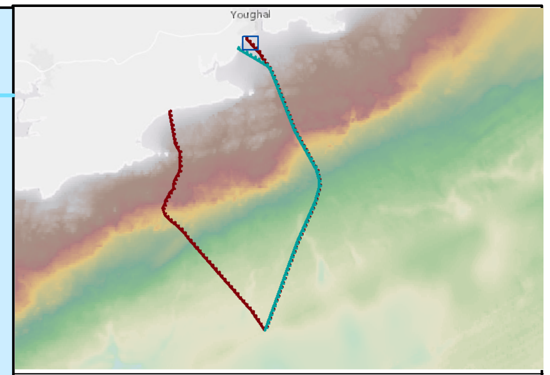
Celtic Interconnector project

FIGURE TITLE

Geotechnical Coring Locations

DRAWN BY	MJG (UoS)	PROJECT NO	17758	FIGURE NO.
CHECKED BY	MW	DATE	23/01/2019	1
APPROVED BY	xx	SCALE@A3	1:125,000	





Legend

- 2018 Sample Locations
- Redbarn Route
- Claycastle Route
- Ballinwilling route

Bathymetry (m LAT)

High : 1.41

Low : -3.12083

0 200m

Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE

Celtic Interconnector project

FIGURE TITLE

Geotechnical Site Investigations Claycastle

DRAWN BY	MJG (UoS)	PROJECT NO	17758	FIGURE NO.
CHECKED BY	MW	DATE	25/01/2019	2
APPROVED BY	xx	SCALE@A3	1:5,000	

Ballinwilling

3.9. **BW2-BH3**

At 1.5 - 2.0m (-2.0 to -2.5m LAT) the geology is described (by Next Geosolutions) as a 'red (2.5Y 4/8) CLAY with frequent plant remains (wood) and pockets of gravel. Plant remains are intact. Gravel is fine to medium, rounded'. This deposit may be comparable to the deposit recorded by IAC Archaeology (2018: 3.2.1; Plate 1) in BW2-BH1 where a 'very loose brown slightly clayey silty fine to medium sand with occasional medium to coarse sub-rounded gravel and occasional stains of organic matter' was encountered at 5.5-10.9m (1.23 to -4.17m LAT). Although this deposit was noted in the field it was, unfortunately, not recovered in the borehole and therefore no physical samples were retained to permit geo-archaeological assessment (Fig. 3).

(blue)	Not recovered
(blue, red outline)	Used for geotech propose
(blue, green outline)	Retained

Figure 3 Samples from BW2-BH3 (from Next Geosolutions)

Redbarn

RB-CPT_VC-1

3.10. The geological description noted the presence of a thin peat recorded at 3.3 - 3.5m (-6.4 to -6.6m LAT) overlying probable Till. The core photographs, however, do not show the presence of a peat horizon. Next GeoSolutions account for this discrepancy by stating that the only organic matter encountered was related to smears of clayey organic matter on the walls of the SPT sampler (Figure 4). The core was therefore deemed to have no geo-archaeological potential.

Figure 4 Samples from RB-CPT-VC-1 (from Next Geosolutions)

Claycastle

CL-BH1

3.11. At 4.5 - 6.0m the geological description (supplied by Next Geosolutions) was of a 'dense dark brown (7.5YR 3/4) to black (10 YR 2/1) slightly gravelly, slightly sandy PEAT with frequent decayed plant material'. This peat deposit is part of the submerged forest located on the foreshore (Cotswold Archaeology 2018b) and was monitored by IAC Archaeology (2018; 3.4.1).

3.12. All the material from 4.5 - 5.0m in Shelby tube P4 was used for geotechnical testing purposes; the only retained sample from 5.0 - 5.45m consisted of a deposit described as sands with organic matter within SPT4. There was no sample recovery at 5.5 - 6.0m, but the next sample recovered, at 6.0m, contained no evidence of peat, thus providing a maximum potential depth for the base of the peat (of 6m) and a thickness of up to 1.5m (Fig. 5).

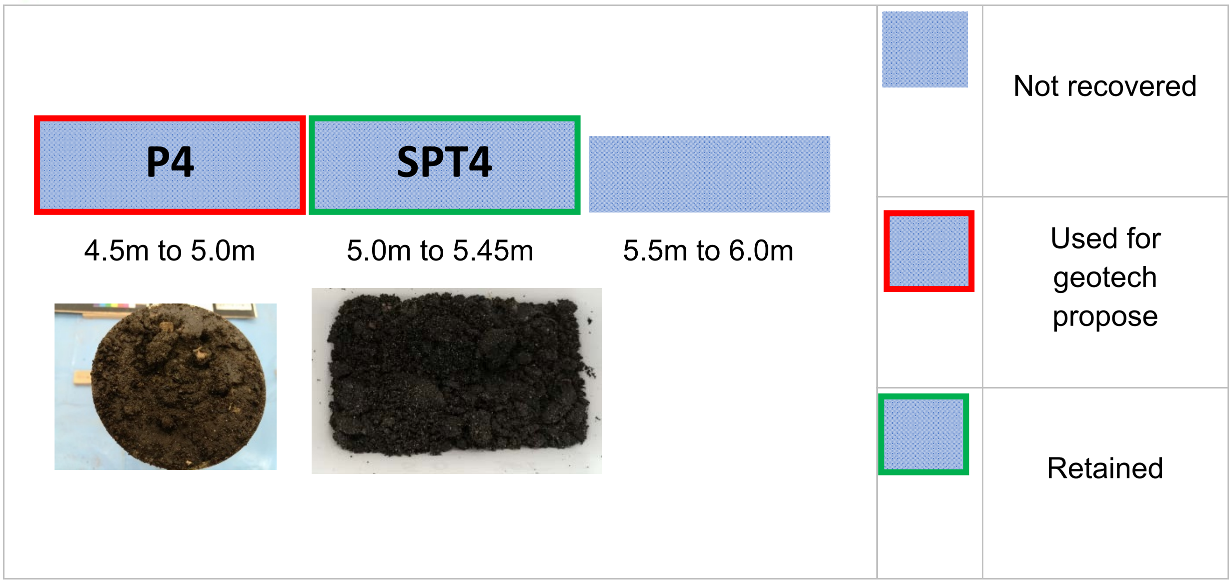

Figure 5 Samples from CL-BH1 (from Next Geosolutions)

CL-BH2

3.13. This core was taken adjacent to the known exposure of the submerged forest and was also encountered in CL-TP2 (see IAC 2018). The recorded sequence was:

- 0.00 - 0.90m: Loose brown (10YR 5/3) gravelly slightly silty fine to medium SAND. Gravel is fine to coarse and sub-angular to sub-rounded of various lithologies;
- 0.90 - 1.50m: Grey silty sand with pockets of silt with rare spongy pseudo-fibrous peat and pseudo-fibrous spongy plant and wood remains. Intense organic odour;
- 1.50 - 3.40m: Very loose grey (2.5Y 5/1) to olive brown (2.5Y 4/4), slightly silty fine to coarse organic SAND with amorphous and fibrous peat;
- 3.40 - 6.50m: Very soft grey (2.5Y 5/1) to greenish grey (GLEY1 5/1) slightly sandy silty CLAY. Between 4.50 - 5.00m a band of slightly gravelly slightly sandy clayey silt, and at 6.00m a light grey (10YR 7/2) slightly gravelly very sandy very silty CLAY. Gravel is fine to coarse, sub-rounded to sub-angular of mudstone.

3.14. The adjacent core (**CL-TP2)** confirmed that the peat deposit was between 0.25m and 1.80m, overlying sand with shell fragments. This could indicate that the peat represents an extension of the peat over previous riverine / marine sand deposits and could therefore potentially provide a useful Late Holocene sea level index point

(SLIP). There was no sample retention of the peat deposits suitable for geo-archaeological recording.

CL-BH3

3.15. A further extension of the submerged forest was recorded, with a possible basal palaeosol preserved at the base of the sequence. The geological description (supplied by Next Geosolutions) for the section of interest, 8.3 - 9.1m (-7.9 to -8.7m LAT), was:

- 8.30 - 8.50m: Black (10YR 2/1) spongy clayey fibrous PEAT;
- 8.50 - 8.80m: Firm grey (2.5 5/1) soft (12 kPa) very gravelly very sandy CLAY with blocks of pseudo-fibrous spongy plant remains;
- 8.80 - 9.10m: Reddish brown (2.5YR 4/3) slightly silty slightly clayey very gravelly fine to medium SAND. Gravel is fine to coarse, sub-rounded to rounded meta-sandstone (low grade) quartz and flint.

3.16. The samples from this core that were available for the depths of interest were limited to 8.20 - 8.50m and 8.80 - 9.00m (Fig. 6); the remainder were either destructively tested or not retained. The core photos do not show a distinct peat horizon; Next GeoSolutions confirmed that the only rare evidence of spongy clayey fibrous peat was encountered at about 8.3m.

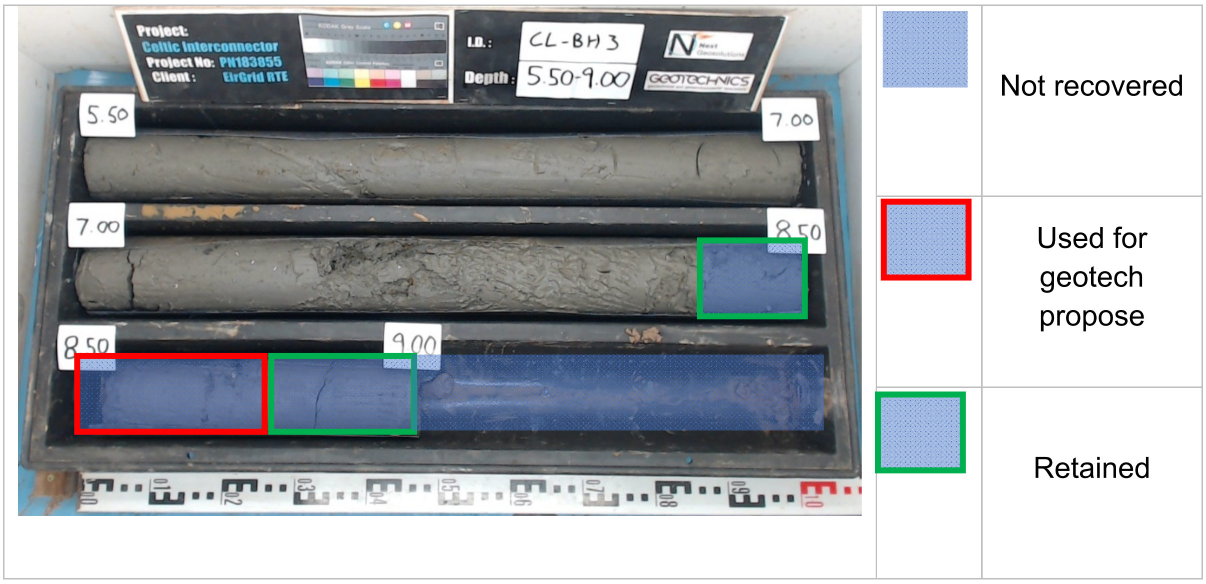

Figure 6 Samples from CL-BH3 (from Next Geosolutions)

CL-CPT_VC-1A

3.17. The geological logs recorded clays with shells and occasional organic matter at 1.6 - 5.5m (-4.0 to -7.9m LAT). Next GeoSolutions confirmed that there was no evidence of peat present and only occasional evidence of amorphous organic matter was highlighted. This core appears to contain a series of clays representing estuarine deposits (Fig. 7). Core **CL-CPT_VC-1**, immediately adjacent to this vibrocore, contained a similar sedimentary sequence.

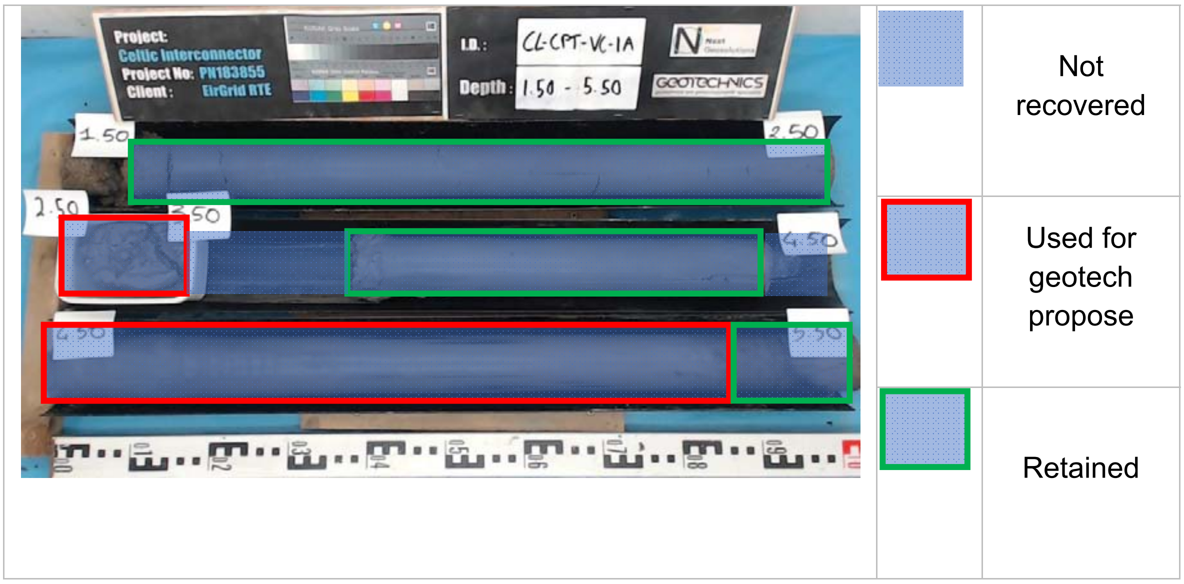

Figure 7 Samples from CL-CPT_VC-1A (from Next Geosolutions)

3.18. The desk-based assessment, and updated descriptions from Next GeoSolutions, resulted in the identification of four core sections from Claycastle beach where sediment was retained that might hold palaeo-environmental potential:

- CL-BH1: 5.00-5.45m;
- CL-BH3: 8.20-9.00m;
- CL-CPT-VC1A 1.6-2.5m; and 3.50-4.50m

3.19. These cores sections were sent to Cotswold Archaeology for geo-archaeological recording (below).

4. GEO-ARCHAEOLOGICAL RECORDING

4.1. The geo-archaeological assessment followed Historic England (2015) guidelines, with descriptions according to Hodgson (1997) including sediment type, depositional structure, texture and colour. Interpretations regarding mode of deposition, formation processes, likely environments represented, and potential for palaeo-environmental analysis were also noted. The results have been tabulated and are presented below (Tables 2, 3 & 4). As all the samples had been sub-sampled, there was little available information regarding sedimentary structures (bedding, laminations, etc) or stratigraphic boundaries. A photographic record of the samples, including key stratigraphic features, has been made to supplement the sedimentary descriptions.

5. RESULTS

5.1. Geoarchaeological descriptions of the samples from each of the four core samples are provided below.

CL-BH1: 5.00 - 5.45m

5.2. A single bulk sample was obtained and confirmed the presence of a woody peat. The elevation of the peat suggests it is probably an onshore extension of the submerged forest deposits encountered on the foreshore and observed in CL-BH2 and CL-TP2 (see IAC Archaeology 2018). The sample may be suitable for an assessment of the waterlogged plant remains but would be of little use for other techniques such as pollen as the sample only represents a single bulk sample.

Table 2 Geo-archaeological description of CL-BH1

Depth in core	Depth (m LAT)	Description	Interpretation
5.00 - 5.45m	-1.67 to -2.12m	10YR 1/1 peat, some fibrous ?root remains and also small wooden ?twigs.	Peat

CL-BH3: 8.20 - 9.00m

5.3. The core sections available represent an estuarine deposit overlying a probable Late Pleistocene Glacial Till. The estuarine deposit was only sampled between 8.20 - 8.50m but contained distinct laminations which may relate to rhythmite deposition within a saltmarsh or mudflat environment. Broken shell could point towards the nearby presence of a channel with higher flow rates leading to the deposition of broken shell during periods of flooding. The base of the sequence, which could indicate a transgressive surface, was not sampled. The core, however, might have palaeo-environmental potential for understanding the environment of deposition associated with the deposits at 8.20 - 8.50m, especially if the organic material within the core is suitable for radiocarbon dating.

Table 3 Geo-archaeological description of CL-BH3

Depth in core	Depth (m LAT)	Description	Interpretation
8.20 - 8.50m	-5.57 to -8.87m	10YR 7/3 No mottles silty clay, finely laminated, stoneless, broken shell at 8.28 and 8.43m, 1-2%, organics, slightly laminated but not full core width, at 8.28, 8.33, 8.37, 8.43, 8.46, 8.51 and 8.57m. Base not reached	Estuarine deposit
8.50 - 8.80m	-8.87 to -9.17	GAP	
8.80 - 9.00m	-9.17 to -9.37	10YR 5/4 1-2% fine mottle, very dense (?over consolidated) 10YR 6/6 clay, finely laminated, sub-rounded to rounded / tabular stones, 10-40mm, very slightly stony, no shell, no organics, base not reached	Possible Glacial Till

CL-CPT-VC1A 1.60 - 2.50m and 3.50 - 4.50m

5.4. The top and base of the 1.60 - 2.50m section was not marked, so it is assumed that the coarser sand-rich horizon is the top of this core section. This is supported by the fact that the underlying Shelby sample is composed of clay with no sand inclusions.

5.5. The core contained a long estuarine sequence, although the base of this sequence was not reached. The coarsening of the grain size in the core suggests a transition towards a higher energy environment and the proximity of channels and / or the littoral zone. The basal clays are likely to represent intertidal environments.

5.6. The presence of intact bivalve molluscs in this deposit suggests a low energy environment and could also be diagnostic, relating to establishing the indicative elevation of this deposit, as well as providing good potential for radiocarbon dating.

5.7. Overlying organics are likely to reflect saltmarsh or reedbed deposits. Some organics could be dated if deemed appropriate taphonomically (i.e. not roots). This core provides the potential to date the change in estuarine conditions which might provide a palaeo-landscape context for the onshore submerged forest.

5.8. If dating is successful, this core could also provide a sea level record if coupled with foraminifera, diatom and pollen assessments.

Table 4 Geo-archaeological description of CL-CPT-VC1A

Depth in core	Depth (m LAT)	Description	Interpretation
1.60 - 1.625m	-4.01 to -4.035m	10YR2/1 No mottles, sandy silt loam, stoneless, small shell (<5mm), 1-2%, no visible organics, Abrupt boundary to:	Estuarine deposit
1.625 - 1.685m	-4.035 to -4.095m	10YR4/1 No mottles, sandy clay, rounded tabular stones, slightly stoney, up to 15mm, bivalve shell (up to 8mm), 2%, no visible organics. Sharp boundary to:	Estuarine deposit
1.825 - 2.50m	-4.095 to -4.91m	10YR4/1 No mottles, silt loam, stoneless (very rare), broken bivalve shell, 1.75, 2.26 and 2.38m. fine organics present at 2.14, 2.20m, with vertical rooting between 2.33-2.42m. Base not reached	Estuarine deposit
2.50 - 3.50m	-4.91 to -5.91m	GAP	
3.50 - 4.50m	-5.91 to -6.91m	10YR 5/1 no mottles, clay, stoneless, intact bivalves up to 25mm, both horizontal and vertical orientation, but not articulated, 3.60-3.66 and 3.77m, 1% small organic at 3.52 and 3.75m. Base not reached	Estuarine deposit

6. PALAEO-ENVIRONMENTAL POTENTIAL

6.1. The three cores subjected to geo-archaeological recording display good potential for understanding the Holocene palaeo-landscape of the Claycastle area. Onshore and offshore cores confirm the presence of estuarine deposits, which correlate with the channel area identified previously in the assessment of the marine geophysical survey data. The submerged forest deposits appear to extend from their intertidal exposures up to the location of **CL-BH1** and may be up to 1.6m in thickness.

6.2. Both the peat and estuarine deposits have the potential to provide material suitable for radiocarbon dating. Coupled with assessments of waterlogged plant remains, molluscs, pollen, diatoms and foraminifera, these cores could provide an important insight into the timing of marine transgression and regression in this area of southeast Ireland.

6.3. The geotechnical samples from **CL-CPT-VC1A** and **CL-BH3** provide sufficient material for an assessment of the changing sedimentary sequence. The sample from **CL-BH1** (coupled with **CL-BH2**) demonstrate the extent of the submerged forest but provide insufficient material for palaeo-environmental assessment.

7. RECOMENDATIONS

7.1. Palaeo-environmental assessment should be undertaken on material from cores **CL-CPT-VC1A** and **CL-BH3**. An assessment of the waterlogged plant remains, and molluscs would identify material suitable for radiocarbon dating. Pollen, diatoms and foraminifera should also be assessed from each core. The proposed sampling strategy for each core is provided in Tables 5 and 6, with total number of samples per technique provided in Table 7

Table 5 Proposed sampling for CL-BH3

Depth in core	Depth (m LAT)	Description	Proposed Sampling
8.20 - 8.50m	-5.57 to -8.87m	10YR 7/3 No mottles silty clay, finely laminated, stoneless, broken shell at 8.28 and 8.43m, 1-2%, organics, slightly laminated but not full core width, at 8.28, 8.33, 8.37, 8.43 and 8.46m. Base not reached	2P, 2D, 2F, 2WL, $1C^{14}$
8.50 - 8.80m	-8.87 to -9.17m	GAP	
8.80 - 9.00m	-9.17 to -9.37m	10YR 5/4 1-2% fine mottle, very dense (?over consolidated) 10YR 6/6 clay, finely laminated, sub-rounded to rounded / tabular stones, 10-40mm, very slightly stony, no shell, no organics, base not reached	No sampling

P = Pollen; D = Diatoms; F = Foraminifera; WL = Waterlogged plant remains and molluscs; C^{14} = radiocarbon

Table 6 Proposed sampling for CL-CPT-VC1A

Depth in core	Depth (m LAT)	Description	Proposed Sampling
1.60 - 1.625m	-4.01 to -4.035m	10YR 2/1 No mottles, sandy silt loam, stoneless, small shell (<5mm), 1-2%, no visible organics, Abrupt boundary to:	1P, 1D, 1F, 1WL
1.625 - 1.685m	-4.035 to -4.095m	10YR 4/1 No mottles, sandy clay, rounded tabular stones, slightly stoney, up to 15mm, bivalve shell (up to 8mm), 2%, no visible organics. Sharp boundary to:	1P, 2D, 1F, 1WL
1.825 - 2.50m	-4.095 to -4.91m	10YR 4/1 No mottles, silt loam, stoneless (very rare), broken bivalve shell, 1.75, 2.26 and 2.38m. fine organics present at 2.14, 2.20m, with vertical rooting between 2.33 - 2.42m. Base not reached	2P, 3D, 3F, 2WL, $1C^{14}$
2.50 - 3.50m	-4.91 to -5.91m	GAP	
3.50 - 4.50m	-5.91 to -6.91m	10YR 5/1 no mottles, clay, stoneless, intact bivalves up to 25mm, both horizontal and vertical orientation, but not articulated, 3.60 - 3.66m and 3.77m, 1% small organic at 3.52 and 3.75m. Base not reached	3P, 3D, 3F, 3WL, $1C^{14}$

P = Pollen; D = Diatoms; F = Foraminifera; WL = Waterlogged plant remains and molluscs; C^{14} = radiocarbon

Table 7 Proposed total number of samples for assessment

Technique	Number of samples
Waterlogged plant remains and molluscs	9
Pollen	9
Diatoms	11
Foraminifera	10
Radiocarbon dating	Up to 3

7.2. The palaeo-environmental assessment of the core samples will aim to:

- Establish the range of freshwater, brackish and marine deposits recorded;
- Determine the preservation of different ecofacts;
- Establish the age of the organic deposits / shells;
- Establish the potential for determining SLIPs from the sediments; and
- Establish any evidence for human activity in the sedimentary record

7.3. The submerged forest deposits at Claycastle should be subject to further investigation. A short campaign of hand-auguring across the beach, by suitably qualified specialists, might prove beneficial to better understand the nature of the peat deposits by a) establishing the depth of the peat deposits across the site, and b) possibly identifying the extent of the deposits. Further archaeological investigation could also be undertaken if there were any further project-specific site investigations in this area. This could take the form of a watching brief, together with palaeo-environmental sampling, during cable installation.

Palaeo-environmental assessment methodology

7.4. A brief outline of the methods to be employed during the palaeo-environmental assessment is provided below. The proposed specialists are listed in Table 8.

Table 8 Proposed specialists for geoarchaeological stage 3 assessment

Technique	Specialist / supplier
Diatom	Dr Tom Hill, Natural History Museum
Foraminifera	Dr Matt Law, L-P Archaeology
Pollen	Dr Michael Grant, COARS
Waterlogged plant remains (WPR) including assessment of presence of insect remains	Sarah Wyles, Cotswold Archaeology
Mollusc	Sarah Wyles, Cotswold Archaeology
Radiocarbon dating	SUERC

Diatom

7.5. Diatom samples will be prepared using the standard technique of Plater et al. (2000). Identifications will be made with reference to Hendy (1964) and van der Werff & Huls (1958–1974).

Foraminifera

7.6. Foraminifera assessments will follow Historic England (2011) guidance for environmental archaeology. Samples will be air-dried, and a standard volume sample of sediment will be passed through a 63µm mesh sieve in water. Foraminiferid tests and other items of palaeo-ecological interest will be extracted under low-power microscopy. Tests will be identified to species level by comparison to a reference collection and brief notes made about condition of preservation. Any ostracods encountered in these samples will be collected, quantified and stored for subsequent identification by a specialist, if required, during Stage 4 Analysis. The assessment will include a full statement of potential and recommendations for any further analysis or archiving / disposal.

Pollen

7.7. Standard preparation procedures will be used (Moore *et al*. 1991). 2cm^3 of sediment will be processed from each sample, with a Lycopodium spike added (two tablets from batch 3862) to allow the calculation of pollen concentrations (Stockmarr 1971). All samples will undergo the following treatment: 20 mls of 10% potassium hydroxide (KOH) (80°C for 30 minutes); 20mls of 60% hydrofluoric acid (HF) (80°C for 120 minutes); 15 mls of acetolysis mix (80°C for 3 minutes); stained in 0.2% aqueous solution of safranin and mounted in silicone oil following dehydration with tert-butyl alcohol. Due to the highly minerogenic nature of some of the samples additional sieving and decanting will be undertaken between the KOH and HF stages, along with an extended period of 10% hydrochloric acid (HCL) dissolution of the calcareous sediments.

7.8. Pollen counting will be undertaken at a magnification of x400 using a Nikon SE transmitted light microscope. Determinable pollen and spore types will be identified to the lowest possible taxonomic level with the aid of a reference collection kept at COARS, University of Southampton. The pollen and spore types used are those defined by Bennett (1994; Bennett et al. 1994), with the exception of Poaceae which will follow the classification given by Küster (1988), with plant nomenclature ordered according to Stace (2010). The pollen assemblage will be calculated as % total land pollen (TLP). The TLP sum will exclude aquatics and pteridophyes, which will be calculated as % + Group. A TLP sum of 100 grains will be sought for the pollen assessment.

Waterlogged plant remains

7.9. Assessment of the waterlogged plant remains entails scanning of the unsorted flots and residues under a x10-x40 stereo-binocular microscope and the recording of presence and relative abundance of waterlogged plant remains. Preliminary identifications of dominant taxa are recorded and tabulated following the nomenclature of Stace (2010).

Mollusc

7.10. The flots and residues are assessed by scanning under a x10 – x40 stereo-binocular microscope to provide some information about shell preservation and species representation. The numbers of shells and the presence of taxonomic groups are quantified and tabulated. Nomenclature is according to Anderson (2005) and habitat preferences according to Kerney (1999).

Radiocarbon Dating

7.11. Wherever possible, identifiable short-lived terrestrial plant macrofossils suitable for dating (following Bayliss **et al**., 2008: xi) will be used. Alternatively, marine molluscs may be dated if intact and showing little evidence of reworking. Dates will be calibrated against the IntCal13 Northern Hemisphere radiocarbon curve (Reimer *et al*. 2013) using OxCal 4.3 (Bronk Ramsey, 1995, 2001) and quoted as calibrated years before present (BP) using the maximum intercept method (Bayliss *et al*. 2008). Date ranges are quoted using the 2σ calibrated range, with end points rounded outwards to 10 years (Mook 1986).

7.12. To conclude, nothing has yet been found at these sites that would prevent the cable coming ashore at any of these locations. Although the peat deposits on Claycastle beach have archaeological / palaeo-environmental potential, nothing has yet been discovered that could not be mitigated through further archaeological site investigation.

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Celtic Interconnector

Volume 3D2 – Appendix 15C

Cork Beaches Archeological Monitoring Report

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IAC Archaeology

ARCHAEOLOGICAL MONITORING AS PART OF THE CELTIC INTERCONNECTOR PROJECT, CLAYCASTLE & SUMMERFIELD/ CLONARD EAST/ BALLYCRENANE, COUNTY CORK

LICENCE NUMBER: 18E0322/ 18R0118

ON BEHALF OF
COTSWOLD ARCHAEOLOGY MARINE

FORESHORE LICENCE: FS006811

LICENCEE: TIM COUGHLAN

DECEMBER 2018

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ABSTRACT

Irish Archaeological Consultancy Ltd has prepared this report on behalf of Cotswold Archaeology Marine (for Eirgrid), to present the results of archaeological monitoring of site investigations associated with the Celtic Interconnector Project. Three potential cable route options were investigated in County Cork at Redbarn Beach (Clonard East townland), Claycastle Beach (Claycastle and Summerfield townlands) and Ballinwilling Strand (Ballycrenane townland). The works were undertaken by Tim Coughlan of IAC Ltd under licence 18E0322/ 18R0118 and in association with Foreshore Licence FS006811.

No features or artefacts of archaeological significance were identified at Claycastle Beach, Ballinwilling Strand or Redbarn Beach during the monitoring of excavations or metal detection.

At Claycastle Beach, it is clear that the remains of a submerged landscape potentially dating to the Holcene, survives beneath the beach. Exposed elements of this landscape were avoided by the site investigation works. However, the organic layer, which contains the remains of tree roots and plant remains, does extend beneath the sand across the full width of the beach and has the potential to contain archaeological features or artefacts, although no specific features or artefacts were identified during monitoring. Should Claycastle Beach be chosen as the preferred cable landfall location, further archaeological assessment will be required.

Once a location and design for the cable has been confirmed, further archaeological assessment and mitigation measures may be required in advance of the development. The assessment should take into account the results of all archaeological investigations to date at the landfall point that is eventually selected.

No further archaeological mitigation is deemed necessary as part of this phase of site investigations.

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1 INTRODUCTION

1.1 GENERAL

The following report details the results of a programme of archaeological monitoring and metal detection undertaken at three locations in County Cork during site investigations associated with the assessment of cable route options that will form part of the proposed Celtic Interconnector Project. The monitoring was undertaken by Irish Archaeological Consultancy Ltd, on behalf of Cotswold Archaeology Marine for Eirgrid under licences 18E0322 and 18R0118. Archaeological monitoring is being carried out in association with Foreshore Licence FS006811.

Monitoring follows on from an archaeological impact assessment that was prepared by Michael Walsh of Cotswold Archaeology Marine on behalf of Eirgrid (2018).

Archaeological monitoring 'involves an archaeologist being present in the course of the carrying out of developments' and has been defined as being carried out 'so as to identify and protect archaeological deposits, features or objects which may be uncovered or otherwise affected by the works' (Department of Arts, Heritage, the Gaeltacht and Islands, 1999b).

FIGURE 1: Location of proposed cable routes

1.2 THE DEVELOPMENT

The future development will consist of the laying of a cable route within a foreshore area as part of the proposed Celtic Interconnector Project. Three cable route options are currently under consideration and full design detail is not available.

2 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

2.1 GENERAL

In 2017 Cotswold Archaeology undertook archaeological assessments (non-intrusive marine and foreshore surveys) to the west of Youghal, County Cork at Claycastle and Redbarn beaches. This included a re-assessment of a previously assessed site at Ballinwilling Strand. The aim was to assess and to map the extent of archaeological remains at these three potential landfall locations as part of the proposed Eirgrid Project.

The foreshore assessments included walkover, hand-held metal detector, and geophysical (electrical conductivity) surveys at Claycastle and Redbarn beaches and a walkover survey on the previously assessed beach (Ballinwilling Strand). The marine archaeological assessment comprised a review of offshore geophysical survey data collected over the proposed route corridors in Irish territorial waters by Next Geosolutions Group, out to the 12 nautical mile (nm) territorial limit.

These assessments were undertaken by Cotswold Archaeology in collaboration with Coastal and Offshore Archaeological Research Services (COARS), University of Southampton (who undertook the offshore geophysical analysis) and Headland Archaeology Ltd who undertook the foreshore geophysical survey and assessment.

The three locations involved in this project are located at Ballinwilling Strand (Ballycrenane townland), Claycastle Beach (Claycastle and Summerfield townlands) and Redbarn Beach (Clonard East townland), County Cork. These sites would have ideal locations for domestic activity throughout the prehistoric period and medieval period, with easy access to coastal resources.

2.2 BALLINWILLING STRAND

Ballinwilling Strand is the most south-westerly site of the potential cable options. There is one recorded monument located in proximity to the proposed route, which consists of a recorded *fulacht fia* (CO089-076) (Figure 2). *Fulachta fia* or burnt mounds are the most commonly identified sites of prehistoric date, generally dating to the Bronze Age. These sites consist of a horse-shoe shaped mound of charcoal-rich material and heat-affected stones, often found in association with a trough or troughs. They are usually located in close proximity to a water source or in a marshy area and used heated stones to heat water within the trough. Many of these sites have been heavily disturbed by later agricultural activities and as a result survive only as an irregular spread of heat-affected stones and charcoal. While they have been traditionally interpreted as sites used for cooking (O'Kelly 1954), others have suggested they may represent other activities such as brewing, dyeing or bathing (Quinn and Moore 2009). It is more likely that no single function can be attributed to these sites with each site requiring an individual interpretation. The SMR file for the *fulacht fia* (CO089-076) close to the proposed cable route states that the site was "levelled in late 1960s".

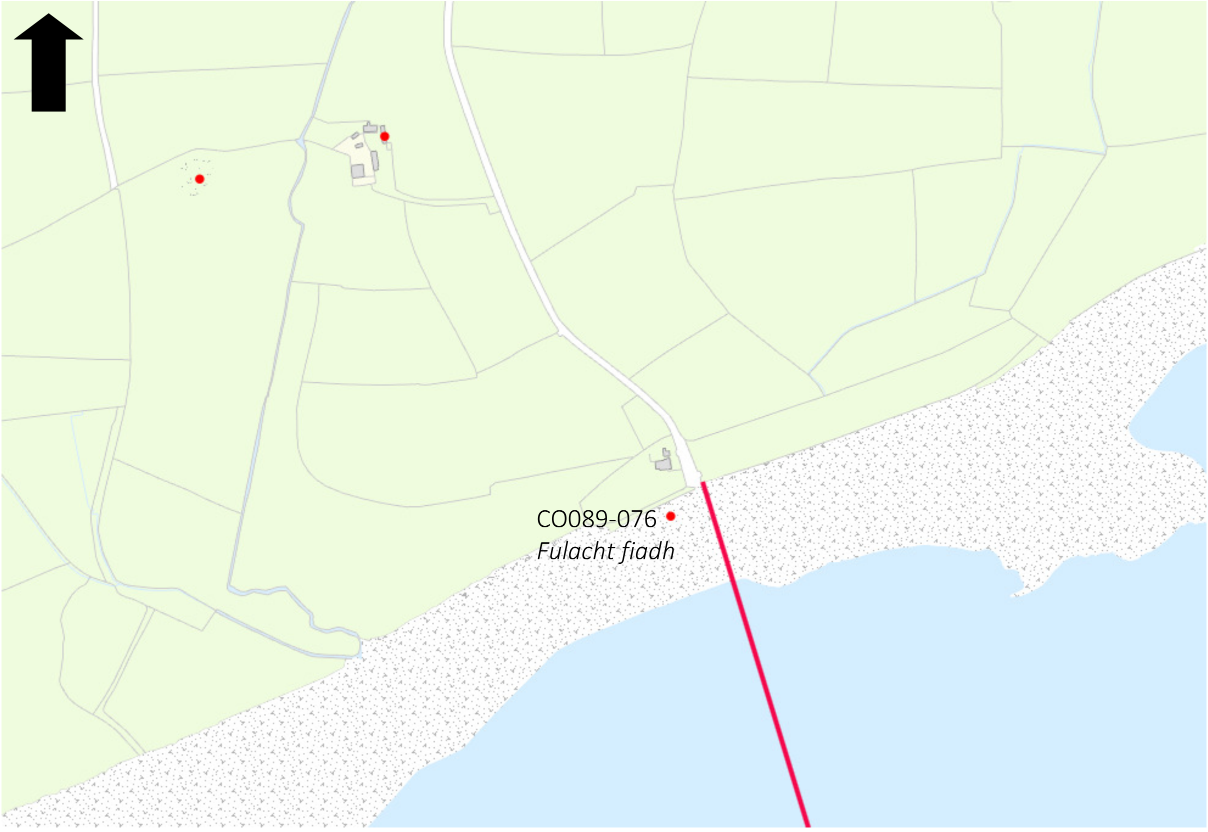

FIGURE 2: Extract from archaeology.ie showing the location works at Ballinwilling Strand

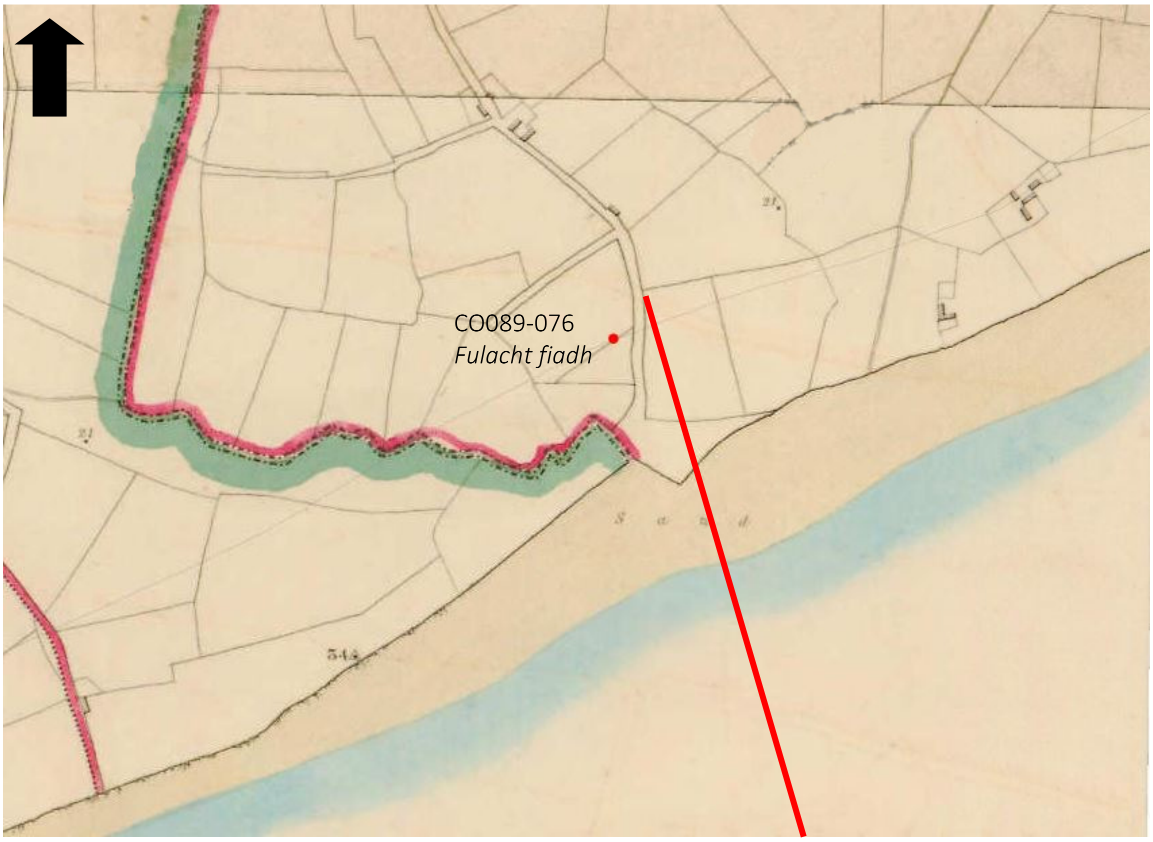

FIGURE 3: Extract from the first edition OS map (1845), showing the location of CO089-076

The remains of sea defences, concrete breakwaters and groynes along the edge of Ballinwilling Strand comprise low value heritage assets. In addition, the 51 responses from the metal detector survey on Ballinwilling Strand appear to relate to buried casual losses of objects on the beach and are not considered of any heritage significance (Headland Archaeology 2015).

The first edition map of 1845 shows that a level of coastal erosion has taken place in the past c. 170 years. The recorded *fulacht fia* was formerly located further inland than the plotted position of the monument today (Figure 3).

There are no recorded ship wrecks located within the vicinity of the proposed foreshore site investigation works.

2.3 CLAYCASTLE BEACH

At Claycastle Beach, the Cotswold Archaeology assessment identified extensive areas of exposed peat with associated remains of tree trunks and roots (Figure 4). The geophysical survey may have detected these remains as extending under the beach sand both landward and seaward. This was assessed as being of high significance. An eroded and heavily encrusted circular object (possibly a pot), lying half exposed in the intertidal zone, was also identified. It could, possibly, be the fossilised remains of a hollowed-out trunk but this seems less likely as the other wooden remains associated with the peat do not appear fossilised. This was also assessed as being of high significance. The remains will be avoided with an exclusion zone.

FIGURE 4: Extract from the Cotswold Archaeology assessment showing potential archaeological remains at Claycastle Beach

There are no recorded monument or recorded ship wrecks located in proximity of the proposed site investigation works at Claycastle Beach. A review of the historic mapping has shown that whilst some coastal erosion has taken place since the 19th century, it does not appear to be at the same scale as Ballinwilling Strand.

2.4 REDBARN BEACH

At Redbarn Beach a line of upstanding stones, running east-west and standing up to 0.4m high were noted during the Cotswold Archaeology survey (2018), which appear to be the remains of earlier sea defences. These were assessed as being of medium significance. A total of 24 individual buried metal finds were noted, which appear to represent casual losses are of very low archaeological significance. A total of 57 readings were noted on the metal detector, which appeared to be aligned in three rows on a northeast-southwest alignment over an area of c 60m x 300m. These buried magnetic anomalies appeared to correlate with a sub-surface depression identified in the geophysical survey and were assessed as being of medium significance. These areas have been excluded from works and are shown on Figure 5.

There are no recorded monument or recorded ship wrecks located in proximity of the proposed site investigation works at Redbarn Beach. A review of the historic mapping has shown that whilst some coastal erosion has taken place since the 19th century, it does not appear to be at the same scale as Ballinwilling Strand.

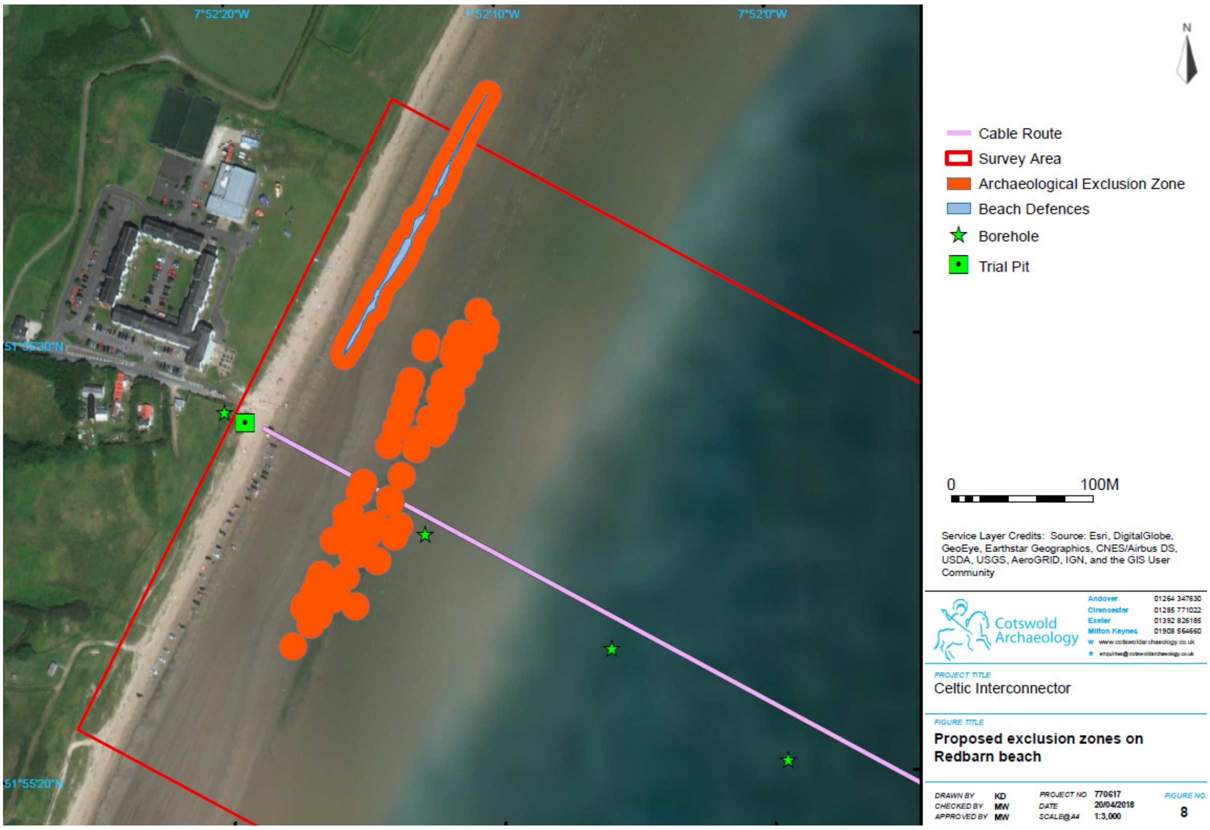

FIGURE 5: Extract from the Cotswold Archaeology assessment showing potential archaeological remains at Redbarn Beach

3 ARCHAEOLOGICAL MONITORING

3.1 GENERAL

Archaeological monitoring of site investigations took place at three potential landfall sites for the Celtic interconnector project: Ballinwilling Strand, Redbarn Beach and Claycastle Beach. Two boreholes and two test pits were monitored at each beach and metal detecting was carried out during the course of the site investigation works.

The maximum depth below surface for boreholes and trial pits was up to 21m and 3.6m respectively. The dimensions of the trial pits varied between 2m x 5.5m whilst boreholes were 165mm in diameter. Following excavation the trial pits were backfilled using only native materials while the boreholes were backfilled using pellet bentonite (compactonite).

The equipment used during the works consisted of the following:

- Borehole – PSM-8G Hydraulic Drilling Rig
- Trial Pit – 21 tonne tracked excavator
- Metal Detector – Garret EuroAce

SI CODE	LOCATION	ITM EASTINGS	ITM NORTHINGS	MAX. WIDTH	MAX. LENGTH	MAX. DEPTH
BW2-BH1	Ballinwilling	570265	**5746647**	165mm	165mm	21m
BW2-BH2	Ballinwilling	570282	**5746588**	165mm	165mm	20m
BW2-TP1	Ballinwilling	570276	**5746622**	3m	5.5m	2m
BW2-TP2	Ballinwilling	570308	**5746478**	3.5m	4.5m	1.9m
RB-BH1	Redbarn	**577581**	**5753228**	165mm	165mm	20m
RB-BH2	Redbarn	**577683**	**5753162**	165mm	165mm	20m
RB-TP1	Redbarn	**577557**	**5753240**	2m	5m	3m
RB-TP2	Redbarn	**577621**	**5753202**	2m	5m	3m
CL-BH1	Claycastle	578396	5754300	165mm	165mm	20m
CL-BH2	Claycastle	578440	5754248	165mm	165mm	20m
CL-TP1	Claycastle	578387	5754308	2.5m	5m	3m
CL-TP2	Claycastle	578432	5754258	2m	5m	3.6m

3.2 RESULTS FROM BALLINWILLING STRAND

Archaeological monitoring of boreholes and test pits took place at Ballinwilling Strand intermittently between 23rd of May 2018 and the 29th of May 2018 (Figure 6). The stratigraphy observed in each borehole or test pit is described below.

3.2.1 BW2-BH1

DEPTH	DESCRIPTION
0–1.5m	Made ground- gravelly anthropogenic soils which were not recovered by pushing sampler.
1.5–4.5m	Brown slightly silty clay of medium to high compaction, with occasional coarse sub-rounded and sub-angular gravel below 3m. The clay became very compacted after 3.5m

	(Plate 1).
4.5–5.5m	Very highly compacted brown slightly sandy clay.
5.5–10.9m	Brown slightly clayey silty fine to medium sand of loose compaction with occasional medium to coarse sub-rounded gravel and occasional stains of organic matter (Plate 1).
10.9–11.8m	Light greyish smooth lightly orange stained medium grained limestone.
11.8–13.9m	Brown slightly clayey silty fine to medium sand of loose compaction, becoming slightly gravelly below 12.3m.
13.9–21m	Light grey with smooth lightly orange stained medium grained limestone (Plate 2). From 18.6m evidence of small quantities of very loose gravelly sandy silt was noted externally on the core barrel. There was no recovery from 18.6m. This may represent a cave filled with loose material.

FIGURE 6: Location of site investigation works at Ballinwilling Beach (possible route of cable is shown in orange)

3.2.2 BW2-BH2

DEPTH	DESCRIPTION
0–2m	Brown slightly silty gravelly fine to medium sand of loose compaction. Increasing gravel content with depth.
2–20m	Light greyish smooth lightly orange stained medium grained limestone with low grade metamorphosis. From 16.9m to 17.9m evidence of small quantities of loose sandy clay was noted externally on the core barrel and on the limestone. There was no recovery from 16.9m and 17.9m. Possibly representing a cave filled with loose material.

3.2.3 BW2-TP1

Test pit BW2-TP1 was excavated using a 21-tonne track machine. The test pit measured 3m (w) x 5.5m (l) x 2m (d) (Plate 3).

DEPTH	DESCRIPTION
0–0.7m	Brown slightly silty and very sandy gravel with frequent inclusions of sub-rounded to sub-angular stones. Sand is medium to coarse.
0.7–1.6m	Dark grey slightly clayey silty medium to coarse sand with sub-rounded to sub-angular stones to brown slightly clayey sandy silt becoming more gravelly with depth.
1.6–2m	Brown slightly clayey sandy gravel with inclusions of sub-rounded to sub-angular stones becoming weathered limestone from 2m. Trial pit stopped at 2m due to presence of bedrock .

3.2.4 BW2-TP2

Test pit BW2-TP2 was excavated using a 21-tonne track machine. The pit measured 3.5m (w) x 4.5m (l) x 1.90m (d) (Plate 4).

DEPTH	DESCRIPTION
0–1m	Brown slightly silty gravelly fine to coarse sand of loose compaction.
1–1.9m	Brown slightly silty very sandy gravel with frequent inclusions of sub-rounded to subangular stones. Sand is medium to coarse. At 1.5m it was noted that there was frequent presence of weathered sub-angular limestone rocks (up to 0.3m deep) becoming weathered limestone from 1.9m. Trial pit stopped at 1.9m due to presence of the bedrock.

No features or deposits of archaeological significance were identified during monitoring of the boreholes and trial pits at Ballinwilling Strand. The deposits recorded are all geological in nature. Furthermore, no items of archaeological significance were discovered during the course of metal detecting.

PLATE 1: Example of upper samples taken from BW2-BH1

PLATE 2: Showing a sample of the limestone taken from BW2-BH1

PLATE 3: BW2-TP1, facing east

PLATE 4: BW2-TP2 during excavation, facing east

3.3 RESULTS FROM REDBARN BEACH

Archaeological monitoring of boreholes and test pits at Redbarn Beach took place intermittently between the 23rd of May and the 31st of May 2018 (Figure 7). The stratigraphy observed in each borehole or test pit is described below.

3.3.1 RB-BH1

DEPTH	DESCRIPTION
0–3m	Brown slightly gravelly fine to coarse sand of loose compaction becoming slightly silty and slightly gravelly below 0.5m.
3–5.3m	Greyish brown silty clay of high compaction becoming very highly compacted brown slightly sandy silty clay from 4.30m and from 5.15m becoming silty fine sand.
5.3–20m	Light greyish smooth lightly orange stained medium grained limestone (Plate 5). Medium bed of silty clay between 5.8m and 6.2m. Low grade metamorphosis below 16.5m.

3.3.2 RB-BH2

DEPTH	DESCRIPTION
0–0.4m	Brown slightly gravelly fine to medium sand of loose compaction with occasional water rolled stones to dark grey very gravelly fine to coarse sand, also of loose compaction.
0.4–1.75m	Very highly compacted greyish brown slightly silty sandy clay.
1.75–2.45m	Pale brown slightly gravelly very clayey medium to coarse sand of loose compaction. Gravel content increasing with depth.
2.45–4.1m	Loosely compacted gravel and water rolled stones. Gravel and rolled stones are sub-angular to angular of limestone and meta-sandstone (low grade). Gravel is medium to

DEPTH	DESCRIPTION
	coarse. Some sandy clay matrix.
4.1–20m	Light grey fine-grained limestone (low grade metamorphism). White dolomite veins cross cutting cores. Purplish pink clay infill in joints. Increasing low grade metamorphosis with depth.

FIGURE 7: Location of site investigation works at Redbarn Beach (possible route of cable is shown in orange)

3.3.3 RB-TP1

Test pit RB-TP1 was excavated with a 21-tonne track machine. The test pit measured 2m (w) x 5m (l) x 3m (d) (Plate 6).

DEPTH	DESCRIPTION
0–0.8m	Brown gravelly fine to medium sand with occasional rounded stone of loose compaction.
0.8–1.4m	Brown slightly gravelly silty fine to medium sand of loose compaction.
1.4–3m	Highly compacted grey brown slightly sandy silty clay becoming very highly compacted with occasional inclusions of gravel and stones. Trial pit completed at 3m.

3.3.4 RB-TP2

The excavation of RB-TP2 was carried out with a 21-tonne track machine. The test pit measured 2m (w) x 5m (l) x 3m (d) (Plate 7).

DEPTH	DESCRIPTION
0–0.2m	Brown silty fine to medium sand of loose compaction.
0.2–2.2m	Highly compacted greyish brown mottled grey sandy clay with occasional inclusions of sub-rounded to sub-angular stones.
2.2–3m	Moderately compacted brown mottled red brown slightly gravelly slightly sandy silt. Trial pit completed at 3m.

No features or deposits of archaeological significance were identified during monitoring of the boreholes and trial pits at Redbarn Beach. The deposits that were recorded were all geological in nature. Furthermore, no items of archaeological significance were discovered during the course of metal detecting.

PLATE 5: Limestone sample from drilling RB-BH1

PLATE 6: RB-TP1 facing southeast

PLATE 7: RB-TP2 facing west

3.4 RESULTS FROM CLAYCASTLE BEACH

Archaeological monitoring of boreholes and test pits at Claycastle Beach took place intermittently between the 24th of May and the 30th of May 2018 (Figure 8). The stratigraphy observed in each borehole or test pit is described below.

3.4.1 CL-BH1

DEPTH	DESCRIPTION
0–4.5m	Brown gravelly fine to coarse sand with occasional water rolled stones of loose compaction.
4.5–6m	Dense brown sandy silt with frequent presence of plants remains and small pieces of wood of loose to moderate compaction. These deposits have the potential to represent significant paleo-environmental remains and may be associated with the area of exposed peat and tree root remains identified at the beach (Walsh 2018).
6–8m	Grey slightly clayey silty fine to medium sand of loose compaction.
8–20m	Red slightly gravelly silty fine to medium sand with occasional water rolled stones of loose compaction. Gravel is fine to coarse, sub-rounded to subangular of mudstone.

3.4.2 CL-BH2

DEPTH	DESCRIPTION
0–0.9m	Brown slightly silty gravelly fine to medium sand of loose compaction. Gravel is fine to coarse and sub angular to sub-rounded of sandstone.
0.9–1.5m	Brown sandy silt throughout fen peat (Plate 8) of loose compaction. There was visible plant remains and wood roots. These deposits have the potential to represent significant paleo-environmental remains (potentially from the Holocene) and may be associated with the area of exposed peat and tree root remains identified at the beach to the WNW of BH 2 (Walsh 2018).
1.5–3.4m	Very loose to loose grey very silty fine to medium sand.

DEPTH	DESCRIPTION
3.4–6m	Grey to brown very sandy silt.
6–7.5m	Light grey silty fine to medium sand with occasional gravel and water rolled stones of loose compaction. Gravel is fine to coarse, sub-rounded to subangular of sandstone.
7.5–20m	Red slightly gravelly silty fine to medium sand with occasional water rolled stones of loose compaction. Gravel is fine to coarse, sub-rounded to subangular of sandstone and mudstone. Gravel content increases with depth.

FIGURE 8: Location of site investigation works at Claycastle Beach (possible route of cable is shown in orange)

3.4.3 CL-TP1

Test pit CL-TP1 was excavated by a 21-tonne track machine. The test pit measured 2.5m (w) x 5m (l) x 3m (d) (Plate 9).

DEPTH	DESCRIPTION
0–2.3m	Brown slightly gravelly fine to coarse sand with occasional stones and shell fragments of loose compaction. Becoming gravelly sand below 1.9m.
2.3–2.6m	Grey very silty fine to coarse sand with occasional shell fragments of loose compaction.
2.6–3m	Dense brown sandy silt within fen peat of loose and moderate compaction. Frequent presence of spongy plant and wood remains. These deposits have the potential to represent significant paleo-environmental remains (potentially from the Holocene) and may be associated with the area of exposed peat and tree root remains identified at the beach to the south of TP1 (Walsh 2018). Trial pit completed at 3m.

3.4.4 CL-TP2

Test pit CL-TP2 was excavated by a 21-tonne track machine. The test pit measured 2m (w) x 5m (l) x 3.6m (d) (Plate 10).

DEPTH	DESCRIPTION
0–0.25m	Brown slightly gravelly fine to coarse sand with occasional stones of loose compaction.
0.25–1.8m	Loose to medium dense brown sandy silt within fen peat. Frequent presence of wood roots and preserved organic matter such as tree leaves and sedges. These deposits have the potential to represent significant paleo-environmental remains (potentially from the Holocene) and may be associated with the area of exposed peat and tree root remains identified at the beach to the west of TP2 (Walsh 2018).
1.8–3.6m	Grey very silty fine to medium sand with occasional shell fragments to grey sandy fine to medium silt of loose compaction. Trial pit completed at 3.6m.

The site investigations at Claycastle revealed that organic remains associated with a submerged landscape have not only been exposed by the action of the tides on the beach (Walsh 2018) but also survive beneath the sands. It is probable that further deposits will be exposed by tidal action in the future. Whilst no specific features or artefacts of archaeological significance were identified during the course of the works, the layer of organic remains has the potential to contain archaeological features, deposits or artefacts of significance. Should Claycastle Beach be chosen as the preferred cable landfall location, further archaeological assessment will be required.

