3 Alternative solutions examined

3.1 Introduction

The consideration of alternatives to the proposed development is central to the environmental assessment process. The EPA Guidelines (2002) in relation to EIS advise that consideration of the main alternatives for the choice of the development is the most effective process for avoiding environmental impacts. Alternatives may be described at three levels: alternative locations, alternative processes and alternative designs as appropriate. This section of the EIS provides an outline of the main alternatives examined throughout the design and consultation process. It addresses the following key issues: alternative locations, key design principles, and detailed design alternatives within the site. The following sections detail the process that was involved in arriving at the chosen solution.

3.2 Alternative locations

The selection of the coastal area off Belmullet as the proposed AMETS location was the outcome of a rigorous process based on technical, environmental and social selection criteria (Marine Institute and ESBI, 2008). It was also informed by consultations with potential users within the Irish Ocean Energy Industry Forum, (where issues such as the operating environment, seabed conditions and mooring requirements were identified), by participation in meetings at EU and international level (including meeting with the European Marine Energy Centre (EMEC)) to develop fully the required concept for the test site.

The test site concept envisages facilitation of wave energy conversion technologies developed both in Ireland and elsewhere in the world. Hence, the site must be capable of accommodating a wide range of wave energy converter types and their specific needs.

Alternative locations were considered in detail by SEAI for the offshore wave energy test site (Marine Institute and ESB International, June 2008). The screening process showed that the west coast of Ireland has an enormous wave energy potential but that it was not over endowed with ideal locations to facilitate a wave energy test site capable of meeting the concept requirements and design considerations.

3.2.1 Key design considerations

Successful development of a potential ocean energy test site requires that a number of elements are characteristic to each of the candidate sites. Detailed selection criteria were developed by ESB International and the Marine Institute as part of a consultative process on the project (ESBI and the Marine institute, 2008). The views of prospective site users and researchers were taken into account in this consultation.

The principal elements on which site selection was based are set out below:

- The site should be located in an open ocean location off the west coast of Ireland and within the 12nm limit.
- A minimum generating capacity of 5MW grid connection should be accommodated, as currently permitted by the Commission for Energy Regulation (CER).
- A water depth range of between 50m and 100m should be available.

- Appropriate logistical support should be available locally (logistic support capability).
- Network connection at medium voltage level – The relative extent and cost of upgrading the local electricity network to accommodate power inputs from the site should be taken into account.
- Minimal impact on the environment and stakeholders.

These principal elements translate into the following ideal requirements for a test site in Ireland:

Deep water close to the coast with a high energy level
A non-rocky seabed to facilitate cabling and anchoring
Good proximity to a well-equipped marine support base
Good proximity to sheltered waters
Good proximity to the existing electrical network
Good road access
Good central operating base accommodation
Sheltered location for bringing cables ashore
Low environmental sensitivity and impact on other stakeholders

It was recognised that the decision-making process had to take place subject to many constraints, including the following:

Technical issues

- The need to cater for depths in the range 50–100m as close to the shore as possible.
- The need to avoid extensive rocky seabed areas.
- Electrical connection issues.
- Cable landing issues (trenching or horizontal directional drilling)

Environmental issues

- The need to recognise environmental constraints such as designated marine and terrestrial areas (cSACs, NHAs, pNHAs, SPAs and potential protected habitats such as subtidal and intertidal reef structures) and to avoid or minimise potential impact on such sites.
- The related issue of planning permission where applicable to land side development.
- Recognition of stakeholder issues that would only arise after a site had been selected.
- The need to keep the scale of operations at a level that would minimise environmental obligations and overall cost.

Regulatory and legal issues

- The level of interaction likely to be necessary between the several agencies jointly involved in permitting in a novel technological area – including the Department of

Environment, Heritage & Local Government, the Commission for Energy Regulation, local authorities, and the Coastal Zone Administration Division of the Department of Communications, Marine and Natural Resources.

Social issues

- The need to establish realistically the strength and aptitude of engineering and marine services likely to be available in the support harbour.
- The attitudes of land owners, fishermen and people living near the sites or support base.

Seven sites with potential for wave energy production were identified along the west coast of Ireland and ranked using the above and additional criteria (Figure 3-1).

As detailed bathymetric and geophysical data was not available for a number of sites, special vessel-mounted surveys were undertaken at Sybil Head, Co Kerry; Goleen Head, Co Clare and Annagh Head, Co Mayo. The general site properties used in characterising and ranking the respective sites were assessed and input into the evaluation process. The ranked sites are listed in Table 3-1.

Preferred site location

The location at Annagh Head, Co. Mayo is considered to be the most suitable site as a result of the site evaluation and selection process. It offers deep water (to 100m water depth) within 17km of the cable landing location and a non-rocky seabed in the proposed test site areas. There is also a non-rocky seabed over most of the proposed cable route to shore. In addition, there are technically feasible landing locations within the Annagh Bay area with good road access and a potential grid connection to Belmullet substation. Although the terrestrial coastal area is within a cSAC, preliminary assessment indicated that any environmental impact would be minimal if care was exercised selecting a route from cable landfall to the proposed substation. None of the offshore test areas or areas along the cable route to shore are designated as cSAC.

Table 3-1: Overall ranking of the prospective wave energy test sites

Rank	Site
1	Annagh Co. Mayo
2	Bray Head Co. Kerry
3	Goleen Bay Co. Clare
4	Sybil Head Co. Kerry
5	Slea Head Co. Kerry
6	Bolus Head Co. Kerry
7	Slyne Head Co. Galway

For ranking detail see **Appendix 2:** Wave Energy Network Connection Point – Site Evaluation and Selection Report.

3.3 Detailed design alternatives

Detailed consideration of design options was made for the following components:

- Location and size of the offshore test areas

- Submarine electricity cable route (preferably a sandy seabed to allow embedment for cable protection)
- Alternative cable landfall locations (preferably sandy shore to allow embedment for cable protection)
- Alternative substation locations

The following sections detail the combined location and design considerations that have been considered.

3.3.1 Location and size of the offshore test areas

In their location, positioning and sizing, offshore test areas were chosen based on how well they met the functional requirements of the project. The criteria on which they were chosen included::

- Location in the vicinity of a feasible cable route
- Suitability of the seabed for mooring of devices
- Orientation of the site in such a way that the general frontage of the area is aligned with the primary wave resource direction
- Suitability of water depths (50m and 100m) for deployment of WECs
- Outcome of discussion with users of sea fishing (trawling) grounds
- Outcome of discussion with users of inshore fishing activities
- Location within the twelve-mile territorial limit
- Location outside any designated military defence zones
- Location outside any designated environmental zones
- Consideration of navigation risk assessment
- WEC array configurations and size (based upon developers' current proposed arrangements)

Based on the above criteria, general areas offshore of Annagh Head were identified and marine surveys of the area was undertaken by the Marine Institute (Marine Institute, 2008, 2011, IMAR (October 2009) , and Coastline survey (September 2010) – available at www.seai.ie/oceanenergy). This provided information on water depth, seabed topography, composition and depth/location of bedrock. A detailed assessment of potential sites was undertaken by ESB International (see **Appendix 2:** Wave Energy Network Connection Point – Site Evaluation and Selection Report). Initially the assessment identified the potential optimum locations for the test areas (Figure 3-1). In brief this concluded that a sand/sediment-based seabed was confirmed in the vicinity of the 100m and 50m water depths, the operating depths required for WECs. A feasible cable route was also identified back to shore. The assessment highlighted the seabed constraint as a fundamental criterion which must be satisfied. If this is not satisfied all other criteria are incidental.

The Navigation Risk Assessment indicated that navigation was not a risk to the proposed test site locations and also that the test site did not pose a risk to navigation (Arup, 2011). Some fishing activity occurs in the proposed test site area, including trawl fishing, which would occasionally pass through a section of the 100m water depth test site and potting activity which could occur at all site locations. However, a sandy substrate is common to the

requirements of the test site, trawl fishing and some potting activity and some impact on these activities would be unavoidable irrespective of the test area location chosen.

Once identified, the potential test areas were discussed in detail with other marine users of those areas as part of the navigation risk assessment and as part of a consultation process with the fishing organisations.