PLATE 8: A peat sample taken during drilling of CL-BH2

PLATE 9: CL-TP1 during excavation, facing southeast

PLATE 10: CL-TP2, showing exposed peat deposits, facing southeast

3.5 CONCLUSIONS

No features or artefacts of archaeological significance were identified at Ballinwilling Strand or Redbarn Beach during the monitoring of excavations or metal detection. The deposits that were recorded were all deemed to be geological in nature.

At Claycastle Beach, it is clear that the remains of a submerged landscape survives beneath the beach. An archaeological assessment undertaken in 2018 (Walsh) illustrated that portions of this landscape have been exposed by tidal action and these areas were avoided by the site investigation works. However, the organic layer, which contains the remains of tree roots and plant remains, does extend beneath the sand across the full width of the beach (as indicated during a geophysical survey by Headland Archaeology). The deposit may represent the remains of a Holocene environment and as such, has the potential to contain archaeological features or artefacts, although nothing of specific significance was identified during monitoring. Should Claycastle Beach be chosen as the preferred cable landfall location, further archaeological assessment will be required.

Once a location and design for the cable has been confirmed, further archaeological assessment and mitigation measures may be required in advance of the development. The assessment should take into account the results of all archaeological investigations to date at the landfall point that is eventually selected.

No further archaeological mitigation is deemed necessary as part of this phase of site investigations.

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CARTOGRAPHIC SOURCES

Ordnance Survey maps of County Cork, 1845, 1899

ELECTRONIC SOURCES

www.excavations.ie – Summary of archaeological excavation from 1970–2017.

www.archaeology.ie – DoCHG website listing all SMR sites with aerial photographs

www.osiemaps.ie – Ordnance Survey aerial photographs dating to 1995, 2000 & 2005 and 6-inch/25-inch OS maps.

APPENDIX 1 SMR/RMP SITES WITHIN THE SURROUNDING AREA

SMR NO.:	CO089-076
RMP STATUS:	Yes
TOWNLAND:	Ballycrenane
PARISH:	Cloyne
BARONY:	Imokilly
I.T.M.:	601382/568183
CLASSIFICATION:	Fulacht fia
DIST. TO DEVELOPMENT:	Adjacent to potential cable route at Ballinwilling Strand
DESCRIPTION:	In marshy area close to Garryvoe beach. Levelled in late 1960s. Butt-trimmed leaf-shaped flint flake (L 0.08m; Wth 0.03m; max. T 0.01m; NMI reg. no 1972:354) found in spread of burnt material after reclamation (Cherry 1990, 50).
REFERENCE:	www.archaeology.ie

APPENDIX 2 LEGISLATION PROTECTING THE ARCHAEOLOGICAL RESOURCE

PROTECTION OF CULTURAL HERITAGE

The cultural heritage in Ireland is safeguarded through national and international policy designed to secure the protection of the cultural heritage resource to the fullest possible extent (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the *European Convention on the Protection of the Archaeological Heritage* (Valletta Convention), ratified by Ireland in 1997.

THE ARCHAEOLOGICAL RESOURCE

The *National Monuments Act 1930 to 2014* and relevant provisions of the *National Cultural Institutions Act 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A National Monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act 1930 Section 2). A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places, and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

OWNERSHIP AND GUARDIANSHIP OF NATIONAL MONUMENTS

The Minister may acquire national monuments by agreement or by compulsory order. The state or local authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

REGISTER OF HISTORIC MONUMENTS

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the register is illegal without the permission of the Minister. Two months notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

PRESERVATION ORDERS AND TEMPORARY PRESERVATION ORDERS

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

RECORD OF MONUMENTS AND PLACES

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for the Culture, Heritage and the Gaeltacht) to establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994. All recorded monuments on the proposed development site are represented on the accompanying maps.

Section 12(3) of the 1994 Act provides that 'where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in case of urgent necessity and with the consent of the Minister, commence the work until two months after giving notice'.

Under the National Monuments (Amendment) Act 2004, anyone who demolishes or in any way interferes with a recorded site is liable to a fine not exceeding €3,000 or imprisonment for up to 6 months. On summary conviction and on conviction of indictment, a fine not exceeding €10,000 or imprisonment for up to 5 years is the penalty. In addition, they are liable for costs for the repair of the damage caused.

In addition to this, under the *European Communities (Environmental Impact Assessment) Regulations 1989,* Environmental Impact Statements (EIS) are required for various classes and sizes of development project to assess the impact the proposed development will have on the existing environment, which includes the cultural, archaeological and built heritage resources. These document's recommendations are typically incorporated into the conditions under which the proposed development must proceed, and thus offer an additional layer of protection for monuments which have not been listed on the RMP.

THE PLANNING AND DEVELOPMENT ACT 2000

Under planning legislation, each local authority is obliged to draw up a Development Plan setting out their aims and policies with regard to the growth of the area over a five-year period. They cover a range of issues including archaeology and built heritage, setting out their policies and objectives with regard to the protection and enhancement of both. These policies can vary from county to county. The Planning and Development Act 2000 recognises that proper planning and sustainable development includes the protection of the archaeological heritage. Conditions relating to archaeology may be attached to individual planning permissions.

Celtic Interconnector

Volume 3D2 – Appendix 15D

Geoarchaeological Assessment of Auger and Test Pit Logs

June 2021

Co-financed by the European Union
Connecting Europe Facility

Tionscadal Éireann
Project Ireland
2040

EIRGRID

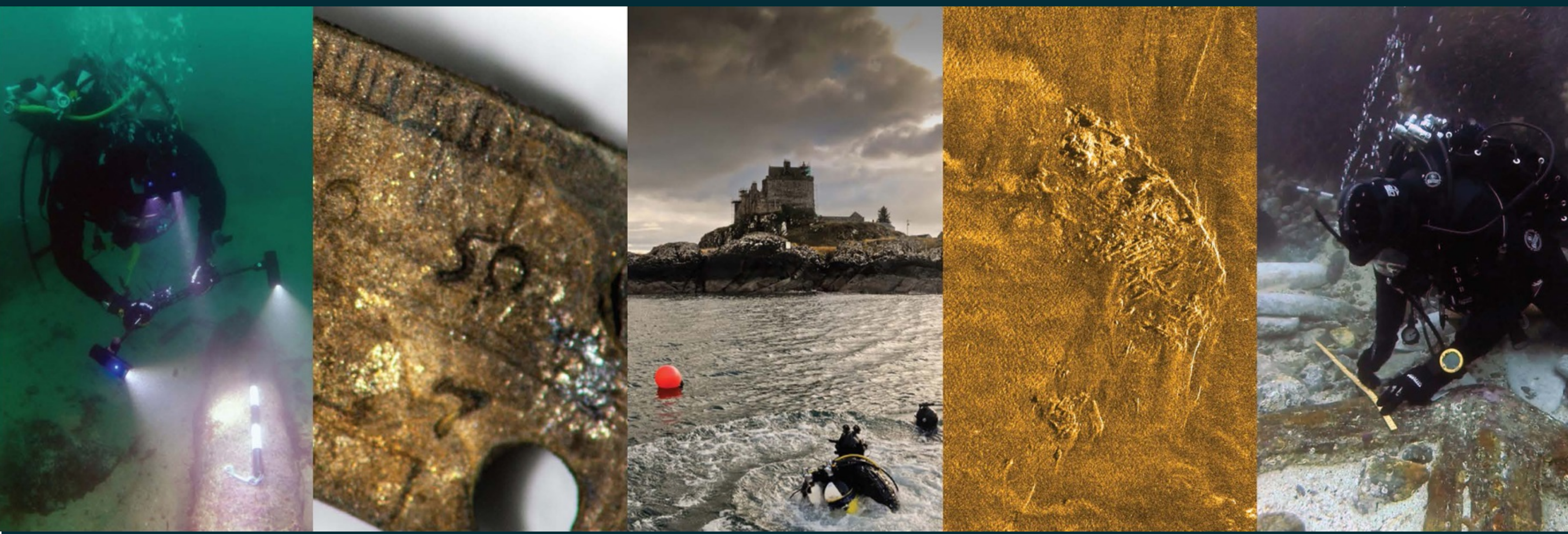
The Oval, 160 Shelbourne Road, Ballsbridge, Dublin D04 FW28
Telephone: 01 677 1700 • www.eirgrid.ie

Cotswold Archaeology marine

Co-financed by the European Union
Connecting Europe Facility

Celtic Interconnector Project

Claycastle beach, Youghal, Co. Cork, Ireland
Geoarchaeological assessment of auger and test pit logs



for

EirGrid plc

19E0278 Final Report

CA Project: 770617

CA Report: 770617_02

May 2019

Andover Cirencester Exeter Milton Keynes Suffolk

Final Report 19E0278

Celtic Interconnector Project

Claycastle beach, Youghal, Co. Cork, Ireland
Geoarchaeological assessment of auger and test pit logs

CA project: 770617

CA report: 770617_02

prepared by date	Caitríona Moore, Director (ABH) Agata Kowalska, Archaeologist Michael Walsh, Senior Marine Consultant May 2019
checked by date	Michael Walsh, Senior Marine Consultant May 2019
approved by signed date	Michael Walsh, Senior Marine Consultant *Not usually signed unless requested by client* May 2019
issue	1.0

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SUMMARY

Project name: Celtic Interconnector project

Cotswold Archaeology (CA) was commissioned by EirGrid plc to investigate the nature and extent of the peats found exposed in the inter-tidal zone at Claycastle beach, Youghal, Co. Cork, Ireland. The peats were investigated using a hand auger and hand-dug test pit logs and the results underwent geoarchaeological assessment. This assessment was carried out in order to understand the extent and the depth of the buried peat deposits, to recover any material which might be of archaeological significance, and to enhance our understanding of the nature of the deposit.

Apart from the exposed areas, the peat is overlain by a fine to coarse sand which becomes more coarse and gravelly with depth. The thickness of the overlying sand ranges from 0.05m to c. 2.70m with the depth of sand coverage increasing on the landward side of the beach. The peat was recorded primarily in the area to the west of the proposed cable route but was not encountered in the north-east of the survey area. The presence of peat in this area, however, cannot be discounted as it may be more deeply buried, although the observation of sand lying directly over the grey sand, which is found below the peat elsewhere on the beach suggests that the peat may be absent from these areas.

The peat deposits recorded in the auger cores range in thickness from 0.85m to 1.20m. According to previous investigations, the thickness of the peat across the site varies from 0.40m (CL-TP1) to 1.45m (CL-TP2). The peat does not appear to extend beyond the most seaward locations investigated during this survey.

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1. INTRODUCTION

Outline

1.1. Cotswold Archaeology (CA) was commissioned by EirGrid plc to undertake a geoarchaeological hand auger survey at one of the proposed landfall locations for the Celtic Interconnector project (henceforth 'the project'). The survey was conducted at Claycastle beach (Claycastle and Summerfield townlands), Youghal, Co. Cork from 7 to 10 May 2019. The survey was undertaken in collaboration with Caitríona Moore of Archaeology and Built Heritage who was the licensee (licence no. 19E0278).

Aims and objectives

1.2. The aims of this hand auger survey were:

- to investigate the extent and the depth of the buried peat deposits in the intertidal zone at Claycastle beach,
- to recover any material which might be of archaeological significance,
- to enhance our understanding of the nature of the deposit.

1.3. This report presents the results of a geoarchaeological assessment carried out on eight auger cores and 33 small test pits, the latter excavated by hand as the sand was too unstable to support an auger core.

2. PREVIOUS RESEARCH

2.1. Walkover surveys conducted on the beach identified extensive areas of exposed peat with associated remains of tree trunks and roots. The foreshore geophysical survey appeared to detect the peat deposits extending under the beach sand both landward and seaward (see Cotswold Archaeology 2018).

2.2. Previous environmental research, conducted in 2001 by J. L. Delahunty (2002), focused on the peat deposits. Two core samples were taken from Ballyvergan Marsh and from Youghal Strand in order to investigate historical charges in local vegetation. The Youghal Strand Core (SC) was extracted within the area of interest, at 51° 56.020 N; 07° 51.545 W. The SC revealed almost two metres of peat deposit above sediments consisting of grey silt. The peat deposit was radiocarbon (^{14}C) dated and the deepest peat from the core was dated to c. 4555 years before present (BP) (3488-3242 BC OxCal). Dates obtained from the SC were calibrated by using the OxCal 4.3 program with 95% probability (OxCal 2019; Table 1).

Table 1 Strand core (SC) 14C data (Delahunty 2002 fig. 3, appendix B).

Depth	Date C14 BP / ID	Date OxCal. 95%	Period
12cm	1920±35 N45297	2-210 AD	Iron Age
86cm	3115±35 N45298	1488-1281 BC	Middle Bronze Age
120cm	3870±34 N45296	2768-2210 BC	Early Bronze Age
180cm	4555±35 N45295	3488-3241 BC	Early Neolithic

2.3. The pollen diagram for the SC suggests that at Youghal the landscape was covered by woodland that formed more than 5,000 years ago amid a freshwater ecosystem inland of the Atlantic Ocean. The changing climate had a significant impact on the woodland cover; around the first century A.D., the landscape was possibly affected by flooding. Consequently, the local woodlands were submerged, and a brackish environment was created northward into the low-lying land (Delahunty 2002, 88).

3. METHODOLOGY

3.1. To fulfil the project aims, 20 locations (four locations along five transects running landward to seaward) were proposed for the hand auger survey (Cotswold Archaeology 2018). Owing to the specific nature of the intertidal zone (very loose sand/gravel sediments), the proposed auger locations had to be moved and adapted in order to obtain suitable locations for the survey. To establish the exact extent of the peat deposit, 20 additional test pits (TPs) were dug in randomly-chosen positions between the previously proposed transects. Most of the TPs were situated c. 10m to the north-west of the area of exposed peat to establish the presence of the peat deposit under the beach sand (see Figs 1 & 2).

3.2. The auger survey was conducted using a standard hand-operated Dutch auger with 1m long extension rods. Hand augering was conducted in eight locations (**CL4001**, **CL4002**, **CL4003**, **CL4005**, **CL4007**, **CL4011**, **CL4012**, and **CL4024**. Unsuccessful attempts were made in numerous other locations but were aborted owing to the instability of the sand. The sediment recovered was laid out and

Legend

- Auger
- Test pit
- Test pit and auger
- Machine test pit
- Youghal Strand Core 2002
- Exposed peat
- Cable Route
- 500m wide CSC

N

0 0.05km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -9.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Auger and test pit locations

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	22/05/2019	1
APPROVED BY	MTW	SCALE@A3	1:1,600	

Legend

N

- Auger
- Test pit
- Test pit and auger
- Machine test pit
- Youghal Strand Core 2002
- Exposed peat
- In phase peat extent (indicative)
- Quadrature peat extent (indicative)
- Auger survey peat extent (indicative)
- Cable Route
- 500m wide CSC

0 0.05km

Coordinate System: WGS 1984 UTM Zone 29N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
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PROJECT TITLE
Celtic Interconnector

FIGURE TITLE
Possible peat extents on Claycastle beach

DRAWN BY	RLF	PROJECT NO	770617	FIGURE NO.
CHECKED BY	MTW	DATE	22/05/2019	2
APPROVED BY	MTW	SCALE@A3	1:1,600	

recorded following standard procedures (Table 2) (Cotswold Archaeology 2017; Munsell 2018; Tucker 2011).

3.3. Augers **CL4002**, **CL4003** and **CL4011** were drilled in areas where the peat was exposed in order to provide a full sedimentary sequence. Three environmental bulk samples were taken from the top, middle and bottom of the peat in each of these auger cores (nine samples in total). All samples were placed into sealable plastic bags and labelled using CA's standard procedures (Cotswold Archaeology 2017).

3.4. 31 small TPs (**CL4004**, **CL4006**, **CL4007** to **CL4010**, **CL4013**, **CL4014**, **CL4016** to **CL4023**, and **CL4025** to **CL4040**) were dug by hand in locations where unstable sediments prevented the use of the hand auger. The TPs were recorded following standard procedures as above (Table 2). All TPs were backfilled as soon as recording had been completed.

3.5. At the time of the survey, the local authority was undertaking groundworks just to the front of the boardwalk on the beach. The opportunity was therefore taken to examine the excavation. This TP was mechanically excavated through drier sand to c. 2.7m.

4. RESULTS

4.1. The auger logs from **CL4002**, **CL4003** and **CL4011** provide a full sedimentary sequence. The lowermost unit comprised grey (2.5Y 5/1) loose fine silt to medium sand deposit (the GREY SAND) with occasional bivalve shell fragments. This unit was overlain by a reddish-black (2.5Y 2.5/1) spongy fibrous silty peat deposit containing identifiable plant material. The well-preserved wood fragments and herbaceous plant remains indicate the presence of woodland and / or reed swamp communities in the past (see Delahunty 2002). The PEAT deposits recorded in these auger cores range in thickness from 0.85m to 1.20m. Overlying the PEAT was a brown (10YR 5/3) to yellowish brown (10YR 5/4) fine to coarse sand (the SAND) with occasional rounded gravel and cobbles of different lithology.

4.2. The majority of the TPs show that the SAND tends to become more coarse and gravelly lower down in the deposit. The SAND coverage in the areas of exposed peat, has probably been eroded by tidal action. Across the entire surveyed area, the SAND ranged in thickness from 0.05m to c. 2.70m. Nine bulk samples were taken from the three auger cores for possible palaeo-environmental analysis. No remains suggesting prehistoric human activity were encountered in the areas of exposed peat.

4.3. It is worth noting that the depth of SAND coverage increased in the landward TPs and auger holes. In test pit **CL4041**, the SAND deposit was c. 2.70m deep (Fig. 3), and no peat was recorded. It corresponds with data obtained from the trial pit log **CL-TP1** and borehole log **CL-BH2**, where the PEAT deposit was covered by c. 0.90m to c. 2.50m of the SAND sediments respectively. In borehole **CL-BH1**, situated next to the car park, the peat was recorded under 4.50m deep deposits of beach sand (IAC Archaeology 2019).

Figure 3 Test pit CL4041

Table 2 Auger and test pit logs

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4001	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Very few very coarse gravel (30 to 60mm).		Auger. End at 0.90m due to side collapse.
	0.40-0.70	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded).		
	0.70-0.90	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarser than unit above. Common cobbles (60 to 200mm) and few (<3%) bivalves shell fragments.		
CL4002	0-1.20	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. From c. 0.75m more humified, pseudo fibrous plant material, less wood visible. More compact at the bottom. Intense organic odour.	<1> 0-0.20; <2> 0.70-0.80; <3>1.00-1.20	Auger
	1.20-1.30	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose. Very few wood fragments (possibly contamination form above).		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4003	0-0.05	SAND	10YR 5/3 Brown	Fine to coarse loose sand.	<4> 0-0.15; <5> 0.60-0.70; <6>0.80-.90	Auger
	0.05-0.90	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. From c. 0.80m more humified, pseudo fibrous plant material. More reddish (2.5R 2.5/4 dark red) in colour and more compact towards the bottom. Intense organic odour.		
	0.90-1.00	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose. Few (<4%) bivalve shell fragments.		
CL4004	0-0.70	SAND	10YR 5/3 Brown	Fine to coarse loose sand. More gravelly towards bottom. Well rounded pebbles and cobbles (20-180mm).		Test pitted to c. 050m and augered to 0.90m. Abandoned due to sides collapsing.
CL4005	0-1.00	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Very few gravel, well rounded (20 to 60mm). More gravelly with depth.		Auger. End at 1.10m due to side collapse and gravel hard to drill.
CL4006	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pitted to c. 030m and augered to 0.60m. Abandoned due to sides collapsing.
	0.20-0.60	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded).		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4007	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. More gravelly towards bottom. Well rounded pebbles and cobbles (20-180mm).		Test pit to c. 0.50m and auger. Stopped at 1.20 due to sides collapse.
	0.40-1.10	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Few (<4%) bivalve shell fragments.		
	1.10-1.20	SAND	10YR 5/4 Yellowish brown	Fine to coarse loose sand. Few very coarse gravel (30 to 60mm).		
CL4008	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pit to c. 0.50m and auger. Stopped at 0.50 due to obstruction (possibly a large cobble).
	0.20-0.50	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
CL4009	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand.		Test pit to c. 0.60m and auger. Stopped at 0.70 due to sides collapse.
	0.40-0.70	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
	0.70-0.72	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4009a	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit to c. 0.30m and auger. Stopped at 1.10 due to obstruction.
	0.30-1.10	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4010	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Auger location abandoned due to high tide.
CL4011	0-1.30	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.	<7> 0-0.30; <8> 0.50-0.60; <9> 1.10-1.30	Auger
	1.30-1.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4012	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Auger. Stopped at 0.50 due to sides collapse.
	0.20-0.50	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4013	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Common well rounded pebbles and cobbles (20-180mm).		Test pit.
CL4014	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0-0.60	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 150mm, moderately sorted, well rounded). Loose.		
CL4015	0-0.80	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Very few shell fragments (<2%). Loose.		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4016	0-0.25	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.25-0.60	GRAVELLY SAND	10YR 5/3 Brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		
CL4017	0-0.10	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.10m		Line of test pits dug by hand to establish presence of the peat towards North. Line started c. 10m from the peat exposure zone. Due to loose sediments and water, no augering was possible.
	0.10+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4018	0-0.25	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.25m		
	0.25+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4019	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.40m		
	0.40+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4020	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. NO Peat **NO** recorded under 0.60m		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4021	0-0.65	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.65m		
	0.65+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4022	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.20-0.60	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		
CL4023	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Stopped due to loose sediments and sides collapse.
	0.30-0.35	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4024	0-0.07	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit and auger. Taken to test the peat presence. Stopped due to sides collapse.
	0.07-0.75	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4025	0-0.13	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.13m		Line of test pits dug by hand to establish presence of the peat. Due to loose sediments and water, location CL4024 was selected for augering.
	0.13+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4026	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.30m		
	0.30+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4027	0-0.45	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.45m		
	0.45+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4028	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. **Peat** under 0.60m		
	0.60+	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4029	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
CL4030	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.50-0.52	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4031	0-0.40	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm).		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4032	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.30-0.33	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4033	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
CL4034	0-0.50	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
CL4035	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel (30 to 60mm) and cobbles (64-150mm) more common with depth.		Test pit. Loose sediments and sides collapse.
	0.30-0.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4036	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Few very coarse gravel and cobbles (20 to 100mm).		Test pit and auger. Loose sediments and sides collapse.
	0.60-0.65	PEAT	2.5Y 2.5/1 Reddish black	Silt with spongy fibrous plant remains and wood fragments. Intense organic odour.		
CL4037	0-0.40	GRAVELLY SAND	10YR 5/4 Yellowish brown	Coarse sand with gravel and cobbles (2 to 180mm, moderately sorted, well rounded). Loose.		Test pit. Loose sediments and sides collapse.

Auger/Test Pit No.	Depth [m]	Unit	Colour	Description	Sample	Comments
CL4038	0-0.60	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.60-0.65	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4039	0-0.20	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.20-0.30	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4040	0-0.30	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose.		Test pit. Loose sediments and sides collapse.
	0.30-0.35	GREY SAND	2.5Y 5/1 Grey	Silty fine to medium sand. Loose.		
CL4041	0-2.70	SAND	10YR 5/3 Brown	Fine to coarse loose sand. Loose. Pebbles and cobbles more common with depth (20-180mm, rounded, <7%).		Machine trial pit

4.4. The peat deposit was not recorded beyond the location of auger holes **CL4002** and **CL4036** (towards the north-east). This concurs with the geophysical survey results which appear not to have detected the presence of peat to the north-east of the proposed cable route (see Fig.3). Owing to the loose nature and the depth of the overlying sandy deposits in this area, it was not possible to achieve any considerable depth with either the hand auger or the TPs.

4.5. The lowermost GREY SAND deposit was recorded in all the TPs in the south-east area of the survey (**CL4009**, **CL4032**, **CL4039**, **CL4038**, **CL4035**, **CL4040**). In these TPs, the GREY SAND was directly overlain by c. 0.3m to 0.4m of the SAND unit so the PEAT unit appeared to be absent. This implies that the peat does not extend into the sea beyond this point. The intertidal geophysical survey did not extend beyond this point as this was the low water point.

5. CONCLUSIONS

5.1. Apart from the exposed areas, the peat is overlain by a fine to coarse sand which becomes more coarse and gravelly with depth. The thickness of the overlying sand ranges from 0.05m to c. 2.70m with the depth of sand coverage increasing on the landward side of the beach. The peat was recorded primarily in the area to the west of the proposed cable route but was not encountered in the north-east of the survey area. The presence of peat in this area, however, cannot be discounted as it may be more deeply buried, although the observation of sand lying directly over the grey sand, which is found below the peat elsewhere on the beach suggests that the peat may be absent from these areas. The peat deposit recorded in the auger cores range in thickness from 0.85m to 1.20m. According to previous investigations, the thickness of the peat across the site varies from 0.40m (**CL-TP1**) to 1.45m (**CL-TP2**). The peat does not appear to extend beyond the most seaward locations investigated during this survey.

5.2. This survey has fulfilled the aims outlined in the method statement and no further work is anticipated. This is the final report on the issued licence and a summary account will be submitted to www.excavations.ie in fulfilment of the licence conditions.

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Celtic Interconnector

Volume 3D2 – Appendix 15E

Marine Archaeology Written Scheme of Investigation

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2040

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Table of Contents

1 Introduction

1.1 Purpose of this document

This Written Scheme of Investigation (WSI) sets out mitigation procedures in respect of known and potential archaeological remains and deposits of geoarchaeological interest that may be affected by the construction of the proposed Celtic Interconnector Project within the Irish Territorial Waters (TW) and Exclusive Economic Zone (EEZ) and the UK EEZ.

This WSI identifies aims of the marine investigations, the generic methodologies and relevant standards of the offshore mitigation strategy referenced in the Environmental Impact Assessment Report (EIAR) and Environmental Report (ER). It conforms to current best practice as set out by guidance from the relevant national regulators, The National Monuments Service (NMS) and Historic England (HE), and the relevant guidance from the appropriate national professional bodies, the Institute of Archaeologists of Ireland (IAI) and Chartered Institute for Archaeologists (CIfA), as appropriate.

The results of previous phases of consultation on the development proposals and the approach and findings of the assessment with the relevant regulators has been taken into account in producing these proposals for mitigation, and further consultation will be undertaken with the Cork Heritage Officer, the Underwater Archaeology Unit of the National Monuments Service, and Historic England to agree the provisions set out prior to the commencement of any investigative or construction work.

This WSI excludes archaeological investigation of deposits of geoarchaeological significance above LAT at Claycastle. Any works carried out in mitigation of disturbance of these deposits would be carried out under licence from the NMS to standards set out and agreed through the licensing process.

This WSI also excludes geoarchaeological investigations within the marine zone, which would be carried out under the terms of an Offshore Project Environmental Remains Strategy that would be agreed with the relevant national regulators.

1.2 Structure

This WSI sets out the project background and geographical scope (Section 1), aims and objectives of archaeological works (Section 2), roles and responsibilities (Section 3), archaeological background (Section 4), followed by scope and standards for archaeological mitigation (Section 5) of Marine Archaeological Remains (Section 5.4). Initial Archaeological Exclusion Zones (AEZ) are identified (Section 5.5). A Protocol for Archaeological Discoveries (PAD: Section 5.6) is set out. Procedures in respect of statutorily designated remains (Section 6) and for archaeological reporting and archival (Section 7) are set out.

1.3 Project Overview

The Celtic Interconnector Project is a joint project being developed by Réseau de Transport d’Electricité (RTE) and EirGrid and is being supported by the European Union’s Connecting

Europe Facility (CEF). It is also a European Union Project of Common Interest (PCI) and a designated e-Highway 2050 project.

The project involves the construction of an electrical circuit between Ireland and France using High Voltage Direct Current (HVDC) technology, the global standard for the transfer of electricity over long distances using underground technology. The interconnector would have a capacity of 700MW (equivalent to the power used by approximately 450,000 homes) and measures approximately 575km in length. The longest spatial element of the Celtic Interconnector would be the submarine circuit which would measure approximately 497km out of the total 575km. The interconnector would form a link between County Cork on the south coast of Ireland and the coast of Brittany in North West France (Nord-Finistère).

The main elements of the interconnector are illustrated in Figure 1.1 and consist of:

- A submarine circuit, approximately 497km in length placed on or beneath the seabed between France and Ireland. The submarine circuit will pass though the territorial waters of Ireland and France and through the Exclusive Economic Zones (EEZs) of Ireland, the UK and France, as shown in Figure 1.2;
- The cable route within the UK EEZ passes approximately 30km to the west of the Isles of Scilly and approximately 75km to the west of Land's End on the UK mainland
- A landfall point where the submarine circuit comes onshore, in France and Ireland;
- A HVDC land circuit between the landfall point and a converter station, in France and Ireland;
- A converter station, to convert the electricity from HVDC to High Voltage Alternating Current (HVAC), which is used on the respective transmission grids in each country;
- A HVAC land circuit between the converter station and the connection point to the grid, in France and Ireland. This circuit is proposed using underground technology;
- A connection point to an existing substation on the transmission grid, in France and Ireland; and
- A fibre optic cable would also be laid along the entire route for operational control, communication and telemetry purposes. It is important that logos, references to the EU, Project Ireland 2040 and EU disclaimers are appropriately included in all key publically facing documentation.

Figure 1.1: Celtic Interconnector Project Elements

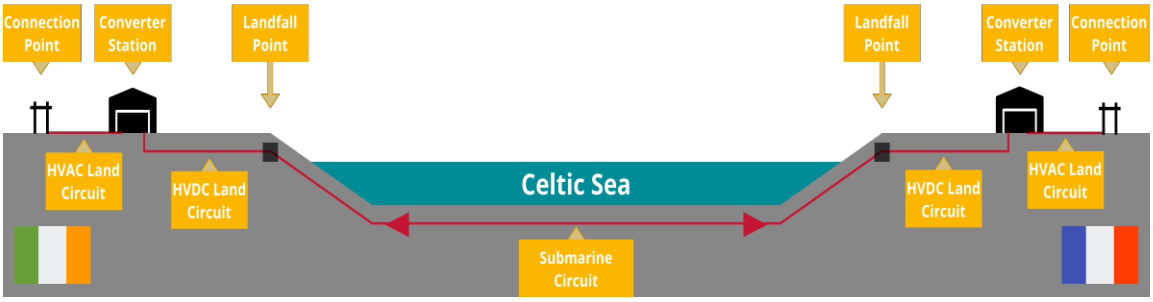
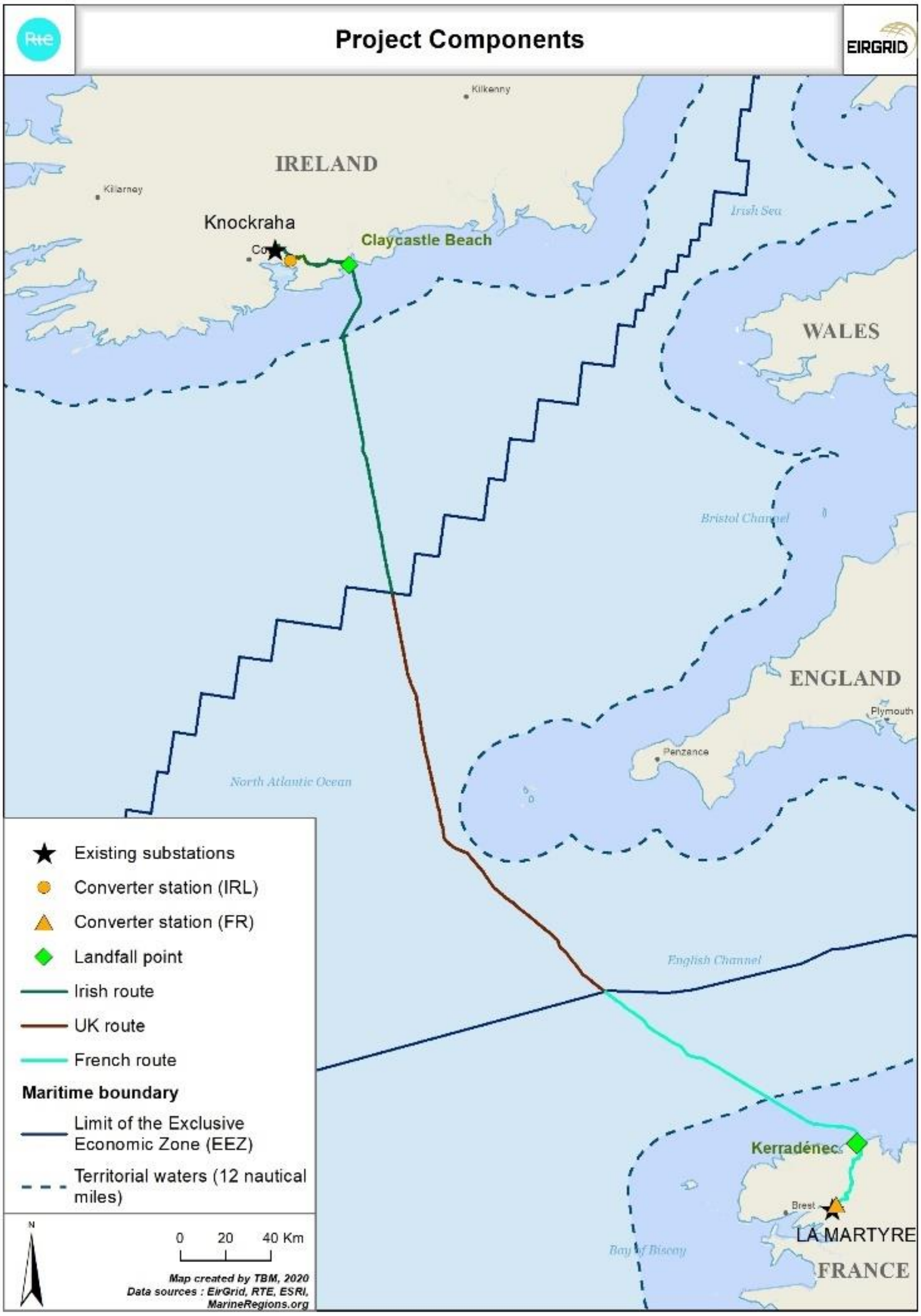


Figure 1.2: Celtic Interconnector Submarine Cable Route Map



1.4 Geographical scope

This Outline WSI applies to the marine elements of the Celtic Interconnector within Irish TW and EEZ and the UK EEZ, focusing on a corridor extending 500m to either side of the proposed cable route centreline.

Mitigation works within the French EEZ and Terrestrial Waters, and within the Irish and French terrestrial zones are provided for elsewhere and do not form part of the scope set out in this Outline WSI.

2 Aims and Objectives

2.1 Aim

The overarching aim of the WSI is to set out the scope and standards for the archaeological mitigation referenced in the EIAR / ER (**Volume 3D Part 1 Chapter 11 Historic Environment and Volume 4 Chapter 11 Historic Environment**).

2.2 Objectives

The objectives of this Outline WSI are as follows:

- To provide for archaeological investigation of areas of potential or confirmed archaeological interest that may be affected by the proposed development;
- To provide for archaeological analysis and interpretation of geophysical survey work carried out in advance of any construction or clearance operations;
- To identify the position and extent of Archaeological Exclusion Zones (AEZs) intended to protect known and potential areas of archaeological interest;
- To provide for avoidance of or mitigation of damage to archaeological remains identified during surveys and the construction period; and
- To set out reporting and licencing requirements for survey, mitigation and observations of archaeological material.

3 Roles and Responsibilities

3.1 Project roles and responsibilities are defined as set out at Table 3.1.

Table 3.1: Project Roles and Responsibilities

Roles	Responsibilities
Developer	• Ensure that WSI is implemented and that any relevant statutory or regulatory requirements and processes are met; • Procure appropriate archaeological support; • Ensuring that any necessary licences or permissions are in place before work commences; • Provide relevant project information as appropriate; and Identify Nominated Contacts for the Protocol for Archaeological Discoveries.
Retained Marine Archaeologist*	• Advise the Developer on interaction with consultees/regulators and specialist contractors; • Monitor the implementation of the agreed WSI, in particular, where delivery of the WSI is divided into discrete lots or where specialist contractors subcontract aspects of the WSI, ensuring that all aspects of the WSI are in scope; • Confirm to the client that any licences required for archaeological works are in place, and that archaeological works required out as a condition of other licences/consents are in place; • Advise on the reporting of findings in line with the PAD; • Monitor compliance with any established AEZs; • Ensuring that any statutory or regulatory requirements are appropriately considered and allowed for in archaeological works; • Where necessary, coordinate reporting of results of investigation or archaeological discoveries so that findings in the UK EEZ which inform understanding of findings in Irish Waters and vice versa are appropriately considered; and • SQEP – The Retained Marine Archaeologist of works must have an appropriate level of qualification and experience in managing and monitoring Marine Archaeological and Geoarchaeological workscopes.
Specialist Contractors (and Sub-Contractors)	• Implement all relevant aspects of the WSI covered by the appointed scope of works; • Produce method statements for the appointed workscope for approval by the relevant regulators; • Securing and holding any relevant excavation, diving or survey licences for archaeological work;

Roles	Responsibilities
	• Ensure that all project staff and subcontractors understand the requirements of the WSI; • Obey all relevant statutory and policy requirements; • Respect constraint maps and AEZs; • Inform the appointed archaeologist(s) of any environmental constraint or matter relating to health, safety and welfare of which they are aware that is relevant to the archaeologists' activities; and • SQEP – All archaeological contractors should have an appropriate level of experience for their project role and archaeological scope, and where works are carried out in Irish Territorial Waters and EEZ must be eligible to hold the necessary licence for excavation or survey.

*The Retained Marine Archaeologist would normally be independent of any appointed contractors, but this role may be filled by an organisation also appointed as a specialist contractor if required.

3.2 Liaison with Regulators

Key Regulators are identified as follows:

- Cork County Heritage Officer (From MHWS to LAT at Claycastle);
- Underwater Archaeology Unit (From MHWS at Claycastle to the UK/Irish Median); and
- Historic England (From the Irish/UK Median to the UK/French Median).

Additional Stakeholders include those providing archaeological support within the Irish Terrestrial Zone and the French EEZ. Communication with these stakeholders will be required, as appropriate, to ensure that applicable findings from these areas can be fed into planning, implementation, and reporting of the works set out in this WSI.

The Retained Marine Archaeologist will establish and maintain a register of stakeholders including client and construction contractors, archaeological contractors, regulators, and other relevant interested parties, including telephone and email contact details for key individuals.

During the Project, communication with the regulators will be undertaken via the Retained Marine Archaeologist in line with a reporting schedule to be agreed with relevant stakeholders. This reporting schedule should consider the need for milestone-based reporting and periodic reporting. Key project milestones may include, but not necessarily be limited to:

- Approval of contractor method statements and licence applications;
- Notification of commencement of works;
- Periodic reporting during works;

- Notification of features identified in surveys;
- Notifications of discoveries through the PAD;
- Notification of completion of fieldwork;
- Periodic updates during post-excavation reporting; and
- Submission of post-excavation reporting.

Method Statements, and any applicable licence applications, for archaeological works will be submitted to the relevant Regulator(s) and Archaeological Curator(s) sufficiently in advance of the planned commencement of works to allow for sufficient time for the review and any amendments to be completed and agreed.

4 Baseline Summary

4.1 Previous archaeological work

Previous archaeological work is summarised at **Table 4.1**.

Table 4.1: Desk based studies

Study	Scope and Key Findings
Ireland-France Celtic Interconnector, Marine archaeology desk-based assessment. (Headland Archaeology 2014)	Marine Archaeology baseline study aiming to: • Assess the nature of the cultural resource in this area; • To outline the archaeological potential of the marine environment; • To aid in the identification of seabed anomalies that may be discovered during the proposed; geophysical survey; and • Inform and propose mitigation for sites that may be impacted by the proposed geotechnical survey. Results: • Identification of recorded potential wrecks and obstructions; and • Identification of potential for survival of deposits of geoarchaeological interest within the intertidal and marine zones.
Ireland-France Celtic Interconnector: Archaeological Review of Geophysical Survey Data (Headland Archaeology 2015)	Review of geophysical (side scan, seismic (pinger) and magnetometer) and bathymetric (MBES) data, in order to identify sites or features of archaeological potential, and to characterise the marine environment in terms of prehistoric landscape potential and significance. Identified three medium potential anomalies and 40 low potential anomalies in proximity of the Cable Survey Corridor (CSC).
Celtic Interconnector – Feasibility Study, Stage 1 Geoarchaeological Assessment of Vibrocore Logs. (Wessex Archaeology 2016)	Geoarchaeological assessment of vibrocore logs from Irish TW and EEZ. Identified locations where deposits of geoarchaeological interest survive.
Celtic Interconnector Project Marine archaeology desk-based assessment (Cotswold Archaeology 2017)	Marine archaeology baseline survey of the revised offshore routes related to the Ballinwinning, Claycastle and Redbarns landfalls. Identified one potential wreck within the Cable Study Corridor (CSC) and areas of geoarchaeological interest.

Study	Scope and Key Findings
Celtic Interconnector Project Marine archaeological impact assessment for proposed ground investigation surveys. (Cotswold Archaeology 2018)	Assessment of the potential effects of proposed ground investigation works at Ballinwinning, Redbarn and Claycastle and within Irish TW.
Archaeological review of foreshore walkover, and foreshore and offshore geophysical survey data. (Cotswold Archaeology 2018)	Walkover and geophysical surveys of potential landfalls at Claycastle and Redbarns and associated cable routes, with a further walkover survey at a potential landfall at Ballinwinning. Identified potential archaeological features within the foreshore at Claycastle and Redbarns and potential features of geoarchaeological interest and one potential wreck within the marine zone.
Archaeological monitoring as part of the Celtic Interconnector Project, Claycastle & Summerfield/ Clonard East/ Ballycrenane, County Cork. (IAC Archaeology 2018)	Archaeological monitoring of ground investigation at Claycastle, Ballinwinning and Ballycroneen. No archaeological remains were observed at Ballinwinning or Ballycroneen, but buried peats were observed at Claycastle.
Celtic Interconnector Project, Marine Archaeology and Cultural Heritage Report. (Cotswold Archaeology 2019)	Consolidates previous reporting, focusing on the final agreed route. Sets out archaeological baseline for the entire route between Irish and French landfalls, identifying areas of geoarchaeological and archaeological interest.
Celtic Interconnector Project Geoarchaeological Assessment. (Cotswold Archaeology 2019)	Assessment of samples recovered from Claycastle and Redbarns beaches identified estuarine deposits and a potential submerged forest in near shore and intertidal areas of Claycastle Beach.
Celtic Interconnector Project Claycastle Beach, Youghal, Co. Cork, Ireland Geoarchaeological assessment of auger and test pit logs. (Cotswold Archaeology 2019)	Report on augering and test pitting at Claycastle beach. Identified buried peats within the proposed cable route.

4.2 Marine Archaeological remains

The estuary of the River Blackwater forms a natural harbour at Youghal, which is recorded as having been formed by exceptional tidal conditions in the early 9th century AD, and which has been in use throughout the historic period. The approach to the harbour appears to be marked by a concentration of recorded losses and obstructions, and while the cable route passes to the south and west of the principal concentration of recorded wrecks, desk-based assessment has noted the presence of a number of recorded and potential wreck sites. The proposed cable route passes through an area to the south-west of the principal routes into and out of the harbour. As the route moves further into the Celtic Sea, it enters an area historically used for access to the Atlantic ports of Ireland, England, Wales, and France and for access to the English Channel, and while recorded and potential wrecks and obstructions become more sparsely distributed, the potential that such features may be affected will remain.

There are no formally designated wrecks within the CSC or wider study area. Previously recorded losses and geophysical anomalies assessed as of medium archaeological potential (no high potential anomalies that cannot be correlated to recorded losses have been noted within the CSC or wider study area) in Irish Territorial Waters and EEZ are summarised at Table 4.2 and within the UK EEZ are summarised at Table 4.3.

Irish TW and EEZ

Table 4.2: Recorded losses, obstructions and geophysical anomalies suggestive of potential wrecks within the CSC

ID	Name	Classification	Place of Loss	Date of Loss	Lat	Long	Source
W10966	Unknown	Unknown	Unknown	Unknown	50.74167	-7.35833	UKHO
W11319	Unknown	Unknown	Celtic Sea	Unknown	51.6625	-7.82817	UKHO Eoghan Kieron
HA2041	Unknown	Medium potential magnetic and sidescan anomaly	Unknown	Unknown	51.40426	-7.69868	Headland Archaeology 2015
HA2051	Unknown	Medium potential magnetic and bathymetric anomaly	Unknown	Unknown	51.4032	-7.70485	Headland Archaeology 2015 (also recorded by Osiris as M61)

ID	Name	Classification	Place of Loss	Date of Loss	Lat	Long	Source
HA2052	Unknown	Medium potential sidescan anomaly	Unknown	Unknown	51.40356	-7.70513	Headland Archaeology 2015
HA2067	Unknown	Medium potential sidescan anomaly	Unknown	Unknown	50.85182	-7.40951	Headland Archaeology 2015
HA2082	Unknown	Medium potential sidescan anomaly	Unknown	Unknown	51.21056	-7.61294	Headland Archaeology 2015
HA5000	Unknown	Medium potential magnetic anomaly	Unknown	Unknown	51.68806	-7.84895	Headland Archaeology 2015 (also recorded by Osiris as M37)

UK EEZ

Table 4.3: Recorded losses, obstructions and geophysical anomalies suggestive of potential wrecks within the CSC

ID	Name	Category	Lat	Long	Comments
21629	Gadsby	Non-dangerous wreck	49.4256667	6.1348333	Recorded as dead wreck of British merchant vessel sunk by the submarine U-39, 33 miles SSW of Wolf Rock. There were no casualties.
21689		Foul ground	49.5481347	6.4544994	Identified as fisherman's fastener first recorded 1977
21646		Foul ground	49.4609236	6.2253535	Identified as fisherman's fastener first recorded 1977
			Easting	**Northing**	
S176		Sonar anomaly	672053.90	5503708.40	Possible wreckage identified in sidescan

ID	Name	Category	Lat	Long	Comments
					sonar survey; measures 7.7m x 4.2m x 1.9m. Appears close to reported wreck 21754 (wreck of British merchant vessel sunk by submarine U-29, 10 miles south of St Mary's, Scilly) and may be related.
M205		Magnetic anomaly	659168.20	5510438.70	Part of a cluster of anomalies possibly representing minor wreckage
M206		Magnetic anomaly	659201.90	5510363.20	Part of a cluster of anomalies possibly representing minor wreckage
M207		Magnetic anomaly	659242.20	5510264.90	Part of a cluster of anomalies possibly representing minor wreckage
M208		Magnetic anomaly	659263.20	5510217.20	Part of a cluster of anomalies possibly representing minor wreckage

No previously identified marine archaeological remains would be affected by the proposed scheme, and it is considered unlikely that marine archaeological remains would be affected by the proposed scheme.

5 Proposed Mitigation

5.1 Introduction

In-principle, mitigation measures for the Proposed Development have been set out in Volume 3D1, Chapter 11 and Volume 4, Chapter 11 of the EIAR / ER. This mitigation comprises a combination of avoidance measures and archaeological investigation in addition to a Protocol for Archaeological Discoveries.

In advance of any archaeological survey or mitigation, the archaeological contractor(s) will produce either an application for the appropriate licence (Irish TW and EEZ) or detailed method statements (UK EEZ) for the archaeological works identified. These Licence applications and/or Methods Statements will detail:

- The scope of the relevant works;
- Relationship to survey and construction programme and survey timetable;
- Archaeological aims and objectives of works;
- Investigation methodology including sampling and finds policies and arrangements for immediate conservation, storage and processing of archaeological material;
- Provisions and timetable for post-investigation processing, assessment and analysis of archaeological material;
- Reporting;
- Provision for reasonable monitoring by local and national regulators; and
- Health, safety, and welfare.

Licence Applications and/or Method statements will be agreed with the Retained Marine Archaeologist in advance of submission to the relevant regulators in sufficient time to allow for regulatory comments and any required revisions to be actioned in advance of the start of works, having regard to response times set out by regulators.

5.2 Marine Archaeological Remains

Review of Marine Geophysical Surveys

Marine geophysical surveys have been undertaken along the entire cable route, with specialist archaeological interpretation carried out of the results of survey within Irish TW and EEZ. Further geophysical surveys are likely to be undertaken as part of the detailed design of the proposed cable route.

Existing geophysical survey data for the UK EEZ and any newly acquired survey data should be reassessed in line with English Heritage (2013) Marine Geophysics Data Acquisition, Processing and Interpretation to ensure that potential archaeological remains can be better characterised and that the AEZ identified at Section 5.5 of this Outline WSI are appropriate.

This process may result in the identification of new AEZ or the modification of existing AEZ. Any modifications to the stated AEZ will be agreed with the relevant national regulator.

The scope and methods of any proposed marine geophysical survey carried out for non-archaeological purposes (e.g.: UXO survey or engineering) will discussed with the Retained Marine Archaeologist to ensure that the requirement to gather archaeological information is appropriately considered. Advice will consider:

- available details of sites and / or anomalies identified in previous desk-based and geophysical survey;
- archaeological potential of areas where no existing sites and/ or anomalies are yet known;
- types of survey and specifications and settings of geophysical equipment to be used;
- survey specifications, including spacing and orientation of lines and cross lines;
- any potential requirement for an on-board archaeological geophysicist during survey; and
- requirements for post-processing, interpreting, and archiving resulting data.

Where further surveys are required to confirm the results of geophysical survey for archaeological purposes (usually only in areas of archaeological interest where impact cannot be avoided), the scope and methods of survey would be agreed with the relevant national regulator.

The results of further geophysical interpretation will be reported in line with requirements for report set out at Section 7 of this Outline WSI.

Archaeological assessment of ROV survey data

The scope and methods of any proposed ROV video/drop down camera survey carried out to investigate obstructions identified in geophysical survey or during the course of clearance/construction activities will be discussed with the Retained Marine Archaeologist to ensure that the requirement to gather archaeological information is appropriately considered. Advice will consider:

- potential requirements for survey licencing by the National Monuments Service;
- details of AEZ and/or geophysical anomalies within the development area;
- types of survey and specifications and settings of imaging equipment to be used;
- the provision of guidance on the types of sites and finds that are anticipated and which would require investigation, and the level of recording required;
- any requirements for review of data recovered from the survey; and
- the potential requirement for an on-board archaeological geophysicist to advise on image capture during survey.

An archaeological method statement would be prepared for any such survey, including archaeological objectives and requirements, and setting out any specific technical requirements to allow for meaningful archaeological results. In Irish waters, this method statement would be a requirement of the licencing process where licencing is required.

Reporting of the archaeological assessment will be required in a timely fashion to support any decision-making on further actions. The format and timetable for reporting shall be set out in any methods statement, to reflect the scope of survey and the equipment used.

The results of these surveys will be used to confirm or modify existing or establish new AEZ, in consultation with the relevant national regulator.

5.3 Archaeological Exclusion Zones

AEZ have been established in respect of all observed geophysical anomalies of demonstrable or suspected anthropogenic origin within the cable survey corridor and are shown at Appendix B. The standard practice in this case is to identify a 100m AEZ around known wrecks or high potential geophysical anomalies, and a 50m exclusion zone around other obstructions or wreckage. These AEZs are defined to encompass the full observed extent of any archaeological remains and a buffer to ensure that these remains will not be affected by the proposed works.

Further AEZs will be defined where anomalies or observations of archaeological material not previously identified are made during the pre-construction surveys or during construction work. The scale and location of such further AEZs will be confirmed with the relevant national regulator.

Further survey work may suggest that established AEZs are not appropriate, either due to anomalies being identified as having non-archaeological origins, or more accurate locations and extent of archaeological material being identified. In these cases, amendments to the established AEZ will be agreed with the relevant national regulator.

Construction work would not normally take place within a defined AEZ, and it is anticipated that any detailed design would have regard to established AEZ. Where works within an AEZ cannot be avoided, further investigation will be required in line with provisions for archaeological review of geophysical and ROV survey as set out at Section 5.4.

Table 5.1 Proposed AEZ within the CSC (Irish TW and EEZ: See also Appendix B maps 1-7)

ID	Name	Classification	Lat	Long	AEZ
W10966	Unknown	Unknown; identified as demasted brig of unknown date (Cotswold Archaeology 2019)	50.74167	-7.35833	100m
W11319	Unknown	Unknown	51.6625	-7.82817	n/a

ID	Name	Classification	Lat	Long	AEZ
HA2041	Unknown	Medium potential magnetic and sidescan anomaly	51.40426	-7.69868	50m
HA2051	Unknown	Medium potential magnetic and bathymetric anomaly	51.4032	-7.70485	50m
HA2052	Unknown	Medium potential sidescan anomaly	51.40356	-7.70513	50m
HA2067	Unknown	Medium potential sidescan anomaly	50.85182	-7.40951	50m
HA2082	Unknown	Medium potential sidescan anomaly	51.21056	-7.61294	50m
HA5000	Unknown	Medium potential magnetic anomaly	51.68806	-7.84895	50m
CA8	Unknown – same as W11319	Unknown	51.66145		n/a
			Easting	**Northing**	
CA1001	Unknown – confirmed location of CA8/W11319	High potential bathymetric and magnetic anomaly. Probable wreck site measuring 91.4m long by 7.3m high	580911	5724197	100m
CA1002	Unknown	Medium potential magnetic anomaly – probable metallic debris	580878	5750872	50m
CA1003	Unknown	Medium potential – magnetic anomaly and small rounded reflector	586418	5738751	50m
CA1005	Unknown	Medium potential anomaly. Bathymetric high close to two magnetic anomalies	580536	5723787	50m
CA1011	Unknown	Medium potential magnetic anomaly with associated small reflector probable metallic debris	580567	5723726	50m

Table 5.2 Proposed AEZ within the CSC (UK EEZ: See also Appendix B maps 8-12)

ID	Name	Category	Lat	Long	AEZ
21629	Gadsby	Non-dangerous wreck	49.4256667	6.1348333	100m
21689		Foul ground	49.5481347	6.4544994	50m
21646		Foul ground	49.4609236	6.2253535	50m
			Easting	Northing	
S176		Sonar anomaly	672053.90	5503708.40	50m
M205		Magnetic anomaly	659168.20	5510438.70	50m
M206		Magnetic anomaly	659201.90	5510363.20	50m
M207		Magnetic anomaly	659242.20	5510264.90	50m
M208		Magnetic anomaly	659263.20	5510217.20	50m

It is not anticipated that any disturbance would arise to the remains identified above where the works respect the defined AEZ.

5.4 Protocol for Archaeological Discoveries

General

While it is not anticipated that previously unknown sites or material would be observed during the construction of the proposed development, measures are required to mitigate any impact on archaeological remains and to ensure that relevant statutory responsibilities are met. The scope of ‘archaeological remains’ includes any submerged prehistoric material, human remains, shipwreck material or aviation material, and material which either falls within the definitions set out in the statutes above or could reasonably be considered to fall within these categories.

Archaeological material does not include modern material with limited informative, cultural or historic value, such as chance loss of cargo or fishing gear, and the Protocol for Archaeological Discoveries (PAD) does not supplant any other requirements to report wreckage, salvage or other loss under other statutory provisions (i.e. those covering environment, safety, navigation, and wreck, salvage or other property rights), and advice on these issues should be taken from appropriately qualified specialists.

The PAD sets out a protocol for action where archaeological remains are observed during survey or construction out with an agreed scheme of archaeological works.

Where unexpected archaeological remains are observed during the conduct of an established archaeological investigation, the responsibility for reporting to the client will be with the appointed specialist archaeological contractor in line with any agreed method statements.

This PAD supplements, and does not supersede, any requirements to report marine wreckage for navigational, wreck or other statutory/guidance/best practice purposes.

This PAD provides for a four-step process:

1 Reporting of potential archaeological material to the Retained Marine Archaeologist;

2 Provision of archaeological advice and, where required definition of temporary exclusion zones (TEZ) and archaeological investigation of identified features/material;

3 Where appropriate, establishment of new or revision of existing AEZs; and

4 Reporting of findings.

All relevant project staff show be briefed on the need for and operation of the PAD to ensure that they are aware of the PAD, can recognise finds of archaeological potential, and understand their responsibilities in respect of this material. Where appropriate, a copy of the PAD should be appended to any written work instructions for reference during works. This applies to any project staff involved in survey or intrusive clearance and construction works, primarily:

- UXO survey(s);
- Prelay grapnel runs, and other clearance works;
- Cable ploughing; and
- Other works with potential for the discovery of material on the seabed and/or recovery of material to the surface.

Reporting potential archaeological material to the Retained Marine Archaeologist

Any observation of archaeological material or material which appears to be of archaeological origin is to be reported to the Retained Marine Archaeologist at the earliest opportunity.

In general, archaeological material should not be handled or deliberately recovered from the seabed without seeking advice from the Retained Marine Archaeologist, but where archaeological material is inadvertently recovered during operations, site staff should:

- Record the location at which the material was found;
- Handle material with care and no more than is necessary to allow for its safe storage;
- Not attempt to clean material or remove encrustations;
- Take photographs and/or video to inform Retained Marine Archaeologist advice;
- Store material in a safe place where it will not be inadvertently lost or broken; and
- Seek advice from the Retained Marine Archaeologist.

Finds of ordnance or other dangerous or controlled materials are to be treated within established protocols for those materials in precedence to any archaeological recording, and while these materials should be reported to the Retained Marine Archaeologist, the provisions of the PAD shall not apply unless these materials have been rendered safe or safe systems of work have been established.

Material should be stored in a condition as close as possible to the conditions from which it was recovered. Waterlogged material should be kept damp and in a dark place where possible.

Where potential archaeological remains are identified in advance of intrusive construction work (e.g., geophysical survey or drop-down video) the location and nature of the anomaly should be reported to the Retained Marine Archaeologist so that an appropriate TEZ can be established, and the observation recorded for archaeological purposes. The works should, where reasonably practicable, considering the nature and importance of the find and the nature of the works, deviate round the identified anomaly.

Where potential remains are identified during or after site clearance or intrusive construction work, deviation of the route is unlikely to represent an appropriate mitigation, and the location at which potential archaeological remains were observed should be reported. Where possible, any remains should be recovered to the vessel so that the nature of the remains can be determined, and work should cease or move to an alternate location while further advice is sought from the Retained Marine Archaeologist.

Provision of archaeological advice

The Retained Marine Archaeologist will arrange for appropriate identification of any material recovered, and, where appropriate, will advise on any temporary restrictions to operations within the vicinity of the find, and the establishment of any TEZ that may be necessary to allow for protection of archaeological remains, pending consultation with the appropriate national regulators.

Where further construction or other intrusive works are required within the vicinity of archaeological material, further investigative survey may be required to fully understand the nature and extent of archaeological remains. The Retained Marine Archaeologist will advise on the scope of such survey and will agree proposals for survey with the relevant national regulator.

The Retained Marine Archaeologist will advise the client on reporting requirements for archaeological purposes, and on potential requirements for route deviation, amendments to working practices or support to further investigation, recording, moving, storage and/or analysis of archaeological material, and will inform the relevant national regulators, agreeing any further actions with the client and relevant national regulator.

Where heritage-based licensing is required for further survey, investigation or recovery and analysis of archaeological material, any such licence will be obtained by the relevant specialist contractor undertaking the proposed work.

Revision or establishment of AEZ

Where archaeological remains are identified and mitigation cannot be achieved by either recovery and recording or movement of these remains or, in the case of remains identified in advance of construction works, the Retained Marine Archaeologist will agree the location and scale of any required AEZ with the relevant national regulators. While this would normally require the extension of existing or establishment of new AEZ, it may be appropriate to move, amend or remove existing AEZ where survey identifies that these have not been appropriately defined.

Reporting of findings

Further to initial reporting of findings to the appropriate national regulator by the Retained Marine Archaeologist, any reporting of identification and analysis of archaeological material will be carried out in line with the general provisions for reporting set out at Section 7 of this Outline WSI, except where superseded by requirements of any formal licence required for those works.

6 Procedures in respect of statutorily protected remains

6.1 General

Any reporting of archaeological material observed during the proposed works shall be made by the Retained Marine Archaeologist, except where reporting is required as a condition of specific archaeological licencing, in which case the named person/organisation in that licencing shall carry out any reporting, ensuring that the Retained Marine Archaeologist is informed.

All artefacts identified from material recovered will be retained, processed, and recorded in accordance with the CIfA Standard and guidance for the collection, documentation, conservation, and research of archaeological material (CIfA 2014) and/or the IAI Code of Conduct for the Treatment of Archaeological Objects in the context of an archaeological excavation (IAI 2006).

The initial processing and storage of soil samples and other ecofactual material will be carried out in accordance with Environmental Archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation (English Heritage, 2011) and Geoarchaeology: using earth sciences to understand the archaeological record (Historic England, 2015) and/or Environmental Sampling: Guidelines for Archaeologists (IAI 2007).

The Methods Statements for each stage of work will identify appropriate named specialists or, where required, licence holders, and will set out:

- Procedures for conservation assessment;
- Procedures for temporary storage, processing and recording of archaeological material;
- A retention and discard policy; and
- Procedures for selection of material for further assessment and analysis.

It is not anticipated that human remains will be present within the CSC, given the prevailing conditions, which are not favourable for the preservation of human remains, and the absence of evidence for wrecks within the working areas. However, in that excavation of human remains is closely governed by statute in both the UK and Ireland, provision must be made in any methods statements for intrusive archaeological works for actions to be taken in the event of human remains being observed or recovered.

6.2 Archaeological Material

Irish TW and EEZ

The National Monuments Amendment Act 1994 sets out that all archaeological objects are the property of the Irish State. As such, procedures for reporting discoveries of archaeological material, its recovery, analysis and storage are required as part of the process of licencing archaeological investigations, and procedures in respect of archaeological material recovered in Irish TW or EEZ will be set out in the detailed methods statements required by this Outline WSI.

UK EEZ

Archaeological artefacts that have come from a ship are considered to be ‘wreck’ for the purposes of the Merchant Shipping Act 1995, and the Receiver of Wreck must be notified within 28 days of recovery.

Arrangements for agreeing reasonable access for study of archaeological material and/or transfer of title of that material to an appropriate receiving museum must be agreed with the lawful owner and/or the Receiver of Wrecks. This is particularly important where analysis of material could be destructive, and such analysis must not take place without appropriate lawful authority.

Any items which are recovered which could be deemed as Treasure[1] will be subject to the provisions of the Treasure Act 1996 . Such material shall normally be removed from site to a secure location as soon as is reasonably practicable and is compatible with appropriate archaeological investigation and recording.

In addition to the statutory authorities the Marine Antiquities Scheme should be informed.

6.3 Human remains

General

The Archaeological Contractor will have available within the team or on call an appropriately qualified and experienced osteo-archaeologist to assist the recovery, storage and processing of any human remains.

Irish Territorial Waters and EEZ

It is a legal obligation under the Coroner’s Act 1962 and the National Monument Acts to notify the Garda Siochana and the National Museum of Ireland where human remains are unexpectedly or accidentally identified. Where it is established that the remains are not recent, they are considered to be archaeological artefacts under the National Monuments (Amendment) Act 1994, which sets out the legal definition of an archaeological object to include ‘ancient human remains.

[1] Treasure is as defined by the Treasure Act 1996 and the Treasure (Designation) Order 2002. In brief, Treasure comprises any metal object, other than a coin, of at least 10 per cent by weight of gold or silver at least 300 years old. A prehistoric object is Treasure where any part of it is precious metal, or where two or more metallic objects come from the same find.

Two or more coins from the same find are Treasure provided they are at least 300 years old and contain 10 per cent gold or silver (more than ten coins containing less than 10 per cent of gold or silver are Treasure). Objects found with Treasure would also comprise Treasure. As finds may have become scattered since they were originally deposited, an object would be part of the 'same find' as another object or coin if it is found in the same place as, or had previously been together with, the other object.

Until such time as the National Museum of Ireland makes a decision on the future retention and care of human remains, the licensed site director has responsibility for their excavation, post excavation care and analysis, and any further works must be carried out under the terms of an excavation licence.

Where appropriate, any Method Statements produced in line with the Outline WSI above will set out clear and specific proposals for the appropriate reporting, recording, excavation, analysis, and storage of human remains.

UK EEZ

In the event of human remains being encountered, the Retained Marine Archaeologist will be informed to allow formal reporting to the national regulator as appropriate. Where appropriate, the Archaeological Contractor will arrange receipt of any necessary licencing to enable the legal removal of any human remains encountered in the works.

Military Remains

The 1986 Protection of Military Remains Act (PMRA) applies to any aircraft which have crashed while in military service and to certain wrecks of vessels which were wrecked while in military service within UK waters. PMRA makes it an offence to disturb, move or unearth military remains which have been designated.

There are no designated protected areas or controlled sites within the CSC, and there are no records of military vessels or aircraft having been lost within the Order limits.

Where remains of military aircraft are observed during archaeological investigation or construction work, intrusive work should cease, and the site be secured while consultation with the Ministry of Defence is undertaken.

It should be noted that the PMRA also applies to aircraft or vessels lost in British military service throughout the world, and the procedures set out below may also apply to where such remains are present out with the UK EEZ.

Where remains of military vessels or aircraft lost in service of nations other than the UK or Ireland are identified, due regard should be given to any requirement to report such discoveries to the relevant national regulator of the nation in the service of which the vessel or aircraft was lost.

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7 Post-Excavation and Reporting

7.1 General

Proposals for reporting of each phase of archaeological work will be set out in the relevant detailed methods statements. These will set out:

- Reporting timetable;
- Reporting process and any requirement for periodic, interim or assessment reporting;
- Provisions for publication or wider dissemination; and
- Archival of physical, paper and/or digital material.

7.2 Reporting of pre-construction surveys

The results of any pre-construction surveys will be necessary to inform project planning and the detail of mitigation requirements and to support consultation with the relevant national regulators. It is therefore important that they are reported in a sufficiently timely manner to inform these purposes. The detailed method statements for these phases of work will set out an agreed timescale for reporting, considering the potential for abbreviated interim or headlines reporting where appropriate, to ensure that the value of the surveys can be realised.

7.3 Post-Fieldwork Reporting

Post-fieldwork reporting may fulfil a number of purposes, and regard must be had to these in setting out the detailed methods statements, which should consider the relevant requirements at the completion of each stage of work.

All stages of post-fieldwork reporting may not be appropriate for all archaeological works, and therefore, any licence applications or detailed methods statements will set out an appropriate format and timetable for the presentation of reporting, having regard to the works completed, the findings of those works and the need to provide an appropriate level of descriptive text, catalogue data, site photography/images, survey data, and maps/plans/charts at each stage.

Reporting stages would normally comprise:

- Fieldwork Completion Reporting:
  - This type of reporting would normally take the form of a summary note, representing a very brief summary sufficient to confirm the completion of fieldwork; provide a scope and timetable for detailed reporting; and signpost any significant findings to inform research and development management pending the production of the full report.
- Assessment Reporting:

  - For more complex interventions, or those producing results which require significant post fieldwork analysis, assessment reporting may be required to provide a rapid summary of the material recovered during the fieldwork and to allow costed recommendations to be made for the final reporting;
  - Assessment reporting is a summary document rather than a detailed record. As such, the level of specialist work and reporting will be sufficient to allow recommendations for detailed work to be made and justified;
  - Any Assessment reporting should present: a project and archaeological introduction; a statement of archaeological background and research aims; an interim statement on the results of fieldwork and a summary of the site archive and work carried out for assessment;
  - The Assessment reporting will set out the Potential of the Data to meet the research aims of the project and a summary statement of the significance of the data to support recommendations for final reporting.;
  - Supporting information will normally include: illustrations at appropriate scales; tabulated data and/or appended specialist reports; and index, references and disclaimers;
- Any requirement for and scope/format of archive or publication reporting will either be specified within the licence application or detailed methods statement, or as a recommendation of the Assessment reporting:
  - Publication Reporting could comprise reporting in a peer-reviewed journal or monograph and supplement or replace full archive reporting, depending on circumstances, and would be used to set out particularly significant findings of the fieldwork, normally focusing on specific aspects that relate to active research; and
  - Popular reporting would be used to report on particularly significant or interesting results of the fieldwork, supporting wider project engagement and communications. This reporting could include press releases and internet or social media posts as well as more formal reports.

7.4 OASIS

For works within the UK EEZ, the relevant contractor must complete the online OASIS form at http://ads.ahds.ac.uk/project/oasis/. Once a report has become a public document, the OASIS form will be validated, placing the information into the public domain on the OASIS website. The archaeological contractor must indicate that they agree to this procedure within the detail method statement submitted to the Retained Marine Archaeologist for approval.

7.5 Permanent Archival and Storage

Relevant recipient museums will be identified in any licence applications or detailed methods statements, along with an agreed discard/retention policy and an outline content of the archive, considering that the works will generate paper records, graphics, artefacts, ecofacts, and digital data.

Before the commencement of fieldwork, contact should be made with the relevant recipient Museum(s) and/or Archive(s) to make the relevant arrangements for cataloguing and receipt of physical, paper, and digital archives as appropriate to that survey. Particular attention should be given to the need to identify an appropriate archive for digital data and that format of digital archive is agreed in advance of submission.

The archaeological contractor will confirm that arrangements for the format, packaging, content and receipt of archaeological material and site archives, including any requirement for security copies have been agreed with the relevant recipient museum or archive before the commencement of fieldwork.

Licence applications and detailed methods statements for each phase of work shall set out an agreed timetable for the deposition of the archive with the recipient museum or archive and shall confirm that the archive has been submitted in a satisfactory form to the receiving museum on completion of works.

8 Conclusion

This document supports the EIAR and is intended for further development post consent with the relevant authorities.

The survey work undertaken to date has revealed a limited amount of locations of archaeological interest within the area of the proposed development, and appropriate AEZ have been defined to ensure the protection of those remains.

The measures provided in this document in addition to the provision of AEZ will be undertaken in collaboration and agreement with the relevant authorities prior to and during the construction of the proposed development.

9 References

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Institute of Archaeologists of Ireland Code of Conduct for Archaeological Excavation. (http://www.iai.ie/wp-content/uploads/2016/03/IAI-Code-of-Conduct-for-Archaeological-Excavation.pdf).

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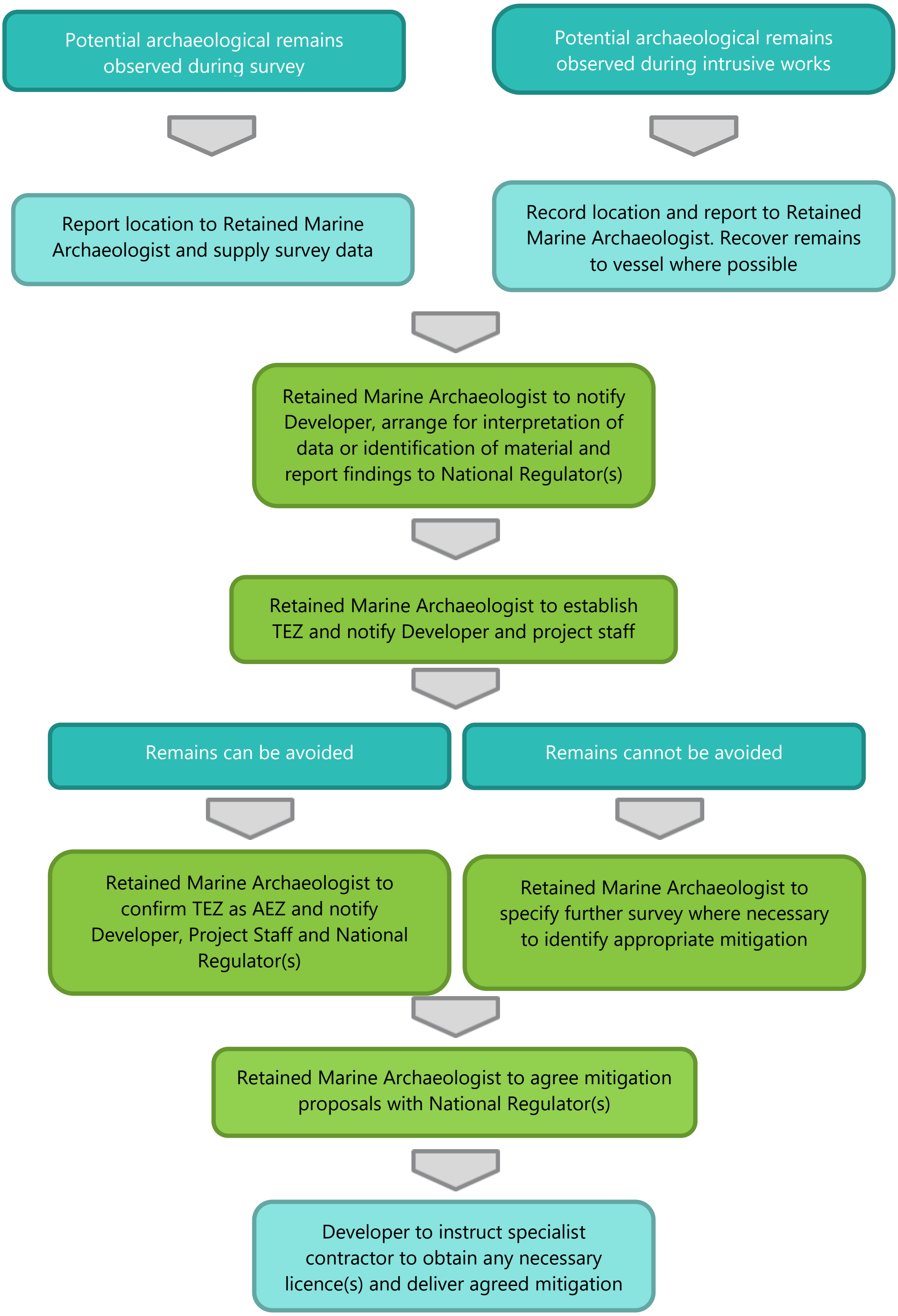
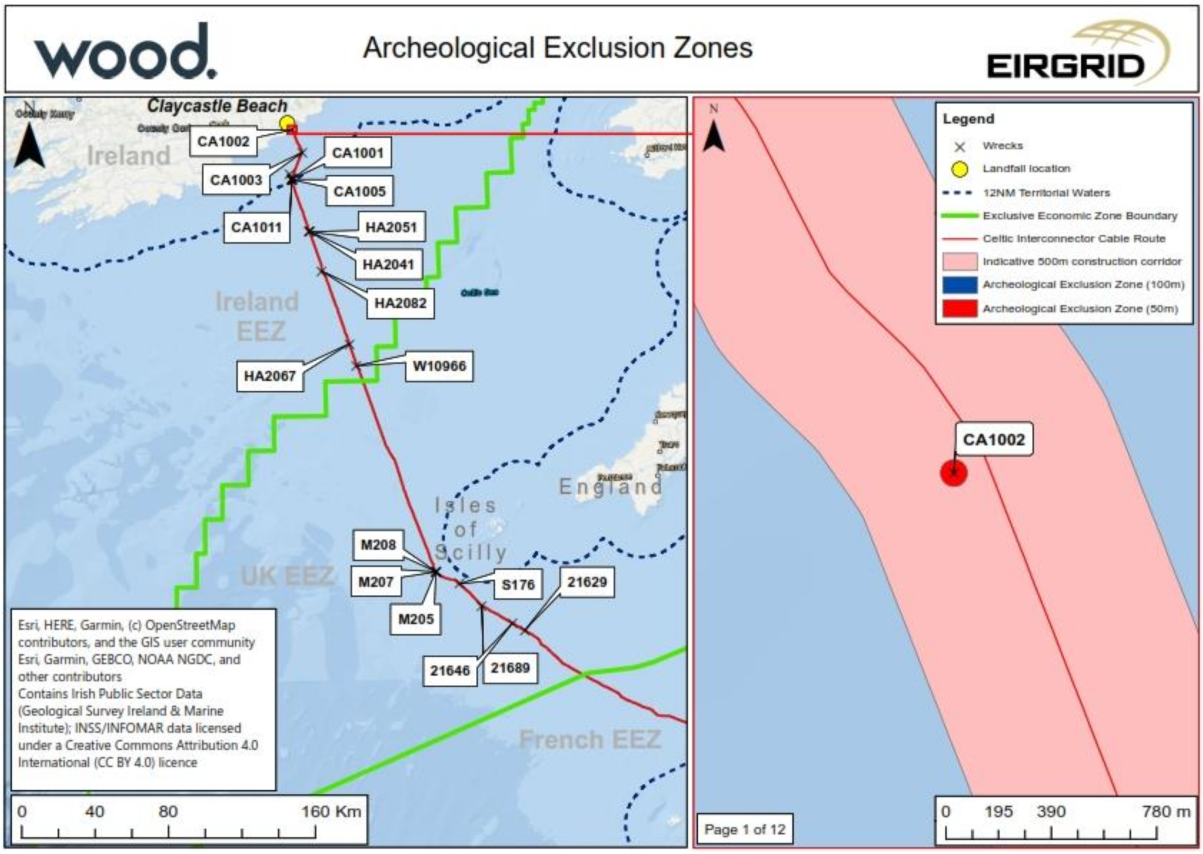
Institute of Archaeologists of Ireland Code of Conduct for the Treatment of Archaeological Objects in the context of an archaeological excavation. (http://www.iai.ie/wp-content/uploads/2016/03/IAI-Code-of-Conduct-for-the-Treatment-of-Archaeological-Objects.pdf).

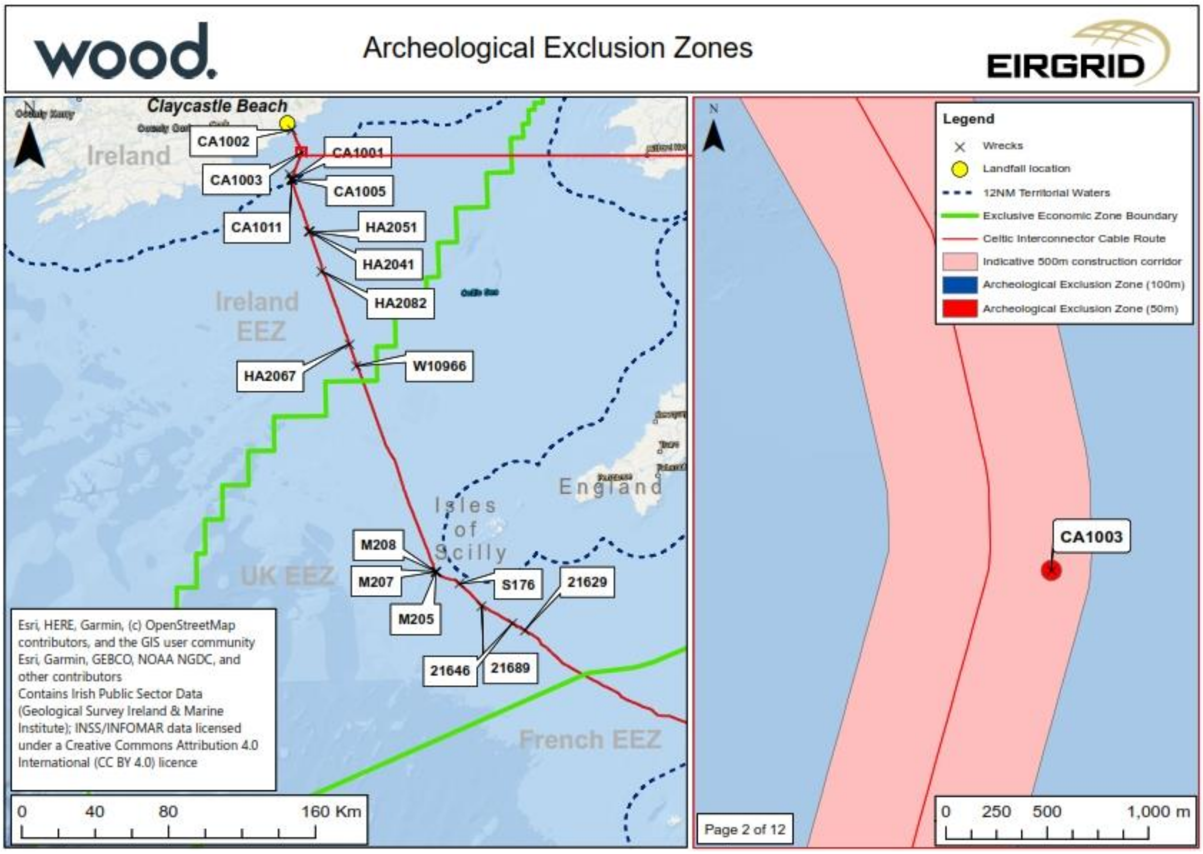
Institute of Archaeologists of Ireland Code of Conduct for the Archaeological Treatment of Human Remains in the context of an archaeological excavation. (http://www.iai.ie/wp-content/uploads/2016/03/IAI-Code-of-Conduct-for-the-Archaeological-Treatment-of-Human-Remains.pdf).

10 Appendix A: PAD Flow Diagram



11 Appendix B: Plans of AEZ




Archeological Exclusion Zones
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England
Isles of Scilly
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M205
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Wrecks
Landfall location
12NM Territorial Waters
Exclusive Economic Zone Boundary
Celtic Interconnector Cable Route
Indicative 500m construction corridor
Archeological Exclusion Zone (100m)
Archeological Exclusion Zone (50m)
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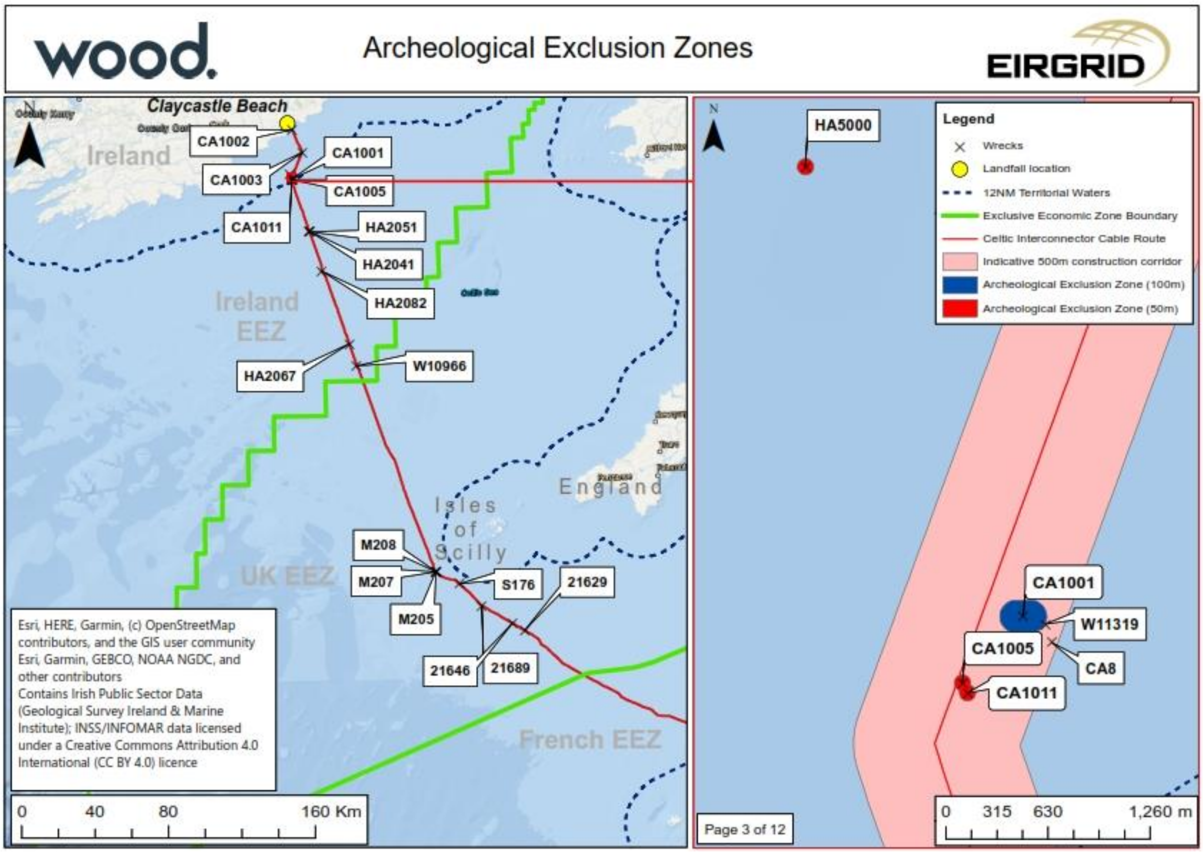
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Celtic Interconnector Cable Route
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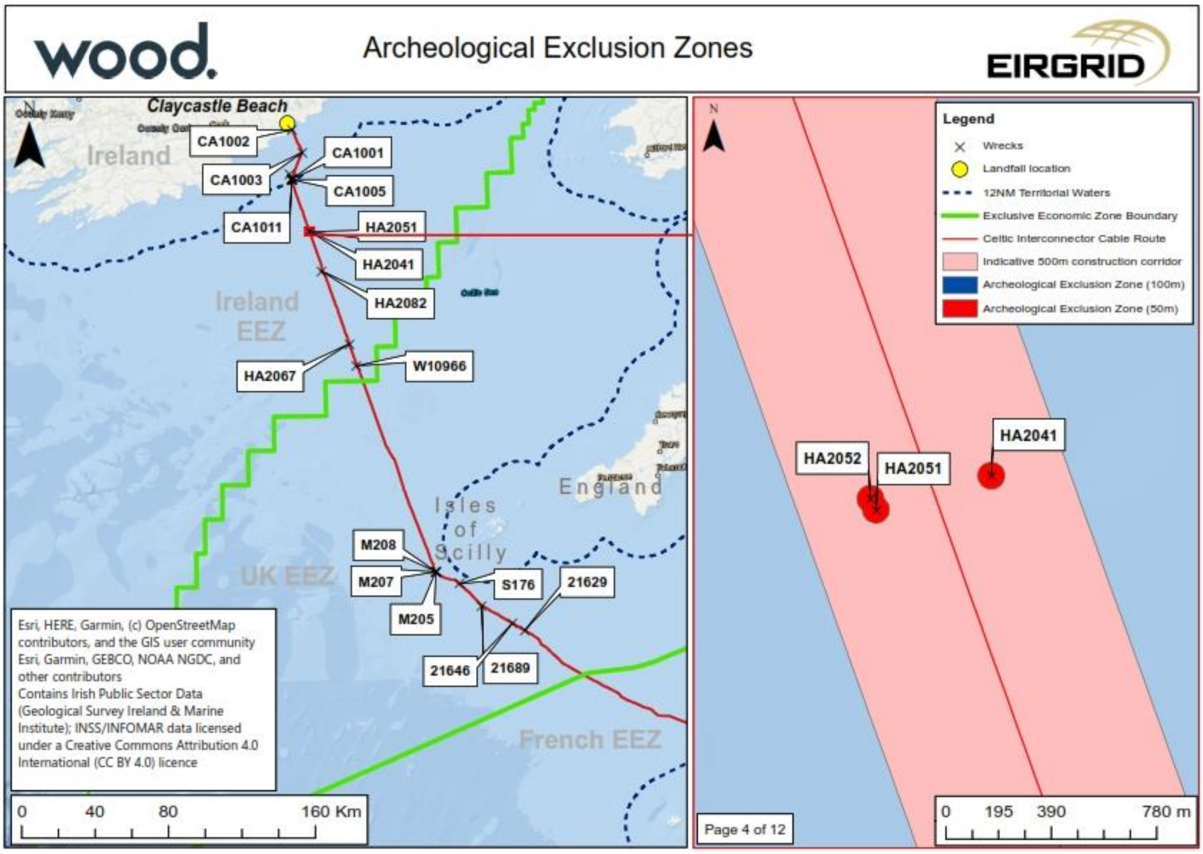
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Landfall location
12NM Territorial Waters
Exclusive Economic Zone Boundary
Celtic Interconnector Cable Route
Indicative 500m construction corridor
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Archeological Exclusion Zone (50m)
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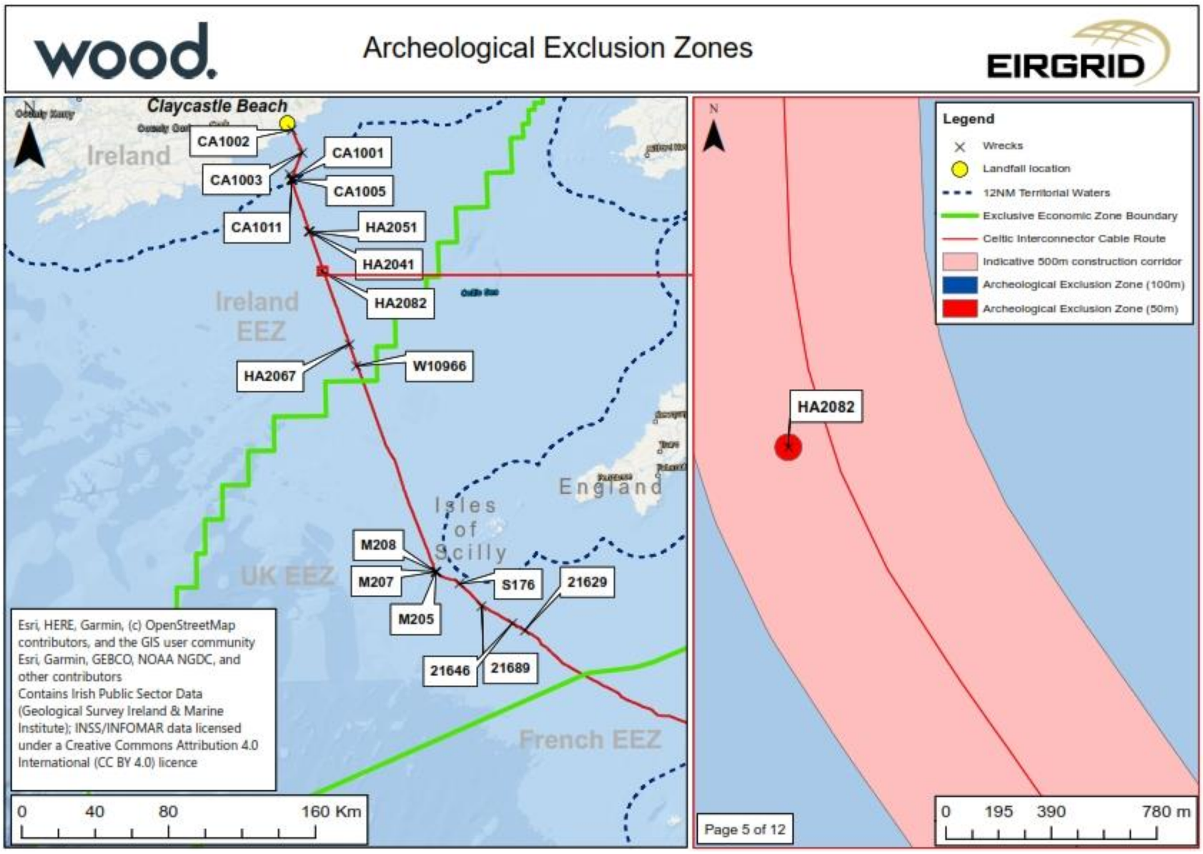
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Archeological Exclusion Zone (50m)
HA2082
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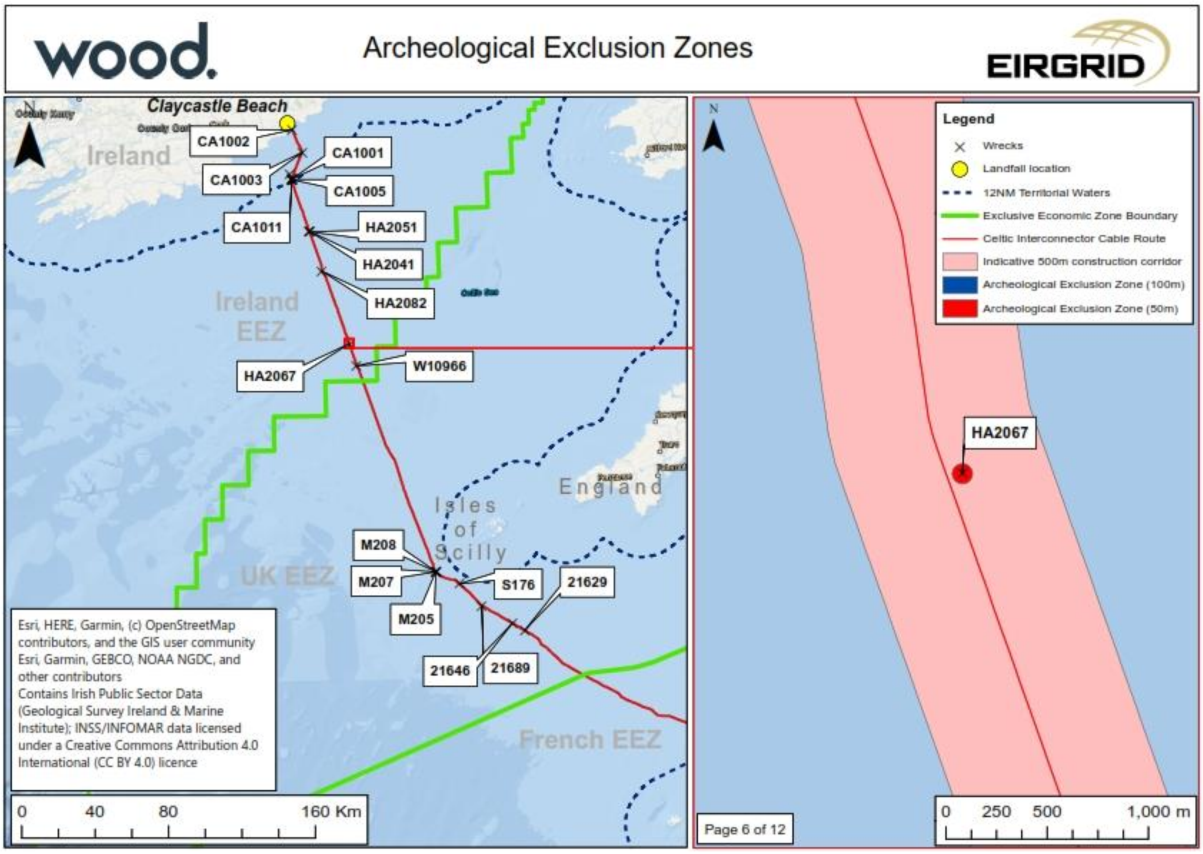
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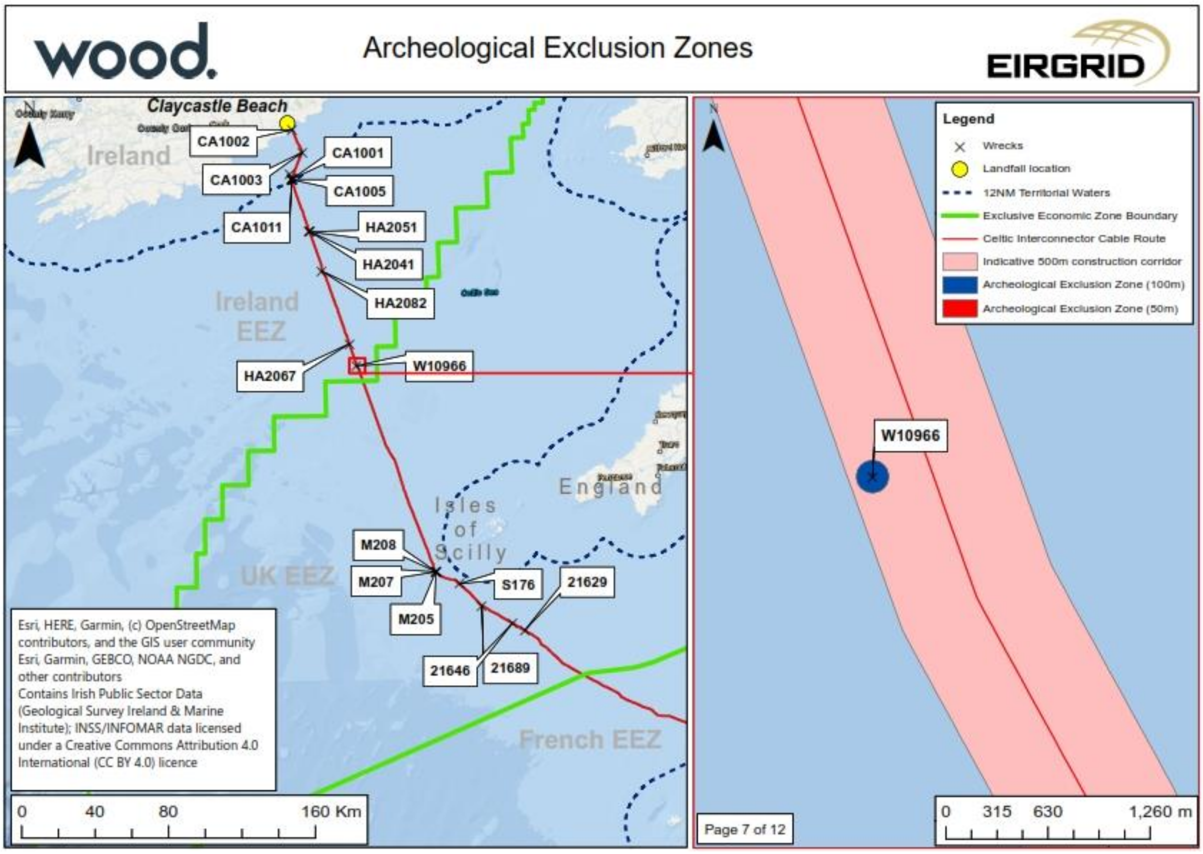
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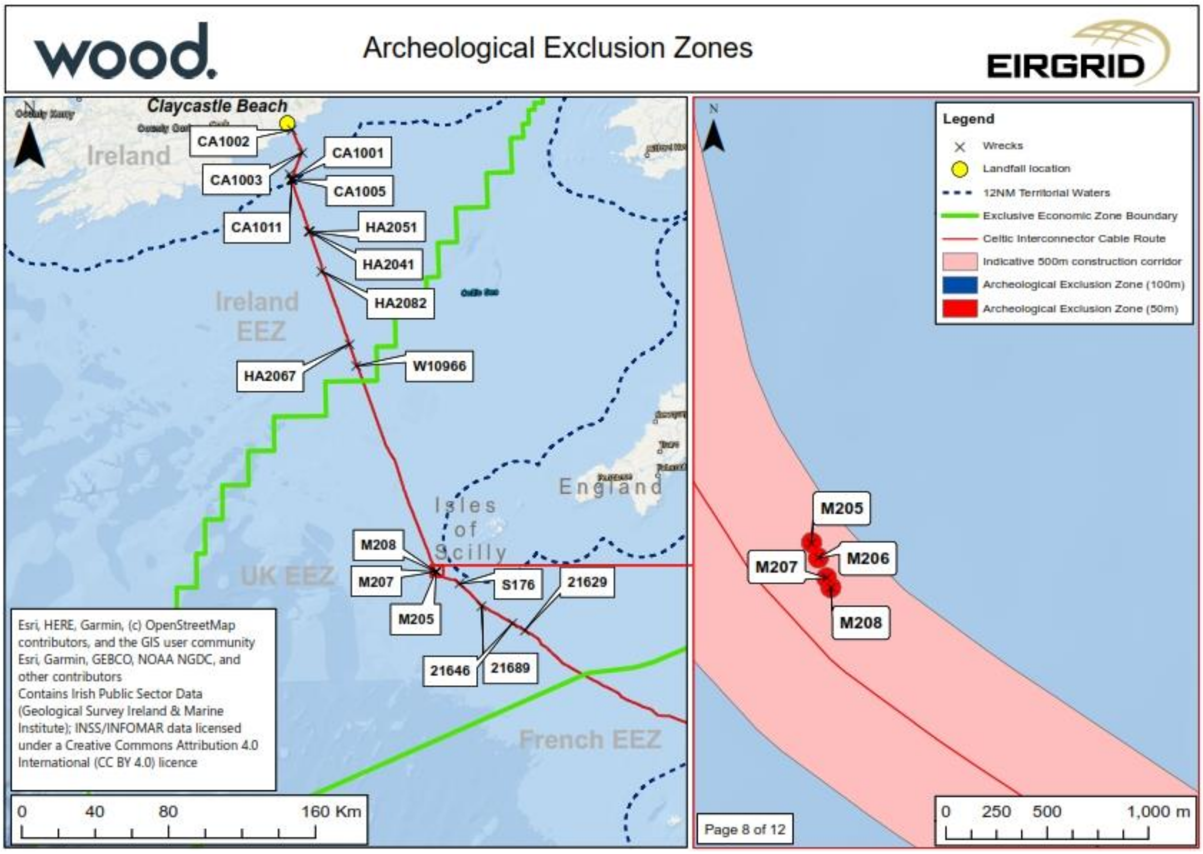
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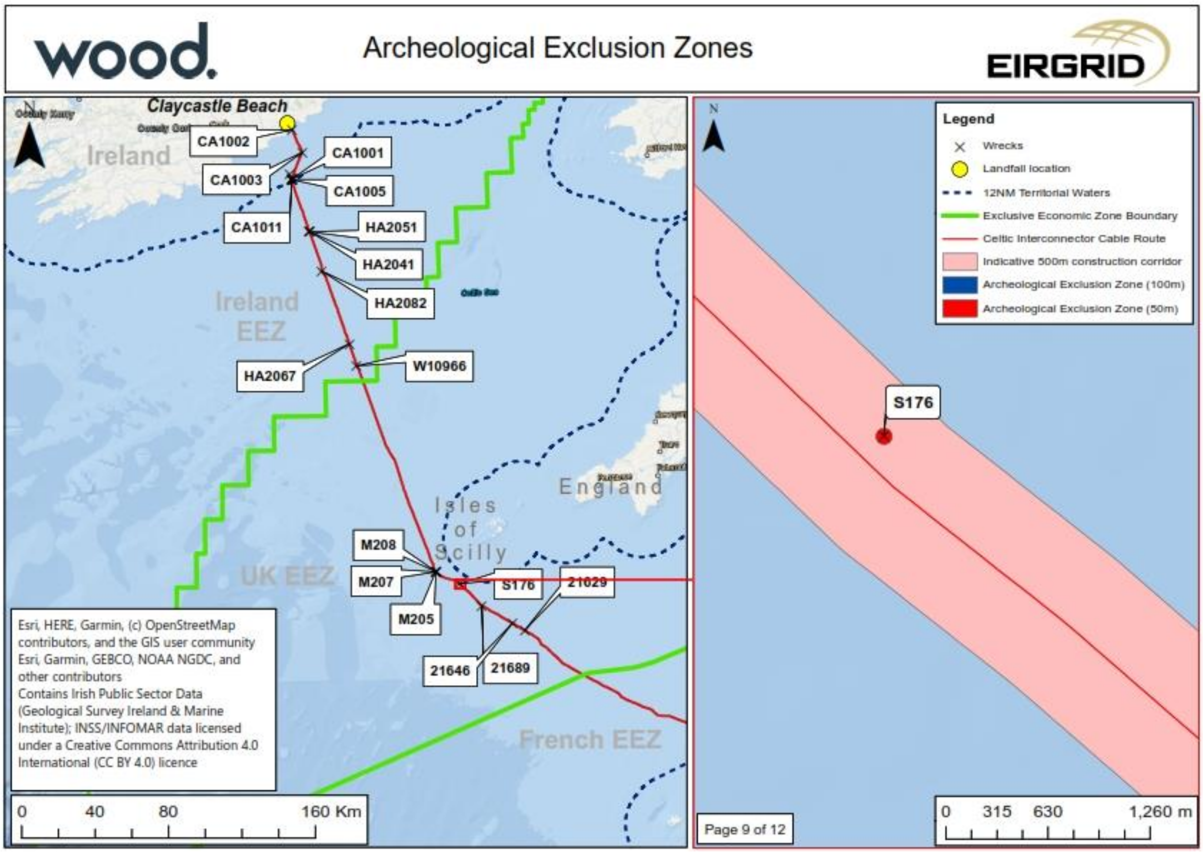
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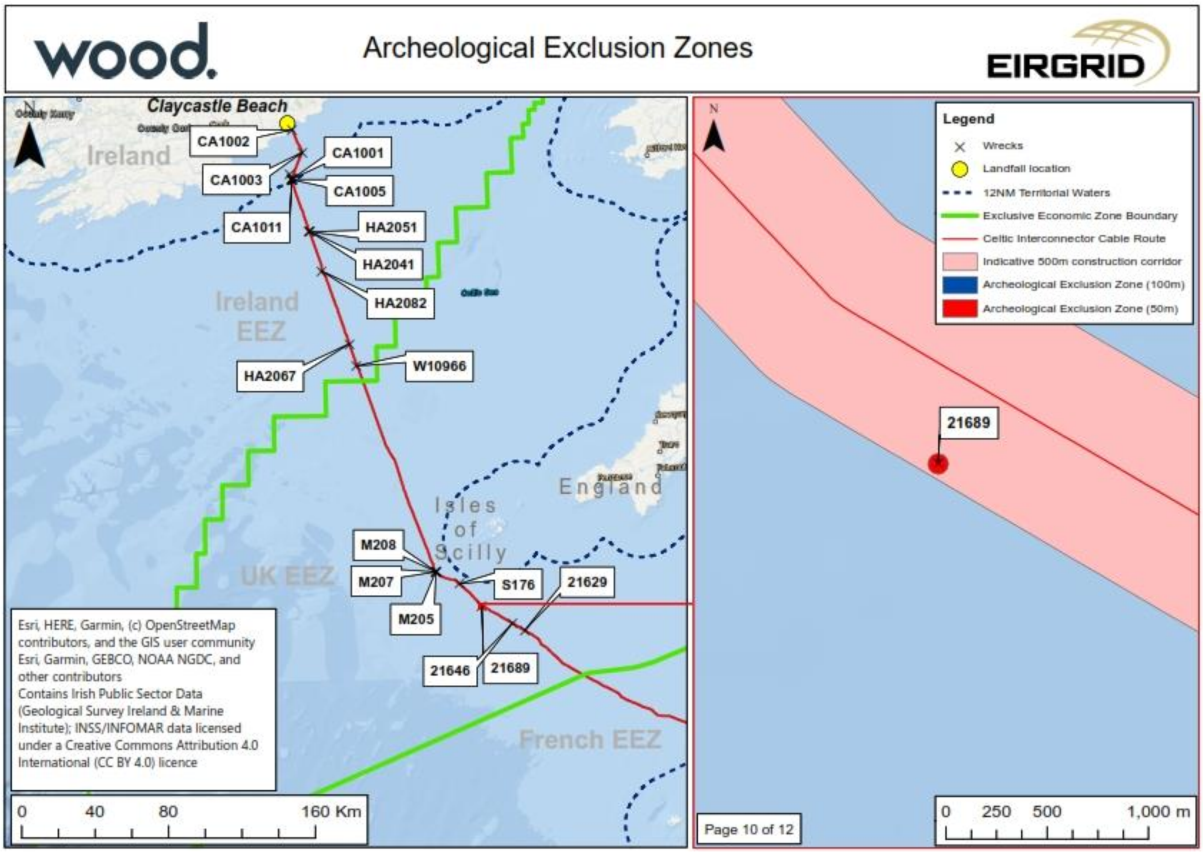
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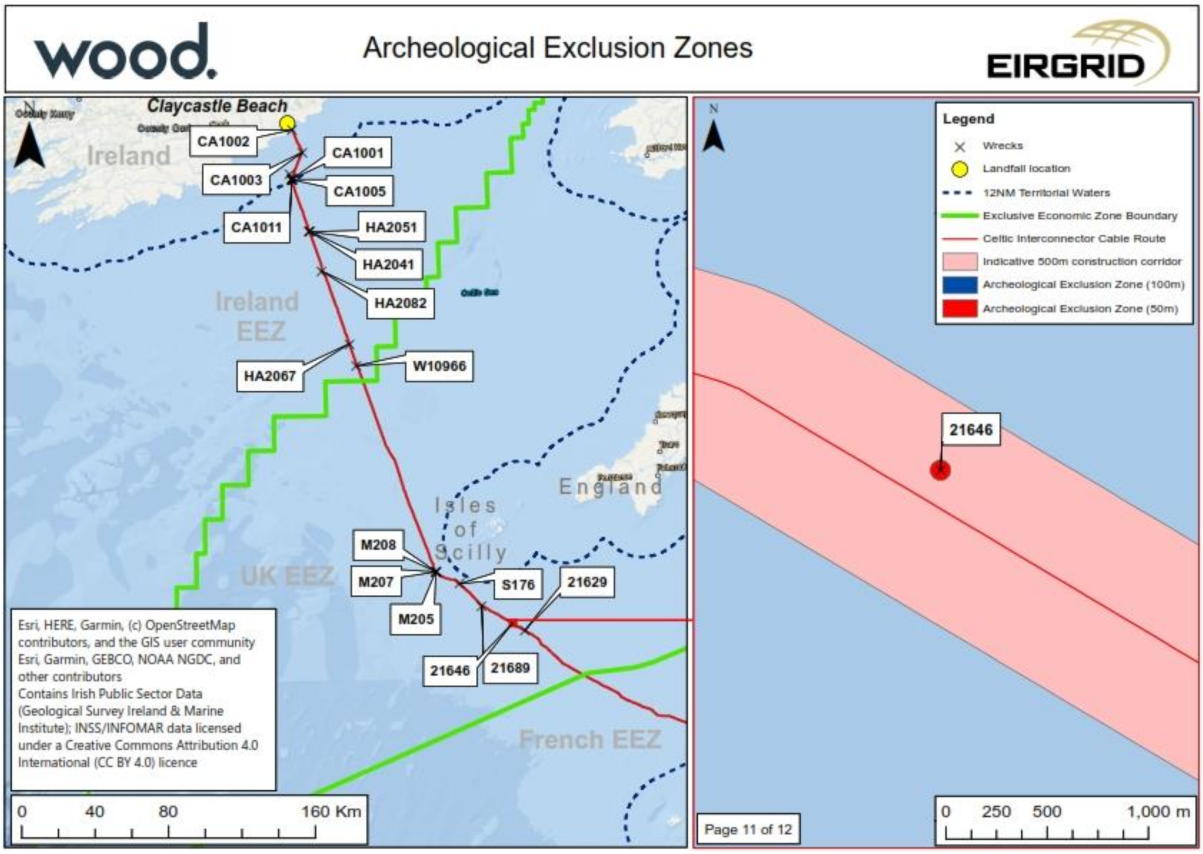
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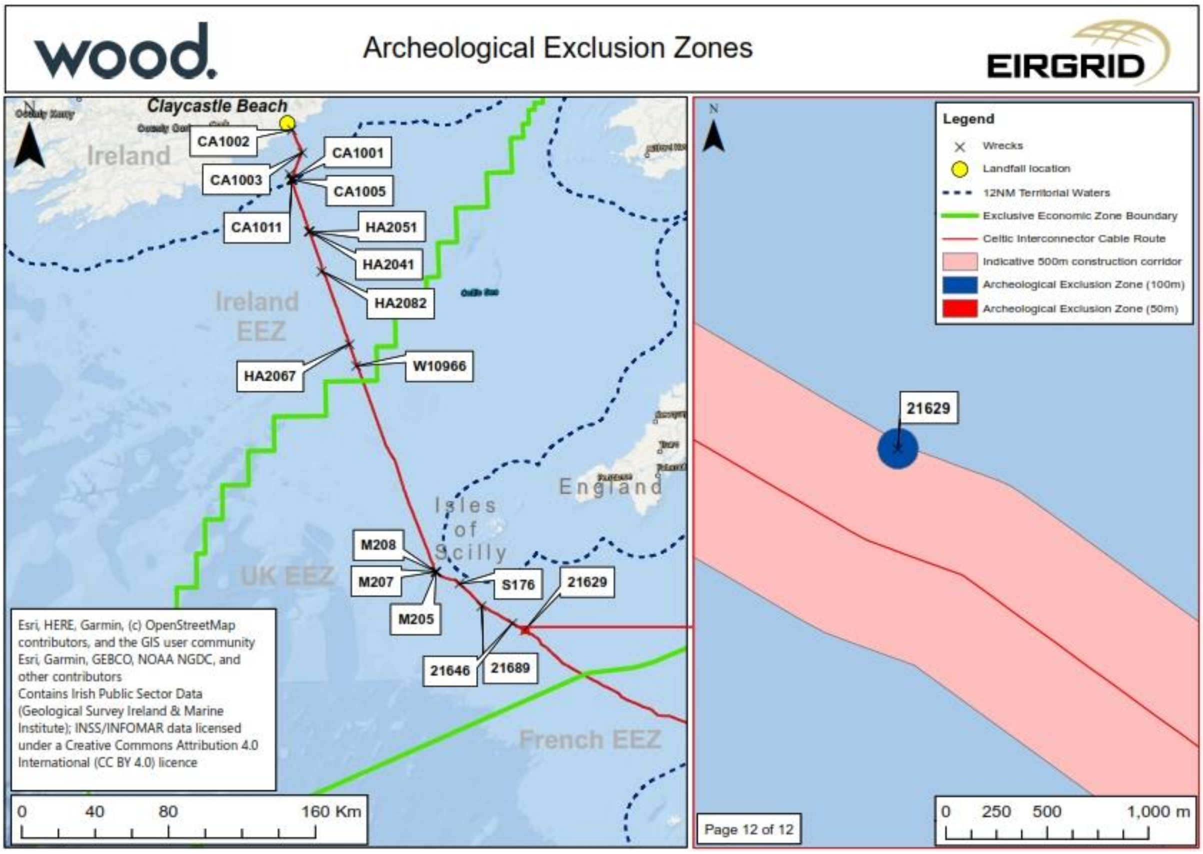
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Celtic Interconnector

Volume 3D2 – Appendix 18A
Shipping and Fishing Cable Risk Assessment

June 2021

Co-financed by the European Union
Connecting Europe Facility

Tionscadal Éireann
Project Ireland
2040

EIRGRID

The Oval, 160 Shelbourne Road, Ballsbridge, Dublin D04 FW28
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Celtic Interconnector Shipping and Fishing Cable Risk Assessment

Prepared by:	Anatec Limited
Presented to:	RTE/EirGrid
Date:	01.04.2016
Revision No.:	04
Reference:	A3728-RTE-RA-2

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Revision Number	Date	Summary of Change
00	15 Jan 2016	Draft of Cable Risk Assessment
01	29 Jan 2016	Final Combined Issue based on Part 1 and Part 2 Report Comments
02	12 Feb 2016	Revision of Combined Issue based on Client Comments
03	29 Feb 2016	Revision based on Additional Comments
04	1 April 2016	Final Issue

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Abbreviations

AIS	-	Automatic Identification System
DWT	-	Dead Weight Tonnage
EU	-	European Union
HVDC	-	High Voltage Direct Current
IACS	-	International Association of Classification Societies
IMO	-	International Maritime Organisation
KP	-	Kilometre Point
MMSI	-	Maritime Mobile Service Identity
MOD	-	Military of Defence
nm	-	Nautical Mile
RTE	-	Réseau de transport d'électricité
SAR	-	Search and Rescue
SOLAS	-	Safety of Life at Sea
TSS	-	Traffic Separation Scheme
VHF	-	Very High Frequency
VMS	-	Vessel Monitoring System

1. Introduction

1.1 Summary

Anatec Ltd were commissioned by Réseau de transport d'électricité (RTE) to undertake a Cable Risk Assessment of the Celtic Interconnector, running between the Irish and French coasts. The Celtic Interconnector is a joint project between RTE and EirGrid. At the time of writing the project is in the feasibility stage, with a final decision on whether the project will proceed expected in mid-2016.

The Cable Risk Assessment consists of a review of the surrounding navigational features relevant to the proposed cable route, an analysis of the nearby shipping and fishing, and a quantitative assessment of the risk to the proposed cable from anchors, foundered vessels, and fishing gear. The analysis in this assessment is based on 12 months of Automatic Identification System (AIS) data.

1.2 Objectives

The objectives of the Cable Risk Assessment are as follows:

1. Review the navigational features in the vicinity of the proposed cable route;
2. Assess the shipping in the vicinity of the proposed cable route;
3. Identify the anchoring activity near the proposed cable route;
4. Assess the fishing activity in the vicinity of the proposed cable route;
5. Estimate the risk to the proposed cable from vessels dragging anchor;
6. Estimate the risk to the proposed cable from vessels dropping anchor in an emergency;
7. Estimate the risk to the proposed cable from foundering vessels; and
8. Estimate the fishing interaction frequency across the proposed cable route

2. Project Overview

2.1 Cable Summary

The proposed Celtic Interconnector consists of an HVDC (High Voltage Direct Current) power cable running between the southern Irish coast, east of Cork, and the northern French coast, west of Roscoff, a subsea cable route approximately 265 nautical miles (490km) in length. A general overview of the proposed cable route is presented in Figure 2.1.