In consultation with the Erris Inshore Fishermen's Association (EIFA), an issue of potential conflict of use with respect to the location of the outer Test Area A (100m water depth) was identified. The area also conflicted to some extent with the towing ground used by the Killybegs Fishermen's Organisation (KFO). To determine the possibility of relocating this test area further northwards, the Marine Institute undertook a third marine survey to further characterise the seabed in the area (Marine Institute 2011). The Marine Institute also undertook a detailed analysis of sediment type and depth to determine the suitability for WECs constrained by the need for anchoring in deep sediment. The survey indicated that it was not feasible to relocate the test area further north to any significant degree due to the presence of glacial till. Deep sediment was identified in two large pockets principally where the test areas were proposed. Sediment thinning was discovered westwards also. The issues raised by the fishing organisations were taken into account to the extent possible in the choice of the Test Area A (see 3.3.1.1).

Overall the assessment concluded that Test Areas A and B were optimum for the purpose of WECs deployment and testing.

Test area size

The size of the test areas was determined to meet the functional requirements of the project and was based on the following criteria:

- Provision of two arrays of up to five WECs each at the deep water location (Test Area A) – based on a 400m buffer zone around each WEC. Equally three individual WECs could be deployed there
- Provision for up to two WECs at the medium water depth location (Test Area B) or equally one small array of WECs at the medium water depth location
- Seabed conditions within the test areas must be suitable for a variety of mooring types requiring suitable seabed substrate.

Arising from discussions with fishing organisations, the shape of Test Area A was redrawn to accommodate the fishing activity to the extent possible and to minimise any potential impact. This resulted in a change of shape from an original rectangular box area to a multi-sided boot shape, (Figure 3-2).

The redrawn area allows for the deployment of different WEC array types while also accommodating EIFA potting activities, although there will still be some loss of ground to both EIFA and the KFO. A third survey was commissioned to assess the potential to adjust the location of Test Area A based on issues raised by fishing organisations. These findings indicated that suitably deep sediment in 100m+ water depth was only available within the original Test Area A (Figure 3-3). This meant that the best compromise that could be offered was a change in shape of Test Area A rather than a complete change of location.

A 400m minimum safety buffer was chosen based on the sites' technical constraints and the need to accommodate the use of the area by fishermen. This follows the principle of exclusion zone procedures adopted in the offshore oil and gas industry, where an exclusion zone of 500m is used during development and testing. The offshore wind industry also establishes 500m exclusion zones during construction and testing activities. Similarly at

EMEC in the Orkney Islands a 500m safety-driven exclusion zone has been adopted at Billia Croo wave test sites in 50m water depth. The minimum 400m exclusion zone is centred around each WECs proposed and in practice results in a large exclusion area in Test Area A based on the presence of two arrays and the shape of the area itself.

The water depth in Test Area A is 100m to accommodate a maximum of two arrays of five WECs such as Wavebob and Pelamis. The water depth of Test Area B is 50m to accommodate smaller arrays of two WECs.

3.3.2 Alternative cable landfall locations

Once the location of the test site had been selected the next question to be answered is where to land the submarine electricity cables that will export the power from the WECs. This is largely dictated by technical issues such as seabed conditions and the need for cable protection, environmental concerns, cultural heritage concerns, socio-economic issues and stakeholder views. Cable protection is essential and ideally the seabed should consist of soft sediment to facilitate cable burial. Following a rigorous assessment of these issues at a number of potential landing locations, the proposed landing site at Belderra Strand was selected as the most suitable. The main reasons for selecting this site were;

- The approach offered a sandy seabed to a sandy beach which would facilitate cable protection
- It offered the possibility of trenching the cable through the beach to the road with minimal impact on the cSAC qualifying interests.
- There were no recorded RMPs along the cable route.

A detailed assessment of possible cable landfall options within Annagh Bay was undertaken to determine the most suitable location for final cable landfall (ESB International, August 2010 and ESB international, June 2010).

The following four options were considered:

- Option A, Annagh Beach (known locally as Port Mór - northeast corner of the bay)
- Option B, Emlybeg Beach (west of the golf course)
- Option C, Belderra Strand
- Option D, west of Belderra Strand (Cross).

The proposed cable landfall locations are shown in Figure 3-4.

The assessment of alternatives for cable landfall also considered the constraints associated with the landside terrestrial cables and possible substation locations as these are integral to any selected option. Hence, alternative routes across the foreshore areas to possible substation locations were also considered at each landing option. Additionally, a qualifying factor is the actual availability of any proposed site in terms of willingness of the landowner to agree to provide the site as a substation location. The principal constraints addressed as part of the assessment of the alternative cable landfall options were:

- The technical feasibility and technical complexity of landing a cable at a particular location
- The potential for environmental impact on the marine and terrestrial ecologies at the landfall locations
- The potential for cultural heritage impact at the landfall locations

- The impact on the amenity value of the area
- The distance from landfall to the proposed substation
- The availability of a substation site

The possibility of installing the cables at Annagh Head on the south side of the peninsula was also considered. This area is outside of any existing habitat-protected area but was not considered viable for cable installation for technical reasons. It would require more complex cable installation methods with higher costs and an increased risk of cable damage at this highly exposed rocky shore.

Landing Option A – Annagh Beach LA1–LA4

Four possible landing points were considered at the Annagh Beach (Port Mór) area, (Figure 3-5). Three options, L-A1, L-A2 and L-A3 pass through the cSAC (Mullet/Blacksod Bay complex, site code 000470)

LA1: Beach area south of Annagh Head adjacent to road. In this location the cables will need to be trenched through the beach and sand dune area to the proposed substation adjacent to the road. (Substation Option A1) This option minimises the length of passage through the SAC designated area to approximately 200m.

LA2: Central beach area south of Annagh Head adjacent to road. In this location the cables will need to be trenched through the beach and intact sand dune area to the proposed substation adjacent to the road. (Substation Option A2 is at approximately 300m and Substation Option A1 is at approximately 400m, through the SAC designated area)

LA3: Foreshore area to southeast of beach. The cables would be trenched through the beach and sand dune area to an existing track/roadway which runs through the sand dune area. The cables would then be trenched along the track route to the proposed substation, (Substation Option A3) approximately 500m through the SAC designated area. The track is narrow and cuts through the dune system.

LA4: Foreshore area 300m west of Annagh beach. The cables would need to land through a rocky shoreline possibly using horizontal direction drilling (HDD) or similar methodology and onto an area of heath above the shore. The distance to the nearest road from this point is approximately 130m. This area is outside any designated area. Annagh Head comprises worked farmland and turbary bog. The south side of Annagh Head is rocky with submerged subtidal reef along its length (marine survey). Landing the cables at any locations on the south side would require HDD from the landside to an area extending beyond the reef. Four boreholes will be required to be drilled at any proposed landing location. Examination of the subtidal survey data and site visits also indicate that it is highly likely that the subtidal reef extends into the intertidal reef areas. So, because the intertidal reef forms a continuum with the subtidal section of reef, it too must be protected as an Annex I habitat. The land side of the Annagh Head peninsula is not designated as a cSAC, cSPA, NHA or proposed pNHA area and any substation would not be located within a designated area. However, the area in this vicinity is now a proposed SPA for corncrakes (*crex crex*).

Landing Option B – Emlybeg Beach LB1 and LB2

This beach is located west of the Carne golf course area and can be accessed by a narrow road and track sloping very steeply down to the beach. There is also a narrow access track

from the road near Annagh Beach which follows the coastal contour and terminates at the northern end of this beach. The beach itself is sandy, and is boulder-strewn near the dune systems.

Two possible landing points have been considered on Emlybeg Beach, (LB1 and LB2, see Figure 3-6). Both options pass through the cSAC (Mullet /Blacksod Bay complex, site code 000470)

LB1: This would land the cable near the termination point of the small local access track to the east of Annagh Beach – this is currently used by the local farming community to access their fields. The cable would be trenched through the beach and then along the access track route to the substation at A3, (within the cSAC) near the road above Annagh Beach. The distance through the cSAC at this location would be approximately 1.3km.