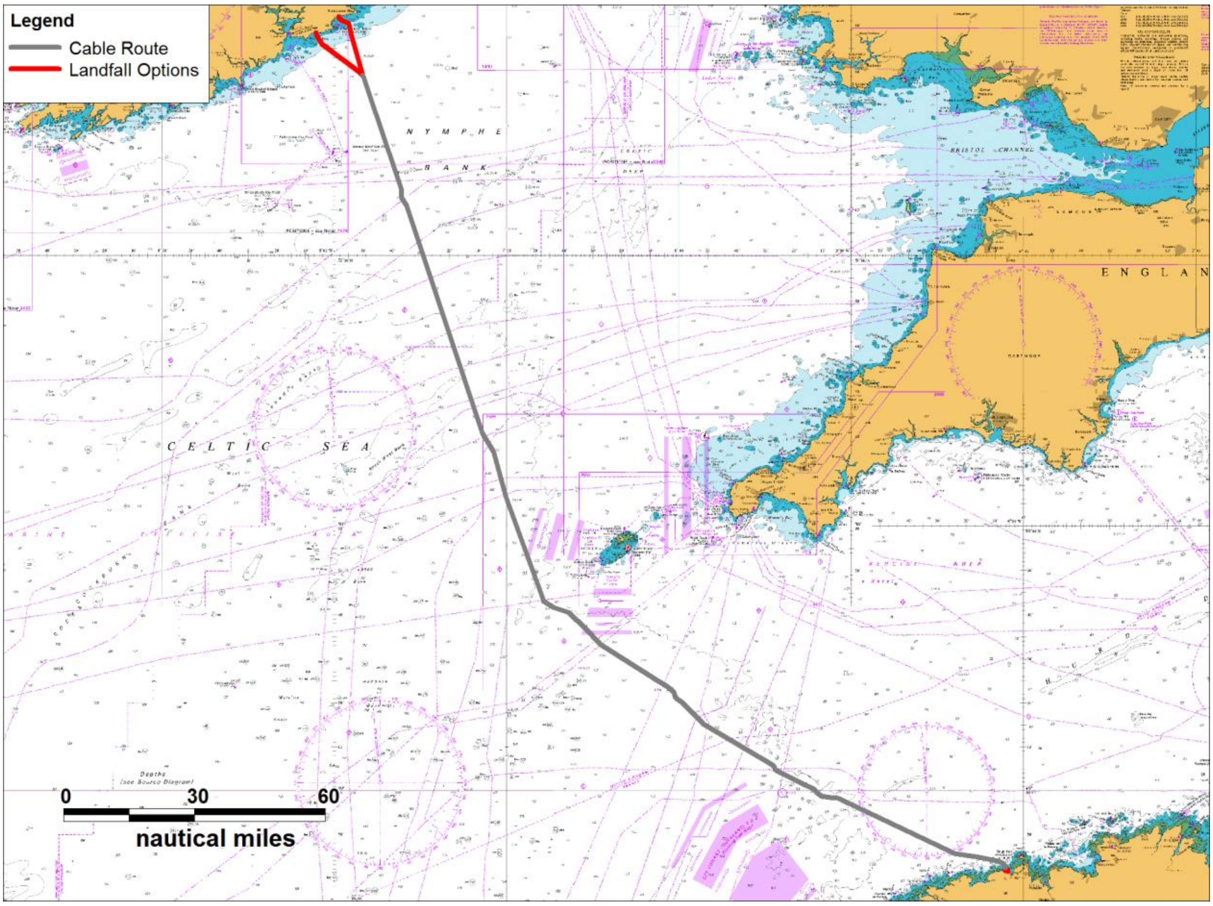

Figure 2.1 Proposed Cable Overview

At the time of writing there are three proposed landfall options at the French end of the cable route (Port Neuf, Kerradenec, and Moguériec), and two at the Irish end of the route (Ballycroneen and Ballinwilling Strand). The French and Irish landfall options are presented in Figure 2.2 and Figure 2.3 respectively. It is noted that this report considers two out of the three French landfall options; Port Neuf and Kerradenec. The third option landing at Moguériec has not been assessed, but is included in Figure 2.2 for reference.

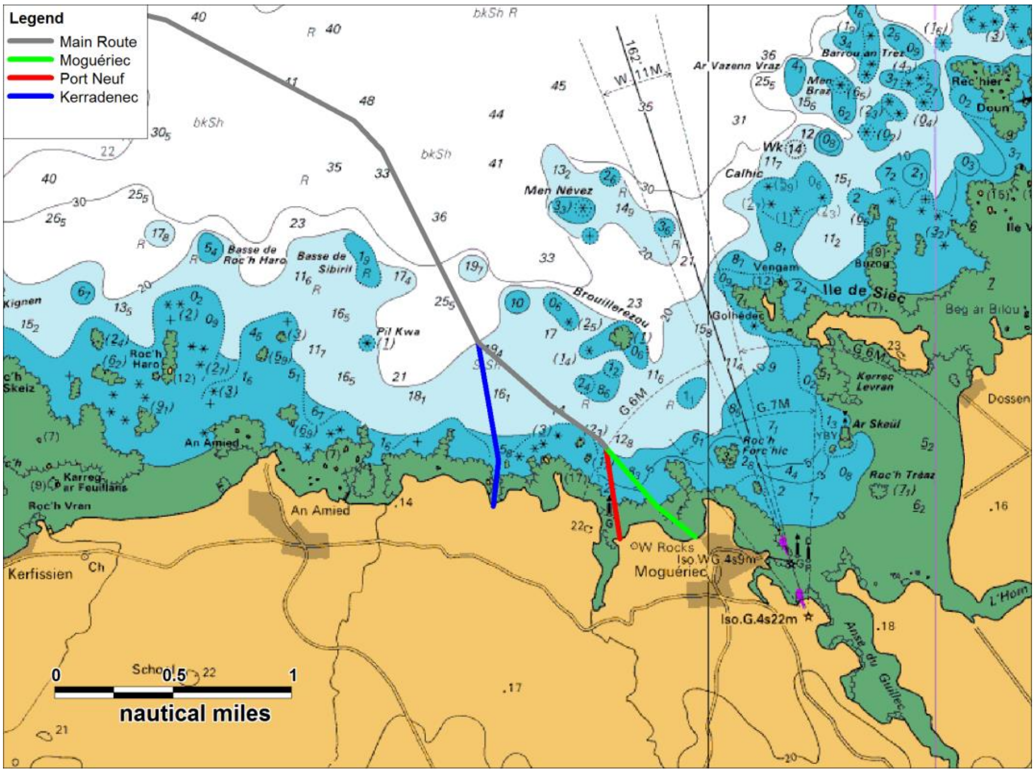

Figure 2.2 Landfall Options on France

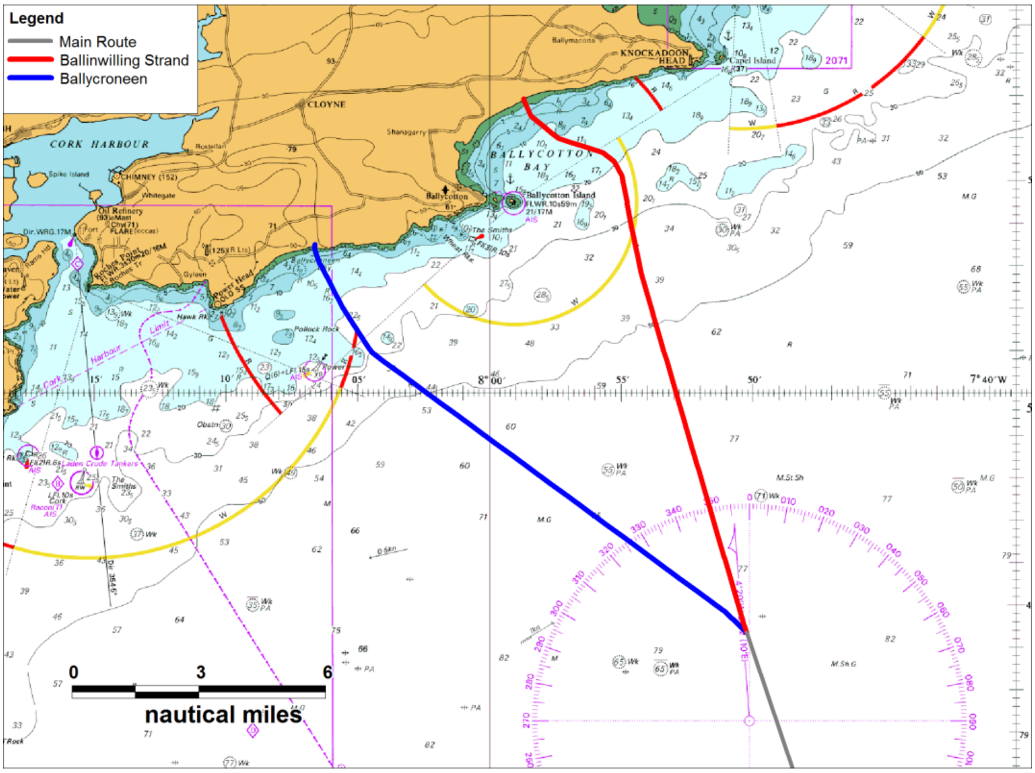

Figure 2.3 Landfall Options on Ireland

2.2 Study Area

The chosen study area consisted of a 5 nautical mile (nm) buffer of the proposed route extended to 10nm at the landfalls to ensure anchoring activity was comprehensively identified within the analysis. The area near the Isles of Scilly was also extended to include the Traffic Separation Schemes (TSS) east of the cable. The study area encompassing the proposed cable route is presented in Figure 2.4. It is noted that while the Moguériec French landfall option has not been assessed in this report, it is included in the study area.

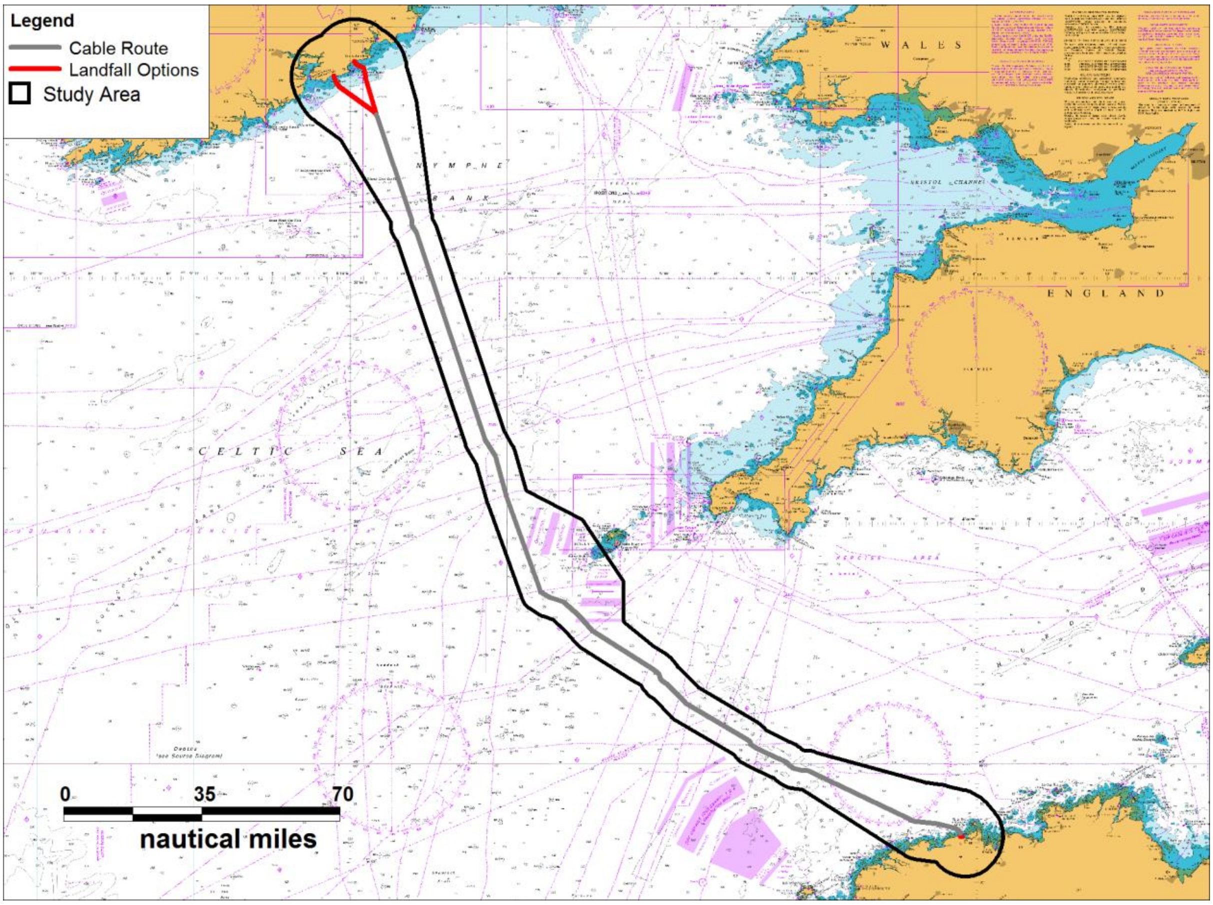

Figure 2.4 Cable Risk Assessment Study Area

3. Data Sources

3.1 Introduction

The shipping analysis has been based on 12 months of AIS data, collected via both satellite and terrestrial receivers. This section presents a description of AIS data, including its limitations.

3.2 Carriage Requirements

Regulation 19 of SOLAS Chapter V (carriage requirements for shipborne navigational systems and equipment) sets out the navigational equipment to be carried on board ships, according to ship type. In 2000, the International Maritime Organisation (IMO) adopted a new requirement (as part of a revised Chapter V) for ships to carry AIS. AIS is a system by which ships send data concerning their position and identity on two individual VHF channels to the shore and other vessels, at very frequent intervals. The data is transmitted automatically via VHF to other vessels and coastal stations/authorities.

The regulation requires AIS to be fitted aboard all ships of 300 gross tonnage (GT) and upwards engaged on international voyages, cargo ships of 500 GT and upwards not engaged on international voyages and passenger ships irrespective of size built on or after 1 July 2002. It also applies to ships engaged on international voyages constructed before 1 July 2002, according to the following timetable:

- Passenger ships, not later than 1 July 2003;
- Tankers, not later than the first survey for safety equipment on or after 1 July 2003; and
- Ships, other than passenger ships and tankers, of 50,000 GT and upwards, not later than 1 July 2004.

An amendment adopted by the Diplomatic Conference on Maritime Security in December 2002 states that ships, other than passenger ships and tankers, of 300 GT and upwards but less than 50,000 GT, will be required to fit AIS not later than the first safety equipment survey after 1 July 2004 or by 31 December 2004, whichever occurs earlier. Ships fitted with AIS shall maintain AIS in operation at all times except where international agreements, rules or standards provide for the protection of navigational information.

As of the 31st May 2014, all EU fishing vessels of length 15m and above are required to carry AIS equipment. Prior to this, from the 31st May 2013, all fishing vessels of length 18m and above were obliged to carry AIS.

A proportion of smaller fishing vessels and recreational craft carry AIS but this is voluntary and they may not broadcast continuously.

It should be taken into consideration when viewing the proceeding analysis that activity from smaller vessels is likely to be under-represented, particularly in the case of fishing and recreational vessels due to the carriage requirements described above. However, it can be assumed that the vessels that do transmit provide an indication of the overall activity and behaviour of these vessels. In addition, the main risk to the proposed cable is likely to be from larger vessels, carrying heavier anchors or fishing gear.

3.3 AIS Sources

The bulk of the following analysis has been based on a data set consisting of a total of 12 months of AIS data providing very good coverage of the area of interest, collected in two consecutive years, during the following periods:

- 1st April to 30th September 2014
- 1st May to 31st October 2015

This ensured the data was as up-to-date as possible, which is vital considering the dynamic nature of shipping and fishing activity, and that it spans different seasons. It is noted that spring, summer and autumn are covered, but winter months are not. A review of seasonal variations has been undertaken in Appendix A (Ref i), and summarised in Section 5.8, in which winter traffic is assessed within the study area using alternative data sources.

To help ensure comprehensive coverage of the area of interest, a combination of satellite and terrestrial (land-based) data has been used. The reporting interval between position reports for a given ship is typically a few seconds up to three minutes, depending on its speed and navigational status (less frequent for anchored and moored vessels). Increases in reporting interval (i.e., longer gaps between positions) were occasionally noted farther offshore (i.e. farther from the coastal AIS receivers), however, the majority of vessels in these areas were typically steaming on passage on steady courses, and therefore the less frequent average reporting interval will not significantly affect accuracy in these areas.

Additional terrestrial AIS data were available covering shorter time periods and / or discrete sections of the area of interest. These data have been used to validate the core (main) data set.

4. Navigational Features

This section identifies and describes the key navigational features in the vicinity of the proposed Celtic Interconnector cable route.

4.1 Ports

The Irish, UK, and French ports in the vicinity of the proposed cable are presented in Figure 4.1, Figure 4.2, and Figure 4.3 respectively.

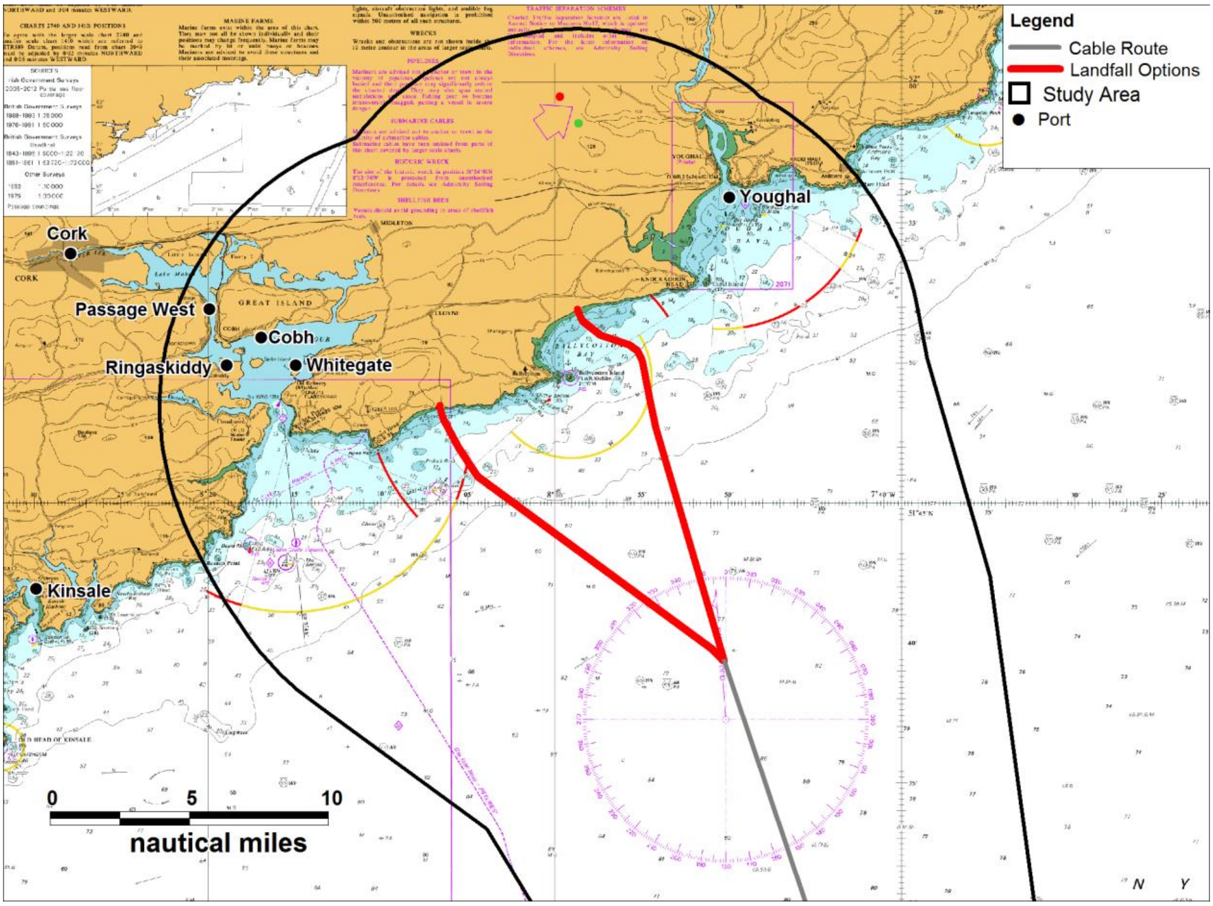

Figure 4.1 Ireland Ports

The most significant Irish port near the route is Cork, with limits encompassing Cobh, Passage West, Ringaskiddy and Whitegate. It is a deep water harbour and can accommodate both large commercial and passenger vessels. The harbour entrance lies 5.7nm to the west of the western route landfall point. Kinsale is a smaller commercial port, located 15nm west of the western route landfall. Youghal harbour is located approximately 6nm to the north east of the eastern route landfall point, and is mainly used by small fishing and recreational vessels.

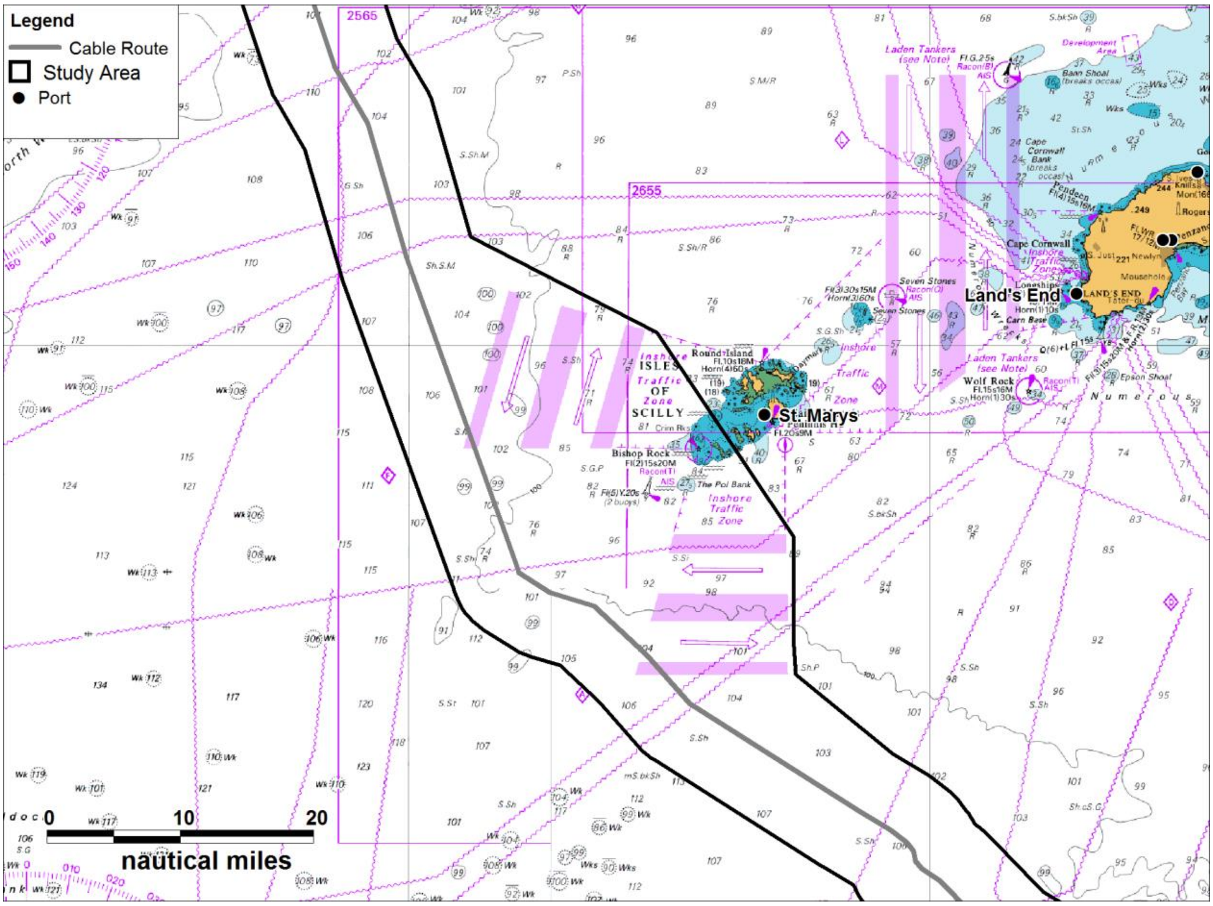

Figure 4.2 UK Ports

The nearest UK port to the route is St. Mary's, on the Isles of Scilly, approximately 18nm from the route. The port caters for yachts, fishing vessels, and passenger vessels. The nearest mainland port is located at Land's End, more than 40nm from the route.

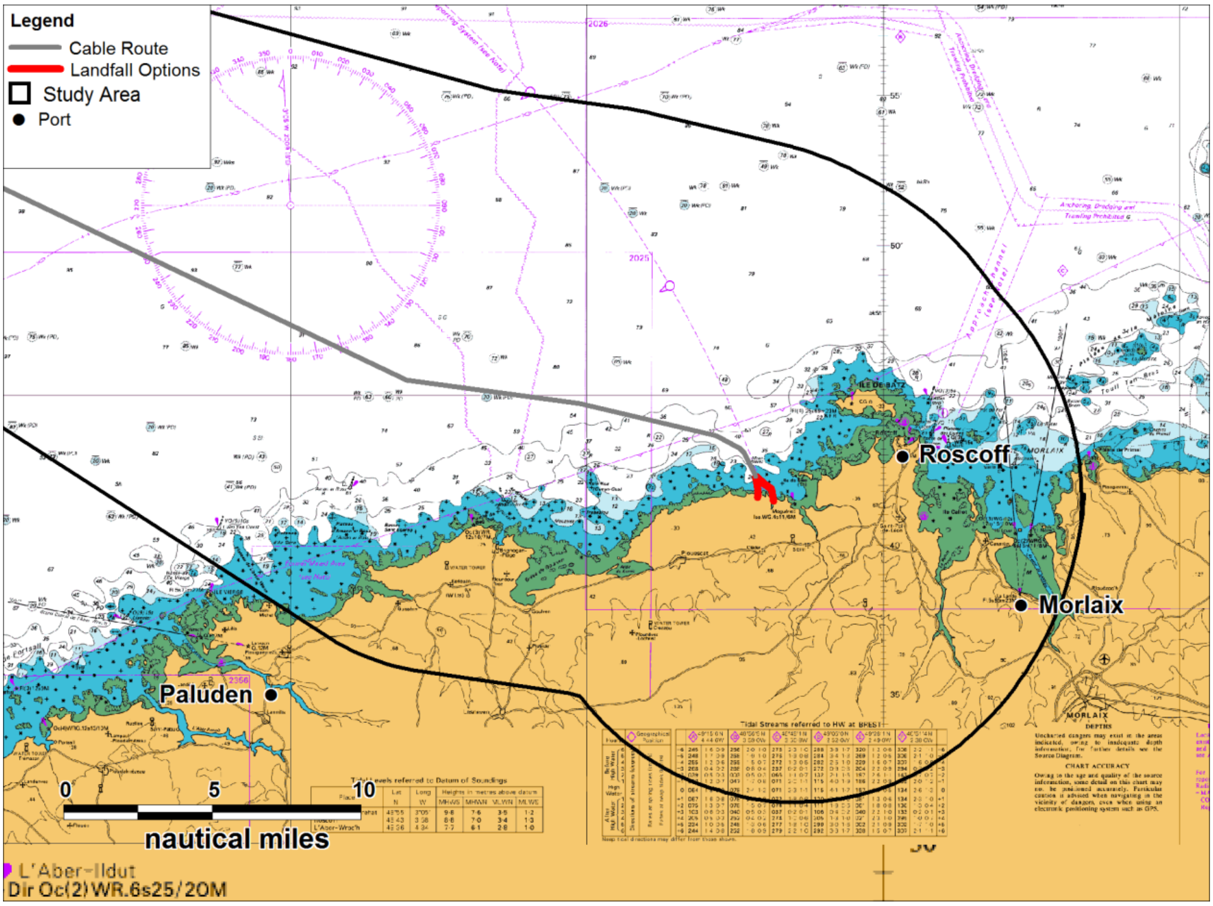

Figure 4.3 French Ports

The port of Roscoff is located 4.6nm to the east of the proposed French landfalls. Equipped with a deep water marina (625 berths), Roscoff also runs ferry services to Cork, and to Plymouth. The port of Morlaix is situated approximately 9nm from the route landfall, and offers 200 berths for vessels with draughts of up to 3m. The small town port of Paluden lies 17nm west of the landfall, outwith the study area.

4.2 Routeing Measures

The IMO routeing measures in place in the vicinity of the proposed cable route are presented in Figure 4.4.

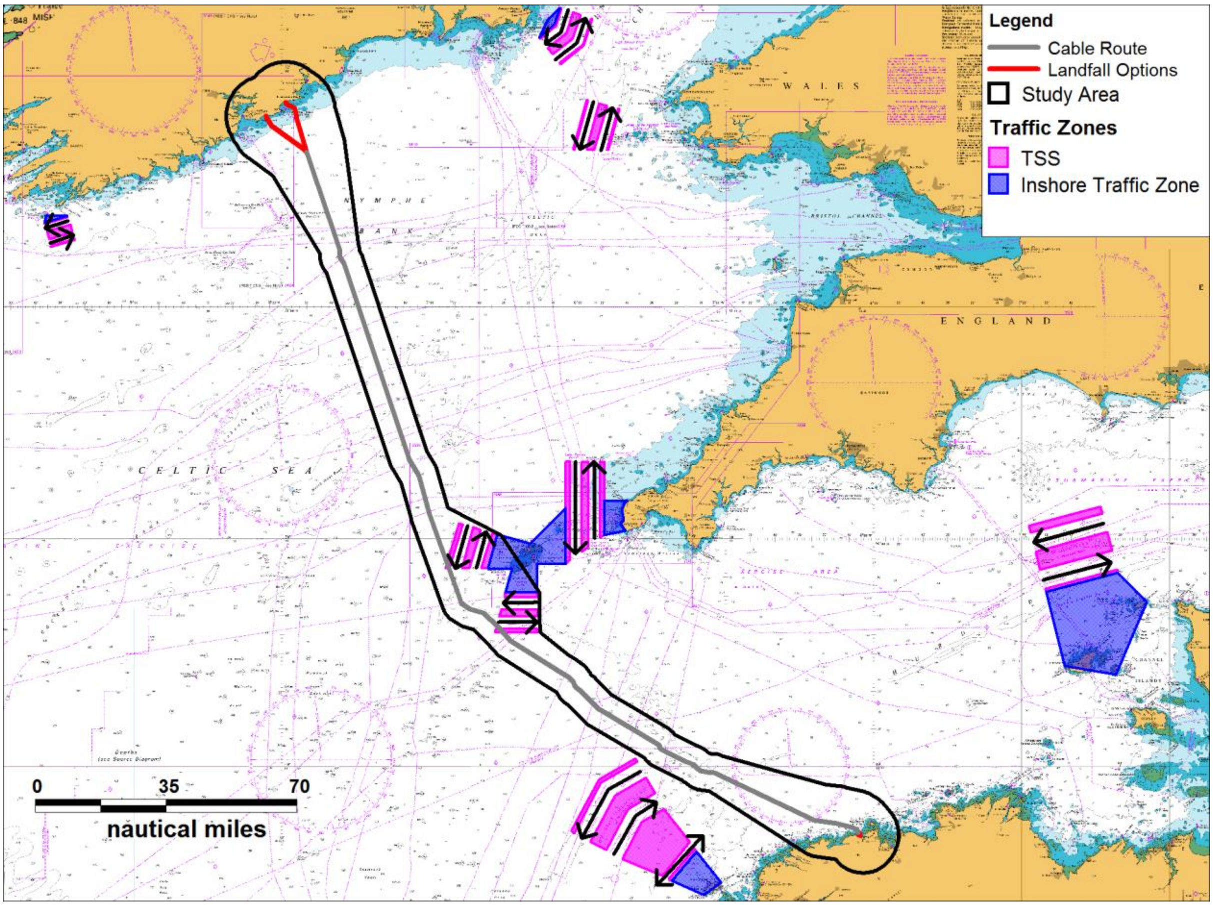

Figure 4.4 IMO Routeing Measures

Traffic Separation Schemes (TSS) are used to separate traffic travelling in opposite directions in busy (or sensitive) areas of shipping. Inshore traffic zones are multi directional, and generally for use by smaller vessels. The West of the Scilly Isles TSS and the South of the Scilly Isles TSS, as well as part of the inshore traffic zones of both, lie within the study area. Traffic lanes associated with other nearby TSS also intersect the route.

4.3 Anchorages

The anchorages identified in the vicinity of the Irish route landfalls are presented in Figure 4.5. Details of the anchorages have been taken from the Pilot Book for the area (Ref ii). Inland anchorages have not been included as they are not relevant to the route.

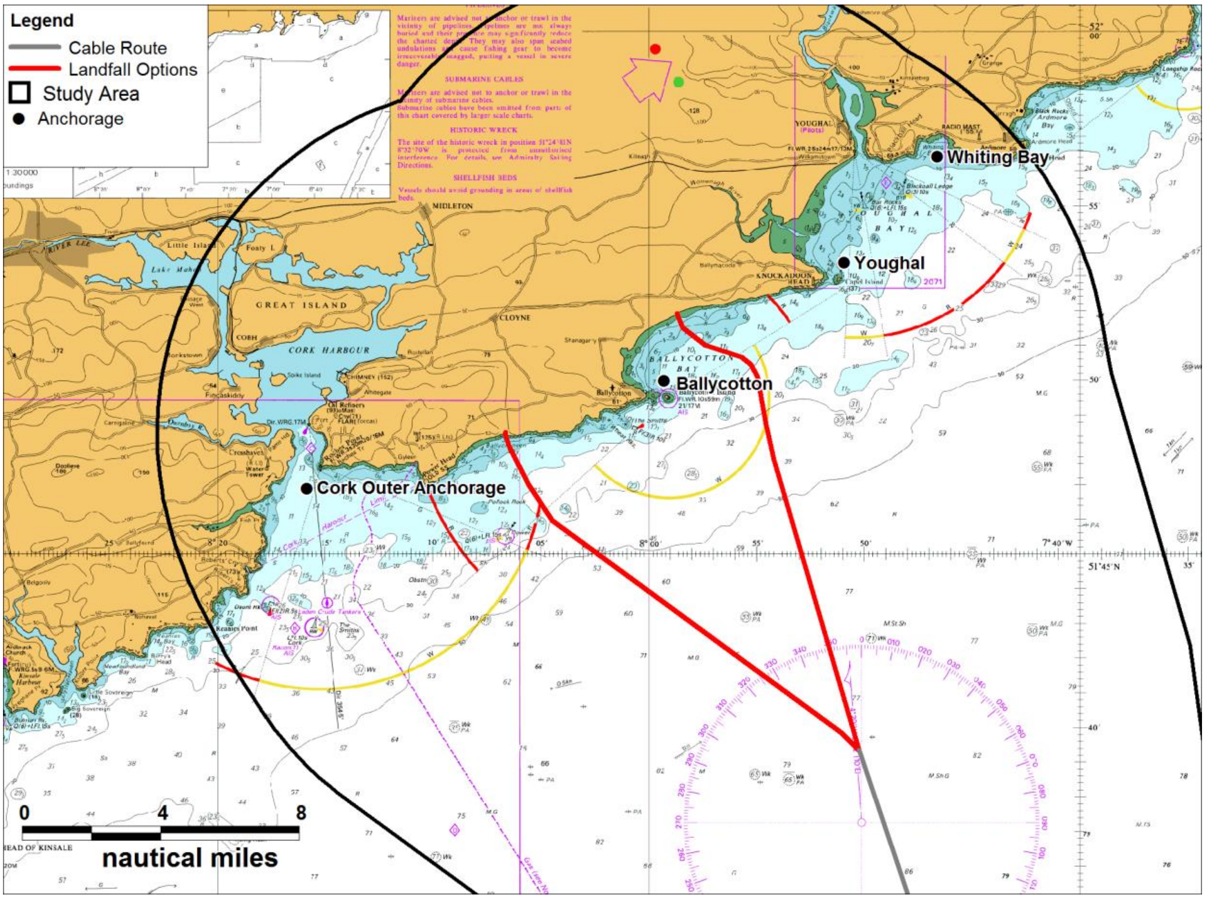

Figure 4.5 Ireland Anchorages

The nearest anchorage in Irish waters to the route is the Ballycotton anchorage, located approximately 1.6nm to the south-west of the proposed eastern landfall option. Anchoring is available here in depths of 13m, where the seabed is composed of sand over mud and clay. Youghal Bay, located 3.7nm to the north east of the proposed eastern landfall option, offers temporary anchorage suitable only in moderate weather. Whiting Bay, located 8nm to the northeast of the proposed eastern landfall option also offers anchorage, however use should be avoided in adverse weather conditions. The Cork outer anchorage, 6nm to the west of the proposed western landfall option, is recommended for temporary use only in depths of 17 to 18m over sand.

Within UK waters, the Isles of Scilly offer various anchorages, the nearest being approximately 20nm to the east of the route, outwith the study area.

The Channel Pilot Book (Ref iii) states that there are no anchorages or harbours suitable for large vessels on the French coast between Le Four and Les Héaux-de-Bréhat, which covers the coastal boundaries of the study area. The Pilot Book also states that small crafts and yachts can find shelter in many of the small coastal ports or creeks, however local knowledge may be required. A review of Admiralty Charts showed the nearest charted anchorage to be approximately 8nm from the route landfalls, within the Baie de Morlaix, as presented in Figure 4.6. It is noted that any vessels anchored here are extremely unlikely to interact with the route due to land in between the anchorage and the route.

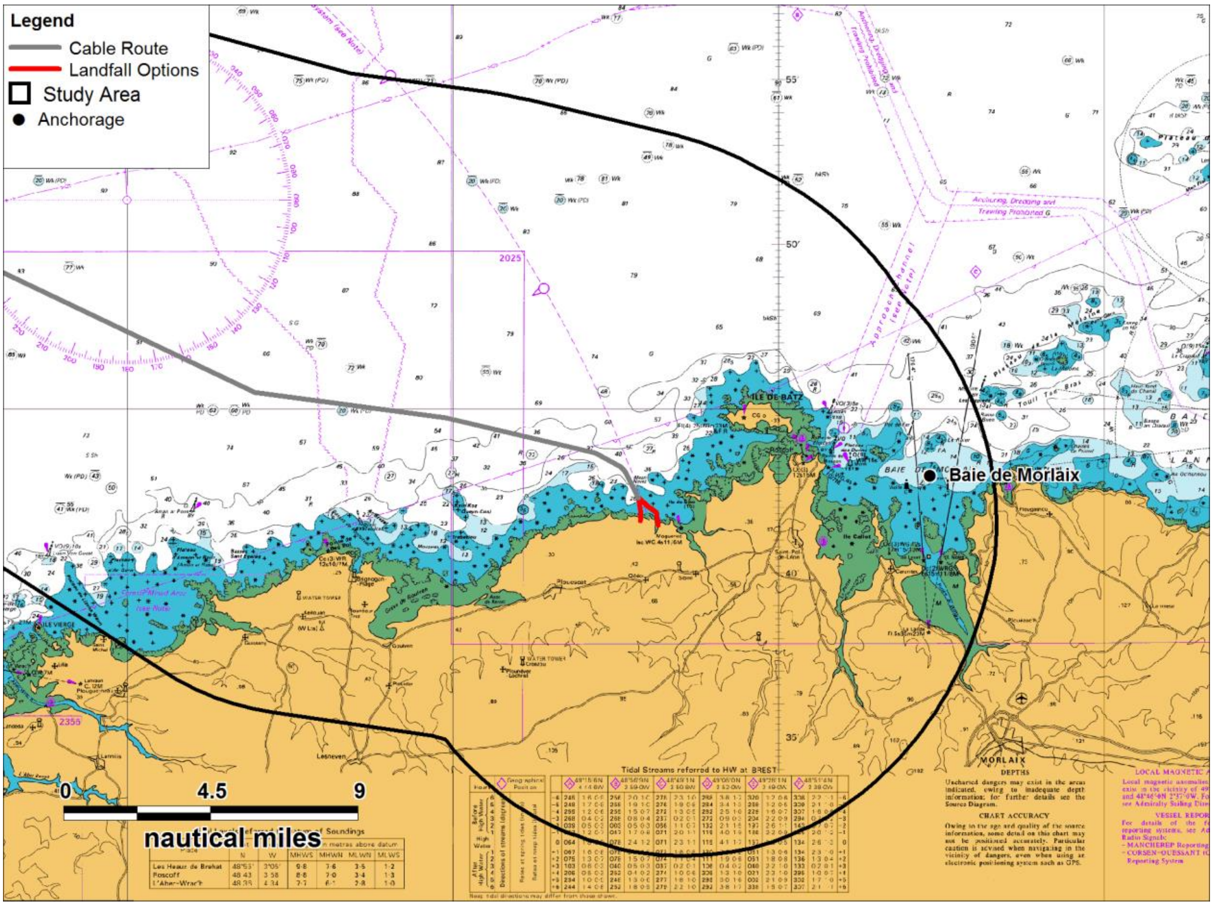

Figure 4.6 Roscoff Anchorage

4.4 Offshore Renewable Energy Developments

The location of the renewable energy developments in the vicinity of the proposed Celtic Interconnector are presented in Figure 4.7. It is noted that the locations presented represent the approximate centre point of the sites rather than their full extents.

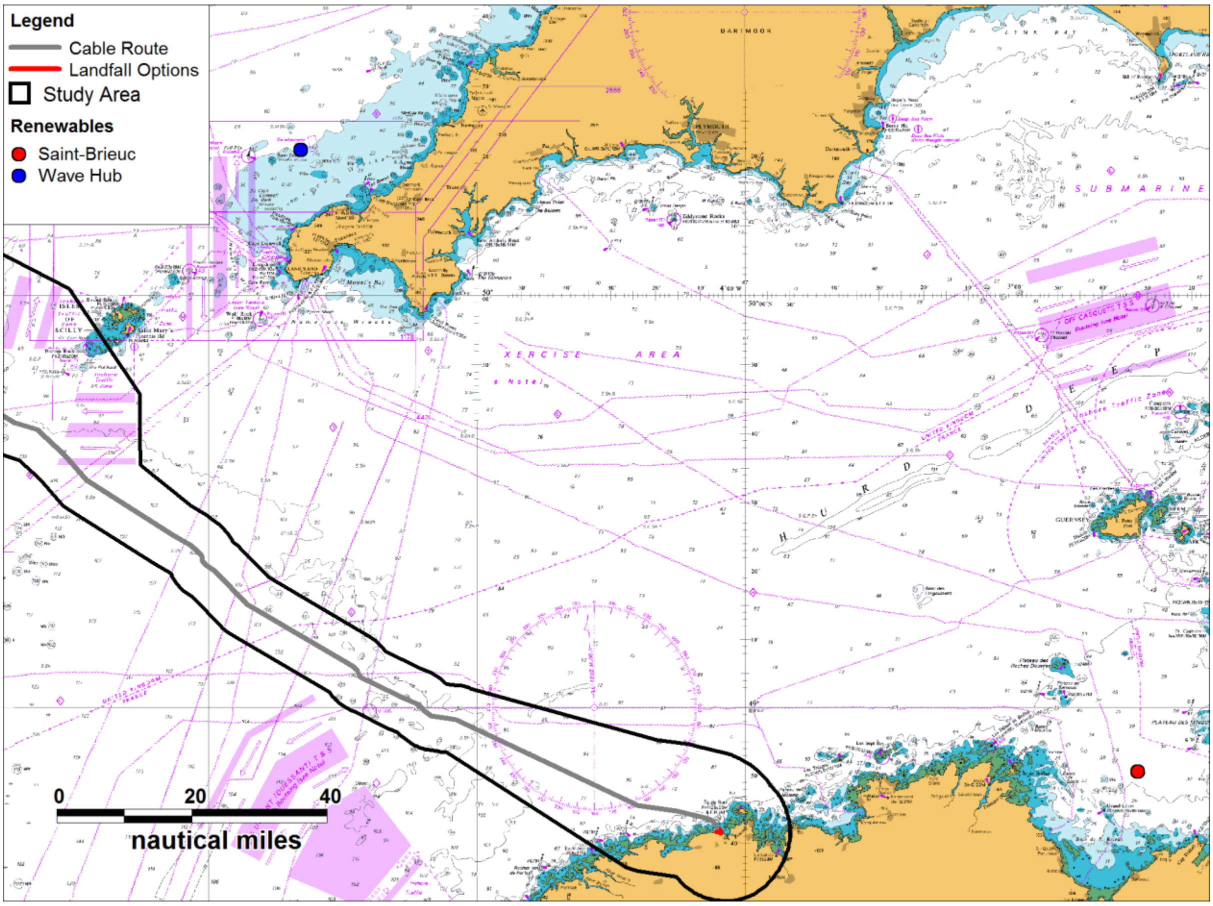

Figure 4.7 Renewable Energy Sites in the vicinity of the proposed Celtic Interconnector

Wave Hub is a fully commissioned demonstrator site, with four berths for testing and developing wave technology. The site is located approximately 55nm to the north east of the route at its closest point. The Saint-Brieuc wind farm is located approximately 60nm to the east of the French landfall, and is in the consenting process. The proposed site covers an area of 102km^2 and can house up to 62 turbines.

4.5 Oil and Gas

The oil and gas infrastructure in the vicinity of the proposed Celtic Interconnector is presented in Figure 4.8.

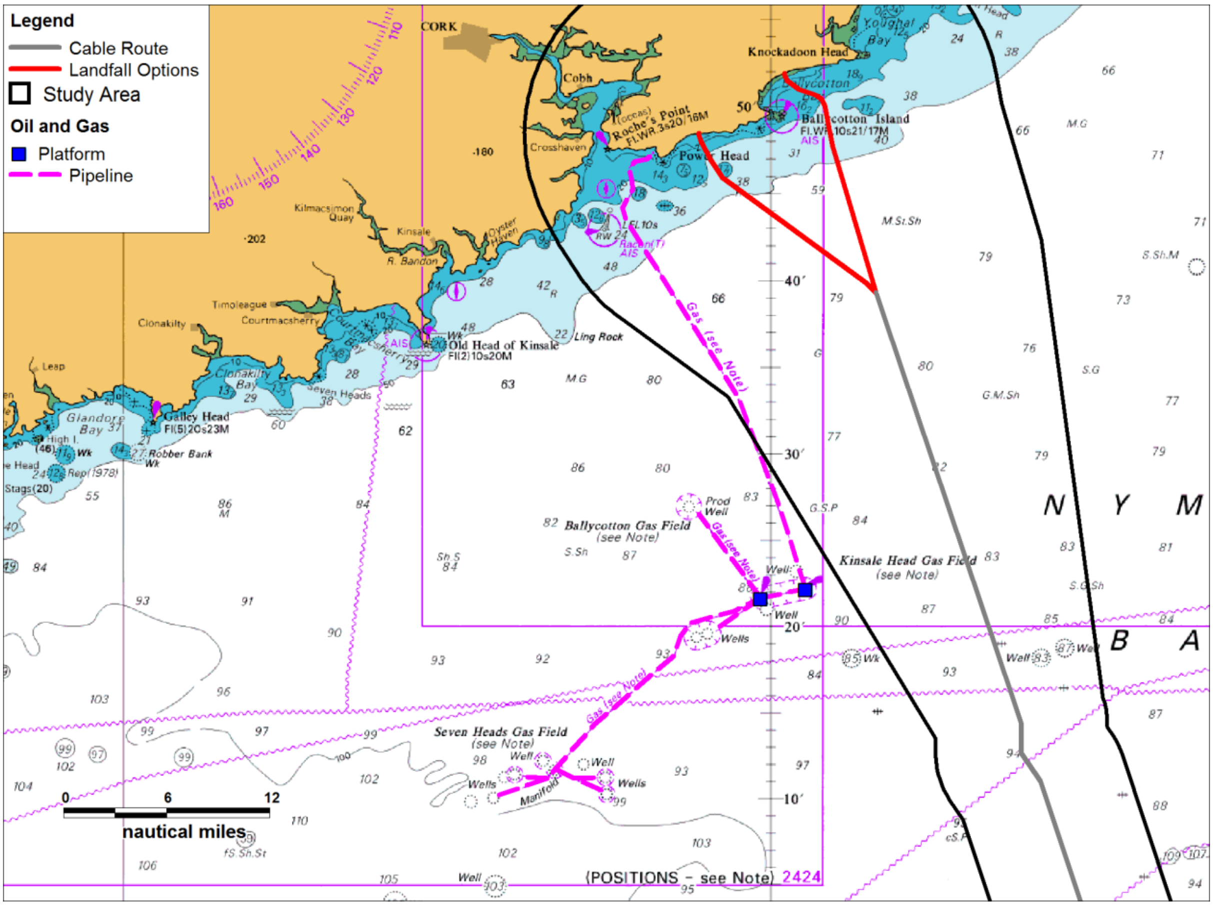

Figure 4.8 Oil and Gas Infrastructure in the vicinity of the proposed Celtic Interconnector

There are two platforms installed at the Kinsale Gas Field, with the easternmost located approximately 9nm west of the route. Subsea pipelines connect the wells at the Ballycotton Field (14nm from proposed route) and the Seven Heads Field (23nm from the proposed cable route) to the Kinsale platforms. A pipeline then connects the platforms to the shore east of the entrance to Cork harbour, at a point approximately 2.7nm west of the proposed western cable landfall point.

No oil and gas infrastructure was identified near the proposed cable route in UK or French waters.

4.6 Military Practice Areas

The UK Ministry of Defence (MOD) practice and exercise areas are presented in Figure 4.9.

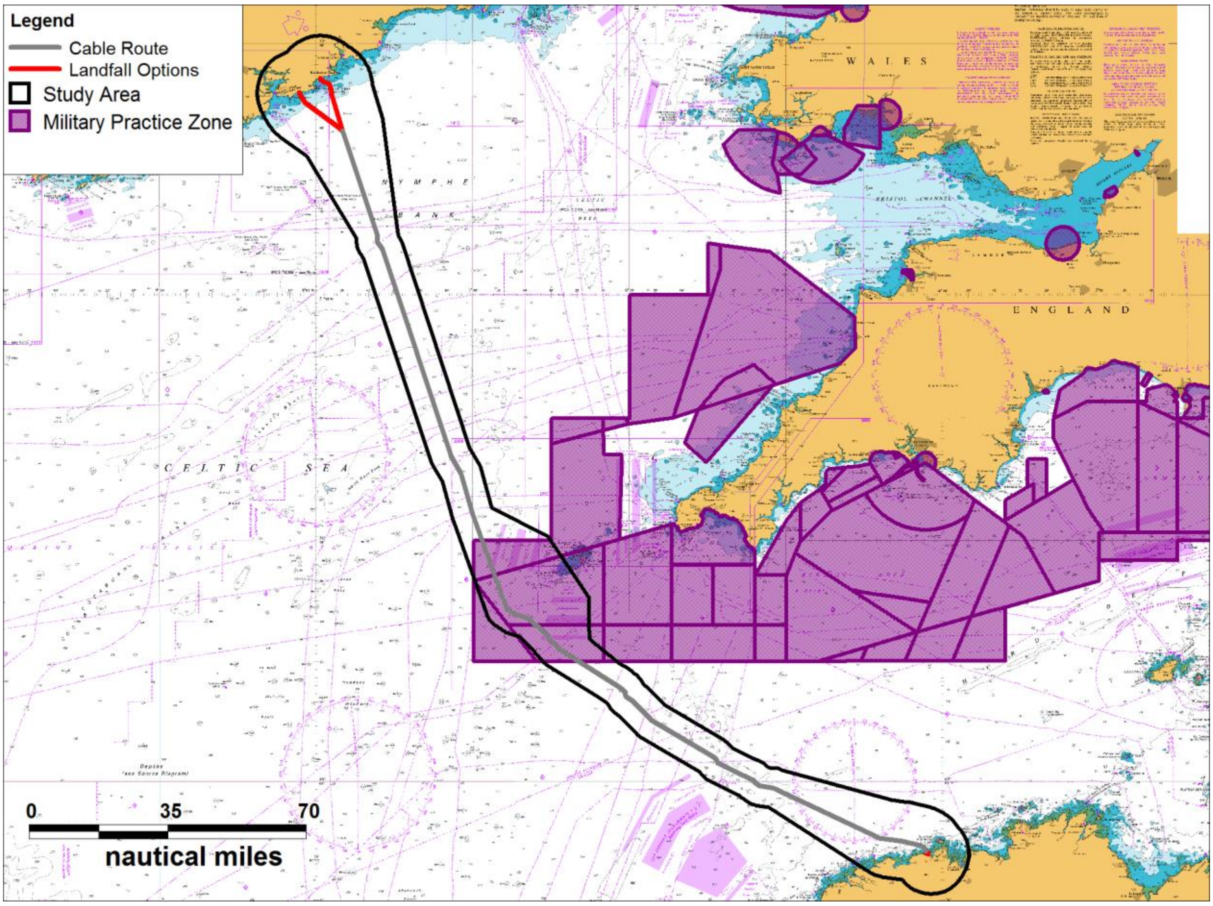

Figure 4.9 Military Practice Zones (UK MOD)

The zones intersecting the route detail their activities as submarine and aircraft practice areas.

Precise military practice and exercise areas were not available outside of UK waters, however the Irish Coast Pilot Book (Ref ii) states that submarine exercises occur in the southern part of the Celtic Sea, to the west of the route.

4.7 Other Cables

Admiralty Charts were used to identify and map the subsea cables intersecting the study area. Survey results provided by RTE and EirGrid were used to identify cables which were in-service at the time of writing. The identified cables are presented in Figure 4.10. (Note: This only depicts cables which intersect the proposed Celtic Interconnector; not all cables within the charted area are shown. Uncharted out-of-service cables have not been included.)

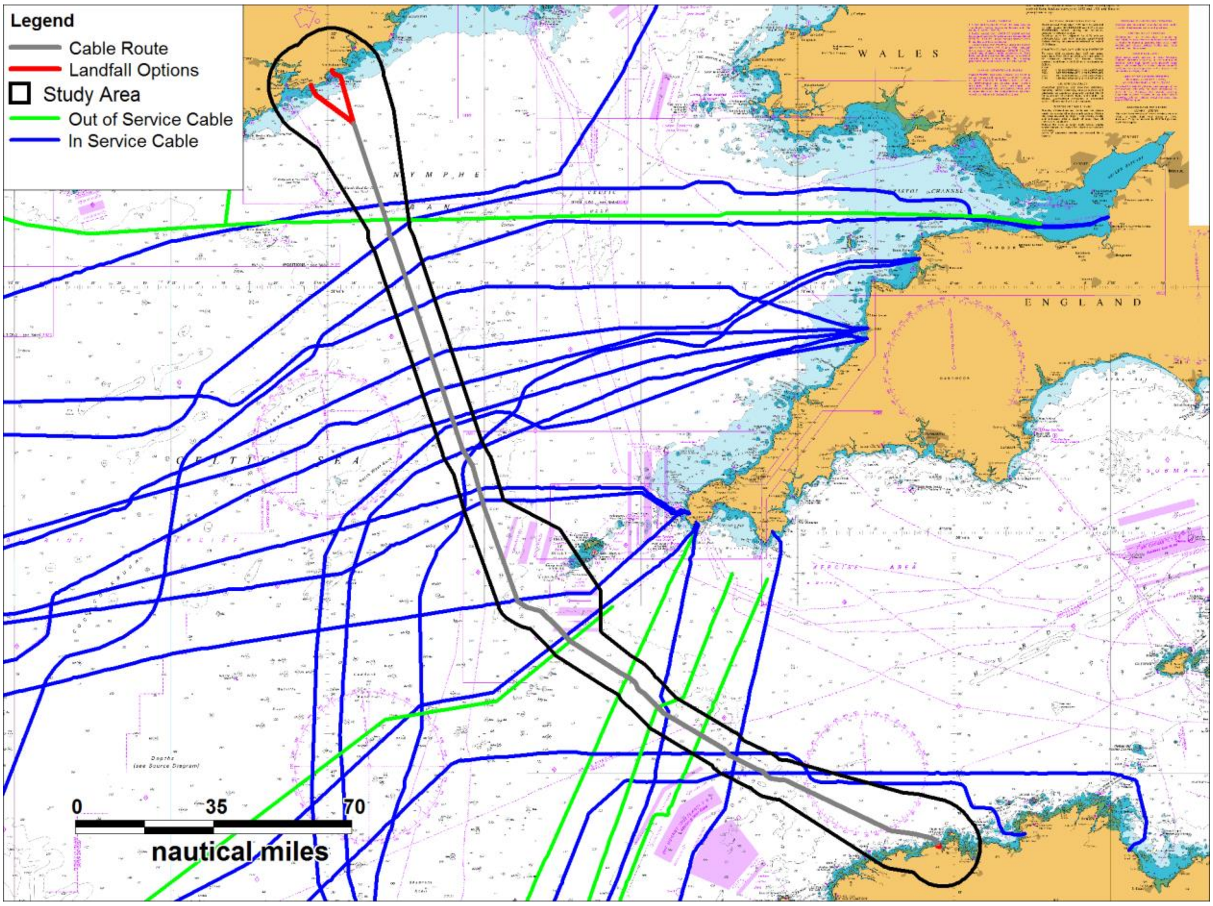

Figure 4.10 Subsea Cabling intersecting Study Area

A total of 18 in-service subsea cables crossed the proposed Celtic Interconnector route, the majority of which were telecoms cables between the UK and other worldwide destinations.

5. Shipping Analysis

5.1 Introduction

This section presents analysis of the AIS shipping data. Assessments of vessel numbers, types, sizes, and densities are provided below. As discussed in Section 3 an AIS data set consisting of 12 months of AIS data collected via both satellite and terrestrial receivers was considered to provide consistent and up-to-date coverage of the study area.

In order to validate the AIS data used in the shipping analysis, additional AIS data collected via terrestrial receivers covering discrete sections of the study area have been used for comparison. The full validation assessment is available in Appendix A (Ref i), and a summary is provided in Section 5.8.

5.2 Vessel Numbers

The monthly vessel counts recorded in the AIS data (based on unique vessels per day) are presented in Figure 5.3. (Note, October 2014 and April 2015 are outside the study period.)

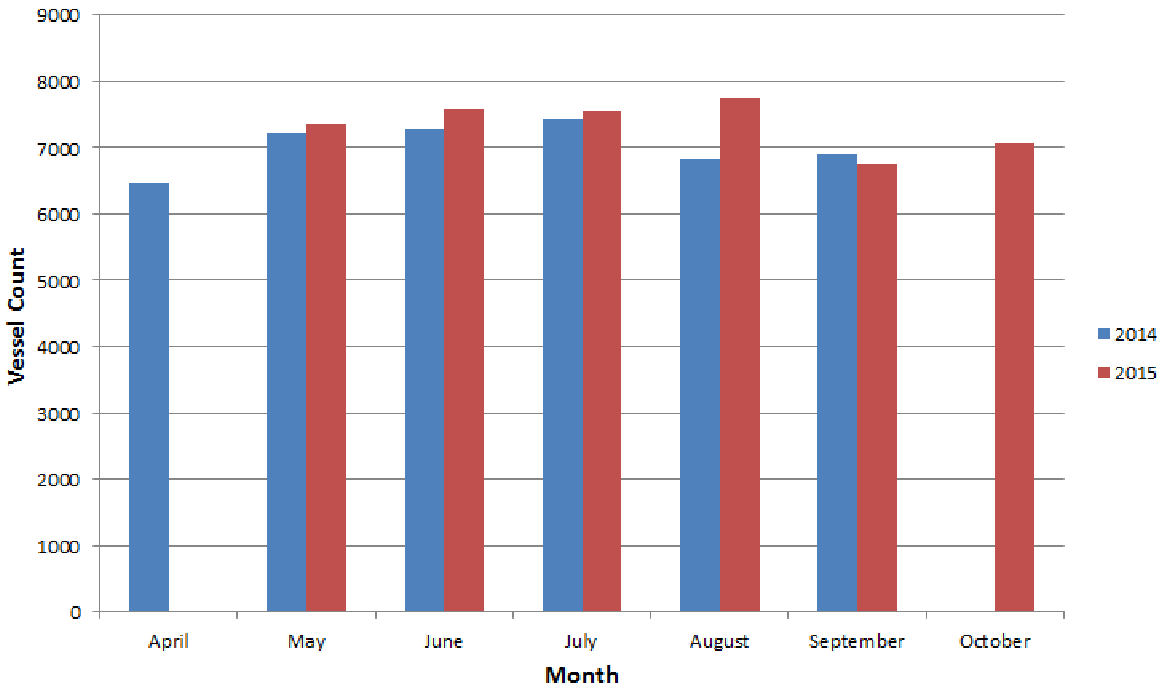

Figure 5.1 AIS Data Monthly Counts

An average of 243 unique vessels were recorded per day within the study area. The busiest day was the 20th August 2015, when 422 vessels were recorded within the study area. The tracks recorded on this day are presented in Figure 5.2.

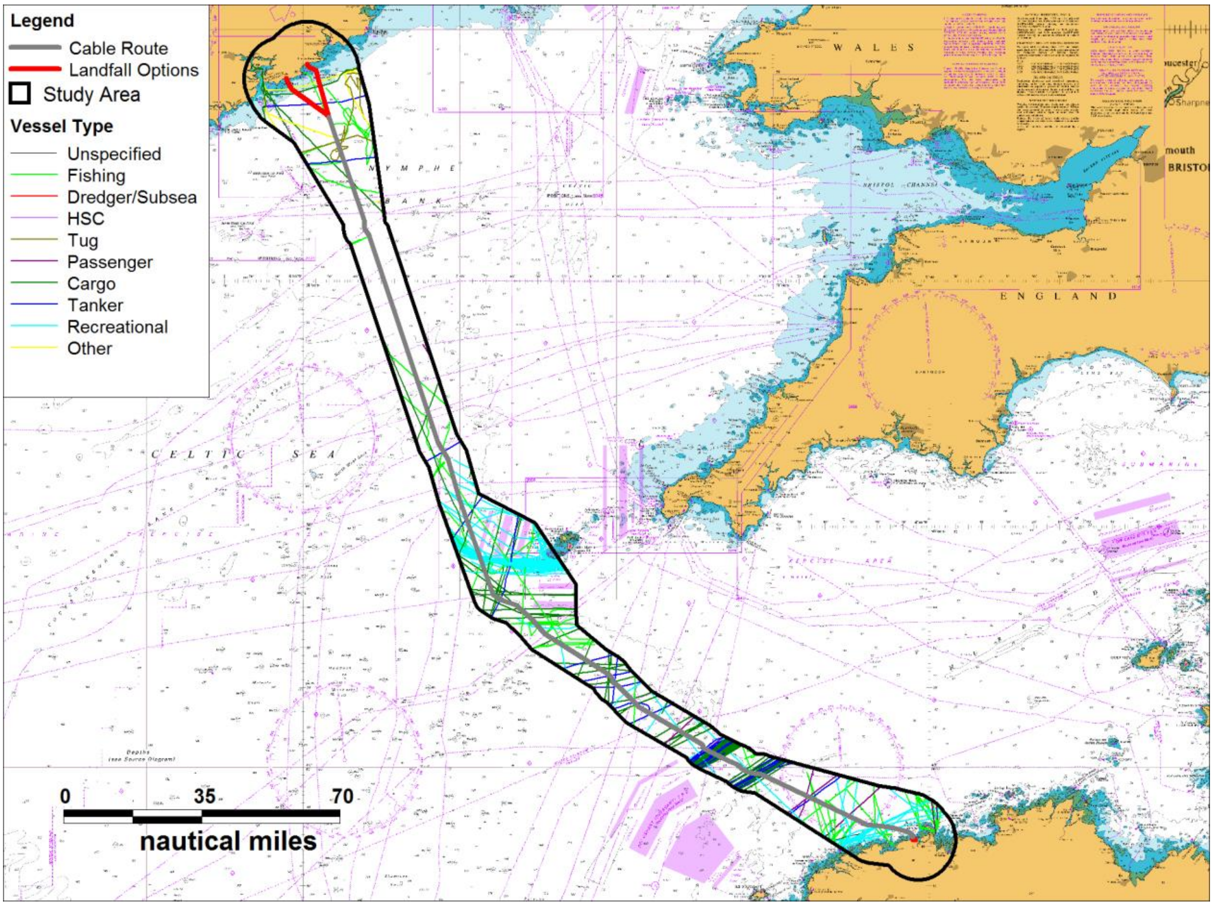

Figure 5.2 Busiest Day – 20th August 2015

5.2.1 Vessel Types

The AIS data colour-coded by vessel type is presented in Figure 5.3.

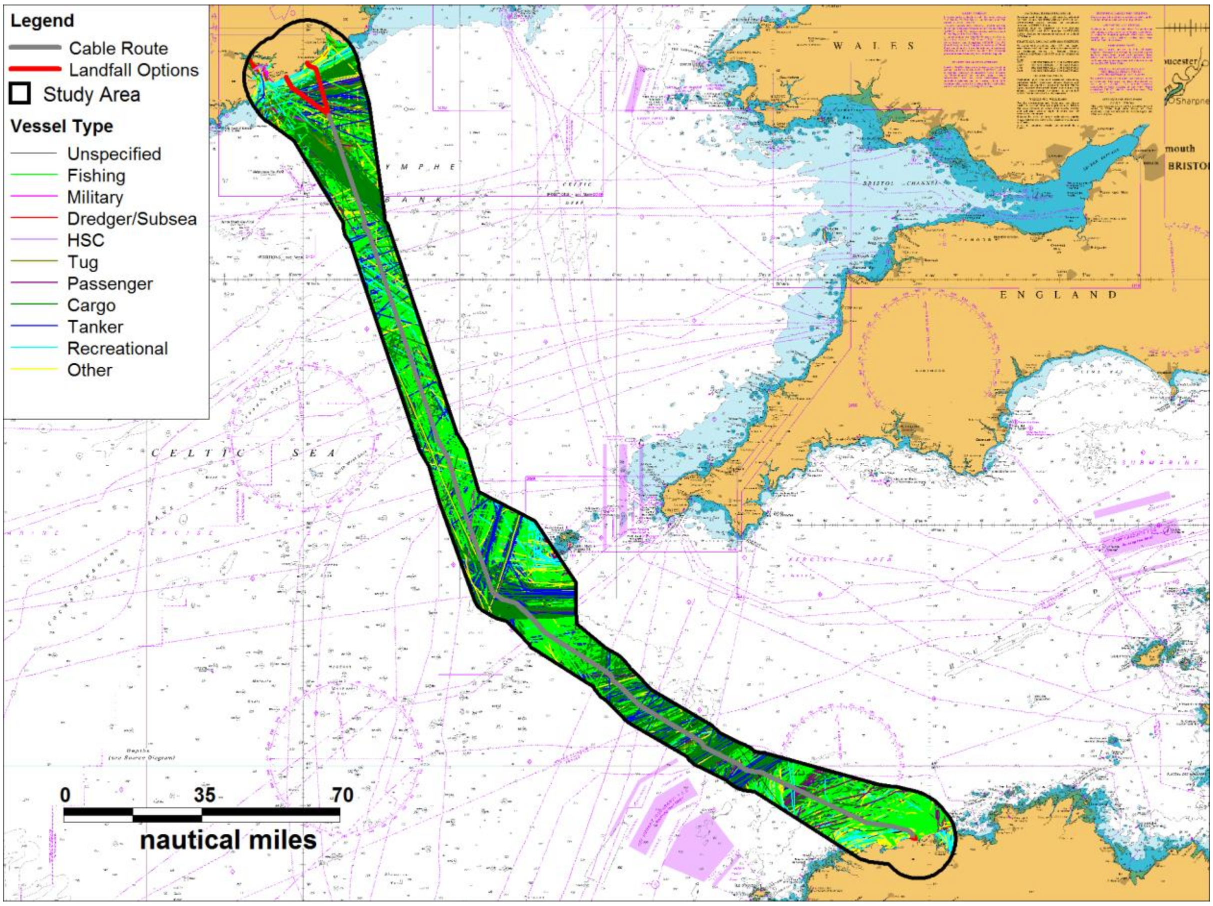

Figure 5.3 AIS Data by Vessel Type

Commercial (tanker and cargo) activity was observed using the shipping routes associated with the Isles of Scilly TSS, and the other TSS within the English Channel either side of the study area. Significant commercial activity associated with the Port of Cork was also noted within the data. Fishing activity was present throughout the study area, a detailed analysis of which is available in Section 7. Zoomed in plots of the AIS data by vessel type are presented in Figure 5.4, Figure 5.5, and Figure 5.6.

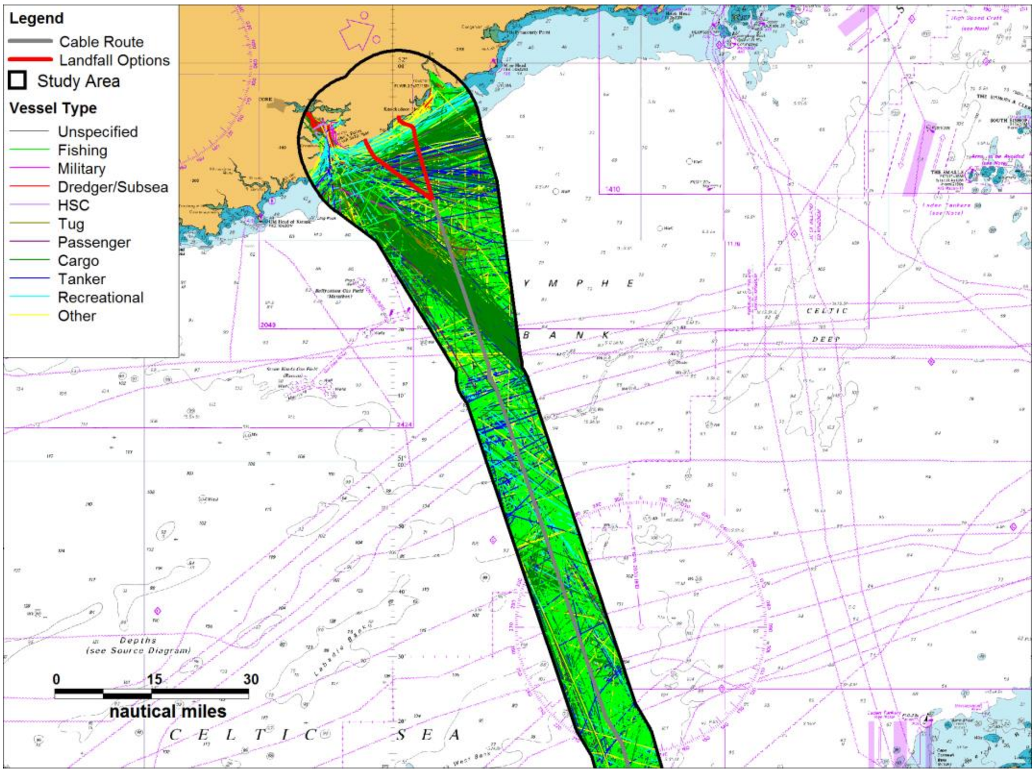

Figure 5.4 AIS Data by Vessel Type – Ireland

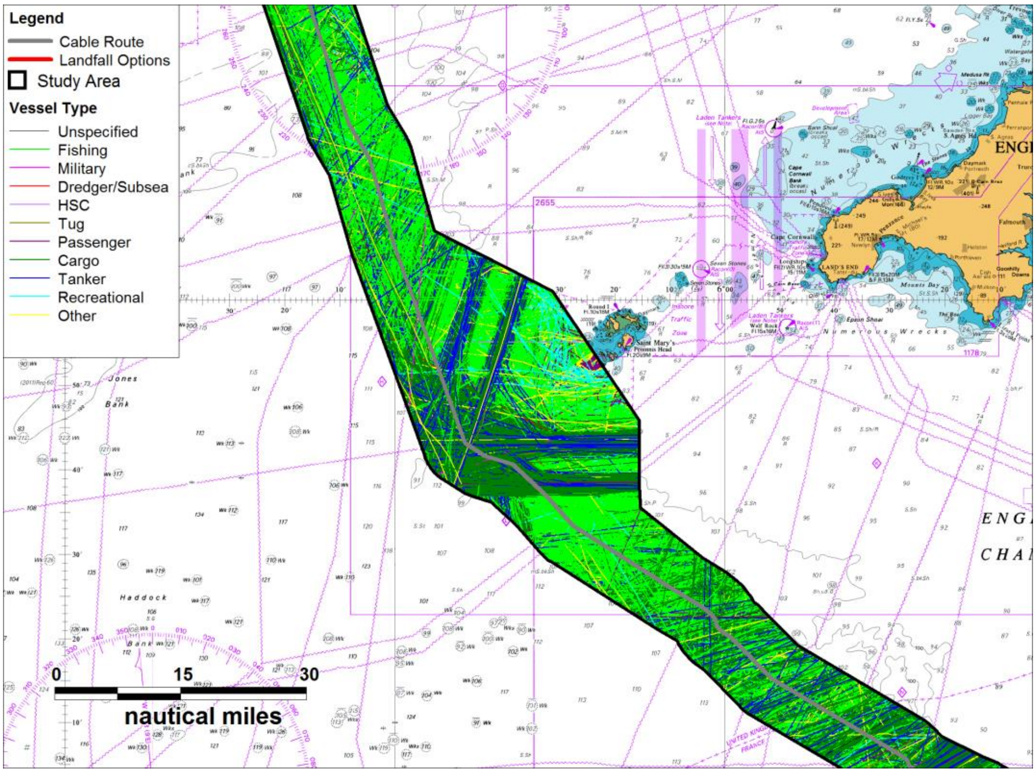

Figure 5.5 AIS Data by Vessel Type – UK

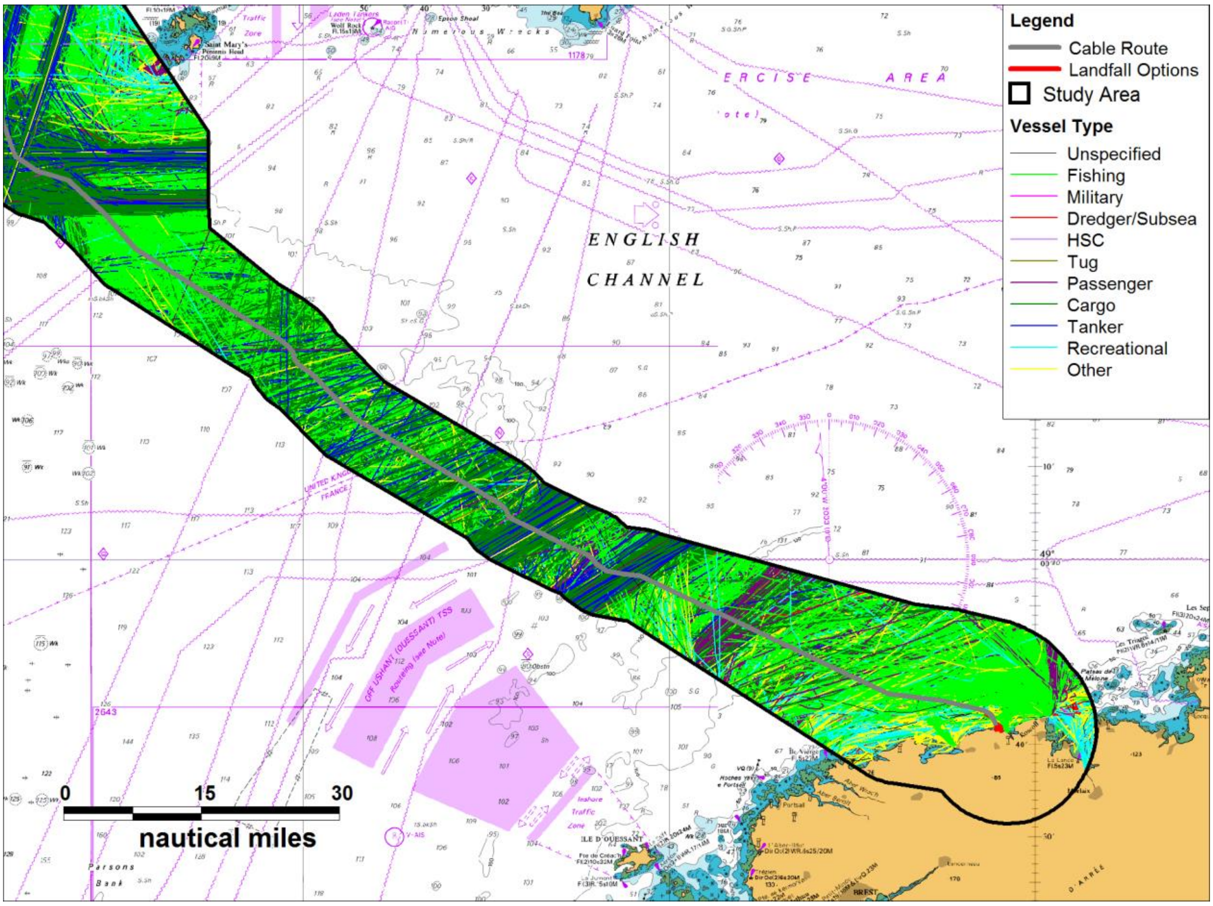

Figure 5.6 AIS Data by Vessel Type – France

The distribution of vessel types within the AIS data is presented in Figure 5.7.

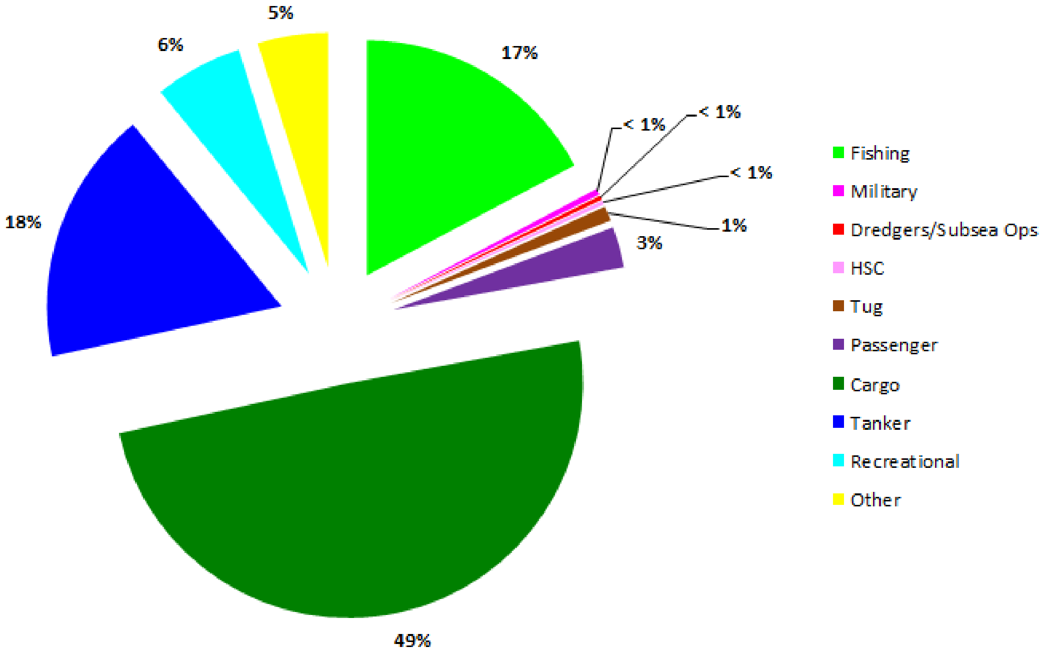

Figure 5.7 AIS Vessel Type Distribution

The majority of vessels within the study area were commercial (49% cargo vessels and 18% tankers). These vessels were observed using the shipping routes associated with the English Channel, and the Scilly Isles TSS (see Section 4.2), and on passage between Ireland (Cork) and the UK. Approximately 17% were fishing vessels. A detailed fishing analysis is presented in Section 7. Recreational vessels accounted for 6%, and "Other" vessels (mainly pilot vessels) accounted for 5%.

5.3 Vessel Sizes

The AIS data colour-coded by vessel length is presented in Figure 5.8.

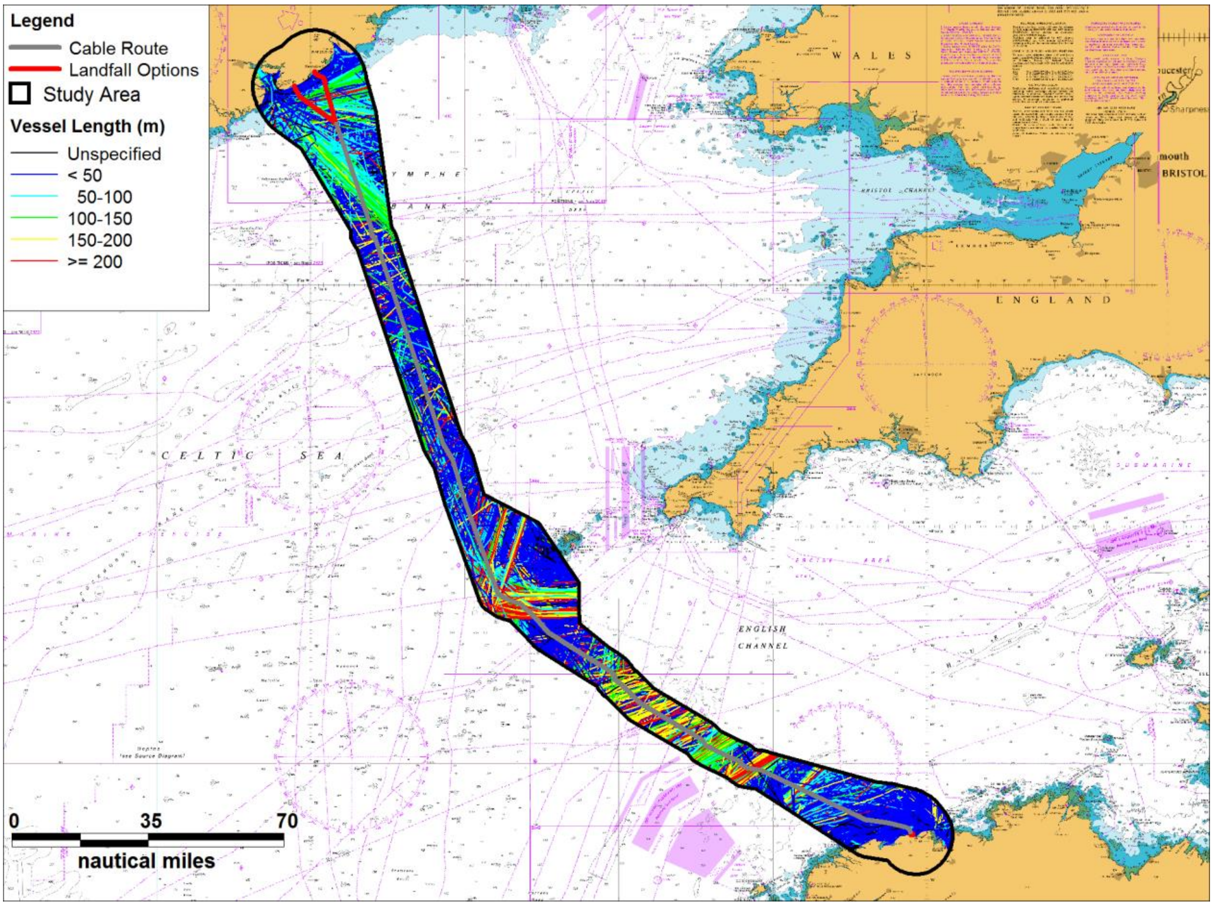

Figure 5.8 AIS Data by Vessel Length

Larger vessels were observed using the lanes associated with the TSS in the study area, and on passage to and from Cork. Smaller vessels (<50m) dominated the other sections of the study area.

Figure 5.9 presents the distribution of vessel lengths within the study area, excluding 3% of vessels that did not broadcast length information.

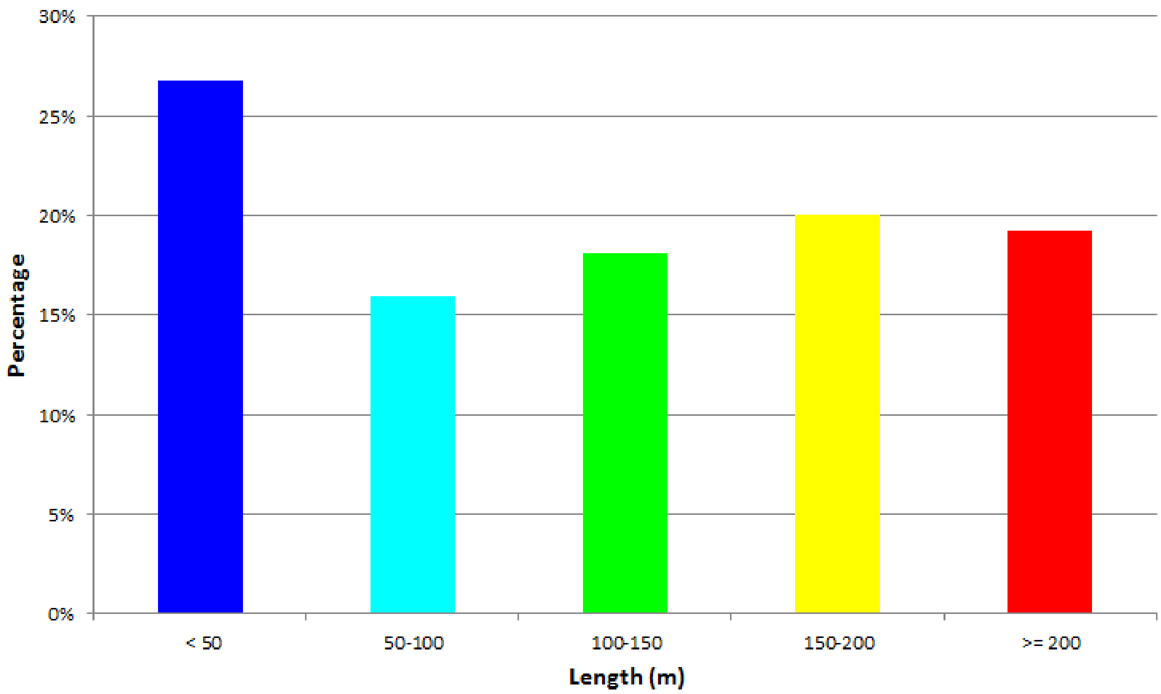

Figure 5.9 AIS Vessel Length Distribution

Approximately 27% of vessels were less than 50m in length. These smaller vessels were mainly fishing and recreational vessels. Vessels greater than 200m in length accounted for 19%. The average length recorded within the data was 131m, and the greatest length recorded was 400m, from seven container vessels utilising the traffic lanes within the English Channel.

The AIS data colour-coded by vessel draught is presented in Figure 5.10.

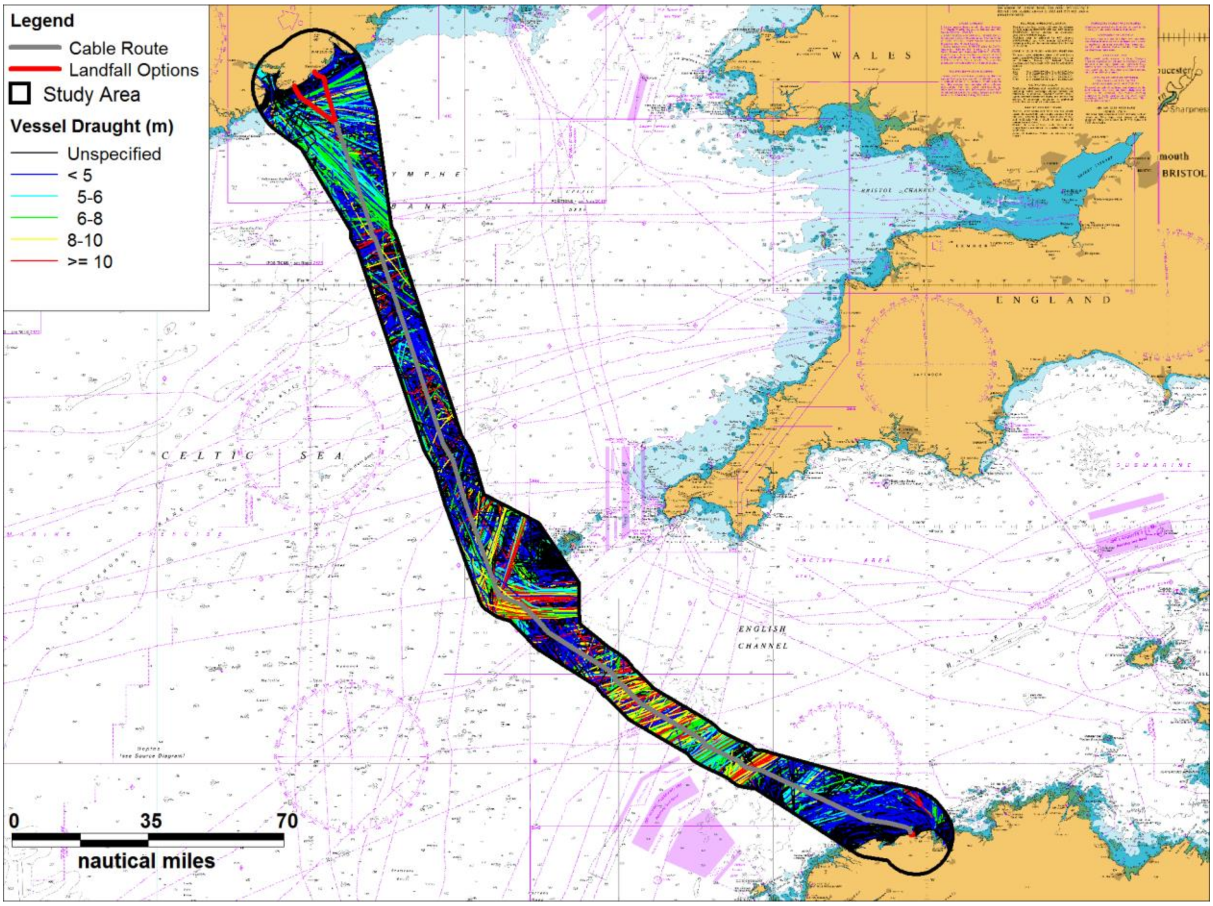

Figure 5.10 AIS Data by Vessel Draught

The areas used by vessels with the deepest draughts corresponded to areas where there were vessels over 200m in length.

Figure 5.11 presents the distribution of vessel draughts within the study area, excluding 19% of vessels that did not specify a draught.

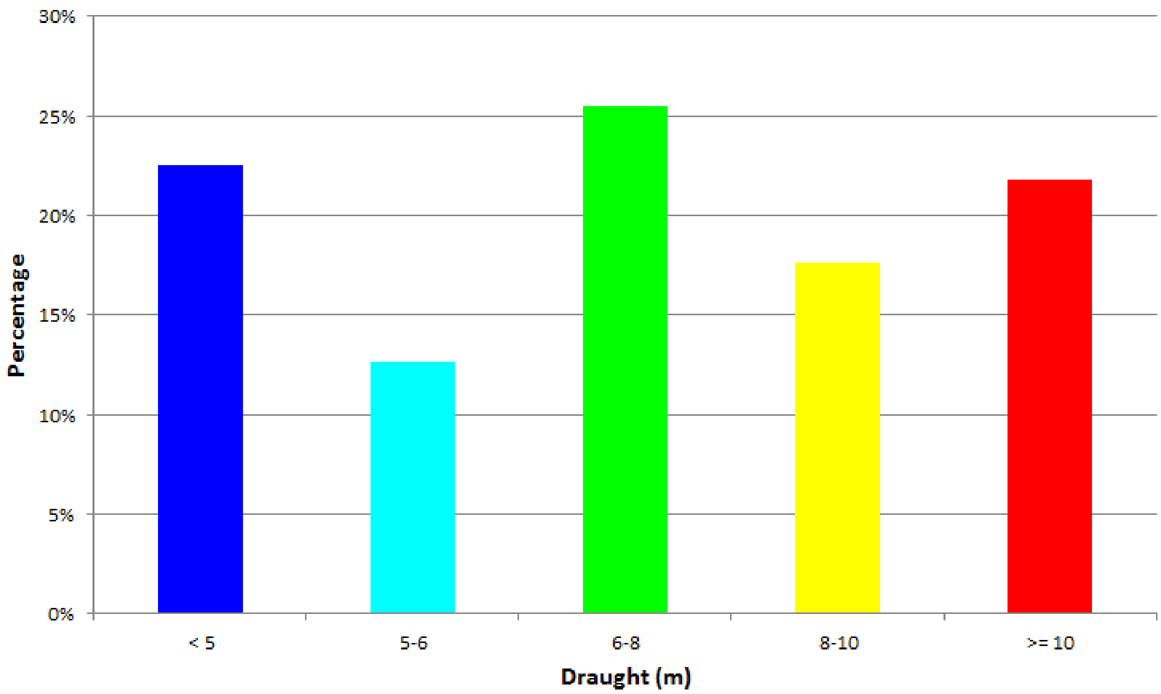

Figure 5.11 AIS Vessel Draught Distribution

Approximately one quarter of vessels transmitted a draught of between 6 and 8m. Vessels with draughts of less than 5m, and vessels with draughts of greater than 10m accounted for 22% each. The average draught recorded over the study period was 7.7m. The maximum recorded draught was 25.5m from the *HS Carmen*, a 237m tanker.

The AIS data colour-coded by vessel Dead Weight Tonnage (DWT) is presented in Figure 5.12. This is not broadcast on AIS but has been researched separately by Anatec based on the ship identify information. Vessels with no DWT information have been placed into a category by approximating a DWT based on their length and type (where length/type information were both available). The vast majority of the remaining vessels (2% of the total) were fishing, unspecified, or "Other" vessels, and have therefore been assumed to be in the smallest size category.

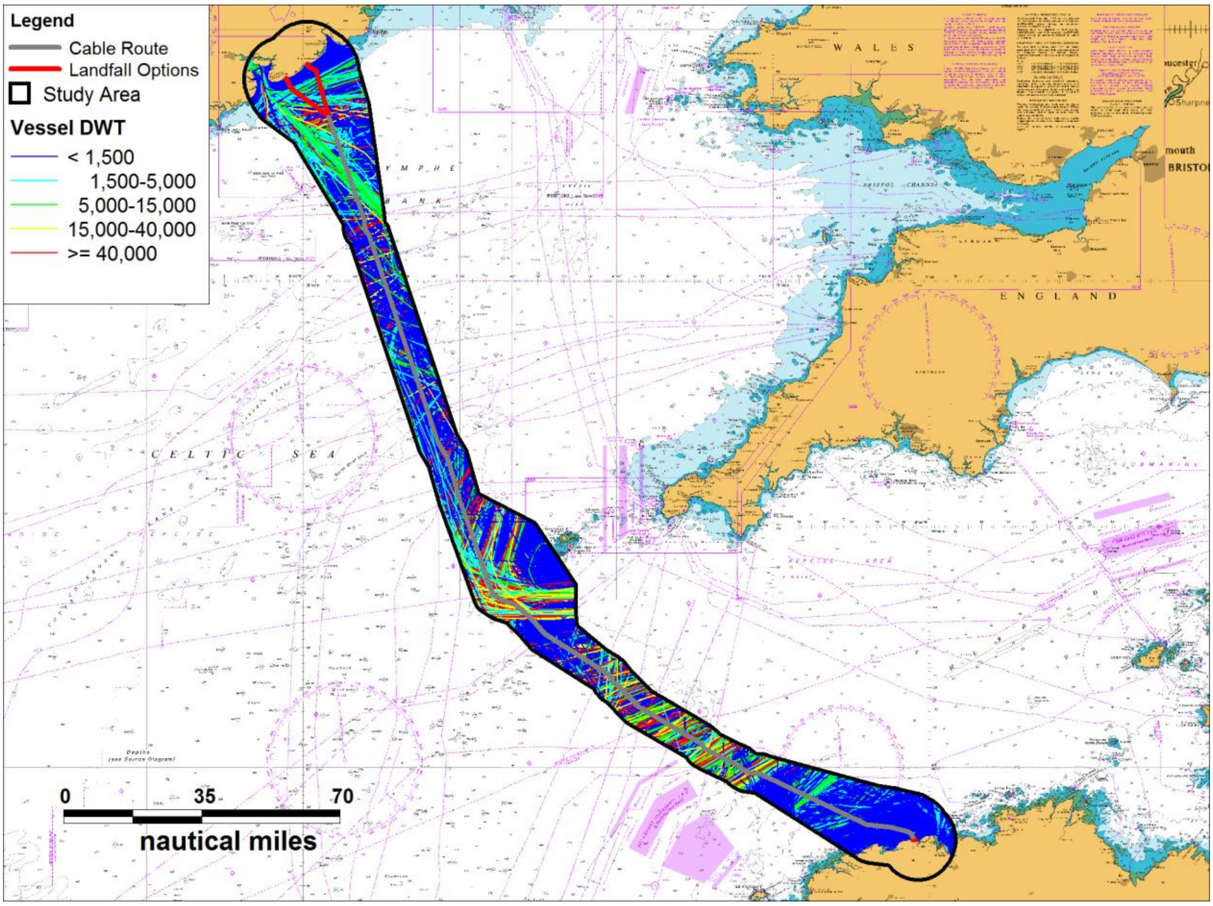

Figure 5.12 AIS Data by Vessel DWT

Figure 5.13 presents the distribution of vessel DWT in the study area.

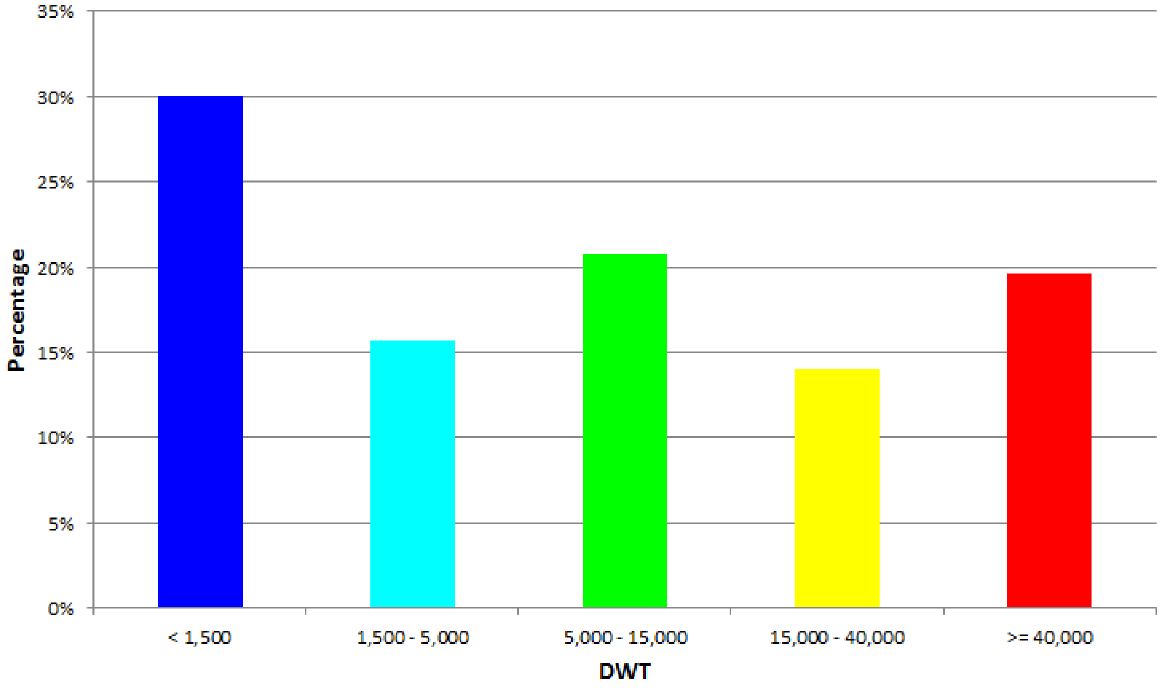

Figure 5.13 AIS Vessel DWT Distribution

Approximately 30% of vessels were of less than 1,500 DWT. One-fifth were vessels of greater than 40,000 DWT. The average DWT during the study period was 23,116, and the maximum was 400,694 DWT, from the *Vale Saham*, a 360m ore carrier (based on vessels with confirmed DWT only).

5.4 Vessel Speed

The AIS data colour coded by vessel speed is presented in Figure 5.14. Note, the presented speeds are average speed per track.

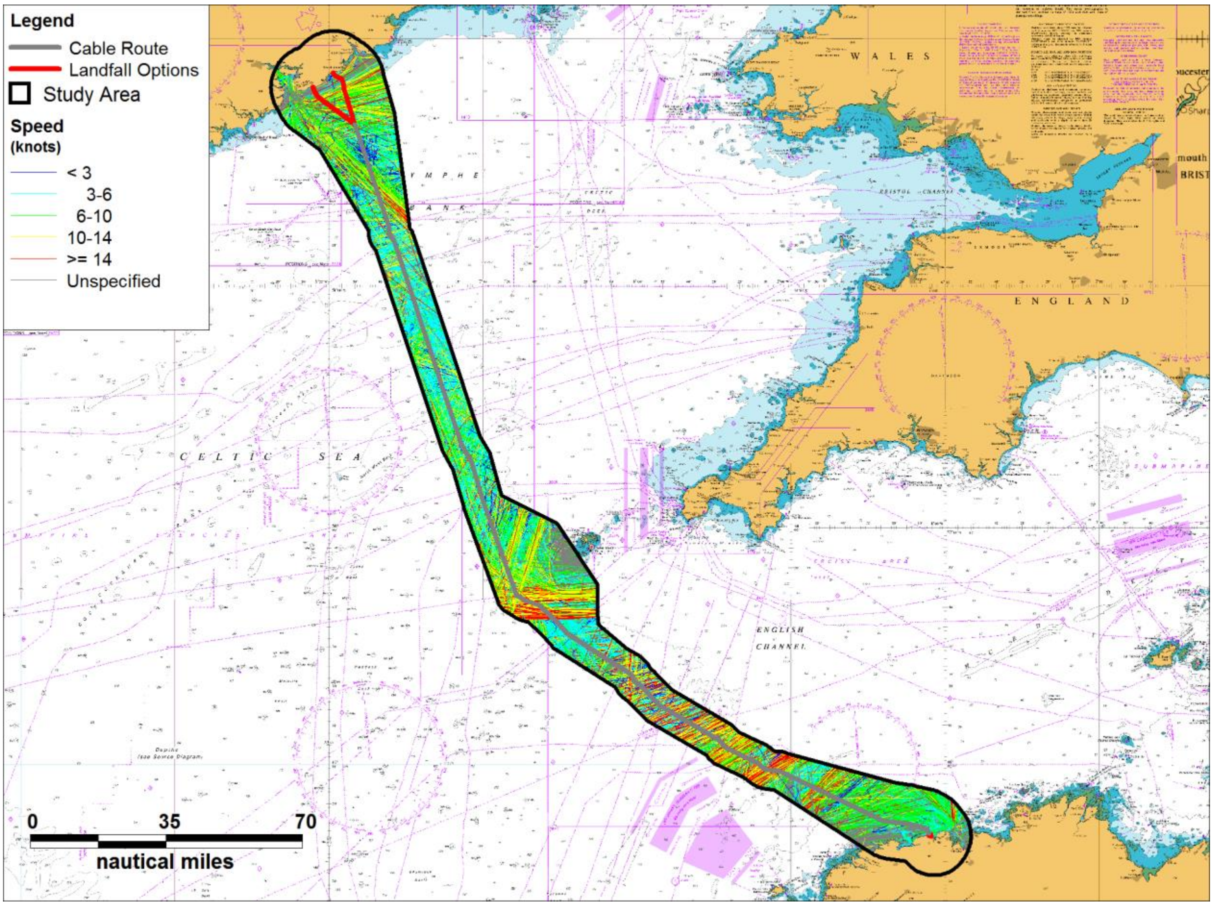

Figure 5.14 AIS Data by Vessel Speed

It is seen that the traffic travelling at speeds of greater than 10 knots was generally comprised of commercial and passenger vessels using the traffic lanes associated with the nearby TSS, or associated with Cork.

The distribution of vessel speed by vessel type and size is presented in Figure 5.15.

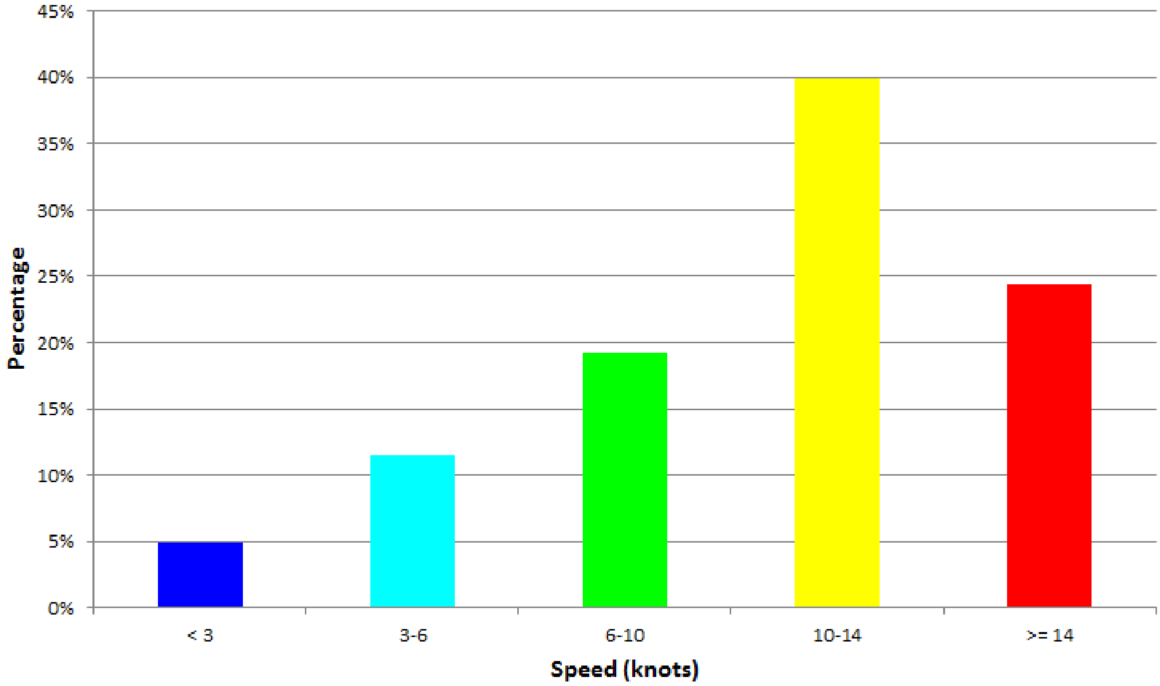

Figure 5.15 Distribution of Vessel Speed

The majority of vessels (64%) were travelling at a speed of above 10 knots, suggesting they were on passage. The average speed recorded within the data was 11.1 knots. The distribution of average speed by vessel type and size is presented in Table 5.1. Cargo vessels, tankers, and fishing vessels accounted for the majority (84%) of traffic, and have therefore been presented individually. All other vessel types have been grouped into the "Other" category.

Vessel Type	Average Speed (knots)				
	< 1,500 DWT	1,500 - 5,000 DWT	5,000 - 15,000 DWT	15,000 - 40,000 DWT	>= 40,000 DWT
Cargo	9.6	9.7	13.1	14.0	14.5
Tanker	11.8	10.6	11.9	12.6	12.1
Fishing	5.1	11.0	12.3	n/a	n/a
Other	6.9	9.9	17.1	14.4	15.0

Table 5.1 Average Speed by Vessel Type and Size

5.5 Vessel Density

The 12 months of AIS data was used to estimate the ship density within the study area, based on the number of track intersects per cell of a 250 x 250m grid. The results are presented in Figure 5.16.

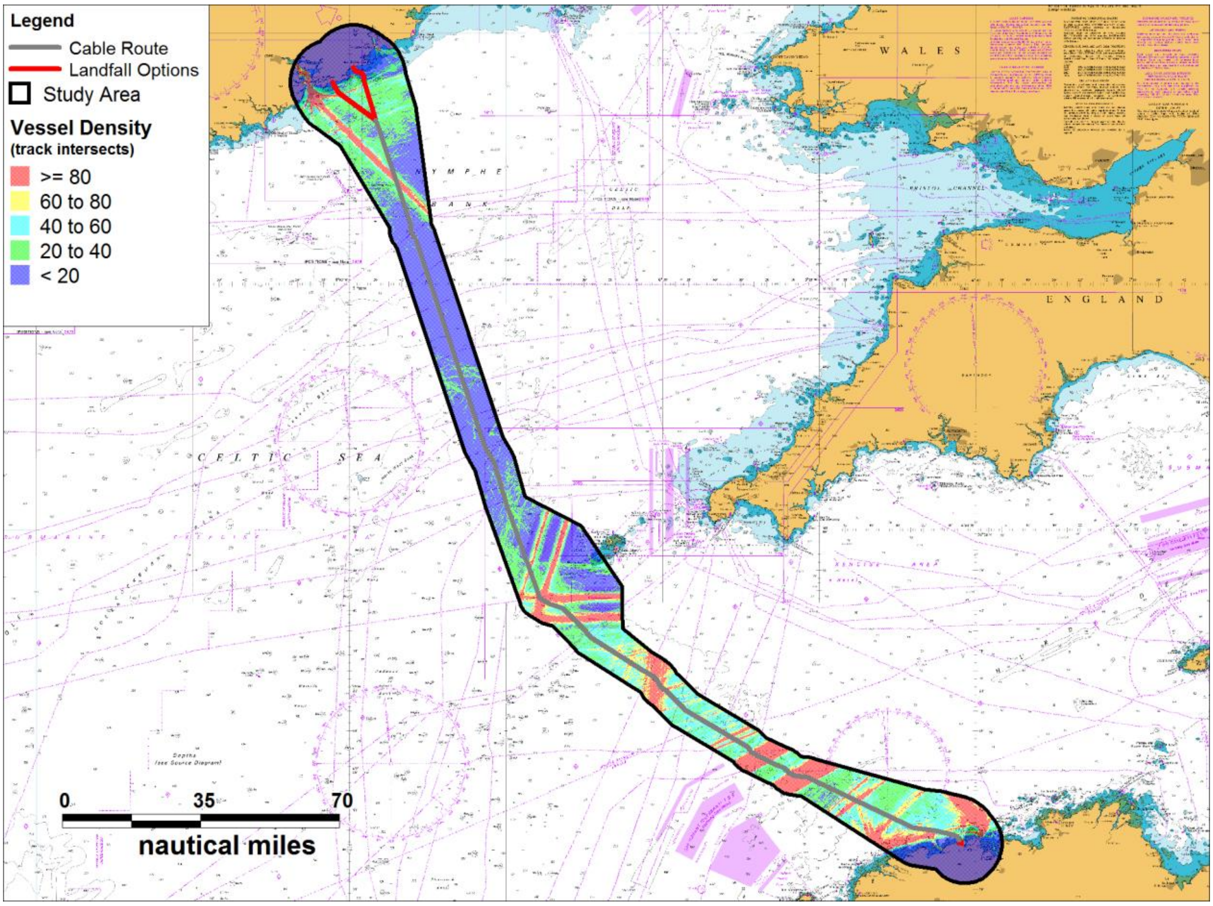

Figure 5.16 AIS Vessel Density

The highest density areas were caused by traffic utilising the lanes associated with the Isles of Scilly and Channel TSS. High density was also seen from the routes used by vessels associated with Cork, and with Roscoff and other French ports. In general, the density was higher in the section of route within southern UK and French waters than in the Celtic Sea.

Detailed plots of the density results are presented in Figure 5.17, Figure 5.18, and Figure 5.19.

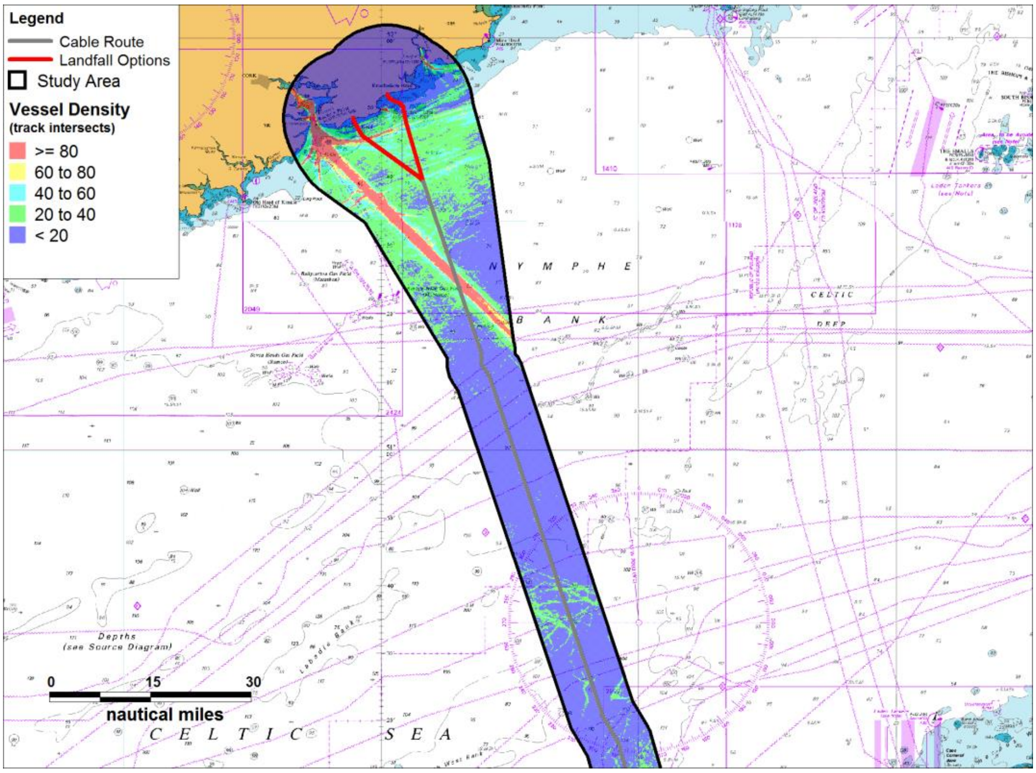

Figure 5.17 AIS Vessel Density – Ireland

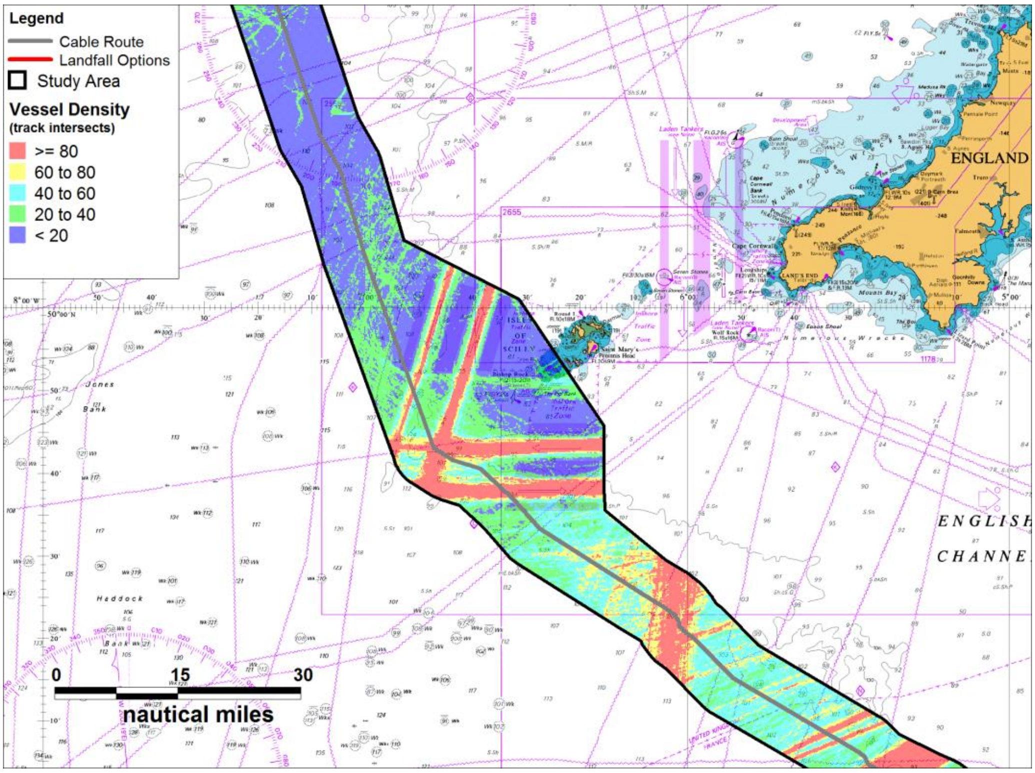

Figure 5.18 AIS Vessel Density - UK

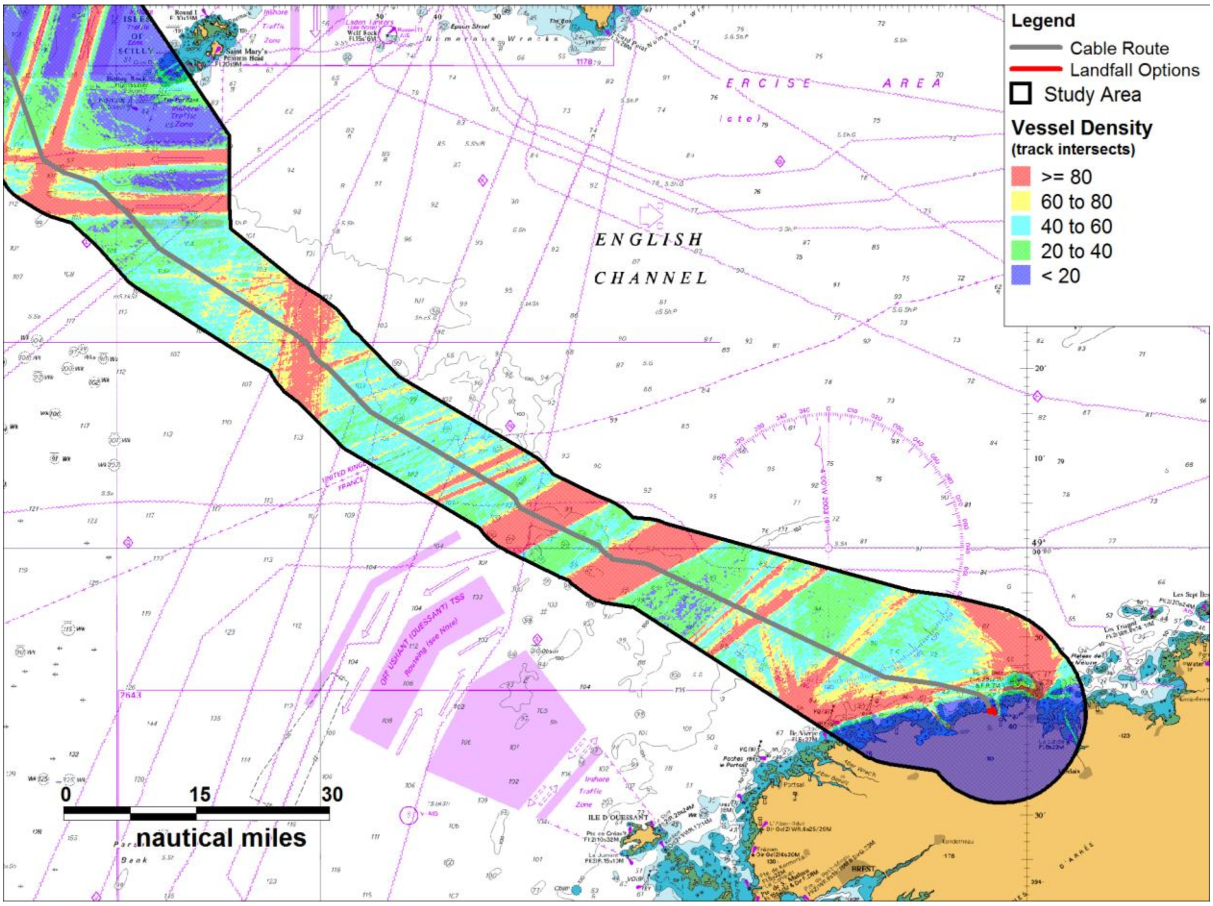

Figure 5.19 AIS Vessel Density – France

5.6 Dredging/Survey Work

As part of the shipping analysis, the AIS data was examined to determine if any unusual shipping activity occurred during the 12 months which could affect the proposed cable. This involved studying the AIS tracks from vessel types that could be engaged in activities other than steaming on passage, anchoring, mooring or fishing. The identified tracks, consisting of survey/research work, and dredging, are presented in Figure 5.20

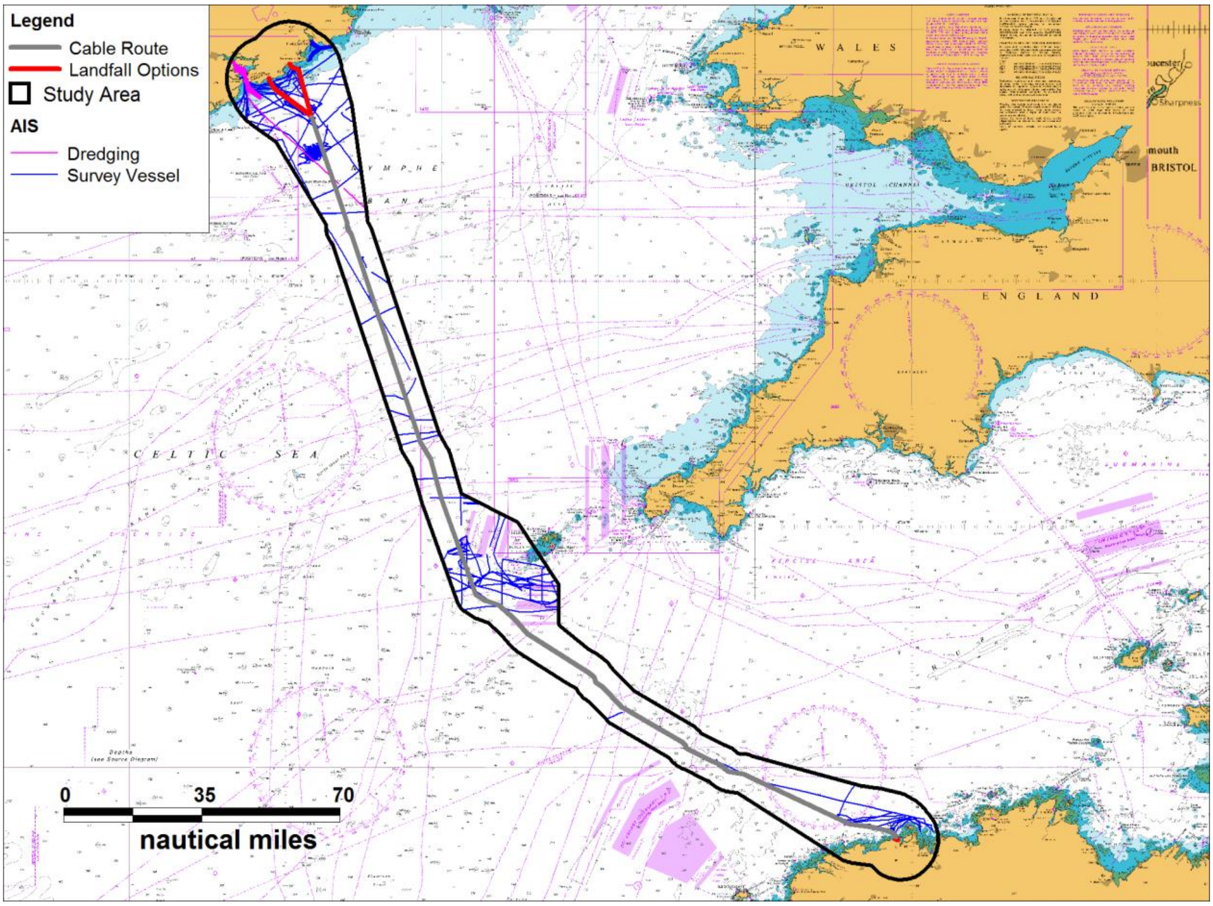

Figure 5.20 Dredging and Survey Work

The only dredging observed within the study was within the vicinity of Cork harbour during September 2014. This area is dredged every three years to maintain the Cork shipping channel. It is noted that no dumping activity was observed within the study area.