LB2: This would land the cable near the termination point of the existing Emlybeg Beach access track from the easterly direction. The dunes slope steeply down to the beach at this location. The total distance to the proposed substation B2, located near the R313 is 2.1km, of which 1.3km would pass along the existing tracks through the cSAC. The elevation at this location would make this option difficult.

Landing Option C – Belderra Strand - LC1, LC2 and LC3

Belderra Strand is located in the south-eastern end of the bay in Cross townland. It is readily accessible by coastal road from the R313. There is a small parking area at the extreme south - western end of the beach. The beach is gently sloping sand to a low sand dune system which is heavily grazed.

Three possible landing points have been considered on Belderra Strand, (LC1, LC2 and LC3. Figure 3-7). The options pass through the cSAC (Mullet/Blacksod Bay complex, site code 000470) which extends down to the low water mark on the beach. At the parking area the dune system has been degraded completely.

L-C1: This would land the cables at the south-western end of the beach where it could be trenched through the beach to the proposed substation location (substation option C1 or C2) on the land side of the coast road. The proposed substation location C1 is elevated and could require excavation in rock to embed the substation in the landscape. The distance through the cSAC would be about 0.24km.

L-C2: This would land the cables in the mid section of the sandy beach. The cables would then be trenched through the beach and low-lying degraded dune system to a substation location on the land side of the coast road (substation option C2). The distance through the cSAC is approximately 0.35km. The substation location is gently sloping agricultural land of low elevation.

L-C3: This would land the cables at the north-eastern end of the beach. The cables would be trenched through the beach and degraded dune area to a substation location on the land side of the coastal road, a distance of some 0.55km through the cSAC. The proposed substation location is gently sloping agricultural land.

Landing Option D – west of Belderra Strand:

A further possible landing option at a location west of Belderra Strand was also examined as it offered a potential short route to land (Figure 3-7). This option would pass through the cSAC and NHA (Mullet /Blacksod Bay complex, site code 000470). Horizontal directional drilling and trenching would be required through the cSAC area (about 0.38km). The substation would be located on agricultural lands outside of the cSAC area.

Decision matrix for cable landfall options

A decision matrix was developed to rank the suitability of the proposed cable landing options. The criteria used for the assessment are provided in Table 3-2.

Table 3-2: Criteria for decision matrix

Criteria	Description	Scoring
Technical installation methodology	Complexity of methodology for cable landing and installation, (for example, horizontal directional drilling (HDD) is more complex than trenching through sand)	High complexity equating to high risk and low complexity to low risk High Complexity =1 Low Complexity = 5
Terrestrial ecology	Landing location within or external to cSAC/NHA and likely level of impact based on preliminary assessment	Based on predicted level of impact High impact = 1 Low impact = 5
Marine ecology	Likelihood of cable route to landing location impacting on reef habitat or marine ecology based on preliminary assessment	Based on predicted level of impact Range: High impact = 1 Low impact = 5
Archaeology	Likelihood of cable route to landing location or cable route to substation impacting on marine or terrestrial archaeology based on preliminary assessment.	Based on predicted level of impact on archaeology Range: High impact = 1 Low impact = 5
Human geography	Potential impact of near shore test area location and landing area on amenity value of beaches and near shore	Based on predicted level of impact Range: High impact = 1 Low impact = 5
Land-side cable length	Based on length of cable which increases likelihood for impact on ecology, archaeology and amenity and also increases cost	Based on length of cable Range: Short (< 500m) = 1 Long (> 1km) = 5
Substation location	Based on whether substation will be located within or external to the cSAC or NHA and extent of predicted impact based on preliminary assessment	Based on predicted level of impact with high risk scoring low and low risk scoring high Range: High impact = 1 Low impact = 5
Proximity to existing grid	Availability of existing potential grid	Based on proximity of a potential existing grid

Criteria	Description	Scoring
	connection and ease of connection	connection No grid = 1 Existing = 5

3.3.3 Summary of cable landfall options assessment

The key constraints identified with each cable landing option are outlined below.

Landing Option A – Annagh Head Peninsula South (LA4)

On the south side of Annagh Peninsula the seabed is rocky with submerged subtidal reef along its length (marine survey). Landing the cables at any locations on the south side would require horizontal direction drilling from the land side to an area extending beyond the reef. Four boreholes will be required to be drilled at any proposed landing location. Examination of the subtidal survey data and site visits also indicate that it is highly likely that the subtidal reef extends into and forms a continuum with the intertidal reef areas. For that reason the intertidal reef must be treated like the subtidal reef as a protected Annex I habitat under the EU Habitats Directive

The land side of the Annagh Head peninsula consists of farmland and turbary bog and is not designated as an cSAC, cSPA, NHA or proposed pNHA area. Any substation would not be located within a designated area. However, the area in this vicinity is now under consideration as a possible SPA for corncrakes (*crex crex*).

Directional drilling would require that a maxi drilling rig have access to the landing location, and this may necessitate bridge and road strengthening on the minor roads leading to Annagh Head. The road to Annagh Head passes through the cSAC area (Mullet/Blacksod Bay complex, site code 000470).

Directional drilling could also take longer (with associated impact) if technical difficulties are met during the drilling process.

The location of a substation on Annagh Head would require export of power through a newly constructed 20kV line which would pass through the cSAC area. Overhead line wooden poles or cables would be located within the cSAC area.

Landing Option A – Annagh Beach locations (LA1, LA2 and LA3)

Landing options LA1, LA2 and LA3. Each of these areas lies within a cSAC and any trenching or construction of substations is likely to impact on intact high-quality sand dunes. The sand dunes in this area currently support a diverse and wide range of plant and invertebrate species including molluscs and many characteristic plant species. The substation compound would be located within the cSAC area also.

There is a subtidal reef, a likely Annex I habitat, fronting the entire Annagh Beach area.

All of Annagh Beach is an RMP site, and there is high potential to uncover archaeological deposits and features.

There is potential to obtain a grid connection at this location.

The location of a substation near Annagh Beach would require export of power through a newly constructed 20kV line which would pass through the cSAC area. Overhead line wooden poles or cables would be located within the cSAC area.

Landing Option B – Emlybeg Beach

Landing option L-B1 travels through the southern end of Annagh Beach Middens (RMP MA:09:014) and would require approximately 2.1km of trenching. The extended length of the trenching, passing through a Records of Monuments and Places (RMP) site and a known archaeologically sensitive area means that this route has probably the greatest potential to uncover archaeology.

The proposed substation would be coincidental with substation location A3 and is within the cSAC area. Export of power from the substation would occur on a newly erected 20kV line or cable passing through the cSAC.

Landing option L-B2 does not travel through any RMP sites.

Both landing options L-B1 and L-B2 and one substation location would lie within the cSAC area.

The substation location, B2, is outside the cSAC, but accessing it would require cabling through part of the cSAC. Of the two landing options,LB1 would follow an existing track which passes through the Annagh Beach intact dune complex. L-B2 would largely follow an existing track to the road R313.

Emlybeg Beach is fronted in part by a subtidal reef which may be impacted by cable-laying in the sandy bottom channels to the north and south of this.

There is potential to obtain a grid connection at this location.

There may be an impact on the Belmullet Golf Club (Carne Golf Links).

Construction at this location would be relatively straightforward involving trenching and excavation.

Landing Option C – Belderra Strand

None of the Belderra Strand landing options LC1, LC2 or LC3 pass through RMP sites. Options LC1 and LC3 pass close to RMP sites where there is potential for secondary material to be uncovered. LC2 does not pass close to any RMP sites.

LC1, LC2 and LC3 all pass through the cSAC area but would have minimum impact on the SAC and significantly less than passage through either Annagh Beach or Emlybeg Beach, particularly if the route passed through the car park area.

For example landing option LC1 may provide the least sensitive option for a landfall location. While this site falls within a cSAC, the route of the cable will not impact on any Annex I habitats and the proposed route is quite short at this point.

The three possible cable routes in the near shore do not pass through any reef structures and follow a sandy bottom to the beach.

All substation options would be located outside the cSAC and NHA areas. Although the possible cable routes would pass through the cSAC, the initial ecological assessment indicated that any impact on the cSAC at this location would be minimal.