Some survey work undertaken within the study area was clearly related to the proposed Celtic Interconnector, however additional work was identified over the route approximately 18nm from the Irish coast. Survey work over a cable intersecting the proposed Celtic Interconnector was also noted within the study area occurring approximately 37nm south of the Irish coast. Work was also observed in Youghal Bay and west of the Isles of Scilly.

The following vessels performing work related to the proposed Celtic Interconnector have been filtered out of the risk modelling performed in the Cable Risk Assessment:

- Proteus;
- MV Chartwell;
- Ernest Shackleton;
- Bibby Tethra;

- MV Lia.

5.7 Cable Crossings

An analysis of the size distribution of vessels crossing the route per Kilometre Point (KP) of the proposed cable was undertaken. It is noted that the KPs for the main route are defined such that they run from north to south, meaning the first KP begins at the Irish landfall point at Ballinwilling Strand, as illustrated in Figure 5.21. The analysis was also performed on the additional Irish landfall option at Ballycroneen, and for the Port Neuf and Kerradenec landfalls on France.

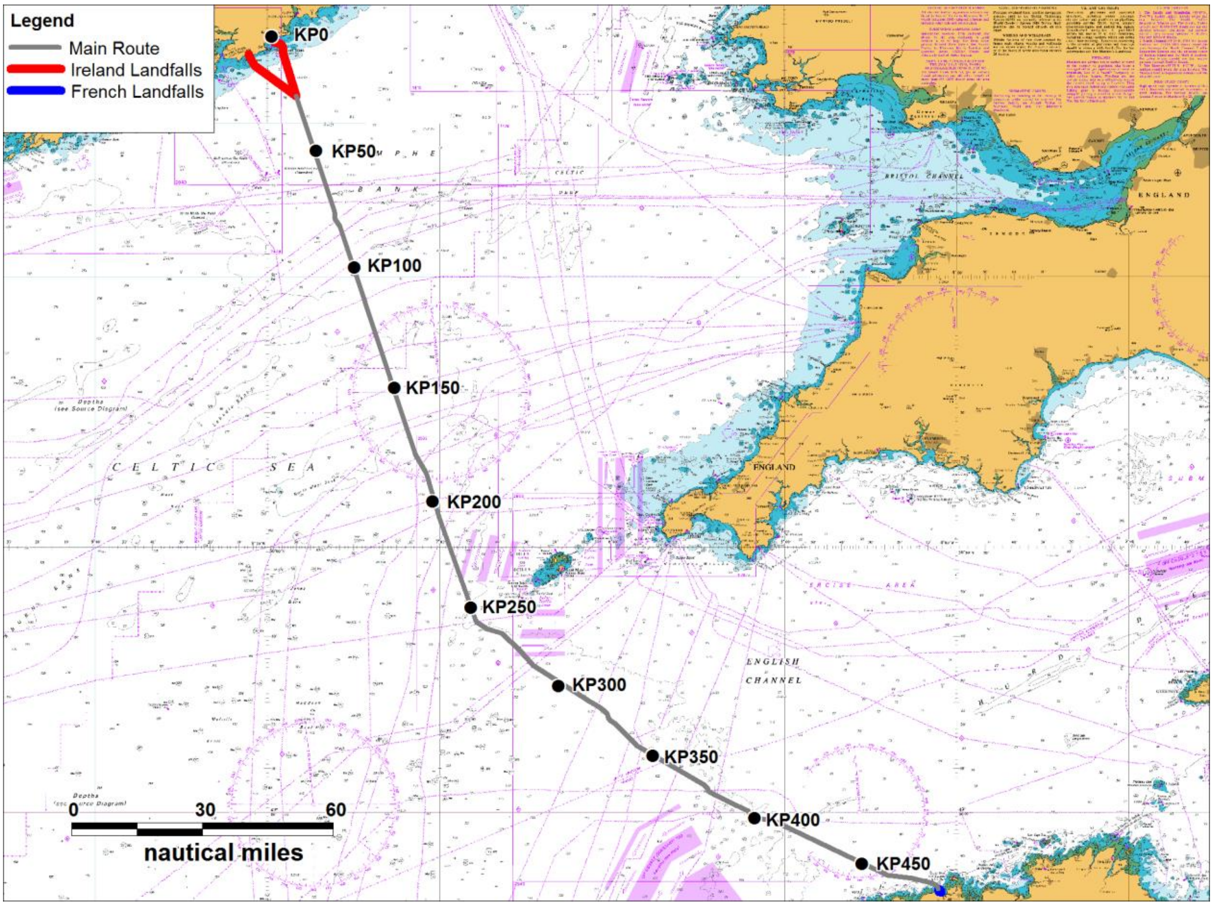

Figure 5.21 Cable Crossing Analysis Subsections

Each section of the route was divided into 1km sections (i.e. KPs). The results of the assessment provide the total number of vessel track intersections per KP and the percentage distribution by size. It is noted that each track is only counted once per KP. The results were broken down into six size categories, as presented in Table 5.2.

Size Category	DWT Range
1	< 1,500
2	1,500 – 5,000
3	5,000 – 15,000
4	15,000 – 40,000
5	40,000 – 100,000
6	>= 100,000

Table 5.2 DWT Size Categories

A summary of the results is presented in Table 5.3 for the main route and Table 5.4 for the landfall options. These provide the number of cable crossings and distribution by size per 50km for the main route and for each of the landfall options. As discussed above, the KPs for the main route are defined such that they run from north to south, meaning the first KP begins at the Irish landfall point at Ballinwilling Strand. The results for the first 50km of the main route therefore include the Ballinwilling landfall, which is also presented separately in Table 5.4 for comparison with the other landfall options.

Cable Route Section	Cable Crossings Per Year	% Distribution of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Main Route – KP 0-50	3,139	54%	17%	15%	5%	7%	1%
Main Route – KP 50-100	2,294	46%	20%	21%	7%	5%	1%
Main Route – KP 100-150	920	67%	13%	10%	3%	6%	1%
Main Route – KP 150-200	1,133	74%	10%	3%	3%	5%	5%
Main Route – KP 200-250	2,286	45%	20%	13%	8%	5%	9%
Main Route – KP 250-300	7,768	30%	8%	11%	21%	24%	6%
Main Route – KP 300-350	7,862	29%	15%	19%	17%	16%	4%
Main Route – KP 350-400	23,502	8%	18%	29%	19%	16%	10%

Cable Route Section	Cable Crossings Per Year	% Distribution of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Main Route – KP 400-450	22,614	15%	20%	27%	16%	13%	9%
Main Route – KP 450-487	3,393	83%	7%	9%	0%	0%	0%

Table 5.3 Cable Route Intersections, Vessel Size Distribution, Main Route

Cable Route Section	Cable Crossings Per Year	% Distribution of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Ballinwilling Strand	1,887	46%	19%	19%	7%	7%	2%
Ballycroneen	2,055	50%	17%	18%	6%	7%	2%
Port Neuf	1	100%	0%	0%	0%	0%	0%
Kerradenec	6	100%	0%	0%	0%	0%	0%

Table 5.4 Cable Route Intersections, Vessel Size Distribution, Landfall Options

Table 5.5 and Table 5.6 present this information in the form of number of vessel tracks crossing each cable route section for each size category.

Cable Route Section	Cable Crossings Per Year	Number of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Main Route – KP 0-50	3,139	1,699	548	469	172	211	40
Main Route – KP 50-100	2,294	1,058	456	485	151	113	31
Main Route – KP 100-150	920	612	118	92	30	57	11
Main Route – KP 150-200	1,133	841	115	33	31	53	60
Main Route – KP 200-250	2,286	1,023	455	294	193	116	205
Main Route – KP 250-300	7,768	2,325	629	819	1,618	1,882	495
Main Route – KP 300-350	7,862	2,252	1,192	1,504	1,355	1,253	306

Cable Route Section	Cable Crossings Per Year	Number of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Main Route – KP 350-400	23,502	1,823	4,234	6,837	4,425	3,792	2,391
Main Route – KP 400-450	22,614	3,411	4,490	6,205	3,536	2,980	1,992
Main Route – KP 450-487	3,393	2,830	253	308	0	2	0

Table 5.5 Number of Cable Route Intersections per Vessel Size, Main Route

Cable Route Section	Cable Crossings Per Year	% Distribution of Vessel Track Intersections					
		Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Ballinwilling Strand	1,887	863	357	364	130	141	32
Ballycroneen	2,055	1,034	354	366	129	140	32
Port Neuf	1	1	0	0	0	0	0
Kerradenec	6	6	0	0	0	0	0

Table 5.6 Number of Cable Route Intersections per Vessel Size, Landfall Options

5.8 AIS Validation

Three auxiliary AIS data sets were used to provide comparison with the core data set analysed in the above sections. The purpose of this additional assessment was to validate the core data set for use in the Shipping Analysis, and to highlight any areas where factoring is required in the Cable Risk Assessment. The full assessment is available in Appendix A (Ref i), and a summary is provided below.

A density analysis showed that the core AIS data set provided the best overall coverage of the study area, however the auxiliary data provided better coverage in some coastal areas over limited periods. A monthly count analysis showed similar results between the core and secondary data sets, with the core data recording higher counts in most cases.

A seasonal analysis showed that vessel activity was lower in winter than in summer for all vessel types within UK waters. An assessment of Irish waters showed an increase in fishing activity during winter when compared to summer, and a marginal increase in cargo vessels. Within French waters, with the exception of a marginal increase in cargo vessels, vessel activity was higher in summer for all types. It was concluded that summer vessel traffic levels were similar to or greater than those in winter, with the exception of fishing near the Irish landfalls. This has been accounted for in the fishing assessment.

6. Anchoring Analysis

6.1 Introduction

Vessels can transmit their navigation status via AIS, however they do not always do so accurately. All AIS tracks from vessels within the AIS data that transmitted their navigation status as 'At Anchor' were checked to ensure their behaviour matched that of an anchored vessel. AIS tracks from vessels which transmitted a navigation status other than 'At Anchor' were used as input to Anatec's Speed Analysis model. The program uses a predefined set of parameters to detect any tracks that may be from an anchored vessel based on their speed and course. This output is then manually checked, and any tracks that can be confirmed as coming from an anchored vessel are added to the tracks from the first step.

6.2 AIS Anchoring

A general overview of the tracks identified as coming from an anchored vessel within the 12 months of AIS data presented in Section 5 are presented relative to the route in Figure 6.1.

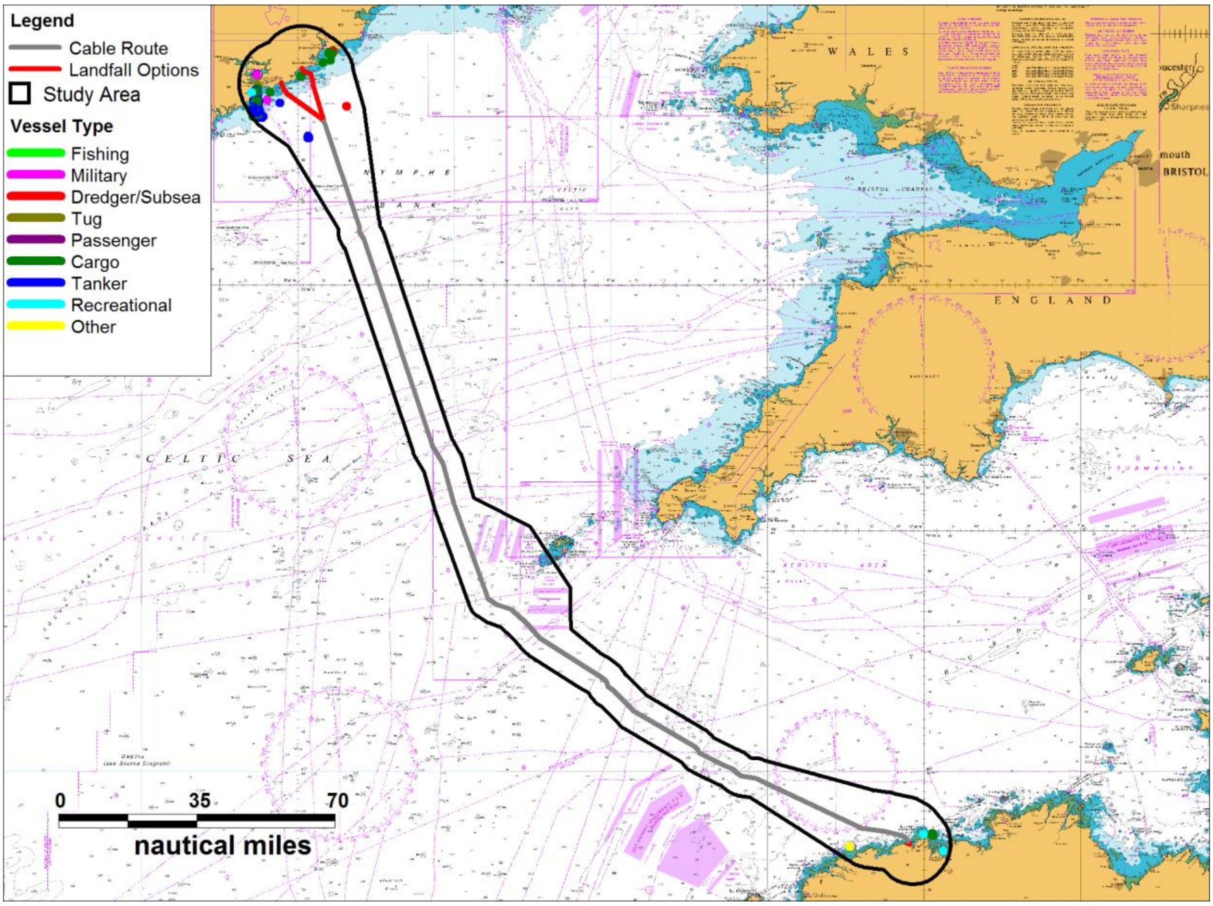

Figure 6.1 General Overview of AIS Anchoring

The majority of anchoring within the study area occurred within Irish waters, with the most significant activity occurring in the Cork Outer Anchorage. Some anchoring activity was also noted in French waters, most of which was associated with vessels outside Roscoff. Detailed plots of the Irish and French anchoring are presented in Figure 6.2 and Figure 6.3 respectively.

No anchoring was observed within UK waters in the study area. Anchoring was noted as occurring just outside the study area in the vicinity of the Isles of Scilly, however the closest occurred more than 20nm from the route.

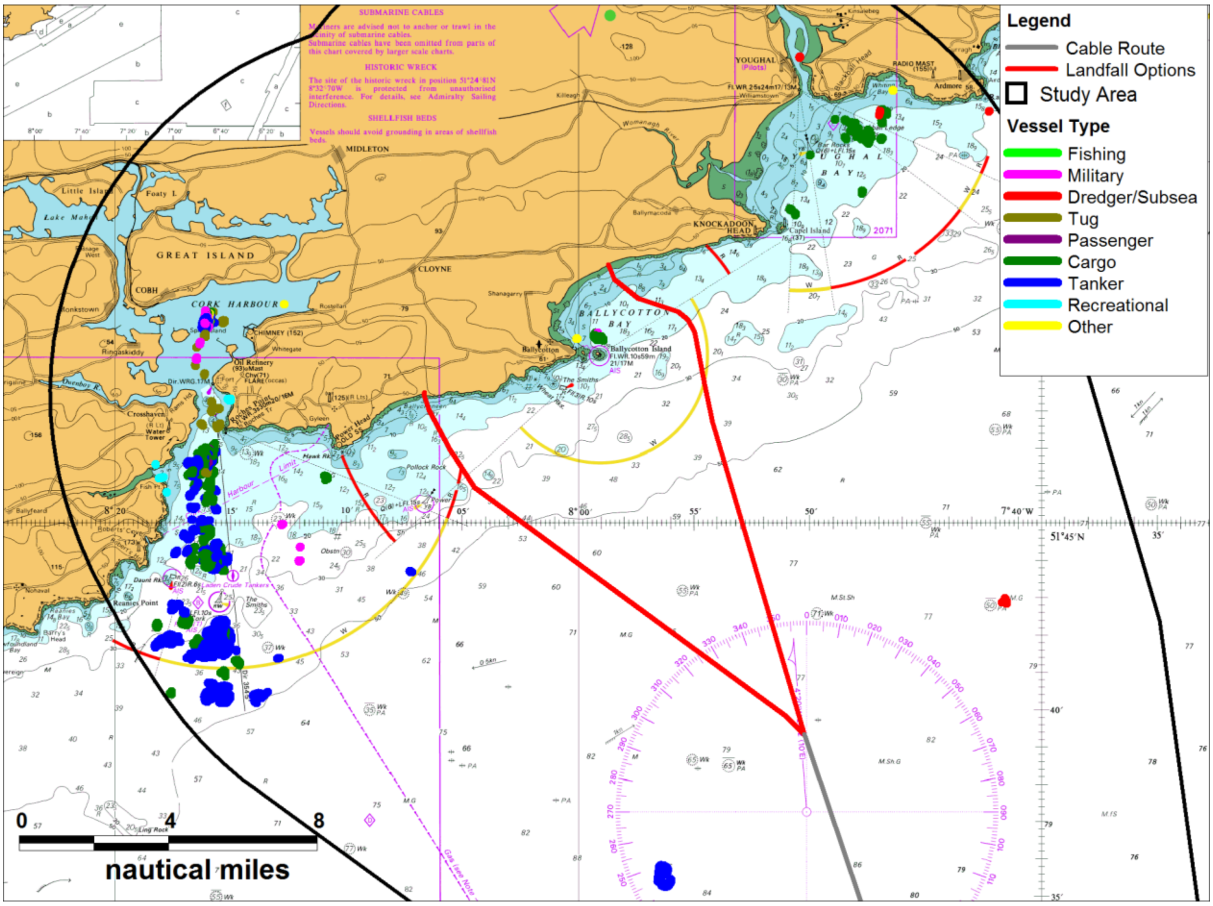

Figure 6.2 AIS Anchoring – Irish Waters

The majority of anchoring within Irish waters was from cargo vessels and tankers using the Cork Outer Anchorage. A military vessel was also noted anchoring within this area. The nearest anchoring to the western cable landfall from vessels entering or leaving Cork was a tanker, approximately 2.8nm from the proposed cable route, however it is noted that with the exception of one cargo vessel (3.2nm) and the military vessel (4.6nm at its closest) all other vessels anchoring in or near the Cork anchorage did not anchor closer than 7nm to the route.

Two cargo vessels and a military vessel were also observed anchoring in Ballycotton Bay, approximately 1.4nm to the south west of the proposed eastern landfall. This was the nearest anchoring to the route within the study area.

Vessels (mainly cargo) were observed anchoring in Youghal Bay, with the nearest anchored vessel 4nm to the north-east of the proposed eastern landfall.

Two vessels anchored further offshore, a tanker 4.8nm to the west of the route, and a dredger, 5.9nm to the east. The tanker anchored at this point on two separate occasions in April 2014.

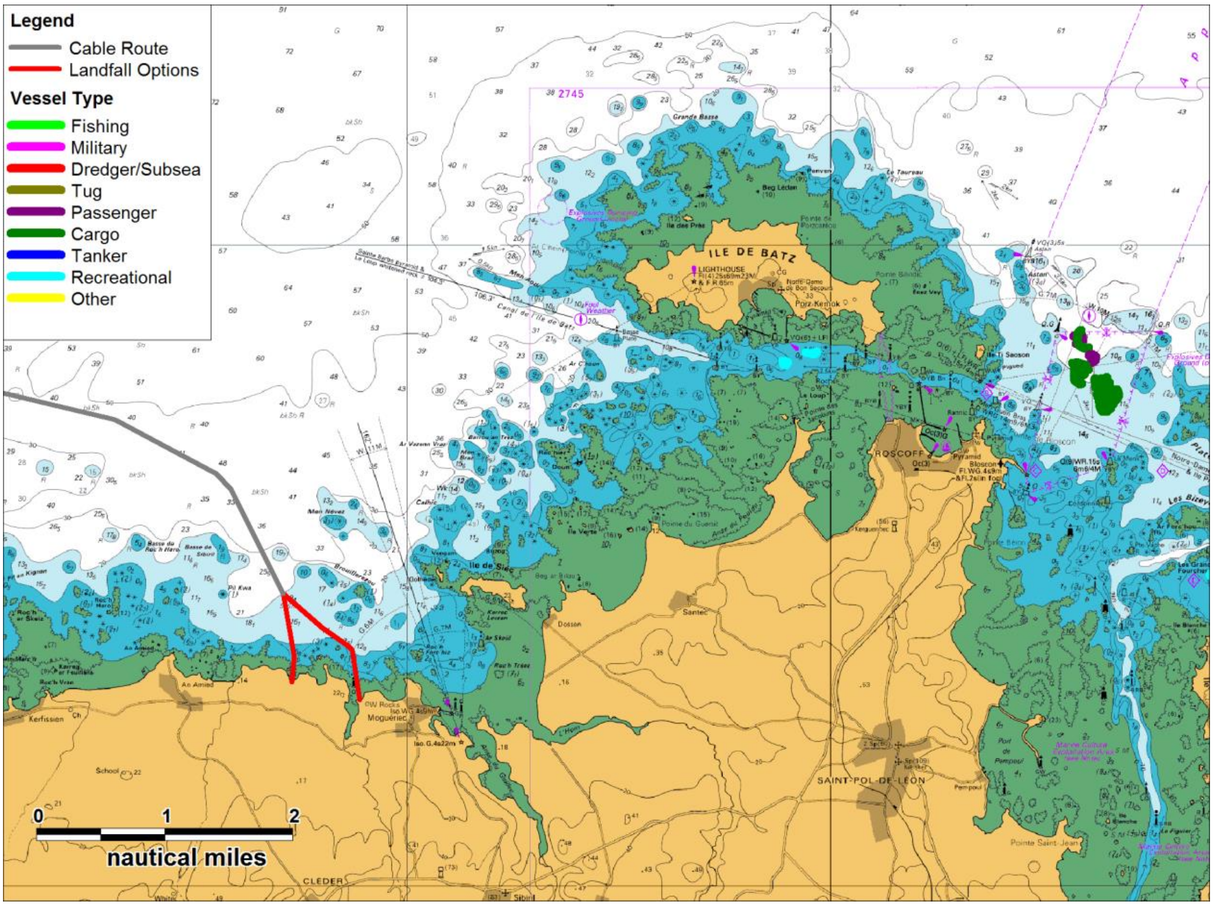

Figure 6.3 AIS Anchoring – French Waters

Recreational vessels were observed anchoring south of the Ile de Batz, approximately 4nm to the north east of the landfalls. The majority of anchoring in the study area within French waters occurred to the east of Roscoff from cargo and passenger vessels. It is noted that these vessels pose minimal risk to the route as the route is protected from these vessels by the land.

6.3 *Anchor Penetration*

The penetration depth of an anchor depends on the size of the anchor and the seabed type. The size of the anchor generally depends on the size of the vessel. A relationship between vessel DWT and anchor size is provided in based on anchor size requirements from the International Association of Classification Societies (IACS). This relationship is presented in Figure 6.4.

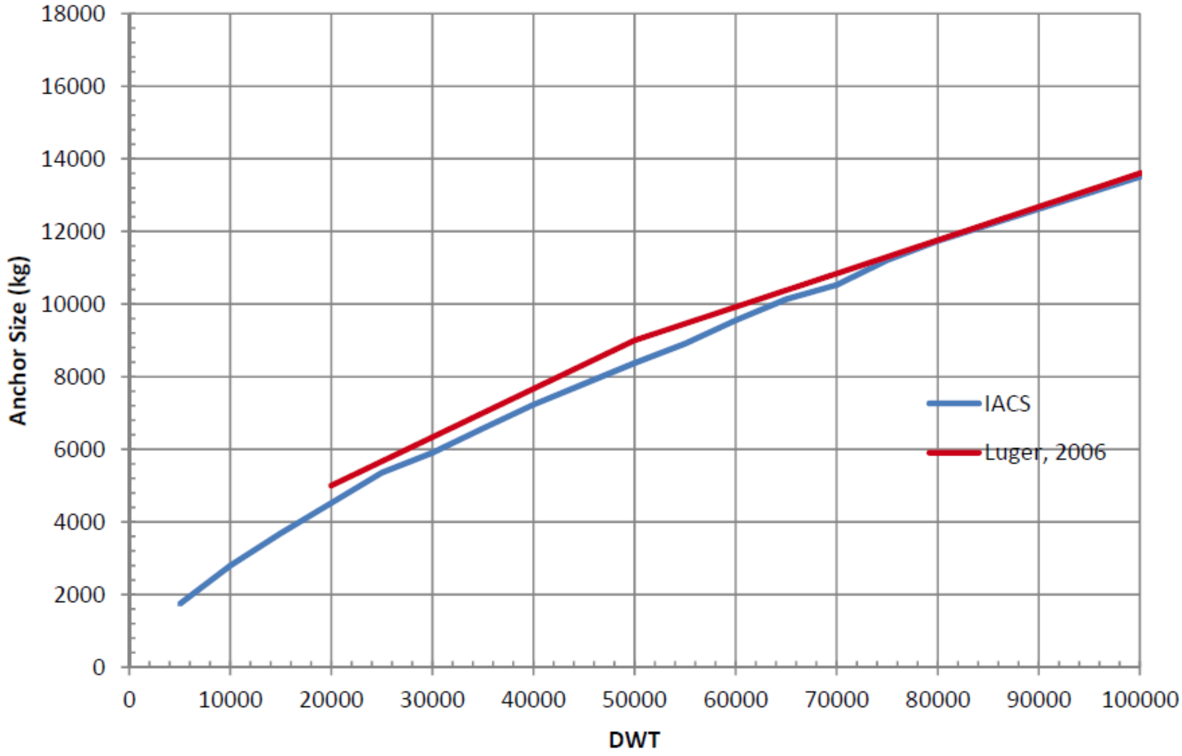

Figure 6.4 Carbon Trust Relationship between DWT and Anchor Size

From this figure, it can be seen that the IACS relationship compares well with anchor sizing proposed by Luger (Ref iv).

Using information from the manufacturers, the anchor mass can then be used to estimate the fluke length of the anchor, which is closely related to the penetration depth. Figure 6.5 shows a typical anchor design (Ref v).

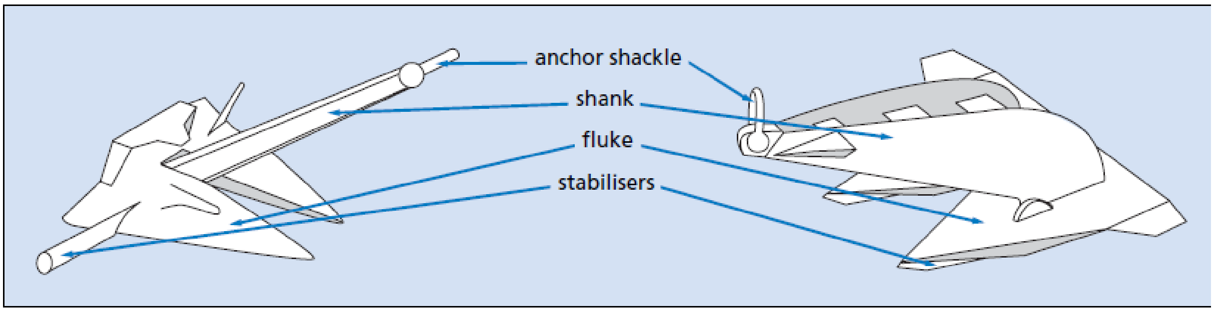

Figure 6.5 Typical Anchor Design

Table 6.1 shows a relationship between vessel DWT, anchor mass and the fluke length for various anchor types. This is based on the Luger relationship and the Vryhof anchor manual (Ref. v).

Vessel DWT	Anchor Mass (kg)	Fluke Length (m)		
		Vryhof	Danforth	Hall
1,500	2,400	2.1	1.7	1.4
5,000	3,000	2.2	1.9	1.5
15,000	4,500	2.6	2.1	1.7
40,000	7,800	3.1	2.5	2.0
200,000	16,500	3.9	3.1	2.6
400,000	26,000	4.5	3.6	3.0

Table 6.1 Vessel DWT, Anchor Mass and Fluke Length

The anchor penetration depth depends on the fluke length, the fluke angle and the seabed type. Typical fluke tip penetration depths for an average fluke angle of 32° are presented in Table 6.2.

Vessel DWT	Average Fluke Tip Penetration (m)
1,500	0.7 – 1.1
5,000	0.8 – 1.2
15,000	0.9 – 1.4
40,000	1.1 – 1.6
200,000	1.4 – 2.1
400,000	1.6 – 2.4

Table 6.2 Average Fluke Tip Penetration

It is assumed that this gives the typical penetration depths for anchors in a ‘medium’ seabed type, e.g. medium dense sand. These are likely to be smaller for harder sediments and larger for softer sediments.

In particular, for softer seabed types, the fluke angle may increase to a maximum of 50° (Ref v) and the anchor shank may embed into the seabed, giving a larger penetration depth. As discussed in Ref vi work by the US Naval Civil Engineering Laboratory indicates that in sands and stiff clays, the fluke tip penetration is limited to 1 fluke length, while in soft silts and clays, anchor penetration is between 3 and 5 fluke lengths. However, based on recent trials carried out in the German Bight, it is considered that the suggested penetration depth of 3 to 5 fluke lengths for soft clay is potentially excessive.

7. Fishing Analysis

7.1 Introduction

This section analyses the fishing activity within the study area. Certain types of fishing gear are operated close to or on the seabed, and therefore have the potential to interact with subsea equipment. This can cause damage to both subsea cables and to the fishing gear. In more serious cases, snagged gear can also cause a vessel to capsize as it attempts to free its gear.

The fishing vessels tracks recorded within the AIS data presented in Section 5 were extracted and analysed. As previously discussed in Section 3, the 2015 and majority of the 2014 AIS survey data covers all fishing vessels 15m length and over, with the remaining 2014 AIS data (April and May 2014) covering vessels 18m length and over. A proportion of smaller vessels may carry AIS voluntarily but they are not obliged to broadcast.

An additional analysis of Vessel Monitoring Service (VMS) satellite fishing data has been presented in Appendix B (Ref vii).

7.2 Fishing Vessel Positions

The fishing vessel tracks from the AIS data (see Section 5) are presented in Figure 7.1. The vessel identity information broadcast on AIS (e.g. name and CallSign) was used to research further details, including gear type, using public domain data, including EU fleets.

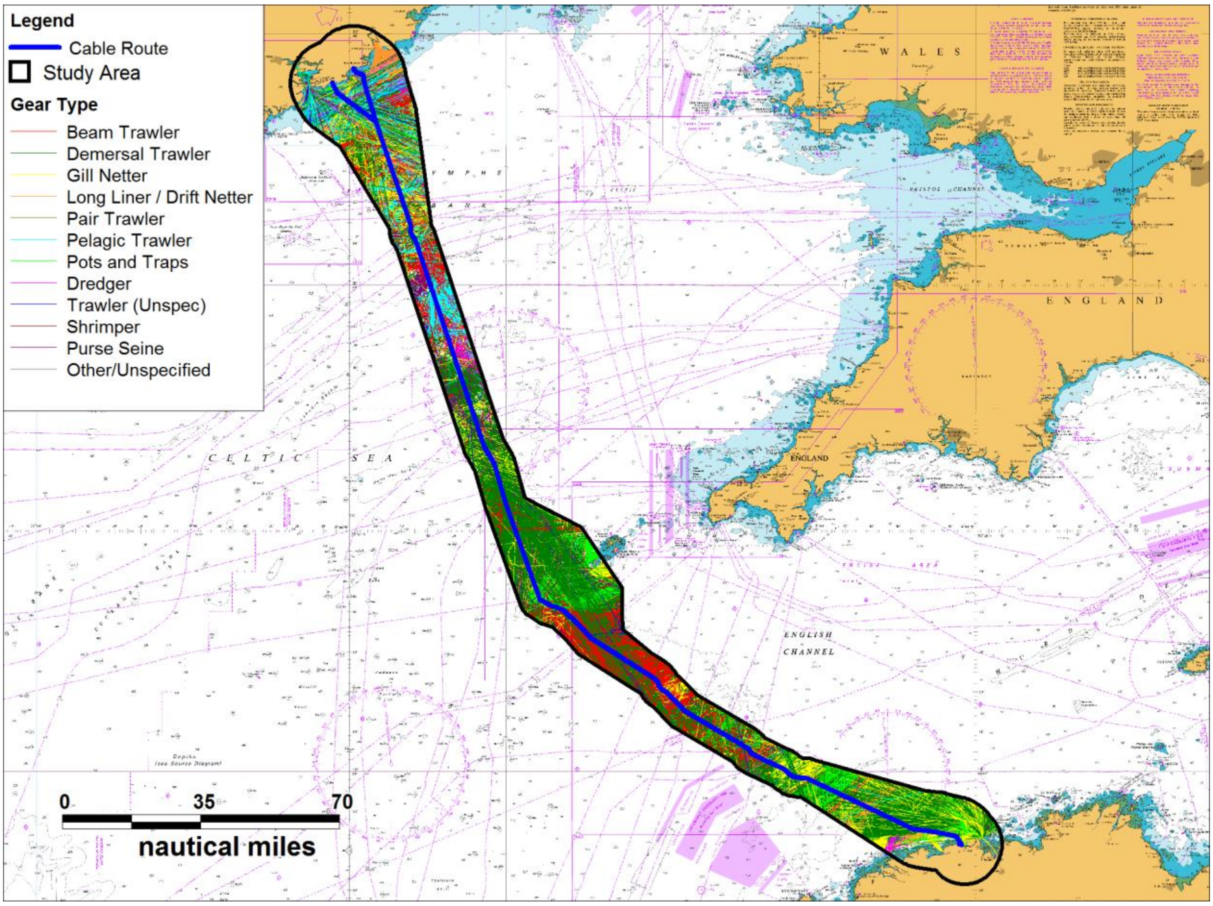

Figure 7.1 AIS Fishing Vessel Tracks (12 Months, 2014/2015)

It can be seen that during the 12 months of AIS data (6 months 2014 and 6 months 2015), there were a significant number of fishing vessels with various gear types tracked within the study area.

7.3 Vessel Numbers

The monthly fishing vessel counts (based on unique vessels per day) are presented in Figure 7.2. It is noted that October 2014 and April 2015 were not covered in the study period.

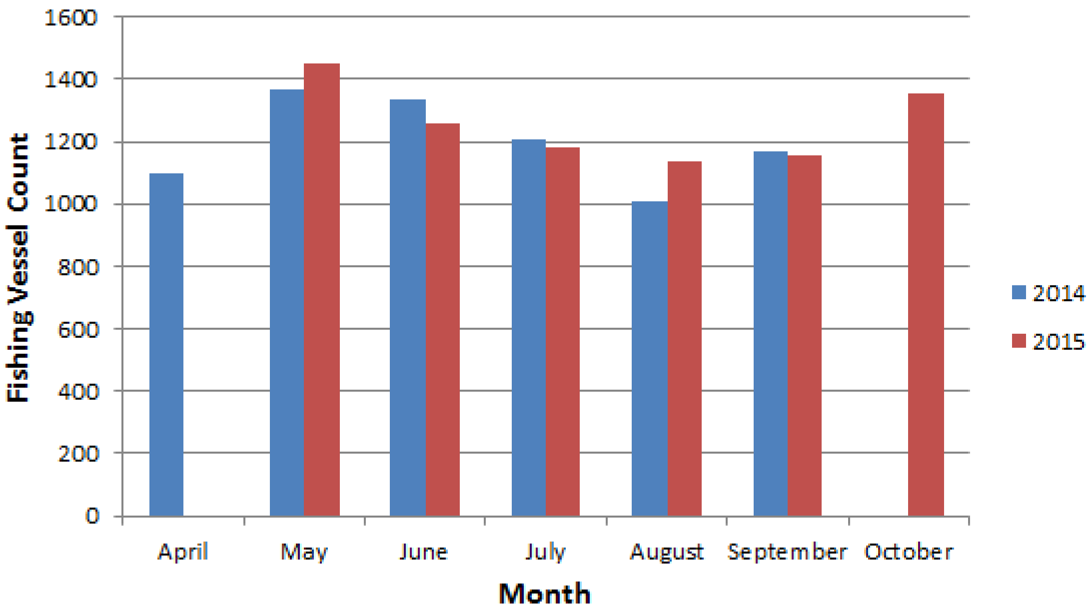

Figure 7.2 Monthly Fishing Vessel Count, 12 Months AIS Data (2014/2015)

An average of 40 unique fishing vessels were recorded per day within the study area. The busiest day was the 3rd October 2015, when 76 fishing vessels were recorded within the study area.

It can be seen that, in both 2014 and 2015, August was the quietest month for fishing vessels and May was the busiest month. As mentioned in Section 5.8, auxiliary data analysed in Appendix A (Ref i) showed fishing activity to be lower in winter than in summer, in UK and French waters, however it is noted that an increase in fishing vessel activity was observed in Irish waters during winter. This has been accounted for in the fishing risk assessment in Section 0.

7.4 Fishing Activity

Some of the vessels in the study area appeared to be steaming on passage rather than actively fishing. Speeds of vessels actively fishing depends on a number of factors, including vessel size, gear type, fishing method, target species, etc. In general, any vessel above 6 knots is likely to be steaming on passage between ports and/or fishing grounds. Fishing vessels travelling below 6 knots could also be steaming (dependent on vessel size and location) but could be actively fishing. To be conservative, it was assumed that all fishing vessels travelling at less than 6 knots were actively fishing. Based on this, the tracks of fishing vessels actively fishing within the study area are presented in Figure 7.3.

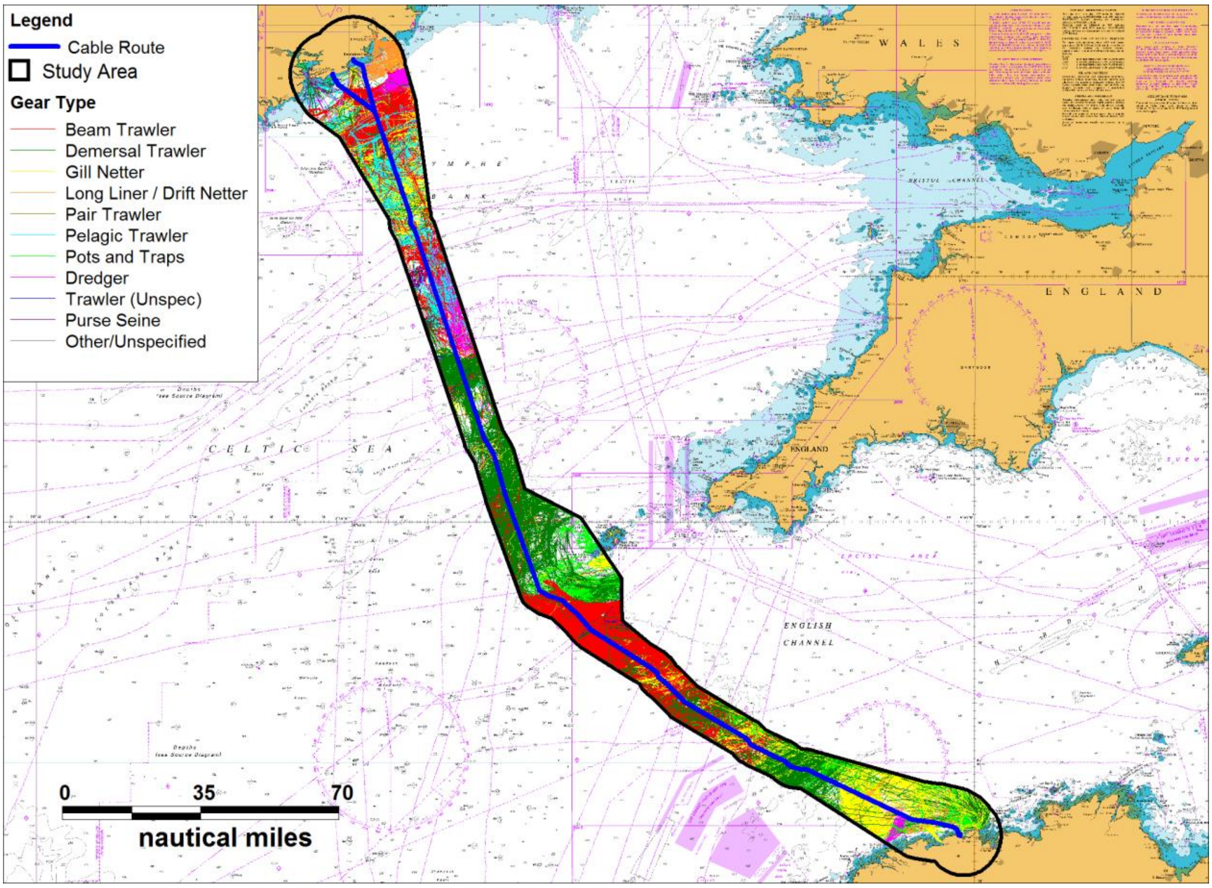

Figure 7.3 AIS Tracks less than 6 knots, 12 Months (2014/2015)

Detailed plots of the subset of fishing vessels with average speeds below 6 knots, in the Irish, UK, and French sectors, are presented in Figure 7.4, Figure 7.5, and Figure 7.6 respectively.

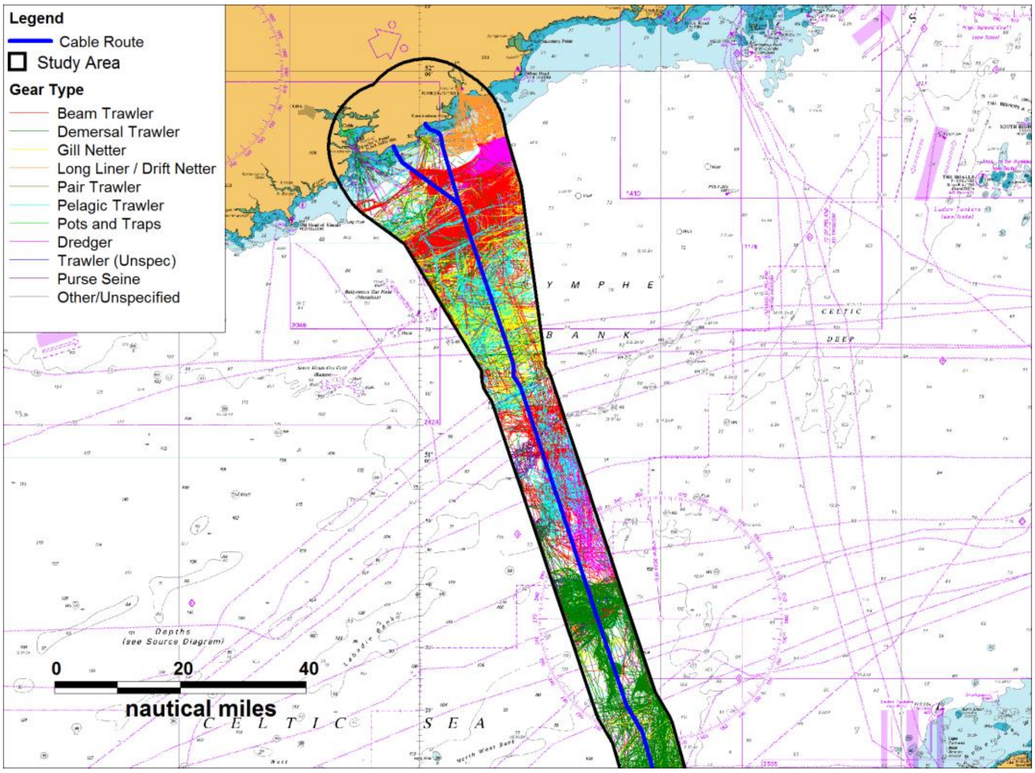

Figure 7.4 AIS Tracks less than 6 knots, 12 Months (2014/2015) – Ireland

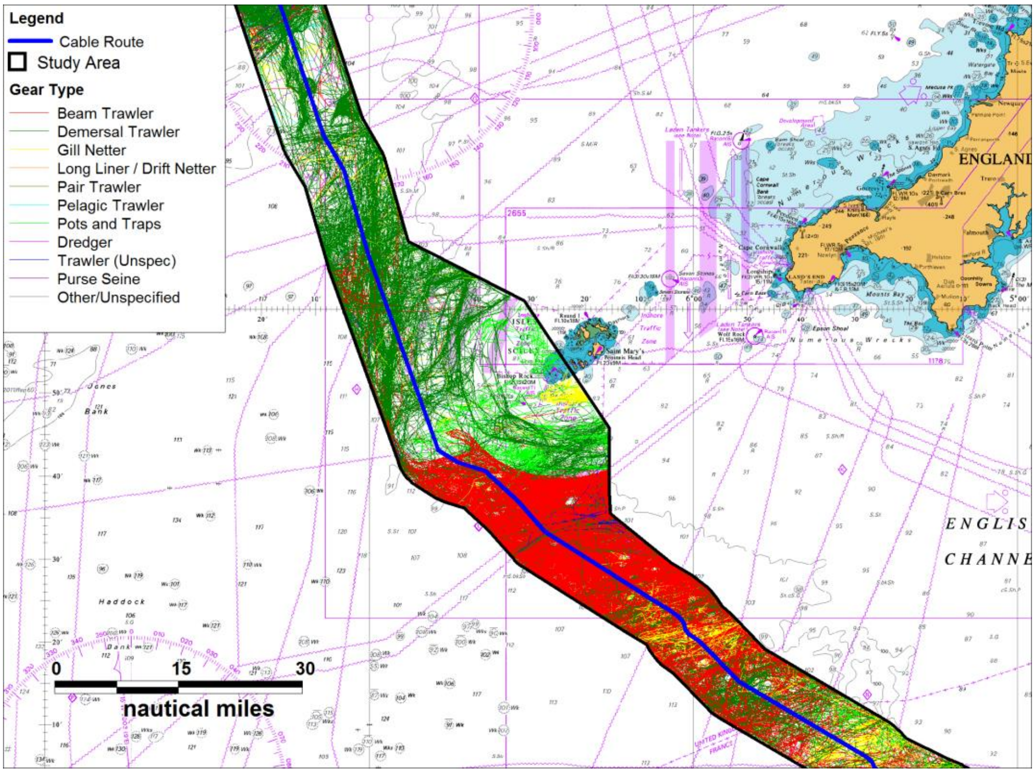

Figure 7.5 AIS Tracks less than 6 knots, 12 Months (2014/2015) – UK

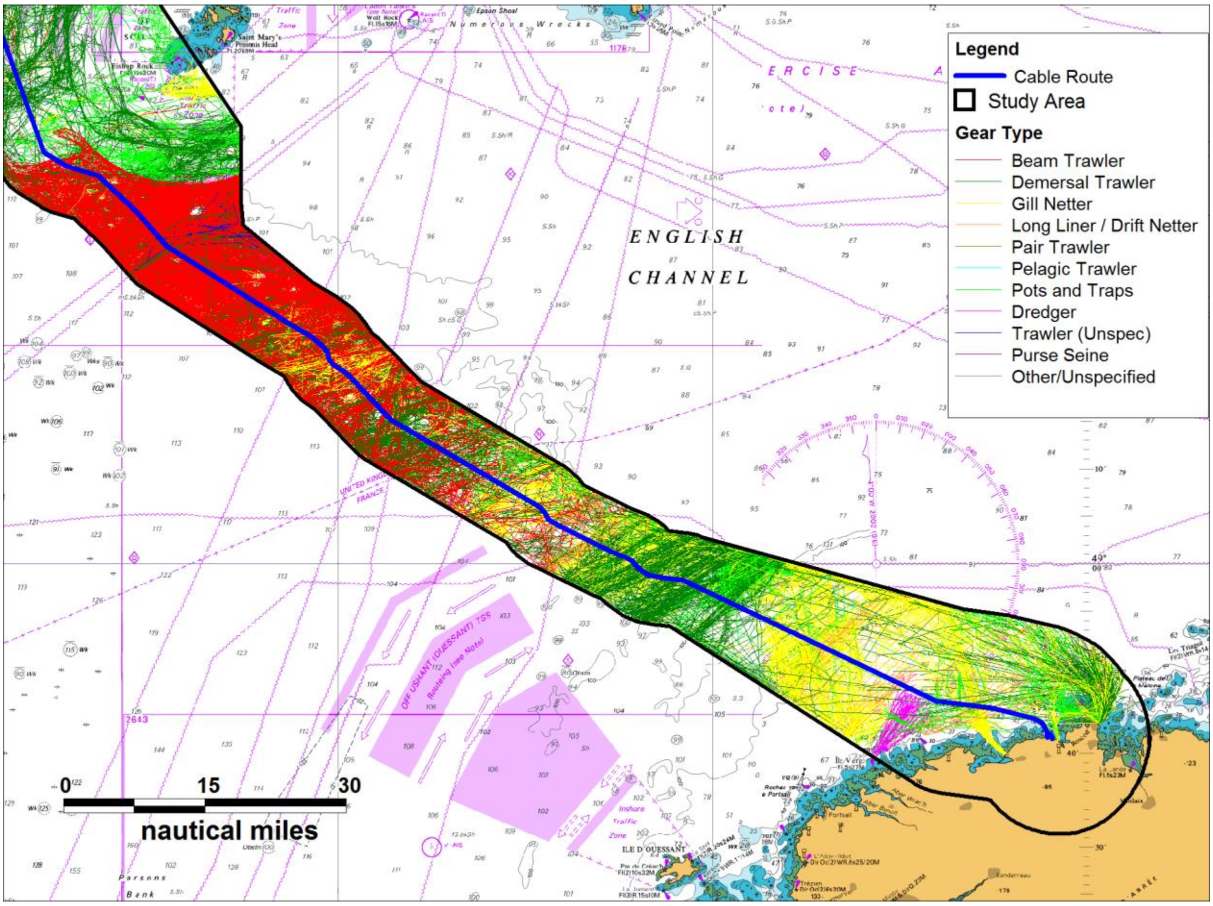

Figure 7.6 AIS Tracks less than 6 knots, 12 Months (2014/2015) – France

7.5 Gear Types

The gear type distribution for vessels actively fishing (i.e., < 6 knots) within the AIS data is presented in Figure 7.7. This is based on unique vessels per day in the study area.

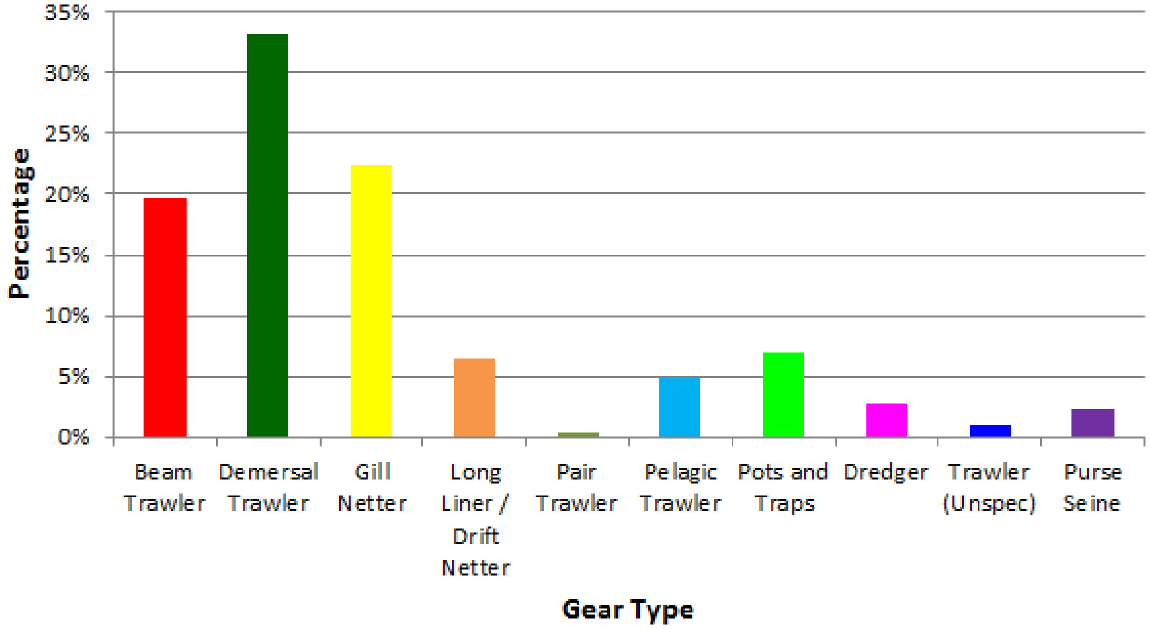

Figure 7.7 Gear Type Distribution, less than 6 knots, 12 Month AIS Data (2014/2015)

It can be seen that the majority of vessels assumed to be actively fishing within the study area were demersal (otter) trawlers (33%), followed by gill netters (22%) and beam trawlers (20%).

It is noted that beam trawlers and demersal trawlers both trawl along the seabed and could therefore interact with the route. Typical penetration depths of these gear types are presented in Section 7.10.

7.6 Vessel Sizes

Figure 7.8 presents the tracks of vessels actively fishing colour coded by vessel length.

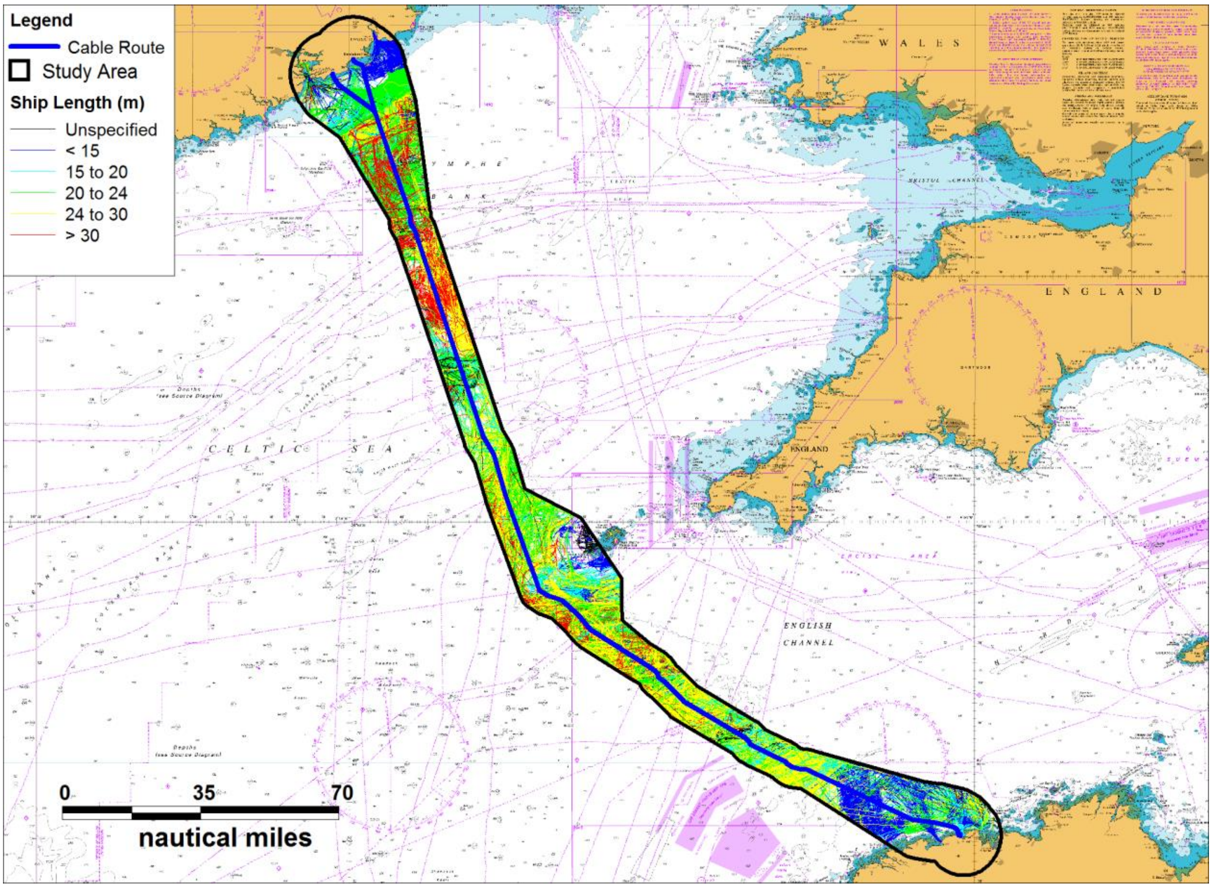

Figure 7.8 AIS less than 6 knots, by Length, 12 Months AIS Data (2014/2015)

It can be seen that the vast majority of vessels actively fishing had length of less than 30m. The distribution of vessels actively fishing by vessel length is presented in Figure 7.9. This is based on unique vessels per day.

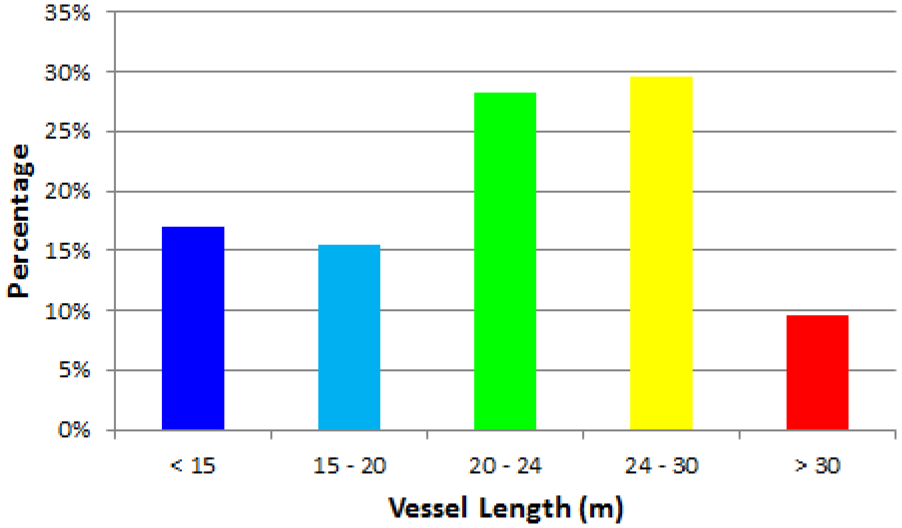

Figure 7.9 Fishing Vessel Length Distribution, less than 6 knots, AIS Data

Figure 7.10 presents the tracks of vessels actively fishing, colour-coded by gross tonnage.

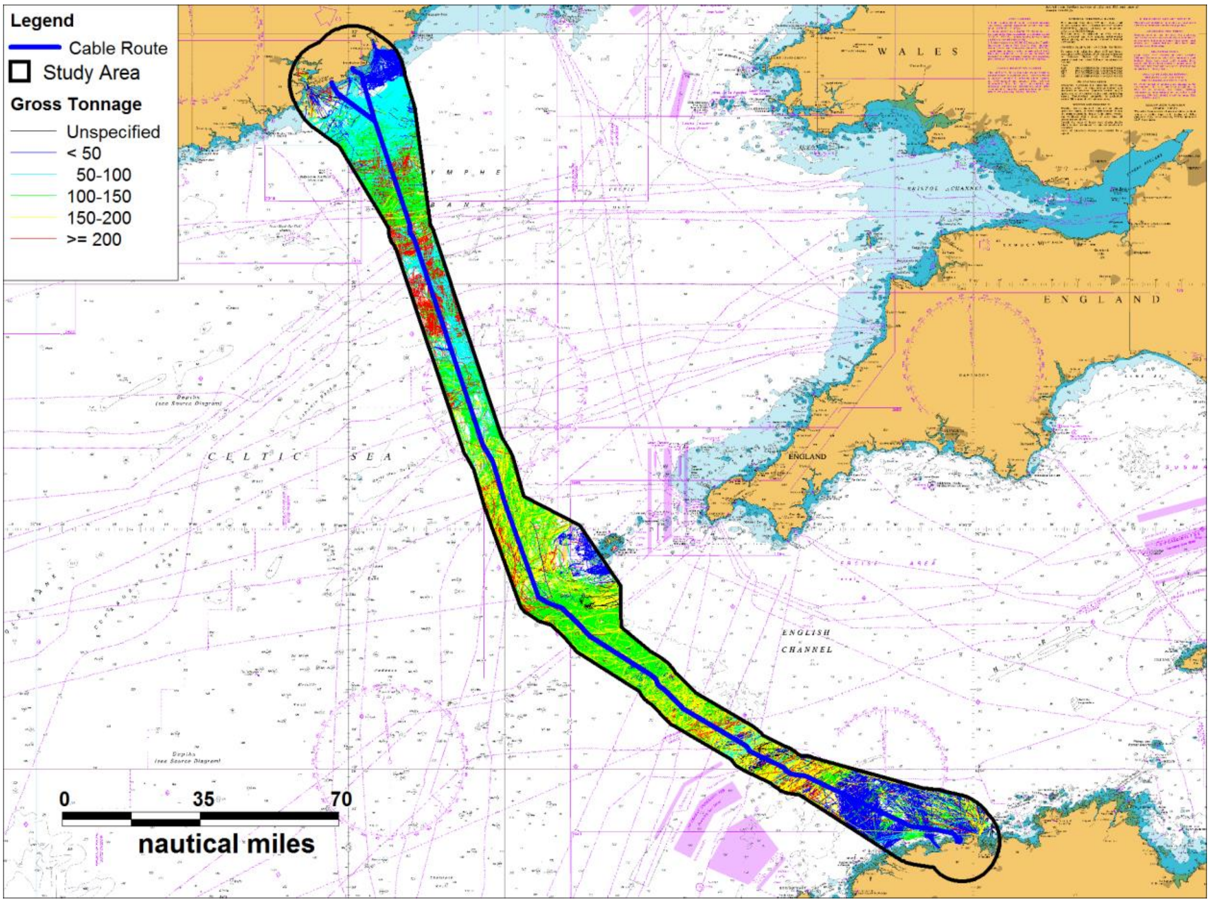

Figure 7.10 AIS less than 6 knots, by GT, 12 Months AIS Data (2014/2015)

The distribution of GT of the vessels at less than 6 knots is presented in Figure 7.11, excluding 1% unspecified.

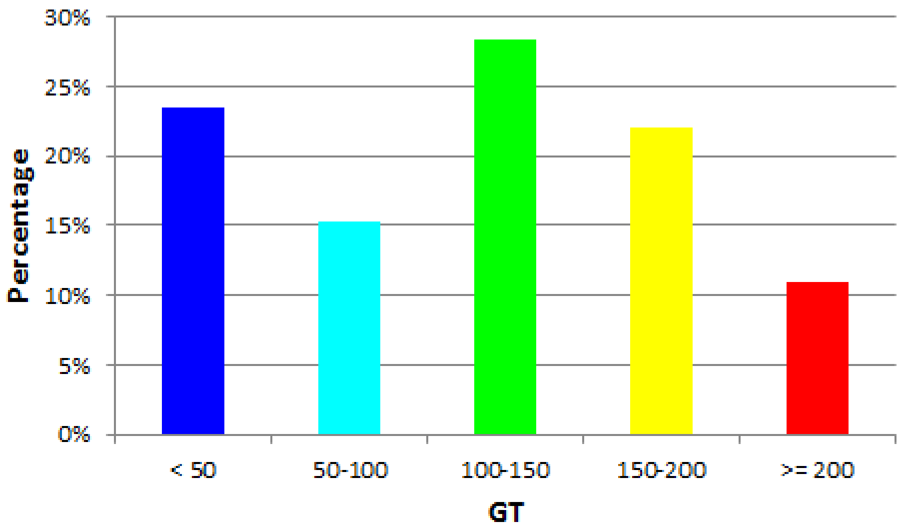

Figure 7.11 Fishing Vessel GT Distribution, less than 6 knots, AIS Data

7.7 Fishing Density

It was seen that the most significant gear types of vessels actively fishing in the study area were demersal (otter) trawlers, beam trawlers and gill netters. In order to identify sections of the proposed cable route where there was a significant amount of fishing activity, density maps for each of these gear types were created. These are presented in Figure 7.12, Figure 7.13 and Figure 7.14.

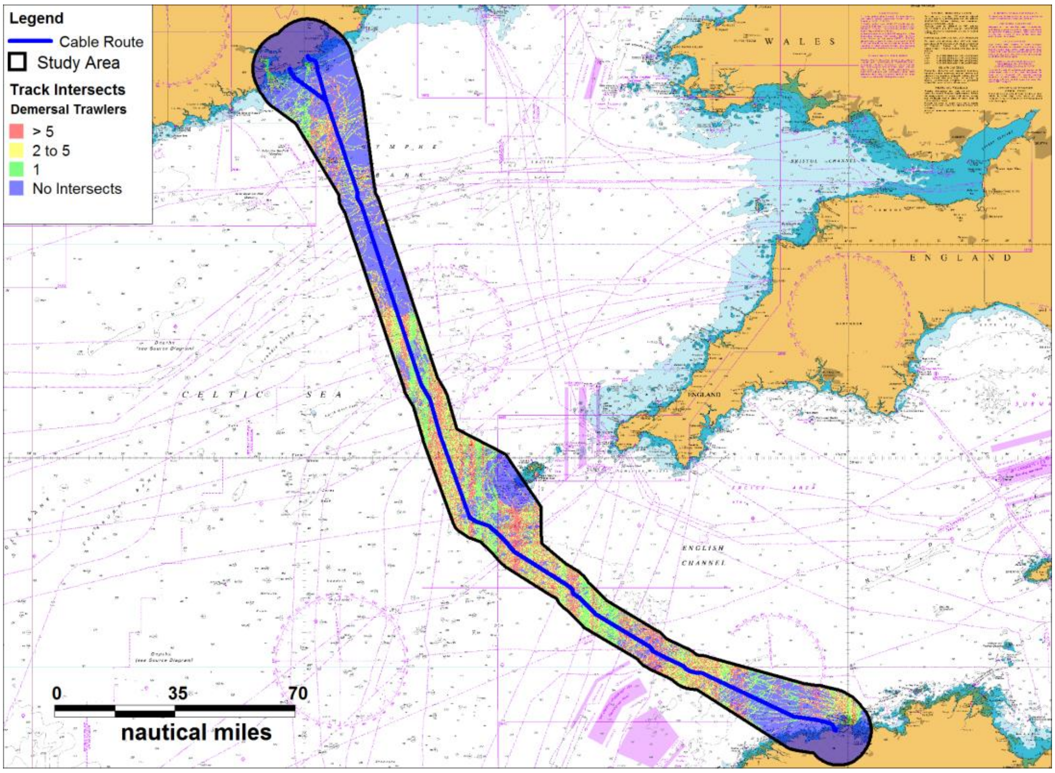

Figure 7.12 Demersal (Otter) Trawlers Actively Fishing, Density Plot

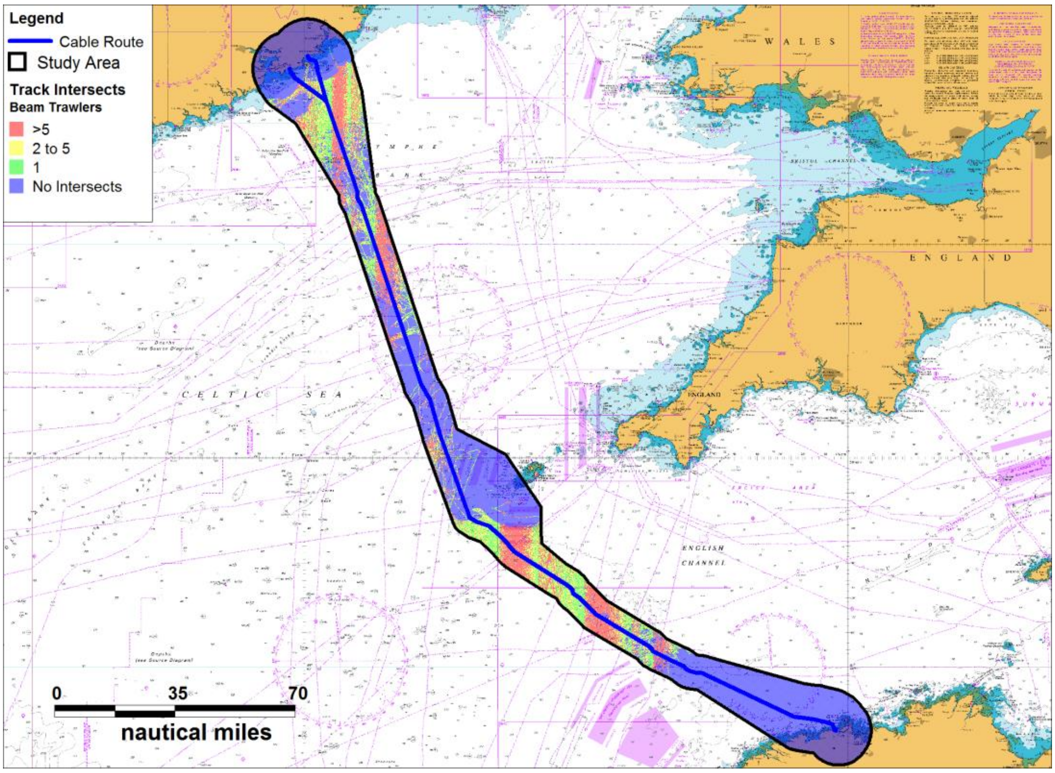

Figure 7.13 Beam Trawlers Actively Fishing, Density Plot

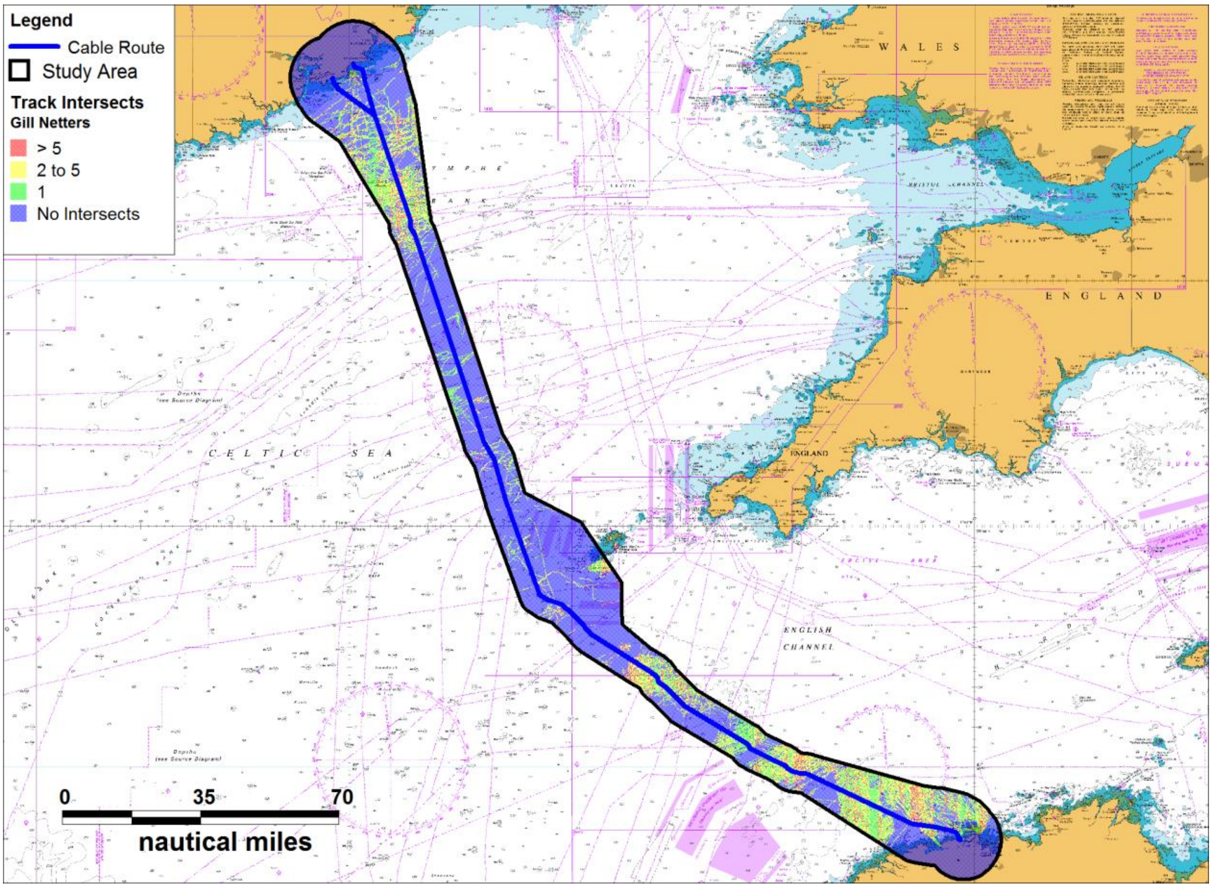

Figure 7.14 Gill Netters Actively Fishing, Density Plot

It can be seen that demersal trawlers were actively fishing within the study area along the majority of the route, while beam trawlers were mainly concentrated in the area off the coast of Ireland and to the SE of the Scilly Isles. The gill netters were seen to be actively fishing close to the Irish and French coasts. The density of gill netters was generally lower than the demersal otter and beam trawlers.

7.8 Fishing Crossing Frequency

This section assesses the frequency of crossings between fishing vessels and the proposed cable route, based on the 12 months of AIS data. A crossing is defined as a situation where a fishing vessel crosses a cable route based on consecutive points being either side of the cable route.

Anatec's Fishing Cable model was used to calculate the total number of crossings of the proposed cable route by fishing vessels.

The assessment focuses on vessels travelling at less than 6 knots, i.e. those that could potentially be actively fishing, since it is these vessels that are likely to interact with the cable.

The model calculates all crossings per KP of the cable route, i.e. if a vessel crosses a cable section multiple times, each crossing is counted within the results. Results are presented on an annual basis.

7.8.1 Fishing Crossing Results

The total number of crossings (by vessels travelling below 6 knots) for the main route was determined to be 8,062 per year, 222 of which were over the Ballinwilling landfall option. In addition, the Ballycroneen landfall option was calculated to have 399 crossings per year. The French landfall route options did not have any fishing-cable crossings.

In order to identify sections of the route considered to be high risk from fishing vessels, the distribution of the annual number of fishing-cable crossings per KP of cable is presented in Figure 7.15.

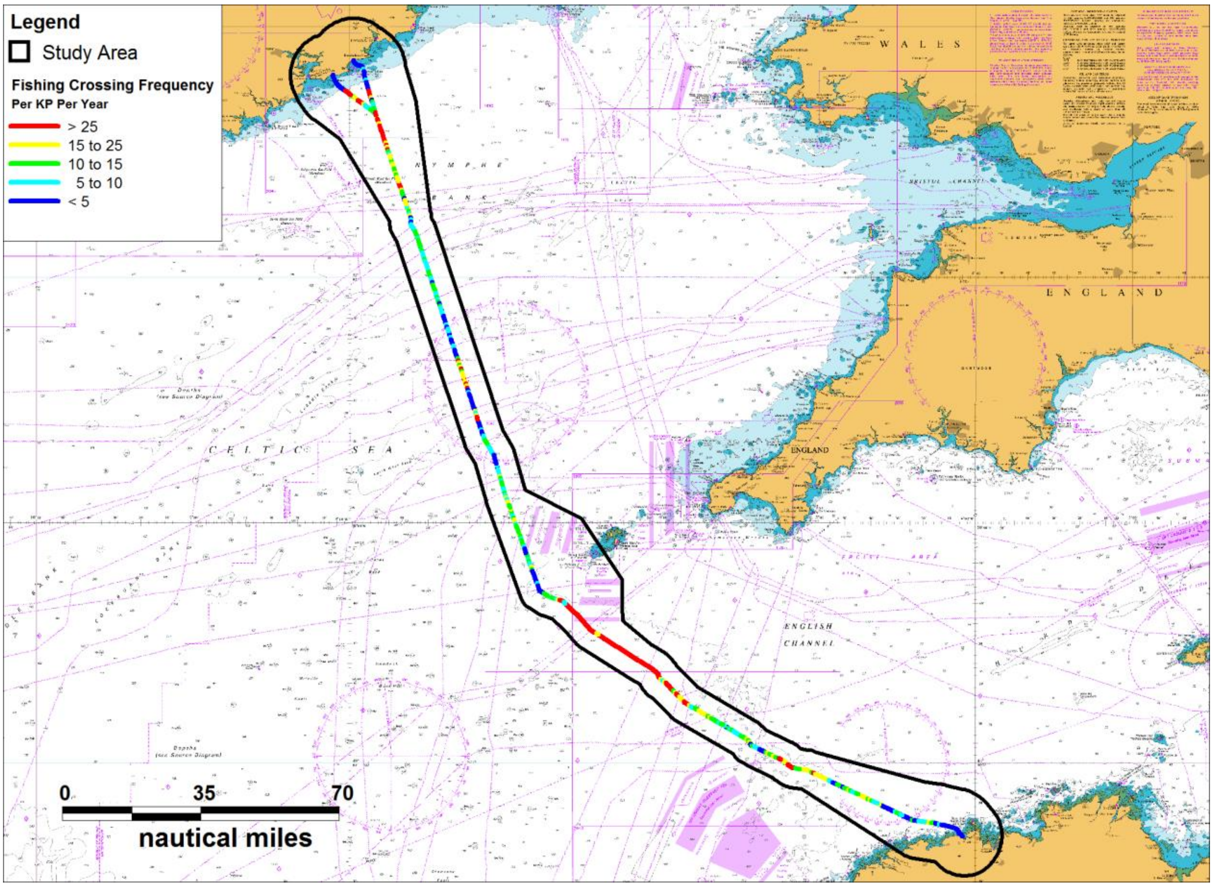

Figure 7.15 Annual Fishing Crossing Frequency Results per KP of Cable Route

It can be seen that the highest risk areas for fishing vessel crossings were the Irish landfall options, KP26 to KP44 on the main route (close to where the Ballycroneen landfall option branches off) and to the south of the Scilly Isles, between KP 265 and KP 343 on the main route.

7.8.2 Results per Gear Type

Figure 7.16 presents a plot of all fishing-cable crossings for vessels travelling at less than 6 knots, colour-coded by fishing vessel gear type.

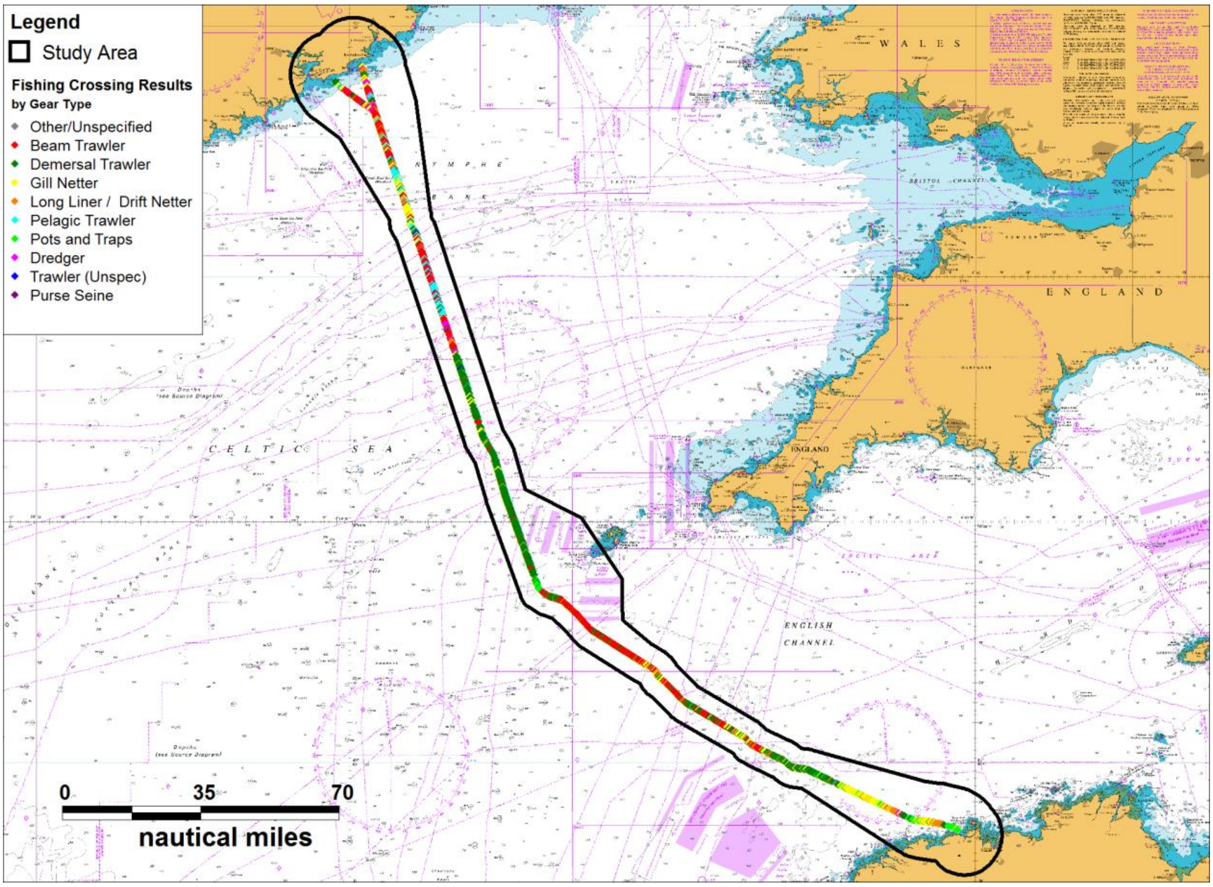

Figure 7.16 Annual Fishing Crossing Results by Gear Type

It can be seen that the majority of crossings were by beam trawlers, demersal trawlers and gill netters.

Table 7.1 and Table 7.2 present a breakdown of the annual number of crossings per gear type per 50km of the main route and for each of the Irish landfall options. There were no crossings of the French landfall options by vessels actively fishing. It is noted that, although there was activity from pair trawlers within the study area, none of these crossed the proposed routes.

Similarly for the ship crossings, the first 50km of the main route contains the Ballinwilling landfall option, although this is also presented separately in Table 7.2 for comparison with the Ballycroneen option.

Cable Route Section	Number of Fishing-Cable Crossings per Year										
	Beam Trawlers	Demersal Trawlers	Gill Netter	Long Liner / Drift Netter	Pelagic Trawler	Pots and Traps	Dredger	Trawler (Unspec)	Purse Seine	Other / Unspecified	Total
Main Route – KP 0-50	474	76	140	76	69	0	58	1	0	3	896
Main Route – KP 50-100	123	64	242	11	212	0	0	5	8	8	673
Main Route – KP 100-150	105	166	15	2	87	0	23	7	13	0	418
Main Route – KP 150-200	22	429	24	0	7	0	4	8	0	1	495
Main Route – KP 200-250	25	461	16	2	1	1	0	0	0	0	506
Main Route – KP 250-300	1603	269	9	0	0	29	0	9	2	0	1921
Main Route – KP 300-350	1083	381	213	0	0	0	1	0	0	0	1678
Main Route – KP 350-400	133	272	193	35	0	25	0	0	0	7	665

Cable Route Section	Number of Fishing-Cable Crossings per Year										
	Beam Trawlers	Demersal Trawlers	Gill Netter	Long Liner / Drift Netter	Pelagic Trawler	Pots and Traps	Dredger	Trawler (Unspec)	Purse Seine	Other / Unspecified	Total
Main Route – KP 400-450	0	250	276	29	0	86	0	0	0	7	648
Main Route – KP 450-488	0	11	67	35	0	40	9	0	0	0	162
Total	**3,568**	**2,379**	**1,195**	**189**	**376**	**181**	**95**	**30**	**23**	**26**	**8,062**

Table 7.1 Annual Fishing-Cable Crossings per 50km, Main Route, by Gear Type

Cable Route Section	Number of Fishing-Cable Crossings per Year										
	Beam Trawlers	Demersal Trawlers	Gill Netter	Long Liner / Drift Netter	Pelagic Trawler	Pots and Traps	Dredger	Trawler (Unspec)	Purse Seine	Other / Unspecified	Total
Ballinwilling Strand	117	13	23	17	6	0	45	1	0	0	222
Ballycroneen	303	19	31	10	15	0	19	1	1	0	399

Table 7.2 Annual Fishing-Cable Crossings, Irish Landfall Options, by Gear Type

It can be seen that 6,072 (75%) of the main route crossings, 342 (86%) of the Ballycroneen landfall option crossings and 176 (79%) of the Ballinwilling landfall option crossings were by demersal vessels (i.e. demersal trawlers, beam trawlers and dredgers), or by a vessel type that could include demersal vessels (i.e. trawlers or unspecified trawlers).

Within the fishing risk assessment in Section 0, the focus will be on demersal vessels actively fishing in the vicinity of the proposed cable routes.

7.9 Vessels Not Broadcasting on AIS

An analysis of fishing vessel crossings was also carried out using the 2009 VMS satellite data in Appendix B. This showed that the number of fishing vessels crossings agreed reasonably well with the AIS analysis, but there was a slightly higher number of crossings in the VMS data.

This could be due to the 5-6 year time difference between the two data sets, as it is possible that fishing locations and levels of activity have changed in this time, due to fluctuations in landings and changes in quota allocations, legislation, economic constraints and other restrictions.

However it has been observed that fishing vessels may temporarily stop broadcasting on AIS while fishing. An analysis in the North Sea investigated situations where fishing vessels had turned off AIS broadcasts while fishing. The analysis used radar survey recordings to compare the fishing vessels identified by radar with those recorded on AIS. It was estimated that, for the North Sea, approximately one third of fishing vessels were not broadcasting their position.

It is unclear whether this factor would be similar for the Celtic Interconnector study area, therefore it has not been applied in this case, but it should be noted that this could lead to under-reporting of fishing vessels in the AIS data.

It is further noted that AIS data only covers vessels greater than 15m in length and there may be some under-reporting of smaller vessels within the data. However, it is considered that, due to their size, these vessels are unlikely to cause significant damage to the proposed cable.

7.10 Fishing Gear Penetration Depths

The likelihood of damage to a buried subsea cable from fishing gear depends on the penetration depth of the equipment. This depends on the gear type and on the seabed type.

Fishing activity recorded in the study area included demersal (i.e. bottom), pelagic (midwater) and static gear types.

Demersal gear types include demersal trawlers, beam trawlers and dredgers. These vessels target both finfish and shellfish species found on or near the bottom of the sea. Demersal trawlers can be used in shallow or deep water, ranging from 25m to 1,000m (Ref viii). Beam trawlers and dredgers tend to be used in water depths up to 200m.

Pelagic gear types include pelagic trawlers and purse seines. These vessels are used principally in fishing for shoaling species, such as herring, mackerel, scad, blue whiting, sprats, etc. (Ref viii). These species may be found close to the surface, in midwater or close to the bottom and, as such, pelagic vessels may be used in a variety of water depths. Pelagic gear is not designed to interact with the seabed and any interaction may cause damage to the fishing gear. It is therefore assumed that the fishermen will ensure that the gear is operated correctly, maintaining a reasonable distance from the seabed, and, as such, pelagic gear is not expected to pose any risk to the cable.

Pair trawlers may be demersal or pelagic. Demersal pair trawlers are generally used in water depths under 200m. Pelagic pair trawlers may be used in a wide range of water depths, with larger trawlers searching for shoals far offshore, in deep water(Ref viii).

Static gear types, such as gill netters, pots and traps and long liners, are used to capture a variety of species, including finfish and shellfish. The gear may be anchored to the seabed to keep it stationary (subject to tides and currents) once in position. These gear types can be used in a wide range of water depths. Since it is assumed that fishermen will carefully choose the position of the fixed gear, taking into consideration the whereabouts of any seabed structures, and since the penetration depth of the anchors required to fix the gear to the seabed is only a few millimetres (Ref ix), these gear types are not considered to pose a risk to the proposed cable.

Of the fishing gear types active in the area, only beam trawlers, demersal trawlers, dredgers and any demersal pair trawlers are expected to interact with the route. Unspecified trawlers may be demersal or pelagic and have therefore been included within the demersal category for the fishing risk assessment in Section 0.

Table 7.3 presents researched penetration depths for vessels with different gear types and seabed types, from a number of sources. It is noted that there is a wide range of values indicated in the literature for fishing gear penetration depths. The values given in Table 7.3 are therefore indicative and subject to variations depending on the source, seabed type, vessel and gear size and other factors.

Gear Type	Penetration Depth	Reference	Substratum
Otter boards	100mm to 150mm	Arntz and Weber, 1970	Muddy fine sand
Otter boards	Up to 300mm	Jones, 1992	Soft mud
Otter trawl ticklers	Thin layer of top substrate	Bridger, 1970	Sand

Gear Type	Penetration Depth	Reference	Substratum
Beam trawls	80mm to 100mm	Margetts and Project Bridger, 1971	Muddy sand
Beam trawls	100mm to 200mm	Houghton et al., 1971	Sand
Beam trawls	0 to 27mm	Bridger, 1932	Mud
Beam trawls	Approximately 60mm	Bergman et al., 1990	Fine to medium hard sand
Beam trawls	200mm	Laane et al., 1990	Mud, sand
Beam trawls	40mm to 70mm	Laban and Lindeboom, 1991	Fine sand
Beam trawls	20mm to 300mm	Rauck, 1988	Mud, sand

Table 7.3 Penetration Depths of Fishing Gear Types

It can be seen that fishing gear tends to penetrate the seabed to only a few centimetres in most seabed types. The maximum penetration depth associated with fishing gear was seen to be 300mm.

8. Anchor Dragging Risk Assessment

8.1 Introduction

This section assesses the risk to the proposed Celtic Interconnector route from anchor dragging, that is, the probability that an anchored vessel loses its holding ground, and subsequently drags its anchor over the proposed cable route. The analysis in this section is based on the anchoring observed in the twelve months of AIS data, as presented in Section 5.

8.2 Methodology and Inputs

An overview of the Anchor Dragging model methodology, inputs, and outputs is presented in Figure 8.1.

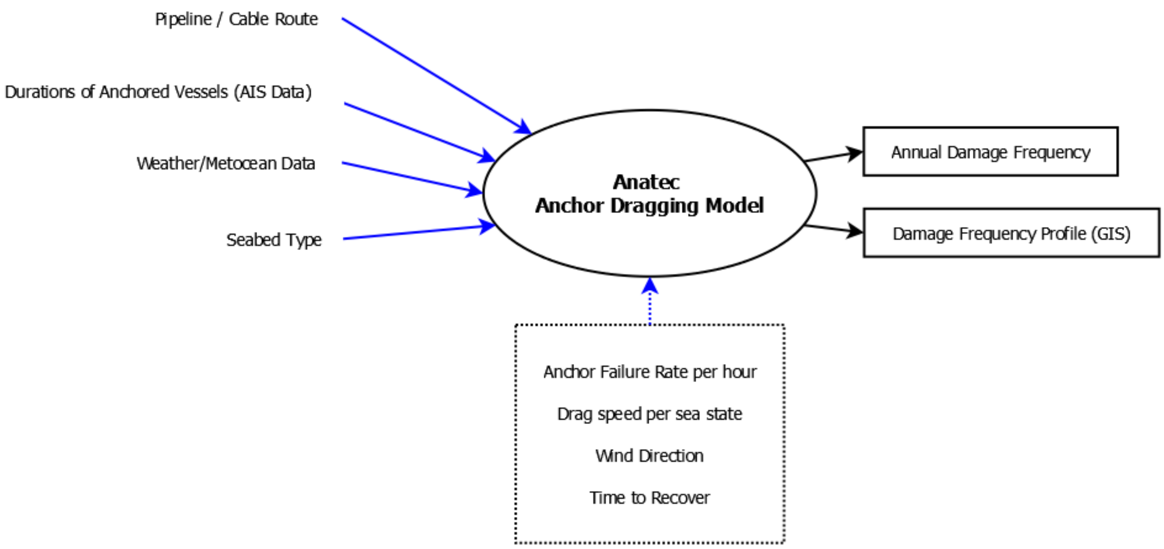

Figure 8.1 Anchor Dragging Model Methodology

The model takes as input a durations table, which consists of a grid containing durations of all vessels at anchor within the study area (presented in Section 6.2). The (hourly) probability that a vessel in a grid cell will drag anchor is given by the following formula:

$$\text{Probability of dragging anchor} = \frac{\text{Anchor Failure Rate}}{\text{Holding Factor}}$$

where the Anchor Failure Rate depends on the wind speed (calm, moderate or severe), and the Holding Factor depends on the sea bed type and mobility, e.g., sand, clay, gravel, etc.

The Anchor Failure Rate is defined as probability that an anchor is expected to lose its holding ground and subsequently drag per hour at anchor in a seabed of average holding ground (e.g. medium dense sand). The Holding Factor is a factor applied to each seabed type, defined by Anatec, which weights each type within the model according to their ability to hold an anchor (see Table 8.1).

The probability of dragging anchor is multiplied by the total accumulated hours that vessels are at anchor in each durations grid cell, for each vessel type and size, in order to get the frequency of dragged anchor events for each grid cell in the durations table.

The probability that a vessel drags anchor towards the cable depends on the direction of the cable from the vessel and the probability that the wind is in that direction.

Once the anchor starts to drag, it is likely that the vessel's crew will recognise this, either by changes in the vessel motion or from an alarm (if a watch zone has been set). The Master may be called and recovery action taken such as paying out more of the anchor chain, deploying the 2nd anchor and/or starting the vessel's engine(s) to allow the vessel to manoeuvre away from any danger. The probability that the action is not taken within the time it takes to reach the cable route is given by the following formula.

$$Probability\ of\ Not\ Recovering = exp\left(-\left(\frac{\text{Distance to Cable}}{\text{Drift Speed}}\right)/(\text{Time to Recover})\right)$$

The Drift Speed varies by wind speed (calm, moderate or severe), and is taken as follows:

- Calm = 1 knot
- Moderate = 1.5 knots
- Severe = 3 knots

The mean time to recover was taken as 15 minutes, based on marine experience and advice from master mariners.

The probability of not recovering is presented graphically in Figure 8.2 for each sea state.

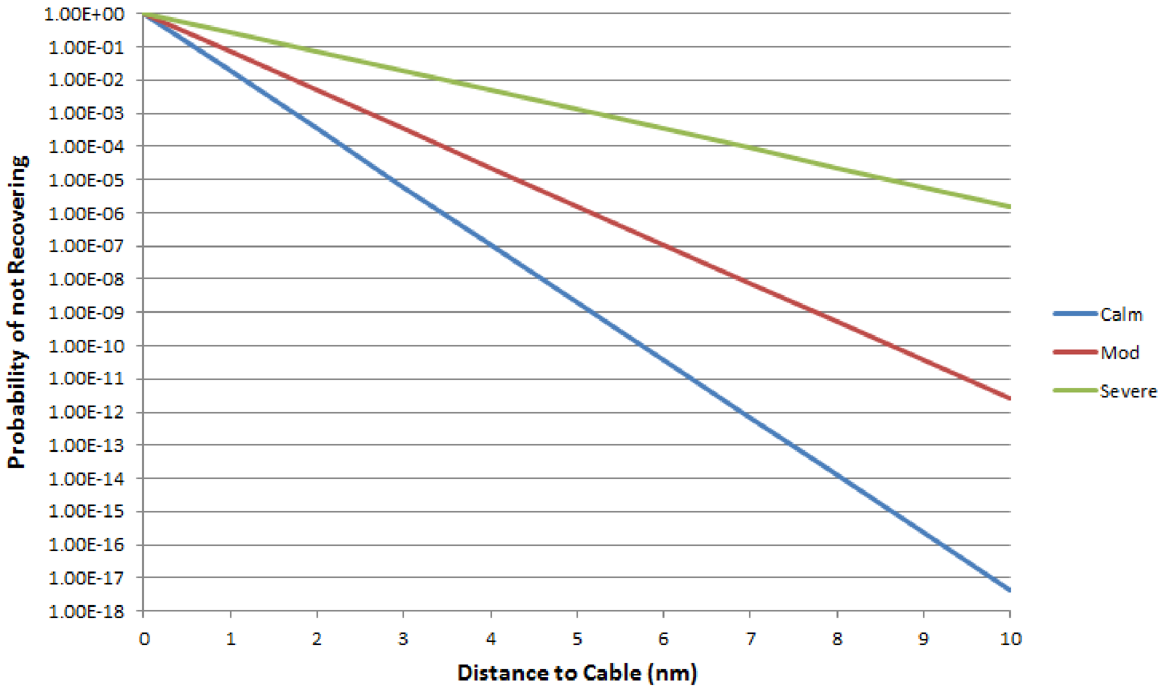

Figure 8.2 Probability of not Recovering

It can be seen that, if the vessel dragging anchor is 1nm from the cable, the probability that it does not recover before reaching the cable varies from 1 in 4 for severe sea states to 1 in 55 for calm seas. In contrast, at a distance of 10nm, the Probability of Not Recovering is approximately 1 in 600,000 for severe sea state, and becomes negligible for calm seas, i.e. there is a very high likelihood that the vessel can recover from a dragged anchor incident before it has drifted 10nm.

The model determines the frequency of anchor drag over the cable by multiplying the probability of dragging anchor with the probability that the anchor drags towards the cable, followed by the probability that the vessel does not recover in time.

The frequency that a vessel in a grid cell drags anchor onto a section of cable is therefore calculated by:

$$\begin{aligned} &\mathit{Anchor\ Drag\ Frequency} \\ &\quad = \sum_{grid\ cell} \sum_{vessel\ type} \sum_{vessel\ size} (\mathit{Anchor\ Duration\ in\ grid\ cell} \\ &\quad \times \mathit{Probability\ of\ Anchor\ Drag\ per\ Hour} \\ &\quad \times \mathit{Probability\ of\ Wind\ in\ Direction\ of\ Cable\ Section} \\ &\quad \times \mathit{Probability\ of\ Not\ Recovering}) \end{aligned}$$

where

$$\text{Probability of Anchor Drag per Hour} = \sum_{sea\ state} \frac{\text{Anchor Failure Rate per sea state}}{\text{Holding Factor}} \times \text{Sea State Probability}$$

The model inputs are described below.

8.2.1 Durations Grid

The AIS tracks from anchored vessels (see Section 6) were used to determine the total number of hours that vessels spent at anchor within each 250m x 250m cell of a grid covering the study area, broken down by vessel type and size. A total of 5,119 hours were recorded during the twelve months, with the vast majority (91%) occurring in or near the outer Cork anchorage.

It is noted that the above total excludes cells in which land shields the anchored ships in the cell from the proposed cable route, should the vessel drag anchor. However, where there was only partial shielding, the cells have been included, which is conservative. It was confirmed this did not significantly affect the results.

Each grid cell with non-zero anchor durations was then assigned a Holding Factor based on the holding power of the seabed type of that cell. Seabed types were identified from the Pilot Books where possible, with Admiralty Charts used as a secondary source. Seabed types considered to have better holding ground were assigned greater Holding Factor.

The Holding Factors used are presented in Table 8.1. Holding Factors have been assigned by Anatec based on information from mariners and experience from previously undertaken anchoring assessments.

Seabed Type	Holding Factor
Mud	1.2
Sand and Mud	1.1
Sand	1
Mud and Gravel	1
Poor Sand	0.9
Gravel	0.9
Broken Shells	0.8
Rock	0.7

Table 8.1 Holding Factor

8.2.2 Weather and Vessel Characteristics

Anchor Failure Rate of ships has not been widely researched in general. It is known from experience to be a rare occurrence, and most common in storm conditions. The following describes the available information:

- Maritime and Coastguard Agency (MCA) commissioned research assigned an AFR of 6.5×10^{-5} per system hour for Inland Waterways and Coastal Waters (Ref. x).
- A report by a Canadian Naval Architect, Robert Allan Ltd (Ref. xi) considered the probability of vessels dragging anchor from various anchorages in British Columbia and assigned AFR values ranging from 0.01 (for smaller vessels) to 0.001 (for larger vessels with possibility of tug assistance). This is the rate that an anchor drags in severe weather per anchored event and each event was assumed to last a day. Hence the hourly AFR would be between 4.2×10^{-4} and 4.2×10^{-5}.
- The Marine Accident Investigation Branch (MAIB) (Ref xii) reported 20 accidents involving dragging anchor then grounding between 1992 and 2007. This corresponds to 1.3 events per year. If it is assumed that grounding only results in 1% of incidents, the AFR would range from approximately 5×10^{-5} to 1×10^{-4} per hour at anchor based on internal research by Anatec on the estimated duration of anchorings in the UK per year.

All sources are in reasonable agreement therefore the MCA value of 6.5×10^{-5} per hour was used in the model i.e. the model estimates that if a vessel was continuously anchored in the area for 2 years then it would drag anchor once during this time.

The failure rate was varied according to weather to make it more likely in severe conditions and less likely in calm conditions, which is aligned with marine experience. It was assumed that the Anchor Failure Rate would be an order of magnitude lower than the average value for calm sea state and an order of magnitude higher for severe sea state. The moderate sea state anchor failure rate was then weighted by sea state probability to ensure that the average anchor failure rate of 6.5×10^{-5} was maintained. Anatec's in-house metocean data was used to estimate the probability of calm, moderate and severe weather for the area. These probabilities varied along the proposed cable route. The average probabilities are provided in Table 8.2.

The anchor failure rates used within the model for each weather state are presented in Table 8.2.

Sea State	Sea State Probability	Anchor Failure Rate (Hourly)
Calm	0.15	6.5×10^{-6}
Moderate	0.80	3.1×10^{-5}
Severe	0.05	6.5×10^{-4}

Table 8.2 Weather States and Anchor Failure Rates

The Metocean data was also used to estimate the probabilities of wind direction.

8.3 Results

It was estimated that a vessel would drag anchor over the cable route once every 7,400 years, which corresponds to a frequency of 5.4 x 10^{-3} over the expected 40 year operational span of the proposed cable. It is noted that this includes the Ballinwilling Strand landfall option, but does not include a French landfall (see Section 2.1).

The anchor dragging frequencies estimated for each of the landfall options are presented in Table 8.3.

	Route	Frequency Per Year	Return Period
Ireland	Ballinwilling Strand	1.4 x 10^{-4}	7,400
	Ballycroneen	5.2 x 10^{-6}	193,100
France	Kerradenec	1.5 x 10^{-8}	67,187,300
	Port Neuf	1.2 x 10^{-8}	85,766,200

Table 8.3 Annual Anchor Dragging Frequency - Landfalls

The Ballinwilling Strand was estimated to experience an anchor dragging incident once every 7,400 years, which corresponds to a frequency of 5.4 x 10^{-3} over the expected 40 year operational span of the proposed cable. It is noted that the risk to this landfall corresponds to 99% of the total main route risk. An anchor dragging incident was estimated to occur over the Ballycroneen Irish landfall option once every 193,100 years, which corresponded to a frequency of 2.1 x 10^{-4} over the expected 40 year operational lifespan of the proposed cable.

The anchor dragging return period for the Kerradenec landfall option was estimated to be 67,000,000 years. The Port Neuf return period was 86,000,000 years. This corresponds to frequencies of 6.0 x 10^{-7} and 4.7 x 10^{-7}, respectively, over the expected 40 year operational lifetime of the proposed cable.

The vast majority of the anchor dragging risk was to the Irish landfall options. As no significant anchoring was recorded in areas that could reach the cable outwith Irish waters, the anchor dragging risk to the cable is very low in French and UK waters.

The results for the Irish landfalls are presented graphically in Figure 8.3. The tracks from anchored vessels have been included in the figure for reference.

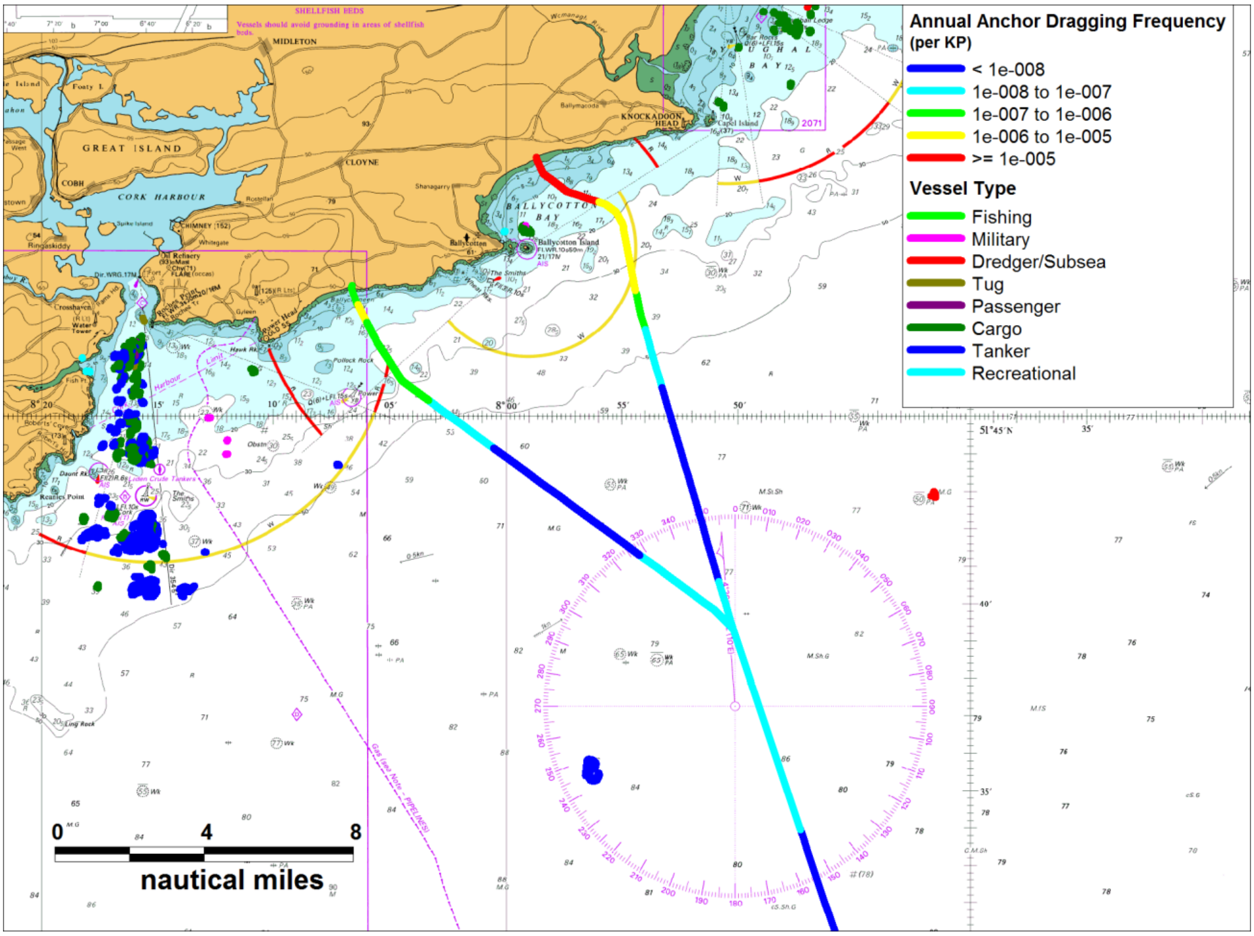

Figure 8.3 Annual Anchor Dragging – Irish Landfalls

The highest risk area was KP 1 to 4 of the main route, resulting from the vessels anchored in Ballycotton Bay (vessels less than 5,000 DWT). The vessels anchored east of the Cork outer anchorage were the most significant contributors to the Ballycroneen landfall option risk, particularly the cargo vessel and tanker anchored shown in Figure 8.3. It was noted that the vessels anchoring in or south of the anchorage (including cargo vessels and tankers greater than 40,000 DWT) contributed to a lesser extent.

Approximately 51% of the anchor dragging risk was from vessels less than 1,500 DWT, and 48% from vessels between 1,500 and 5,000 DWT. This was largely due to the anchoring in Ballycotton Bay. The annual anchor dragging risk for the main route split by 50km sections is presented in Table 8.4 divided by vessel size. The results for the landfall options split by size are presented in Table 8.5. Where the total return period of a section was less than once every billion years the risk has been labelled as negligible. The size categories are presented in Table 5.2.

Main Route Section	Anchor Dragging Risk					
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
KP 0-50	6.92E-05	6.54E-05	1.38E-09	Negligible	Negligible	6.17E-07
KP 50-100	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 100-150	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 150-200	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 200-250	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 250-300	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 300-350	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 350-400	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 400-450	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
KP 450-487	8.07E-08	4.46E-08	Negligible	Negligible	Negligible	Negligible
Total	6.93E-05	6.54E-05	1.38E-09	Negligible	Negligible	6.17E-07

Table 8.4 Annual Anchor Dragging Frequency by Size – Main Route

Landfalls	Anchor Dragging Risk					
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Ballinwilling Strand	6.92E-05	6.54E-05	1.38E-09	Negligible	Negligible	4.97E-08
Ballycroneen	1.10E-07	3.39E-07	3.94E-06	4.13E-07	1.23E-07	2.50E-07
Port Neuf	1.17E-08	Negligible	Negligible	Negligible	Negligible	Negligible
Kerradenec	1.49E-08	Negligible	Negligible	Negligible	Negligible	Negligible

Table 8.5 Annual Anchor Dragging Frequency by Size - Landfalls

9. Emergency Anchoring Risk Assessment

9.1 Introduction

This section investigates the potential risk to the proposed cable from vessels anchoring in an emergency.

Anatec's Emergency Anchoring model estimates the probability that a vessel sailing over a cable route suffers engine failure and subsequently drops anchor onto the cable. Calculations are performed within a Geographical Information System (GIS) with relevant shipping and operational data (e.g. vessel durations, water depth, distance to shore) as input. The emergency anchoring analysis has been based on the twelve months of AIS data presented in Section 5.

9.2 Methodology and Inputs

The Emergency Anchoring model combines the durations of vessels travelling near the cable route with the probability that a vessel suffers engine failure and the probability that the vessel drops anchor in an emergency (based on water depth and distance from the shore) to calculate the frequency of anchor drop due to emergency anchoring.

An overview of the emergency anchoring methodology, inputs and outputs is presented in Figure 9.1.

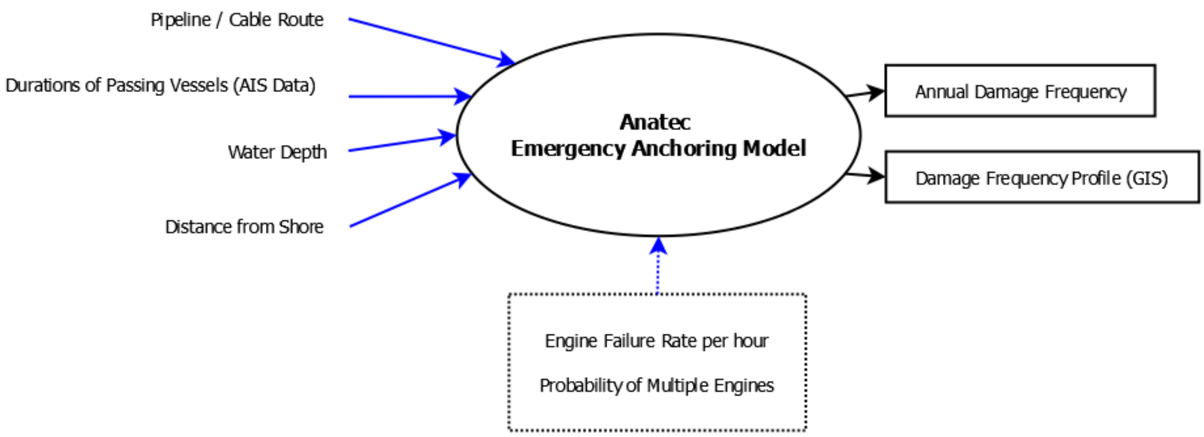

Figure 9.1 Emergency Anchoring Methodology

The formula for calculating the emergency anchoring probability is provided below:

$$\begin{aligned} &Emergency\ Anchoring\ Frequency \\ &\quad = \sum_{grid\ cell} \Bigg(Water\ Depth\ Factor \times Distance\ Factor \\ &\quad \times \sum_{vessel\ type} \sum_{vessel\ size} (Durations\ in\ grid\ cell \times Engine\ Failure\ Rate \\ &\quad \times Twin\ engine\ probability) \Bigg) \end{aligned}$$

The input tables used by the Emergency Anchoring Model are described below.

9.2.1 Exposure Grid

Vessels that passed within 100m of the proposed cable route were considered to have the potential to cause damage to the cable by anchoring in an emergency. The 100m buffer is chosen to account for the possibility that:

- There may be slight inaccuracies in the vessel's Global Positioning System (GPS)
- The location of the anchor on the vessel may be some distance from the location of the GPS
- Following anchor drop, the anchor may drag a short distance before settling into the seabed

It is noted that, in some cases, a dropped anchor from a vessel transmitting its location outside the 100m buffer may still interact with the cable (e.g. if the distance between the GPS and anchor drop location is longer than 100m or if the anchor drags farther than 100m and towards the cable).

However, in the majority of cases, the 100m buffer is considered to be conservative, as it assumes that all vessels dropping an anchor within 100m could interact with the cable whereas, in reality, the location of the anchor drop could be far from the cable or the anchor could drag away from the cable before settling. Furthermore, the approximate diameter of the proposed cable is 300mm, indicating that the seabed area covered by the cable is 0.15% of the total area of the 100m buffer. In addition, information on dimensions for various anchor types (Ref v) shows that the maximum length of the largest anchors (65,000 kg) was approximately 10m, with the majority of anchor dimensions significantly smaller than this. This suggests that an anchor dropped within the 100m buffer is more likely to impact an area of seabed that does not contain the cable than the cable itself.