The beach is used for amenity purposes and Mayo County Council have provided a hard stand parking area on the sea side of the road and to the west end of the beach. Bathing is not generally practised here as a strong tidal rip is reported by beach users and surfers. It is not a designated bathing area.

Surfers use the area at the south-west end of Belderra Strand.

Construction at this location would be relatively straightforward involving trenching and excavation.

There is potential to obtain a grid connection at this location..

Landing Option D – west of Belderra Strand

The area is rich in archaeology and cabling onshore is likely to result in impact in the area.

The cable route would pass through the cSAC area but the substation would be located outside the SAC.

Landing the cables west of Belderra Strand would require passage through a subtidal reef structure near the shore.

Construction would be technically difficult requiring HDD and or excavation.

Conclusion on preferred cable landing option

The overall ranking of potential landing sites is provided in Table 3-3. This was derived using the Criteria set out in Table 3-2. Belderra Strand ranks the highest in terms of minimum predicted impact on terrestrial and marine ecology and archaeology. It is technically the easiest construction option also.

In conclusion, Belderra Strand (landing option LC1) appears to be the location that will cause the least disturbance to habitats or species of conservation importance within the study area. It will not have a predicted impact on the cultural heritage of the area and is technically the easiest to construct. The construction period would also be of short duration if trenching and excavation are used. There is also potential to obtain a grid connection at this location. It is therefore considered to be the preferred route for the cable and landfall option. In addition, the route through Belderra Strand will terminate at the car park area where a cable joint box can be constructed.

Table 3-3: Ranking of potential landing sites

Landing Area	Install Method	Total Score	Overall Comment	Rank
LA4 Annagh Peninsula	Horizontal directional drilling (HDD) and trenching	**25**	HDD increases risks to the project, more complex technical install method, greater chance for weather delays and therefore higher costs Much greater install cost generally than more conventional methods. Main advantage is that it is outside SAC but could impact on Annex I reef habitat in the marine environment Road reinforcement may be necessary in cSAC through which road passes Area may be designated as an SPA for corncrakes Overhead line to export power must pass through the cSAC area. Some existing national monuments recorded on the peninsula, which indicates that potential exists for further archaeological discoveries.	**3**

Landing Area	Install Method	Total Score	Overall Comment	Rank
L-A1,2,3 Annagh Beach	Trenching and rock seam	**22**	Install method is technically less risky than LA4. Offshore rock seam and reef structures are major issues as the cables must pass through these. All landing options are in the cSAC area with intact dune systems and with high risk of impact. Substation locations all within cSAC area. Entire beach area is an RMP site with high potential for impact	**5**
L-B1 Emlybeg Beach north	Trenching and significant onshore trench also	**23**	Install method technically straightforward Long onshore cable length, costly Landing option in cSAC but possible to make use of existing track Substation within cSAC area Reef structures fringe onto route High risk of encountering archaeological heritage	**4**
L-B2 Emlybeg Beach south	Trenching and significant offshore trenching also	**26**	Install method technically straightforward. Long onshore cable lengths. Golf course major issue but possible to use existing track to avoid golf course. Offshore reef area fringes onto route. Not near any RMP site and low risk of archaeological impact	**2**
L-C1,2,3 Belderra Strand	Trenching through sediment	**34**	Install method technically straightforward; cheapest and lowest risk technically for installation methodology for cables Short distance through cSAC; possibility to direct cables route through existing car park within the cSAC to local road to minimise impact on cSAC Substation location outside cSAC. Existing grid in proximity Moderate to low archaeological risk as all routes pass some distance from any RMP sites	**1**
D West of Belderra Strand	Rock break / HDD plus land trench	**20**	Install method technically more complex; HDD may be required indicating an increased installation risk Landing option within the cSAC area Substation outside cSAC Archaeologically significant area with associated high risk of impacting unrecorded human burials	**6**

3.3.4 Alternative substation locations

Once the submarine electricity cable landing location was identified, the next stage was to identify a suitable substation location. Again technical, environmental and cultural heritage issues were evaluated in selecting the final location for the proposed substation. Landscape considerations were also taken into account and discussions held with the planning authority as to the positioning of the substation buildings and screening requirements.

The selection of a suitable location at Belderra Strand was determined subject to the following development criteria:

- Proximity to Belderra Strand landing point for cable access
- Suitably sized land holding (large enough to accommodate the substation compound and access road)
- Suitable topography and ground conditions including flooding history
- Visual impact to local community and amenities
- Connectivity to public roads
- Connectivity to overhead electricity network
- Environmental concerns
- Cultural heritage concerns
- Availability for potential purchase

Initially three substation location options were identified at the scoping stage of the project. However, following site visits and a review of landholdings in the area, three potential sites were identified at the original locations of Options 1, 2 and 3. All of the selected sites are in the lands outside the cSAC zoned area.

Each of the potential sites has sufficient lands to facilitate the proposed substation compound.

The extent of each of the selected landholdings is shown on the attached plan shown in Figure 3-8.

Substation site Option 1

Site no. 1 is located immediately south/south east of the public road at Belderra strand and is close (approximately.300m) to the landing point for the submarine cable.

The lands are open fields/grasslands used currently for grazing. They have some rock outcrops and drain naturally to the north via existing land drains.

There are some existing houses overlooking the site but the station design can minimise any potential visual impact.

The site lends itself well to any potential connection to the existing overhead electricity network to the south.

There is no record of any archaeology or flooding on the site.

Vehicle access would be via the public road or an existing service track which runs along the western site boundary. Should this track be utilised for station access, medium scale civil works would be required to develop suitable surface and access to the station.

Photo 3-1: Site 1 Looking north to Belderra Strand

Substation site Option 2

Site no. 2 is a long narrow holding located to the south of the public road at Belderra Strand (Figure 3-8).

The site is serviced to the north by a public road and is approximately 430m from the landing point of the submarine cable. The topography of the site rises steeply to the west from the public road but levels out to the west of the site, which is the area where the station would be developed.

The lands are open fields/grasslands used currently for grazing. They have some rock outcrops and drain naturally to the north via existing land drains.

The site is not overlooked and it is expected that the station designs and screening can minimise any potential visual impact.

There is no record of any archaeology or flooding of the site and the lands can connect to the existing overhead electricity network without significant issue.

Vehicle access would be via the public road but such is the change in gradient required this would involve considerable civil works and cut-and-fill operations to develop a road to any station location. Such works may alter the landscape and amenity of the area significantly.

Photo 3-2: Site no. 2 looking northeast

Substation site Option 3

Site no.3 is a large holding located south-west of the public road at Belderra strand.

The site is serviced to the north by a public road and is approximately 400m from the landing point of the submarine cable. The topography of the site rises to the west from the public road similar to that of site No. 2. The land holding levels off to the west and it would be in this level area that a proposed station could be located.

The lands are open fields/grasslands used currently for grazing. They have some rock outcrops and drain naturally to the north via existing land drains.

The site is not significantly overlooked and station design can minimise any potential visual impact.

There is no record of any archaeology or flooding of the site and connectivity to the local electricity network can be easily achieved.

Vehicle access would be via the public road but again such is the change in gradient required this would involve considerable civil works and cut-and-fill operations to develop a road to any station location. Such works may alter the landscape and amenity of the area significantly.

Photo 3-3: Site no. 3 looking north towards Belderra Strand

Conclusion on preferred substation location

The overall ranking of potential substation sites is provided in Table 3-4. All three sites identified for the proposed substation are technically suitable for the necessary development.

All sites are large enough to cater for the scale of the station and its incorporation with the local environment, with sites 2 and 3 requiring considerable road development due to their topography where they adjoin the existing public road network.

Site no.1 is the closest to the landing point for the submarine cable, and the development of the site would require less civil works for roadways compared to sites 2 and 3, thus minimising costs and impact on the amenity of the area. It can also be screened from any nearby house.

Site no. 1 was therefore identified as the preferred site for the proposed station. The holding can be developed to accommodate the station with minimal impact to the amenity of the area and the site is in close proximity to the landing point for cable access.

Table 3-4: Ranking of potential substation location sites

Substation Location	Comment	Rank
Site no.1	Open fields/grasslands used currently for grazing with some rock outcrops Drains naturally to the north via existing land drains Some existing houses overlooking the site but the station design can minimise any potential visual impact Feasible connection to existing overhead electricity network No record of any archaeology No record of flooding on the site Medium scale civil works required to access site	1
Site No.2	Open fields/grasslands used currently for grazing with some rock outcrops Drains naturally to the north via existing land drains Site not overlooked and station designs/screening can minimise any potential visual impact No record of archaeology No record of flooding Feasible connection to existing overhead electricity network Gradient issue requiring considerable civil works and cut-and-fill operations to develop a road to any station location	2/3
Site No. 3	Open fields/grasslands used currently for grazing with some rock outcrops Drains naturally to the north via existing land drains Site not overlooked and station designs/screening can minimise any potential visual impact No record of archaeology No record of flooding Feasible connection to existing overhead electricity network Gradient issue requiring considerable civil works/ cut and fill operations to develop a road to any station location.	2/3

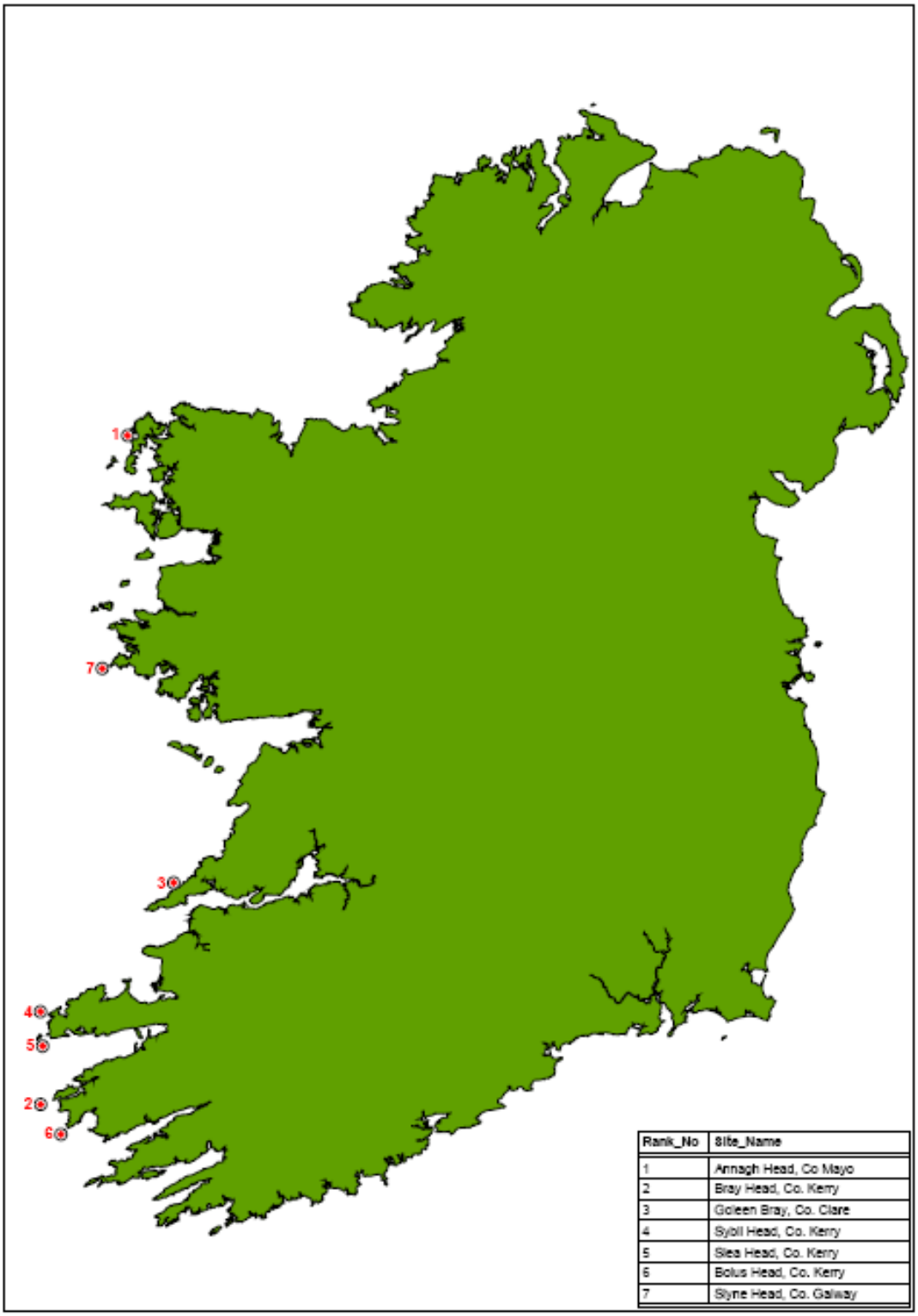

Figure 3-1: Candidate wave energy test site locations

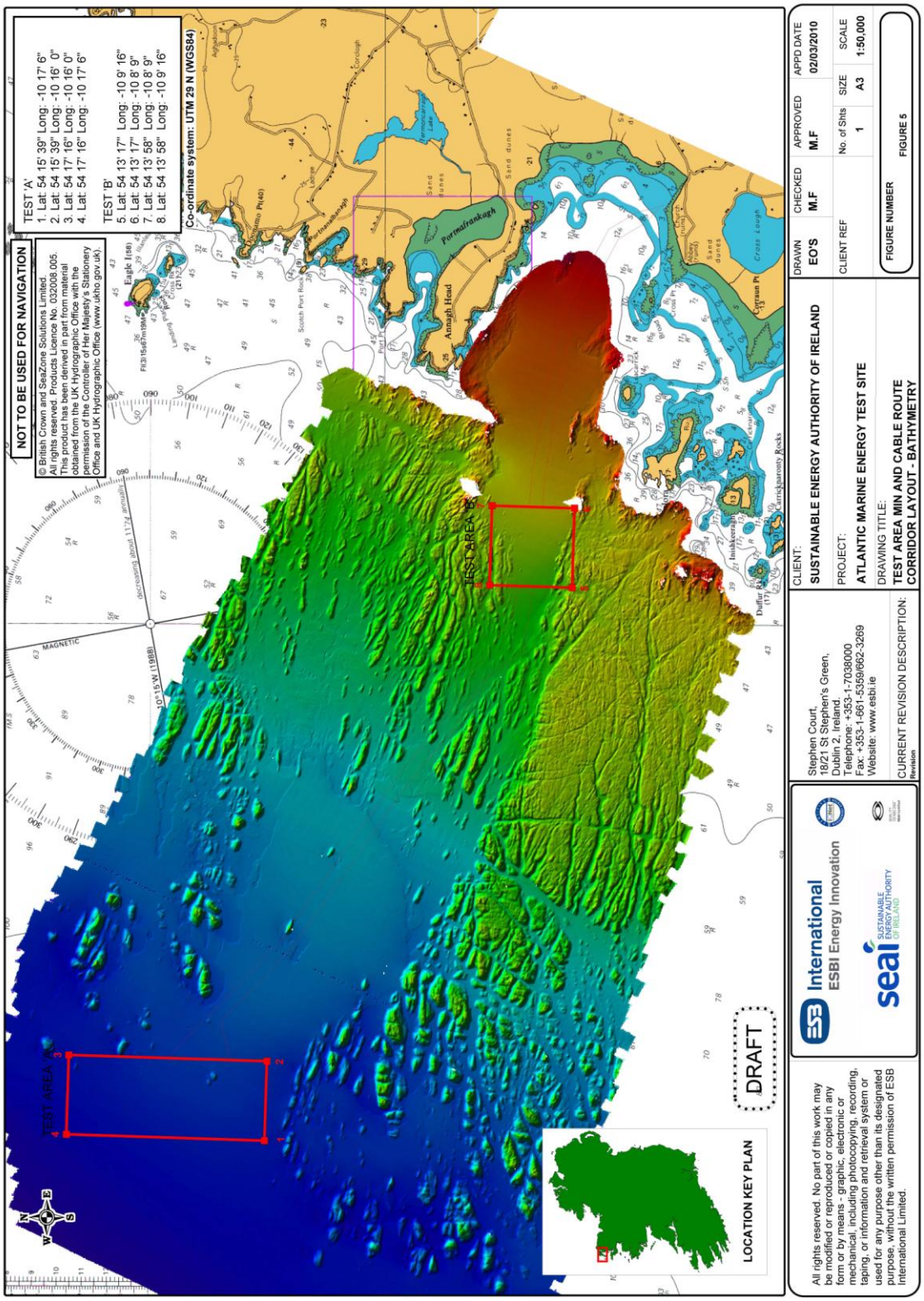

Figure 3-2: Original Atlantic Marine Energy Test Site test area locations

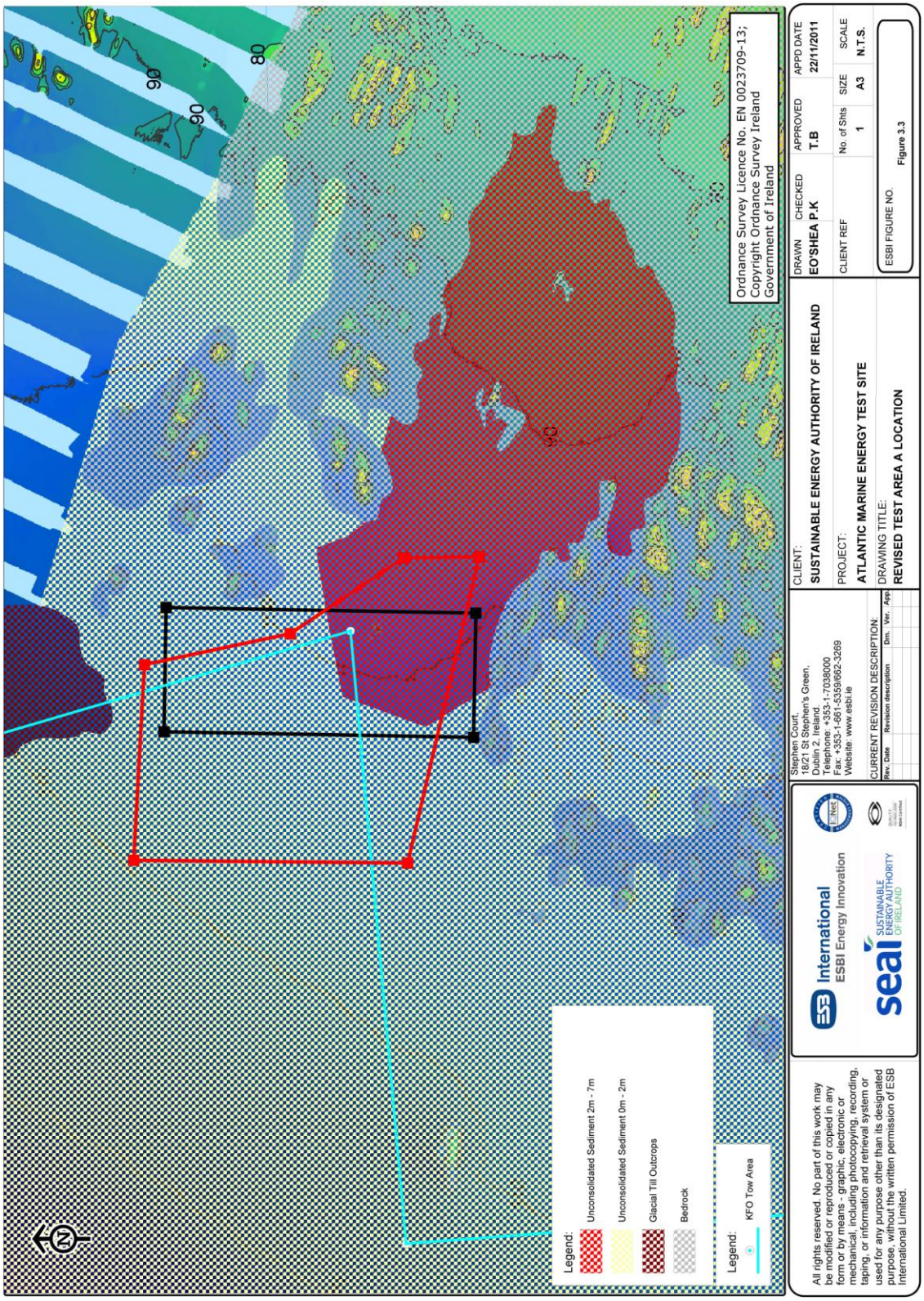

Figure 3-3: Redesigned test area A (red outline)