The AIS data were used to populate a 250m x 250m grid encompassing the proposed route, plus 100m buffer, with vessel durations by type and size. The grid was then cropped to the 100m buffer. This is illustrated in Figure 9.2, which shows an example of the 250m x 250m cells used prior to, and post cropping. When the grid cell is cropped to the buffer, the durations are factored according to the proportion of area of the cropped cell compared to the area of the full 250m by 250m cell.

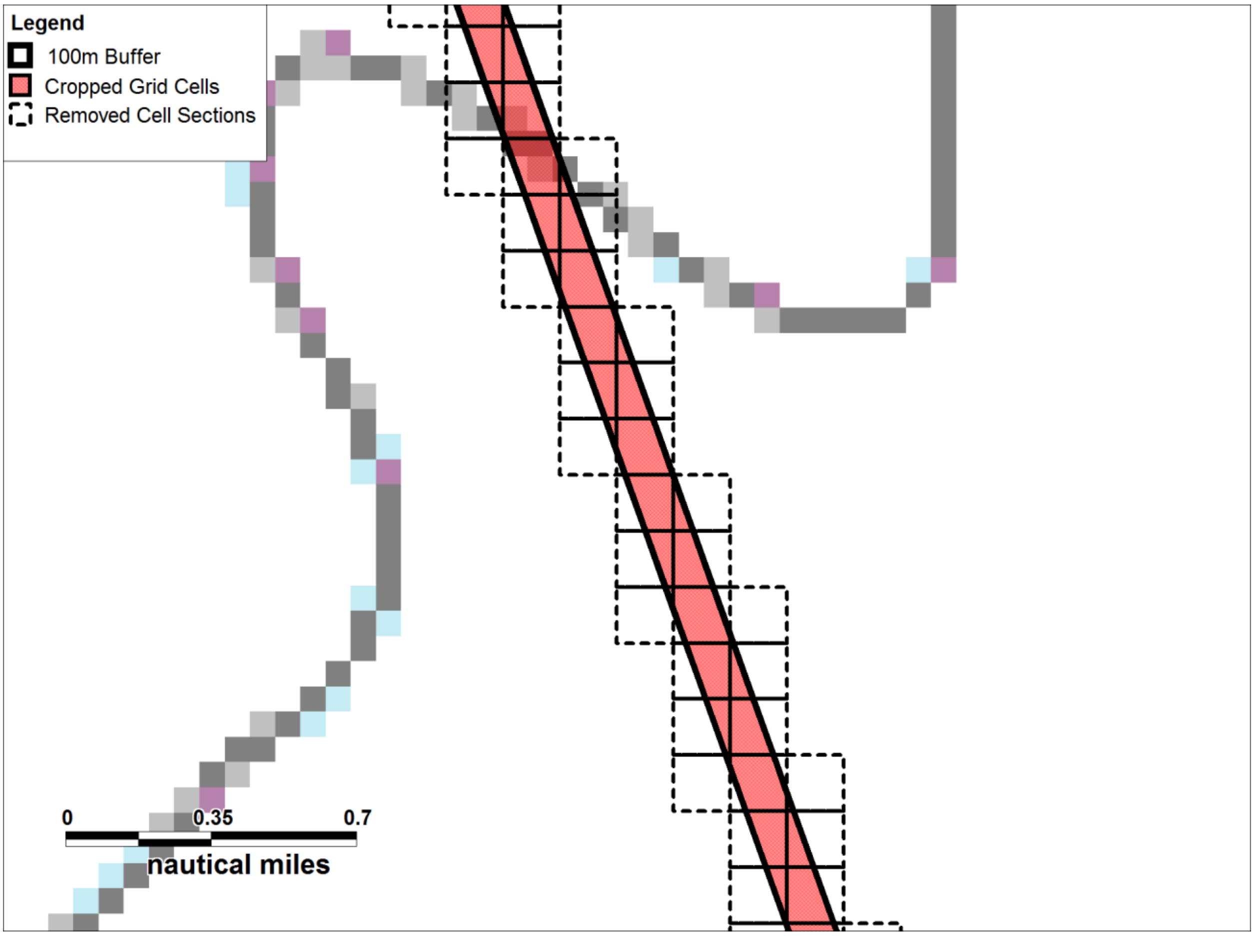

Figure 9.2 Cropped Grid Illustration

The total durations of vessels within 100m of the proposed cable route during the twelve month study period was estimated to be 1,432 hours.

The durations were multiplied with the probability of engine failure per hour, taking into account the proportion of vessels with single and multiple engines, determined according to the AIS data.

9.2.2 Engine Failure Rate

The engine breakdown probability is assumed to be 2×10^{-5} per hour. This generic failure rate is commonly cited in literature, including maritime risk studies performed on behalf of the UK Government (Ref. xiii) and US Government (Ref. xiv). The source(s) of the figure is unknown but as shipping is an international industry with standards developed and regulated through the IMO, it is assumed to be applicable to the shipping within the study area. To add further sensitivity, the failure rate has been combined with the likelihood that a vessel has more than one engine, based on vessel type and size, to give the probability that a vessel breaks down. The number of engines was assessed using vessel details for traffic travelling within 100m of the proposed cable route, identified in the AIS data.

The frequency of emergency anchoring was then estimated by combining this information with the probability that the vessel drops anchor, based on the vessel type and size and the water depth and distance from the shore. This takes into account that, on drifting, the Master will normally take some time (unless there is an immediate hazard such as risk of grounding) to assess the situation, including the location of any subsea structures identified on charts, and will only drop anchor if unavoidable or if unaware of the presence of a cable.

9.2.3 Water Depth

The probability that a vessel drops its anchor depends on the water depth, with the likelihood of dropping anchor in deeper waters lower than in shallower waters due to limitations on the length of anchor chain. The probability that a vessel anchors in a particular water depth, depending on vessel size, is given in Table 9.1.

DWT	**Water Depth Factor**			
	< 20m	**20 – 50m**	**50 – 100m**	**> 100m**
0 – 1,500	1	0.5	0.1	0.01
1,500 – 5,000	1	0.6	0.25	0.05
5,000 – 15,000	1	0.75	0.4	0.1
15,000 – 40,000	1	0.9	0.5	0.25
40,000 – 60,000	1	1	0.67	0.33

Table 9.1 Water Depth Factors

9.2.4 Distance from Shore

A vessel is more likely to drop anchor in an emergency if it is closer to shore, to prevent damage from grounding. The probability of anchoring for each distance range is given in Table 9.2.

Distance from Shore	**Distance Factor**
0 – 2 nm	0.5
2 – 5 nm	0.25
5 – 10 nm	0.1
> 10 nm	0.05

Table 9.2 Distance Factor

9.3 Results

It was estimated that a vessel would drop anchor in an emergency over the main route (inclusive of Ballinwilling landfall) once every 3,600 years. Over an estimated 40 year operational life of the proposed cable, this corresponds to a frequency of 1.1 x 10^{-2}. The emergency anchoring risk was greater than that from anchor dragging.

The results of the Emergency Anchoring analysis for the landfall options are presented in Table 9.3.

Country	Route	Frequency Per Year	Return Period
Ireland	Ballinwilling Strand	4.6 x 10^{-5}	21,700
	Ballycroneen	6.7 x 10^{-5}	14,900
France	Kerradenec	1.6 x 10^{-6}	646,100
	Port Neuf	3.5 x 10^{-7}	2,872,800

Table 9.3 Annual Emergency Anchoring Results Summary - Landfalls

The Ballycroneen landfall option emergency anchoring return period was approximately 15,000 years. Over the 40 year life of the proposed cable, this corresponds to a frequency of 2.7 x 10^{-3}. The emergency anchoring return period of the Ballinwilling Strand landfall option was estimated to be 22,000 years, corresponding to a frequency of 1.8 x 10^{-3} over the 40 year operational life.

The Kerradenec and Port Neuf French landfall options had return periods of approximately 650,000 and 2,900,000 respectively, corresponding to frequencies of 6.2 x 10^{-5} and 1.4 x 10^{-5} over the lifespan of the proposed cable.

An overview of the results is presented in Figure 9.3.

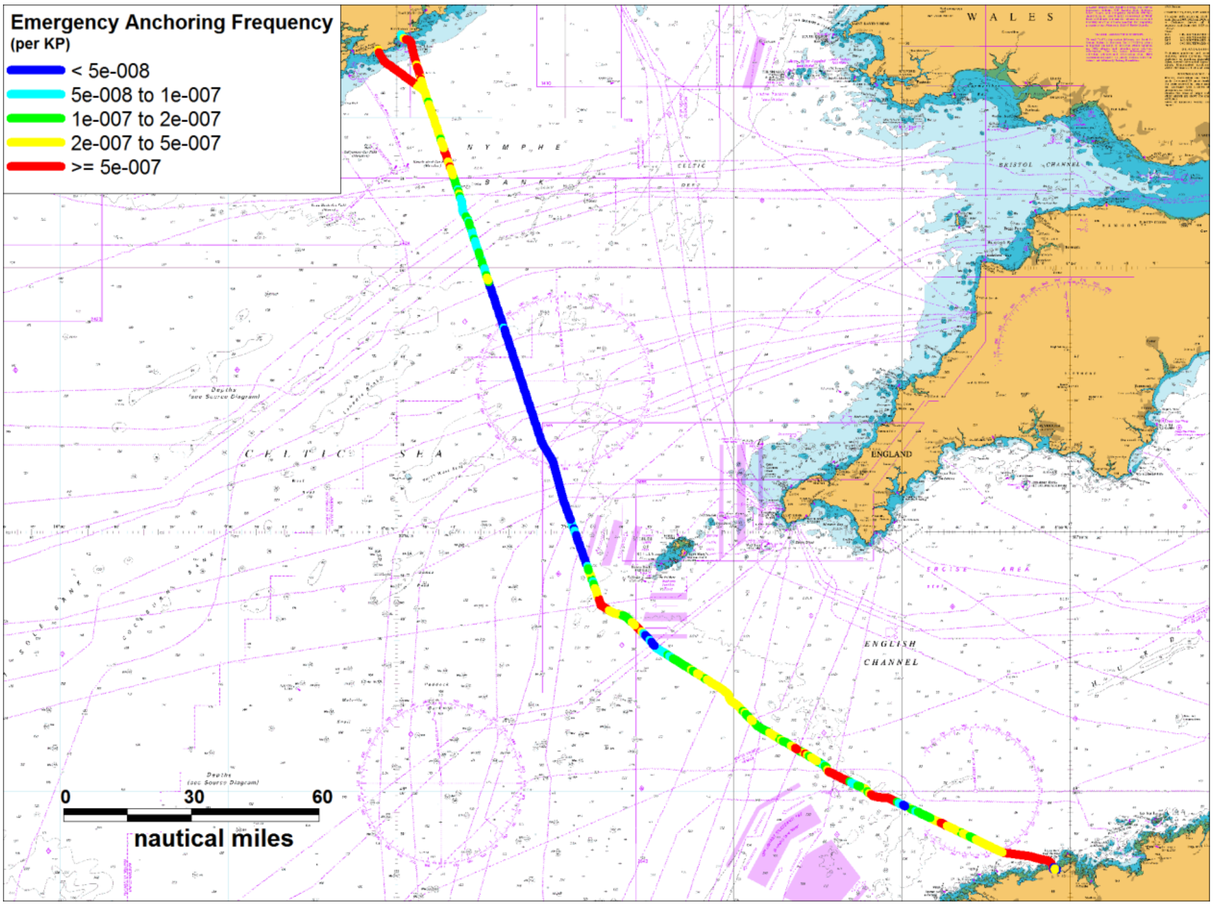

Figure 9.3 Annual Emergency Anchoring Frequency – General Overview

The following significant areas of emergency anchoring risk were identified:

- Irish Landfalls, due to the high vessel durations from coastal traffic routes combined with the proximity to danger (Irish coast) and, to a lesser extent, water depths;
- Intersection of the proposed cable with commercial traffic associated with Cork, between KPs 52 and 57, largely due to high vessel durations;
- Intersection of the proposed cable with northbound traffic and westbound traffic southwest of the Isles of Scilly, KPs 252 and 259, largely due to vessel durations;
- Entrance of the Eastbound lane of the Southern Isles of Scilly TSS, KPs 273 to 276 due to high commercial vessel durations;
- Both westbound (KPs 379 to 388) and eastbound (KPs 400 to 411) routes associated with the English Channel TSS due to the high commercial vessel durations;
- KP462 onwards, due to vessel durations, proximity to danger (French coast), and shallower water depths.

The emergency anchoring risk by size for per 50km of the main route is summarised in Table 9.4, and the result by size for each landfall option are presented in Table 9.5. KP0-50 is inclusive of the Ballinwilling Strand landfall option. The size categories used are presented in Table 5.2.

Main Route Section	Emergency Anchoring Risk					
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
KP 0-50	3.44E-05	6.80E-06	7.18E-06	1.32E-06	1.50E-06	7.18E-07
KP 50-100	4.24E-06	1.55E-06	3.18E-06	1.18E-06	9.18E-07	3.87E-07
KP 100-150	8.91E-07	8.65E-08	1.22E-07	1.46E-07	5.87E-07	7.07E-08
KP 150-200	3.23E-07	4.53E-08	3.65E-08	8.26E-08	1.83E-07	2.39E-07
KP 200-250	5.51E-07	5.42E-07	6.08E-07	7.81E-07	6.36E-07	7.79E-07
KP 250-300	1.31E-06	1.08E-06	1.97E-06	6.08E-06	9.12E-06	2.85E-06
KP 300-350	8.48E-07	7.02E-07	1.40E-06	3.28E-06	4.53E-06	1.31E-06
KP 350-400	1.01E-06	2.53E-06	6.58E-06	1.08E-05	1.22E-05	7.28E-06
KP 400-450	6.47E-06	4.03E-06	7.17E-06	1.06E-05	1.18E-05	7.63E-06
KP 450-487	8.13E-05	9.08E-07	3.88E-07	Negligible	1.33E-07	Negligible
Total	**1.31E-04**	**1.83E-05**	**2.86E-05**	**3.42E-05**	**4.17E-05**	**2.13E-05**

Table 9.4 Annual Emergency Anchoring Frequency by Size – Main Route

Landfalls	Emergency Anchoring Risk					
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
Ballinwilling Strand	3.12E-05	5.38E-06	6.88E-06	1.09E-06	1.02E-06	4.89E-07
Ballycroneen	4.08E-05	9.89E-06	1.11E-05	2.46E-06	2.05E-06	8.09E-07
Port Neuf	3.48E-07	Negligible	Negligible	Negligible	Negligible	Negligible
Kerradenec	1.55E-06	Negligible	Negligible	Negligible	Negligible	Negligible

Table 9.5 Annual Emergency Anchoring Frequency by Size - Landfalls

Overall, approximately half the emergency anchoring risk was from vessels less than 1,500 DWT. A total of 23% of the risk was from vessels larger than 40,000 DWT.

10. Foundering Risk Assessment

10.1 Introduction

A foundering event occurs when a vessel fails structurally and sinks. This type of incident has the potential to damage a subsea cable if a vessel sinks over its route. The Foundering feature of Anatec's COLLRISK model was run to assess the risk of a vessel foundering along the proposed cable route. This section uses the twelve months of AIS presented in Section 5 to assess the risk to the proposed cable from foundering.

10.2 Methodology and Inputs

The model uses the durations of vessels by type and size, and the probability of severe weather conditions to estimate the likelihood that a vessel will founder over the proposed cable route.

Anatec's Foundering model has been calibrated based on historical shipping accident data in the UK and Western Europe (49 - 62 North, 12 West - 4 East) over the 10-year period 1989 to 1998 (inclusive) as recorded in the Lloyd's Register Casualty Database. (Ref xiii). Incidents that occurred to vessels at sea have been included, whilst incidents that occurred within harbours, canals, rivers and lakes have been excluded.

The data was used to estimate the probability that vessels of differing type and size categories would founder in different weather states. The results of this analysis were then used to weight the model accordingly for each vessel type and size.

The Foundering model uses as input the grid of vessel durations along the proposed cable route by vessel type and size that was used in the emergency anchoring model, and weather data for the area, detailing the probability of different weather states. The output is a grid where each cell contains the frequency that a vessel will founder within its boundary.

As with emergency anchoring, (Section 9), vessel durations covered a 100m buffer of the proposed cable route. Total annual vessel durations within the 100m buffer of the entire proposed cable route were 1,432 hours.

10.3 Results

It was estimated that a vessel would founder over the main route (including Ballinwilling Strand Irish landfall) once every 400 years. Over the 40 year lifespan of the proposed cable this resulted in a frequency of 0.1.

The foundering risk was observed to be higher than that of anchor dragging and emergency anchoring. This is largely due to the proportion of small vessels sailing near the cable, which historically present a higher risk of foundering, especially in heavy seas. Small vessels, in particular fishing vessels, also contributed higher vessel durations than large vessels, which tended to steam quickly through the study area. In addition, the water depths along the majority of the proposed cable route are fairly high, indicating that vessels (particularly small vessels) are less likely to anchor in an emergency, which reduces this risk.

The results of the foundering analysis for each landfall option are presented in Table 10.1.

Country	Route	Frequency Per Year	Return Period
Ireland	Ballinwilling Strand	8.0×10^{-5}	12,600
	Ballycroneen	1.3×10^{-4}	7,800
France	Kerradenec	4.4×10^{-7}	2,279,300
	Port Neuf	9.5×10^{-8}	10,570,200

Table 10.1 Annual Foundering Results - Landfalls

The Ballycroneen landfall foundering frequency was estimated to be once every 7,800 years. This corresponds to a frequency of 5.2×10^{-3} over the lifespan of the proposed cable. A foundering incident was estimated to occur once every 12,600 years over the Ballinwilling Strand landfall option, which corresponds to a frequency of 3.2×10^{-3} over the proposed cable operational life.

The Kerradenec and Port Neuf French landfall options had return periods of approximately 2,300,000 and 10,600,000 years respectively, corresponding to frequencies of 1.8×10^{-5} and 3.8×10^{-6} over the lifespan of the proposed cable.

An overview of the foundering results is presented in Figure 10.1.

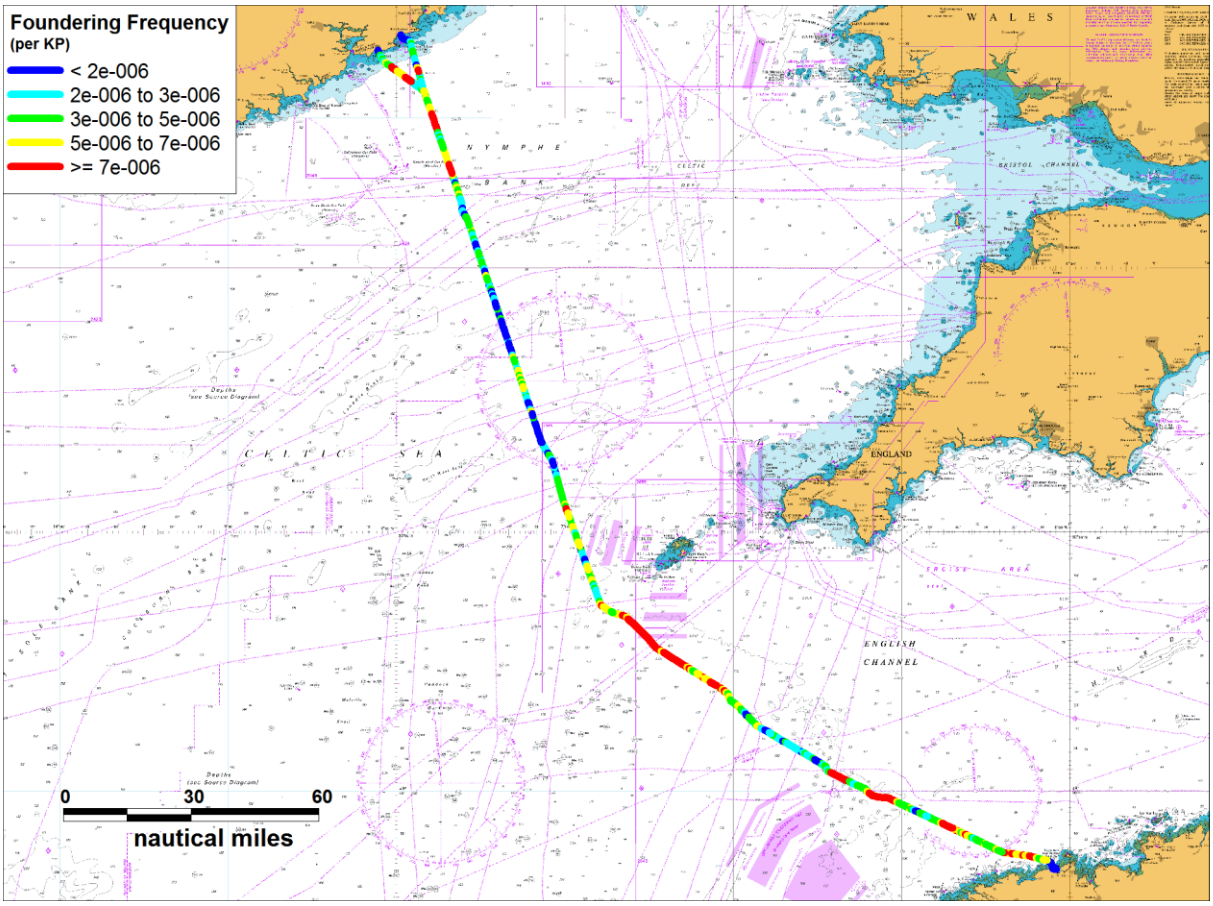

Figure 10.1 Foundering Frequency – General Overview

A summary of the foundering risk by size for the main route is presented in Table 10.2. The results for each landfall option are presented split by size in Table 10.3. Size categories are presented in Table 5.2.

Main Route Sections	Foundering Risk					
	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6
KP 0-50	2.00E-04	1.31E-05	1.36E-06	2.06E-06	9.53E-07	7.63E-08
KP 50-100	1.96E-04	6.64E-06	4.79E-06	3.47E-06	8.57E-07	1.48E-07
KP 100-150	1.33E-04	2.09E-06	6.57E-07	3.49E-07	5.75E-07	7.33E-08
KP 150-200	1.50E-04	1.30E-06	1.93E-07	5.28E-07	3.94E-07	1.39E-07
KP 200-250	1.94E-04	1.04E-05	2.43E-06	4.34E-06	1.21E-06	4.18E-07
KP 250-300	4.81E-04	1.08E-05	5.42E-06	3.13E-05	1.66E-05	4.16E-06
KP 300-350	2.32E-04	1.12E-05	4.93E-06	1.21E-05	5.12E-06	1.50E-06
KP 350-400	1.38E-04	3.71E-05	2.06E-05	3.97E-05	1.67E-05	7.23E-06

Main Route Sections	Foundering Risk					
	Size 1	**Size 2**	**Size 3**	**Size 4**	**Size 5**	**Size 6**
KP 400-450	2.36E-04	3.98E-05	2.04E-05	3.90E-05	1.66E-05	8.10E-06
KP 450-487	1.80E-04	1.48E-06	1.75E-08	Negligible	4.17E-08	Negligible
Total	**2.14E-03**	**1.34E-04**	**6.08E-05**	**1.33E-04**	**5.90E-05**	**2.18E-05**

Table 10.2 Foundering Frequency by Size – Main Route

Landfalls	Foundering Risk					
	Size 1	**Size 2**	**Size 3**	**Size 4**	**Size 5**	**Size 6**
Ballinwilling Strand	7.25E-05	3.60E-06	1.09E-06	1.61E-06	6.31E-07	4.34E-08
Ballycroneen	1.20E-04	4.50E-06	1.25E-06	2.31E-06	7.44E-07	5.84E-08
Port Neuf	9.46E-08	Negligible	Negligible	Negligible	Negligible	Negligible
Kerradenec	4.39E-07	Negligible	Negligible	Negligible	Negligible	Negligible

Table 10.3 Foundering Frequency by Size – Landfalls

The majority of the foundering risk was from vessels less than 1,500 DWT, with an estimated frequency of 2.14 x 10^{-3} on the main route. This corresponds to approximately 84% of the total. It is noted that approximately three quarters of the total risk was from fishing vessels, as fishing vessel activity was significant within the study area (approximately one third of input durations), and small fishing vessels are assumed to be at a high risk of foundering within the model.

10.4 Sensitivity Analysis – Buffer Size

The foundering model methodology assumes that any vessel that founders within 100m of the proposed cable could cause damage to it. This is a conservative assumption for small vessels, but may not be conservative for very large vessels.

A sensitivity analysis on the buffer size was therefore carried out to investigate the effect of using varying buffer sizes per vessel size category.

10.4.1 Conservatism of 100m Buffer

Assuming that the orientation of a foundered vessel is random, the probability that a vessel of a certain length located at any point within a 100m buffer of the cable intersects the cable can be calculated. The table below shows the probabilities for varying vessel sizes. It is assumed that the centre-point of the vessel may be located at any point within the 100m buffer.

Vessel Length (m)	Probability that Vessel Intersect Cable
50	19%
100	38%
200	76%
300	89%
400	94%

Table 10.4 Probability that Vessel within 100m Buffer Intersects Cable

This shows that the probability that a small, foundered vessel positioned at a random point in the 100m buffer intersects the cable is small. In contrast, the probability that a very large vessel foundering at a random point in the 100m buffer intersects the cable is high.

The foundering methodology assumes that 100% of vessels with centre-points in the 100m buffer will intersect the cable. The table above shows that this is very conservative for small vessels (only 19% of 50m vessels would intersect the cable), but not necessarily conservative for very large vessels.

The use of the 100m buffer is conservative for all vessels less than 200m in length, since if the centre-point of such a vessel lies outside the 100m buffer, this vessel would not intersect the cable. If the centre-point lies within the 100m buffer, the probability of intersecting the cable is less than 100%. The average vessel length of unique vessels within 100m of the proposed Celtic Interconnector was 134m. Therefore, if the centre-point of an average vessel was located at a point outside the 100m buffer, it would not intersect the cable. The probability that a 134m vessel within the 100m buffer intersects the cable is 51%.

Note that if the end point (bow or stern) of the vessel is used in the analysis rather than the centre-point, the calculation would be different and vessels of 100-200m could intersect the cable from outside the 100m buffer. However the probability of intersecting at smaller distances would be less than that calculated using the centre-point, as the vessel could be orientated away from the cable rather than towards it. It is expected that the results would even out when integrated over all distances. The vessel centre-point approach is preferred as it is consistent with the grid durations' methodology used to generate the model inputs.

For vessels larger than 200m (24% of vessels in the study area), there is a chance that a vessel situated outside the 100m buffer might intersect the cable. This is (at least partly) counteracted by the probability that not all such vessels foundering inside the buffer distance will intersect the cable, as is currently assumed.

However, due to the inherent conservatism associated with the current approach for all vessels less than 200m length (76% of vessels in the study area), for example a conservatism factor of 51% for the average length vessel, and the fact that a significant proportion of vessels are much smaller (i.e. 62% of 100m vessels within the 100m buffer will not intersect the cable), combined with the fact that smaller vessels are more likely to be involved in a foundering incident, it is concluded overall that the current foundering methodology is conservative.

10.4.2 Varying Buffer Sizes

An analysis was carried out to investigate the effect on the foundering results of using a different buffer size per vessel size category. Table 10.5 presents the average, 90th percentile and maximum lengths for each size category used in the model. This is based on unique vessels within the study area per day.

Size Category	DWT Range	Length (m)		
		Average	90th Percentile	Maximum
1	0 – 1,500 DWT	21	33	163
2	1,500 – 5,000 DWT	97	125	238
3	5,000 – 15,000 DWT	138	185	348
4	15,000 – 40,000 DWT	180	210	360
5	40,000 – 100,000 DWT	233	294	336
6	> 100,000 DWT	308	367	400

Table 10.5 Vessel Lengths per Size Category

Note that the maximum length is much larger than the average and 90th percentile for the smallest size categories. This is due to passenger vessels (e.g. superyachts, cruise ships) that have a low DWT in comparison with the vessel length (compared to e.g. container ships).

Based on this information, the 90th percentile length was adopted as the new buffer size for each size category. In order to keep the calculations simple, without a need for re-running the model, it was assumed that the vessel durations are proportionate inside and outside the 100m buffer. The results per size category were therefore determined by factoring each size category by the 90th percentile length divided by 100m, e.g., 33/100 in the case of Size 1 vessels compared to 367/100 for Size 6. It can be seen that in all cases except Size 1, the factor will be higher than 1.

This approach is still conservative, as it assumes that all vessels within the new buffer will interact with the cable, whereas, based on Table 10.4 above, only a certain proportion of vessels inside the buffer will interact with the cable. In addition, 90% of vessels in each size category have no possibility of interacting with the cable from outside the buffer. In fact, based on the approach above, using the centre-point of the ship, only vessels that are at least twice the buffer size could interact with the cable from outside the buffer.

The results of the sensitivity analysis for the main route and for each landfall option are presented in Table 10.6. The original results are also provided for comparison.

Route	Sensitivity Analysis Results		Original Results	
	Frequency Per Year	Return Period	Frequency Per Year	Return Period
Main Route	1.5×10^{-3}	660	2.6×10^{-3}	400
Ballinwilling Strand	3.6×10^{-5}	27,900	8.0×10^{-5}	12,600
Ballycroneen	5.5×10^{-5}	18,300	1.3×10^{-4}	7,800
Kerradenec	1.5×10^{-7}	6,902,700	4.4×10^{-7}	2,279,300
Port Neuf	3.1×10^{-8}	32,032,800	9.5×10^{-8}	10,570,200

Table 10.6 Annual Foundering Results – Sensitivity Analysis

The total foundering frequency for the proposed main route was estimated to be one in 660 years using the sensitivity assessment approach.

It is noted that the effect of the sensitivity analysis was to reduce the overall foundering risk by 40%. This is due to the reduction in risk for vessels in the smallest size category, which contributed 84% of the original foundering risk.

For the sensitivity analysis, vessels in the smallest size category contribute 46% of the main route foundering risk.

10.5 Historical Foundering Incident Data

In order to validate the results of the foundering model, twenty years of Marine Accident Investigation Branch (MAIB) data (recorded between 1994 and 2013 inclusive) was analysed to assess recorded historical foundering incidents. This data generally covers all incidents in UK waters, and incidents outside UK waters involving a UK registered vessel.

In order to assess purely foundering incidents within the MAIB data, only incidents that were categorised as “Flooding/Foundering” by the MAIB and where the vessel was lost were considered. Such incidents identified to have occurred near the Celtic Interconnector are presented in Figure 10.2.

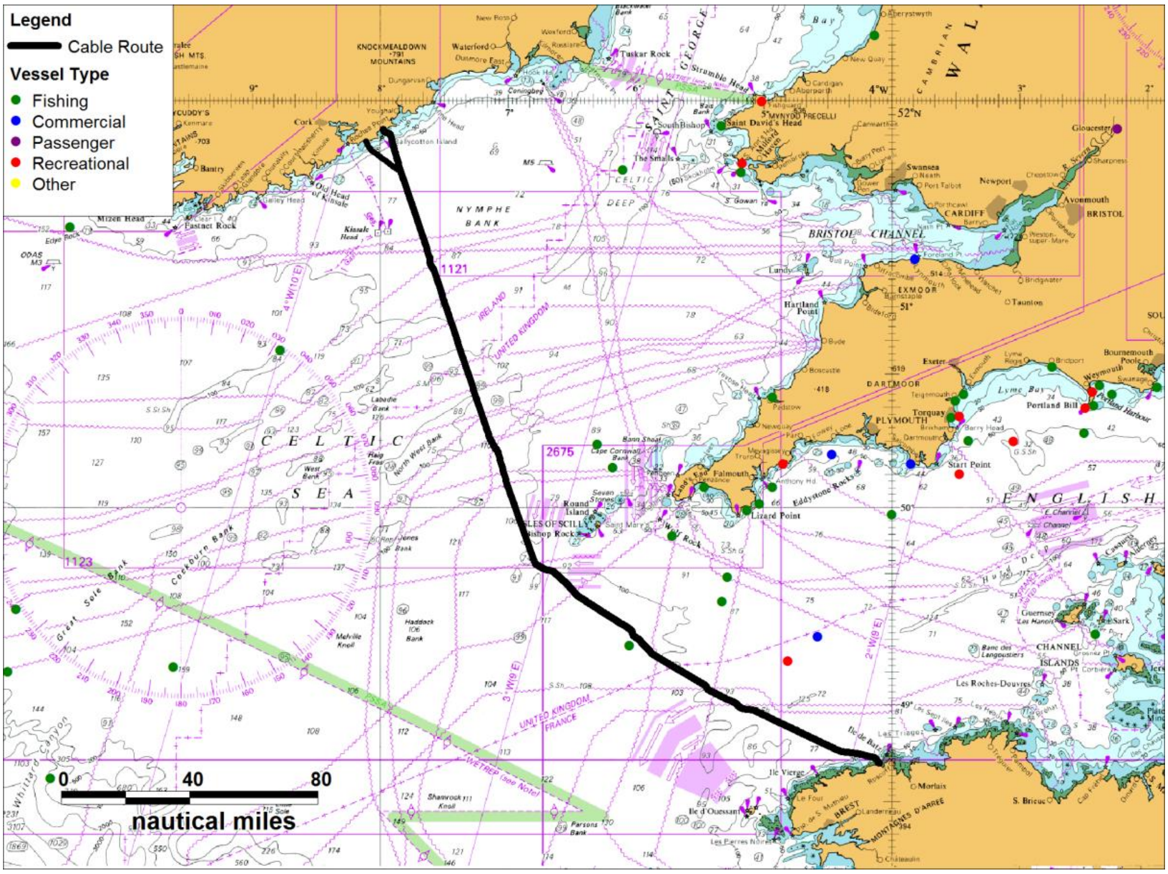

Figure 10.2 MAIB Foundering Incidents near Celtic Interconnector

During the twenty year study period, nine incidents of foundering were recorded within 50nm of the proposed cable route (seven fishing vessels, one recreational vessel, and one cargo vessel). The nearest foundering incident to the proposed cable occurred in September 2000 approximately 3nm from the route, in the south-west approaches to the English Channel. The vessel involved was a fishing vessel with a length of 23m, and a gross tonnage of 71. The synopsis given by MAIB was as follows:

> *Vessel was trawling for scallops when the bilge alarm sounded. The source of the flooding could not be identified. The seacocks in the engine room were closed, but this did not stop the flooding. The vessels bilge pumping could not contain the flooding, a coastguard helicopter put another pump on the vessel, but the flooding still increased, so the vessel was abandoned. She sank shortly after.*

Approximately 77% of all foundering incidents within the MAIB data involved fishing vessels during the studied 20 year period, which was in line with the original foundering modelling, which estimated that 75% of the total foundering risk was from fishing vessels.

Within the 20 year study period, the vast majority of vessel founderings were from vessels estimated to be less than 1,500 DWT. Again, this finding was in line with the original foundering modelling.

Overall, the foundering incidents within the MAIB data correlated well with the original foundering model assessment, as the data demonstrated that foundering incidents have occurred near the cable historically, and the majority of recorded incidents were from small fishing vessels.

11. Fishing Risk Assessment

11.1 Introduction

This section investigates the potential risk to the proposed cable routes by vessels fishing in the vicinity. The analysis is based on the fishing activity recorded in the 12 months of AIS data presented in Section 7.

The majority of the AIS data covers vessels of 15m length and over. The smaller vessels that are not covered, which are likely to be prevalent in coastal areas in particular, should not pose a threat to the proposed cable assuming standard protection measures are taken.

11.2 Methodology

The annual risk frequency associated with fishing vessels was assessed by calculating the number of hours per year that vessels were recorded to be actively fishing within the vicinity of the proposed cable. As a first approach, it was assumed that any vessel recorded actively fishing within 100m of the proposed route could potentially cause damage to the cable from gear components (e.g. trawl board, clump weight, etc.).

The assessment focuses on vessels travelling at less than 6 knots, i.e. those that could potentially be actively fishing, since it is these vessels that are likely to interact with the cable. It is noted that this is a conservative assumption, as it may include some vessels that are steaming through the area.

Since vessels that deploy their gear within the water column rather than along the seabed are not likely to pose any risk to the proposed cable, the assessment considers only vessels with demersal fishing gears (i.e. demersal trawlers, beam trawlers and dredgers), or a gear type that could include demersal vessels (i.e. pair trawlers or unspecified trawlers).

The fishing durations in the Irish sector (KP 0 to KP56) were factored by 1.08 to account for the fact that the Irish auxiliary data set indicated that fishing activity in winter was 16% higher than in summer, i.e. since the core data set covers spring, summer and autumn, but not winter, half of the durations are factored by 16%.

The factored durations were then divided by the total number of hours in a year to provide the annual frequency (in terms of vessel-years) that fishing vessels have the potential to interact with the proposed cable per KP and per gear type (demersal gears only).

11.3 Results

It was estimated that the annual frequency, in terms of vessel-years, of fishing vessels interacting with the main route was 3.77×10^{-2}. This equates to a demersal vessel actively fishing within 100m of the proposed cable for 330 hours, or approximately 2 weeks, every year. Over the 40 year lifespan of the proposed cable this gives a total frequency of approximately 1.5 vessel-years, i.e. a demersal vessel actively fishing within 100m of the proposed cable for an aggregate period of 1.5 years over the lifespan of the cable.

The results of the fishing risk assessment for each landfall option are presented in Table 11.1. It is noted that no demersal vessels were actively fishing within 100m of either of the proposed French landfall options.

Country	Route	Frequency Per Year	Vessel Hours Per Year
Ireland	Ballinwilling Strand	1.3×10^{-3}	11
	Ballycroneen	2.8×10^{-3}	24

Table 11.1 Annual Fishing Frequency Results - Landfalls

The Ballycroneen landfall frequency was estimated to be 2.8×10^{-3}. This corresponds to a frequency of 40 vessel-days over the lifespan of the cable. The frequency for the Ballinwilling Strand landfall option was estimated to be 1.3×10^{-3}, which corresponds to a frequency of 18 vessel-days over the proposed cable's operational life.

The risk to the Kerradenec and Port Neuf landfall options from fishing vessels was considered to be negligible.

An overview of the fishing frequency results per KP of cable is presented in Figure 11.1.

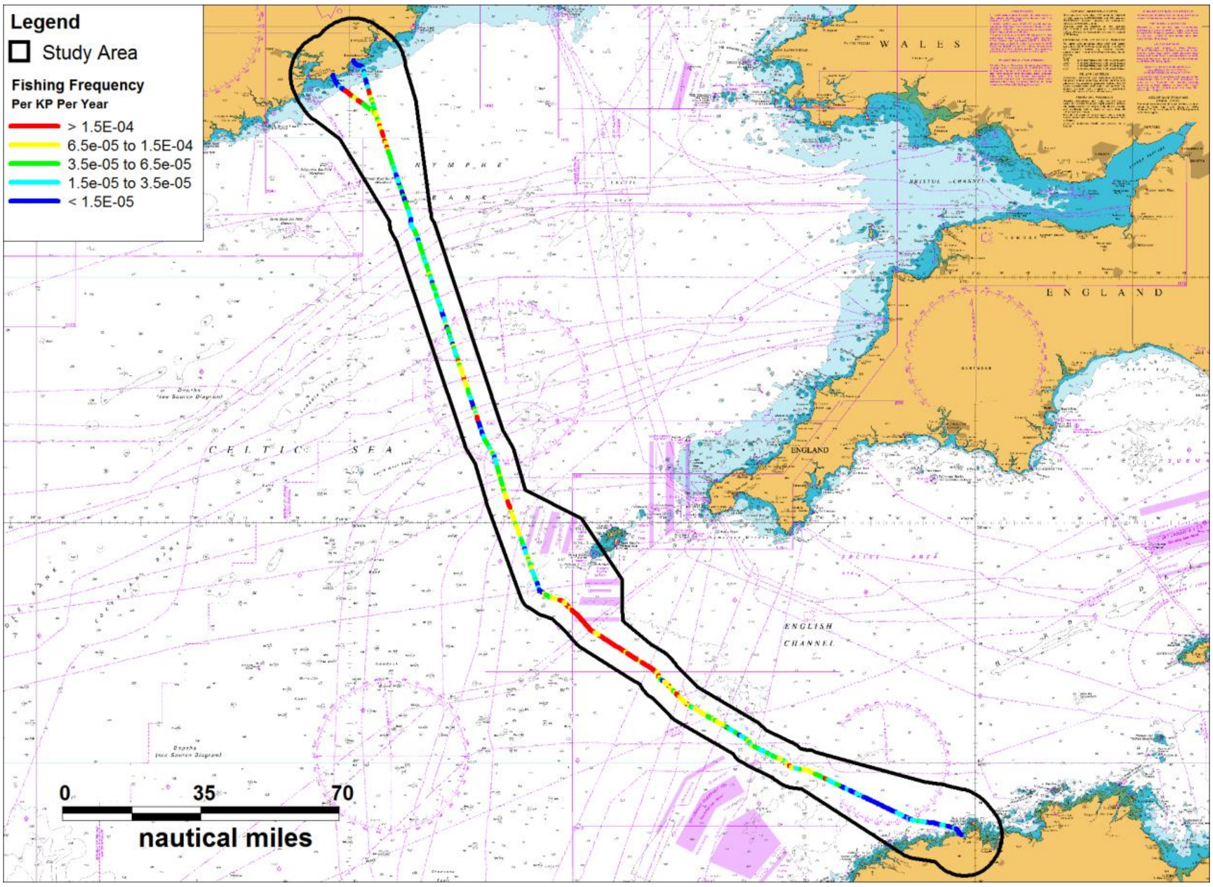

Figure 11.1 Annual Fishing Frequency Results – General Overview

It can be seen that the highest risk areas for fishing vessel crossings were the Irish landfall options, from KP27 to KP40 on the main route (close to where the Ballycroneen landfall option branches off) and to the south of the Scilly Isles, between KP 265 and KP 343 on the main route.

A summary of the fishing frequency results by gear type per 50km of the main route is presented in Table 11.2. The results for the Irish landfall options are presented in Table 11.3.

Cable Route Section	Fishing Frequency				
	Beam Trawlers	Demersal Trawlers	Pair Trawlers	Dredgers	Unspecified Trawlers
Main Route – KP 0-50	2.61E-03	8.53E-04	2.61E-05	3.08E-04	1.36E-05
Main Route – KP 50-100	1.02E-03	5.89E-04	Negligible	Negligible	3.01E-05
Main Route – KP 100-150	8.87E-04	9.03E-04	Negligible	2.27E-04	4.23E-05
Main Route – KP 150-200	1.06E-04	2.60E-03	Negligible	1.62E-05	6.55E-05
Main Route – KP 200-250	1.74E-04	3.64E-03	Negligible	Negligible	Negligible

Cable Route Section	Fishing Frequency				
	Beam Trawlers	**Demersal Trawlers**	**Pair Trawlers**	**Dredgers**	**Unspecified Trawlers**
Main Route – KP 250-300	9.10E-03	1.99E-03	Negligible	Negligible	5.52E-05
Main Route – KP 300-350	5.14E-03	2.36E-03	Negligible	3.66E-05	Negligible
Main Route – KP 350-400	9.03E-04	1.69E-03	Negligible	1.35E-05	Negligible
Main Route – KP 400-450	Negligible	1.78E-03	Negligible	Negligible	Negligible
Main Route – KP 450-487	Negligible	4.54E-04	Negligible	6.17E-05	Negligible
Total	**1.99E-02**	**1.69E-02**	**2.61E-05**	**6.63E-04**	**2.07E-04**

Table 11.2 Fishing Frequency by Gear Type – Main Route

Landfalls	Fishing Frequency				
	Beam Trawlers	**Demersal Trawlers**	**Pair Trawlers**	**Dredgers**	**Unspecified Trawlers**
Ballinwilling Strand	7.16E-04	3.01E-04	7.48E-06	2.26E-04	1.41E-05
Ballycroneen	2.20E-03	4.19E-04	6.31E-06	1.04E-04	2.72E-05

Table 11.3 Fishing Frequency by Gear Type – Landfalls

For the main route and both of the Irish landfall options, beam trawlers contributed approximately 50% of the risk frequency. Demersal trawlers also contributed a significant proportion of the risk from fishing vessels.

Figure 11.2 presents the breakdown of the fishing risk frequency by gross tonnage, for the main route and the Ballinwilling and Ballycroneen landfall options.

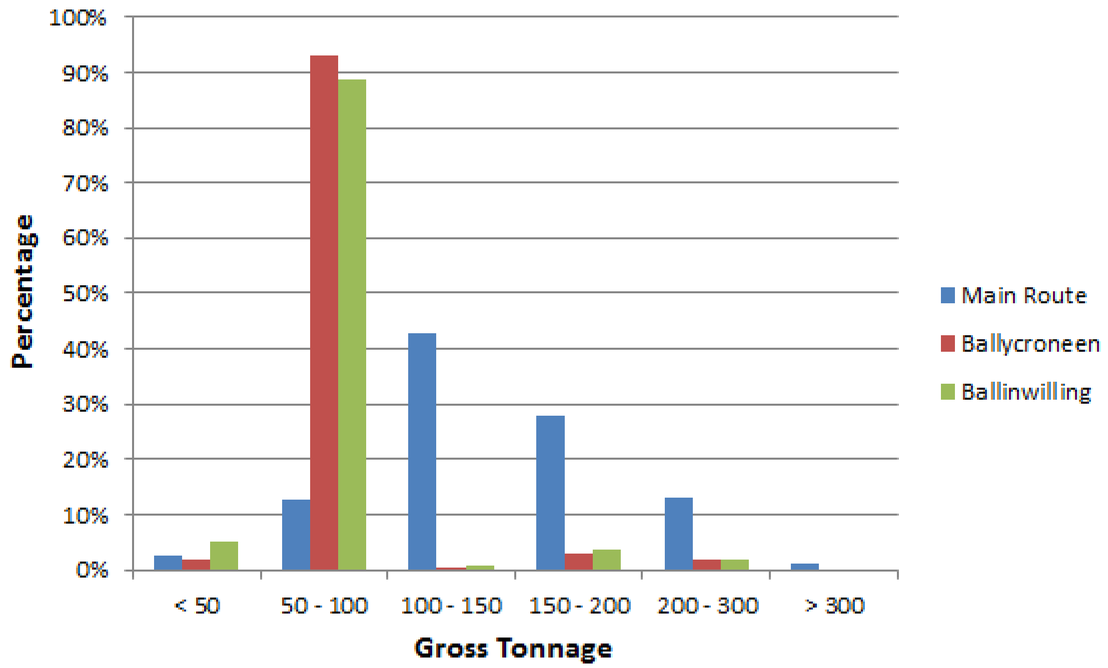

Figure 11.2 Gross Tonnage Distribution, Demersal Vessel Crossings

For the main route, the majority of demersal vessel crossings by vessels considered to be actively fishing across the proposed cable route (71%) had gross tonnage between 100 and 200 GT. For the Ballycroneen and Ballinwilling landfall options, the majority of crossings (93% and 89% respectively) had gross tonnage between 50 and 100 GT.

Figure 11.3 presents the breakdown of the fishing risk frequency by engine power, for the main route and the Ballinwilling and Ballycroneen landfall options.

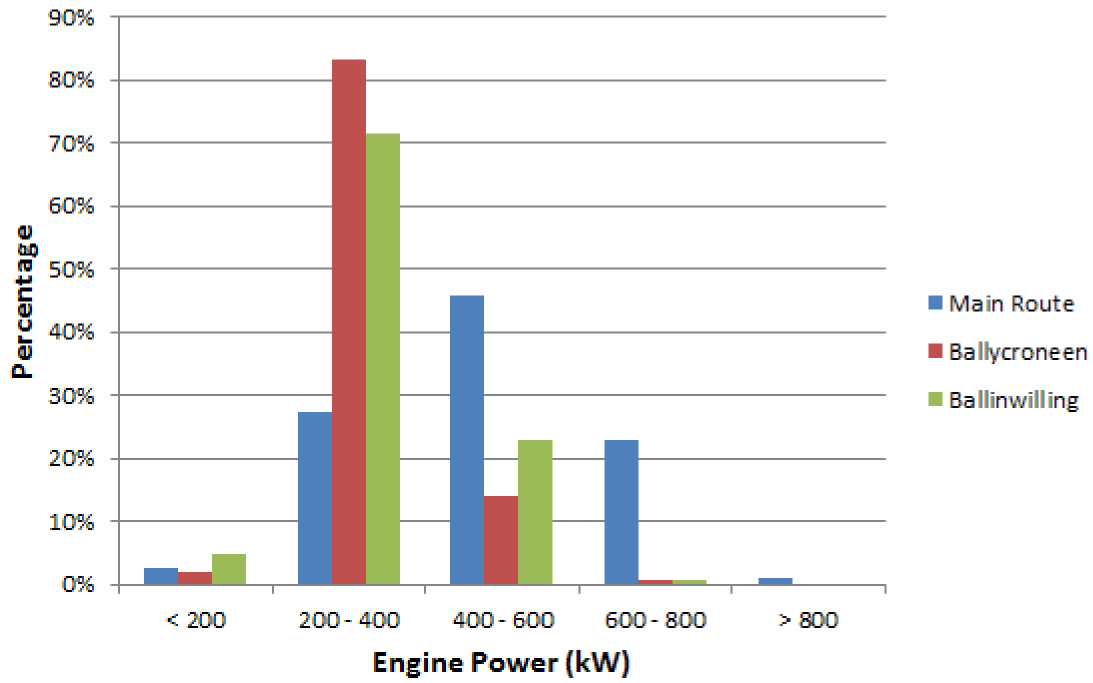

Figure 11.3 Engine Power Distribution, Demersal Vessel Crossings

It can be seen that, for the main route, the vast majority of demersal vessel crossings by vessels considered to be actively fishing across the proposed cable route (96%) had engine power between 200 and 800 kW, while for the Ballycroneen landfall option, the vast majority of crossings (83%) had engine power between 200 and 400kW. The vast majority (94%) of the Ballinwilling crossings had engine power between 200 and 600kW.

12. Summary

A Cable Risk Assessment was undertaken for the proposed Celtic Interconnector route and landfall options. Six months of 2014 AIS data and six months of 2015 AIS data was used to perform a shipping analysis, and to assess the risk to the proposed cable route from anchors, foundering vessels, and fishing vessels. A review of the navigation features in the area was also included.

12.1 Shipping Analysis

An average of 243 unique vessels per day were recorded within the study area during the 12 months. Approximately half of all traffic was comprised of cargo vessels, with a further 18% being tankers. Fishing vessels accounted for 17% of the total.

The average vessel length recorded during the 12 months was 131m, and the average draught was 7.7m (excluding 19% unspecified). The AIS data showed that the larger vessels tended to remain on routes associated with the Isles of Scilly and Channel Traffic Separation Schemes, unless they were on approach to ports within the study area.

The majority of vessels determined to be at anchor within the study area were located in the outer Cork anchorage. Vessels also anchored in Ballycotton Bay, with the closest being a fishing vessel anchored 0.8nm from the proposed Western cable landfall. The majority of anchoring within French waters occurred from vessels waiting outside Roscoff. No anchoring was recorded within in UK EEZ waters.

12.2 Fishing Analysis

An average of 40 unique fishing vessels per day were recorded within the study area during the 12 months.

A speed analysis was used to provide an indication of the areas of active fishing activity within the study area. The majority of vessels actively fishing within the study area were demersal trawlers, gill netters and beam trawlers.

An analysis of fishing vessels crossing the proposed cable route showed that the total number of crossings (by vessels travelling below 6 knots) for the main route was determined to be 8,062 per year, 222 of which were over the Ballinwilling landfall option. In addition, the Ballycroneen landfall option was calculated to have 399 crossings per year. The French landfall route options did not have any fishing-cable crossings.

75% of the main route crossings, 86% of the Ballycroneen landfall option crossings and 79% of the Ballinwilling landfall option crossings were by demersal vessels (i.e. demersal trawlers, beam trawlers and dredgers), or by a vessel type that could include demersal vessels (i.e. trawlers or unspecified trawlers).

It is noted that AIS data only covers vessels greater than 15m in length and there may be some under-reporting of smaller vessels within the data. However, it is considered that, due to their size, these vessels are unlikely to cause significant damage to the proposed cable.

It is further noted that fishing vessels may turn off their AIS broadcasts while fishing, leading to under-reporting of fishing activity in the AIS data.

A comparison with auxiliary AIS data sets (Appendix A) and VMS satellite data from 2009 (Appendix B) indicated that the core AIS data set provided a good representation of the fishing activity. However, the fishing activity in the Irish sector was shown to be higher in winter than in summer and the inputs to the fishing risk assessment were therefore factored accordingly.

12.3 Risk Modelling

12.3.1 Anchor Dragging

It was estimated that a vessel would drag anchor over the main route once every 7,400 years. Over the expected 40 year life of the proposed cable, this corresponds to a frequency of 5.4 x 10^{-3}.

The Ballinwilling Strand was estimated to experience an anchor dragging incident once every 7,400 years, which corresponds to a frequency of 5.4 x 10^{-3} over the expected 40 year operational span of the proposed cable. A vessel was estimated to drag anchor over the Ballycroneen landfall option once every 193,100 years, corresponding to a frequency of 2.1 x 10^{-4} over the expected 40 year life of the proposed cable. The vast majority of the risk associated with anchor dragging was to the Irish landfalls.

The Kerradenec and Port Neuf landfall options had return periods of 67,187,300 and 85,766,200 years respectively, corresponding to frequencies of 6.0 x 10^{-7} and 4.7 x 10^{-7}.

Approximately 99% of the risk to the cable was from vessels of less than 5,000 DWT.

12.3.2 Emergency Anchoring

It was estimated that a vessel would drop its anchor in an emergency over the main route once every 3,600 years. Over the 40 year life of the proposed cable, this corresponds to a frequency of 1.1 x 10^{-2}.

It was estimated that a vessel would drop its anchor in an emergency over the Ballycroneen landfall option once every 14,900 years. Over the 40 year life of the proposed cable, this corresponds to a frequency of 2.7 x 10^{-3}. The emergency anchoring return period of the Ballinwilling Strand landfall option was estimated to be 22,000 years, corresponding to a frequency of 1.8 x 10^{-3} over the 40 year operational life.

The Kerradenec and Port Neuf French landfall options had return periods of approximately 650,000 and 2,900,000 respectively, corresponding to frequencies of 6.2 x 10^{-5} and 1.4 x 10^{-5} over the lifespan of the proposed cable.

Approximately half the emergency anchoring risk was from vessels less than 1,500 DWT, and 23% from vessels greater than 40,000 DWT.

12.3.3 Foundering

It was estimated that a vessel would founder over the proposed cable route once every 400 years. Over the 40 year lifespan of the cable this resulted in a frequency of 1.0 x 10^{-1}.

The foundering return period of the Ballycroneen landfall option was estimated to be 7,800 years. This corresponds to a frequency of 5.2 x 10^{-3} over the lifespan of the proposed cable. A foundering incident was estimated to occur once every 12,600 years over the Ballinwilling Strand landfall option, which corresponds to a frequency of 3.2 x 10^{-3} over the proposed cable operational life.

The Kerradenec and Port Neuf French landfall options had return periods of approximately 2,300,000 and 10,600,000 years respectively, corresponding to frequencies of 1.8 x 10^{-5} and 3.8 x 10^{-6} over the lifespan of the proposed cable.

Approximately 84% of the risk was from vessels less than 1,500 DWT. Overall, 75% of the foundering risk was from fishing vessels.

A sensitivity analysis to investigate the effect of using varying buffer sizes per vessel size category was undertaken. The total foundering risk for the main route reduced by 40%, corresponding to a return period of 660 years.

12.3.4 Comparison

The annual frequencies of anchor dragging, emergency anchoring, and foundering are presented for the main route and landfall options in Table 12.1 for comparison. The foundering results are based on the sensitivity analysis using the varying buffer sizes per vessel size category as these are considered more realistic.

Route	Anchor Dragging	Emergency Anchoring	Foundering	Total
Main Route	1.4 x 10^{-4}	2.8 x 10^{-4}	1.5x 10^{-3}	1.9 x 10^{-3}
Ballycroneen	5.2 x 10^{-6}	6.7 x 10^{-5}	5.5 x 10^{-5}	1.3 x 10^{-4}
Ballinwilling	1.4 x 10^{-4}	4.6 x 10^{-5}	3.6 x 10^{-5}	2.2 x 10^{-4}
Port Neuf	1.2 x 10^{-8}	3.5 x 10^{-7}	3.1 x 10^{-8}	3.9 x 10^{-7}
Kerradanec	1.5 x 10^{-8}	1.6 x 10^{-6}	1.5 x 10^{-7}	1.7 x 10^{-6}

Table 12.1 Risk Modelling Summary

It was estimated that a vessel anchor or a foundering vessel would interact with the main route once every 518 years.

For the Ballycroneen landfall option, this frequency was once every 8,000 years while the Ballinwilling landfall option was once every 5,000 years.

It was estimated that a vessel anchor or a foundering vessel would interact with the Kerradenec landfall option once every 600,000 years, falling to once every 2.6 million years for the Port Neuf landfall option.

The highest risk to the proposed Interconnector cable was from vessels foundering over it. This is due to the proportion of small vessels sailing near the cable, which historically present a higher risk of foundering. Small vessels, in particular fishing vessels, also contributed higher vessel durations than large vessels, which tended to steam quickly through the study area. In addition, the water depths along the majority of the proposed cable route are fairly high, indicating that vessels (particularly small vessels) are less likely to anchor in an emergency.

For the Ballinwilling landfall option, anchor dragging presented the highest risk, due to the location of vessels at anchor very close to the cable route. For the other landfall options, the emergency anchoring risk was highest due to the smaller water depths and distance to danger near the coast, meaning that vessels were more likely to anchor in an emergency over the landfall options than along the main route.

12.4 Fishing Risk Assessment

The annual risk frequency associated with fishing vessels was assessed by calculating the number of hours per year that demersal vessels were recorded to be actively fishing within the vicinity of the proposed cable route and dividing this by the total number of hours in a year.

It was estimated that the annual frequency, in terms of vessel-years, of fishing vessels actively fishing over the main route (plus 100m buffer) was 3.77×10^{-2}, or approximately two weeks per year. Over the 40 year lifespan of the proposed cable this equates to a fishing frequency of 1.5 vessel-years, i.e. a demersal vessel actively fishing within 100m of the proposed cable for 1.5 years over the lifespan of the cable.

The Ballycroneen landfall frequency was estimated to be 2.8×10^{-4}. This corresponds to a frequency of 40 fishing vessel-days over the lifespan of the proposed cable. The frequency for the Ballinwilling Strand landfall option was estimated to be 1.3×10^{-3}, which corresponds to a frequency of 18 fishing vessel-days over the operational life of the cable.

The risk to the Kerradenec and Port Neuf landfall options from fishing vessels was considered to be negligible.

Approximately 50% of the fishing risk frequency was from demersal otter trawlers, with beam trawlers also contributing a significant proportion of risk.

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