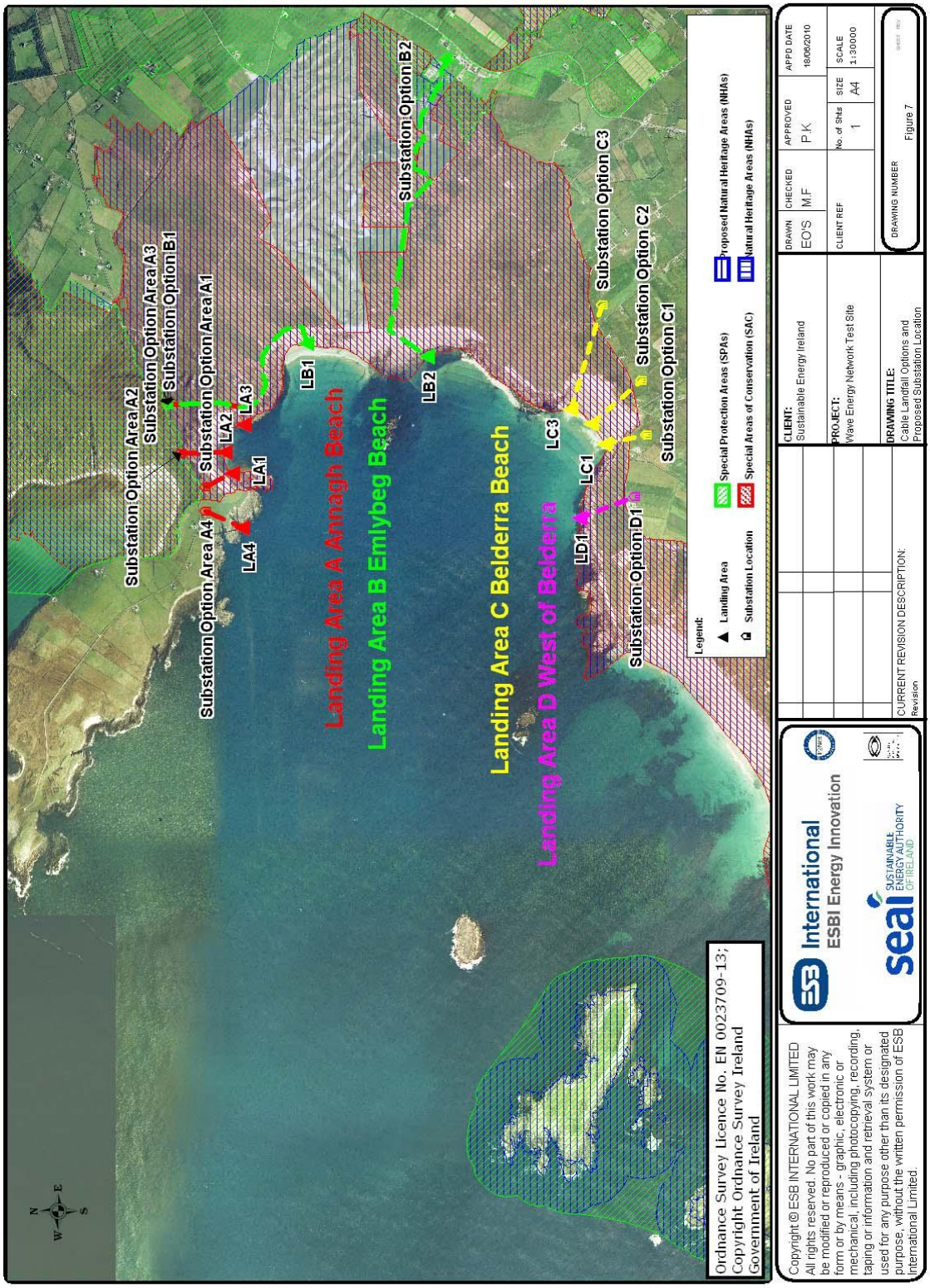

Figure 3-4: Cable landfall options and potential substation locations

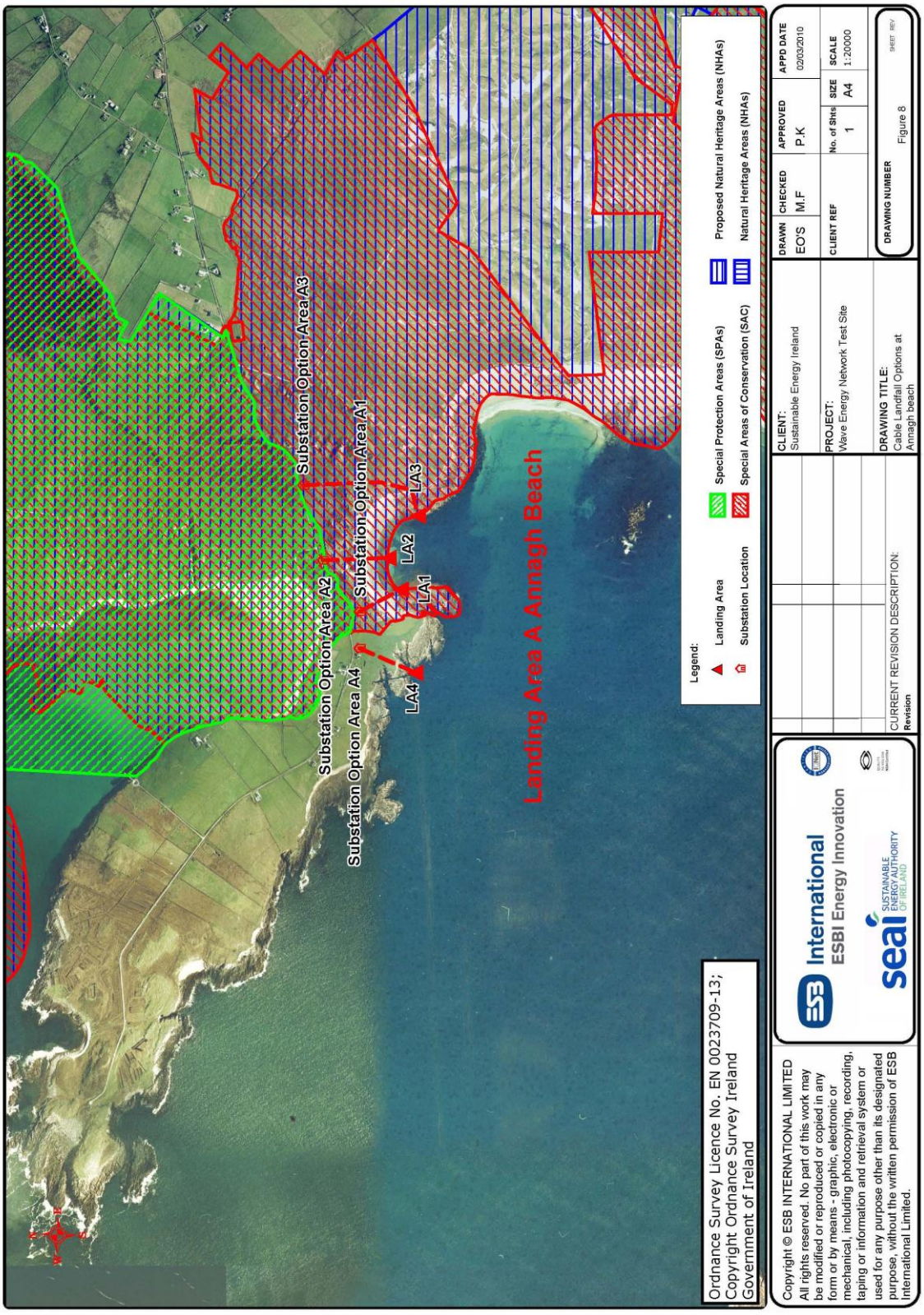

Figure 3-5: Cable landing options at Annagh Beach and Annagh Head (south)

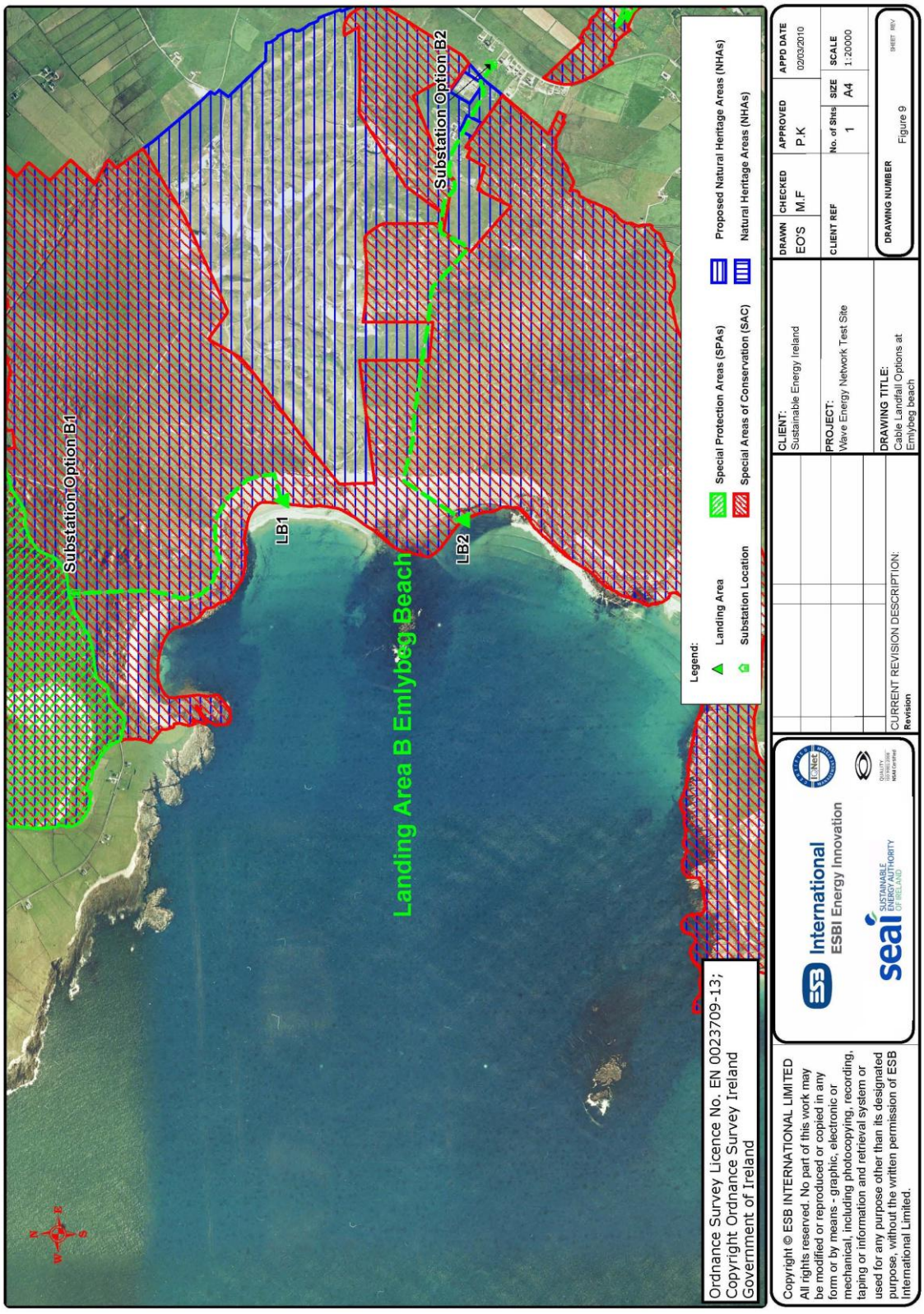

Figure 3-6: Cable landing options at Emlybeg Beach

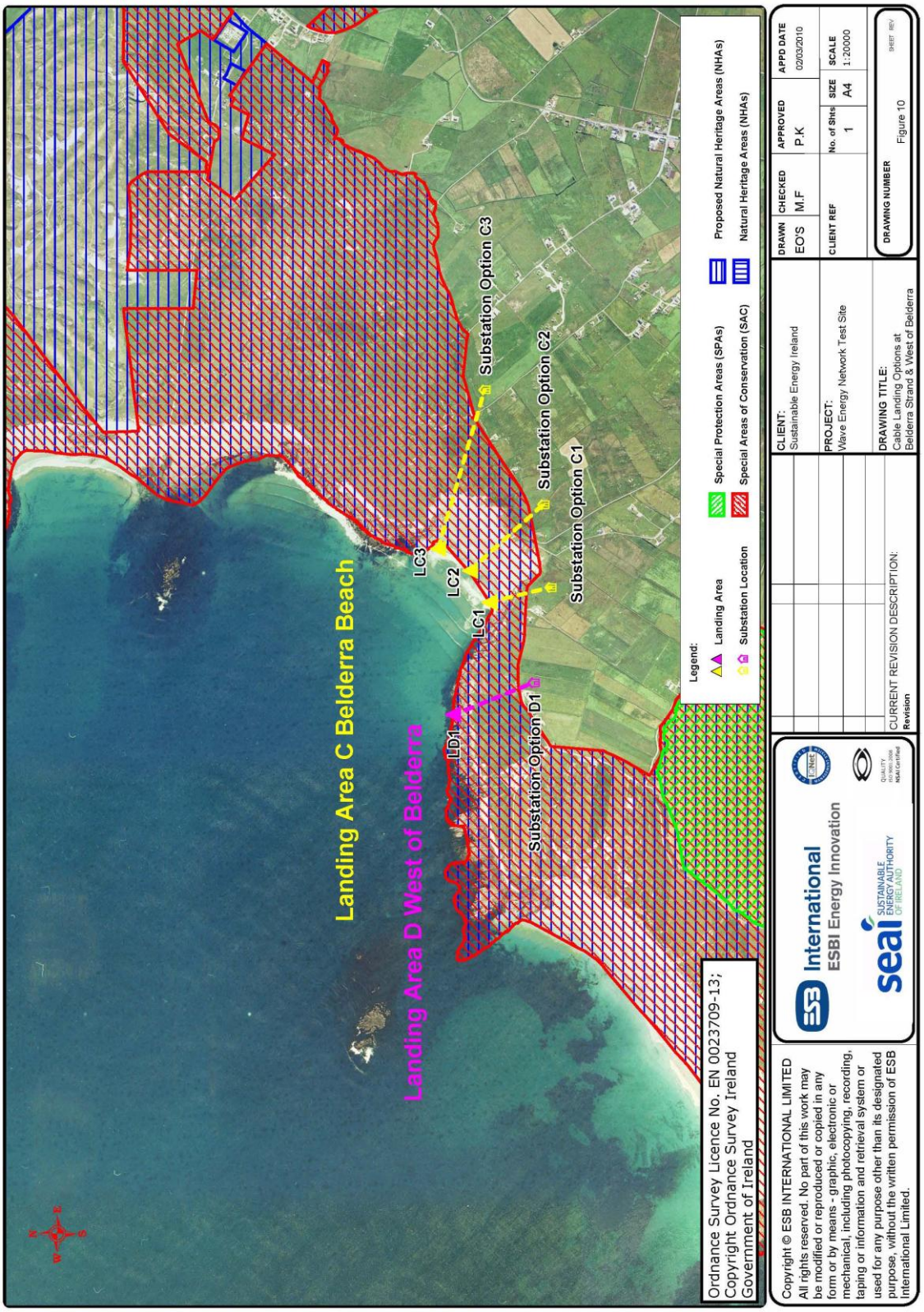

Figure 3-7: Cable landing options at Belderra Strand

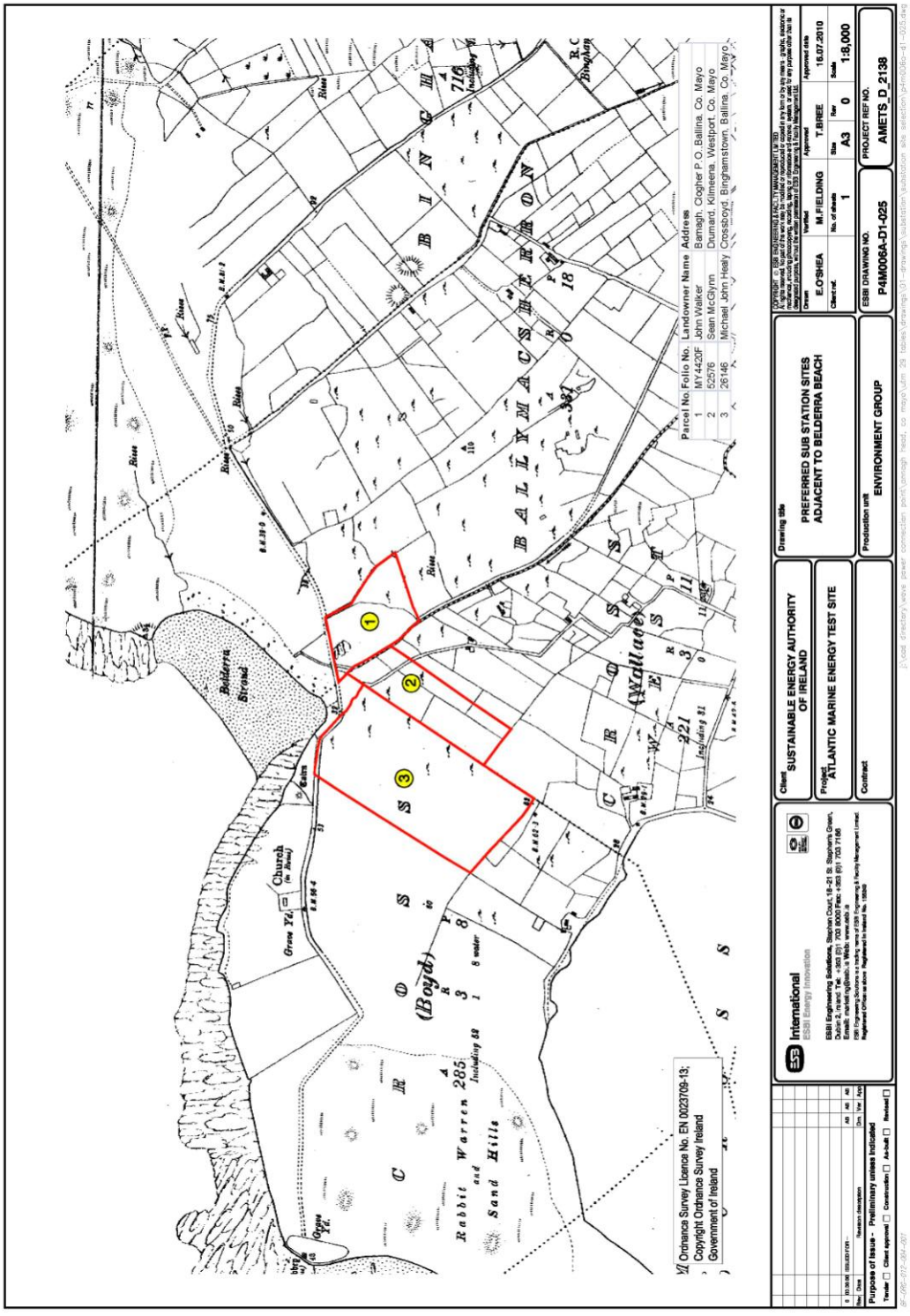

Figure 3-8: Landholdings assessed for potential substation compound location